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Conserving Energy in New Buildings: Analysis of Nonregulatory Policies

R. M. Scheer
L. A. Nieves
R. P. Mazzucchi

May 1981

Prepared for the U.S. Department of Energy
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EXECUTIVE SUMMARY

The Energy Conservation and Production Act (P.L. 94-385) mandates that mandatory building energy performance standards (BEPS) be written for new residential and commercial buildings. The building energy performance standards should "achieve the maximum practicable reduction in energy and encourage use of renewable energy resources for space conditioning of buildings." However, public concern over federal regulations whose costs exceed their benefits has raised doubts about the desirability of mandatory building energy standards. The research described in this report was performed by the Pacific Northwest Laboratory (PNL) for the U.S. Department of Energy (DOE), Assistant Secretary for the Office of Conservation and Solar Energy (CS), Office of Building and Community Systems (BCS). This report examines nonregulatory alternatives to the mandatory standards approach for conserving energy in new buildings and seeks to determine whether or not the alternatives are feasible and cost-effective.

Survey data for new building construction were reviewed to assess current market conditions and to determine whether or not builders and consumers were choosing more energy-efficient designs without mandatory standards. DOE documents prepared in support of the building energy performance standards program were reviewed to identify major problems with the mandatory standards approach. Energy conservation policy literature was reviewed and appropriate government officials were interviewed to identify a relevant range of nonregulatory policy alternatives for conserving energy in new buildings. Finally, major alternatives were analyzed in regards to probable costs and effectiveness.

MAJOR FINDINGS

The major findings of the study can be broken down into six categories.

Nonregulatory Alternatives

- Three nonregulatory policy areas were identified:

1. information and education programs, including a mass media campaign, a "Truth in Energy Act," a technology transfer program, and an expansion of the Energy Extension Service
2. tax incentives and disincentives, including tax credits for conservation and sales strategies for new residential and commercial buildings
3. mortgage and finance programs, including loan rate subsidies for purchasers of energy-efficient properties and revision of lender expense-to-income tests of credit worthiness to include expected energy costs.

Major Gaps in Information

- Recent evidence suggests that building practices are changing rapidly. However, the lag in collecting building data prevents accurate assessment of current trends, which are crucial for policy making.
- No basis exists for estimating possible changes that would occur in the designed energy performance of buildings as a result of implementing any of the program alternatives examined. Too little is known about the relative importance of various building attributes in design and purchasing decisions to predict, except generally, how those decisions would be affected by various government programs.
- Lack of information regarding tradeoffs between capital investment and fuel savings, and thus regarding existing economic incentives for energy conservation in commercial buildings, made analysis of program applicability to the commercial sector infeasible. Extending the analysis would require developing life-cycle-cost information for the commercial sector, as well as an understanding of the current role of energy costs in determining building designs.

- Performance evaluations are lacking for various existing federal programs designed to stimulate improved building construction or consumer conservation behavior, even for long-standing and heavily funded programs.

Current Market Status

- Over the past few years the National Association of Home Builders (NAHB) and Professional Builder magazine have conducted surveys that indicate that consumers and builders are demanding and supplying more energy-efficient dwellings. However, these surveys do not clearly indicate whether or not the activity represented "optimal" efficiency improvements or whether the activity is in response to higher energy prices, government programs, or changing consumer attitudes.
- Mandatory standards can be implemented to achieve optimal energy-efficient building design, but regional differences in fuel prices, climatic conditions, taxes, and building codes make balanced implementation difficult. Since mandatory standards are to be implemented over a period of years, they must rely on energy price forecasts to achieve optimal efficiency levels in new buildings. Given current uncertainties about future energy and economic conditions, continued revision of the standards may be necessary. This is likely to inconvenience consumers, confuse builders, and overburden regulators. Lastly, because mandatory standards could result in arbitrary decisions that restrict freedom of choice, all relevant policy options should be carefully examined before the standards approach is adopted.

Information and Education Programs

The major criticisms of existing and previous programs to stimulate energy conservation in new construction are summarized below:

- lack of focus on the informational needs and motivations of specific industry actors
- absence of data on the effectiveness of various techniques and programs to improve new construction practices
- apparent lack of coordination among various government programs to present consistent and reliable information appropriate for their region to building industry actors.

Another major impediment is purchasers' inability to estimate space conditioning costs until after the building purchase is made. A similar situation existed for automobile buyers until the EPA initiated a fuel efficiency labeling program. A similar program for buildings was discussed in Congressional hearings in 1975 but was rejected due to controversy over the method by which space conditioning costs would be estimated.

The following four elements are needed to improve existing federal information programs.

1. a mass media campaign to illustrate the historical patterns of energy use, detail the precarious nature of current consumption patterns, and present estimated fuel price projections
2. an energy-labeling program that is designed for residential and commercial building transactions and which includes a disclosure and analysis of the structure's energy integrity and probable energy costs
3. a technology transfer program to supply builders and designers with skills and plans for energy-efficient building construction and operating cost estimation
4. an expansion of the Energy Extension Service to provide the public information on energy alternatives and potential benefits of conservation

Information and education programs offer the benefit of supporting self-adjusting market forces rather than adding to existing federal regulations. However, additional information is needed to conclusively evaluate the effectiveness of such programs as substitutes for mandatory standards.

