Chapter 5

Policy Options for the U.S. Congress

Contents

Boxes

Chapter 5
Policy Options for the U.S. Congress

INTRODUCTION

Energy use in buildings accounts for an increasing share of total U.S. energy consumption—horn 27 percent in 1950 to 33 percent in 1970 to 36 percent in 1990.[1] At present, buildings account for over 60 percent of all electricity and nearly 40 percent of all natural gas used in the United States.[2] Fortunately new, highly efficient technologies are available that can provide needed energy services in buildings (e.g., heating, lighting, and cooling) while using significantly less energy. In many cases these technologies cost more initially, but these initial costs are paid back through reduced energy costs.

OTA has estimated that energy use in U.S. buildings could be reduced about one-third by 2015, relative to projected consumption without policy change, through the use of cost-effective, commercially available technologies.[3] Many other estimates of this savings potential exist and, although the results vary, there is general agreement that the untapped potential for improved energy efficiency in buildings is significant. Exploiting these opportunities would yield important benefits for the United States, including: 1) reduced energy expenditures, freeing up capital for other investments; 2) decreased environmental damage by offsetting energy production and use; and 3) reduced dependence on imported energy, enhancing national security.

There are several arguments for an enhanced Federal Government role in promoting energy efficiency.

—Numerous market imperfections lead to the selection of energy-using equipment that may not be societally optimal. These imperfections are discussed in detail in chapter 3 and include:

- When evaluating energy savings, consumers discount future savings very heavily—up to 50 percent or more;
- A separation between those paying for energy-using equipment and those paying to operate the equipment is common, leading to reduced incentives for efficiency;
- Decisions on the purchase and use of energy-using equipment require comparisons of many product attributes. When consumers make trade-offs during these decisions, which are often complex, these other product attributes often overshadow energy efficiency;
- Individuals pursue several goals when making energy-related decisions, but very few pursue the goal of minimizing life-cycle costs;
- Energy costs are relatively low (e.g., about 1 percent of salary costs in a typical office), so those concerned with cost reduction often focus their attention elsewhere; and
- Energy efficiency is often (mis)perceived as requiring discomfort or sacrifice, limiting its appeal.

Government programs and policies can be used to correct or minimize the effects of these imperfections.

—The numerous, untapped opportunities for energy savings that now exist suggest that current market conditions alone will not ensure the full implementation of these opportunities, although society as a whole may be better off if they were implemented.

—Energy production and use has significant environmental and other externalities (effects not captured in price), requiring government action to correct them.

Yet enthusiasm for a larger Federal role in energy efficiency must be tempered with a recognition of several important points:

. Attempts to increase energy efficiency through regulation or other governmental action may have unanticipated administrative or other costs;

[1] Industry (37 percent) and transportation (27 percent) account for the remainder. Data include energy losses in the conversion and transmission of electricity. U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1990*, DOE/EIA-0384(90) (Washington, DC: May 1991), p. 13.

[2] Ibid., pp. 173, 215.

[3] Cost-effective is defined here as positive net present value to the consumer. See ch. 1 for a detailed discussion of energy savings estimates.

. Past Federal efforts to implement energy efficiency have had mixed success (see chapter 4);
. Current levels of energy efficiency reflect consumer preferences given existing economic incentives and levels of information; and
. Consensus on the best methods to promote efficiency is often lacking.

Innovative research and development by both the public and private sectors has yielded a number of highly energy efficient technologies. However at present many of these technologies are not being adopted at cost-effective levels.[4] This chapter discusses policy options to encourage greater use of cost-effective, energy efficient technologies.

POLICY OPTIONS

A variety of Federal policy actions could encourage greater energy efficiency in buildings. Although the options outlined in this chapter are quite diverse, several issues are worth recognizing when considering any options. Perhaps most importantly, there is no single policy that will address all impediments to efficiency. There are multiple technologies, decisionmakers, and energy users in buildings; the barriers to efficiency discussed in chapter 3 are diverse, and so must be the policies to overcome them. Greater attention in the future to program evaluation would yield better information on what works and what needs improvement, but at present levels of knowledge it is clear that several different policy approaches would be needed to improve energy efficiency in buildings.

The diversity of current State and utility programs provide a context to consider Federal policies for improving building energy efficiency. In almost all areas of energy efficiency policy-incentives; information; research, development, and demonstration (RD&D); regulation—numerous States and utilities are more active than the Federal Government. Increased Federal efforts would be most effective if they complemented these existing efforts. In most cases, States and utilities would welcome Federal support and assistance to promote energy efficiency in buildings; however, in a few areas—notably building codes and utility regulation—an enhanced Federal role would be controversial.

Policies for implementing energy efficiency in buildings can be divided into six types:

1. Increasing the incentives for efficiency-As noted in ch. 3, individuals often have few or mixed financial incentives for energy efficiency. Federal policies can address this issue by increasing or improving these incentives, e.g., through tax or pricing changes.
2. Federal leadership through procurement, public recognition, and demonstration-The Federal Government has considerable purchasing power due to its size, and this power can be used to increase the sales and distribution of energy efficient technologies.
3. Research, development, and demonstration for efficiency-The Federal Government conducts RD&D on buildings technologies, and changes in RD&D planning and execution could help improve the value and application of the results.
4. Encouraging utilities to invest in efficiency—Utilities are well-equipped to implement efficiency, and Federal actions can support utility efforts.
5. Mandating efficiency through codes and standards--In some cases regulation may be needed to set minimum efficiency levels, and such regulation may be most appropriate at the Federal level.
6. Improving information and awareness of efficiency opportunities-Information can enhance and support other efficiency programs such as rebates. As the benefits of information are diffuse, a government role in providing information may be appropriate.

Each type of policy is discussed separately, and a number of specific options within that type are presented. These specific options are grouped into three distinct levels, in order of increasing Federal involvement and energy savings. Many other levels are imaginable, but the three levels presented here are intended to illustrate the range of possible policies Congress could consider.

The *basic* level includes relatively low cost, simple policy options that require little or no new legislation or change from present practice. If Congress determines that changes are needed to effect improvements in energy efficiency, then the basic level could be considered as a first step. The *moderate* level includes several options that are more ambitious and in many cases require modify-

4 As discussed in ch. 1, there is general but not unanimous agreement that a considerable potential exists for cost-effective energy savings.

ing existing legislation and increasing Federal spending. The *aggressive* level includes options that are quite ambitious, require new legislation, or require an increased Federal role in energy regulation; the options on this level require additional funding.

Most of the policy options offered by OTA are intended to capture economically justifiable efficiency opportunities that are available but not realized under current market conditions. There is one exception: the incorporation of externalities (effects not captured in price) would in all likelihood raise prices and thereby shift this range of opportunities.

As discussed in chapter 4, the national effects of past Federal programs enacted to increase energy efficiency are often not known or have not been measured reliably. The likely effects of future Federal efforts are even more uncertain; technologies change over time, market response to Federal programs is poorly understood, many governmental programs work in tandem with others (making a program-by-program estimate of effects misleading), and the diversity of buildings and individuals affecting their energy use complicates predictions of the effects of any major policy change. Therefore, OTA does not provide estimates of the financial or energy savings associated with these levels or options. Moreover, OTA suggests that readers understand these limitations when considering *any* projections of energy savings associated with any proposed policy option.

Increasing the Incentives for Efficiency

As discussed in chapter 3, individual choices largely determine the level of energy efficiency in buildings—architects designing an office building, engineers specifying lighting systems for a business, or consumers selecting a new refrigerator, These choices are influenced by individual values, information, and perceptions of the costs and benefits of energy efficiency. A basic policy strategy to motivate greater energy efficiency, therefore, is to decrease the expense and/or increase the benefits of saving energy, which is the purpose of incentives.

A variety of incentives are available to encourage energy efficiency in buildings. This discussion focuses on incentives that the Federal Government could consider, including:

- energy pricing, particularly energy taxes, which could incorporate externalities into prices;
- evaluating and improving Federal grant programs that fund measures for building energy efficiency;
- making appliance efficiency rebates nontaxable; and
- incorporating energy efficiency into federally financed home mortgages.

Perhaps the simplest policy to encourage greater efficiency is to raise the price of energy through, for example, taxes. From an economic perspective, a guiding principle in setting prices is to reflect the true costs to society of producing and using goods and services, Energy may be ‘‘underpriced’ ‘—that is, its true cost to society may be higher than what consumers actually pay, because environmental externalities, government RD&D subsidies, and other costs are generally not reflected in energy prices. Several States have attempted to determine exactly what cost to attach to these factors and have integrated these calculations into their energy planning.[5]

Federal options to increase energy prices raise a number of issues, many beyond the scope of this report. For example, some argue that major increases in energy prices could place some U.S. businesses at a competitive disadvantage both domestically and internationally.[6] In addition, increasing energy prices through taxes or other means may raise equity concerns; low-income households, for example,

5 About 19 States currently have some provision for incorporating environmental externalities into energy planning. New York State, for example, attaches a penalty of 1.4 cents per kWh for electricity from a coal plant when considering bids for new generation. Vermont adds a 5 percent penalty (“adder”) to supply resources, and a 10 percent credit to demand-side resources, to reflect environmental externalities and the reduced risk of DSM. Massachusetts gives a 5 percent rate-of-return bonus to utilities for demand-side resources to reflect their environmental benefits. However, few States currently have provisions for explicitly incorporating externalities into actual energy prices. See Pace University Center for Environmental Legal Studies, *Environmental Costs of Electricity (New* York: NY, Oceana Publications, Inc., 1990); also Temple, Barker, and Sloane, Inc., Electric Power Research Institute, *Environmental Externalities: An Overview of Theory and Practice,* EPRI CU/EN-7294 (Palo Alto, CA: Electric Power Research Institute, May 1991).

6 See, e.g., J. Anderson, *‘Presentation to the American Public Power Association’s National Conference,’ Electricity Consumers Resource Council (ELCON), Washington DC, June 18, 1991.

spend a larger share of their income on residential energy than do higher-income households.[7]

Federally funded grants are the principal tool used by the Federal Government, as measured by budget, to encourage energy efficiency in buildings. To illustrate, 84 percent of the Department of Energy (DOE) budget devoted exclusively to buildings energy conservation (including RD&D) is in the form of grants for retrofits to existing buildings; these grants totaled $230 million in 1991, while buildings conservation RD&D totaled $43 million that same year.[8] (Chapter 4 discusses Federal grant programs in detail, including specific suggestions for improving them.) However relatively little is known about the cost-effectiveness of the retrofits performed with these grant dollars, suggesting that greater attention to monitoring and evaluation is warranted.

Federal tax incentives could improve participation in a variety of efficiency programs, particularly those offered by utilities. The current tax treatment of utility rebates, for example, could be considered for change.[9]

In 1989 the Internal Revenue Service (IRS) ruled that utility rebates should be treated as taxable income. Some argue that taxing rebates limits consumer interest in them, thereby reducing the effectiveness of such programs.[10] Although a subsequent IRS ruling maintained that utility bill credits promoting the purchase of efficient appliances are nontaxable, evidence suggests that a cash rebate can be a much more powerful method of promoting efficiency than a bill credit. A rebate provides an immediate cash reward, while a bill credit can be confusing and obscure,[11] Furthermore, as noted in chapter 3, many individuals making equipment selection decisions (e.g., builders and landlords) do not pay the energy bills, making such credits irrelevant to their decisions.

If rebates remain taxable, utilities will either shift to bill credits (thereby missing many energy-related decisions), increase rebate amounts to account for the taxes (requiring greater utility expenditures to achieve the same response), or simply accept a lower response due to the reduced value of the rebate to consumers. The cost to the U.S. Treasury of making rebates nontaxable is uncertain; by one estimate, utilities spend about $200 million annually on residential rebates.[12] Assuming this figure is accurate and that commercial sector rebate spending is the same, and assuming a combined marginal tax rate of 20 percent, the lost revenue by not taxing rebates could be as high as $80 million per year. On the other hand, indirect revenue gains could offset these potential losses if consumer savings were expended on other, taxable activities. Clearly, understanding the effects on the Treasury of making rebates nontaxable would require considerable analysis. The response to utility rebate programs, however, will invariably be lower if rebates continue to be taxed than if they were made tax-free.

