Chapter 4

A Review of Federal Efforts To Increase Energy Efficiency in Buildings

Box 4-A--Chapter Summary

This chapter reviews past and present Federal programs promoting energy efficiency in buildings. These programs have adopted numerous strategies, including incentives (tax credits, weatherization grants, loan subsidies); Federal leadership (providing public recognition for voluntary energy savings); research, development, and demonstration (RD&D); codes and standards; and information (appliance labels, building energy audits, and technical assistance). A review of these programs suggests that Federal efforts to reduce energy use in buildings often generate significant and cost-effective energy savings, but inappropriate performance measures and a lack of ongoing evaluation have prevented many of them from attaining the full range of cost-effective energy savings available. In fact, the authorizing legislation that establishes building efficiency programs often fails to focus on the promotion of cost-effective energy savings. In addition, many Federal programs were never implemented as planned. Major programs were targeted for elimination, experienced massive budget cuts, suffered delays, or were simply never implemented because of changes in administration priorities in the early 1980s. Specific options for improving the cost-effectiveness of Federal programs are offered.

State, local, and utility programs are reviewed briefly as well. Although this chapter focuses on Federal programs, many State and utility programs surpass Federal efforts in promoting energy efficiency in buildings. The wide variety of nonfederal activity suggests that Federal programs will be most effective if they complement and support, rather than duplicate, these other activities.

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Chapter 4

A Review of Federal Efforts To Increase Energy Efficiency in Buildings

INTRODUCTION

The preceding chapters have discussed trends in U.S. building energy use, the technologies available to make that use more efficient, and barriers limiting the adoption of these technologies. This chapter reviews Federal, State, and utility programs designed to promote building energy efficiency, many of which have been designed, at least in part, to spur the wider use of some of the technologies noted earlier.[1] The purpose of this chapter is to indicate the goals of building energy programs, identify the barriers to energy conservation and efficiency they attempt or have attempted to resolve, indicate their results (where known), and highlight key implementation issues associated with each.

A major lesson from this review is that Federal efforts to reduce energy use in buildings have led often to significant and cost-effective energy savings, but inappropriate performance measures and a lack of ongoing evaluation have prevented many of them from attaining the full range of cost-effective energy savings available. In fact, the authorizing legislation that establishes building efficiency programs often fails to focus on the promotion of cost-effective energy savings. To help improve existing programs and policies, this chapter offers options—both general and program-specific-for Congress and the Department of Energy (DOE) to consider. The program-related issues discussed in this chapter are given with the expectation that these programs (and others like them) would be valuable vehicles for achieving significant, cost-effective energy savings available in U.S. buildings, as suggested in chapter 1.

Another major lesson from this review is that many Federal programs were never implemented as planned. Major programs were targeted for elimination, experienced massive budget cuts, suffered delays, or were simply never implemented. Many of these changes stemmed from specific Federal policy changes exerted by the administration in the 1980s. Several Federal programs initiated in the late 1970s and early 1980s had been in operation only a few years before they were scaled back (or eliminated) by shifts in Federal political priorities.

The first part of this chapter is organized by the several types of building energy efficiency and conservation programs directed by the Federal Government: incentives (tax credits, weatherization grants, loan subsidies); Federal leadership in promoting voluntary energy savings through public recognition; research, development, and demonstration (RD&D); codes and standards; and information (appliance labels, building energy audits, and technical assistance). Many programs apply several of these approaches, but they are organized here according to their primary focus. The enabling legislation authorizing the major Federal programs discussed in this chapter is listed in box 4-B. Major building conservation and efficiency programs administered by the Federal Government in the last two decades are described briefly in box 4-C. As used in this chapter, a program is an effort designed specifically to reduce energy use in buildings or building-related equipment.

REVIEW OF FEDERAL PROGRAMS

Incentive Programs

As suggested in chapter 3, financial incentives can encourage consumer investments in energy efficiency. The Federal Government has offered several incentive programs to reduce energy use in buildings, including tax credits, weatherization grants, and loan subsidies.

Tax Credits

The Energy Tax Act of 1978 (Public Law 95-618; ETA), as amended by the Crude Oil Windfall Profit

[1] A variety of other programs have had and will have important effects on building energy use, but they are not discussed in this report, because their primary focus lies beyond building energy use. The Clean Air Act Amendments of 1990 (Public Law 101-549), for example, allow utilities to earn pollution reduction credits for reducing the energy demands of their consumers, but the focus of that program is emissions reductions, not building energy conservation per se.

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Box 4-B—Major Legislation Authorizing Federal Energy Programs for Buildings

The statutes listed below generally covered multiple energy policy issues and programs, but only those elements concerning building energy use are mentioned below. Most of these statutes have been amended since their original passage but, for simplicity, only the initial legislation is given below. The statutes are listed in chronological order, and the dates in parentheses indicate when the measures were signed into law.

Energy Policy and Conservation Act (Public Law 94-163; December 22, 1975)-Directed the Federal Trade Commission to develop and promulgate labels listing energy use for new appliances; directed the Federal Energy Administration and later the Department of Energy (DOE) to develop voluntary appliance efficiency standards; and established the State Energy Conservation Program to provide technical assistance for energy conservation efforts at the State and local level.

Energy Conservation and Production Act (Public Law 94-385; August 14, 1976)_Required the development of national mandatory Building Energy Performance Standards for all new U.S. buildings; these standards were later made voluntary for all nonfederal buildings (public Law 97-35); and created the Weatherization Assistance Program to fund energy saving retrofits for low-income households.

National Energy Extension Service Act (Public Law 95-39; June 3, 1977)-Established the Energy Extension Service, a State-administered energy information, education, training, and demonstration program overseen and funded by DOE.

Energy Tax Act (Public Law 95-618; November 9, 1978+Granted residential energy conservation and renewable energy tax credits for income tax years 1978 to 1985.

National Energy Conservation Policy Act (Public Law 95-619; November 9, 1978)-Established the Residential Conservation Service, which required large electric and natural gas utilities to provide residential energy audits to their customers; created the Institutional Conservation Program, a matching grant program providing monies for energy audits and energy saving retrofits in nonprofit institutional buildings (colleges, schools, and hospitals); required the voluntary appliance efficiency targets being developed under the Energy Policy and Conservation Act to become mandatory standards; and required the national mortgage associations to encourage lending institutions to offer extended mortgage credit for the purchase of energy efficient homes.

Energy Security Act (Public Law 96-294; June 30, 1980)-Established the Commercial and Apartment Conservation Service, which required large electric and natural gas utilities to offer energy audits for commercial and multifamily buildings; and created the Solar Energy and Energy Conservation Bank at the Department of Housing and Urban Development to provide grants and loan subsidies for energy conservation and solar energy retrofits in low- and moderate-income households and in commercial and agricultural buildings with nonprofit owners or tenants.

Low-Income Home Energy Assistance Act (Public Law 97-35; August 13, 1981)-Established the low-Income Home Energy Assistance Program (LIHEAP), a block grant program administered by the Department of Health and Human Services that provides funds to low-income households for heating and cooling expenditures. As amended, this legislation allows states to allocate 15 percent of their L IHEAP monies to weatherization; upon request, HHS may raise this amount to 25 percent.

National Appliance Energy Conservation Act (Public Law 100-12; March 17, 1987)-As amended (Public Law 100-357), this statute established energy standards for the 13 categories of new appliances covered under the Energy Policy and Conservation Act as amended. The NAECA requires DOE to review and update these standards to keep pace with technological improvements.

Tax Act of 1980 (Public Law 96-223), revised the Internal Revenue Code of 1954 to encourage *inter alia* residential energy conservation and renewable energy investments. The residential credits applied to income taxes and were available for investments made between April 20, 1977 and December 31, 1985. The discussion here is focused on the conservation credits.

The ETA income tax credits for residential conservation investments were limited to 15 percent of the first $2,000 expended for a maximum potential credit of $300. Conservation expenditures were limited to residential units in the United States that were substantially complete by April 20, 1977 and that were the principal residences of occupants claiming the credit. Conservation expenditures eligi-

Box 4-C—Major Federal Programs Designed To Reduce Energy Use in Buildings

The Arab oil embargo of 1973-74, several major domestic natural gas shortages, and other events fueled national concerns about U.S. energy security in the 1970s. In response, the U.S. Congress established a variety of national programs aimed at reducing energy use in all sectors. The major programs designed to reduce energy use in buildings are described below. Several of these programs no longer exist.

Department of Energy

Appliance energy standards were initially devised as voluntary energy efficiency targets that the Federal Energy Administration, predecessor agency to the Department of Energy (DOE), was directed to promulgate under the Energy Policy and Conservation Act. These targets were to represent energy savings of at least 20 percent for the covered products, as measured by expected 1980 energy use levels relative to known 1972 levels. Under the National Energy Conservation Policy Act of 1978 (Public Law 95-619), however, the targets were changed to mandatory standards. In January 1981, after DOE had announced that promulgation of the standards was imminent, a series of internal Department policy changes made by the newly arrived Reagan administration delayed their issuance. After 6 years, two major legal actions by environmental and consumer groups, and a pocket-vetoed bill that restated Congress' intent to have mandatory national appliance efficiency standards, the National Appliance Energy Conservation Act (Public Law 100-12; NAECA) became law on March 17, 1987.

The NAECA, as amended, designates minimum efficiency or maximum energy consumption levels for 13 categories of covered products and requires DOE to update and strengthen these standards on a regular basis in order to keep pace with technological improvements. Thus far, the Department has revised standards for refrigerator-freezers, freezers, small gas furnaces, dishwashers, clothes washers, and clothes dryers--all at levels more stringent than the original NAECA requirements.

Building Energy Performance Standards (BEPS) were originally the responsibility of the Department of Housing and Urban Development (HUD). The BEPS were originally intended to be mandatory national energy performance standards for all newly constructed buildings, as required by Title III of Public Law 94-385. Later amendments to this statute transferred these responsibilities to DOE (Public Law 95-91; 1977), directed the issuance of interim standards for new Federal buildings by August 1981 (Public Law 96-399; 1980), and made the standards voluntary for all nonfederal buildings (Public Law 97-35; 1981). At present, DOE has issued mandatory interim standards for all Federal residential buildings and voluntary standards for all commercial and multifamily high-rise buildings. Voluntary interim standards for nonfederal residential buildings are still pending (as of January 1992).

Institutional Conservation Program (ICP) is a Federal institutional grant program administered by the States through DOE regional offices. Program grants fund energy audits and energy conservation measures in nonprofit schools (primary and secondary), colleges and universities, and hospitals. Originally, only buildings constructed before April 20, 1977 were eligible for ICP grants, but recent legislation extended that cutoff date to buildings constructed before May 1, 1989 (Public Law 101-440; 1990). The purpose of this program is to provide conservation retrofit funds for institutions with limited capital resources, hence the exclusive participation of nonprofit organizations. A recent national evaluation of ICP energy savings determined that program costs through 1988 totaled almost $1.4 billion (1987 dollars) and resulted in an estimated 1987 cumulative energy savings of 0.3 quadrillion Btus (317 trillion Btus) worth an estimated $1.9 billion (1987 dollars). The total cost figure includes both DOE grant outlays and the matching funds required of participating institutions. By this simple measure, ICP has exceeded its break-even payback costs by $500 million. In addition, DOE estimates that ICP-funded measures completed by 1988 will save an extra $400 million per year over their remaining lifetimes.[1]

Residential Conservation Service (RCS) required large electric and natural gas utilities to offer residential energy conservation audits to their consumers. The operating assumption of the program was that residential consumers would invest in energy saving retrofits if they had adequate information about the energy and financial savings potential of their homes. This assumption proved optimistic. However, State and utility programs that included financial incentives in their programs enjoyed the highest audit request rates, and the highest retrofit activity, in the Nation. By law, the RCS expired in 1989.

[1] U.S. Department of Energy, Assistant Secretary, Conservation and Renewable Energy, An *Estimate of Aggregate Energy Savings Due to the ICP Program,* DOE/SF/00098-H2 (Washington DC: March 1988), pp. vi, 33.

(Continued on next page)

Box 4-C—Major Federal Programs Designed To Reduce Energy Use in Buildings--Continued

State Energy Conservation Program (SECP) requires States to develop and implement energy conservation programs as a condition to receive Federal monies for a variety of State and local financial and technical assistance programs designed to save energy. All 50 States, the District of Columbia, and six U.S. territories participate in this program, which offers professional and consumer energy education programs and materials, demonstration programs, and technical assistance for conservation efforts in all sectors. As an effort to enhance existing State and local energy conservation efforts, SECP is administered with another DOE program, the Energy Extension Service (EES); both channel Federal resources and expertise to participating States.

Weatherization Assistance Program (WAP) was authorized in 1976 to provide grant monies for the weatherization of low-income households in order to reduce their fuel expenses. Funds are used for retrofits, related repairs, and consumer education. WAP funds are disbursed by DOE through State and local agencies to community organizations that are responsible for client selection, weatherization installation and repairs, financing, and consumer education. Roughly 1,200 local organizations participate in WAP, most with staffs of only 5 to 10 people.[2] Using DOE and other Federal weatherization funds, these groups reach about 250,000 households annually.[3]

Department of Housing and Urban Development

Manufactured Home Construction and Safety Standards are Federal standards with minimum quality requirements that apply to manufactured housing. These standards provide a means to administer Federal energy efficiency guidelines to this specialized portion of the new housing market.

Minimum Property Standards (MPS) are residential construction requirements that apply to federally financed housing, and they include provisions for energy efficiency. New homes are required to meet MPS standards to qualify for Federal Housing Administration and Veterans Administration loans.[4]

Solar Energy and Energy Conservation Bank was authorized to provide financial assistance for conservation and solar measures to low- and moderate-income households, as well as commercial and agricultural buildings with nonprofit owners or tenants. The Bank suffered early uncertainties over resources-Congress rescinded virtually all program funding in fiscal year 1981-but the program appeared to make very promising progress in later years. According to HUD estimates, conservation investments made during the last year of the program (1987) achieved average simple paybacks of 4.4 years.[5]

Department of Health and Human Services

Low-Income Home Energy Assistance Program (LIHEAP) is a block grant program that provides financial assistance to low-income households for their energy expenses. Up to 25 percent of LIHEAP monies may be used for weatherization, but States spend on average only about 9 percent for that purpose. In fiscal year 1990, LIHEAP serviced roughly 6 million households, but only 148,000 homes received weatherization assistance.[6]

Federal Trade Commission

Appliance efficiency labeling is required under Title V of the Energy Policy and Conservation Act of 1975 (Public Law 94-163), as amended. Administered by the Federal Trade Commission, the labeling program became effective in May 1980 and covers 13 categories of appliances and equipment. As required, the labels indicate estimated annual energy costs and list the range of estimated costs for similar products to provide consumers comparative information.

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2 M. Schweitzer, "Energy Conservation for Low-Income Households: A Study of the Organization and outcomes Of Weatherization Assistance Programs," *Energy Systems and Policy*, vol. 12, No. 2, 1988, pp. 102, 105.

3 U.S. Department of Energy, Office of the Assistant Secretary for Conservation and Renewable Energy, "Report on the Present Weatherization Grant Program," prepared for the U.S. Senate, Committee on Appropriations, Aug. 29, 1989, p. 5.

4 E. Hirst, J. Clinton, H. Geller, W. Kroner, and F.M. O'Ham (cd.), *Energy Efficiency in Buildings: Progress & Promise* (Washington, DC: American Council for an Energy-Efficient Economy, 1986), p. 167.

5 U.S. Department of Housing and Urban Development, Solar Energy and Energy Conservation Bank, *Solar Energy and Energy Conservation Bank: FY 1987 Annual Report to the Congress* (Washington DC: 1987), pp. 3,6.

6 U.S. Department of Health and Human Services, Division of Energy Assistance, *Low Income Home Energy Assistance Program: Report to Congress for Fiscal Year 1990* (Washington, DC: September 1991), p. vii.

other Federal Programs

Green Lights is a voluntary commercial lighting retrofit program formally initiated by the Environmental Protection Agency (EPA) in January 1991. The program encourages major corporations to perform cost-effective lighting retrofits at all their U.S. facilities to lower electricity use and thereby reduce the pollution associated with its generation. In exchange for technical assistance and Federal Government recognition, Green Lights participants agree to conduct lighting retrofits in at least 90 percent of the total square footage of their U.S. facilities within 5 years of signing an agreement with EPA. Program participants are expected to implement only those lighting retrofits that will be cost-effective and that will not compromise lighting quality. As of December 1991, roughly 150 companies had enrolled in the program.

Residential energy conservation and renewable energy tax credits were available for income tax years 1978 to 1985. Conservation expenditures were limited to residential units located in the United States that were substantially complete by April 20, 1977 and that were the principal residences of occupants claiming the credit. Allowable conservation expenditures included insulation, exterior storm windows, exterior storm doors, automatic setback thermostats, caulking, weatherstripping, and all associated installation costs. The residential conservation credits were limited to 15 percent of the first $2,000 invested for a maximum potential credit of $300. For a variety of reasons, participation in the program was low.

ble for the ETA credits included insulation, exterior storm windows and doors, automatic setback thermostats, caulking, and weatherstripping.[2] To be eligible for the credit, conservation expenditures had to originate with the taxpayer and remain in operation at least 3 years. Credits applied to both materials and installation costs.[3]

There are no reliable determinations of the economic costs and benefits of the ETA residential conservation credits. A variety of policy and market changes were working simultaneously to motivate conservation investments in the residential sector.[4] As a result, determining the *incremental* effect of the Federal tax credits on residential energy investments has been elusive.[5] By reducing consumer first costs for conservation and renewable investments, the credits clearly created social benefits but at undetermined social costs.

As these comments suggest, studies analyzing the effectiveness of the Federal residential tax credits as inducements to energy conservation and renewable energy investments have been inconclusive.[6] One of these studies suggested that the increasing price of energy relative to other goods and services was the principal factor behind the decline in residential energy consumption at the time the tax credits were available.[7] Average U.S. household energy costs rose sharply (nominally by about $400) from 1978 to 1984.[8] And a decline in real income in the early

2fibllc~w95.61 8, 92 Stat. 3175.77, sec. 101(a). Other conservation expenditures eligible for the residential tax credit were energy saving furnace replacement burners, flue adjustment devices, electrical or mechanical furnace ignition systems that replaced gas pilot lights, exterior thermal windows, exterior thermal doors, and meters displaying energy costs. Public Law 95-618, 92 Stat. 3177, sec. 101(a).

[3] Public Law 95-618, 92 Stat. 3176-77, sec. 101(a).

[4] Namely, Federal, State, and utility energy conservation programs were encouraging consumers to save energy through information and other incentives, the 1979 Iranian revolution pushed oil prices up for several years, and public commitment to energy conservation generally increased during this period.

[5] E. Hirst, R. Goeltz, and H. Manning, *Household Retrofit Expenditures and the Federal Residential Energy Conservation Tax Credit*, ORNL/CON-95 (Oak Ridge, TN: Oak Ridge National Laboratory, July 1982), pp. 5,37.

[6] See, for example, references cited in footnotes 5, 7, 14, and 17.

[7] US. Library of Congress, Congressional Research Service, *An Economic Evaluation of Federal Tax Credits for Residential Energy Conservation*, Report No. 82-204E (Washington, DC: December 1982), pp. 7-10, 41-61. An OTA analysis completed shortly after the tax credits became available suggested the same. See U.S. Congress, Office of Technology Assessment, *Residential Energy Conservation*, *OTA-E-9* (Washington, DC:* U.S. Government Printing Office, July 1979), vol. 1, pp. 6, 20-22.

[8] Specifically, the nominal increase in household energy costs was from $724 (1978) to $1,123 (1984). (These figures refer onty to site energy use and exclude household transportation costs.) See U.S. Department of Energy, Energy Information Administration, *Residential Energy Consumption Survey: Trends in Consumption and Expenditures, 1978-1984*, DOE/EIA-0482 (Washington DC: June 1987), p. 19.

