Summary

INTRODUCTION

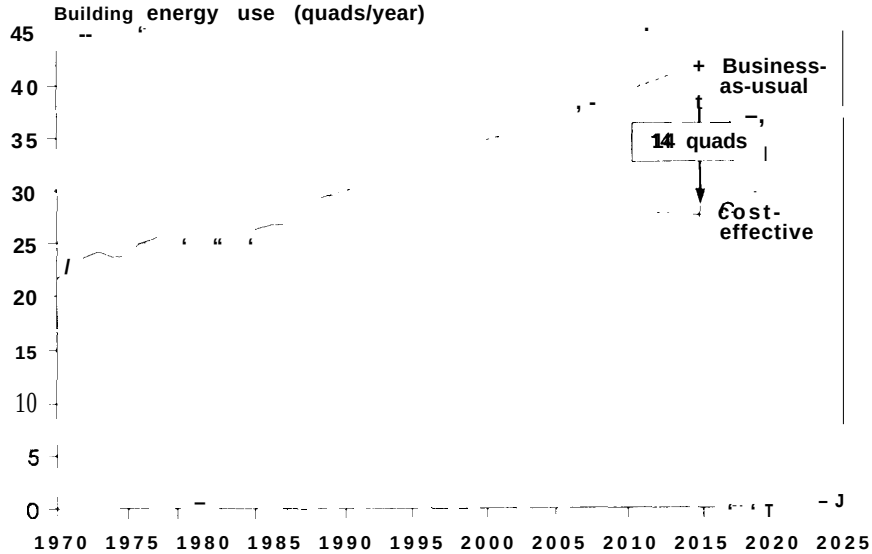
Residential and commercial buildings account for about one-third of U.S. energy consumption, at an annual cost of $170 billion. Using commercially available, cost-effective technologies, building energy consumption could be reduced up to one-third by 2015, compared to a business-as-usual projection (figure 1).[1] 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. Along with saving both energy and money, wider use of efficient technologies would address multiple environmental concerns, offset the need for additional electricity generating capacity, and reduce national dependence on imported oil. This report assesses technologies for enhanced energy efficiency in buildings, discusses why they are not widely used, and offers Federal policy options for encouraging their use.

BACKGROUND

Energy use in buildings has grown in the last 20 years (figure 1). Sheer increases in numbers underlie much of this growth-more people, more households, and more offices. Increased service demand —more air conditioning, more computers, larger houses—has contributed as well. However, the application of improved technology has moderated this growth. Energy efficient building shells, appliances, and building designs have lowered energy intensity in residences (energy use per household per year) and stabilized energy intensity in the commercial sector (energy use per square foot per year).

Building energy use in the future will be driven by technological change but will also be influenced by

Figure l—Building Energy Use: Two Future Scenarios



NOTE: "Business-as-usual" is OTA's estimate of future consumption without policy change. "Cost-effective" is OTA's estimate of future consumption if all energy efficient technologies with a positive net present value are implemented. There is considerable uncertainty in both estimates. See text for details.

SOURCE: Office of Technology Assessment, 1992 (see ch. 1).

[1] Cost-effective is defined here as positive net present value to the consumer at a 7 percent real discount rate. See ch. 1 for a detailed discussion of energy savings estimates.

Table I--Cost-Effectiveness of Selected Energy Efficient Technologies

Technology	Typical payback (years)
Additional insulation	6 to 7
Compact fluorescent lamps	Less than 2
Condensing gas furnace-95% + efficient	4 to 7
Electronic ballasts for commercial lighting	3 to 4
Improved burner head for oil furnaces	2 to 5
Residential duct repair	Less than 2
Highly efficient room air conditioner	6 to 7
Water heater tank insulation	Less than 1

NOTE: Payback is the amount of time for the energy savings to exceed the additional first costs. Paybacks shown here are based on the incremental first cost and undiscounted savings of the highly efficient unit relative to a standard efficiency unit. Actual, measured savings rather than predicted savings are used where available. Paybacks will vary depending on climate, use patterns, and other factors.

SOURCE: Office of Technology Assessment, 1992 (see ch. 2).

other factors, including population and economic growth, changes in household size, changes in lifestyle, and migration patterns. Although the complexity and interactions of these factors make it difficult to predict accurately future levels of building energy use, OTA estimates that, in a ''business-as-usual' scenario (i.e., assuming no policy change), building energy use will continue to grow at a moderate pace, reaching roughly 42 quads by 2015. An alternative perspective, assuming all energy efficient technologies with a positive net present value to the consumer are implemented, suggests building energy use could actually decrease to about 28 quads by 2015. This corresponds to an annual energy savings of 14 quads by 2015 (figure 1), worth $80 billion at today's energy prices.

ENERGY EFFICIENT TECHNOLOGIES

As suggested by the modeling results described above, there is considerable potential to further improve energy efficiency in U.S. buildings. For most major energy uses, there is a large efficiency gap between the average new units and the most efficient new units available. For example, residential gas furnaces are available with an efficiency of 97 percent, compared to the 78 percent typical of new units sold today. The most efficient room air conditioner on the market today uses 28 percent less energy than the average new unit. Many houses in the United States still lack basic efficiency features, such as storm windows and ceiling insulation. In many cases new technologies have other benefits as well, such as longer life, quieter operation, and greater ease of use. For example, many new commercial lighting technologies can provide a higher quality of light and use far less energy.

While many efficient technologies cost more to purchase, energy savings often more than repay the extra capital cost (table 1). The financial returns offered by these technologies are typically far better than those offered by other personal financia1 investments.

IF IT'S SUCH A GOOD IDEA, WHY HAVEN'T WE DONE MORE OF IT?