Tax credits are another form of tax incentive that could be used to improve energy efficiency in U.S. buildings. As discussed in chapter 4, U.S. experience with residential conservation tax credits reveals uncertain results, but the potential costs and benefits of offering such credits in the future are worth assessing. One drawback with tax credits is that, unlike utility rebates, tax credits are not received at the time of purchase but only after a tax claim is filed.

---

[7] U.S Department of Energy, Energy Information Administration, *Household Energy Consumption and Expenditures 1987, part 1: National Data*, DOE/EIA-032 *1(87)* (Washington, DC: October **1989), p. 46.** One way to correct the potential equity problems of increasing energy prices is to link price increases with a simultaneous and similar decrease in low-income tax rates. Providing low-income rebates is another option. Either approach could be revenue-neutral.

[8] 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, pp. 272-273.

[9] An increasing number of utilities offer rebates t. their customers who purchase energy efficient equipment. In one recent survey, at least 106 U.S. utilities were identified as offering customer rebates. *Rebate Report,* D & R International (Silver Spring, MD), vol. 2, October 1991, pp. 1-7. Rebate programs are seen by many utilities as a powerful tool for implementing efficiency, because rebates for appliances-much like rebates for cars-provide an instant cash reward for the desired behavior.

[10] Determining consumer response to rebate taxation is difficult, but the perceived value of the rebate is certainly reduced by taxation. Research in the residential sector has found that the "hassle factor" is an important constraint on efficiency, and taxing rebates clearly adds to the complexity and paperwork of the program.

[11] See testimony of Thomas D. Morron, Vice President, Edison Electric Institute, before the Senate Committee on Finance, Subcommittee on Energy and Agricultural Taxation, June 14, 1991, p. 8.

[12] C.M. Antinori, "Will Taxes Still Bite Into Rebates?" *Home Energy, vol. 8, No. 3,* May/June **1991, p. 11.**

Box 5-A—The Residential Mortgage Industry and the Federal Government

The Federal Government has long played a role in encouraging the availability of housing at a reasonable cost, and much of that Federal support has been through insuring, purchasing, or otherwise supporting mortgages. Today, the Federal Government participates in the mortgage industry in both the primary and the secondary markets. In the primary market, about 18 percent of new single-family home sales are financed with direct Federal Government backing through the Federal Housing Administration (FHA), the Veterans Administration (VA), and the Farmers Home Administration (FmHA) (table 5-A-l).

Table 5-A-l—Financing of New, Privately Owned Single-Family Houses, 1988

Financing source	Percent of houses
Conventional	63
Federally financed:	
FHA-insured.	13
VA-guaranteed.	4
FMHA.	1
Cash/equivalent.	18

NOTE: Percents do not sum to 100 due to rounding.

SOURCE: U.S. Department of Commerce, Bureau of the Census, Statistica/Abstract of the United States: 7990 (Washington, DC: U.S. Government Printing Office, January 1990), p. 715.

In the secondary market, several institutions created by the Federal Government-notably the Federal Home Loan Mortgage Corporation (Freddie Mac), the Federal National Mortgage Association (Fannie Mae), and the Government National Mortgage Association (Ginnie Mae)-purchase conventional mortgages from original lenders such as banks and credit unions. The requirements of these federally sponsored institutions, therefore, can influence conventional mortgages in areas such as building efficiency.

Energy efficient mortgages (EEMs) are another response to first cost barriers that commonly limit building energy efficiency. A mortgage is typically a long-term, relatively low-interest source of funds and offers a practical means of capitalizing efficiency investments in buildings. The Federal Government plays a significant role in both the primary and secondary mortgage market (box 5-A), suggesting that mortgages could be a viable Federal policy lever to pursue energy efficiency in buildings.

Energy efficient mortgages can work in several ways. Once a new home is deemed "energy efficient," the portion of income a buyer can spend on monthly mortgage payments can be increased—e.g., from 28 to 30 percent. The underlying rationale is that an efficient house will have lower monthly energy costs, and the resulting savings could be applied to the mortgage payment. Homeowners benefit because overall housing costs (which include mortgage and energy) can remain constant or even decrease (box 5-B), and they acquire a more valuable

Box 5-B—How a More Efficient House Can Cost Less

The conventional wisdom holds that efficiency costs more than standard practice. If one uses mortgages to finance efficiency, however, even measures with relatively long paybacks can result in lower, not higher, housing costs.

As discussed in chapter 2, the use of superinsulating technologies can reduce space heating energy requirements by 80 to 90 percent at an additional first cost of about $4,000 to $7,500 per house. The average new gas-heated house in the Midwest costs $477 per year to heat and $81 per year to cool[1] Assuming superinsulation could reduce space-conditioning energy use 85 percent, the dollar savings would total $474 per year ($477 + $81, times 0.85), or about $40 per month. Assuming an additional first cost of $5,750 for the superinsulation, the simple payback (assuming no energy price increases) would be an unimpressive 12.1 years. However, if the additional $5,750 was financed through a 30-year, 8-percent mortgage, the increase in the monthly mortgage bill would be $42. The net additional monthly cost for superinsulation, therefore, would be $42 (addition to mortgage) minus $40 (energy savings), or $2. If energy prices rose at 3 percent per year, energy savings would exceed the addition to the mortgage after 2 years. Thus, after 2 years the superinsulated house would result in a lower monthly housing (mortgage plus energy) cost.

[1] J. Koomey, J. McMahon, C. Wodley, *Improving the Thermal Integrity of New Single-Family Detached Residential Buildings*, LBL-29416 (Berkeley, CA: Lawrence Berkeley Laboratory, July 1991), p. 34.

house. Lenders can benefit because borrowing increases (assuming risk does not increase as well).

A second type of energy efficient mortgage applies to existing homes. Allowing efficiency improvements to be financed as part of the mortgage provides a relatively low-cost source of capital for efficiency improvements and can also reduce overall housing costs, which include energy payments, if the additional mortgage payment is more than outweighed by the energy cost reduction.

A third type of energy efficient mortgage includes projected energy costs in the mortgage calculations. A typical mortgage is based on a calculation of the costs of principal, interest, taxes, and insurance (PITI). Adding energy costs (PITI+E) to this calculation could improve the financial attraction of a home that costs more but uses less energy. The difficulty with this approach is making a reliable prediction of energy costs, which are influenced by occupant behavior, energy price changes, weather, and other variables.

Provisions for energy efficient mortgages already exist but are almost never used. A random sample of 5,000 Federal Housing Administration (FHA) loan files, for example, found only one loan that used an EEM.[13] Possible explanations for low EEM participation include lack of awareness, paperwork requirements, and the threat of delays or even loan cancellations stemming from the additional requirements.

Incentives: Basic Options

DOE spends about $230 million per year, and the Department of Health and Human Services (HHS) about $130 million per year, on grants for energy conservation retrofits in buildings, yet few data on the cost-effectiveness of these grants are available. Congress could direct DOE and HHS to set aside an adequate amount of program spending for program evaluation. Such evaluations could measure the costs and benefits of each program and identify areas requiring improvement. Utilities typically spend 3 to 10 percent of their demand-side program budget on evaluation. Although OTA was unable to determine exactly what fraction of Federal grant spending is applied to evaluation, it may be considerably lower than this.

Energy costs may not currently reflect their true costs to society due in part to their failure to incorporate environmental and other externalities. Methods to measure and evaluate these externalities need improvement if efficient pricing is to occur. Congress could direct and fund DOE to expand research on the measurement and pricing of externalities associated with energy production, distribution, and consumption. Such externalities need not be limited to environmental or negative effects, and they may not always favor the most energy efficient technologies, but measuring them could reveal their magnitude and importance to the U.S. economy. Of course, regulatory programs can have the effect—whether directly or indirectly-f pricing externalities; for example, Federal and State environmental regulations often require the mitigation of externalities associated with energy production and use, which commonly introduces costs. More directly, several States incorporate environmental externalities to some degree into energy planning. At a minimum, such State efforts could benefit from a better understanding of the true costs of currently uncaptured energy externalities.

Incentives: Moderate Options

Congress could pass legislation making utility rebates nontaxable. Taxing appliance rebates reduces the potential impact of utility incentive programs by limiting the financial gains from purchasing efficient units. By making utility rebates nontaxable, Congress could enhance utility rebate programs.

Congress could enact or increase taxes on the production and use of fuels consumed in the buildings sector. In addition to providing deficit-reducing revenues, such taxes would spur efficiency improvements as well as the market for demand-side services. Even though U.S. energy prices are among the lowest in the industrial world, the benefits of energy taxes would have to be weighed against the potential economic and trade effects of enacting or increasing such taxes.

Congress could direct and fund DOE to provide technical and financial assistance to States interested in measuring and pricing energy externalities. As noted above, at least 19 States have some provisions for incorporating externalities into

[13] W. Prindle, "Energy Efficient Mortgages: Proposal for a Uniform Program," *Proceedings of the ACEEE 1990 Summer Study on Energy Efficiency in Buildings* (Washington DC: American Council for an Energy-Efficient Economy, 1990), p. 7.155.

their energy planning. DOE could assist these and other States interested in improving this aspect of their energy planning, particularly as the nature and impact of externalities can vary greatly by State.

Congress could direct the Federal housing and national mortgage agencies to simplify and expand their energy efficient mortgage programs. Energy efficient mortgages are available but rarely used. As discussed above, this option could improve the affordability of many homes, which is especially important for first-time buyers, and it could increase the amount of business conducted by lending institutions. Simplifying the paperwork requirements in obtaining energy efficient mortgages, more visible promotion of the programs by the Federal and State Governments and lenders, and possibly improving program design and marketing would encourage greater use of these neglected financial options.

Incentives: Aggressive Options

Congress could mandate the measurement and pricing of energy externalities. This could occur gradually, over a period of years or even decades. At present, the most frequently discussed externality associated with energy production and use is environmental pollution, but the extent and nature of many environmental externalities are often poorly understood, and attempting to assign dollar values to them would be controversial. One currently discussed option is to levy a carbon tax based on the carbon dioxide emissions associated with fossil energy consumption. Other major pollutants associated with building energy use include sulfur oxides (SO_x), nitrogen oxides (NO_x), and chlorofluorocarbons (CFCs). These other externalities could be addressed through end-use taxes (which already exist for major CFCs), reductions of Federal energy supply subsidies, or increases in royalty fees for energy exploration and development on public lands.

A national effort to price energy externalities could begin with the Federal sector. Establishing select procurement criteria that cost major externalities (e.g., the use of CFCs in building heating, ventilating, and air conditioning (HVAC) systems) could provide useful lessons about how to conduct such an effort on a national scale. Federal energy programs could also stress the evaluation and incorporation of externalities in their regulatory efforts, including appliance labeling, building and appliance standards, RD&D planning, and utility demand-side management support.

Federal Leadership: Procurement, Recognition, and Demonstration

The purchasing power of the Federal Government, and the resulting ability to demonstrate innovative technologies and to develop their markets, is immense. Major efficiency gains could be attained through procurement and demonstration efforts that do not rely on conventional policy tools such as national efficiency standards, tax incentives, and information dissemination. In addition, the Federal Government could encourage efficiency through voluntary public recognition programs stressing environmental stewardship, economic competitiveness, or other valued attributes of energy efficiency, These approaches are voluntary and rely primarily on the market.

Policy options to improve the energy efficiency of the Federal sector are discussed in a separate OTA report.[14] That report stressed the value of Federal procurement to support markets for efficient products and services, as well as to demonstrate efficiency measures for private sector applications.[15] Some of these options are discussed below.

Energy efficiency has both environmental and economic benefits, and an innovative, voluntary Federal program has been designed to provide public recognition to organizations for their contributions to environmental protection through energy efficiency. In the Green Lights program, operated by the Global Change Division in the Office of Air and Radiation at the Environmental Protection Agency (EPA), participating companies agree to survey and upgrade lighting equipment, where appropriate, as long as such upgrades are profitable to the company and do not compromise lighting quality. EPA agrees to provide technical support and information and, perhaps more importantly, to provide public recognition to participating companies for their contribu-

[14] U.S. Congress, Office of Technology Assessment, *Energy Efficiency in the Federal Government: Government by Good Example?, OTA-E-492* (Washington, DC: U.S. Government Printing Office, May 1991).

[15] Ibid., pp. 105-113.