Table 4-l—Use of the Residential Energy Conservation Tax Credits by Income (1983)

	Family income less than $10,000	$10,000 $14,999	$15,000 $19,999	$20,000 $2&99	$30,000 and higher	Total
Percent of homes that claimed a tax credit on their 1983 return	9	11	17	21	26	17
Percent of homes that claimed a tax credit on their 1983 return that would have made all the same improvements if the tax credit had not been available	100	89	93	84	88	88
Percent of homes that made at least one conservation improvement in 1983 but did not claim a tax credit, for the following major reasons[a]:						
Unaware of the credit.	38	37	30	20	19	26
Expenditure too small to claim[b] . . .	18	16	22	22	28	23
Did not file the long form[c].	34	28	28	19	12	21
Total with at least one reason	86	87	83	81	86	85

[a]AJthough respondents could list more than one reason, percentages are below 100, because not all reasons are listed here. The other reasons given for not claiming the credits were minor, were not reported by the Energy Information Administration due to large statistical variance, or both; those reasons included reluctance to file tax forms, use of the maximum credit in previous years, ineligible home, and no taxes filed in 1983.

[b]The Energy Tax Act of 1978 (public Law 95-618) disallowed residential conservation credits less than $10 (sec. 101 a). As the credits amounted to 15 percent of the f first $2,000 expended, this meant that the minimum expenditure eligible for the credit was just over $66,

[c]Filing the IRS long form was required to claim the tax credit.

SOURCE: U.S. Department of Energy, Energy Information Administration, *Residential Energy Consumption Survey: Housing Characteristics 1984,* DOE/EIA-0314(84) (Washington, DC: October 1986), p. 27.

1980s may also have contributed to the drop in residential energy use during the period the credits were available.[9]

From 1978 to 1985, there were about 30 million claims for the residential conservation credits, amounting to nearly $5 billion (nominal dollars) in lost revenues to the U.S. Treasury. The largest number of annual claims for the conservation credits came in the first year-about 6 million. For the next 5 years (1979-83), the total number of returns declined steadily (to 2.4 million in 1983), but climbed again the last 2 years (2.7 million in 1985).[10]

A 1983 household survey conducted as part of the DOE Energy Information Administration's (EIA) Residential Energy Consumption Survey (RECS) suggests why national use of the conservation credit waned. The survey determined that 85 percent of U.S. households that had conducted conservation retrofits in 1983 bypassed the conservation tax credits entirely. The nonclaimants in the survey explained that they were unaware of the credits, they did not use the Internal Revenue Service (IRS) long form (required to claim the credit), or the amount of their investment was too small to claim a credit. Other, less common reasons given for foregoing the credit included the difficulty in filling out the tax credit forms and ineligibility (table 4- 1).[11]

Actual claims for the conservation credits correlated directly with income; the highest level of participation (26 percent) was in the highest income category ($30,000 and up), and the lowest levels of participation (9 to 11 percent) were in the lowest income categories (less than $15,000). Perhaps the most interesting finding in the 1984 RECS study was that most respondents claimed they would have made the same conservation investment without the credit. Eighty-eight (88) percent of respondents who

9 U.S. Library of Congress, Congressional Research Service, *An* Economic. *Evaluation Of Federal Tax Credits for Residential Energy Conservation,* Report No. 82-204E (Washington DC: December 1982), pp. 9,58.

10 These are summary figures compiled by OTA from unpublished IRS data. John Kozielec, Internal Revenue Service, personal communication, June 24, 1991.

11 U.S. Department of Energy, Energy Information Administration, Residential Energy *Consumption Survey: Housing Characteristics 1984*, DOE/EIA-03 *14(84)* (Wasington, DC: October 1986), p. 27.

had claimed the conservation credit asserted they would have made the same expenditures without the tax credits.[12] This suggests that the incremental value of the credits as inducements to perform retrofits may have been negligible, and the credits may have created a windfall for many energy investors who would have made the same conservation investments anyway .13

The IRS required claimants to indicate the nature of their expenditures. From 1978 to 1981, about 85 percent of credited conservation expenditures were for insulation, storm windows, and storm doors; caulking and other conservation retrofits comprised the small remainder of expenditures in this category. Though more homes in this period made insulation investments, the total cost of storm doors and windows for program participants was slightly higher.[14] Experience in other Federal programs, however, suggests that many of the credited retrofits (particularly storm doors and windows) were among the least cost-effective.[15] In addition, the program did not establish incentives or guidelines to promote *cost-effective* retrofits; the principal goal was to encourage retrofits that consumers judged worthwhile (by whatever criteria they chose).

The rental housing market was minimally affected by the residential energy tax credits.[16] Under the principal residence requirement necessary to obtain the credits, landlords were generally ineligible, while renters generally had little financial incentive to retrofit their units (especially if they did not pay their energy bills directly). This lost market was important because, at the time the credits were available, one-third of the 80 million housing units in the United States were rented.[17]

In sum, the conservation credits established under the Energy Tax Act appear to have been bypassed by most consumers that performed retrofits. Apparently, other factors motivated retrofits more strongly. This suggests that the tax incentives were a windfall for most claimants. There are several explanations (given below) for this general disregard of the conservation credits, which Congress should be aware of if it considers re-enacting such credits in the future.

- The conservation credits were poorly advertised and were restricted to claimants using the IRS long forms. The 1984 RECS study determined that these were the two most common reasons for not claiming the credits. First, the study revealed that a significant portion of consumers were unaware of the credits (between 19 and 38 percent, depending on income). In fact, awareness decreased with decreasing income, suggesting that the relative need to advertise incentive programs to low-income groups is greater than for higher income groups. Second, low-income households and renters may have been discouraged or prevented from claiming the credits, because many of them generally do not file long forms.
- The rate of the conservation credits (15 percent) was probably too low to motivate widespread retrofitting. This was a major reason given for all income groups in the 1984 RECS study. Interestingly, Congress considered extending and increasing the conservation credits to 25 percent for tax years 1985 to 1988 for households earning less than $30,000,[18] but no measure was enacted.

12 U.S. Department of Energy, Energy Information Administration, *Residential Energy Consumption Survey: Housing Characteristics 1984,* DOE/EIA-0314(84) (Washington, DC: October 1986), p. 27.

13 Yet the survey had at least two drawbacks. First, respondents were questioned well after they made their investments; they were not asked the extent to which the availability of the credits motivated them to undertake the investments in the first place, or whether learning about the Federal credits was connected to their seeking energy improvements in their principal residences. Also, the survey did not determine the potential effects of a *larger* credit.

14 U.S. Department of Energy, Energy Information Administration, *An Economic Evaluation of Energy Conservation and Renewable Energy Tax Credits,* DOE/NBM—6000728 (Washington, DC: October 1985), Service Report, p. 12.

15 See, e.g., J. Schlegel, J. McBride, S. Thomas, and P. Berkowitz, "The State-of-the-Art of Low-Income Weatherization: Past, present, and Future," *Proceedings of the ACEEE 1990 Summer Study on Energy Efficiency in Buildings* (Washington DC: American Council for an Energy-Efficient Economy, 1990), vol. 7, p. 7.212.

16 J. Clinton, H. Geller, and E. Hirst, "Review of Government and Utility Energy Conservation Programs," *Annual Review of Energy 1986* (Palo Alto, CA: Annual Reviews, Inc., 1986), vol. 11, p. 109.

17 U.S. Department of Energy, Energy Information Administration, *Residential Energy Consumption Survey: Trends in Consumption and Expenditures, 1978-1984,* DOE/EIA-0482 (Washington, DC: June 1987), p. 118. See also P. McDevitt and R. Peterson, "Residential Energy Conservation: An Investigation of the Post Tax Credit Era in the U.S.," *Journal of Public Policy & Marketing,* vol. 4, 1985, p. 45.

18 U.S. Department of Energy, Energy Information Administration, *An Economic Evaluation of Energy Conservation and Renewable Energy Tax Credits,* DOE/NBM—6000728 (Washington, DC: October 1985), Service Report, p. v.

- The principal residence requirement under the ETA prevented landlords (and those owning two or more homes) from using the credits. If landlords had been able to use the conservation credits, a larger portion of the sizable rental market, which comprised from 26 to 31 million units between 1978 and 1984,[19] probably would have received retrofits.
- Other economic changes (notably the rise **in** household energy costs and the drop in personal income) during the late 1970s and early 1980s were probably more significant inducements to perform retrofits than were the energy tax credits. A change in energy prices, depending on the relative level, may exert a stronger influence on conservation investments than tax credits.
- The lag time between financing retrofits and enjoying the tax credits (from several months to a year or more) probably diminished the value of the credits as a financial incentive for many consumers. This issue was not addressed in the 1984 RECS, but the more distant the enjoyment of financial incentives, the less likely that consumers will pursue them.

Therefore, U.S. experience with residential energy conservation tax credits reveals uncertainty about their merits as financial incentives. Although nearly 30 million credit claims were made, their ultimate economic benefits have not been reliably determined. Greater efforts to target low-income groups and renters, to encourage the adoption of cost-effective measures, to advertise the program and, perhaps, to increase the allowable credit limits could have increased participation in the program and maybe improved its benefit-cost ratio, which is still undetermined.

Weatherization Grants

The Federal Government currently offers two major weatherization assistance programs for low-income households.[20] Based on historical budget allocations, low-income weatherization is the major focus of Federal efforts to conserve energy in U.S. buildings. The combined budgets of these two programs have consistently been higher (about $330 million in 1991) than any other Federal program aimed at energy conservation in buildings. (For example, the 1991 DOE buildings conservation research and development (R&D) budget was about $43 million.) The DOE Weatherization Assistance Program (WAP), the older of the two, is authorized under Title IV of the Energy Conservation and Production Act (Public Law 94-385), as amended.

The WAP funds weatherization measures for low-income households to reduce their energy use. The other program, the Low-Income Home Energy Assistance Program (LIHEAP) authorized under Title XXVI of Low-Income Home Energy Assistance Act (Public Law 97-35) as amended, primarily subsidizes energy bills for low-income households. However, States may use 15 percent of their LIHEAP funds for low-income weatherization (up to 25 percent with an approved waiver application).

The weatherization components of these programs are intended to reduce residential energy costs for low-income families, which typically spend larger fractions of their incomes on energy relative to higher income households. For example, families earning less than $5,000 per year spend on average 25 percent of their household income on energy, while higher income families (earning $15,000 or more) spend 5 percent or less of their income on energy.[21] And families earning less than $5,000 Per year consume on average 68 percent more energy to heat a square foot of living space than those earning $15,000 or more.[22] Low-income residences are often older and in greater disrepair than those of higher income groups. According to DOE, energy savings of 25 percent or more are possible for a substantial number of low-income homes eligible for Federal weatherization monies .[23]

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19 U.S. Department of Energy, Energy Information Administration, *Residential Energy Consumption Survey: Trends in Consumption and Expenditures, 1978-1984,* DOE/EIA-0482 (Washington, DC: June 1987), p. 118.

20 In this context, weatherization refers t. measures designed to save heating and cooling energy by shell, equipment, and behavioral changes applied to existing homes.

21 U.S. Department of Energy, Energy Information Administration, Household *Energy Consumption and Expenditures 1987, Part 1: National Data,* DOE/EIA-0321/1(87) (Washington, DC: October 1989), p. 50.

22 Based on natural gas heating expenditures and adjusted for climate. This difference across the income groups is somewhat smaller for electrically heated households (about 52 percent). These OTA calculations are based on data in ibid., pp. 101, 104.

23 U.S. Department of Energy, Office of the Assistant Secretary for Conservation and Renewable Energy, ''Report on the Present Weatherization Grant Program," prepared for the U.S. Senate, Committee on Appropriations, Aug. 29, 1989, pp. v, 35.

The other major Federal weatherization grant program in operation is the Institutional Conservation Program (ICP). This program provides match monies to nonprofit schools and hospitals for energy audits and retrofits and is discussed after the low-income programs,

Weatherization Assistance Program--Administered by the Weatherization Assistance Program (WAP) Division, which is within the Office of Technical and Financial Assistance (formerly the Office of State and Local Assistance Programs) at DOE, WAP funds energy conservation measures for low-income households at no charge to the residents. With its creation by the Energy Conservation and Production Act (ECPA) in 1976, WAP supplemented an existing Federal weatherization program overseen by the Community Services Administration (CSA). The CSA authorized its local grantees in 1974 to assist low-income households burdened with rapidly rising fuel prices caused by the Arab oil embargo of 1973. The CSA program was the first of its kind but was eliminated in 1981, leaving WAP as the sole Federal program designed exclusively to weatherize low-income households.[24]

State requirements vary, but households with incomes less than 150 percent of the Federal poverty line, incomes less than 60 percent of their State's median income level, or receiving welfare are generally eligible for WAP funds. State expenditures were limited to an average of $1,600 per household, which includes apartments, but recent legislation allows that amount to adjust annually with inflation or by 3 percent, whichever is smaller,[25] These funds are available for materials and labor (installation and related repairs), and priority is given to households having elderly or handicapped residents.

Until recently, at least 40 percent of WAP funds were required to cover materials costs, but recent legislation allows States to bypass this requirement if they apply energy audits to client households to determin e optimal retrofit needs and if they establish weatherization criteria that ensure cost-effective retrofits-not merely energy saving ones.[26] No more than 10 percent of WAP monies may be used for administrative costs.[27]

As with the former CSA program, a WAP priority is to use nonprofit, nongovernmental community action programs (CAPS) to manage weatherization services locally. Local agencies, whether CAPS or others, install the conservation measures for participating households. Roughly 1,200 such groups participate in WAP, with average staff sizes of only 5 to 10 people.[28] As a result, the program is highly decentralized, and most major efforts-client selection, weatherization installation, and financing-are provided by these generally small, local groups.

The WAP has changed considerably in its 15-year history. Initially, 90 percent of grant funds were restricted to materials costs; all labor was provided by trainees working under the Comprehensive Employment and Training Act (CETA); priority was given to households with elderly or handicapped residents; and rental units could be weatherized if the resultant benefits accrued mostly to tenants rather than their landlords. (ECPA disallowed landlords to raise rents on the basis of weatherization improvements .29) Subsequent statutory and rules changes, however, have altered the program.

In recent years, DOE regulations have allowed WAP to fund furnace repairs and adjustments, raised the program eligibility limit twice (currently at 150 percent of the poverty level, up from 100 percent in 1979), granted States additional discretion to admin-

[M] J. Schelegel, J. McBride, S. Thomas, and P. Berkowitz, "The State-of-the-Art of Low-Income Weatherization: Past, Present, and Future," *Proceedings of the ACEEE 1990 Summer Study on Energy Efficiency in Buildings* (Washington, DC: American Council for an Energy-Efficient Economy, 1990), vol. 7, p. 7.206.

25 State Energy Efficiency Programs Improvement Act of 1990, Public Law 101-440, 104 Stat. 1013, sec. 7(e)(2).

26 Ibid., sec. 7(d)(3).

27 This requirement was identified as a major program impediment in a national survey of local programs. See M. Schweitzer, ' 'Energy Conservation for Low-Income Households: A Study of the Organization and Outcomes of Weatherization Assistance Prograrn.s, " *Energy Systems and Policy, vol. 12, No. 2, 1988,* p. 111. However, recent legislation partially corrects this problem, because agencies receiving less than $350,000 per year may use an additional 5 percent for administrative costs. See State Energy Efficiency Programs Improvement Act of 1990, Public Law 101-440, 104 stat. 1013, sec. 7(d)(2).

28 Ibid., pp. 102, 105.

29 J. Schelegel, J. McBride, S. Thomas, and P. Berkowitz, ''The State-of-the-Art of Low-Income Weatherization: Past, Present, and Future, " *Proceedings of the ACEEE 1990 Summer Study on Energy Efficiency in Buildings* (Washington, DC: American Council for an Energy-Efficient Economy, 1990), vol. 7, p. 7.206.

ister their WAP programs, established a maximum *average* spending cap of $1,600 per household, and provided the option to spend as little as 40 percent of program costs on materials.[30] The minimum materials costs were lowered in response to growing evidence that more emphasis on labor, especially for related repairs, could result in important energy savings.[31] In addition, household cooling efficiency retrofits are now eligible for WAP funds.[32]

The only national WAP evaluation was completed in 1984 and represented program results through 1981. The study determined that average annual household energy savings were roughly 10 percent.[33] The numerous statutory and rule changes to the program since 1981, however, render this early national assessment of the program obsolete. Although DOE recently initiated the second national evaluation of the program, the final report will not be available until the end of 1993.[34]

Until the second national evaluation is finished, it is encouraging to consider that WAP has evolved from a largely volunteer, inexperienced labor force (under CETA) into a skilled force using more sophisticated diagnostic technologies in weatherization assessments. Moreover, the goal of achieving cost-effective energy savings has become increasingly common in State and local planning. Seemingly obvious in retrospect, the notion of cost-effective weatherization—that is, funding retrofit options for which the energy savings, discounted appropriately, exceed the initial investment-is not required by the legislation that authorizes WAP. That now obvious oversight is being addressed somewhat on the State and local levels, but no Federal legislation has yet required all WAP projects to be cost-effective.

OTA has identified several major issues for Congress to consider regarding WAP.

- Though WAP pursues a variety of goals in selecting clients for weatherization (e.g., targeting the handicapped and the elderly), stressing or even requiring cost-effective weatherization (with paybacks generally ranging, for example, no longer than 5 to 8 years) would better ensure that program monies are spent more carefully.
- The State allotment scheme for the disbursement of Federal WAP funds could be reassessed. Federal regulations require DOE to determine State WAP allotments based on several criteria: climate, the relative number of low-income households, and the share of residential energy consumption for each State. This WAP disbursement scheme, however, has apparently allowed colder States to receive a higher proportion of WAP funds than other States with relatively larger low-income populations or relatively greater low-income energy expenditures. One proposed alternative is to adjust WAP funding according to the size of a State's low-income population and on the State's household energy expenditures. This, apparently, would result in a different flow of WAP funds to the States.[35] Recent legislation requires DOE to update annually the data used to determine WAP allotments but does not direct the agency to revise its scheme accordingly.[36]
- Delays (both State and Federal) in reimbursing local weatherization programs have been identified as a major impediment to WAP success, affecting long-range planning, sol-

30 Ibid,

31 Ibid.

32 These include replacement air conditioners, ventilation equipment, window films, and shading devices. See State Energy Efficiency Programs Improvement Act of 1990, Public Law 101-440, 104 Stat. 1012, sec. 7(a).

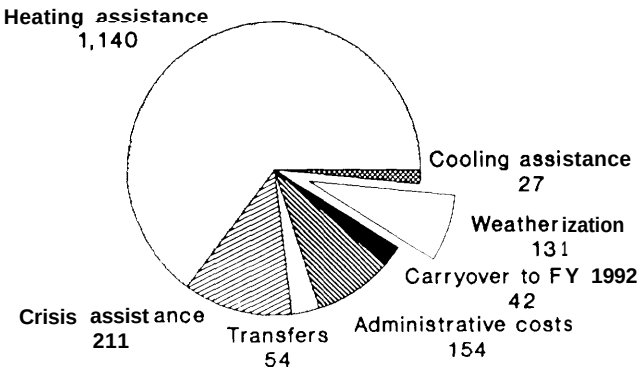
33 G.E. Peabody, U.S. Department of Energy, Energy Information Administration *Weatherization Program Evaluation* SR-EEUD-84-1 (Washington DC: August 1984), Service Report, pp. 1, 18.

34 D.A. Beschen and M.A. Brown, U.S. Department of Energy, ''Evaluation Plan for the Weatherization Assistance program,' October 1990, figure A-1 .