If cost-effective technologies are available, why aren't they in greater use? OTA interviews suggest commercially available, energy efficient technologies are not used for 'good' reasons-reasons quite understandable from the perspective of the individual decisionmaker. These reasons include the following:

- There is often a separation between those who purchase energy-using equipment and those who pay to operate the equipment, which undermines existing incentives for efficiency. For example, one-third of housing, and one-quarter of commercial building floor space, is leased or rented rather than owned.
- Decisions on purchasing energy-using equipment require comparisons across many attributes, such as frost cost, performance, appearance, features, and convenience. These other attributes often overshadow energy efficiency considerations.
- Individuals pursue several goals when making energy-related investment decisions—for example, minimizing the time to make a decision, spending the least amount upfront, or minimizing risk by obtaining the same item that worked before. Very few pursue the goal of minimizing life-cycle costs (the sum of capital and operating costs over the life of the equipment), which energy efficient technologies achieve.
- When trading off frost cost and energy savings, consumers will not invest in efficiency unless it offers very short payback periods-less than 2 years for home appliances, for example. In contrast, personal financial investments generally offer much lower returns.
- Energy costs are relatively low (about 1 percent of salary costs in a typical office, for example),

so those concerned with cost reduction often focus elsewhere.

- Energy efficiency is often (mis)perceived as requiring discomfort or sacrifice, limiting its appeal.

These reasons have slowed the acquisition and use of many proven energy efficient technologies. For example, despite their attractive 3- to 4-year payback, less than 4 percent of all fluorescent light ballasts shipped in the United States in 1990 were of the efficient electronic design. These reasons suggest that policy changes may be needed to encourage cost-effective efficiency.

REVIEW OF PAST FEDERAL EFFORTS

The Federal Government has in the past supported efforts to increase energy efficiency, with mixed results. The multiple Federal programs aimed at saving energy in buildings are often narrow in scope, overlooking critical barriers that prevent cost-effective investments in efficiency. Many programs stress only two strategies: providing information or funding retrofits for low-income households and small firms.

Cost-effectiveness criteria are generally not used in program planning or evaluation, particularly in those programs offering grant monies. Federal programs aimed at saving energy in buildings often achieve measurable energy savings, but the cost-effectiveness of those savings remains unclear. Program evaluation is infrequent. For example, the Federal Trade Commission (FTC) appliance labeling program was evaluated only once in its 12-year history, and the Department of Energy's Weatherization Assistance program (WAP) was evaluated only once in its first 15 years. To understand the successes and failures of program goals and implementation, all programs should undergo regular evaluations. Such evaluations require relatively few resources compared to other program activities, and they have the potential to improve greatly program benefits by fine-tuning (or revamping) efforts to save energy in buildings.

POLICY OPTIONS

There are numerous policy options available to the U.S. Congress that could be used to encourage greater use of cost-effective energy efficient technologies. Increasing energy efficiency is in the Nation's interest, yet there are arguments both for and against changes in Federal policy. Arguments for Federal policy change include the market imperfections noted above (e.g., short payback requirements and a separation between those making investment decisions and those paying operating costs), the large untapped potential for energy and financial savings from increased efficiency, and the existence of environmental and other externalities. Arguments against changes in Federal policy include: attempts to increase energy efficiency through regulation or other similar methods may have unanticipated administrative or other costs; past Federal efforts to implement energy efficiency have had mixed success; current levels of energy efficiency reflect consumer preferences given existing economic incentives and levels of information; and there is often little consensus on the best methods to promote efficiency.

Federal policies for improving building energy efficiency must be considered in the context of the diverse State and utility efforts already underway. In almost all areas of energy efficiency policy—incentives, information, research & development, regulation-States and utilities are often 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, however in a few areas-notably building codes and utility regulation—an enhanced Federal role would be controversial.

OTA identifies a number of policy options to promote greater use of cost-effective energy efficient technologies. These options make use of several strategies, including:

Changing the incentives for efficiency. Individuals often have few or mixed financial incentives for energy efficiency. Federal policies can address this issue by enhancing these incentives, for example, through pricing changes and tax policy.

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.

Research, development, and demonstration (RD&D) for efficiency. The Federal Government conducts RD&D on buildings technologies, and changes in RD&D planning and execution could help ensure the applicability and usefulness of the results.

Encouraging utilities to invest in efficiency. Utilities are well-equipped to implement efficiency, and Federal actions such as technical support for least-cost planning can aid their efforts.

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.

Improving information and awareness of efficiency opportunities. The Federal Government can provide information to enhance and support other efficiency programs such as rebates and incentives.

OTA offers a number of specific options of each type. These specific options are grouped into three distinct levels, in order of increasing Federal involvement and energy savings. The *basic* level includes relatively low-cost, simple policy measures that require little or no new legislation or change from present practice (box A). 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 some cases require changes to existing legislation and increased Federal spending (box B). The *aggressive* level includes options that require new legislation, an increased Federal role in energy regulation, and increased Federal spending (box C). Many such packages could be constructed; the three described here are intended only to illustrate the range of options Congress could consider.

In summary, energy efficient technologies that save energy and money are commercially available, yet often underutilized. The indirect benefits of these technologies-reduced environmental damage, enhanced economic competitiveness, and increased national security-would be considerable. OTA offers three levels of policy options to promote greater use of these technologies.

It is useful to compare the options in this report to those contained in the National Energy Strategy (NES), a comprehensive strategy proposed by the Administration in 1991. OTA finds that the NES options do not represent the range of options Congress could consider to implement energy efficiency in buildings. This report expands the menu of options for the U.S. Congress to consider to implement energy efficiency in buildings.

Box A—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 B—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 fired 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 fund 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 C—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.

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