Tax Incentives

The Energy Tax Act of 1978 (P.L. 95-613) established tax credits for energy conserving retrofit of existing homes and addition of solar equipment to both new and older homes. No tax incentives exist that apply to conservation strategies or passive solar use in new residential or commercial construction. Most state-level property and income tax programs apply only to solar and renewable resource equipment costs. Defining qualifying investments due to the multiple attributes of many possible conservation strategies as well as the climate and fuel price variations across the country will make an equitable and effective tax incentive program difficult to design.

In addition, tax credits for new buildings impact investment differently depending upon whether the building is gas, oil, or electrically heated. For gas-heated homes conservation improvements are favorable within the first five years of home ownership, and a tax incentive possibly could make conservation investments even more attractive. However, for electrically heated homes and even with gas-heated homes, lack of economic incentives has not been indicated as the key reason for lack of energy conservation investment.

Mortgage and Finance Programs

The federal government exerts substantial influence on the real-estate financing process and may improve the energy efficiency of new building construction through direct loan subsidies (perhaps through a "solar bank") or procedural changes by Federal National Mortgage Association (FNMA), Federal Home Loan Mortgage Corporation (FHLMC), Federal Housing Administration (FHA), and the Department of Housing and Urban Development (HUD), etc.

Of the existing and proposed mortgage and finance provisions reviewed, the two most promising are changing expense-to-income tests of credit worthiness to include energy costs (PITI + U), and offering a loan rate subsidy to purchasers of energy-efficient properties. Several general problems exist with these and other reviewed provisions:

- Recent lender surveys indicate that policies requiring substantial federal intervention will not be adopted rapidly.

- Existing inflationary conditions have dominated the concerns of lending institutions and have therefore left energy conservation objectives with secondary importance.
- If the policy requires a definition of an "energy-efficient building," developing a consistent and widely acceptable definition may be costly.
- Many existing and proposed policies are designed for retrofitting the existing building stock and are not easily extended to new construction.
- Overall information concerning policy effectiveness is lacking.

RECOMMENDATIONS

Numerous surveys have indicated that the American people are ignorant about energy issues. However, preceptions are changing rapidly because of recent events, starting with the oil embargo of 1973-74, long lines at the gas pump and problems at Three Mile Island. Because of the many information sources and the subject's complexity, many Americans are confused and searching for direction. In such an atmosphere, a well-organized education effort to heighten awareness of energy issues and alternatives may have dramatic results. The following program elements may improve federal conservation policies:

- Determine the utility and feasibility of a building energy labeling program in a pilot project.
- Evaluate technology transfer program results and quantify expenditures.
- Examine the potential for coordinating the conservation information programs of various agencies to improve overall program quality.
- Launch a pilot informational program to better estimate costs, gain knowledge of media and public support, and determine the effect on new building purchase and construction.

- Determine whether or not building construction practices are changing in response to fuel price changes and if so, at what rate.
- Determine optimal building energy efficiency, considering local energy prices, and climatic conditions and compare that optimum to local building practices.

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1.0 INTRODUCTION

The research described in this report was performed by the Pacific Northwest Laboratory (PNL) for the U.S. Department of Energy (DOE), Assistant Secretary for the Office of Conservation and Solar Energy (CS), Office of Building and Community Systems (BCS). The principal objective of the work was to develop recommendations to improve DOE policies for conserving energy in new buildings.

The Energy Conservation and Production Act (P.L. 94-385) dictates that mandatory building energy performance standards (BEPS) be written for new residential and commercial buildings. The purpose of the building energy performance standards is to "achieve the maximum practicable reduction in energy and encourage use of renewable energy resources for space conditioning of buildings." However, public concern over federal regulations whose costs exceed their benefits has raised doubts about the desirability of mandatory building energy standards. This report examines nonregulatory alternatives to the mandatory standards approach for conserving energy in new buildings to determine whether or not those alternatives are more desirable.

For several years efforts have been under way to identify what constitutes optimal energy efficiency in buildings. Based on the wealth of technical and economic information generated by this effort, several alternative federal approaches for achieving optimal energy conservation levels are feasible. Of the feasible alternatives, mandatory performance standards have received the most thorough exploration of costs and effectiveness. The objective of this research effort is to analyze the costs and effectiveness of nonregulatory options relative to those of a regulatory approach. This effort requires identifying nonregulatory program alternatives, estimating program costs and effectiveness, and comparing cost/effectiveness estimates with the regulatory approach. Unfortunately, information was not available to make a complete comparison of regulatory with nonregulatory alternatives. This report presents preliminary findings and should be judged as the first step toward a more complete analysis.

1.1 APPROACH

The objectives of this study were:

- to evaluate the current market for energy efficient new buildings to determine what improvements to the market, if any, are needed
- to identify major problems with the mandatory standards approach
- to identify existing and potential nonregulatory policy alternatives for conserving energy in new buildings
- to analyze expected costs and effectiveness of these nonregulatory alternatives.

To accomplish these objectives, four major tasks were outlined. First, survey data on new building construction practices were reviewed to assess current market conditions to determine whether or not builders and consumers were choosing more energy-efficient designs on their own. Second, DOE documents prepared in support of the building energy performance standards program were reviewed to identify major problems with the mandatory standards approach. Then, a review of the energy conservation policy literature was conducted and appropriate government officials were interviewed to identify a relevant range of nonregulatory policy alternatives for conserving energy in new buildings. Fourth, the alternatives were analyzed for expected costs and effectiveness.