35 The LIHEAP has a different allocation scheme that partially corrects this same problem. In particular, the second of two allocation formulas used in LIHEAP resolves this presumed inequity. The selection of a formula in a given year depends on the amount of appropriations in that year. When appropriations are below $1.975 billion, which has been the case for several years, the first formula is applied. That formula favors colder States, because it stresses climate and total State heating costs, When appropriations exceed $1,975 billion, though, the second formula is used, which bases State LIHEAP allocations according to each State's actual share of heating costs for low-income households—not the climate nor the total State heating costs. See M.F. Smith and J. Richardson, U.S. Library of Congress, Congressional Research Service, '' Weatherization Assistance Programs of the Departments of Energy and Health and Human Services, 90-285 EPW, June 1990, p. 7.

36 State Energy Efficiency Programs Improvement Act of 1990, Public Law 101-440, 104 Stat. 1013, sec. 7(c)(2).

Figure 4-1 —Use of Funds in the Low-Income Home Energy Assistance Program, Fiscal Year 1991 (in millions of current dollars)



SOURCE: Unpublished data from U.S. Department of Health and Human Services, Office of Energy Assistance, July 1991. These 1991 data are based on estimates from a 1991 LIHEAP telephone survey.

vency, and local performance. A recent review of local performance indicated that the average time to reimburse local agencies was roughly 30 days. About 25 percent of the agencies participating in the same review, however, had to wait an average of at least 38 days or longer to receive funds for performed work,[37]

Resolving these critical WAP issues is likely to improve the timeliness, quality, and cost-effectiveness of the program. Regarding timeliness, combined WAP/LIHEAP weatherization efforts reach about 250,000 households annually, which suggests that reaching the 15 to 18 million households that have not yet participated in the program (by DOE estimates)[38] would require an additional 60 to 70 years. Addressing the issues discussed above, leveraging more State and utility resources for low-income weatherization and, perhaps, allowing a greater percentage of LIHEAP funds to apply to low-income weatherization could substantially shorten this projected period.

Low-Income Home Energy Assistance Program—Since 1982, the WAP has been supplemented by the Low-Income Home Energy Assistance Program, which is administered by the Department of Health and Human Services (HHS). The LIHEAP is an outgrowth of Crisis Intervention, a program initiated in 1974 under the auspices of the now defunct Community Services Administration low-income energy assistance program.[39] Enacted by Title XXVI of the Low-Income Home Energy Assistance Act of 1981 (Public Law 97-35), LIHEAP disburses funds to States to assist with heating and cooling bills for their eligible low-income households.

At their discretion, States may use up to 15 percent of their LIHEAP funds for low-income weatherization; with HHS approval, that maximum can increase to 25 percent. The uses of LIHEAP funds in 1991 are given in figure 4-1. In recent years, WAP and LIHEAP together have weatherized more than 250,000 households a year at a Federal cost of about $300 million annually.[40]

As figure 4-2 illustrates, States expend on average between 7 and 10 percent of their LIHEAP funds on weatherization. If more LIHEAP funds were directed to weatherization, the need to assist many low-income households with their energy bills in outlying years could diminish, but then the Federal Government may not be able to reach as many households in a given year. For example, LIHEAP heating assistance payments have averaged around $200 per household,[41] far less than the average amount allowed for weatherization in WAP (about $1,600 per household). By this simple comparison, directing all current LIHEAP monies to weatheriza-

[37] M. Schweitzer, "Energy Conservation for Low-Income Households: A Study of the Organization and Outcomes of Weatherization Assistance Programs,' *Energy Systems and Policy, vol.* 12, No. 2, 1988, p. 110. This source indicated that most States further restrict local agency administrative expenses to about 5 percent.

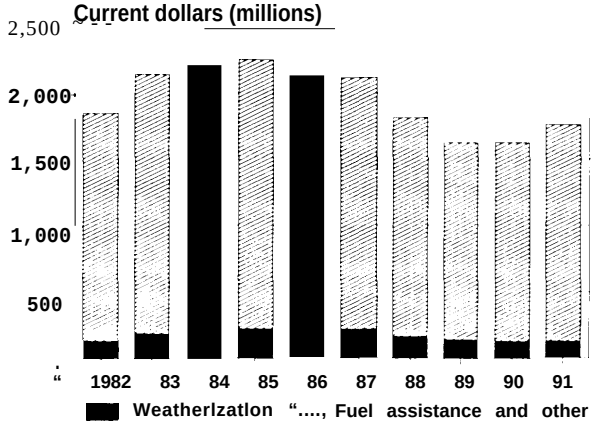
[38] U.S. Department of Energy, office of the Assistant Secretary for Conservation and Renewable Energy, "Report on The Present Weatherization Grant Program, ' prepared for the U.S. Senate, Committee on Appropriations, Aug. 29, 1989, p. 41. These estimates of nonparticipating households do not exclude those previously weatherized in separate State and utility programs. The actual number of nonparticipants, therefore, is overstated to some degree.

[39] J. Schlegel, J. McBride, S. Thomas, and P. Berkowitz, ' 'The State-of-the-Art of Low-Income Weatherization: Past, Present, and Future," *Proceedings of the ACEEE 1990 Summer Study on Energy Efficiency in Buildings* (Washington, DC: American Council for an Energy-Efficient Economy, 1990), vol. 7, pp. 7.206-7.207.

[40] M.F. Smith and J. Richardson, U.S. Library of *Congress,* Congressional Research Service, ''Weatherization Assistance Programs of the Departments of Energy and Health and Human Services,' 90-285 EPW, June 1990, p. 4.

[41] Unpublished data provided by U.S. Department of Health and Human Services, Office of Energy Assistance, to OTA, July 31, 1991.

Figure 4-2--Weatherization Funding in the Low-Income Home Energy Assistance Program, Fiscal Years 1982-91



SOURCE: Unpublished data from U.S. Department of Health and Human Services, Office of Energy Assistance, July 1991, The 1991 data are based on estimates from a 1991 LIHEAP telephone survey, and the remaining data are historical.

tion would reduce the number of households serviced annually by a factor of about eight, but placing greater emphasis on weatherization could reduce the ultimate energy requirements of eligible households over time.

Although LIHEAP is principally an energy assistance program, there are several important issues worth considering about its weatherization efforts:

- The cost-effectiveness of weatherization measures funded by LIHEAP is not being assessed, nor are there clear program policies or measures that encourage cost-effective weatherization.
- Federal requirements or policies to leverage LIHEAP weatherization monies with State and utility resources are appropriate to consider. The private U.S. utility industry benefits secondarily but substantially from Federal LIHEAP outlays, because these funds are used to assist low-income households that might not otherwise pay their energy bills as quickly or at all. By providing energy assistance, LIHEAP offsets utility arrearages from delayed or missed payments by low-income households. (Utility arrearages from delayed residential payments amount to hundreds of millions of dollar-s annually.)42 As a result, Congress could determine whether private utilities should provide greater assistance to a Federal effort from which these firms benefit.

Institutional Conservation Program—The ICP is a Federal institutional grant program administered by States through DOE regional offices. Since 1980, ICP grants have funded energy audits and the application of energy conservation measures to over 20,000 schools (primary and secondary), colleges, universities, and hospitals.[43] The program is designed to assist the financing of energy audits and retrofits in the nonprofit institutional sector, where resources are generally limited.

Until 1990, ICP eligibility was limited to nonprofit institutional buildings constructed before April 20, 1977. Recent legislation, however, shifted the eligibility to such buildings constructed before May 1, 1989.[44] By 1988, ICP spending totaled almost $1.4 billion and resulted in an estimated cumulative energy savings of 0.3 quads (317 trillion Btus) worth an estimated $1.9 billion.[45] This spending figure includes both DOE grant outlays and the matching funds required of participating institutions. By this measure alone, the ICP has exceeded its break-even payback costs by $500 million.[ti]

There are two kinds of ICP grants. Technical analysis (TA) grants fund energy audits to determine appropriate energy conservation measures (ECMS) for participating institutions. ECM grants fired the design, acquisition, and installation of energy conservation measures for participating institutions. Except in cases of demonstrated hardship, ICP grants are limited to 50 percent of participant costs. Where hardship has been demonstrated, ICP will fund up to 90 percent of the TA or ECM. By the end of 1987, ECM grants resulted in an average

42p. Rodgers, M. Foley, and R. Tucker, *Survey of Electric and Natural Gas Utility Uncollectable Accounts and Service Disconnections for 1984* (.Washington, DC: National Association of Regulatory Utility Commissioners, October 1985), pp. 41-48.

43 N.E. Collins, R.C. Kammerud, and P.H. Kier, *Energy Conservation* in *Hospitals, Colleges and Universities, and Public School Districts: Results of a National Evacuation* (Argonne, IL: Argonne National"Laboratory, May 1988), p. 30.

44 State Energy Efficienc, Programs Improvement Act of 1990, Public Law 101-44O, 104 Stat. 1011, sec. 6(b)(l).

45 U.S. Department of Energy, Office of Conservation and Renewable Energy, *An Estimate of Aggregate* Energy Savings *Due to the ICP program,* DOE/SF/00098-H2 (Washington, DC: March 1988), p. vi. Figures in this section are expressed in 1987 dollars.

46 ICP-funded measures completed b, 1988 are expected to save an additional $400 million per year over their remaining lifetimes. Ibid., p. 33.

energy savings of 12 percent for participating educational facilities and 8 percent for participating hospitals.[47]

As of 1988, approximately 115,000 schools, colleges, and hospitals comprised the institutional sector. Ninety percent of these institutions were schools, but they accounted for only 35 percent of the total institutional energy use. This suggests that the energy intensity (energy use per square foot of floor space) of schools is far lower than colleges or hospitals.[48] Given the large number but low energy intensity of schools, a separate Federal effort could target colleges and hospitals, because they are relatively less numerous but more energy intensive. As of 1988, however, 80 percent of ICP grants were awarded to schools .49

Summary figures confirm the point that ICP program monies are reaching the less energy-intensive buildings eligible for assistance: ICP grants have reached 29 percent of the eligible institutional floor space but that space consumes only 27 percent of the total energy in the eligible portion of the institutional subsector.[50] Nevertheless, paybacks are favorable for all subsectors, averaging 3.6 years. The cost of conserved energy has been estimated at just over $2 per million Btu.[51] If this figure accurately reflects true ICP savings, this program is probably the most cost-effective Federal energy grant program in operation, and the use of energy audits invariably contributes to this success.

Loan Subsidies

Solar Energy and Energy Conservation Bank—The SEECB (or the "Bank") was authorized by the Energy Security Act of 1980 (Public Law 96-294) to subsidize the purchase and installation of conservation and renewable energy measures in households (one to four families), multifamily buildings (more than four families), and nonprofit commercial and agricultural buildings with low- and moderate-income owners and tenants. The goal of the program, which was administered by the Department of Housing and Urban Development (HUD), was to encourage energy conservation and the use of renewable energy sources (solar, wind, and wood) in buildings to reduce national dependence on foreign energy supplies.[52] Although later extended 6 months, the original statutory sunset date for the Bank was September 30, 1987.[53]

Bank monies were disbursed through cooperative agreements executed with States, all of which participated in the program at least 1 year.[54] The original funding authorization for the Bank was unprecedented for a Federal conservation and renewable energy incentive program designed for low-income groups-over $3 billion for fiscal years 1981 through 1984.[55] Before the program was implemented, however, the newly arrived Reagan administration proposed cutting the 1981 Bank budget from $300 million to $250,000, which Congress did.[56] The revised 1981 budget was intended to cover only administrative expenses; funding authorized for 1982 to 1984 reactivated the

47 Ibid., p. vi.

48 In fact, measured in thousands of Btus per square foot per year (kBTU/sq ft/yr), median energy intensities for ICP-eligible buildings are the following: schools 130, colleges 240, and hospitals 420. N.E. Collins, R.C. Kammerud, and P.H. Kier, *Energy Conservation in Hospitals, Colleges and Universities, and Public School Districts: Results of a National Evaluation* (Argonne, IL: Argonne National Laboratory, May 1988), pp. 14-15.

49 Ibid., p. 43.

50 Ibid., p. 44.

51 Ibid., p. 43. For comparison, the average cost of electricity in 1987 (the year represented in the ICP energy *savings estimates)* for the residential and commercial sectors has been estimated at $21.18 per million Btu and natural gas at $5.12 per million Btu the same year. See U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1990*, DOE/'EIA-0384(90) (Washington DC: May 1991), p. 69.

52 Energy Security Act of 1980, Public Law 96-294, 94 Stat. 719, sec. 503.

53 Energy Security Act of 1980, Public Law 96-294, 94 Stat. 722, sec. 505(a). House Joint Resolution 395 (December 21, 1987) extended SEECB authorization to March 15, 1988. Congress officially withdrew all unspent monies in 1990, although Bank activities had essentially ceased by mid-1988. Public Law 101-507, 104 Stat. 1364.

54 US Department of Housing and Urban Development, Solar Energy and Energy Conservation Bank, *Solar Energy and Energy Conservation Bank: FY* 1987 *Annual Report to the Congress* (Washington, DC: 1987), p. 7.

55 The $3.025 billion originally authorized for the Bank were designated primarily for conservation measures ($2.5 billion for fiscal years 1981 to 1984), with the remainder designated for renewable measures ($525 million for fiscal years 1981 to 1983). Public Law 96-294,94 Stat. 737, sec. 522(a)-(b).

56 Omnibus Budget Reconciliation Act of 1981, Public Law97-35. See associated Senate **Report** (Budget Committee) No. 97-139, June 17,1981, p. 384,

program, but at substantially reduced levels.[57] By the time the Bank effectively expired in September 1987, program expenditures totaled only $76 million and assisted about 98,000 projects .58 All administration requests for the Bank budget after 1981 were zero.[59]

The virtual elimination of the Bank budget in 1981 contributed to the delay in program implementation. Interim rules establishing program requirements were not promulgated until May 1983,[60] and final rules were not issued until March 1984.[61] Given the 1987 sunset date, program planners could expect only 3 1/2 years of operation. In fact, Congress enacted no new budget authority for the Bank after 1985; budget authority for fiscal years 1986 and 1987 was zero, although $1.7 million of recaptured 1985 funds were reappropriated for 1988.[62]

Bank funds subsidized loans (either the principal or interest portions) for energy conservation and renewable energy measures installed in newly constructed or existing (pre-1980) buildings; grants for energy conservation measures were also available under the program. Any Bank funds allocated to States but not expended within prescribed periods were recaptured and redistributed; this was intended to encourage the timely use of Bank funds and to prevent States from hoarding program resources. Also, the Energy Security Act prevented Bank participants from claiming energy conservation or renewable energy credits available under the Energy Tax Act (Public Law 95-618).[63]

The Energy Security Act directed the Bank to decrease assistance with increasing income according to enacted guidelines to ensure that the lowest income groups would receive the greatest assistance.[64] As a result, by the end of 1987,65 percent of program funds had been disbursed to the lowest income group defined in the statute. In 1987, the last year of major program activity, average loan subsidies were $1,053 and average matching grants were $720.[65] Ninety percent of total program funds were allocated to conservation measures.[66]

The Energy Security Act directed HUD to analyze annually the cost-effectiveness of the Bank program, by comparing total expenditures against total energy savings,[67] but the statute did not impose limits on program assistance according to any measure of cost-effectiveness. Nonetheless, HUD proposed in the 1983 interim rule that energy conservation and passive solar measures should achieve a 7-year simple payback, as determined by an energy audit, to receive Bank assistance.[68] Although this payback test was based on DOE guidance issued for the Residential Conservation Service (RCS), there were objections to the HUD proposal, and later that year Congress prohibited any limits on Bank assistance that were based on projected energy savings.[69]

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57 The Omnibus Budget Reconciliation Act of 1981 (Public Law 97-35) sec. 1071 reduced the Bank budget to $150 million for fiscal years 1982 to 1984. Subsequent legislation reduced this funding even further, to $135 million. Public Law 98-181, 97 Stat. 1235, sec. 463(f)(l).

58 U.S. Department of Housing and Urban Development, Solar Energy and Energy Conservation Bank, *Solar Energy and Energy Conservation Bunk: FY 1987 Annual Report to the Congress* (Washington, DC: 1987), p. 2.

59 Walter Preysnar, U.S. Department of Housing and Urban Development, former Program Director, SEECB, personal communication, Nov. 25, 1991.

60 48 *Federal Register 24254* (May 31, 1983).

61 49 Federal *Register 9865* (Mar. 16, 1984).

62 U.S. Department of Housing and Urban Development, Solar Energy and Energy Conservation Bank, Solar Energy *and Energy Conservation Bank: FY 1987 Annual Report to the Congress* (Washington, DC: 1987), p. 12.

63 Public Law 96-294, 94 Stat. 723, sec. 506(f). The residential credits under the Energy Tax Act were available for tax years 1978 to 1985. In addition, the Energy Security Act prevented Bank assistance from being counted as income for any individual participating in the program. Public Law 96-294, 94 Stat. 726, sec. 509(c).

64 Public Law 96-294, 94 Stat. 726-729, sec. 511-512 For example, owners or tenants of single family residences earning less than 80 percent Of their median area income (MAI), the lowest income group in the program, were eligible for $1,250 of assistance, while those earning between 80 and 100 percent of their MAI, the second lowest income group, were eligible for only $875 of assistance. See 48 *Federal Register 24265 (May 31, 1983).*

65 U.S. Department of Housing and Urban Development, Solar Energy and Energy Conservation Bank, *Solar Energy and Energy Conservation Bank: FY 1987 Annual Report to the Congress* (Washington, DC: 1987), p. 4.

66 Ibid., p. 9.

67 Public Law 96-294, 94 Stat. 736, sec. 519(a)(3).

68 48 *Federal* Register 24262, 24265 (May 31, 1983).

69 Housing and Urban-Rural Recovery Act of 1983, Public Law 98-181, sec. 463(c)(2). According to the former SEECB program manager, this prohibition was imposed to prevent further delays in program implementation. U.S. Department of Housing and Urban Development, former Program Director, SEECB, personal communication, Nov. 25, 1991.

Despite HUD objections to this prohibition,[70] the Bank appears to have conducted an extremely cost-effective program. According to HUD estimates, SEECB conservation investments made in 1987 achieved average simple paybacks of 4.4 years.[71] As with RCS, however, these estimates were based on State reports that summarized audit estimates of energy savings potential; no Federal effort was made to test the reliability of these estimates or the actual effect of the retrofits by using fuel use data, surveys, or other methods.[72]

The implementation lessons applicable to the Bank and worthy of attention by Congress are the following:

- Encouraging or requiring energy audits prior to the disbursement of Federal funds for building retrofits may be appropriate. Energy audits inform consumers about economical retrofit options, which will encourage them to spend their (and Federal) monies as effectively as possible. Of course, performing audits requires resources that could be used for retrofits, but audit costs are relatively minor compared to major retrofits, and they can indicate the most cost-effective retrofit opportunities.
- The use of mandatory cost-effectiveness requirements for Federally subsidized residential retrofit assistance has not been tested. The Bank was never able to test this option, but it is likely that such Federal requirements would improve the cost-effectiveness of residential retrofit programs.

Federal Leadership

Providing Public Recognition for Voluntary Energy Savings

Green Lights Program-Green Lights is a voluntary, cooperative corporate program formally initiated by the Environmental Protection Agency (EPA) in January 1991. The program is intended to reduce commercial building energy use by encouraging companies to conduct voluntarily all possible cost-effective lighting retrofits at their U.S. facilities. To participate in the program, companies sign nonbinding agreements to survey lighting at all their U.S. facilities and to perform retrofits in at least 90 percent of their total floor space. Retrofits are required only where they would be cost-effective and where they would not compromise lighting quality. By reducing lighting energy use, the program aims to reduce the air and other pollution associated with extracting and burning fossil fuels for electricity generation.

The Green Lights program operates on the assumption that a variety of highly efficient lighting technologies have been developed but insufficiently implemented in the last decade.[73] To address all of the relevant barriers to energy efficiency, ranging from inadequate information to financing, the Green Lights program consists of several distinct arms.