297-936 0 - 92 -10 : QL 3

tion to environmental protection.[16] Thus far, corporate response to the program has been impressive, due in part to the high value participants place on public recognition and positive publicity. Furthermore, participating companies welcome a voluntary, mutually beneficial alliance with a regulatory agency.

Another program, called the Golden Carrot, involves the EPA, utilities, environmental organizations, and a State energy office in a voluntary effort to build and demonstrate highly efficient refrigerators. The utilities will offer rebates to consumers that purchase the advanced refrigerators, which are intended to be at least 25 percent more efficient than 1993 Federal standards will require, consumers are given a financial incentive to purchase what promise to be highly efficient units, and manufacturers are guaranteed a market for their product by the utility. With guarantees of Federal procurement, similar programs might enjoy even larger markets.

Federal Leadership: Basic Options

Encourage energy efficiency in Federal buildings by changing procurement guidelines for energy-using equipment so as to incorporate energy efficiency. As mentioned, the Federal market for energy-using technologies is substantial. Procurement policies that advance efficiency could be implemented *and enforced,* Such policies could include revising Federal procurement guidelines to implement life-cycle costing techniques (which would tend to favor cost-effective efficiency technologies); providing financial and other awards (such as bonuses or shared savings) to individuals and agencies responsible for achieving energy cost savings; and establishing guidelines that set minimum efficiency levels for purchased equipment.

Extend the EPA Green Lights concept to other contexts. The EPA program is an innovative voluntary effort that could serve as a model for other programs. For example, the Federal Government could recognize commercial firms that improve significantly (by some pre-determined measure) the efficiency of their space conditioning equipment without compromising comfort. Another possibility is to recognize publicly developers that construct a certain number or fraction of buildings in any year that surpass a given energy efficiency guideline. Such efforts could be recognized for their energy, environmental, or other merits.

Federal Leadership: Moderate Options

Allocate (or increase access to) funds for efficiency improvements in Federal buildings. Resources could be channeled through a revolving Federal fund,[17] as earmarked monies designated exclusively for building efficiency improvements (usable only if energy audits indicate that proposed measures are warranted and cost-effective), or through policies encouraging Federal participation in utility demand-side management, cost sharing, rebate, or other private financing options.

Encourage manufacturers, utilities, and other interested parties to extend the Golden Carrot program concept to other technologies for demonstration and marketing. Collaborative, voluntary programs providing incentives for increased efficiency, such as the Golden Carrot program, could be extended to other technologies-freezers, water heaters, heat pumps, clothes washers—using Federal efficiency standards as benchmarks to surpass,

Federal Leadership: Aggressive Options

Actively promote the demonstration of efficient technologies in Federal buildings to strengthen markets for energy efficient goods and services. One way to promote this is to allow participating agencies to retain some portion of their financial savings in exchange for taking the risk of using an innovative technology.

Federal RD&D in the Buildings Sector

Research, development, and demonstration (RD&D) is the process that generates new technology for adoption in the marketplace. This process drives the improvement of technologies that increase energy efficiency and reduce energy use in buildings. In general, only industry and the State and Federal Governments have the resources and interest to sustain this process.

---

16 According to EPA, ''EPA will publicly recognize successful Green Lights corporations. It intends to credit those companies for their contributions to pollution prevention, and seeks to ensure that customers, shareholders, employees, and the public arc aware of their achievements in protecting the environment with energy efficiency. From J. Lawson and B. Kwartin, ''Green Lights on Energy Savings, ' *LD+A*, February 1991, p. 7.

17 For a s[illegible]l example of such a program, see M. Verdict, J. Haberl, D. Claridge, D. O'Neal, W. Heffington, W. Turner, ' 'Monitoring $98 Million in Energy Efficiency Retrofits: The Texas Loanstar Program, ' *Proceedings of the ACEEE 1990 Summer Study on Energy Efficiency in Buildings* (Washington. DC: American Council for an Energy-Efficient Economy, 1990), p. 7.261.

The building sector is highly fragmented by region, size, and function-from builders to equipment manufacturers, architects to real estate professionals. For example, single-family residential construction firms in the United States alone number over 90,000.[18] In addition, there are thousands of building equipment manufacturers and hundreds of architectural and engineering fins.[19] This fragmentation makes it difficult for the building sector to pool its resources to conduct RD&D. In addition, this industry, as with any other in the United States, is driven by the need to sustain profits in the short-term, which tends to discourage RD&D because of its high costs and uncertain returns. Yet RD&D generates technologies that improve performance, increase reliability, save energy, and reduce costs for this sector. As a result, the Federal Government has a critical role to play in identifying, planning, and funding RD&D in the buildings sector.

For all sectors—but buildings in particular-there are several critical issues worth considering in the development of an RD&D agenda for the Nation:

Selecting a mix of research projects givcn limited resources: The Federal energy RD&D program is a mix of basic and applied research that addresses both demand and supply technologies. (Most of the comments in this section relate to applied research.) The relative attention and funding given to these various project types reveals the relative weighting of priorities (whether or not they are stated) in an RD&D program. Thus, policymakers and program planners have to consider the overall mix of their total RD&D effort in setting programwide research goals-and identify the most promising individual projects worthy of research—in order to determine the optimal allocation of often limited RD&D resources.

Identifying non-hardware research needs: The conventional notion of research involves technological hardware development, but building design tools, improved operations and maintenance (O&M) practices, computer software, and behavior-oriented research offer numerous opportunities to help implement emerging technologies, improve existing programs, and reduce energy use. These non-hardware technologies are worth identifying and improving; they include, for example, computer systems to monitor and regulate whole building systems for optimal energy efficiency, econometric methods to evaluate energy conservation programs, tools for conducting least cost planning, and social science and marketing analyses to improve technology transfer.

Improving program planning by defining and integrating technology-specific and program-specific goals: Technology-specific goals and better RD&D program planning are essential for Congress and DOE to assess the merits of technologies chosen for development, as well as the benefits the Nation can expect to realize with DOE RD&D investments. Without well-defined program goals, there is no guarantee that the selection of technology-specific research projects will adhere to consistent principles or have a consistent direction. And without technology-specific research goals, broad program goals function as little more than wish lists. Both sets of goals (program-wide and technology-specific) should be recognized as interdependent and should be made as specific as possible, with the links between them made clear (box 5-C).

Involving industry in project planning, funding, and execution: This would increase the probability of interest in (and a market for) technologies that are successfully developed and demonstrated. Involving industry (to the extent practical) at the outset of project planning would also improve the chances that new technologies not only save energy but also consider the concerns of manufacturers and others--concerns that are typically broader than just energy efficiency and might include required changes to manufacturing processes, cost, reliability, and consumer interest. The fragmentation of the buildings sector could complicate industry involvement; unlike the transportation sector, where a few major manufacturers dominate the industry, the buildings industry consists of a diversity of firms with greatly differing financial and technical resources. However, the potential benefits of increased industry involvement suggest that its pursuit in RD&D would be worthwhile.

[18] U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States: 1991* (Washington, DC: U.S. Government Printing Office, 1991), p. 715.

[19] M.A. Brown, *Technology Transfer Strategies of the U.S. Department of Energy's Conservation Program*, ORNL/CON-277 (Oak Ridge, TN: Oak Ridge National Laboratory, December 1988), p. 47.

Box 5-C—The DOE Multi-Year Program Plan

Since 1983, the Department of Energy Office of Conservation and Renewable Energy has used a multiyear planning process to establish national conservation goals and to organize technology-specific projects. Currently termed the "Multi-Year Program Plan" (MYPP), this annual process culminates in the publication of an internal DOE document that covers the 5 fiscal years subsequent to the upcoming year; thus, the MYPP developed in 1991 covers fiscal years 1993 to 1997.[1] While the MYPP establishes ambitious national program goals and outlines the technologies that are being targeted for development to help meet those goals, the document does not generally indicate long-term goals for the actual technologies beyond their development nor does it indicate the expected economic returns from DOE funding allocated for these projects.

For example, the portion of the current MYPP relating to buildings research defines one goal: to hold constant to 2030 the use of nonrenewable energy in U.S. buildings.[2] However, the document neglects to indicate the relationship between this goal and the technology-specific research proposals outlined in the report; there is no ledger that sums up or projects the contribution of the technologies that will contribute to the DOE goal. In short, at least for building-related RD&D, there is no identifiable connection between DOE program objectives and DOE projects. This is important, because the technical merits of any particular project need to be weighed against other proposals; many research ideas have merit, but not all can be pursued. A better planning process will better determine an optimal portfolio of promising conservation projects.

Of course, developing and analyzing methods to integrate long-term program goals with multiyear research plans would shift some resources away from RD&D to internal administration, but this shift could be small relative to the entire Office of Conservation and Renewable Energy budget, and it could improve considerably what is achieved with that budget. At present, the Department could better seine public RD&D objectives through the MYPP process in at least two ways. First, where practicable, DOE could attempt to delineate more clearly the expected end-use results (including costs and benefits) of each technology-related RD&D project, Second, DOE could open the process to include more public and industry review of these planning documents. Such changes to the MYPP planning process could help the Department link better its program objectives with its technology-specific projects.

---

1 U.S. Department of Energy, Office of Conservation and Renewable Energy, *Multi-Year Program Plan Fiscal Years 1993-1997*, DOE/CE-0329 (Washington DC: U.S. Department of Energy, April 1991). Note: This document is used for internal DOE planning and is listed as "administratively confidential." As a result, OTA does not discuss specific projects or budget figures contained in the report.

2 Ibid., vol. I, p. 6-8.

On the other hand, lack of industry interest in any project is not by itself sufficient reason to abandon a good idea. Federal RD&D policymakers must weigh broader, more long-term issues than can be expected from the building industry. Federal initiative and funding has helped speed the development of key building energy efficiency technologies, such as solid-state ballasts and low-emissivity (low-e) windows, at times when there was little initial industry interest in developing them.[20] Industry interest, therefore, should not solely determine whether the Federal Government funds an RD&D project,

One promising option for increasing industry involvement in project planning is the use of an outside review panel, such as the Critical Review process, which was developed by the DOE conservation office in 1985. This process convened independent panels to assess the merits and direction of DOE conservation RD&D projects under consideration but, as reported by the General Accounting Office (GAO), the Critical Review program was seldom used even though it was recognized as useful in project planning.[21] A program like Critical Review is helpful in promoting industry participation in DOE project planning and implementation,

---

20 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. 357-395.

21 U.S. Congress, General Accounting Office, *Conservation Planning and Management Should Be Strengthened*, GAO/RCED-90-195 (Gaithersburg, MD: U.S. General Accounting Office, July 1990), pp. 27-35.

especially in assessing issues such as the technical and economic potential of existing technologies, the clarity and soundness of project goals, and potential obstacles to technology transfer once a new technology has been demonstrated successfully. Nonetheless, the Critical Review program was terminated in 1990.22

Engaging in demonstration and technology transfer: This is the process by which lessons from the laboratory are applied in practice. Technology transfer is the ultimate goal of RD&D programs. No *applied* research project is truly successful unless its results are implemented. After the development of new efficiency technologies, successful demonstration and marketing are critical to ensure that they reach the market. After an initial emphasis on technology transfer, the DOE RD&D program in the 1980s changed focus. In the last decade, DOE RD&D has concentrated on long-term, high-risk research efforts that the agency believed would not be undertaken by private industry .23 DOE relied on the private sector to press the transfer of new energy technologies once they were developed, but the results of that reliance were often mixed.

In the buildings sector, for example, DOE-funded research led to the development of residential heat-pump water heaters, a technology that consumes far less energy than conventional electric resistance water heaters. However, these units have shown minimal market penetration due to their high first cost; currently, less than one percent of water heaters sold make use of the new heat pump technology. [24] AS these heaters have the potential to achieve large residential energy savings, there is a key role for improved technology transfer because participation of more manufacturers and vendors could lead to reduced costs.

According to a 1989 review by the Oak Ridge National Laboratory, "DOE's technology transfer funds are typically very limited. "[25] The most recent DOE report on technology transfer in the DOE buildings program confirms the general emphasis on technology development over technology transfer.[26] Recognizing the need for research with practical applications, DOE has taken an encouraging step with its RD&D agenda. The Department maintained that the energy RD&D program in 1991 would begin to balance better high-risk basic research projects with applied research having more immediate practical applications.[27]

Expanding demonstration and technology transfer activities would increase the probability that the fruits of DOE-funded research gain industry and consumer acceptance and thereby enjoy wider use in the marketplace. To make this change would not necessarily require changes in total funding but could entail a basic requirement that all technology RD&D projects (or the overall RD&D program) incorporate a distinct and adequately budgeted demonstration and technology transfer component prior to their initiation. These resources could then be available whenever successful research projects needed further DOE attention to ensure product development and marketing.