1.2 ORGANIZATION OF THE REPORT

Chapter 2.0 briefly reviews survey data to assess present public awareness of energy issues and energy-efficient building design. Homebuyer and homebuilder surveys are reviewed and conservation motivations are discussed.

Chapter 3.0 examines the provision of technical and economic information to various actors affecting building design decisions. This approach assumes that the economic incentives and technical means to achieve energy conservation goals already exist but that critical information is lacking.

Chapter 4.0 examines how adjustments to the tax structure could enhance economic incentives and counter economic disincentives for energy conservation.

Qualifying buildings for tax benefits would almost certainly require certification of design energy consumption. The effectiveness of tax incentives would depend in part on dissemination of public information regarding the incentives.

Chapter 5.0 examines subsidies, such as subsidized mortgages and loan guarantees, which lower the cost of money or other costs but do not change the market structure facing the consumer. Certification that buildings qualify for such treatment would probably be required.

Chapter 6.0 presents recommendations based on the study's findings.

2.0 REVIEW OF CURRENT CONDITIONS

Using available survey results, this chapter assesses the current level of energy awareness and reviews public attitudes toward energy-efficient building designs. The reasons why particular actors seek information are described and specific information techniques are outlined.

2.1 CONSERVATION MOTIVATIONS

To understand consumer decisions, the factors that motivate individuals to acquire information about energy conservation must be examined. For conserving energy in buildings, the three major motivations are economics, ethics, and recognition.

Economic activities permeate every stage of the construction process, since most entities engage in the activity for profit. Consequently, producing a salable commodity is extremely important and historically necessitates minimizing a building's purchase price. However, escalating fuel costs are making the structure's operating costs increasingly important and are driving consumers to include these costs in their purchasing decision. A rational consumer will select a building with the lowest life-cycle costs by estimating both the capital and operating costs over the period of occupancy and will consider the investment's tax benefits and resale value. Because of the competition among many independent builders, the buyer's preference determines the types of structures constructed. Thus, as fuel prices and operating costs increase, consumers are becoming better informed about the value of energy and conservation. As long as the net prices paid for energy and other items reflect relative production costs, decisions made based upon economic motivation alone will maximize society's welfare.

For many consumers, the energy conservation ethic is a motivating force to gain energy information. Energy use consequences not reflected in energy prices are coming under scrutiny. Energy use impacts, such as resource depletion, environmental degradation, public health, and national security, provide additional incentives to conserve energy above and beyond the purchase price.

As people become more aware of the impacts of their actions, most followers of this ethic believe energy prices should be increased to provide more accurate price signals to nonfollowers.

Recognition by the press and clients is another force motivating citizens to gain energy information. Builders and developers wish to be identified as promoting energy efficiency to stimulate demand for their services. In addition, several design competitions and grant programs encourage the development of energy-efficient building through rewards and recognition of winning entrants. As the total effect of energy consumption on society becomes clearer individuals can be expected to desire recognition as energy conservation promoters.

Most building actors are influenced by some combination of these and other motivations to obtain energy information and to make optimal conservation investments. Complete absence of adverse impacts is a distinct advantage of efforts to conserve energy. Increasing awareness of Man's degradation of the delicate ecosystem has served to promote energy conservation because conservation reduces such destruction.

Whatever the motivation, an individual will seek reliable information sources if the costs of such knowledge are not excessive. Thus, given motivation, the next step in the learning process is to institute mechanisms that will efficiently transfer the information.

2.2 CURRENT PUBLIC AWARENESS OF ENERGY ISSUES

Numerous studies indicate that consumers lack knowledge of the energy problem, its causes or possible solutions. The rapidly increasing complexity of technological development and repeated demonstrations of the capacity for technological advances to provide a steadily improving standard of living has led the average person to rely upon experts to solve complex problems. It is becoming increasingly evident though, particularly in light of the exhaustibility of fossil fuels and environmental degradation due to coal and nuclear generation of electricity, that no quick technological fix is in sight. Limits to energy availability and their impacts are just beginning to be realized.

During the natural gas shortage in February of 1977, about 60% of the population felt the fuel shortage was real, but by March less than half thought so. This fraction has not changed significantly since the Arab oil embargo of 1974. About one-third of the population is quite skeptical about any energy shortage and believe that it is contrived for economic or political gain by vested interests (Federal Energy Administration (FEA) 1977).

Whatever the public believes about the causes of energy shortages, a great deal of public ignorance exists. Only half of the public believed that the U.S. imported oil to satisfy its energy demands and only one-tenth of those polled in a May 1976 survey by Jeffrey Milstein had an accurate idea of how much oil the U.S. imports. Although more recent survey information on public awareness was unavailable, there are indications that the general public is becoming more aware that a real energy problem exists, particularly in light of long lines at the gas pumps.

Even if consumers become convinced that energy shortages are real, most studies indicate that conserving behavior does not necessarily follow. In fact, no relationship has been found between belief in the reality of the energy problem and any actual conserving behavior. However, compared to disbelievers, those who think that energy shortages are real are more likely to hold attitudes that deny consumers the right to waste energy and that support policy proposals fostering energy conservation. More importantly, most studies did not examine the major effect of escalating fuel costs on consumer behavior, although it is the primary motivator. This work needs to be done.