The first program arm is the Decision Support System designed to assist companies with lighting surveys, the identification of retrofit options, and the final selection of a retrofit option that maximizes energy savings without compromising lighting quality. A separate Green Lights effort, the National Lighting Product Information Program, is designed to provide reliable information about lighting technologies and options to interested companies that may question product claims or potential employee response to lighting changes. Beyond such information about technical performance, the Green Lights program also offers a support project to inform participants about retrofit financing options, including assistance offered by utilities, government, energy service companies, and other more conventional lending institutions such as banks.

The Green Lights program distinguishes several participant groups: corporate partners, manufacturer allies, electric utility allies, and lighting management company allies. To join the program, each group must sign a nonbinding memorandum of understanding with EPA that describes the responsibilities of EPA and the participant. As of December

70 "In the opinion of the Bank. . .the new legislation [Public Law 98-181] has impaired the Bank's ability to focus appropriately on the most cost-effective expenditures. " 49 *Federal Register 9867* (Mar. 16, 1984).

71 U.S. Department of Housing and Urban Development, Solar Energy and Energy Conservation Bank, *Solar Energy and Energy Conservation Bank: FY 1987 Annual Report to the Congress* (Washington, DC: 1987), pp. 3, 6.

72 Walter Preysnar U.S. Department of Housing and Urban Development, former Program Director, SEECB, personal communication, Nov. 25, 1991.

73 See EPA pamphlet, "Green Lights: A Bright Investment in the Environment, " July 1991.

1991, roughly 150 companies had enrolled in the program.

Although few actual measured energy savings data are available at present, the Green Lights offers an innovative approach to saving energy in the private sector that is worth duplicating, because it stresses cooperation, public recognition, cost-effective energy savings, and voluntary participation.

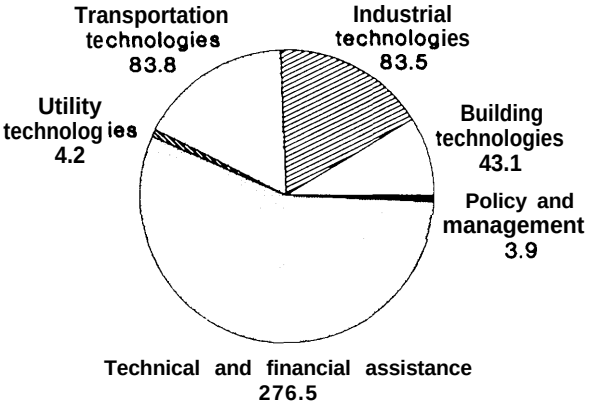
Research, Development, and Demonstration Programs

This section reviews the budgets and several major accomplishments of the DOE energy conservation research and development (R&D) program for buildings. This DOE program is administered by the Deputy Assistant Secretary for the Office of Building Technologies, who is under the Assistant Secretary for Conservation and Renewable Energy. The other Conservation and Renewable Energy offices at the level of Deputy Assistant Secretary are Industrial Technologies, Transportation Technologies, Utility Technologies, and the Office of Technical and Financial Assistance. This organizational scheme was adopted in April 1990 to consolidate better the office's efforts by end-use sector. The fiscal year 1991 Office of Conservation and Renewable Energy budgets by office are shown in figure 4-3.

With few exceptions, the most successful DOE conservation R&D projects related to buildings were initiated, and some completed, before the Department's conservation budget was severely cut in the early 1980s (box 4-D). Solid-state fluorescent light ballasts, for example, were developed through DOE-funded work between 1976 and 1980, accounting for a total Federal R&D investment of about $3 million. These efficient ballasts represent a 20 to 25 percent energy efficiency improvement over conventional magnetic ballasts, and their use is expected to save billions of dollars in lighting energy costs over the next several decades.[74]

However, not all conservation R&D funding results in major successes nor should this be expected. One goal of conservation R&D is to explore the potential for improving the efficiency of energy use; much of that exploration requires trial and error. Indeed, even when technology is improved in the laboratory, high costs, inadequate marketing, or poor consumer response often limit or prevent its adoption. For example, commercially available heat pump water heaters consume about one-half the energy used by conventional electric resistance water heaters, but high first costs have slowed their market penetration.[75]

Figure 4-3--U.S. Department of Energy Conservation Research and Development Budget by End-use Sector, Fiscal Year 1991 (in millions of current dollars)



SOURCE: U.S. Department of Energy, *United States Department of Energy Fiscal Year 1992 Congressional Budget Request,* DOE/CR-0001 (Washington, DC: February 1991), vol. 4, p. 273.

The low penetration of several important energy efficient technologies indicates that Federal research cannot be limited strictly to technical improvements—there should be a commensurate Federal effort to demonstrate and market these technologies once they are developed. Such marketing requires ongoing evaluations of consumer, builder, and manufacturer preferences, as well as a detailed understanding of the barriers that prevent the wider adoption of these technologies. To assist the marketing effort, there could be more aggressive implementation of newer, efficient technologies in the building retrofit programs administered by DOE.

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74 H. Geller, J.P. Harris, M.D. Levine, and A.H. Rosenfeld, "The Role of Federal Research and Development in Advancing Energy Efficiency: A $50 Billion Contribution [o the US Economy," *Annual Review of Energy* 1987 (Palo Alto, CA: Annual Reviews, Inc., 1987), vol. 12, pp. 381-382.

75 M.A. Brown, L.G. Berry, and R.K. Goel, *Commercializing Government-Sponsored Innovations: Twelve Successful Buildings Case Studies,* ORNL/CON-275 *(Oak* Ridge, TN: Oak Ridge National Laboratory, January 1989), pp. 70-81.

Box 4-D—DOE Conservation Research and Development for Buildings: Four Successful Projects

A variety of energy conservation technologies associated with buildings has emerged from DOE-funded R&D projects. Many of the most important successes resulted from work initiated prior to the drastic cuts in the DOE conservation R&D budget that occurred in fiscal year 1982. A brief history of the development of four of these DOE-sponsored technology projects is given below: high-efficiency refrigerator compressors, high-efficiency refrigerator-freezers, solid-state fluorescent ballasts, and low-emissivity window coatings. This history is a limited but useful indication of the Federal R&D contribution to advancing building energy conservation.

High-efficiency refrigerator compressor—Using DOE funds, the Oak Ridge National Laboratory (ORNL) funded the development of a prototype high-efficiency refrigerator compressor from 1977 to 1981. This work was conducted by the Kelvinator Co., a major appliance manufacturer. Refrigerators and freezers account for about 10 percent of primary energy use in the residential sector, and compressors use between 70 and 85 percent of that energy. Through design changes in the refrigerator motor and suction muffler, Kelvinator achieved an improvement in compressor efficiency of 44 percent. By one estimate, this improvement will save $1,1 billion in consumer energy costs annually by 2005. According to the same source, DOE involvement in this project hastened commercialization by 2 years.[1]

High efficiency refrigerator-freezer—From 1977 to 1983, ORNL funded a project conducted by Amana Refrigeration, Inc. in cooperation with Arthur D. Little, Inc. to improve overall refrigerator-freezer efficiency. Six design changes were selected for the prototype model, including thicker cabinet insulation, relocation of the fan motor outside the freezer, improved door gaskets, and separate evaporators for the freezing and refrigerating sections. The resulting energy savings were 60 Percent.[2]

Although these refrigerators were not widely marketed, the success of this research contributed to the development of the 1990 and 1993 refrigerator standards under the National Appliance Energy Conservation Act (Public Law 100-12). In brief, the successful design changes in the prototype model compelled DOE to consider them in its refrigerator efficiency rulemaking under the National Energy Conservation Policy Act (Public Law 95-619; NECPA) in the early 1980s. Although the Department never promulgated real legally binding standards under NECPA, the California Energy Commission (CEC) set its 1992 refrigerator standard based on the DOE analysis behind this NECPA effort, which indicated the feasibility and cost-effectiveness of adopting the technologies incorporated in the DOE prototype. Subsequently, the 1992 CEC standard was used to develop the 1990 and 1993 NAECA refrigerator standards. Thus, DOE-funded research was instrumental in demonstrating technologies that were eventually used to guide the development of Federal appliance efficiency standards.[3]

1 H. Geller, J.P. Harris, M.D. Levine, and A.H. Rosenfeld, "The Role of Federal Research and Development in Advancing Energy Efficiency: A $50 Billion Contribution to the US Economy," *Annual Review of Energy 1987* (Palo Alto, CA: Annual Reviews, Inc., 1987), vol. 12, pp. 360-361, 391,

2 Ibid., p. 391.

3 David B. Goldstein, Natural Resources Defense Council, written communication to OTA, Oct. 11, 1991.

(Continued on next page)

Despite major successes in building and other energy technology R&D in the late 1970s and early 1980s, the DOE conservation R&D budget was severely cut in the 1980s (figure 4-4). These cuts stemmed from a major Federal R&D policy change introduced by the Reagan administration, which advocated a shift toward private sector funded R&D. As a result, DOE conservation R&D budget requests were lower than the actual budgets authorized by Congress from fiscal years 1983 through 1990. In fiscal year 1983, the administration's conservation R&D budget request for buildings, industrial, and transportation activities was zero.[76] Congress continued funding these conservation programs but at levels far below the 1979 to 1981 fiscal years.

The sharpest drop in the overall DOE conservation R&D budget was experienced in fiscal year

76 U.S. Congress, General Accounting Office, *Energy R&D: DOE's Allocation of Funds for Basic and Applied Research and Development*, GAO/RCED-90-148BR (Gaithersburg, MD: May 1990), p. 24.

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Box 4-D—DOE Conservation Research and Development for Buildings: Four Successful Projects-Continued

Solid-state fluorescent ballast-In 1977, researchers at Lawrence Berkeley Laboratory (LBL), another DOE-funded national energy lab, began work on solid-state fluorescent ballasts, a technology that had promising theoretical potential at the time but had not yet been developed. With DOE funding, LBL began working with two small contractors to develop these ballasts; none of the major ballast manufacturers decided to participate in this effort. DOE was involved in this effort until 1980, shortly after the efficacy of the new ballasts was demonstrated in several test projects, including one at a Veterans Administration medical facility in Long Beach, California. These ballasts allow about a 25 percent reduction in fluorescent lighting energy use without losses in illumination. By one estimate, DOE involvement hastened commercialization of this technology by 5 years.[4] At present, solid-state ballasts are installed only in 3 percent of fluorescent fixtures in the United States.[5] However, their penetration in the new ballast market reached 10 percent in the first 6 months of 1991,[6] and future sales are projected to increase.[7]

Low-E **window** coating--Low-emissivity (low-e) coatings are designed to reduce heat loss or gain through windows. Similar to other DOE projects begun in the late 1970s and early 1980s, initial industry interest in researching and developing this technology was low. Windows account for significant heat transfers in buildings; as noted in chapter 2, the R-value (or resistance to heat transfer) of atypical wall in the United States is 15, whereas a single-pane window has an R-value of just 1. Low-e coatings increase window R-values. As noted in chapter 2, low-e double-pane windows presently on the market have R-values ranging from 2.5 to 3.2, an improvement over the uncoated double-pane R-value of 2. As with solid-state ballasts, DOE funded this project through LBL. The initial DOE interest and financial backing in the low-e project contributed to its early progress, which prompted window manufacturers to invest $150 million of their own funds in this effort by the mid-1980s. Commercialization of the first low-e window coatings, despite a few early setbacks, occurred in 1983, an estimated 5 years sooner than it would have without DOE support.[8] Today, large window manufacturers offer low-e glass as an option for almost all of their products.[9]

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4 H. Geller, J.P. Harris, M.D. Levine, and A.H. Rosenfeld, "The Role of Federal Research and Development in Advancing Energy Efficiency: A $50 Billion Contribution to the US Economy," *Annual Review of Energy 1987* (Palo Alto, CA: Annual Reviews, Inc., 1987), vol. 12, pp. 360,379-383.

5 U.S. Department of Energy, Office of Conservation and Renewable Energy, *A Compendium of Energy Conservation Success Stories 90, DOIZKH1OO93-83* (Washington, *DC: December* 1990), p. 19.

6 Figure refers to sales for the first two quarters of 1991. U.S. Department of Commerce, Bureau of the Census, *Current Industrial Reports: Fluorescent Lamp Ballasts, Second* Quarter 1991 (Washington, DC: September 1991), p. 1.

7 Arthur D. Little, Inc., *Supply and Demand of Compact Fluorescent Lamps and Electronic Ballasts* (Cambridge, MA: January 1991), p. 17.

8 H. Geller, J.P. Harris, M.D. Levine, and A.H. Rosenfeld, "The Role of Federal Research and Development in Advancing Energy Efficiency: A $50 Billion Contribution to the US Economy," *Annual Review of Energy 1987 (Palo Alto,* CA: Annual Reviews, Inc., 1987), vol. 12, pp. 360,383-390.

9 J. Trombly, "Window Company Standardizes Low-E Glass," *Home Energy,* May/June 1990, pp. 6-7.

1982, when funding dropped 71 percent from $300.1 million to ***$87.2*** million (current dollars). While the total DOE conservation R&D budget has been increasing modestly since 1982, the 1991 budget in current dollars was only 62 percent of the 1980 budget. The 1991 DOE buildings conservation R&D budget in current dollars was only 44 percent of the 1980 **budget**.[77] This is not to suggest that the 1980 funding level was optimal, but it serves as a benchmark for other fiscal years, because it was the largest conservation R&D budget in DOE history.

While funding is critical, the Federal commitment to energy conservation R&D cannot be measured solely by budget size. Other important measures of Federal coremitment to energy conservation R&D include the actual division of overall funding between basic and applied research, the mix of R&D

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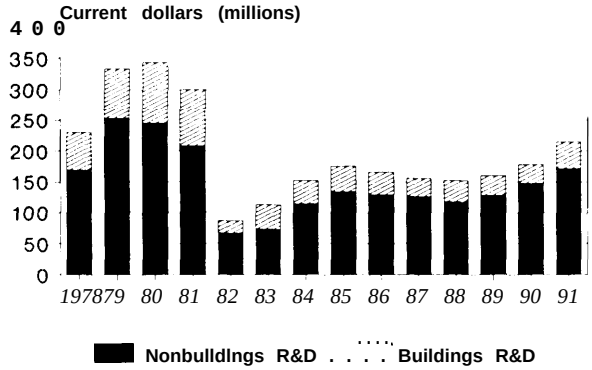
77 In current dollars, the total DOE conservation R&D budget was $343.7 million in 1980 and $214.7 million in 1991. The DOE building conservation R&D budget in current dollars was $98,3 million in 1980 and $43.1 million in 1991. The 1980-82 data are from F.J. Sissine, U.S. Library of Congress, Congressional Research Service, IB85130, *Energy Conservation: Technical Efficiency and Program Effectiveness,* CRS Issue Brief, April 1991. The 1991 data are from U.S. Department of Energy, *United States Department of Energy Fiscal Year 1992 Congressional Budget Request,* DOE/CR-0001 (Washington DC: February 1991), vol. 4, p. 273.

Figure 4-4--U.S. Department of Energy Conservation Research and Development Budgets, Buildings Versus Nonbuildings Funding, Fiscal Years 1978-91



SOURCE: Fiscal years 1978 to 1989 from F.J. Sissine, U.S. Library of Congress, Congressional Research Service, *Energy Conservation: Technical Efficiency and Program Effectiveness,* CRS Issue Brief 85130 (Washington, DC: Congressional Research Service, April 1991); fiscal years 1990 and 1991 from U.S. Department of Energy, *United States Department of Energy Fiscal Year 1992 Congressional Budget Request,* DOEfCR-0001 (Washington, DC: February 1991), vol. 4, p, 273.

funding divided between end-use sectors and fuel types, the degree to which technology demonstration and transfer play a role in R&D, and the level of private sector involvement and cost sharing. Thus, simply raising the DOE conservation R&D budget will not by itself ensure program success. At least as important, for example, will be a well-defined R&D plan along with a steady level of funding, at whatever level, particularly if Congress hopes to maximize private sector cooperation in DOE R&D efforts.

Building Codes and Appliance Standards

Building codes are legally binding requirements that apply to structures and their occupancy to ensure public health, safety, and welfare. Although the traditional focus of code efforts has been health and safety (e.g., sanitation and fire protection), energy efficiency has assumed greater prominence in building code development in the last two decades. While codes are adopted and enforced locally, few municipalities develop their own codes; instead, four major organizations develop and publish model building codes for State and local use: the Building Officials & Code Administrators International, the International Conference of Building Officials, the Southern Building Code Congress International, and the Council of American Building Officials, which is a federation of the first three organizations .78

Appliance efficiency standards are legally binding requirements designed to ensure minimum efficiency levels in new products. As discussed below, Federal programs in the last 20 years have been involved in building codes and standards, as well as appliance efficiency standards.

Building Codes and Standards

Two Federal agencies, the Departments of Energy and Housing and Urban Development, have been active in the development of model or actual building energy codes and standards. Although the number of buildings constructed annually for Federal Government use is limited, the government directly finances about 27 percent of new home mortgages through the Federal Housing Administration, the Veterans Administration, and the Farmers Home Administration.[79] Eligibility requirements for Federal financing can directly influence building design and construction.

Building Energy Performance Standards (BEPS)—Under authority of the Energy Conservation and Production Act (Public Law 94-385), DOE first issued draft building energy performance standards (BEPS) in 1979 for new commercial and residential buildings. The BEPS compliance approach was highly innovative, and DOE considered it to be a ''radical departure from standard practices of the building community. ' '[80] Yet BEPS offered no

78 National *Association* of Home Builders, *Understanding Building Codes and Standards in the United States, rev.* ed. (Washington, DC: 1989), pp. 7-8.

79 This figure represents the portion of total mortgages applying t. new, privately owned one-family houses sold in 1990. See U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States: 1991,* 111th ed. (Washington, DC: U.S. Government Printing Office, 1991), p. 721.

8052 *Federal Register* 17053 (May 6, 1987). The most significant aspect of the proposal was the introduction of the ' 'whole building energy budget. ' The standards set a maximum energy consumption level for a type of building in a given climate, In all, DOE approved 21 types of buildings and 78 climate zones; each commercial building type had an assigned energy budget for each climate zone. The proposed standard required the use of computer simulation to demonstrate that a proposed building design met the prescribed energy level. The residential proposal included prescriptive packages, but the standard was unclear about whether compliance with the prescriptive package also met the energy budget requirements.

guidance on how to comply with defined energy budgets. Although the performance approach had been available in the prevailing building standard issued by ASHRAE,[81] builders rarely used it. Given this unfamiliarity with performance criteria, therefore, most of the 1,800 comments DOE received on the initial proposed rule claimed that BEPS was unsuitable for a mandatory building standard. Many comments stressed the difficulty of calculating energy performance formulas and the likely costs of computer analysis necessary to demonstrate compliance.

More than 1,000 comments maintained that the ASHRAE standard would be a preferable substitute.[82] Many States had already adopted the ASHRAE standard, which contained the traditional criteria familiar to the building community. The following year, Congress restricted mandatory building energy standards to the Federal sector, making BEPS voluntary for all other sectors.[83] DOE was also required to project the impact of the standard on construction costs, design, and expected energy savings; the impacts of the residential standards on the ability of low- and moderate-income persons to purchase or rent buildings had to be assessed as well.[84] In addition, Federal building standards were required to meet the life-cycle cost criteria detailed in the Code of Federal Regulations.[85]

DOE has established three separate standards to comply with its revised mandate. The frost, the interim mandatory standards for new Federal residential buildings, was proposed in 1986.[86] The crux of the standard is the Conservation Optimization Standard for Savings in Federal Residences (COST-SAFR) program, a computerized calculation procedure designed to select the most cost-effective measures available for the building on a life-cycle basis. The program assigns values to the measures, allowing builders to decide whether to meet or exceed the energy consumption goal for the building type, A DOE economic analysis of these energy standards concluded that life-cycle cost savings would average about $760 per unit.[87]

The second, voluntary standards for new commercial and multifamily high-rise residential buildings, were published in 1989.[88] DOE planned to publish the third standard, voluntary nonfederal residential guidelines (VOLRES), in June 1991.[89]

Minimum Property Standards—Through a variety of legislation, Congress has directed HUD to issue an energy standard for housing programs within the agency and for manufactured homes. The Federal Government first issued the Minimum Property Standards (MPS) in the 1950s to establish energy criteria for homes using federally financed mortgages.[90] The standard limited the level of household utility expenses and reduced the rate of default on home mortgage loans. The latest MPS is the 1984 version developed by HUD. In November of 1990, HUD issued a proposed rule for adopting an updated energy standard. The rule proposes that 'all detached one and two family dwellings and one family townhouses not more than three stories in height shall comply with CABO Model Energy Code, 1989 Edition, including 1990 supple-

81 ASHRAE is the American Society of Heating, Refrigerating and Air-Conditioning Engineers. ASHRAE standards are commonly used in building design.