A different kind of arrangement, the cooperative research and development agreement (CRADA), has received increasing attention since the passage of the Federal Technology Transfer Act of 1986 (Public Law 99-502). This statute created incentives for Federal agencies and national laboratories to execute CRADAs to improve the transfer of Federal research results to the private sector. In brief, these agreements ease the restrictions on Federal-private cooperation by, for example, allowing Federal laboratories to grant exclusive licensing arrangements with parties collaborating on RD&D projects (e.g., private industry, State and local governments, and nonprofit groups) and allowing Federal laboratories to use funds provided by nonfederal parties

22 Kenneth Friedman, DOE Office of Conservation and Renewable Energy, personal communication% Jan. 16, 1991.

23 This is reflected i, the portfolio of research projects selected in the 1980s, as well as key policy documents published by the agency. For example, see U.S. Department of Energy, *The National Energy Policy Plan,* DOE/S-0040 (Washington, DC: 1985), pp. 34-35.

24 Carl C. Hiller, Senior Project Manager, Residential Systems, Electric Power Research Institute, personal communication, Mar. 4, 1992. See also 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. 75, 86, 123.

25 Ibid., p. 121.

26 U.S. Department of Energy, Office of Building and Community Systems, *Analysis and Technology Transfer Annual Report 1988, DOE/CH/OOO16-H2* (Washington, DC: May 1989), pp. ES-1, 2-9.

27 U.S. Congress, General Accounting Office, *DOE's Allocation of Funds for Basic and Applied Research and Development,* GAO/RCED-90-148BR (Gaithersburg, MD: May 1990), p. 11.

participating in Federal RD&D projects.[28] At present, the DOE Office of Building Technologies (OBT) is participating in at least three CRADAs.[29]

Performing program evaluation: As discussed in chapter 4, formal evaluations of DOE building energy programs, including conservation RD&D, are rare. Such evaluations identify program achievements as well as implementation problems. Although long-range planning and budgeting are conducted annually for 5-year periods in the DOE conservation program, program-wide RD&D evaluations are not conducted on any regular or visible basis.

The general scope of OBT RD&D projects—as well as a select number of their successes—are well-documented, but there is no consistent method employed by the Department that compares the costs and benefits of projects during or after their execution, that evaluates how program planning and funding contribute to actual project results, or that indicates measurable energy and economic gains expected from the improvement of technologies under development. Program evaluations that incorporated these issues would enhance long-term RD&D planning and define better the purposes and expected results of specific RD&D projects. Such evaluations would be most valuable if they allowed cross-program comparisons and considered both demand and supply RD&D.

Funding: A predictable policy option is to increase funding for a particular activity. Although this would expand the scope of the Federal building conservation RD&D effort, it would not, by itself, ensure a better one. Improving planning, setting realistic goals, cooperating more closely with industry, identifying technology transfer opportunities, and performing program evaluations are equally vital to the success of the DOE-applied RD&D program for buildings. Of course, performing most of these tasks would require additional resources, unless Congress and DOE are willing to reduce the number of building conservation RD&D projects and shift more resources to fewer projects. But if Congress determines that the current OBT goal—holding nonrenewable energy use in U.S. buildings constant until 2030-is a realistic and desirable one, then current buildings conservation RD&D funding (in the range of $50 million per year) is probably too low.

RD&D: Basic Options

Congress could require all DOE Office of Building Technologies (OBT) applied research projects reaching the demonstration stage to conduct some minimum level of technology transfer and market assessment. One simple but relatively inflexible method for ensuring such work would be to establish a minimum percentage of funding for these functions as part of all applied OBT projects or, alternatively, as part of the entire program budget. A better method would address the process that incorporates technology transfer into project planning and execution. This would guarantee that technology transfer is conducted for all applied research projects that have demonstrated technological advances. Such a requirement should not apply to basic or high-risk RD&D work, where transferable achievements are not expected in the short-term.

Specific provisions for technology transfer in each applied RD&D projector for the entire applied research program increase the probability that research success is actually applied beyond the laboratory. The Stevenson-Wydler Technology Innovation Act of 1980 (Public Law 96-480) *inter alia* required each Federal laboratory to establish an Office of Research and Technology Applications (ORTA) to conduct technology transfer from the labs to State and local governments and the private sector and directed each lab with a total annual budget exceeding $20 million to place at least one full-time professional in its ORTA. Federal agencies that operated or directed one or more national laboratories were required to earmark a minimum of 0.5 percent of their RD&D budgets to fund technology transfer efforts at their respective agencies and at their labs, including support for each ORTA.[30] This funding earmark was later repealed (Public Law 101-189), because Congress determined that agencies were using their discretionary authority under

[28] U.S. Congress, General Accounting Office, *Diffusing Innovations: Implementing the Technology Transfer Act of 1986*, GAO/PEMD-91-23 (Gaithersburg, MD: May 1991), pp. 7,76.

[29] U.S. Department of Energy, Office of Conservation and Renewable Energy, *Conservation and Renewable Energy Technologies for Buildings*, DOE/CH10093-85 (Washington, DC: May 1991), p. 20.

[30] Public Law 96-480, 94 Stat. 2318, sec. 11.

the Stevenson-Wydler Act to waive the requirement.[31]

Flexibility in Federal RD&D program planning is essential, but technology transfer is too vital to the success of research programs, in OTA's view, to eliminate completely some minimum level of effort for this function. Congress could consider restoring (and even increasing) the minimum technology transfer funding requirement established by the Stevenson-Wydler Act *and* deny waivers, although such requirements risk inflexibility. One clear problem is determining an adequate level of technology transfer funding that does not significantly reduce the resources for research itself. Other, more flexible approaches for improving technology transfer efforts could address the process by which technology transfer is conducted but could also require careful attention to, and incentives for, such transfer. Such options include greater use of cooperative R&D agreements (CRADAs, discussed above), an industry liaison (separate from designated project managers) to manage technology transfer activities for appropriate RD&D projects, senior management and corporate recognition efforts for successful technology transfer efforts, and a clear and aggressive commitment to Federal procurement for emerging technologies.

Encourage or require DOE to define specific technological goals that relate to program objectives in the DOE Conservation multiyear planning process. As discussed earlier, the DOE Conservation program annually develops a planning document (the Multi-Year Program Plan, or MYPP) that lists proposed RD&D projects for upcoming years. However, the utility of that planning process could be improved by clarifying the actual measurable benefits to consumers that each project aims to achieve. Despite the articulation of overall RD&D program goals in the MYPP, the document fails to clarify how those goals will be achieved by the technology-specific projects proposed. Improving the multiyear planning process in this way would require a shift of some resources to this activity or an increase in the program budget.

Conduct regular RD&D program evaluations for Congress in order to identify the successes, failures, and future direction of projects in the DOE Office of Building Technologies (OBT). Internal methods at the DOE Conservation office notwithstanding, Congress does not have the benefit of reviewing program-wide evaluations of OBT RD&D projects on a regular basis. As a result, the actual benefits of RD&D funding cannot be assessed by Congress in a regular or consistent way. Although they would require additional resources, regular evaluations would measure the progress of DOE building conservation RD&D projects more reliably and would inform Congress better about DOE RD&D progress.

RD&D: Moderate Options

Make greater use of market surveys to assess manufacturer and consumer response to new technologies prior to initiating OBT RD&D projects. Even when program planners correctly identify the most promising technological opportunities for reducing energy use in buildings-related RD&D, there is no guarantee that manufacturers will be able to adopt anew technology or that consumers will respond favorably to that technology. As a result, market surveys performed prior to project initiation can uncover potential problems or opportunities which, if accounted for in the RD&D process, can help ensure that the final product is marketable.[32] In addition, market surveys may uncover institutional issues (e.g., building code requirements) that could impede market success of new technologies. Performing market surveys would require shifting some resources to this activity, perhaps even a minor increase in the OBT budget.

Increase industry involvement in RD&D project planning, funding, and execution. Regardless

31 The National Competitiveness Technology Transfer Act of 1989 (Public Law 101-189) repealed the ().5 percent funding earmark, requiring instead that "sufficient funding, either as a separate line item or from the agency's research and development budget" be designated for technology transfer activities. Public Law 101-189, 103 Stat. 1679, sec. 3133(e)(2). As explained in the House Conference report:

> "The conference agreement would repeal the one-half percent funding requirement for technology transfer programs under Stevenson-Wydler and the related waiver provisions. These changes are not intended to reduce that commitment to technology transfer but rather acknowledge that this requirement has been universally waived during the Act's 9-year history and that there is a lack of certainty that one-half percent provides the appropriate amount of funding. '

House Conference Report No. 101-331 (Nov. 7, 1989), p. 761. From *U.S. Code* ***Congressional and Administrative*** *News*, 101st Congress—First Session (St. Paul, MN: West Publishing, 1989), vol. 3, p. 1151.

32 However, market surveys are not always appropriate. For example, if a fundamentally new technology is under consideration, surveys may have little value or relevance in predicting the eventual market response.

of the technological advances achieved in RD&D programs, industry must eventually adopt and market new technologies before their practical applications can be realized on a large scale. To gain industry's input in RD&D program planning (and to improve the prospects of its adopting RD&D products), industry could be engaged to contribute to this process as early as possible through workshops, requests for proposals, and screening committees consisting of senior DOE managers and industry representatives (e.g., similar to the Critical Review program mentioned above).

Stressing cost sharing and outside funding where possible would help ensure that industry truly invests itself in the Federal RD&D process. Although it does not involve cost sharing, the Small Business Innovation Research (SBIR) program provides grants to small companies attempting to develop and commercialize new technologies, and is a useful model to encourage the involvement of small, competitive firms in project execution.[33] (Often, small firms will pursue RD&D projects that the larger appliance and equipment manufacturers show little initial interest in.[34]) Given the fragmented nature of the buildings sector, early and sustained industry involvement in DOE RD&D project planning, funding, and execution are good options to ensure that projects are well-defined and target clear opportunities for efficiency improvements.

There are potential problems that arise with increased industry involvement, such as the potential for conflicts of interest or controversy over granting exclusive rights to technologies developed with public funding, but the potential gains of correcting the currently low level of industry involvement in DOE RD&D projects could far outweigh the burden of avoiding such problems. One simple measure of industry participation in Federal buildings energy RD&D is the fraction of government-funded research spending awarded to industry. In fiscal year 1988, for example, only 13 percent of OBT RD&D funds were awarded directly to industry. That same year, the DOE industrial and transportation conservation RD&D programs awarded far more of their RD&D funds to industrial firms, 55 and 65 percent respectively (table 5-1).[35]

Table 5-l—Allocation of Research Funds in the U.S. Department of Energy Conservation Program (by percent, fiscal year 1988)

	Buildings	Transportation	Industry
National laboratories. . . .	74	18	30
Industry.	13	65	55
Universities.	3	5	14
Other.	10	12	2

SOURCE: M.A. Brown, *Technology Transfer Strategies of the U.S. Department of Energy's Conservation Program,* ORNL/CON-277 (Oak Ridge, TN: Oak Ridge National Laboratory, December 1988), p. 44.

Examine the feasibility of both least-cost and net benefit planning for the DOE applied conservation RD&D programs. The results of such studies should be reported to Congress. One way for DOE to determine the optimal mix of RD&D projects could be to conduct least-cost RD&D planning; that is, to establish a research agenda that attempts to pay the least cost for a given set of anticipated benefits. Defining the parameters of and actually conducting least-cost RD&D planning credibly would be extremely difficult, but not impossible. This option suggests that DOE evaluate the feasibility of adopting a planning method for applied conservation research that pursues a least cost mix of energy efficiency technologies.

As an alternative, DOE could examine the feasibility of performing net benefit RD&D planning, such as that performed by the Gas Research Institute

33 The SBIR program is operated by the US. Small Business Administration in conjunction with 11 Federal agencies, including DOE, under authority of the Small Business Innovation Development Act of 1982 (Public Law 97-219). The program funds small businesses to conduct research projects through the development stage; although a major goal of the program is to encourage commercialization, product marketing is not funded by the Federal Government. See U.S. Small Business Administration, Office of Innovation, Research and Technology, *Small Business Innovation Development Act: Eighth Year Results* (Washington, DC: July 1991), 8th Annual Report.