A major study in 1976 by Jeffrey S. Milstein for the Office of Conservation and Solar Applications (CS) indicated that although most Americans believed that fuel shortages were contrived, an even larger majority believed energy conservation was important. More than half of the respondents to an Federal Energy Administration (FEA) commissioned Gallup Survey felt that the fuel shortages were artificial, but 83% said the need to conserve energy was very serious or somewhat serious (FEA 1977). These results may indicate that many consumers found conservation important because of high energy costs rather than because energy shortages required it.

Numerous factors may contribute to public confusion about energy issues: 1) a lack of practical knowledge of what to do 2) a lack of personal involvement in the problem 3) a belief that others should act first, and 4) conflicts with desires for comfort and convenience. The energy integrity of new buildings has been a low-ranking purchasing determinant because of most buyers' inability to weigh the benefits of energy conservation against the increased capital cost and to estimate the structure's overall energy performance. To consider these factors and estimate space conditioning costs over the life cycle of the building, the potential buyer needs both energy performance information and an understanding of fuel use and prices.

2.3 CURRENT PUBLIC AWARENESS OF ENERGY-EFFICIENT BUILDING DESIGN

The building energy performance standards (BEPS) economic analysis (Pacific Northwest Laboratory 1979) indicates that rational building buyers would prefer structures that are 30 to 40% more energy-efficient than those constructed in 1977. Buyers do not demand such buildings for many reasons, but the major reason appears to be a lack of reliable information and the ability to best use available information. Other reasons include the lack of energy-conserving building features in speculative construction and difficulties in obtaining financing, both of which can most likely be rectified through an improved understanding of energy information by appropriate actors.

Specific knowledge of energy-conserving attributes in buildings is seriously lacking. A 1976 Federal Energy Administration (FEA) study found that 36% of the respondents did not know that lower wattage bulbs use less electricity, and 59% thought that leaving an incandescent light burning used less energy than switching it on and off as needed. Although water heating is the second largest residential energy user, only 42% knew where to find the water heater and how to set the controls. Only 13% of the respondents believed that their homes needed additional insulation, although 20% of the homes had no insulation whatsoever and many more were inadequately insulated (FEA 1976). The study clearly indicated that the public needs to know energy waste sources and methods to reduce both energy loss and energy consumption.

Because the benefits of an energy-efficient building often are not realized until the purchasing decision has been made, the buyer needs to be able to estimate fuel savings and balance them against additional first cost to make a rational purchasing decision. This tradeoff can best be analyzed through life-cycle costing. A National Demographic Corporation study of the impact of a marketing program designed to increase energy efficiency of residential appliances found that less than 30% of those interviewed could explain the logic of the slogan, "Products that Save Energy Pay for Themselves," even after a fairly vigorous advertising campaign (DOE 1978). Since an accurate life-cycle-cost analysis requires consideration of anticipated energy savings, incremental conservation measure costs, fuel prices and escalators, opportunity costs of capital, and various tax considerations, the potential for the method's use by consumers is severely limited, but extremely relevant. Although the fundamental concepts can be understood by anyone with a basic knowledge of arithmetic, selecting input parameters and calculating cost can be beyond the average citizen's skill level. Therefore, providing potential buyers with life-cycle cost information to permit a comparative assessment of options seems the most appropriate method to help the public reduce energy loss and energy consumption.

A three-year series of surveys, conducted by Professional Builder magazine (1976, 1977, 1978) and aimed at families entering the housing market, indicates an increasing awareness of energy considerations and a growing willingness to alter buying patterns somewhat to realize a cost savings on energy. Although common opinion once held that builders and buyers tend to look only at first costs and ignore operating or life-cycle costs when selecting a structure's features, these surveys suggest that this may no longer be the case.

Table 1 presents the results of a Professional Builder's query (phrased as follows):

"Suppose you were interested in a new home and a builder told you that by spending \$600 more at the time of construction, he could cut your heating and cooling bills by \$100 per year. What would be your reaction?"

TABLE 1. Percentage of Potential Homebuyers Willing to Initially Spend \$600⁺ to Save \$100⁺ Annually on Energy

	<u>1975 Data</u>	<u>1976 Data</u>
<u>BY FAMILY INCOME</u>		
Less than \$15,000	89.2	87.9
\$15,000-\$19,000	89.7	89.2
\$20,000 or more	89.1	92.3
<u>BY HOME PRICE RANGE</u>		
Under \$25,000	90.2	88.8
\$25,000-\$34,999	90.8	90.1
\$35,000-\$44,999	88.9	85.5
\$45,000-\$54,999	84.6	84.1
\$55,000-\$64,000		94.7
\$65,000 or more	90.6*	95.5

*1975 data available only as "\$55,000 or more"

SOURCE: Statistical data on Professional Builder survey provided to Office of Technology Assessment (OTA) by Cahnners Publishing Company, 1977; 1978 data not available by income group and house price range.

Among 248 potential buyers of single-family homes in 1975, 80.5% expressed their willingness to make the investment and 8.9% more said they would spend even more. In 1976 the total fraction remained nearly the same (80.1%); however, 15.1% expressed a willingness to spend more. In 1977 93.2% of the respondents indicated willingness to make the investment, and in 1978 the fraction dropped slightly to 89%. Of particular interest in Table 1 is the willingness of various income groups to make similar levels of conservation investments.