82 52 *Federal Register 17054* (May 6, 1987).

83 Housing and Community Development Act of 1980, Public Law 96-399, sec. 326; and Omnibus Budget Reconciliation Act of 1981, Public Law 97-35, Title X, Subtitle D.

84 42 U.S.C. 6833(a)(l)-(2).

85 10 CFR Part 436, Subpart A. Life. cycle cost (LCC) is a method of economic evaluation that estimates the costs and savings Over the life Of the item in question. Federal agencies are required to use the method when evaluating new building designs.

86 51 *Federal Register 29754* (Aug. *20,* 1986). This proposal became a final interim rule in 1988. A final rulemaking cannot be promulgated until DOE conducts a demonstration of the final interim standards and reports the results to Congress. See 53 *Federal Register 32536* (Aug. 25, 1988).

87 U.S. Department of Energy, Office of Building and Community Systems, Economic Analysis in *Support of Interim Energy Conservation Standards for New Federal Residential Buildings,* DOE/CE-0223 (Washington, DC: June 1988), vol. 4, pp. vi, 3.8.

88 54 *Federal Register* 4538 (Jan. 30, 1989). See 10 CFR Part 435.

89 B. Reid Detchon, Principal Deputy Assistant Secretary, office of Conservation and Renewable Energy, U.S. Department of Energy, testimony at hearings before the Senate Subcommittee on Energy Regulation and Conservation, Committee on Energy and Natural Resources, Mar. 19, 1991, p. 2. As of December 1991, these standards had not been issued.

90 The National Housing Act, 12 U.S.C. 1702 authorizes the Secretary of Housing and Urban Development to prescribe standards for determining the acceptability of dwellings for families and care-type facilities. The standards are to ''establish the acceptability of. . properties for mortgage insurance. . .' 12 U.S.C. 1715l(f).

Table 4-2—Federal Energy Standards for New Buildings

Code	Application	Status
HUD Minimum Property Standards (1950s)	Residential buildings receiving Federal mortgages	To be replaced with Council of American Building Officials 'Model Energy Code' (1989 edition)
National Manufactured Housing Construction and Safety Standards (1974)	All manufactured housing	Active
DOE Building Energy Performance Standards (1979)	All new construction	Never implemented; supplanted by performance standards listed below
DOE Mandatory Performance Standards for New Federal Residential Buildings (1989)	Federal residential construction (95 percent is military housing)	Active
DOE Energy Performance Standards for New Commercial Buildings (1990)	Mandatory for Federal commercial buildings. Voluntary for private sector commercial buildings.	Active
DOE voluntary guidelines for nonfederal residential buildings	Voluntary standards for nonfederal residential buildings	Under development; issuance pending

SOURCE: Office of Technology Assessment, 1992.

ments. . ."[91] An interim rule has been drafted and is awaiting approval by the Office of Management and Budget (as of December 1991).

Manufactured Home Construction and Safety Standards—The National Manufactured Housing Construction and Safety Standards Act of 1974 (Public Law 93-383) sought to reduce the number of accidents in manufactured homes and assure their quality and durability .92 The construction standard that emerged from the act also contained provisions for building shells and heating and cooling systems. In 1990, Congress passed legislation directing HUD to assess current Federal standards on manufactured homes.[93]

Table 4-2 lists Federal standards bearing on building energy efficiency.

Appliance Standards

National Appliance Energy Conservation Act—This legislation was passed nearly 12 years after Congress first became concerned about appliance energy use (box 4-E). The statute and its amendments establish minimum efficiency or maximum energy use standards for appliances listed as covered products under the Energy Policy and Conservation Act (Public Law 94-163) as amended. The current group of covered products is listed in table 4-3. The NAECA standards apply to these covered products.

The NAECA established numerical standards for most (7 of 13) of the appliance categories (e.g., refrigerators, room air-conditioners, central air-conditioners, furnaces, and fluorescent lamp ballasts); other covered products were given design standards. As required by law, subsequent DOE rulemakings have strengthened the energy requirements

91 55 *Federal Register* 46637 (Nov. 5, 1990).

92 42 U.S.C. 5401-5425.

93 Public Law 101.625, 104 Stat. 4414, sec. 943(d) HUD recently proposed amendments to these standards. 57 *Federal Register 6420* (Feb. 24, 1992).

Box 4-E—A Brief History of the National Appliance Energy Conservation Act of 1987

In 1975, Congress passed the Energy Policy and Conservation Act (EPCA), requiring the Federal Energy Administration (FEA), later succeeded by the Department of Energy (DOE), to develop voluntary appliance efficiency targets. These targets were required to represent reductions in energy use of new appliances of at least 20 percent by 1980 compared to their known 1972 levels.

By the end of 1978, the new Federal DOE had been established, assuming the duties of the now defunct FEA, and had been directed to develop mandatory appliance efficiency standards for 13 categories of new products under the National Energy Conservation Policy Act (NECPA); the statute identified nine of these covered products as priorities for standard setting. On January 2, 1979, DOE published an advance notice of proposed rulemaking for the nine priority products.[1] As required by NECPA, this required DOE to promulgate final standards by January 2, 1981.[2]

DOE proposed standards for 8 of the 13 covered products in June 1980.[3] The following January, DOE notified Congress that the new appliance standards were essentially complete.[4] Later that month, however, the newly arrived Reagan administration requested that Congress repeal the DOE appliance standards program on the grounds that it represented inappropriate regulatory policy. The next month, after Congress had not acted on the administration proposal, DOE announced that a new review of the economic analysis underlying the standards was necessary before the Department could promulgate them.[5] In October, a citizen suit was brought against DOE to compel promulgation of the standards, which by then were delinquent 10 months.[6] The suit was settled in 1982, after DOE published a notice of proposed rulemaking for eight of the nine priority covered products; the notice proposed that "no standards" standards be adopted.[7]

Arguing that standards were neither economically justitified nor likely to result in significant energy savings, DOE actually promulgated the proposed "no standards" standards through rulemakings for eight of the covered products in late 1982 and 1983.[8] This prompted the filing of a second citizen suit in late 1983 in the U.S. Court of Appeals for the District of Columbia Circuit. The suit challenged the "no standards" standards as contrary to law. Agreeing with the petitioners, the Court voided the DOE rules in July 1985 as arbitrary and capricious interpretations of the EPCA as amended and directed DOE to initiate a new rulemaking.[9]

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1 44 *Federal Register* 49.

2 "A rule prescribing an energy efficiency standard for a type (or class) Of covered products. . .shall be published. . .in no 'vent later than 2 years after publication of the advance notice." Public Law 95-619,92 Stat. 3262, sec. 422.

345 *Federal Register 43976* (June 30,1980).

4 R. Alta Charo, L.R. Stearns, and M. Case, "Overview of Legal Issues Arising in the Development of Federal and State Appliance Efficiency Standards," *Columbia Journal of Environmental Law, vol.* 11, No. 2, 1986, p. 322.

5 Ibid., p. 322.

6 *Natural Resources Defense Council v. Edwards, Civ.* No. 80-2546 (D.D.C.).

747 *F&feral Register* 14424 (Apr. 2, 1982).

8 See 47 Federal *Register* 5'7198 (Dec. 22, 1982) and 48 *Federal Register 39376* (Aug. 30,1983).

9 *Natural Resources Defense Council v. Herrington, 768* F.2d 1355 (D.C. Cir. 1985).

mandated by NAECA. The covered products and their corresponding energy use, efficiency level, or design requirements under NAECA are listed in table 4-4.

As there are multiple NAECA standards for most of the product categories, table 4-4 lists for simplicity only one standard based on a generally representative size and design.[94] As table 4-4 indicates, there is often a large difference between the energy use or efficiency of appliances meeting the NAECA standards and the same for the best models that are listed as commercially available. However, these products are not always comparable. For example, the criteria used to determine what constitutes commercial availability can vary considerably; some commercially available products may be more expensive,

94 For example, there are seven separate NAECA numerical standards for refrigerator-freezers, based *on varying sizes* and designs (e.g., with or without through-the-door ice service), but the standard shown in table 4-4 applies to units having designs that account for approximately 73 percent of new refrigerator and refrigerator-freezer sales. See 54 *Federal Register 47935 (Nov. 17, 1989).*

During the 1970s and 1980s, California and a few other States had established their own appliance efficiency standards. The emerging mix of State standards, in fact, motivated the appliance manufacturing industry to seek uniform national standards. As a result, the major appliance manufacturer organizations began negotiations in early 1986 with the Natural Resources Defense Council to develop national standards. An agreement was reached in July 1986, which was subsequently written as proposed legislation and was based on previously enacted State standards. This legislation was introduced in August 1986 in both Houses of Congress (H.R. 5465, S. 2781). After waiting nearly 7 years for standards, Congress passed H.R. 5465 on October 15, 1986. Unlike previous legislation, H.R. 5465 proposed actual minimum standards to be established by statute for the EPCA covered products. However, President Ronald Reagan pocket-vetoed the measure on November 1, 1986 on the argument that appliance efficiency standards were not consonant with the administration's policy of minimal Federal regulatory involvement in the marketplace.[10]

The next year, however, Congress passed an essentially identical bill (S. 83, or the National Appliance Energy Conservation Act) on March 3, and President Reagan signed it on March 17,1987. Amendments to NAECA, passed in 1988 (Public Law 100-357), added fluorescent lamp ballasts to the list of EPCA covered products and established minimum efficiency levels for them. As discussed in the text, DOE has already upgraded many of these standards, as required by law.

10 The official Memorandum of Disapproval maintained that" [t]he bill intrudes unduly on the free market, limits the freedom of choice available to consumers who would be denied the opportunity to purchase lower-cost appliances, and constitutes a substantial intrusion into traditional state responsibilities and prerogatives." Senate Report No. 100-6, Jan. 30, 1987, p. 4. See U.S. Code Congressional and Administrative News, 100th Congress-First Session, 1987, vol. 2, p. 55.

may serve only niche markets, or may not provide identical or comparable services as their more widely sold counterparts. The intended point of the table is that there is often a large efficiency gap between the average product sold and the best commercially available one. Chapter 5 offers options to encourage greater use of cost-effective energy efficient appliances.

Energy savings—Researchers at the Lawrence Berkeley Laboratory (LBL) examined the effect of the NAECA appliance standards before DOE began updating the original statutory targets. The study determined that NAECA would yield a total estimated electricity savings of 822 terawatthours (TWh), or roughly 2.8 quadrillion Btus (quad) of end-use energy, for appliances purchased between 1990 and 2015. This energy savings translates to net dollar savings estimated at $24.5 billion.[95]

A major strength of the LBL study was that it measured the energy and economic impacts separately by each DOE region, finding that net social benefits of NAECA will be positive for all regions.[96]

Table 4-3—Covered Products Under the Energy Policy and Conservation Act, as Amended

1.	Refrigerators, refrigerator-freezers, freezers
2.	Room air conditioners
3.	Central air conditioners (CACs) and CAC heat pumps
4.	Water heaters
5.	Furnaces
6.	Dishwashers
7.	Clothes washers
8.	Clothes dryers
9.	Direct heating equipment
10.	Kitchen ranges and ovens
11.	Pool heaters
12.	Television sets
13.	Fluorescent lamp ballasts

SOURCE: 42 U.S.C. 6292(a). Under certain conditions, EPCA authorizes the Secretary of Energy to add appliances to the list of covered products. 42 U.S.C. 6292(b).

The study estimated that national electricity savings will be 2.5 percent, while the savings for all fuels will be less, about 0.8 percent.[97]

The effective dates for the NAECA standards are 1988, 1990, 1992, and 1993, depending on the appliance. DOE is required to review (and update

95 Expressed as 1987 dollars and based on a 5 percent real discount rate. This figure represents the sum of electricity savings ($30.7 billion) and fuel savings ($8.2 billion) less incremental appliance costs ($14.5 billion). The LBL researchers estimated the lifetime energy savings of NAECA appliances purchased between 1990 and 2015, These estimates, therefore, include energy savings beyond 2015. J.H. Eto, J.E. McMahon, J.G. Koomey, P.T. Chan, and M.D. Levine, *The Regional Energy and Economic Impacts of The National Appliance Energy Conservation Act of 1987, LBL-25471* (Berkeley, CA: Lawrence Berkeley Laboratory, June 1988), pp. 11, 13.

96 Ibid., p. 19.

97 Ibid., p. 11.

Table 4-4-National Appliance Energy Standards and Efficiencies

Covered product	NAECA standard	Average shipped	Best available
Refrigerator-freezers [a]	960 kWh/yr(I 990) 688 kWh/yr (1 993)	884 kWh/yr (1 990)	840 kWh/yr (1 989)
Freezers [b]	706 kWh/yr (1 990) 533 kWh/yr (1 993)	679 kWh/yr (1 990)	585 KWh/yr (1 989)
Room air conditioners [c]	9.0 EER (1990)	8.7 EER (1990)	12.0 EER (1990)
Heat Pumps [d]	10.0 SEER (1992) 6.8 HSPF (1 992)	9.1 SEER (1988) 6.9 HSPF (1988)	16.4 SEER (1 989) 9.2 HSPF (1989)
Water heaters [e]:			
Electric	*88.4%* EF (1990)	—	98.0% EF (1 990)
Natural gas	52.50/' EF (1990)		74.0% EF (1990)
Furnaces [f]	78.00/' AFUE (1 992)	750/0 AFUE (1988)	97.30/0 AFUE (1989)
Dishwashers	Shall have option to dry without heat (1988) Energy factor 0.46 (1994)	Energy factor 0.37 (1990)	·
Clothes washers [h]	Shall have option to rinse without heat (1 988) Energy factor 1.18 (1994)	Energy factor 0.99 (1990)	—
Clothes dryers [i]	Gas operating machines shall not be equipped with constant burning pilots (1988) Energy factor 3.01 (1994)	N/A	N/A
Direct heating equipment	See 42 U.S.C. 6295(e)(3)	N/A	N/A
Kitchen ranges and ovens	Gas operating machines having an electrical supply cord shall not be equipped with constant burning pilots (1990)	N/A	N/A
Pool heaters	Thermal efficiency of at least 78%(1 990)	—	—
Television sets	Reserved by NAECA; DOE may prescribe rule no sooner than 1992 [j]	N/A	N/A
Fluorescent lamp ballasts	See 42 U.S.C. 6295(g)(5)-(6).	—	—

[a] NAECA refrigerator-freezer standards shown here are for automatic defrost units with top-mounted freezers, no through-thedoor ice, and with adjusted volumes of 20.8 cubic feet. Data for 1990 average shipped products from Robert M. Gants, Association of Home Appliance Manufacturers, written communication to OTA, Oct. 18, 1991. Data for 1989 best available products refer to automatic defrost units with top-mounted freezers having unadjusted volumes of 18.0 cubic feet. See American Council for an Energy-Efficient Economy, *The Most Energy-Efficient Appliances -1989-90 Edition* (Washington, DC: 1989), p. 5.

[b] NAECA freezer standards shown here apply to upright, manual defrost units with an adjusted volume of 26.1 cubic feet. Data for 1890 average shipped products from Robert M. Gants, Association of Home Appliance Manufacturers, written communication to OTA, Oct. 18,1991. Data for 1989 best available product refers to an upright, manual defrost unit with an unadjusted volume of 15.8 cubic feet. See American Council for an Energy-Efficient Economy, *The Most Energy-Efficient Appliances -1989-90 Edition* (Washington, DC: 1989), p. 8. *Note:* Using DOE methods for adjusting freezer volumes, this best available unit has an adjusted volume of 27.3 cubic feet. See 10 CFR Part 430, Subpart B, Appendices Al and B1.

[c] NAECA room air conditioner standard shown here applies to units without reversecycle, with louverd sides, and with capacities ranging from 8,000 to 13,999 Btus. Data for 1990 average shipped products from Robert M. Gants, Association of Home Appliance Manufacturers, written communication to OTA, Oct. 18, 1991. Data for 1990 best available product from Association of Home Appliance Manufacturers, 1991 *Directory of Certified Room Air Conditioners,* Edition No. 1 (Chicago, IL: October 1990).

[d] NAECA heat pump standards shown here apply to split (rather than single package) systems. The NAECA SEER standards appiy to central air conditioning systems as well. Data for average shipped from "Integrated Heat Pump System," *EPRIJournal, vol. 15, No. 2,* March 1990, p. 41. Data for best available from American Council for an Energy-Efficient Economy, *The Most Energy Efficient New Appliances -1989-90 Edition* (Washington, DC: 1989), p. 18.

[e] NAECA water heater standards are adjusted in inverse proportion to heater volume; i.e., the standards are eased with increasing size. The standards shown here apply to 50 gallon units. Data for best available from Gas Appliance Manufacturer's Association, *Consumer's Directory of Certified Efficiency Ratings* (Arlington, VA: October 1989), pp. 134, 163.

[f] Data for average shipped and best available gas furnaces from American Council for an Energy-Efficient Economy, The *Most Energy Efficierrt New Appliances 1989-90 Edition* (Washington, DC: 1989), pp. 21-22.

[g] Energy factor refers to cycles per kWh. Standard shown here refers to standard size dishwashers (exterior width of 22 inches or greater), 1994 standard for compact dishwashers (exterior width less than 22 inches) is energy factor 0,62. See 56 *federal Register 22279.* By DOE estimates, this standard level will correspond to an average annual energy consumption of 498 kWh for new dishwashers. See U.S. Department of Energy, *Technical Support Document: Energy Conservation Standards for Consumer Products: Dishwashers, Clothes Washers, and Clothes Dryers, DOE/CE-0299P* (Washington, DC: December 1990), p. 5-2.

[h] Energy factor refers to Cubic feet per kilowatts per year, Standard shown here applies to top loading standard models (capacities of 1.6 cubic feet or greater). Revised NAECA standard for top loading compact units (capacities less than 1.6 cubic feet) is an energy factor of 0.90. See 56 *Federal Register 22279.* The 1988 standard for top loading semiautomatic, front-loading, and suds-saving clothes washers were unchanged by this rulemaking.

[i] Energy factor refers to pounds per kilowatts, Standard shown here refers to standard size (capacities of 4.4 cubic feet or greater) electric clothes dryers. There are three additional standards for clothes dryers (two for compact electric units and one for natural gas units). See 56 *Federal Register 22279.* Average and best available energy factors for clothes dryers are not readily available, because the FTC exempts these appliances from its energy labeling program. See U.S. Department of Energy, Office of Codes and Standards, *Technical Support Document: Energy Conservation Standards for Consumer Products: Dishwashers, Clofhes Washers, and Clofhes Dryers,* DOE/CE-0299P (Washington, DC: December 1990), p. 4-5.

[j] See 42 U.S.C. 6295(i)(3).

KEY: kWh/yr - kilowatthours per year; EER - energy efficiency ratio; SEER - seasonal energy efficiency ratio; HSPF - heating seasonal performance factor; EF = efficiency factor; AFUE - annual fuel use (or utilization) efficiency; N/A = not readily available. Appliance energy information for these products is not readily available, because FTC rules exempt these appliances from Federal labeling requirements.