34 See 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. 357-395. In addition, the Energy-Related Inventions Program (managed by DOE in conjunction with the National Institute of Standards and Technology) is authorized under the Federal Nonnuclear Energy Research and Development Act of 1974 (Public Law 93-577) and funds energy-related research conducted by small firms. The program has awarded more than $24 million in research monies to 329 projects. U.S. Department of Commerce, National Institute of Standards and Technology, *Energy Related Inventions Program: A Joint Program of the Department of Energy and the National Institute of Standards and Technology: Status Report for Recommendations 251 Through 523* (Washington, DC: March 1991), p. 1-3.

35 M.A. Brown, *Technology Transfer Strategies of the U.S. Department of Energy's Conservation Program,* ORNL/CON-277 (Oak Ridge, TN: Oak Ridge National Laboratory, December 1988), p. 44.

(GRI), the research arm of the natural gas utility industry. The annual GRI RD&D budget requires Federal Energy Regulatory Commission (FERC) approval. To gain that approval, GRI is required to budget only RD&D projects that are expected to result in net benefits to existing classes of end-use consumers. That is, the projected benefits of RD&D projects must be greater than the projected costs of performing them.[36]

RD&D planning of either kind (least-cost or net benefit) would focus better the DOE conservation RD&D planning effort to ensure that the best opportunities for energy technology RD&D are selected. Such planning would help DOE maximize the benefits of the public investment in conservation RD&D. However, the small size and scope of the OBT program would not warrant the considerable investment in performing such an evaluation by itself; applying such a rigorous standard for research planning would be more appropriate for the entire Office of Conservation and Renewable Energy program, rather than just one part of it.

Establish an ambitious level of technology transfer and marketing efforts for OBT RD&D projects beyond that currently pursued. This level would represent an effort to conduct technology transfer more ambitious than in the basic level, such as assigning a full-time professional staff to assist exclusively with technology transfer within major programs such as OBT. Another option is to set aside a given percentage of the OBT budget to technology transfer. In recent years, OBT has spent 10 percent or less of its RD&D budget on technology transfer.[37] In the future, OBT could designate as much as 15 to 20 percent of its budget for transfer and marketing (at least in cases where technical improvements have been made). Other options—such as increasing the use of CRADAs (discussed above), encouraging personnel exchanges between the national laboratories and industry, and training program management and staff in marketing techniques--could also improve technology transfer efforts.

Increase OBT funding for RD&D work. To some participants in the debate on national RD&D priorities, a substantial funding increase is considered an attractive policy option to enhance any RD&D program, As this report stresses, however, a shift in program emphasis or modest (but targeted) increases in funding for the DOE conservation RD&D program could yield significant returns. The breadth and quality of DOE conservation RD&D efforts would likely increase with increased funding, but Congress should ensure that basic programmatic improvements are made or planned prior to any major funding increases. As discussed in chapter 4, one of the most prolific periods in DOE buildings conservation research (based on demonstrated technological advances resulting in measured energy savings) was during the late 1970s and early 1980s when RD&D funding was high. The 1991 OBT conservation budget, however, was only 44 percent (in current dollars) of the 1980 budget. If Congress increased funding for the Office of Conservation and Renewable Energy program substantially, net benefit or least-cost planning for the program could become a vital yardstick to determine how best to allocate resources between numerous projects in different offices.

RD&D: Aggressive Options

Require DOE to market buildings conservation RD&D results to utilities, State agencies, and its own regulatory programs, including the Office of Codes and Standards (within the Office of Building Technologies). This would help ensure that conservation RD&D results are imparted to interested groups in a timely fashion. These groups are at the center of numerous regulatory, incentive, and other efficiency efforts, suggesting that well-marketed RD&D results would strengthen their ability to keep pace with and even push technical advances. Appointing utility and State liaisons to market RD&D results is one way to achieve this.

Require DOE to perform least-cost or net-benefit-applied conservation RD&D planning. This would be a major departure from current applied conservation RD&D budget and program planning, and it would require a major effort (at least initially). The suggestion does not apply to basic RD&D, where high-risk, long-term work is the norm, and where

36 A. Lee Wallace, Director of Regulatory and Legislative Affairs, Gas Research Institute, written communication to OTA, Aug. 16, 1991.

37 U.S. Department of Energy, Office of Buildings and Community Systems, *Analysis and Technology?' Transfer Annual Report 1988*, DOE/CH/00016-H2 (Washington, DC: May 1989), p. 2-9. *Note:* The proportion of technology transfer funding in an office such as OBT (10 percent) should not be confused with the seemingly modest requirements under the Stevenson-Wydler Act (discussed above), because that legislation channeled resources from entire agency RD&D budgets, not just particular RD&D offices.

ultimate returns are often difficult to predict. However, it is an appropriate concept to consider for Federal agencies conducting applied RD&D, where public monies are being spent for ostensibly identifiable public benefits. If one or both of these planning methods is determined to be feasible, DOE could initiate such an effort to ensure that expected RD&D benefits exceed expected RD&D costs. Of course, either planning method would require several years to implement, but both have the potential to maximize public returns on Federal RD&D investments.

Utilities and Energy Efficiency[38]

Utilities are ideally positioned to promote energy efficiency in buildings. They have monthly contacts with consumers through their billing systems, they have historical and current data on consumer energy consumption, and they provide service throughout the United States. Until recently, however, utility regulation provided utilities with no direct financial incentives to encourage efficiency among their consumers. In fact, under traditional principles of utility regulation, utility profits were tied to sales—the more energy sold by the utility, the greater its revenues and profits.

In recent years, some States have changed utility regulation to provide utilities with financial incentives for efficiency investments. These changes have included both limiting disincentives for efficiency, for example by decoupling revenues from sales, and providing positive incentives for efficiency .39 Even without financial incentives, many utilities have found that efficiency measures can be a quick and inexpensive way to meet demand growth. In addition, many States and utilities are adopting least-cost planning techniques to ensure appropriate use of efficiency .40

At present, utilities are probably the single most important institutional vehicle for implementing efficiency in buildings. For example, there are over 1,000 electric utility-run efficiency programs in the residential sector[41] and over 340 in the commercial sector.[42] These Programs include changes in rate structures, financial incentives for consumers such as rebates and loans, information programs such as audits and technical assistance, RD&D, and demand-side bidding.[43] Another promising option not applied as widely is a reduced hook-up fee for energy efficient buildings, which utilities can use to encourage energy efficient construction.

The results in some States have been quite impressive. In California, for example, utility programs undertaken through 1987 promoting energy efficiency in the residential and commercial sectors were estimated to have cut new capacity needs by over 1,800 megawatts in 1987—the equivalent of about two new large coal or nuclear powerplants.[44]

State regulatory agencies have primary jurisdiction over utility resource planning, demand-side

38 The role of utilities in implementing efficiency is discussed in detail in a forthcoming OTA report.

39 The California Public Utilities Commission uses a rate-setting mechanism known as the Electric Rate Adjustment Mechanism (ERAM), which decouples utility profitability from the amount of electricity sales. For a full discussion of ERAM and other imovative efficiency incentive mechanisms, see J. Cole and M. Cummings, "Making Conservation Profitable: An Assessment of Alternative Demand Side Management Incentives,' *Proceedings of the ACEEE 1990 Summer Study on Energy Efficiency in Buildings* (Washington DC: American Council for an Energy-Efficient Economy, 1990), pp. 5.35 -5<50.

40 Least-cost planning (LCP) can be defined as "a process of examining all electricity-saving and electricity-producing options to select a mixture of options that minimizes total customer cost." (D. Moskovitz, *Profits and Progress Through Least-Cost Planning* (Washington, *DC:* National Association of Regulatory Utility Commissioners, November 1989), p. vi.) The term integrated resource planning (IRP) is also used. There are few arguments against the *concept* of LCP. Almost all agree that meeting energy service needs at the lowest feasible cost is appropriate. However, there is considerable controversy over the *implementation* of LCP. Calculating costs, structuring regulatory incentives, and allowing for nonutility participants have all proven controversial. Furthermore, concerns about administrative costs, the difficulty in predicting and measuring saved energy, and disagreements over relative subsidies have complicated implementation. The interpretation of just what constitutes LCP varies but, according to one 1990 survey, 23 States had least-cost planning of some kind in operation, and another 8 States were initiating it. Edison Electric Institute, Rate Regulation Department, *State Regulatory Development in Integrated Resource Planning* (Washington, DC: Edison Electric Institute, September 1990), p. 2.

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

42 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.

43 Some utilities request bids from outside firms for new energy supplies. Extending the bidding process to allow bids for energy savings is called demand-side bidding.

44 California Energy Commission, *Energy Efficiency Report,* P400-90-003 (Sacramento, CA: October 1990), p. 30. For comparison, a large coal-fired or nuclear powerplant has a capacity of about 900 MW.

management programs, and retail rates. Barring a revolutionary shift in the balance of Federal and State utility jurisdiction, State regulatory agencies will continue to play the major role in efforts to encourage utilities to promote building energy efficiency.

Federal influence over State regulatory authorities and utility-run energy efficiency programs is limited and indirect and is based in part on: 1) management and oversight of ''Federal utilities"—the power marketing administrations and the Tennessee Valley Authority; 2) Federal Energy Regulatory Commission jurisdiction over interstate transactions, wholesale rates, and multistate holding companies regulated under Federal law; and 3) Department of Energy information, technology development, and technical support programs.

There are several examples of Federal Government support for greater consideration of efficiency by utilities. The Pacific Northwest Electric Power Planning and Conservation Act (Public Law 96-501) instituted a regional council for electricity planning in the Pacific Northwest and required that the council consider efficiency as a resource when assessing future electricity supplies. DOE currently funds a least-cost planning research program within the Office of Utility Technologies, with an annual budget of about $3 million in fiscal year 1991.45 The Clean Air Act Amendments of 1990 (Public Law 101-549) authorize emission allowances for energy conservation (sec. 404(f)), and the Environmental Protection Agency is developing rules to implement these provisions.

Congress could promote utility conservation programs in several ways, including an expansion of DOE technical support, changes in regulatory policies, and changes in Federal utility plannirig and management. In considering these options, understanding the interaction of State versus Federal regulatory oversight of utilities is important. Historically, utility regulation has long been managed primarily at the State level, and any expanded Federal role could be controversial.

Utilities: Basic Options

National experience with least-cost planning is increasing but uneven, and many utilities have a clear need to understand better the design, operation, and performance of efficiency programs. **Congress could instruct** DOE to expand its research and development related **to the design, operation, and evaluation of utility efficiency programs. Similarly**, the Federal Government could help States learn from each other about how to implement least-cost planning and how to design, operate, and evaluate energy efficiency programs. **Congress could instruct** DOE to increase its activities as an information clearinghouse for efficiency program design, operation, and evaluation.

The Northwest Power Planning Council, established in response to Federal legislation, is charged with addressing future power requirements in the Pacific Northwest by considering both demand and supply options. Congress **could instruct** DOE to evaluate whether the Northwest Power Planning Council represents a useful model **for energy planning that could be applied to other regions of the country.**

Utilities: Moderate Options

The Federal utilities[46] account for about 19 percent of U.S. electricity sales.[47] Congress could direct the Tennessee Valley Authority (TVA) and **the power marketing administrations to better integrate least-cost planning techniques and principles into their operations and management.** Establishing such requirements would be a first step to ensuring that public monies spent on power generation are applied in the most cost-effective manner possible.

The Federal Energy Regulatory Commission (FERC) has jurisdiction over all wholesale electricity and natural gas transactions in the United States. **Congress** could instruct FERC to examine its ratesetting and other regulatory actions to determine their consistency with State-approved utility least-cost plans.

45 U.S. Department of Energy, *U.S. Department of Energy Fiscal Year 1992 Congressional Budget Request, DOE/m-ml (Washington,* DC: February 1991), vol. 4, p. 438.

46 These include the Federal Power Marketing Administrations (PMAs), which are part of DOE, and the Tennessee Valley Authority (TVA).

47 U.S. Department of Energy, Energy Information Administration, "Sales of Electricity Available for Resale," *Financial Statistics of Selected Investor-0u3nedE[ectric Utilities 1989*, DOE/EIA-0437(89)/1(Washington, DC: January 1991), p. 3.