Given the complex interplay between builders and buyers in determining home features, both the buyers' desires and the builders' perceptions of them should be examined. Builders remain the primary decisionmakers in new construction and their decisions are based largely on what they believe will

sell. Professional Builder (June 1978) asked housing contractors, "How important is energy conservation to your customers?" Fifty-three percent said energy conservation was very important and 44% said somewhat important. This recent evidence indicates that purchasers of new housing are energy-conscious and that builders are increasingly sensitive to that concern.

Architects are another important actor for determining home features. They ranked information availability as among the most important constraints to achieving conservation in new building design (AIA Research Corporation 1978). However, the building design professions have failed to develop an energy conservation research tradition or to institutionalize research that would generate new knowledge to support new building practices. In fact, architects and designers often rely upon peripheral disciplines for research results. These disciplines often fail to translate their results into forms that are easily understood by practitioners. Unfortunately, they fail to recognize the critical needs that practice-oriented research would clarify. Although a lack of knowledge is a problem for some substantive areas, abundant data critical to effective conservation designs do exist. Unfortunately, they are not readily available in a useful form to design professionals because the presentations are too theoretical or abstract. This information gap could be bridged by developing appropriate design tools and data from successful demonstration projects.

Lenders and financial intermediaries also play an important role. Because of the voluminous amount of paperwork lenders must generate to provide financing for structures, a hesitancy exists to further complicate matters by assessing the structure's thermal integrity in the lending process. However, as energy expenditures constitute a larger share of a borrower's disposable income (up from 6.5% in 1970 to 8.5% in 1978), lenders are finding that owners of energy-efficient structures are less likely to default on loans.

The informational needs of specific building industry actors to make more rational decisions based upon available or readily developed information sources are summarized in Table 2. Existing and attempted programs are reviewed below to provide such information.

TABLE 2. Energy Informational Needs and Motivations of Building Industry Actors

Actor	Information Needs	Motivations
Designers	<ul style="list-style-type: none"> - performance data on conservation technologies - insulation, passive solar, etc. - cost effectiveness data of design parameters - computation design tools - fuel price and estimated escalators 	<ul style="list-style-type: none"> - status - recognition of good work - ethical obligation to design efficient structures
Builders	<ul style="list-style-type: none"> - energy efficient construction practices - evaluation of alternative building materials - marketing tools - quality control and testing data - fuel price and estimated escalators 	<ul style="list-style-type: none"> - marketability of buildings - reputation as a quality builder
Lenders	<ul style="list-style-type: none"> - life-cycle cost analyses of conservation measures - computational tools to estimate energy costs - comparative data to select most efficient designs - fuel price and estimated escalators 	<ul style="list-style-type: none"> - reduced default on loans - increased demand for loans
Regulators/ Appraisers	<ul style="list-style-type: none"> - energy-efficient construction practices - computational tools to estimate energy consumption - performance data on emerging technologies - comparative data to certify/quantify relative conditioning costs - fuel price and estimated escalators 	<ul style="list-style-type: none"> - compliance with law - improved job satisfaction through more accurate estimation
Realtors	<ul style="list-style-type: none"> - value of energy-efficient design - features of energy-efficient design - marketing tools - comparative data to assess relative energy use - fuel prices and estimated escalation 	<ul style="list-style-type: none"> - increased sales volume - increased buyer satisfaction - improved credibility as investment adviser
Buyers	<ul style="list-style-type: none"> - energy efficiency of buildings - life-cycle costs of ownership - methods of energy use reduction - comparative data of building performance - fuel prices and estimated escalation 	<ul style="list-style-type: none"> - reduced total costs; - status of owning an energy-efficient structure - moral rewards of reduced waste
Subcontractors	<ul style="list-style-type: none"> - specific energy-efficient construction practices - quality control - evaluation of alternative building materials - business repercussion of shoddy work 	<ul style="list-style-type: none"> - reputation as competent subcontractor - opportunity for specialized advancement - increased work load

3.0 INFORMATION AND EDUCATION PROGRAMS

Evaluating the effectiveness of information and education programs to stimulate conservation behavior is difficult because of the building industry's complex decision-making process and the public's perceptions of the value of energy. Lenders, builders, regulators, architects, designers, manufacturers of building supplies, contractors for heating and cooling equipment, and building consumers interact collectively to determine a building's construction. The perceptions and interactions of these participants in new construction decisions are a function of information regarding fuel and equipment price and availability, tax and regulatory activities, technological innovations and other factors. Thus, a comprehensive view of the primary actors' informational needs is needed to assess the potential impact of energy information on their decisions and to evaluate the relative efficiency of the information and educational approach.

3.1 CURRENT OUTREACH PROGRAMS

The Comprehensive Program and Plan for Federal Energy Education, Extension and Information Activities (Department of Energy 1978) describes 63 programs related to energy conservation and renewable fuels throughout the federal establishment. Currently, weatherization programs receive by far the largest expenditure of federal funds for conservation activities. Since these activities apply exclusively to retrofit applications, however, they are not particularly relevant to new building practices. Because of the vast number of programs, this analysis will address only those programs in 10 representative states: Alabama, Connecticut, Minnesota, New Mexico, Pennsylvania, Tennessee, Texas, Washington, Wisconsin, and Wyoming. Total government spending, including state contributions in these 10 states, came to \$37.1 million in 1978, of which 66.4% or \$24.63 million was federally funded. A breakdown by organization and state is presented in Tables 3 and 4 and a cursory cost analysis is shown in Table 5.