NOTE: The figures for average sold and best available products are preliminary and are subject to change.

where necessary) all of these standards within 3 to 10 years, depending on the appliance. New or amended standards are required to achieve the maximum improvement in energy efficiency (or the maximum reduction in energy use) that is both technologically feasible and economically justified.[98] In no case may DOE revisions to NAECA standards allow a decrease in the efficiency, nor an increase in the energy use, of covered products. Table 4-5 lists DOE statutory deadlines for revising NAECA standards,

As table 4-5 indicates, DOE has issued two final rulemakings that update the original NAECA statutory standards: refrigerators, refrigerator-freezers, freezers, and small gas furnaces (November 1989) and dishwashers, clothes washers, and clothes dryers (May 1991). LBL researchers have estimated that the two revised rulemakings will generate *additional* savings (beyond the original, unrevised standards) of about 7.5 quads primary energy for appliances purchased from 1993 through 2015. These savings are worth an estimated net present value of about $11.4 billion.[99]

Information Programs

Appliance Labels

The Energy Policy and Conservation Act (Public Law 94-163; EPCA), as amended, requires the Federal Trade Commission (FTC, or the Commission) to develop and promulgate appliance energy labels for 13 covered products, *m The FTC is directed to label only those covered products for which DOE has prescribed test procedures that measure either the efficiency or energy use of a given appliance. An underlying principle of this program is that lack of information about comparative product efficiencies and operating costs prevents consumers from identifying and purchasing more efficient appliances. As a result, EPCA requires appliance labels to list estimated annual operating costs for each product, as well as the range of operating costs for other commercially available products in the same appliance class. The estimates of annual operating costs are provided in the belief that consumers can make more informed appliance purchase decisions when they possess reliable information about comparative product efficiencies.[101]

The Commission promulgated the first labeling rule in November 1979, establishing label formats for 7 of the 13 covered products: refrigerators and refrigerator-freezers, freezers, dishwashers, water heaters, clothes washers, room air conditioners, and furnaces,[102] The remaining covered products were exempted, because the Commission determined that labeling them would not be economically feasible, would not assist consumers in making purchase decisions, or both. In many cases, the estimated added costs of product labeling resulted in a labeling exemption on economic grounds.[103]

The Commission's decision to exempt the five covered products from labeling were based on DOE estimates of energy use and appliance industry analyses of labeling costs. In most cases, the FTC appliance labeling exemptions appear to have been

98 42 U.S.C. 6295(l)(2)(A).

99 Expressed as 1987 dollars using a real discount rate of 7 percent. (These summary figures include savings from small gas furnaces purchased from 1992 through 2015.) Estimated savings for the November 1989 rulemaking are given in U.S. Department of Energy, Office of Conservation and Renewable Energy, Building Equipment Division, *Technical Support Document: Energy Conservation Standards for Consumer Products: Refrigerators and Furnaces, DOE/CE-0277* ('Washington DC: November 1989), pp. 5-7 to 5-15. Estimated savings for the May 1991 rulemaking are given in U.S. Department of Energy, Office of Conservation and Renewable Energy, Office of Codes and Standards, *Technical Support Document: Energy Conservation Standards for Consumer Products: Dishwashers, Clothes Washers, and Clothes Dryers,* DOE/CE-0299P (Washington, DC: December 1990), pp. 5-3 to 5-14.

100 As originally passed, EPCA covered products were the following: 1) refrigerators and refrigerator-freezers, 2) freezers, 3) dishwashers, 4) clothes dryers, 5) water beaters, 6) room air conditioners, 7) home heating equipment (not including furnaces), 8) television sets, 9) kitchen ranges and ovens, 10) clothes washers, 11) humidifiers and dehumidifiers, **12)** central air conditioners, 13) furnaces, and 14) any other type of consumer product defined by the Administrator of the Federal Energy Agency as covered. These duties were assumed by the Secretary of Energy when that Department formed in 1977, In addition, the National Appliance Energy Conservation Act of 1987 (Public Law 100- 12; NAECA) and its 1988 amendments (Public Law 100-3S7) added pool heaters and fluorescent lamp ballasts to this list (42 U.S.C. 6292). These statutes also extended the labeling requirements to the two new covered products (42 U.S.C. 6294). For a complete list of current EPCA covered products see the discussion in this chapter on appliance efficiency standards and table 4-3.

101 R.F. Dyer, ''A Longitudinal Analysis of the Impact of the Appliance Energy Labeling Program--Final Report, ' November 1986, prepared for the Federal Trade Commission, Office of Impact Evaluation, p. 2.

102 The decision t. label heat Preps and central air conditioners was postponed, because DOE had not completed test procedures for these two products. Label requirements for these covered products were promulgated in a later rulemaking. See 52 *Federal Register 46888 (Dec.* 10, 1987).

103 The appliances exempted from labeling were clothes dryers, home heating equipment other than furnaces, television sets, kitchen ranges and ovens, and humidifiers and dehumidifiers. 44 *Federal Register 66466 (Nov.* 19, 1979).

Table 4-5—DOE Schedule for Revising the NAECA Standards

Covered product	Final rule date
Round I	
Refrigerators, refrigerator-freezers, freezers, and small gas furnaces	November 17, 1989[a]
Dishwashers, clothes washers, and clothes dryers	May 14, 1991[b]
Room air conditioners, water heaters, pool heaters, direct heating equipment, fluorescent lamp ballasts, furnaces, clothes washers,[c] television sets, and kitchen ranges and ovens	January 1, 1992
Central air conditioners and central air conditioning heat pumps	January 1, 1994
Round II	
Furnaces	January 1, 1994
Refrigerators, clothes dryers, and dishwashers	January 1, 1995
Kitchen ranges and ovens, and room air conditioners	January 1, 1997
Water heaters, pool heaters, and direct heating equipment	January 1, 2000
Central air conditioners and central air conditioning heat pumps	January 1, 2001
Round III	
Furnaces	January 1, 2007

[a]54 Federal Register 47916. See 10 CFR Part 430. This revised rule was due July 1, 1989.42 U.S.C. 6295.
[b]56 Federal Register 22250. See 10 CFR Part 430. This revised rule was due January 1, 1990.42 U.S.C. 6295.
[c]DOE is reevaluating the NAECA standards for clothes washers so soon after revising the original standard, because horizontal axis technology was not considered in the May 1991 rulemaking from lack of public interest during the comment period. Because they require considerably less water than conventional vertical axis machines, horizontal axis products, which are common in Europe, consume far less energy.

SOURCE: Adapted from U.S. Department of Energy testimony in hearings before the House Subcommittee on the Department of the Interior and Related Agencies, Committee on Appropriations, Apr. 30, 1991. See *Department of the Interior and Related Agencies Appropriations for 1992* (Washington, DC: U.S. Government Printing Office, 1991), part 11, p. 1438.

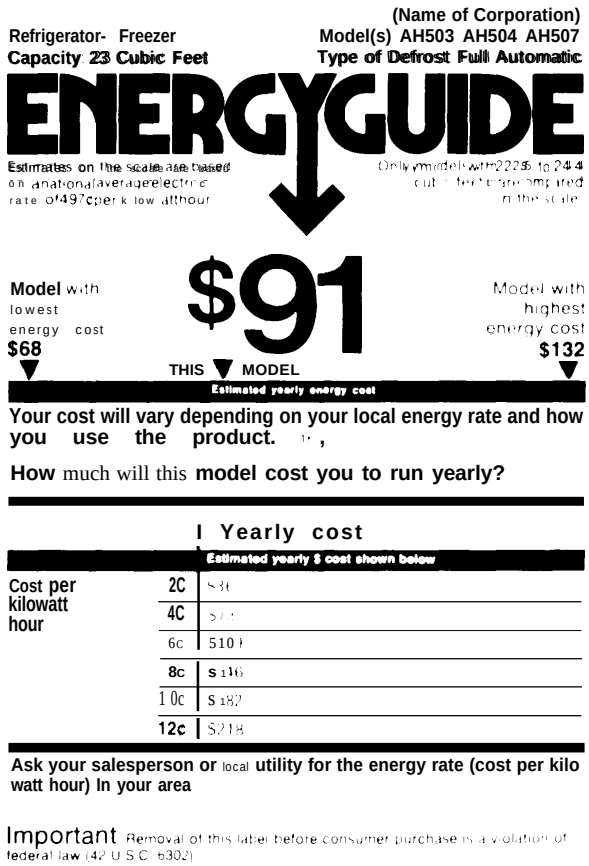


Photo credit: Federal Trade Commission

The Federal Trade Commission requires many new appliances to display labels that indicate the units' expected energy use or efficiency.

well considered. For example, the Commission found that all humidifiers operate at the maximum possible efficiency (exceeding 95 percent) and their operating costs are all basically equal, the difference between the lowest and highest energy users amounting to less than $1 per year. As a result, the Commission reasoned that the additional costs of labeling humidifiers were not warranted and that such labeling would not assist consumers in making their purchase decisions. And television sets and some kitchen ranges and ovens were exempted, because their annual operating costs were extremely low, suggesting again that labels would not assist consumers in making their purchase decisions.[104]

However, the FTC exempted clothes dryers and heating equipment other than furnaces based on narrow ranges of appliance efficiencies and operating costs that existed in 1979. The rulemaking failed to evaluate (or at least indicate) opportunities for future improvements in either efficiency or operating costs. Electric clothes dryers, for example, showed a narrow range of operating costs in 1979 ($39 to $45 per year), but these total costs were not small. For some products, therefore, the FTC criteria

[104] 44 *Federal Register 66468-66469* (Nov. 19, 1979).

for determining the merits of labeling may be inadequate, because they fail to assess potential product improvements. And energy labels may spur improvement by encouraging manufacturers to increase product efficiencies, lower operating costs, or both when technical opportunities exist. Of course, the degree of that potential must be evaluated in relation to the costs of labeling.

The Commission has performed one evaluation of appliance label effectiveness in the 1 l-year history of the program. Completed in 1986, the study determined that roughly one-third of clothes washer buyers and nearly half of refrigerator buyers who were aware of the labels claimed that the information affected their purchase decisions. [105] In addition, the evaluation suggested that appliance labels served an increasingly important role in purchase decisions as the program progressed. The portion of consumers noting energy efficiency as an important attribute for refrigerators, for example, increased during the study period from nearly 12 percent in 1979 to about 21 percent in 1983. Questions about important appliance attributes were unaided and preceded any mention of energy use in the questionnaire. The actual role of the FTC labels in that change of consumer preference, however, was not assessed.[106]

Aside from this early and limited evaluation, the Commission has not performed any formal assessments of appliance energy labeling, even though new appliance efficiencies and operating costs have changed in the 12 years since the original rulemaking. At present, the Commission has no plans to conduct another labeling evaluation. Current efforts are focused on the completion of a rulemaking process begun in 1988, Dubbed the "cleanup rulemaking," because it will refine current labels, the Commission is considering several policy questions for this effort, such as whether the new NAECA standards will raise product efficiencies enough to render labels relatively unimportant. Also, the Commission is considering whether the required labels could be limited to display models—rather than every salable appliance-as a way to save costs,[107]

After 12 years, U.S. experience with appliance labeling is fairly extensive, but the value and impact of that experience remain poorly understood, primarily from a lack of regular program evaluation. The FTC appliance labeling program, however, reveals several interesting points for Congress to consider.

- Although consumers may consider energy information when making their appliance purchases, the actual value to consumers of the current FTC labels remains unclear. Regular evaluations covering more products would provide data on the merits of the appliance labels, whether and how to improve them, and the potential effects of limiting labels to display models. More regular evaluations would suggest whether consumers use the information on current labels and the kind of information that would best assist their appliance purchase decisions. Furthermore, if the FTC performs additional labeling evaluations, it should reassess the products currently exempted from the program.

The 1986 FTC evaluation confirmed that consumers use the information on appliance labels but did not determine if the labels could be improved. Also, program costs might decrease if labels were limited to display models, but consumers may be less likely to notice the labels as well. In fact, stores do not always display all of their appliance models. As a result, potential cost savings would have to be considered in relation to the primary program goal of providing information meant to assist consumer purchase decisions.

- Providing information about life-cycle costs might improve the value of current appliance energy labels, but determining such

105 R.F. Dyer, "A Longitudinal Analysis of the Impact of the Appliance Energy Labeling Program-Final Report," November 1986, prepared for the Federal Trade Commission, Office of Impact Evaluation, p. 7. However, the telephone questionnaire used in the surveys quizzed consumers about energy prior to the question about purchase decisions, suggesting that respondents may have been inadvertently cued ("aided") for the question about purchase decisions.

106 Ibid., p. 5. In nominal terms, U.S. residential electricity prices rose almost 55 percent in the study period (1979-83). This rise was equivalent to a real price increase of 17 percent (1982 dollars). See U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1989*, DOE/EIA-0384(89) (Washington, DC: May 1990), p. 217. Thus, rising prices may have been far more important than labels in motivating consumers to consider appliance efficiencies in their purchase decisions, but the FTC labels at least allowed consumers to make informed decisions about energy use if they were so interested.

107 James Mills, Attorney, Division of Enforcement, FTC, personal communication, Mar. 25, 1991. The notice for the proposed "cleanup rulemaking" is at 53 *Federal Register 22106* (June 13, 1988).

costs may be difficult. Life-cycle costs are the sum of purchase and operating costs discounted over the life of a product. At present, this information is not included on appliance energy labels, but it could influence consumer purchase decisions and drive the market to produce more efficient goods. Life-cycle cost information would impart more complete information about comparative appliance costs, but making allowances for retail price shifts and determining appropriate discount rates could complicate such an effort.

- Where labeling is not economically feasible or is not likely to assist consumers in making purchase decisions, other policy actions to improve energy efficiency, such as standards or incentives, may be more appropriate. For example, FTC furnace labels convey only information on how to use them efficiently; they are not designed for purchasers, because many furnace purchasers (builders, landlords) are generally not their users, effectively excluding users from purchasing decisions. As a result, standards or incentives may override critical market barriers to efficiency that exist when appliance purchasers are not users.

In addition, FTC appliance labels may increase the probability that consumers will be informed about comparative product efficiencies in their purchase decisions, but such information is not necessarily a critical determinant in those decisions. Concerns about first cost, reliability, warranty coverage, color and design, and special features (e.g., refrigerators offering through-the-door ice) may be more important to the majority of consumers. As a result, labels can be expected to inform consumers interested in appliance efficiency but not necessarily to inspire that interest.[108]

. The likelihood that the National Appliance Energy Conservation Act will compress the range of comparative efficiencies in new appliances suggests a need to reassess the value of the FTC labels as an information tool. The NAECA, passed in 1987, sets energy standards for new appliances. If this statute has the effect of compressing the efficiencies of new appliances, the costs and benefits of the FTC labels need to be reevaluated. The continued use of appliance energy labels could exert a market pressure that might spur appliance efficiency improvements even greater than will be realized under NAECA; alternatively, their continued use could represent an unwarranted administrative cost in a market that may become relatively uniform in terms of efficiency.[109]

- The information on the FTC labels is often used by utilities to determine rebates in their appliance efficiency programs. Utility programs offering rebates for the purchase of efficient appliances are becoming increasingly common,[110] and the FTC labels provide an accepted benchmark by which U.S. utilities can determine and advertise the efficiency of individual products.

Through regular evaluation and possible improvements or expansions, the FTC appliance labeling program could better fulfill the original rationale for its creation: to help consumers make more informed purchase decisions regarding appliance energy efficiency. The costs of such changes as well as their likely effects on consumer purchase decisions, however, need to be assessed before final determinations of their desirability can be made, especially given the new NAECA standards.

Building Energy Audits

There have been two major Federal programs designed to provide building owners and occupants with building-specific information about energy use

108 Other policy approaches—such as rebates, higher energy prices, or standards-maybe better tools to achieve efficiency, but they introduce their own costs as well. The tradeoffs (including estimations of cost-benefits) of using any policy tool need to be understood, but information programs generally exert effects, especially in relation to energy efficiency, that are difficult to measure.

109 Experience with appliance standards in California prior to the development of Federal standards suggests that such programs only temporarily compress the range of new product efficiencies. As noted by a staff member of the California Energy Commission, "data taken from manufacturer's [sic] directories before and after the adoption of [the California] standards indicate that the range of efficiencies available narrows only slightly in the frost year and expands to its pre standards range in the course of 2 to 3 years, " See M. Messenger, ''An Overview of California's Appliance Efficiency Programs, " *Proceedings From the ACEEE 1986 Summer Study on Energy Efficiency in Buildings* (Washington DC: American Council for an Energy-Efficient Economy, August 1986), vol. 6, p. 6.52.

110 For example, a survey of utility demand-side management efforts identified 91 appliance efficiency programs offered by 75 electric utilities and determined that rebates were the most common incentive used to promote these programs. See Battelle, *1988* Survey *of Residential-Sector Demand-Side Management Programs,* EPRI CU-6546 (Palo Alto, CA: Electric Power Research Institute, October 1989), pp. 4-1,4-10.

and potential savings through utility-sponsored audits. Neither exists today, because participating utilities lacked sufficient incentives to conduct the programs, State regulatory efforts have encouraged many utilities to develop their own conservation programs, and the administrative requirements for conducting the Federal programs were often onerous.

The two programs were the Residential Conservation Service (RCS), which expired in 1989, and the Commercial and Apartment Conservation Service (CACS), which was repealed in 1986. Though both of these programs have been terminated, at least one (RCS) offers clues about some of the key barriers and implementation problems confronted by Federal programs aimed at reducing energy use in buildings. In particular, national experience with the Residential Conservation Service illustrates that utilities can play a vita] role in implementing building energy conservation programs, especially when they are given adequate incentives for participat ion.

In addition, the RCS experience suggests the need to incorporate flexibility in the administration of national programs to allow States and utilities to tailor their programs according to their regional circumstances. Lessons from the RCS could assist Congress and Federal agencies working on similar demand management programs today, such as the DOE Weatherization Assistance program (discussed earlier).

Residential Conservation Service—The RCS was created with the expectation that residential consumers would invest in energy saving retrofits if they were given adequate information on how to reduce energy use in their homes. As with appliance labels, there was a general belief that lack of information was the decisive barrier preventing investments in residential energy efficiency. The expectation, however, proved optimistic, failing to recognize that other important barriers prevent investments in energy conservation, even when consumers are aware of the potential value of such investments. And even after retrofits have been completed, changes in occupant behavior (' 'rebound effect' or poor quality materials or workmanship can diminish actual savings. As designed, the Federal RCS program did not address either the availability and costs of financing conservation retrofits nor the varying regional availability of conservation supply and installation services. In addition, and perhaps most importantly, the program did not address the strong disincentives investor-owned, profit-driven utilities confront in attempting to encourage conservation, an activity that can lower their revenues when successful.

The focus of the RCS program was the 'Class A' audit, which involved an on-site inspection by a trained professional, typically assisted by computer analysis, to determine potential energy savings. Required by the National Energy Conservation Policy Act (Public Law 95-619; NECPA), the on-site audits represented the major cost of the RCS program. Each audit typically lasted several hours and cost an estimated $130 in 1983. Although DOE rule changes relaxed some program requirements, the national average audit cost was only $30 lower 6 years later (table 4-6).[111]

Utility audit offers were typically conveyed by mail. During the program, the nearly 74 million eligible RCS customers received more than 296 million audit offers; in other words, an average of four audit offers each during the IO-year operation of the program (1980-89). On a yearly basis, the ratio of audits requested to those offered was low, ranging from 1,9 to 4.3 percent (figure 4-5). By the end of the program in 1989, 11 percent of the eligible population had participated in the program.[112] This was at the low end of the initial DOE participation goal of 7.5 to 35 percent expected by 1985.[113] The cumulative national participation rate, however, was actually above the level (4 to 7 percent) at which DOE estimated the program would be cost-effective.[114]

111 Figures here are expressed in 1984 dollars. See table 4-6. The DOE rule changes allowed at least one State (California) to cut its average audit time in half, which reduced its program costs by one-third. See J.A. Walker, T.N. Rauh, and K. Griffin, ''A Review of the Residential Conservation Service program, " *Annual Review of Energy 1985* (Palo Alto, CA: Annual Reviews, Inc., 1985), vol. 10, pp. 302-303.