As mentioned above, about 23 States are currently using some form of least-cost planning, and another 8 States are in the process of implementing it. **Congress could instruct** DOE to support through grants, technical support, or other means, State and utility efforts related to the design and implementation of least-cost planning. Such support could be directed at both States that currently use least-cost planning and those considering it. In addition, **Congress could encourage or require States not already doing so to consider adopting least-cost plans.**

Utilities: Aggressive Options

Most of the electricity sales by the federally owned utilities are to other utilities and not to ultimate customers. **Congress could direct the federally owned utilities to provide incentives for or require its customer utilities to adopt least-cost plans.** Such a requirement could be accompanied by technical support from the federally owned utilities to its customer utilities for least-cost plan preparation and implementation.

Mandating Efficiency: Codes and Standards

The government can mandate energy efficiency. Such regulation can be controversial and costly but has been used in the past to achieve social goals, such as ensuring public health and safety in buildings. As noted in chapter 4, codes and standards for energy efficiency already exist in many jurisdictions. This section discusses Federal options to amend current building codes and standards as well as appliance standards. There are advantages and disadvantages to adopting such mandates. For example, the impact of an appliance standards program is easier to determine than that of other policy measures such as information and incentives, because there is less uncertainty in market response. On the other hand, standards may raise the price of appliances and limit consumers flexibility to make their own decisions reflecting their own individual preferences and requirements.[48]

Building codes and standards—The historical function of building codes has been to ensure the health and safety of inhabitants, but recently they have been directed at energy efficiency as well. Building codes are typically implemented and enforced at the local, county, or State level. Local or county codes are often based on a State model code, which is then modified to fit local requirements. Currently all 50 States have some energy efficiency requirements in State building codes, but the scope, stringency, and enforcement of these requirements vary widely. Federal building standards for energy efficiency are mandatory for federally owned or financed buildings and voluntary for other buildings.

Although Congress could direct the improvement of building energy codes in numerous ways, several issues should be recognized to guide choices. First, an increased Federal role in what is traditionally a State and local matter would be controversial. Informal interviews with code professionals and builders revealed strong resistance to a national building code or standard for several reasons, including the potential for reduced flexibility in building design, a possible increase in construction costs that could threaten the marketability of a new home, and uncertainties about often complex provisions, which could lead builders to ‘‘over build’ in order to erase doubts about compliance.

These potential drawbacks could be major barriers to new construction, which understandably concern builders, but their input in the development of flexible and clear building codes could prevent or alleviate many of these problems. In addition, other policies promoted in tandem-such as an aggressive Federal energy efficiency mortgage program or State and utility involvement in pushing incentives such as reduced hook-up fees for efficient buildings—could also improve the marketability of highly efficient buildings.

A second and related point is the importance of enforcement. Codes are often enforced by local and county-level officials and, without their support, implementing code changes would be difficult. (This also raises the issue of Federal assistance in training and assisting code enforcement officials, discussed below.) Inadequate code enforcement could create incentives for noncompliance, because builders adhering to guidelines could experience a competitive disadvantage if those failing to comply are not punished. An additional prerequisite to success, therefore, would include the development

48 For example, an efficiency standard for a space heating furnace may be cost-effective under average conditions and use, but if the furnace is installed to back up a solar heating system it may no longer be cost-effective.

of adequate State and local expertise for building professionals to consult for assistance.

Third, the increasing complexity of buildings and codes could complicate the implementation of aggressive codes. The shift toward performance codes rather than prescriptive codes,49 for example, has been a mixed blessing; performance codes can increase flexibility in building design but can significantly complicate enforcement by requiring complex calculations to demonstrate compliance. Improved methods of building energy analysis, however, could alleviate this problem.

Building Codes and Standards: Basic Options

Assess compliance with and enforcement of existing State building codes as they pertain to energy **efficiency.** OTA interviews with builders suggest that enforcement of State building codes varies greatly; such enforcement generally occurs on the local level, where expertise and resources vary considerably. To determine the status of State efforts, and to guide Federal ones, DOE, the Department of Housing and Urban Development (HUD), and other relevant agencies could assess the level of both compliance with and enforcement of existing State building codes as they pertain to energy efficiency.

One code often used as a benchmark is the Council of American Building Officials Model Energy Code (CABO MEC) for low-rise residential construction; this model code was updated in 1989 (CABO MEC '89). About 11 States have codes that equal or surpass the CABO MEC '89, while about 34 States have codes less stringent.[50] Several studies have found that the CABO MEC '89 is cost-effective. An analysis by the Alliance to Save Energy, for example, suggests that if the 34 States with codes less stringent than the CABO MEC '89 adopted that model code, the resulting changes in new homes would achieve paybacks of less than 2 years-based on the estimated incremental rise in construction costs and the resulting energy savings.[51] Furthermore, the Alliance found that in some regions codes stricter than CABO MEC '89 would provide a 4-year payback.[52] A study by Battelle compared the CABO MEC '89 to both the CABO MEC '86 and the HUD Minimum Property Standards (MPS) and found CABO MEC '89 the most cost-effective for homeowners—both from a life-cycle cost and a first-year cash flow perspective.[53]

Extension of CABO MEC '89 requirements to federally financed homes would speed widespread adoption of this code. (This was required of HUD by the Cranston-Gonzalez Affordable Housing Act of 1990 (Public Law 101-165) but is yet to be implemented.) Approximately 18 percent of new single-family homes are financed through the Federal Housing Administration (FHA), the Veterans Administration (VA), and the Farmers Home Administration (FmHA). If these three agencies were to require CABO MEC '89, then builders would have to build to these requirements in order to sell to home buyers that finance their homes through these agencies. Since many builders design and construct homes before the specific buyer is known, builders would tend to build to CABO MEC '89 requirements in case a prospective buyer intended using federally assisted financing. The net effect would be that most new homes in the FHA/VA/FmHA price range would be built to CABO MEC '89 levels.

The Cranston-Gonzalez Affordable Housing Act of 1990 (Public Law 101-625) required the HUD Secretary to promulgate standards that meet or exceed the CABO MEC '89.[54] In November 1990 HUD published a proposed rule that: "all [federally financed] detached one and two family dwellings

---

49 Performance codes set a maximum allowable energy consumption level, and thereby allow for any combination of technologies as long as the consumption level is not exceeded. prescriptive codes, in contrast, have specific technical requirements such as minimum insulation levels. Most recent codes, including Council of American Building Officials Model Energy Code, 1989 edition, have both performance and prescriptive elements.

50 Based on data presented in B.D. Howard and W.R. Prindle, "Better Building Codes for Energy Efficiency, ' Final Report (revised) (Washington, DC: The Alliance to Save Energy, September 1991), pp. 5-7.

51 Ibid., p. 44. One State—Indiana—had a 3-year payback; the rest all had paybacks of less than 2 years.

52 Ibid., p. 40.

53 A.D. Lee R.G. Lucas, C.C. Conner, *Comparison of the Economic Effects of Three Residential Energy Codes on Home Buyers* (Richland, WA: Battelle, November 1990), p. iii. These cost-effectiveness studies typically assume that builders use the performance approach (see footnote 49); however OTA interviews with builders suggest that many find the performance approach too complex and therefore use the prescriptive approach. Therefore these studies may overestimate actual cost-effectiveness. This point also suggests a need to provide builders better tools and training to increase use of the performance approach.

54 Public Law 101-625, 104 Stat. 4093, sec. 109.

and one family townhouses not more than three stories in height shall comply with CABO Model Energy Code, 1989 Edition, including 1990 supplements. '[55] As of February 1992, the final rule was still under consideration by the Office of Management and Budget (OMB). Congress could ensure that section 109 of the Cranston-Gonzalez **Affordable Housing Act of 1990 (Public Law** 101-625) requiring the use of CABO MEC '89 in federally assisted housing is implemented. This would ensure that most new, moderately priced homes meet the CABO MEC '89.

There are other model codes and model standards offered by industry groups. Among the best known are the standards designed by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). This group has developed both residential and commercial standards, and their experience has been instrumental in the development of the DOE building efficiency standards and guidelines. As a result, in conjunction with organizations such as CABO and ASHRAE, DOE **could continue to improve Federal building standards and guidelines and provide implementation materials and support services to promote their use on the State level.** Such support services could include the provision of software technologies to assess compliance and resources to hire and train local and State code enforcement staff.

Building **Codes and Standards: Moderate options**

Congress could direct and fund DOE to provide technical and financial support to those 34 States with residential building codes less stringent than CABO MEC '89 to evaluate the cost-effectiveness of upgrading their codes to the CABO benchmark. Financial incentives could be used to promote code adoption. This would reach the higher-priced homes not eligible for FHA, VA, or FmHA financing.

Codes for commercial buildings already exist as well. The DOE Energy Performance Standards for New Commercial Buildings (1990), designed in conjunct ion with ASHRAE, could be used as a model code. **Congress could direct and fund DOE to provide technical and financial support to** States **considering the adoption of more stringent commercial building codes,** again to evaluate the cost-effectiveness of upgrading the existing State codes. This would allow States to maintain their jurisdiction over building codes but would demonstrate the energy and economic savings potential of improving the State codes.

Another option is to encourage the extension of codes to existing buildings. Retrofit-on-resale ordinances (also known as residential energy conservation ordinances) are used in some areas to require minimal efficiency features when ownership Changes.[56] Congress **could direct and fund DOE to provide technical and financial assistance to communities and States instituting retrofit-on-resale rules.** Such rules reach all buildings, including low-income and rental residences, which are often difficult to reach with other programs.

Congress **could direct and fund DOE to enlarge its efforts at code official training and education.** Code enforcement is a continuing concern, and as codes become more complex training becomes increasingly important.

Building Codes and Standards: **Aggressive Options**

Congress could require States to meet or exceed federally set minimum building efficiency standards, such as the Building Energy Performance Standards (BEPS). This would certainly meet strong resistance from States but would ensure that all codes meet a common, standard level of efficiency, Implementation would require technical and financial assistance to States, as well as oversight to ensure compliance. One way to implement such requirements would be through the State Energy Conservation Program (SECP), which requires States to implement conservation plans that meet certain conditions prior to receiving Federal funding for their programs,

Congress **could encourage or require secondary mortgage market institutions (e.g., the Federal Home Loan Mortgage Corporation) to require new residences to meet the CABO MEC '89 (or some other major code).**

Appliance standards—The principal goal of appliance standards is to eliminate the least efficient new appliances by setting minimum energy effi-

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

[56] In San Francisco, for example, both residential and commercial buildings must meet certain minimum energy efficiency levels prior to resale.

ciency levels for new units. Typically, standards establish requirements on the design of an appliance, the minimum efficiency of an appliance, or the maximum energy use of an appliance. Standards improve the efficiency of the appliance stock only at the rate that old appliances are replaced by new, more efficient ones (the turnover rate), plus the rate at which new applications occur.[57]

Other policy options, e.g., energy taxes and financial incentive programs, may also encourage the elimination of the least efficient appliances, but in some situations standards may represent the least-cost option for improving appliance efficiencies. For example, the cumulative national energy consumption for an appliance may be significant, but the cost of operating any single appliance is small. This suggests that extremely aggressive information programs and/or sizable incentives would be necessary to motivate consumers to purchase appliances as efficient as standards would require, especially if the first costs of more efficient appliances were greater. As a result, the cost of applying these other policy options to attain the same level of energy savings as standards may be quite large for some appliances. Conversely, standards could increase the first costs of new appliances, which could affect manufacturers by reducing sales. Appliance price increases might also have regressive effects if lower income groups are less able to purchase them.

As a next step in the DOE appliance standards program, Congress could consider extending the coverage of the National Appliance Energy Conservation Act of 1987 (Public Law 100-12; NAECA). Several appliances, notably lamps and commercial HVAC (heating, ventilating, and air conditioning) equipment, are not presently covered in the NAECA program but use a significant amount of energy. As discussed in chapter 3, those selecting and installing commercial HVAC equipment are typically not those paying the costs of operation, providing an incentive for the selection of low first cost, inefficient equipment. Standards, if set correctly, could eliminate the most inefficient models.