Federal energy outreach activities have mainly focused on retrofit applications, but several notable programs oriented toward new construction have

TABLE 3. Federally Supported Energy Outreach Activities and Budgets for FY 1978
(In Thousands of Dollars) By Program for Each EES State

CPP*

												Total Program in EES States
Program Description		AL	CT	MI	NM	PA	TN	TX	WA	WI	WY	
<u>DOE PROGRAMS</u>												
Conservation Education Programs		3	3	9	1	11	4	11	3	4	1	50
Solar Technology Transfer					40		40		40			120
Appropriate Technology Grants			100	100						100		300
Conservation Technology Transfer			10				50					60
EPCA/ECPA		643	642	1240	593	2157	935	3515	430	1750	785	12,690
Project Conserve		21	18	54	7	69	25	72	21	27	2	316
Academic and public programs		9	7	22	3	28	10	29	8	11	1	128
SUBTOTAL - DOE		576	780	1425	644	2265	1064	3627	502	1892	789	13,664
<u>FEDERAL AGENCIES (MAJOR PROGRAMS OTHER THAN DOE AND WEATHERIZATION)</u>												
DOC - EADC						30	30					60
DOC - Technical Assistance				50							50	100
DOC - Professional Services					25				25			50
DOC - University Centers		7		7	7		7	7	7			42
HUD - Solar Demonstrations		35	352	264	228	262	36	488	13	97	0	1,775
HUD - Franklin Institute		50	95	190	30	28	6	245	60	160	15	879
CSA - R&D Energy Grants		130	18			49			50	400		647
CSA - Consumer Infor. & Educ.		28	79	18			15	13	41		16	210
USDA - Cooperative Extension		233	199	590	74	755	270	788	228	296	25	3,458
ACTION/VIST & University Year		17	14	43	5	56	20	57	17	22	2	253
EPA - Auto Fuel Economy		23	20	58	7	75	27	77	22	29	2	340
TVA - Various		706					824					1,530
<u>FEDERAL WEATHERIZATION OUTREACH</u>		234	223	976	146	1316	377	571	353	529	72	4,797
<u>MINOR FEDERAL PROGRAMS</u>		4	4	11	1	13	5	14	4	5	0	61
<u>TOTALS (excluding DOE/EES)</u>		2143	1784	3632	1167	4849	2681	5887	1322	3430	971	27,866
<u>ENERGY EXTENSION SERVICE (EES)</u>		1,003	992	861	880	880	880	1,114	880	874	877	9,241

*Comprehensive Program and Plan for Federal Energy Education, Extension and Information Activities; DOE/IR-005 (Feb. 1978).

TABLE 4. Department of Energy - EPCA/ECPA Outreach Budgets for FY 1978
(In Thousands of Dollars)
(Includes State and other matching funds)

<u>EPCA Program</u>	<u>AL</u>	<u>CT</u>	<u>MI</u>	<u>NM</u>	<u>PA</u>	<u>TN</u>	<u>TX</u>	<u>WA</u>	<u>WI</u>	<u>WY</u>
Thermal Efficiency Standards	75	63	15	--	200	40	33	34	140	30
Lighting Efficiency Standards	30	45	--	--	90	--	63	--	--	--
Transportation	80	89	95	--	400	115	69	39	260	5
Residential Houses	15	107	50	328	42	123	2947	111	--	415
Commercial	50	49	113	128	--	240	600	95	1063	49
Project Conserve	90	--	305	--	--	85	--	--	--	--
Recycling	30	5	50	--	--	--	--	9	--	--
Waste Oil	--	4	20	14	45	--	--	--	8	--
Technology - Small Business	--	--	165	--	--	--	--	--	--	--
Agriculture	--	--	67	14	300	--	100	7	20	151
Natural Gas Conservation	--	--	--	--	380	--	--	--	--	--
Information and Education	<u>55</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>90</u>	<u>--</u>	<u>29</u>	<u>--</u>	<u>--</u>
Subtotal EPCA Outreach	425	362	880	484	1457	693	2912	324	1491	650
<u>ECPA Supplemental</u>										
Energy Audits	*	80	246	33	300	*	*	51	*	97
Public Education	<u>---</u>	<u>200</u>	<u>114</u>	<u>76</u>	<u>400</u>	<u>---</u>	<u>---</u>	<u>55</u>	<u>---</u>	<u>38</u>
Subtotal ECPA Outreach	218	280	360	109	700	242	603	106	259	135
TOTAL EPCA/ECPA	643	642	1240	593	2157	935	3515	430	1750	785

*Data not available.