112 U.S Department of Energy, Office of State and Local Assistance programs, *Summary and Highlight of RCS Annual Reports: 1982 'o 1989, '@' 1990,* p. 6. *Note: The* DOE RCS participation figures may not be adjusted for multiple audit requests from single households, suggesting that there may be some double counting of audit requests.

113 U.S. Congress, General Accounting Office, *Federal Home Energy Audit* Program Has *Not Achieved Expectan'ens,* GAO/RCED-87-38 (Gaithersburg, MD: December 1986), p. 3.

114 47 *Federal Register* 27771 (June 25, 1982).

Table 4-6-Residential Conservation Service: Average Program Expenditures Per Audit 1983-89 in Constant 1984 Dollars

	1983	1984	1985	1986	1987	1988	1989
Utilities	128.00	129.00	100.00	110.00	115.00	92.00	99.00
States	1.76	1.56	1.21	2.50	2.36	1.63	1.25
Federal (DOE) ... ,	0.69	2.19	0.56	0.43	0.13	0.15	0.20
Total.	130.45	132.75	101.77	112.93	117.49	93.78	100.45

SOURCE: U.S. Department of Energy, Office of State and Local Assistance Programs, *Summary and Highlights of RCS Annual Reports: 1982 to 1989,* April 1990, p.1O.

The cost-effectiveness of the early RCS program appears to have been marginal. A 1984 program evaluation concluded that participants performed less cost-effective retrofits than nonparticipants; the evaluation suggested that actual savings were lower than estimated savings due to previous retrofits, imperfect engineering estimates, and customer rebound effects.[115] A subsequent evaluation suggested that program cost-effectiveness improved in later years, where measured benefit-cost ratios for RCS participants ranged from 0.9 to 2.1. (Benefit-cost ratios greater than 1 indicate that benefits exceed Costs.)116

It is important to note that NECPA did not require utilities to conduct a cost-effective RCS audit program-perhaps because utilities were intended to pay for the bulk of program costs, and it was assumed they would minimize these costs. Moreover, by stressing primarily the on-site audits rather than follow-up retrofits, NECPA created a program far too narrow in scope. The RCS would likely have enjoyed better success if utilities were directed or encouraged to conduct cost-effective programs, if the performance of conservation retrofits subsequent to audits had been stressed more strongly, and if program administrators had monitored whether the retrofits suggested by the auditors as most economical were those actually installed by consumers.

Although the ultimate cost-effectiveness of RCS is uncertain, the program created an important precedent for many State and utility residential conservation efforts by providing experience in program implementation, suggesting the value of providing incentives for consumer participation, and highlighting the need to develop better tools for determining the effectiveness of residential conservation programs. Today, State and utility conservation programs typically encourage household energy audits and retrofits, suggesting that the lessons from this defunct national program have current value for the Federal Government as well. In particular, if Congress decides in the future to mandate a national audit program similar to the RCS--or if it wishes merely to assist related Federal, State, or utility programs-it would be well served to consider the factors behind low RCS participation rates and how to correct them to ensure more cost-effective energy savings in conservation programs.

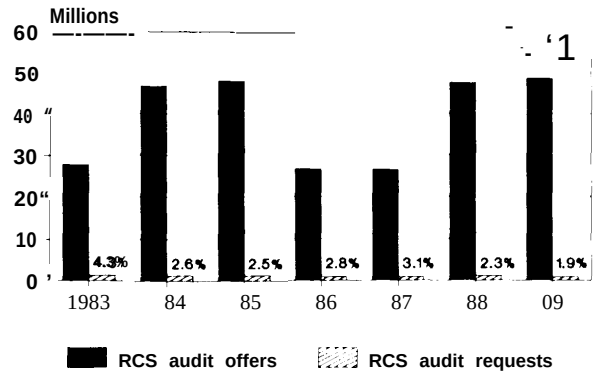
- Consumers and utilities lacked sufficient incentives to participate in the program. Although many consumers were aware of the RCS, providing financial incentives for them to participate would almost certainly have improved program success.[117] One of the major barriers to conservation investments is high first cost (i.e., purchase cost), even when such investments pay back relatively quickly. Not

115 M.L. Frankel and J.A. Duberg, "Energy Audits as an Investment: The Residential Conservation Service Program Analyzed,' *Public Utilities Fortnight/y,* Apr. 12, 1984, pp. 21-22. In this context, a ''rebound effect' refers to changes in consumer behavior that diminish the savings expected from a conservation retrofit.

116 U.S. Department of Energy, *Update of the Evaluation of the Residential Conservation Service program,* DOE/CS/10097---T1 (Washington, DC: September 1986), vol. I, p. ES-2. This range of estimated benefit-cost ratios was based on evaluations of eight utility programs from several regions and was calculated assuming a 5-percent discount rate, Many analyses of RCS program cost-effectiveness are unreliable, because they are based on inconsistent State or household reports that used varying methods of calculating RCS energy savings, but the 1986 DOE study is an exception. That analysis considered only programs that provided actual residential fuel use data---not household or other estimates of energy savings—which made it far more reliable.

117 As discussed earlier, Federal income tax credits were available for residential conservation investments made in tax years 1978 to 1985 but were probably too small and not advertised well enough to have much effect on consumer behavior. In fact, as discussed earlier, a DOE survey found that most households conducting retrofits in 1983 neglected to claim any of the tax credits.

Figure 4-5—Residential Conservation Service Audit Offers and Requests, 1983-89



SOURCE: U.S. Department of Energy, Office of State and Local Assistance Programs, *Summary and Highlights of RCS Annual Reports.' 1982 to 1989,* April 1990, p. 6.

surprisingly, States offering special consumer incentives—such as no- or low-cost loans for retrofits--consistently showed higher participation rates in the RCS program. For example, Massachusetts, Rhode Island, and Connecticut offered consumers financial or other incentives, and their participation rates were among the highest in the Nation—between 16 and 20 percent, well above the national total of 11 percent. Moreover, the 10 utilities with the highest participation rates all offered financial or other incentives for participation. These 10 utilities experienced participation rates ranging from 17 to 53 percent, roughly one-and-a-half to almost five times the national average.118

Utilities generally lacked incentives to participate in the RCS program as well. The large electric and natural gas utility industry in the United States is largely investor-owned and profit-driven. As a result, successful conservation programs have, from the perspective of many utilities, the perverse effect of reducing their revenues, especially under the prevailing State utility regulatory structure of the late 1970s and early 1980s, which generally prevented utilities from profiting directly from consumer energy savings. Though many States are revising their utility regulatory programs to allow these companies to profit from conserving energy, some investor-owned utilities still have few incentives to promote consumer energy savings. For utility-oriented conservation programs to achieve optimal results under an investor-owned system, utilities in the future will have to be able to enjoy profits from both providing *and* saving energy.

- Utilities and States were burdened with complex RCS program requirements not directly related to promoting cost-effective energy savings. As enacted, the RCS placed large administrative burdens on utilities: the program required them to announce and provide audits, compile lists of retrofit contractors for their customers, arrange for customer retrofit financing, and establish procedures for resolving customer/contractor disputes. These requirements placed utilities in the undesirable position of acting as liaisons between customers and contractors without ensuring the utilities any economic return for their efforts. Among other things, these controversial program requirements prevented most States from participating in the RCS program until 1982 or 1983. As late as 1983, about 10 States had not initiated any RCS program.119
- The availability of retrofit installation services may have been limited in many areas. At the time the RCS was created, the Edison Electric Institute estimated that accomplishing the program's ambitious goals would require 320,000 auditors and 2.5 million insulation installers,[120] a growth in this service industry that appeared unlikely given the original 5-year life of the program. Any future national effort to promote residential energy conservation retrofits through audit or other programs should first ensure that the growth of the accompanying service industry occur gradually over a longer period—to allow for sufficient time to develop auditor and installation personnel and expertise.
- Insufficient program marketing to low-income households and renters. Significant energy savings opportunities are common in low-income and rented households. These units

118 These figures represent participation through the 1987 reporting period. See U.S. Department of Energy, Office of State and Local Programs, *1 987 General and Summary Reports to Congress on the Residential Conservation Service Program* (Washington, DC: December 1987), pp. 18-21.

I 19 J.A. Walker, T.N. Rauh, and K, Griffin, "A Review of the Residential Conservation Service Program," *Annual Review of Energy 1985* (Palo Alto, CA: Annual Reviews, Inc., 1985), vol. 10, pp. 290291.

120 Ibid., p. 288.

are often older, needing repair, and thus less energy efficient, yet they were not specially targeted in most States. Department of Energy surveys for the RCS program confirmed the low participation of these groups.[121]

- Many consumers had performed retrofits before the Federal program was initiated. Several States had conducted their own residential conservation programs prior to the creation of the RCS. Also, natural gas shortages in the winter of 1977 and rising oil and electricity prices in the late 1970s motivated many consumers to conduct retrofits before the RCS program was even initiated. In fact, many utilities reported that energy savings in their own conservation programs were greater than those from the Federal RCS,[122] and many may have promoted their own energy conservation programs more aggressively than the DOE effort.
- The uncertain future of the RCS program after 1985 coupled with energy price drops in the late 1980s probably contributed to dwindling participation rates at the end of the program. Moves to repeal the RCS before its apparent sunset date of January 1, 1985 left program planners uncertain of its future; in fact, the program was largely in limbo during 1985 and 1986, when there were disputes about whether it needed reauthorization.[123] It was not until the passage of the Conservation Service Reform Act (Public Law 99-412) in August 1986 that DOE, State, and utility program administrators were fully certain that the program would continue. In those 2 years, however, audit offers dropped nearly 50 percent. At the same time, the real price of energy had been falling, making its largest drop in 1986. These events suggest why annual RCS participation rates (measured as the annual fraction of audits requested to those offered) were the lowest in the last 2 years of the program-2.3 percent (1988) and 1.9 percent (1989). See figure 4-5.

Commercial and Apartment Conservation Service—The impetus behind the CACS program was similar to the RCS: to provide information through energy audits to induce building owners and occupants to conserve energy through retrofits and operational changes. The CACS required large electric and natural gas utilities to offer energy audits to small commercial buildings and centrally heated or cooled multifamily apartment buildings with five or more units.[124] Unlike the RCS program, however, only a few States submitted implementation plans, and only one State (Michigan) initiated a program.

In the event that any States did not submit CACS implementation plans, the Energy Security Act directed DOE to implement a Federal Standby Plan, which the Department issued in September 1985.[125] Though the Standby Plan became effective 1 month later, Congress repealed the program the next year (Public Law 99-412). According to a DOE official in the office that administered the program, State disinterest in the CACS stifled the program from the outset, funds appropriated to the program were always low, and no final report or final evaluation of the program was completed.[126]

Technical Assistance

DOE administers two major programs that offer education, technical assistance, and demonstration services to nonfederal organizations such as State and local governments, commercial businesses, academic institutions, and other, generally small-

121 U.S. Department of Energy, Office of State and Local programs, 1987 *General and Summary Reports to Congress on the Residential conservation Service Program* (Washington, DC: December 1987), p. 4.

122 U.S. Congress, General Accounting Office, *Federal Home Energy Audit Program Has Not Achieved Expectations*, GAO/RCED-87-38 (Gaithersburg, MD: December 1986), p. 4.

123 The dispute centered on the meaning of the expiration date for requiring RCS program announcements, as allowed in the National Energy Conservation Policy Act (Public Law 95-619). The DOE interpreted that date (January 1, 1985) as the implied termination date for the entire program. Others, such as the General Accounting Office, disagreed with that position, arguing that utilities had a continuing obligation to conduct their other RCS program activities. See Harry R. Van Cleve, U.S. General Accounting Office, testimony at hearings before the House Subcommittee on Energy Conservation and Power, Committee on Energy and Commerce, Sept. 5, 1985.

124 The Energy Security Act of 1980 (Public Law 96-294) defined small commercial buildings as those consuming less than 4,000 kWh per month, 1,000 therms of natural gas per month, or 100 million Btus of any other fuel. In addition, Title V of the Act expanded the RCS program to include as of January 1, 1982 all multifamily apartment buildings with five or more units that *lacked* central heating or cooling systems.

125 so *Federal Register* 37818 (Sept. 17, 1985).

126 Andre Van Rest, U S Department of Energy, office of Conservation and Renewable Energy, former DOE manager of the Commercial and Apartment Conservation Service, personal communication, Mar. 27, 1991 and Feb. 4, 1992.

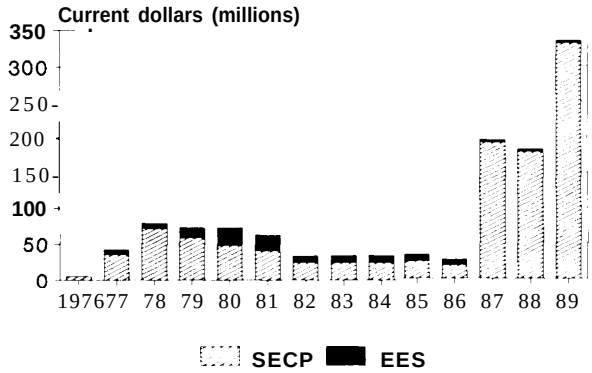
scale energy users. These are the State Energy Conservation Program (SECP) and the Energy Extension Service (EES), Their combined budget history is given in figure 4-6. All 50 States, the District of Columbia, and six Territories participate in both programs, each of which requires a 20 percent finding match.[127]

State Energy Conservation Program—Under the Energy Policy and Conservation Act (Public Law 94-163), States are required to develop and implement conservation plans through the State Energy Conservation Program (SECP).[128] The 1975 statute directed the Federal Government to oversee and assist States in the development and implementation of their own conservation programs, which were required to reduce the energy demand in each State by at least 5 percent of its anticipated 1980 consumption level. To be eligible for financial assistance under the Act, each State had to submit a conservation plan indicating how the statutory conservation goal would be reached.

State plans were required to contain five basic elements, two of which related to building energy efficiency: mandatory lighting efficiency standards for public buildings (except those owned or leased by the Federal Government) and mandatory thermal efficiency standards and insulation requirements for new and renovated buildings (except those owned or leased by the Federal Government).[129] All States have implemented programs that meet the five EPCA requirements, and most States have developed additional conservation programs that supplement the SECP. These programs include energy education, energy technology demonstration, and technical assistance.[130] Examples of several SECP-related buildings efforts convey a sense of the program (box 4-F).

SECP appropriations have decreased since 1979, but monies transferred from Petroleum Violation Escrow funds (from Exxon and Stripper Well judicial rulings stemming from oil overcharge suits) since 1987 have expanded program resources in recent years far beyond original funding levels (figure 4-6).

Figure 4-6-Combined Funding for the State Energy Conservation Program and the Energy Extension Service, 1976-89



NOTE: The sharp increase in SECP funding since 1987 stems entirely from newly available oil overcharge funds. In current dollars, actual SECP appropriations have been decreasing since 1979. In recent years, administration requests for SEC P/EES funding have sought only these overcharge funds.

SOURCE: U.S. Department of Energy, Office of Technical and Financial Assistance, *Eleventh Annual Report to Congress and the Secretary of Energy on the Nationwide Energy Extension Service Program,* DOE/CE-0291 P (Washington, DC: July 1990), p. 6; Office of State and Local Assistance Programs, Annual *Report* to *the President and the Congress on the State Energy Conservation Program for Calender* Year *1989,* DOE/CE-O296P (Washington, DC: December 1990), p. 3.

DOE does not estimate the cost-benefits of SECP energy savings, because there are great uncertainties in calculating savings from such a diversity of relatively small-scale activities; measuring the incremental energy savings that have resulted from past SECP efforts would be difficult and almost certainly unreliable.[131] On the other hand, program funding has increased dramatically in recent years with the availability of petroleum violation monies, and Congress and DOE may wish to determine if

127 U.S. Department of Energy, *United States Department of Energy Fiscal Year 1992 Congressional Budget Request*, DOE/CR-0001 (Washington, DC: February 1991), vol. 4, p. 470.

128 A State is any State, the District of Columbia, Puerto Rico, and the territories and possessions of the United States.

129 42 U.S.C. 6322(c).

130 U.S. Department of Energy, *Annual Report to the* President *and* th, *Congress on* the *State Energy Conservation program for Calender year* 1989, DOE/CE-0296P (Washington, DC: December 1990), pp. 1-2.

131 One review of the SECP suggested that typical residential energy savings ste mming from the program have been small, perhaps 5 percent, but the review suggested that savings could reach 10 percent if feedback on personal energy use was provided. Yet published estimates of SECP energy savings are often unreliable, because they are commonly based on household reports of energy savings rather than actual fuel-use *information. See* J. Clinton, H. Geller, and E. Hirst, ' 'Review of Government and Utility Energy Conservation Programs, '' *Annual Review of Energy 1986* (Palo Alto, CA: Annual Reviews, Inc., 1986), vol. 11, p. 104.

Box 4-F—Examples of State Energy Conservation Program Projects[1]

- ***Cultural*** **Heritage Center (Pierre, South** Dakota): This demonstration project was conducted under the auspices of the gubernatorial Office of Energy Policy and the State Historical Society and involved the installation of passive solar, efficient lighting, and automated control designs and technologies at the center. Eight separate efficiency measures, ranging from earth sheltering to heat recovery ventilation, are now demonstrated to the Center's 25,000 annual visitors.
- Cabell Couny Courthouse Demonstration ***Project (Huntington,*** West Virginia): This project involved the installation of a commercially available, but seldom used, natural gas pulse boiler and heat distribution system in the Courthouse to demonstrate the applicability of this technology as an alternative to larger, centralized boilers. Typical of the 55 courthouses in the State, the Cabell County building is a brick and stone structure that had proven difficult to heat. This project is expected to save 53 percent of previous energy use in the Courthouse.
- ***Community Energy Management Program*** (Oklahoma Department of Commerce): The CEMP is a community-oriented, technical assistance effort designed to implement cost-effective energy efficiency and conservation options for local governments in the State. Trained Local Energy Officers operate the program and receive input from local groups and interested individuals.

1 Us. Department of Energy, *Annual Report to the President and the Congress on the* State *Energy Conservation Program for Calender Year 1988,* DOE/CE/0293P ('ashington, DC: October 1989), p. 5; U.S. Department of Energy, *Annual Report to the President and the Congress on the State Energy Conservation Program for Calendar Year 1989,* DOE/CE-0296P (Washington, DC: December 1990), pp. S-6.

more rigorous evaluations of program effectiveness (including cost-benefits) should become integral to SECP planning and evaluation.[132]

Energy Extension Service--EES provides basic information, education, and training-such as audits and self-help workshops—to homeowners, farmers, small businesses, local governments, and other, small-scale public institutions. The purpose of the program, which is administered with the SECP, is to maintain a decentralized system of information to serve the local needs of small-scale energy users; technical assistance and demonstration projects are offered as well. EES programs are State designed, and DOE disburses funds through grants to State energy offices or other State entities designated by their governors to administer the program. States distribute these funds according to DOE-approved plans. Several examples of EES efforts convey a sense of the program (box 4-G).

A review of a State energy official survey suggested that on-site workshops, auditor training, and well-targeted information programs are the most effective part of the EES program. The study viewed general information dissemination as the least effective program function.[133] Reliable calculations of SECP and EES energy savings are extremely difficult to make on a national level given the diversity, small-scale, and decentralized nature of projects in both these programs.

Despite the lack of reliable data on energy savings, however, both programs are important networks for conveying Federal monies and expertise to the State and local level, and both programs are connected to small-scale energy users that could help DOE demonstrate technologies emerging from its energy conservation research and development projects. In addition, the auditor and other training offered by these programs help establish and sustain local expertise and markets for weatherization and other conservation services. Finally, SECP and EES efforts could complement other Federal programs (such as the Weatherization Assistance Program and the Institutional Conservation Program, both discussed above) that are designed to operate on the local level.