However, there are several potential drawbacks to expanding NAECA coverage to commercial HVAC equipment. First, some commercial building products (e. g., large HVAC systems) are often custom-built, which could require equipment-specific design and testing analyses to determine compliance with efficiency standards. This is in contrast to the residential appliances currently covered by NAECA, which are generally "off the shelf' that is, they are manufactured and sold in relatively uniform sizes and designs, which has eased the development and adoption of their efficiency standards. Furthermore, if standards reduce the availability of equipment (e.g., due to manufacturers exiting the market due to high retooling costs), this could constrain commercial building designers and architects.

DOE already has discretionary authority to add *residential* equipment to the list of NAECA-covered products.[58] The Department could probably add lamps to the NAECA product list under this authority; however, extension of coverage to commercial HVAC equipment would require new legislation.

Appliance Standards: Basic Options

DOE **could examine the feasibility and likely impacts of extending NAECA coverage to appli**ances and equipment **not covered by the program.**

Appliance Standards: Moderate Options

Extend NAECA **coverage to include residential and commercial equipment not currently covered by the program.** A variety of both residential and commercial equipment is not covered by NAECA, including commercial HVAC systems and lamps. Their inclusion in the program would ensure that the least efficient units among them are eliminated from

[57] While efficiency standards are not designed to affect appliance turnover rates—only the energy consumption of a new appliance when an old one is replaced-they can have an indirect effect on such rates. For example, stringent efficiency standards may increase the first cost of new appliances and thereby discourage some consumers from purchasing new units.

[58] "The Secretary may classify a type of consumer product as :1 covered product if he determines that—(A) classifying products of such type as covered products is necessary or appropriate to carry out the purposes of [his chapter, and (B) average annual per-household energy use by products of such type is likely to exceed 100 kilowatt-hours (or its Btu equivalent} per year. " 42 U S C. 6292(b)(1)(A)-(B)

the market. This is the basic goal of NAECA, but its coverage remains incomplete.[59]

As noted earlier, there are potential problems with extending equipment efficiency standards to commercial equipment, particularly HVAC systems. As an alternative, Congress could consider a more modest expansion of the appliance standards program, such as adding lamps to the list of NAECA-covered products; currently, NAECA lighting standards apply to fluorescent ballasts only.

Appliance Standards: Aggressive Options

Adopting more stringent cost-effective NAECA standards by identifying equipment efficiency levels that represent longer paybacks than most current standards allow. Despite the large energy savings and economic benefits expected from the NAECA program, additional cost-effective savings may be possible if standards representing longer paybacks are considered. In particular, the payback periods for updated electric appliance standards under NAECA are generally short, ranging from zero years (clothes washers) to roughly 2.5 years (refrigerators and clothes dryers).

To allow an initial determination of the economic feasibility of any proposed appliance standard, NAECA established a rebuttable presumption: any appliance standard is economically justified if the resulting energy savings in the frost year paid back one-third of the additional production costs, which implies that a 3-year payback meets the criterion. The statute requires other considerations prior to final determinations of the technical and economic feasibility of any proposed standard but, as a point of departure, the NAECA rebuttable presumption encouraging standards with no less than 3-year paybacks could be extended to a longer period (e.g., 5 years). More stringent appliance standard levels that represent longer paybacks than those generally chosen by DOE—but that still meet the vital criteria of technological and economic feasibility-are possible. This option suggests that DOE identify and adopt them.

Improving Information and Awareness of Efficiency Opportunities

Programs providing information about energy efficient technologies and practices have been historically quite popular. Information is relatively inexpensive, politically noncontroversial (as few would argue against consumer education), and usually supported by all interested parties. From an economic perspective, poor information receives much of the blame for the neglect of many cost-effective efficiency technologies. Energy information can be imparted in many forms, including labels and rating systems, demonstration programs, energy audits, and workshops.

Unfortunately it is difficult to show conclusively that information programs have significant direct effects on behavior or energy use. Several studies have attempted to measure the effects of information—e.g., labels, audits, feedback on consumption, and advertising-on behavior, but the results are generally inconclusive. This is not to suggest that information has no effect, only that the effect is very difficult to measure. The evidence does suggest that information *alone* may not have much direct influence on behavior in many cases.[60] Information programs are built on the premise that people will generally do what is cost-effective if they know what specific opportunities exist. As discussed in chapter 3, however, consumers and other decisionmakers often define cost-effective differently than do analysts, and consumers often lack the incentive or motivation to use energy efficient technologies. In such cases information alone will have little effect.

There are, however, several reasons to promote information programs. A demonstration program, for example, may not have much effect by itself, but may have considerable success when combined with a financial incentive. Several State and utility programs, such as those offering rebates, depend on a credible energy rating. Determining compliance with building energy codes could be easier if energy-using equipment was clearly labeled for energy consumption. And increased consumer awareness of, and interest in, energy efficiency could

59 Lamps, for example, are not covered by the program but, according to the American Council for an Energy-Efficient Economy, lamp efficiency standards could save more than 7 quads of primary energy by 2010 worth an estimated $30 billion (1990 dollars). Howard Geller, Executive Director, American Council for An Energy Efficient Economy, personal communication% July 3, 1991.

60 As one review of information programs concluded, "informational programs are not sufficient to induce individuals to engage in resource conserving behaviors." R. Katzev and T. Johnson, Promoting *Energy Conservation* (Boulder, CO: Westview Press, 1987), p. 25.

influence builders, architects, vendors, and others. The synergistic effects of information when combined with incentive programs and the need for credible ratings to support rebates, codes, and other programs suggest that information programs deserve attention.

There are several arguments for increasing the Federal role in improving the availability and quality of energy-related information. The benefits of improved information are diffuse and difficult to measure, making it difficult for utilities to justify large expenditures on such programs. However the benefits, although admittedly difficult to document, are certainly not zero, suggesting a government role in providing information is appropriate. Furthermore information must be credible in order to be effective, and the Federal Government may be perceived as more credible than other sources with a direct economic interest in the outcome of a consumer investment.

As discussed in chapter 4, the Federal Government currently administers several energy information programs. The Energy Policy and Conservation Act (Public Law 94-163), as amended, requires that certain energy-using consumer products be labeled for their energy use and/or annual energy costs. The Residential Conservation Service was a federally funded program that provided building occupants with information on the benefits of building retrofits. Several DOE programs provide energy efficiency information through demonstrations, educational programs, workshops, and other methods.

Analyses of past Federal efforts to provide energy-related information indicate that information programs are more effective if they are:

- targeted at specific people and specific behaviors;
- combined with other programs, such as incentives; and
- evaluated regularly, and the results of these evaluations are then used to improve the program.

Several options to improve the goals and coverage of these programs are detailed below.

Information: Basic Options

At present, several energy-using consumer products are exempted from labeling requirements.[61] **Congress could instruct the Federal Trade Commission (FTC) to revisit its 1979 exemption rulings for appliance energy labeling.** Recent technical advances[62] and secondary effects on manufacturers[63] should be included in the analysis.

At present, energy labeling is restricted to residential equipment. **Congress could instruct the FTC and/or DOE to assess the feasibility of extending labeling requirements to commercial sector equipment.** HVAC equipment, office equipment such as computers and copiers, lighting equipment[64] and commercial refrigeration equipment could be considered.[65]

Windows and lamps are significant energy users in the residential sector but are not presently covered by the labeling requirements. Congress **could extend labeling requirements to windows and lamps.**

Congress could instruct the FTC and/or DOE to investigate alternative label designs that might inform consumers better. There are several ways the present label format could be altered, including:

- showing life-cycle operating costs;
- providing dollars (a readily understood unit of measure) wherever possible; and
- including data on all technologies that provide the service, rather than just the single technology, as a comparison.[66]

61 Products currently exempted include clothes dryers, some home heating equipment, television sets, and kitchen ranges and ovens.

62 For example, the original rulemaking exempted clothes dryers because of the very small variation in operating costs among then-existing models. However, as noted in ch. 2, new dryer technologies such as heat pumps could cut dryer energy use (and operating costs) significantly.

63 The existence of a label may spur a manufacturer to produce a highly efficient product it would not otherwise produce, as the label would provide a marketing advantage over other models.

64 Labels for light ballasts were required by the NAECA amendments of 1988 (Public Law 100-357).

65 Such labeling efforts would require close cooperation with industry to ensure that testing and labeling procedures are credible and accurate.

66 For example, 1,&1,on electric water heaters show estimated annual operating costs for that unit, as well as the range for all electric water heaters of a comparable size. Instead, the labels could show a range for all comparable water heating technologies, such as heat pump water heaters and gas water heaters.

297-936 0 - 92 -11 : QL 3

Information: Moderate Options

The existence of a credible, accurate home energy rating system would allow consumers to compare the energy efficiency of different homes, would make it easier for mortgages to incorporate energy efficiency, and would provide a credible measure of success for builders using energy efficient technologies and practices. Congress **could direct DOE to explore methods for producing an accurate, verifiable whole-building rating, and to provide technical support for State and utility programs that rate whole buildings.**[67] To produce a credible rating, a number of technical questions require resolution.[68]

Efficiency is sometimes viewed as requiring sacrifice, and some consumers distrust innovative, energy efficient technologies. In many cases, however, energy efficiency offers other benefits as well; for example, more efficient lights in commercial buildings may provide more attractive illumination in addition to saving energy. Demonstration projects showing that efficiency works can dispel outdated beliefs equating conservation with discomfort and inconvenience. Congress **could encourage DOE to work with manufacturers, designers, and builders to demonstrate energy efficient equipment that works.** For example, DOE could sponsor an architectural design competition for energy efficient buildings that use efficient, commercially available technologies, and grants to finance the actual construction of these designs could be provided. In return for the grant, a builder could agree to hold open houses, during which other builders and consumers could see the buildings in operation.

Identifying and implementing efficiency opportunities in existing buildings sometimes requires specialized knowledge. Involving architecture and engineering schools in building energy audits would provide that knowledge and would also encourage interest in building science in the next generation of technically skilled people. Congress could encourage DOE to set up a building audit program involving architecture and engineering schools.

Information: Aggressive Options

Congress could require point-of-sale disclosure of whole-building energy ratings. Such ratings could be applied to both new and existing buildings. Methods to produce such ratings are still under development, but when they are improved their use could be mandated. As an intermediate step, their use could be limited to federally financed sales.

ASSEMBLING THE OPTIONS

No single policy or program will be sufficient to generate substantial improvements in energy efficiency; the barriers limiting such efficiency are diverse and so must be the policies to overcome them. To assist with the selection of options, the three levels of options discussed above are assembled into three packages below. Many such packages could be constructed; the three described here are intended only to illustrate the range of options Congress could consider. Basic options are low cost options that could be implemented relatively easily (box 5-D). Moderate options are somewhat more ambitious and may require new legislation and moderate increases in spending but would result in considerable efficiency gains (box 5-E). Aggressive options include changes in the Federal role in energy regulation and could be quite controversial. Nevertheless, OTA believes they could result in significant improvements in national energy efficiency (box 5-F).

Decisions by Congress as to what level to consider and what specific options to pursue will of necessity be guided by political, financial, and other considerations. However it should be noted that, with the exception of the pricing options, at all three levels only those technologies that would be economically justified using life-cycle costing techniques are promoted.[69]

---

67 Several States and utilities already have home energy rating systems in place. See R. Vories, "What Makes Rating Systems Tick," *Home Energy*, vol. 6, No. 2, March/April 1989, p. 22.

68 For example, using past consumption data as a basis for a rating is thought to be inaccurate due to the effects of occupant behavior. How large is this effect, and what data are needed to control for this effect? For new buildings, can short-term measurements of consumption under test conditions provide a reasonable estimate of long-term consumption? Can commercial buildings be rated as well as residences?

69 Economically justified is used here relative to current and forecasted energy prices. A fourth level, maximum technical potential regardless of cost-effectiveness, could be considered by the Congress under extreme conditions. Such a level is not discussed here.

Box 5-D—The Basic Package

Incentives

- Direct the Departments of Energy (DOE) and Health and Human Services to set aside an adequate amount of program spending for program evaluation; particularly to determine the cost-effectiveness of low-income weatherization.
- Direct and fund DOE to expand research on the measurement and pricing of externalities associated with energy production, distribution, and consumption.

Federal leadership

- Encourage energy efficiency in Federal buildings by upgrading procurement guidelines for energy-using equipment so as to incorporate energy efficiency.
- Extend the Environmental Protection Agency (EPA) Green Lights concept to other end users.