TABLE 5. Per Capita Analysis of Federal/State Energy Conservation Outreach

<u>FY 1978</u>	<u>AL</u>	<u>CT</u>	<u>MI</u>	<u>NM</u>	<u>PA</u>	<u>TN</u>	<u>TX</u>	<u>WA</u>	<u>WI</u>	<u>WY</u>	<u>Total in EES States</u>
Totals - Federal/State programs other than EES (From Figure 1, \$000)	2143	1784	3632	1167	4849	2681	5887	1322	3430	971	27,866
DOE Extension Service Funding (\$000)	1003	992	861	880	880	880	1114	880	874	877	9,241
EES + Other Federal/State	3146	2776	4493	2047	5729	3561	7001	2202	4304	1848	37,107
EES/(EES + Other)	31.9%	35.7%	19.2%	43.0%	15.4%	24.7%	15.9%	40.0%	20.3%	47.5%	24.9%
Populations (Thousands, 1975)	3614	3095	9157	1147	11827	4188	12237	3544	4607	374	53,790
Non-EES Funding (\$/person)	0.59	0.58	0.40	1.02	0.41	0.64	0.48	0.37	0.74	2.60	0.52
EES Funding (\$/person)	0.28	0.32	0.09	0.77	0.07	0.21	0.09	0.25	0.19	2.34	0.17
Total Federal/State Funding (\$/person)	0.87	0.90	0.49	1.79	0.48	0.85	0.57	0.62	0.93	4.94	0.69

been implemented. For example, the conservation education program manages a multimedia public service announcement program to raise the awareness of energy issues, develops material for elementary and secondary educational programs and conducts market research for new technologies. A solar energy technology transfer program provides rapid response of information to the needs of the building community, including builders, architects, labor unions, engineers, financiers, utilities, and other interested parties. The program strives to link current research with practitioners' needs. The technology and information transfer program develops commercialization plans for energy conservation strategies resulting from research efforts. An academic program branch develops and disseminates materials and gives grants to institutions of higher learning to support training activities for teachers to facilitate inclusion of energy topics in school curricula. The public program's branch and the publication branch of DOE's intergovernmental and institutional relations section provide printed material for public dissemination. Many other lesser scale activities are under way but they are too numerous to mention and data on their effectiveness were lacking in the literature.

Review of all federal programs impacting energy conservation information reveals an apparent lack of focus. Considerable duplication of effort and overlapping of responsibility occurs, which seems to obscure the common goal of information exchange. Without a clear focus and organized plan to achieve a higher level of energy awareness in the American public, the effectiveness or ineffectiveness of the many programs is difficult to evaluate.

A pilot program initiated in October of 1977 and entitled "The Energy Extension Service" (EES) was begun partly to focus federal efforts within each of the 10 pilot states. The goal is to provide personalized services tailored to the needs of small-scale energy users and to focus on increasing their capability to make and implement informed decisions. Each state program was initially funded at \$1.1 million. A review of the service after one year of operation led DOE to recommend that the program be expanded nation-wide. Some of the survey's more important findings follow (Department of Energy 1979):

1. Fifty-two percent of EES clients found the information more useful than information from other sources and 38% found it as useful as other sources.
2. The total average cost of EES services per client was \$72.
3. A significantly greater proportion of EES clients (73%) expressed a more positive attitude toward energy conservation than did a comparison group (54%).
4. As a whole significantly more EES clients have taken energy conservation action (84%) than a comparison group (77%).
5. EES had a major influence on 29% of the conservation action taken.
6. EES clients plan to invest approximately twice as much money in energy conservation than a comparison group.

Unfortunately, very little data are available on the effectiveness of particular informational efforts to stimulate the construction of energy-efficient homes. This lack of data occurs partly because informational programs focus on homeowners' retrofit activities and exclude other building actors in new construction evaluation. Discussions with researchers involved with technology transfer programs indicated that builders and designers are highly interested in collecting information on energy-efficient design performance and marketability. No studies have been conducted to determine whether the information impacted the actual construction of new buildings, but followup discussion with builders indicated that it had. Because a speculative builder's first priority is to build structures that will sell, builders expressed a strong desire for marketing tools to convince homebuyers of the value of more energy-efficient dwellings.

Since 1970 energy consumption patterns in the residential sector have diverged from previous times. Americans as a group were increasing their home energy use at an average rate of 4.7% a year prior to 1970; since then the rate has decreased to 2.6%. Moreover, the total growth is mainly attributable to a growth in the number of households. The per home consumption declined

between 1970 and 1977. Comprehensive data collected by the National Association of Homebuilders on the thermal integrity of new construction for 1974-1976 show significant increases in thermal quality over the period. Property owners' attitudes toward energy costs and energy conservation have changed significantly over the past 5 years and in response many builders have raised their standard for energy efficiency in homes and are actively promoting energy features in sales.

The major failures of existing and previous outreach programs to stimulate energy conservation in new construction are summarized below:

1. lack of focus on the informational needs and motivations of specific industry actors
2. an absence of data in the literature on the effectiveness of various techniques and programs to improve new construction practices
3. apparent lack of coordination among various government agency programs to present to building actors consistent and reliable information.

To determine how informational programs might achieve more effective results, the various actors' motivations to gain knowledge and to evaluate the various techniques that are used to information transfer should be examined.

3.2 CURRENT INFORMATION PROGRAMS

This section identifies information techniques that can be used to effectively stimulate efforts to improve the thermal integrity of new building construction. Rapid energy conservation rates can be attained with varying effectiveness through mass media presentations, building labeling, and technology transfer programs to interested individuals.

Mass media campaigns are attractive because of their rapid impact and wide exposure. Examples of successful media campaigns include efforts to reduce littering and careless forest fires. By repeatedly focusing the public's attention on issues of concern, beneficial results have been

realized. The anti-litter campaign, waged largely through national television commercials, resulted in an estimated 30 to 50% reduction of litter. A similar reduction in forest fires is believed to have been achieved, although accurate estimation is difficult because of increasing use of forest areas and variations in annual weather characteristics.