132 This was one of a series of recommendations in a 1982 General Accounting Office (GAO) report, and it is still pertinent today. In their report, GAO made a variety of recommendations for improving the SECP after States missed the 1980 national goal of reducing their energy use at least 5 percent. See U.S. Congress, General Accounting Office, *State Energy Conservation Program Needs Reassessing, EMD-82-39* (Gaithersburg, MD: April 1982).

133 J. Clinton, H. Geller, and E. Hirst, "Review of Government and Utility Energy Conservation Programs," *Annual Review of Energy 1986* (Palo Alto, CA: Annual Reviews, Inc., 1986), vol. 11, p. 104.

Box 4-G-Examples of Energy Extension Service Projects[1]

- *School Lighting* (Washington): The Washington Energy Extension Service in cooperation with its State Energy Office has provided training to school districts on how to reduce energy use through lighting changes in classrooms, gymnasiums, and other school areas.
- *Cogeneration Demonstration* (Taos, New Mexico): With the assistance of Federal funds partially matched by the State's Energy, Minerals, and Natural Resources Department, the Taos Coronado Center, a local community meeting and business place, has installed a cogeneration system expected to save over $10,000 in energy costs annually.
- *State Government Lighting (Rhode* Island): A combined State, utility, and nonprofit group effort has leveraged Federal EES funds to upgrade lighting systems in State buildings, which are expected to reduce total State government electricity costs by 20 percent.
- *Seniors' Weatherization and Training* (Kentucky): The SWAT program is a combined effort, joining the State EES with seven local nonprofit groups. The nonprofits recruit and train volunteers to weatherize residences of the elderly. With materials donated by a major corporation, the SWAT team in 1989 offered information and weatherization services to over 850 homes in the State.

1 U.S. Department of Energy, *Tenth Annual Report to Congress and the Secretary of Energy on the Nationwide Energy Extension Service Program,* DOE/CE-0266 (Washington, DC: March 1989), p. 10; U.S. Department of Energy, *Eleventh Annual Report to Congress and the Secretary of Energy on the Nationwide Energy Extension Service Program, DOE/CE-O291P* (Washington, DC: July 1990), pp. 8-10.

NONFEDERAL PROGRAMS TO PROMOTE ENERGY EFFICIENCY IN BUILDINGS

Efforts to promote energy efficiency in U.S. buildings have by no means been restricted to Federal initiatives; State, local, private sector, and utility programs have in many instances been seminal in promoting energy efficiency in U.S. buildings. This section reviews briefly some of these programs. The intent is not to provide a comprehensive list of all such programs but rather to provide some indication of the level of nonfederal activity. This will allow for a better determination of how Federal programs can best complement the existing network of other programs.

States and utilities have been leaders in implementing energy efficiency. State efforts include those by State energy offices, State-level R&D organizations and, perhaps most importantly, State regulatory agencies. In some States, utility regulators have aggressively promoted efficiency by requiring the development of utility conservation programs or by providing financial incentives for utilities to develop such programs.

State Programs

State efforts to promote energy efficiency in buildings vary greatly. Some States—notably California, New York, Wisconsin, and Massachusetts—have been very aggressive in pursuing building energy efficiency. State-level organizations implementing these programs vary as well, but in many States the lead organization is the State utility regulatory body, commonly the public utility commission. In some States the public utility commissions, via the utilities they regulate, have been strong proponents of energy efficiency. Utility programs are reviewed below.[134]

State-level efforts to promote efficiency are not limited to utility regulatory programs. Many States have State energy offices, which often administer Federal funds such as those from the DOE weatherization assistance program and from oil-overcharge funds.[135] State energy offices use a variety of programs to promote efficiency, including audits, loans, grants, and general information efforts. For example, the Washington State Energy Office operates an information clearinghouse with a staff of technical experts that responds to public inquiries

134 A detailed discussion of the role of utilities in implementing energy efficiency will be provided in OTA, "Utilities and Energy Efficiency," forthcoming,

135 From 1973 t. 1981011 companies i the United States were subject to price controls on their crude oil and refined petroleum products. Investigations by the DOE's Economic Regulatory Administration uncovered a number of violations of these controls by oil companies. Many of these violations resulted in court decisions requiring oil company payments to DOE for use in State energy conservation programs. As of September 1987, oil companies had paid about $6 billion into a petroleum overcharge escrow account held by DOE. See U.S. Congress, General Accounting Office, *State's Expenditures of Warner Amendment Oil Overcharge Funds,* GAO/RCED-88-1 *19BR* (Gaithersburg, MD: May 1988).

about energy efficient construction for new commercial buildings.[136]

Some States have R&D agencies that are also active in energy efficiency (table 4-7). These agencies are typically funded by utilities, State revenues, or both and work closely with utilities, regulators, and State government officials to target R&D efforts in areas most relevant to their State needs.

At least 33 States have adopted mandatory building energy codes. Many of the remaining States provide model codes for their counties and local governments. Generally, State codes are based on the prominent codes issued by national organizations, primarily the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and the Council of American Building Officials (CABO), However, some States such as California and New York have expanded their role from code adopters to code designers.

Local Programs

Historically, local governments have not been active in promoting energy efficiency in the private sector. There are, however, several notable exceptions. A few cities have responded to fiscal pressures by attempting to reduce energy consumption in city-owned buildings and equipment. The city of Phoenix, for example, has an active energy conservation program that has included lighting and heating, ventilating, and air conditioning (HVAC) retrofits to city-owned buildings, automated controls for lighting at city parks, and improved maintenance of HVAC units in city-owned buildings.[137] Electricity and/or gas service in some communities is provided by small municipal utilities, or 'munis,' which may have strong efficiency programs. The city of Palo Alto, California, for example, is served by a city-managed utility that offers a wide range of efficiency programs.

Many communities have building codes that may have energy requirements. Local building codes sometimes extend to the existing building stock as well. In San Francisco, for example, both residential and commercial buildings must meet energy efficiency levels as a condition of resale.[138]

Table 4-7-Selected State-Level Energy Efficiency R&D Organizations

Organization	Year established
California Energy Commission	1975
California Institute for Energy Efficiency	1988
Florida Solar Energy Center	1974
Iowa Energy Center	1990
Kansas Electric Utilities Research Program	1981
New York State Energy Research and Development Authority	1975
North Carolina Alternative Energy Center	1980
Wisconsin Center for Demand-Side Research	1990

SOURCE: Office of Technology Assessment, 1992.

Utility Programs

Utilities are in a unique position to implement efficiency programs for buildings: they have direct access to consumers and fuel use information, they have the resources and expertise to understand and respond to local conditions and markets for their service areas, and they can provide incentives and information to their consumers directly through their regular billing procedures. Readers interested in the role of utilities in efficiency are referred to a separate OTA report.[139] This section briefly outlines the types of building efficiency program utilities currently offer.

Utility involvement in energy efficiency is a relatively new development. Traditionally, utilities viewed their role as providing dependable electric and gas supplies at a reasonable cost; they were not involved in how the energy was used. In recent years, however, uncertainty over future demand, plant siting constraints, environmental regulations, and other concerns have put increasing pressure on

136 G. Caan, "The Washington State Energy Office Technical Unit: An Approach to Delivering Technical Services in the Public Sector," *Proceedings of the ACEEE 1990 Summer Study on Energy Efficiency in Buildings* (Washington DC: American Council for an Energy-Efficient Economy, 1990), p. 7.17.

137 City of Phoenix, "City of Phoenix Energy Conservation Program," Public Works Department, Phoenix, AZ, January 1991.

138 K. Egel, J. Cook, and B. Knox, "Mandating Energy Efficient Commercial Buildings: San Francisco's Commercial Energy Conservation Ordinance," *Proceedings of the ACEEE 1990 Summer Study on Energy Efficiency in Buildings* (Washington, DC: American Council for an Energy-Efficient Economy, 1990), p. 7.43.

139 OTA, "Energy Efficiency and utilities," forthcoming.

utilities to plan better their future capacity needs.[140] One result of these forces is the emergence of a new concept of utility planning termed 'least-cost planning' (LCP), or, more recently, 'integrated resource planning' (IRP).

A basic idea behind these concepts is that consumers do not require energy per se but energy services (lighting, heating, cooling) and are therefore best served if these services are provided at the lowest overall cost. For example, it may be less expensive for a utility to install energy-efficient lights in offices than to build a new powerplant to meet the demand of less efficient lights. The service provided is the same, but the overall cost to provide it may be lower.[141]

Thus, LCP (or IRP) entails a process in which demand and supply options are evaluated together to determine how to meet consumer energy needs at the lowest cost; such planning is now practiced in at least 23 States.[142] Interest in such planning has also led to the aggressive promotion of demand-side measures in many States. These measures, often referred to as 'demand-side management' (DSM) efforts, include efficiency and other actions that reduce the total cost of energy services (e.g., ice storage, which may actually increase net consumption but which reduces peak electricity demand and therefore reduces net costs).

At present there are over 1,000 utility-run efficiency programs for the residential sector [143] and over 340 for the commercial sector. [144] Many utilities work closely with State regulators and with the private sector in designing, executing, and evaluating their programs. These programs include changes in rate structures, financial incentives such as rebates and loans, information programs providing audits and technical assistance, R&D, and demand-side bidding,

First Cost Reduction: Probably the most popular type of program for encouraging energy efficiency is a reduction in first cost. Tax credits, low-interest loans, grants, and rebates are often used by utilities to provide a financial incentive for efficiency by reducing the up-front costs. For example, over 20 utilities offer rebates to their commercial customers if they purchase energy efficient HVAC equipment.[145] Several utilities provide rebates to their residential customers for buying efficient refrigerators. Low-interest loans are often offered in conjunction with residential audit programs. A utility in Washington State provides its commercial customers with two free compact fluorescent lamps.[146]

Rates: Working with State public utility commissions, utilities have used changes in rate levels and rate structures to influence energy use. Traditionally rates are set at the State level, although the Public Utility Regulatory Policies Act of 1978 (Public Law 95-617) promotes the use of innovative rate structures, such as time-of-day, seasonal, and interruptible rates.

Most utilities currently offer a wide range of rate schedules. For example, the electric utility serving the District of Columbia offers 16 different rate schedules, including time-of-use rates for residences and demand/consumption[147] time-of-day rates for larger commercial customers.[148] The effects of these innovative rate schedules on consumption are

140 The electric utility industry is described in detail in U.S. Congress, Office of Technology Assessment, *Electric Power Wheeling and Dealing, OTA-E-409* (Washington, DC: U.S. Government Printing Office, May 1989), ch. 2.

141 In fact, in this example the service (lighting) probably improves, as new energy-efficient lighting often provides higher quality light as well.

142 A survey conducted in 1990 found that 23 States are practicing IRP, 8 States are in the process of implementing it. and 11 are considering it. See Edison Electric Institute, Rate Regulation Department, *State Regulatory Developments in Integrated Resource Planning* (Washington, DC: September 1990), p. 2.

143 Battelle, *1988 Survey of Residential-Sector Demand-Side Management Programs*, EPRI CU-6546 (Palo Alto, CA: Electric power Research Institute, October 1989), p.iii.

144 Battelle-Columbus Division, 1987 *Survey of Commercial-Sector Demand-Side Management Programs*, EPRI CU-6294 (Palo Alto, CA: Electric Power Research Institute, March 1989), p.iii.

145 Ibid., p. 2-14.

146 American Council for an Energy-Efficient Econom, (ACEEE), ' 'Lessons Learned: A Review Of Utility Experience With Conservation and Load Management Programs for Commercial and Industrial Customers, published by the New York State Energy Research and Development Authority (NYSERDA), Report 90-8, April 1990, Appendix.

147 Meaning that customers are charged for both how much electricity they use at any one time (demand, measured in kW), as well as how much electricity they use over the entire billing period (consumption, measured in kWh).

148 Potomac Electric Power Co., ' 'Rate Schedules for Electric Service in the District of Columbia,' Rates and Regulatory Practices Group, Apr. 3, 1990.

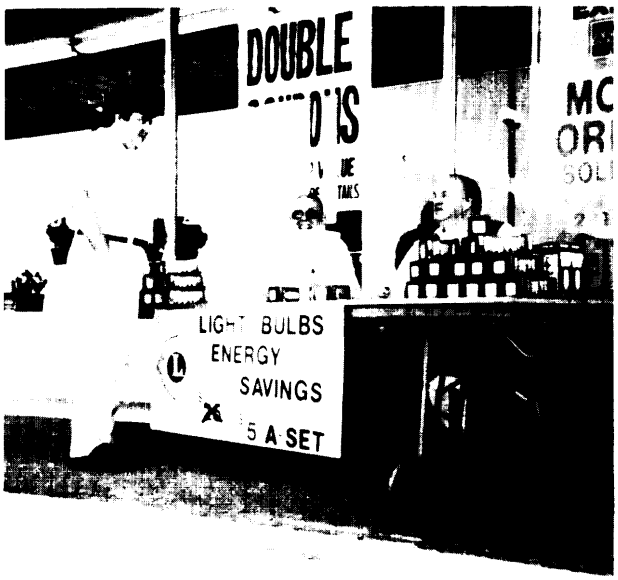


Photo credit: Paul Komor

***Some* utilities work with local service organizations to advertise, distribute, and sell efficient technologies at or below cost to interested consumers.**

not well documented. There is some evidence that equipment design and operation is influenced by rate schedules in large commercial buildings. For example, a large office building in Arizona recently installed an ice-storage machine that makes ice at night when electricity is less expensive and then uses that ice during the day to cool the building.[149] The existence of time-of-use rates provided the necessary incentive.

Direct load control: This entails a utility paying its customers for the right to control directly their appliances, and the idea is used by over 350 Utilitles.[150] A utility serving Maryland, for example, gives residential customers a $9 credit on their monthly electric bill in exchange for the right to turn off their central air conditioner for short periods on peak demand days.

Information programs: Many utilities offer audits to their customers, in which an energy analyst visits the building, takes various measurements, and makes recommendations for specific energy-saving retrofits. In many cases the audits are tied to a low-interest loan for financing the recommended measures. Here again evaluations are scarce, but there is some evidence that coupling an audit with a loan program increases both participation rates and energy savings.[151]

There are other types of information programs as well. Wisconsin utilities, for example, have developed a labeling system for rental housing. The label, similar in appearance to those found on residential appliances, provides a measure of heating energy requirements. Another effort, the Energy Edge Project, is a $16-million program administered by several groups--one utility, two State energy offices, and a private company-and aims to demonstrate and evaluate efficient technologies for new commercial buildings.[152] And the Bonneville Power Administration's 'Blue Clue' program labels highly efficient appliances with blue ribbons.[153]

State regulators now typically require utilities to evaluate their efficiency programs to compare them with supply-side options. Unfortunately program evaluation is quite complex; several groups are working to improve the evaluation methods, but more work is needed. For example, the 'free rider' problem—where program participants would have performed the same actions without the additional incentive-complicates evaluation of these programs.

R&D: Utilities also conduct R&D, both at the individual utility level and via R&D consortia. The Electric Power Research Institute, for example, is funded by voluntary contributions from member utilities. Its 1991 R&D budget was $267 million, and

149 "Ariz. Firm Keeps Energy Costs to a Quarter of Local Average," *Energy User News,* June 1991, p. 1. In this case, total energy use may actually be higher than that from a traditional system, but electricity demand and energy costs are lower.

150 Battelle, *1988 Survey of Residential-Sector Demand-Side Management Programs,* EPRI CU-6546 (Palo Alto, CA: Electric Power Research Institute, October 1989), p. 6.2.

151 S. Nadel, "Electric Utility Conservation Programs: A Review of the Lessons Taught by a Decade of program Experience," *Proceedings of the ACEEE 1990 Summer Study on Energy Efficiency in Buildings* (Washington, DC: American Council for an Energy-Efficient Economy, 1990), p. 8.181.

152 W. Miller, S. Vogt, G. Vincent, J. Perry, K. Anderson, and G. Gaan, "~SSO13S Learned for the Energy Edge Project for New Commercial Buildings," *Proceedings of the ACEEE 1990 Summer Study on Energy Efficiency in Buildings* (Washington DC: American Council for an Energy-Efficient Economy, 1990), p.7.117.

153 Battelle, *1988 Survey of Residential-Sector Demand-Side Management Programs,* EPRI CU-6546 (Palo Alto, CA: October 1989), p. 4-17.

$36.2 million (14 percent) of this was budgeted for end-use research.[154] The Gas Research Institute (GRI) is funded primarily through contributions from interstate natural gas pipeline companies. The 1991 GRI budget was approximately $202 million, of which $95 million (47 percent) was allocated to end-use research.[155]

Demand-side bidding: A few utilities have used a bidding process to secure new electricity capacity. For example, a utility might request private companies to submit bids for providing the utility with 100 megawatts (MW) of new capacity. The bidder could use either new supply (e.g., cogeneration) or efficiency (e.g., a lighting retrofit) to 'supply' the needed capacity. Although the concept is conceptually appealing, initial experience with bidding has been mixed, and more research is needed, particularly in bid evaluation and the incorporation of performance uncertainties. In particular, high transaction costs and difficulty in measuring the effects of some efficiency programs (e.g., information and design assistance) have limited its use.[156]

As these examples suggest, a variety of utility programs have been used to implement energy efficiency in buildings, but there is little agreement on what works best, and program evaluation is a continuing concern. By one estimate, utility-run demand-side management programs led to national reductions in electricity consumption of 1.3 to 1.8 percent in 1990. Electricity demand reduction was estimated at 3.7 to 4.2 percent—about 20 gigawatts of summer on-peak demand.[157] The cost-effectiveness of these investments is somewhat uncertain. However, by one estimate, total utility expenditures for DSM are about $1.2 billion annually (1990).[158] This works out to about $180 per kilowatt, or less than one-half the capital cost of a gas turbine.[159] Although the uncertainty of this number must be recognized, it does suggest that in many cases DSM may be less expensive than traditional supply-side options.

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154 Electric *power Research* Institute, *Research and Development Program 1991-1993* (Palo Alto, CA: January 1991), p. 7.

155 Gas Research Institute, *1992-1996 Research and Development Plan and 1992 Research and Development Program* (Chicago, IL: April 1991), p.28.

156 For a detailed discussion of bidding, see C. Goldman and D. Wolcott, ' 'De~d-Side Bidding: Assessing Current Experience, ***Proceedings*** *of the ACEEE J990 Summer Study on Energy Efficiency in Buildings* (Washington, DC: American Council for an Energy-Efficient Economy, 1990), p. 8.53. Also, Strategic Decisions Group, *Bidding for Electric Resources: An Industry Review of Competitive Bid Design and Evaluation*, EPRI CU-6089 (Palo Alto, CA: Electric Power Research Institute, May 1989).

157 Barakat & Chamberlin, Inc. and EPRI, *Impact of Demand-Side Management on Future Customer Electricity Demand: An Update,* EPRI CU-6953 (Palo Alto, CA: September 1990), pp. **3-6, 3-7.** Savings are relative to a 1988 base year.

158 S. Nadel, ''Electric Utility Conservation Programs: A Review of the Lessons Taught by a Decade of Program Experience, *Proceedings of the ACEEE 1990 Summer Study on Energy Efficiency in Buildings* (Washington, DC: American Council for an Energy-Efficient Economy, 1990), p. 8.179.

159 The initial Capital requirement for a gas turbine is about $400 per kilowatt. Electric Power Research Institute, *TAG Technical Assessment Guide--Electricity Supply 1989,* EPRI P-6587-L (Palo Alto, CA: November 1989), vol. 1, Rev. 6, p. 7-55. Estimate in text assumes that DSM expenditures for 1988, 1989, and 1990 contributed to the DSM savings seen in 1990 and also assumes that DSM costs in 1988 and 1989 were the same as in 1990. This probably overestimates costs, because DSM expenditures have generally increased each year.