Research, development, and demonstration

- Require all DOE Office of Building Technologies applied research projects reaching the demonstration stage to conduct some minimum level of technology transfer and market assessment.
- Encourage or require DOE to define specific technological goals that relate to program objectives in the DOE Conservation multiyear planning process.
- Conduct regular RD&D program evaluations for Congress to identify the successes, failures, and future direction of projects in the DOE Office of Building Technologies.

Utilities

- Instruct DOE to expand its research and development related to the design, operation, and evaluation of utility efficiency programs.
- Instruct DOE to increase its activities as an information clearinghouse for efficiency program design, operation, and evaluation.
- Instruct DOE to evaluate whether the Northwest Power Planning Council represents a useful model for energy planning that could be applied to other regions of the country.

Mandates

- Assess compliance with and enforcement of existing State building codes as they pertain to energy efficiency.
- Ensure that section 109 of the Cranston-Gonzalez Affordable Housing Act of 1990 (Public Law 101-625) requiring the use of the Council of American Building Officials Model Energy Code, 1989 Edition (CABO MEC '89) in Department of Housing and Urban Development assisted housing is implemented.
- In conjunction with organizations such as the Council of American Building Officials and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, instruct DOE to continue to improve Federal building standards and guidelines and provide implementation materials and support services to promote their use on the State level.
- Instruct DOE to examine the feasibility and likely impacts of extending the coverage of the National Appliance Energy Conservation Act of 1987 to include appliances and equipment not covered by the program.

Information

- Instruct the Federal Trade Commission (FTC) to revisit its 1979 exemption rulings for appliance energy labeling.
- Instruct the FTC and/or DOE to assess the feasibility of extending labeling requirements to **commercial** sector equipment.
- Extend labeling requirements to windows and lamps.
- Instruct the FTC and/or DOE to investigate alternative label designs that might inform consumers better.

Box S-E—The Moderate Package

Incentives

- Pass legislation making utility rebates nontaxable.
- Enact or increase taxes on the production and use of fuels consumed in the buildings sector.
- Direct and fund DOE to provide technical and financial assistance to States interested in measuring and pricing energy externalities.
- Direct the Federal housing and national mortgage agencies to simplify and expand their energy efficient mortgage programs.

Federal leadership

- Allocate (or increase access to) funds for efficiency improvements in Federal buildings.
- Encourage manufacturers, utilities, and other interested parties to extend the Golden Carrot concept to other technologies for demonstration and marketing.

Research, development, and demonstration

- **Make greater use of market surveys to assess manufacturer and consumer response to potential new technologies prior to initiating Office of Building Technologies** (OBT) RD&D projects.
- **Increase industry involvement in RD&D project planning, funding, and execution.**
- **Examine the feasibility of both least-cost and net-benefit planning for** DOE applied conservation RD&D programs.
- Establish an ambitious level of technology transfer and marketing efforts for RD&D projects of OBT beyond that currently pursued.
- Increase OBT funding for RD&D work

Utilities

- **Direct the Tennessee Valley Authority and the power marketing administrations to integrate better least-cost planning techniques and principles into their operations and management.**
- **Instruct the Federal Energy Regulatory Commission to** examine its rate setting and other regulatory actions to **determine their** consistency with State-approved utility **least-cost plans.**
- **Instruct DOE to support through grants, technical support, or other means State and utility efforts related to the design and implementation of least-cost planning.**
- **Encourage or** require States not already doing so **to consider adopting least-cost plans.**

Mandates

- **Direct and fund DOE to provide technical and financial support to those 34 States with residential building codes less stringent than CABO MEC '89 to evaluate the cost-effectiveness of upgrading their codes to the CABO benchmark.**
- **Direct and fired DOE to provide technical and financial support to States considering the adoption of more stringent commercial building codes.**
- **Direct and fired DOE to provide technical and financial assistance to communities and States instituting retrofit-on-resale rules.**
- **Direct and fund DOE to enlarge their efforts at code official training and education.**
- **Extend National Appliance Energy Conservation Act of 1987 coverage to include residential and commercial equipment not currently covered by the program.**

Information

- **Direct DOE to explore methods** for producing an accurate, verifiable whole- building rating, and to provide technical support for **State and utility programs that rate whole buildings.**
- **Encourage DOE to work with manufacturers, designers, and builders to demonstrate energy efficient equipment that works.**
- **Encourage DOE to set Up a building** energy audit program involving architecture and engineering schools.

Box 5-F—The Aggressive Package

Incentives

. Mandate the **measurement and pricing of energy externalities.**

Federal leadership

. **Instruct DOE to promote actively the demonstration of efficient technologies in Federal buildings to strengthen markets for energy efficient goods and services.**

Research, development, and demonstration

. Require DOE to market buildings conservation RD&D results to utilities, State agencies, and its own regulatory programs, including the Office of Codes and Standards (within the Office of Building Technologies).
. Require DOE to perform least-cost or net-benefit conservation RD&D planning.

Utilities

• **Direct federally owned utilities to provide incentives to, or require, its** customer utilities to adopt least-cost plans.

Mandates

. Require States to meet or exceed federally set minimum building efficiency standards, such as the Building Energy Performance Standards (BEPS).
. Adopt more stringent cost-effective National Appliance Energy Conservation Act standards by identifying equipment efficiency levels that represent longer paybacks than most current standards allow.
• Encourage or require secondary mortgage market institutions (e.g., the Federal Home Loan Mortgage Corporation) to require residences to meet the Council of American Officials Model Energy Code 1989 Edition (or some other major code).

Information

. Require point-of-sale disclosure of whole-building energy ratings.

SUMMARY AND CONCLUSIONS

OTA has shown that there are numerous opportunities to increase the efficiency of energy use in the residential and commercial sectors. Energy efficient technologies that would Provide net economic benefits "are commercially available yet often neglected by consumers. OTA has offered policy options to promote greater use of these technologies. These options are grouped into three levels: basic, moderate, and aggressive.

It is useful to compare the options discussed here to those contained in the National Energy Strategy (NES), a comprehensive strategy proposed by the Administration in 1991. The intent is to provide a sense of how the NES options related to residential and commercial energy efficiency compare to those offered by OTA. Box 5-G summarizes the NES options related to building energy efficiency. To illustrate the similarities and differences, options from the NES[70] and from OTA are compared~

NES: Increase support for research and development to:

- reduce costs and improve performance of residential energy technologies;
- reduce costs and improve performance of commercial-building energy technologies, including lighting systems, windows, heating and cooling equipment, and design techniques; and
- develop methods [in both the residential and commercial *sectors]* of measuring and improving indoor comfort and environmental quality.[71]

70 These Options are from the *National Energy Strategy, 1st cd., 1991/1992* (Washington, DC: U.S. Government Printing Office, February 1991), pp. 40-53.

71 Ibid., pp. 41, 49.

Box 5-G-The National Energy Strategy: Summary of Options[1]

1. Increase **support for research and development to:**
   - **. reduce costs and improve performanceof** residential and commercial-building energy technologies.
   - **. develop methods of measuring and improving indoor comfort and environmental quality.**

2. Increase energy efficiency of new housing by:
   - • providing technical **information and assistance to industry, utilities, and State and local governments.**
   - **. assisting State and local governments in adopting and enforcing Federal energy-efficiency standards through local building codes***
   - **• requiring new federally subsidized homes and new manufactured housing to conform to mor, stringent energy-efficiency standards.**

3. **Retrofit existing residences by:**
   - **. supporting home energy ratings and the use of energy-efficiency criteria in mortgage loans.**
   - **. helping States to implement effective programs to retrofit housing occupied by low-income households.**
   - **. demonstrating exemplary energy management in federally supported public housing.**
   - **. retrofitting existing federally owned housing.**

4. **Improve the energy efficiency of residential appliances by using existing authority to update residential appliance efficiency standards to keep pace with new technology.**

5. **Provide information and technical assistance to:**
   - **. support industry, utilities, and State and local governments in developing and implementing effective programs, including adoption of** Federal **efficiency guidelines in local building codes.**
   - **. extend Federal performance testing and labeling to lighting products and other equipment.**
   - **• accelerate commercial application of new technologies.**

6. **Implement efficiency guidelines and standards where needed for**
   - **• lighting ballasts.**
   - **• new buildings,**

7. **Exercise Federal leadership by:**
   - **• increasing energy efficiency in** Federal building design, operation, and procurement through improved management.
   - • using Federal facilities to test promising new technologies.

---

1 From *National Energy Strategy: Powerful Ideas for America*, 1st ed. (Washington, DC: U.S. Government Printing Office, February 1991), pp. 41,49.

The NES identifies cost reduction and improved technical performance as key goals for buildings-related RD&D. In contrast, OTA's discussion stresses that implementation, rather than just improved technical performance, is of key concern. As the options in this report suggest, improving RD&D project planning and implementation through regular use of market surveys, increased industry involvement in project planning, and more emphasis on technology transfer would provide better assurances that applied RD&D projects will ultimately have practical applications. Examining least-cost or net benefit RD&D planning could be used to further assist DOE in ensuring that RD&D projects result in net societal benefits. And if feasible, actually implementing either RD&D planning method would better ensure that public RD&D funds are targeted at the most promising efficiency opportunities.

NES: Increase energy efficiency of new housing by:

- . providing technical information and assistance to industry, utilities, and State and local governments.

NES: Retrofit existing residences by:

- • helping States to implement effective programs to retrofit housing occupied by low-income households.

NES: Provide information and technical assistance [in the commercial sector] to:

- support industry, utilities, and State and local governments in developing and implementing effective programs, including adoption of Federal efficiency guidelines in local building codes .72

Both OTA and the NES stress the importance of supporting State and utility efforts to improve energy efficiency. OTA's analysis, however, points to the importance of frequent, rigorous program evaluation to determine how best to spend limited resources for maximum benefit. To this end, OTA offers policy options to encourage more frequent and more rigorous evaluation of Federal spending. In addition, OTA's options include those directed at assisting State and utility efforts designed to address all environmental and other externalities (not just indoor air quality) of energy production and use, Such efforts would allow decisionmakers to determine the level and desirability of incorporating the social costs of providing and using energy in their jurisdictions or service areas. Even more aggressive would be a Federal requirement to incorporate environmental and other externalities in energy planning and pricing. Both the NES and OTA suggest that DOE and FERC work to expand the adoption of least-cost planning by utilities.

NES: Increase energy efficiency of new housing by:

- . assisting State and local governments in adopting and enforcing Federal energy-efficiency standards through local building codes, and
- requiring new federally subsidized homes and new manufactured housing to conform to more stringent energy-efficiency standards.

NES: Improve the energy efficiency of residential appliances by using existing authority to update residential appliance efficiency standards to keep pace with new technology. Implement efficiency guidelines and standards where needed for 'lighting ballasts and new buildings. ' '[73]

The NES options relating to mandatory appliance standards suggest that no changes are needed to current coverage or authority. In contrast, OTA has offered several options, including examining the feasibility and effects of extending the appliance standards program to additional products. The NES options relating to building codes and standards are relatively similar to the OTA options, but Federal priorities are not well-defined in the NES. In fact, OTA in this report provides options that include Federal Goverment analysis of existing compliance with State and local energy codes, technical support for the 34 States with codes less stringent than the CABO MEC '89 to encourage their improvement, and coordination with trade groups (e.g., the Council of American Building Officials and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers) to promote the wider adoption of existing energy codes and building energy standards (whether Federal or otherwise) that are the most suitable for interested States.

In these and other areas, the options offered by the NES generally fall at or below those offered by OTA at the ''basic' level. This suggests that the NES options do **not** represent the full range of options Congress **could consider to implement energy efficiency in the** residential and commercial sectors. Distinctions between NES and OTA policy options, however, do not suggest the desirability of any single option nor any single level of action. To be sure, no one policy option can be expected to secure the triple interest in forging a national energy policy: to improve economic competitiveness and growth by encouraging net reductions in national energy spending; to foster national security by reducing energy imports; and to safeguard the national and global environment by reducing the emissions associated with energy production and use. A reliable, comprehensive, and secure national energy policy will invariably include a range of options working on a variety of levels.

This report does not advance any one policy option nor any package as a national energy solution; it does, however, expand the menu of options for energy efficiency in U.S. buildings presented in the National Energy Strategy.

72 Ibid.

73 Ibid.