The pilot advertising program in Denver, conducted during the Fall of 1977 to stress the concept of "The Energy Cost of Ownership" (commonly known as life-cycle costing), is another example of the value of a mass media campaign to stimulate energy conservation. Following the campaign, Denver homeowners proved to be significantly more aware of the energy saving potential of various measures, particularly those that entailed the installation of specific energy conserving devices in the home. Of 15 such measures examined, residents exhibited increased savings consciousness on nine of them. Following the demonstration program, homeowners were more cognizant of the overriding role of home heating in their total energy use pattern. More generally, a significantly greater awareness developed of the energy issue as a top national priority. The perception that individuals can contribute to energy conservation increased significantly. Recognition and recall of the three television commercials that were used in the program averaged approximately 45% one to four weeks following airing. This figure compares to an average figure of 30% recall for satisfactory commercial performance. The performance of a mass media campaign is highly dependent upon presentation quality and producer credibility.

In response to the perceived need to conserve energy, the citizenry is turning to many groups for information. A survey of Denver, Colorado and Salt Lake City, Utah residents indicated that the two most credible information sources were groups of scientists and engineers and the U.S. Department of Energy (1978). University economists ranked well behind these sources, but far ahead of others. Traditional media sources, such as local television and radio stations and local newspapers did not fare so well. Elected officials, such as President Carter or local elected officials, experienced lower than average credibility ratings for energy topics. The ratings of the various informational resources are presented in Table 6.

TABLE 6. Individual or Groups Credibility
Regarding Energy Information^(a)

	<u>Percentage</u>
A group of scientists and engineers	39
The U.S Department of Energy	27
A group of economists from colleges and universities	9
Public Service Company	9
President Carter	8
Local Congressional representative	4
Local television stations (such as Channel 2, 4, 7, or 9)	4
Local favorite radio station	2
The <u>Denver Post</u>	2
Sears, Roebuck and Company	1
Montgomery Ward	--
The <u>Rocky Mountain News</u>	<u>1</u>
N =	541

(a) Percentages total more than 100% due to multiple
mentions.

The least credible sources were those perceived to make a profit on the sale of energy-conserving equipment. Consequently, builders will be perceived as having an inherent bias in their informational programs for homes they build. Retail establishments and utility companies also suffered low credibility ratings because consumers believe their profit motives are significant.

The automobile industry has demonstrated the potential of rating products, using appropriate labeling strategies to encourage selection of energy-efficient products. Programs that inform car buyers of new cars' relative fuel economy have resulted in a 20-25% increase in efficiency of new cars purchased compared to a 0.7% increase experienced in a control group. The data were compiled for 1976 calendar year when the program was relatively new.

Discussions with EPA representatives at the testing facility in Ann Arbor, Michigan, indicated that the conservation impact should be greater this year because dealers are required to distribute a Fuel Economy Guide to all car buyers and to advertise use and availability. Since over 70% of new car buyers presently collect sales brochures prior to purchase, the number of guide users is expected to be high. No similar study has been reported for building labeling, but such data should be collected to evaluate its potential effectiveness. In February of 1975 Congressional hearings on energy labeling and disclosure included statements by many professional engineers and builders that labeling programs show great promise to stimulate market activity leading to conservation (U.S. Senate 1975). At that time the primary objections to the concept centered around the inability to accurately model a building's design performance.

Programs for the transfer of technical information from experts to practitioners are believed to have tremendous potential for reducing buildings' space conditioning energy consumption. Seminars and conferences to share information on energy conservation technologies and techniques in new construction are rapidly growing in number and attendance. Most builders, being small entrepreneurs, cannot develop their own customized plans appropriate for their particular climate and location. However, they appear to be willing to spend considerable sums to attend privately delivered information programs. Due to the complexity and sophistication of building modeling, it seems most appropriate for a central group of professional designers to provide plans and energy-use estimates to builders as an informational source. Energy-use estimates can then be used as a marketing tool and would provide a substantial incentive to builders to construct such buildings. Recent communications with builders revealed a consensus that such a technique would be well received and rapidly implemented. Such a program, recently launched by the Tennessee Valley Authority, has met with tremendous acceptance by the local building industry.

3.3 PROPOSED INFORMATION AND EDUCATION PROGRAM TO STIMULATE THE CONSTRUCTION OF ENERGY-EFFICIENT STRUCTURES

The following combination of programs could stimulate construction and marketing of energy-efficient structures through market activity resulting from informed consumer choices. The program should be centrally organized but implemented by the state and localities. The program consists of four key ingredients.

1. a "Truth in Energy Act" to require that building purchasing transactions include an analysis and disclosure of the structure's energy integrity
2. a technology transfer program to supply builders and designers with skills and plans for energy-efficient building construction and operating cost estimates
3. a mass media campaign to illustrate the historical patterns of energy use, detail the precarious nature of current consumption patterns, and present estimated fuel price projections
4. an expansion of the Energy Extension Service to supply information to the general population on energy alternatives and potential conservation benefits.

Truth in Energy Act

The Truth in Energy Act, which, as stated, would require that building ownership transfers include a disclosure and analysis of the structure's energy integrity, would facilitate the inclusion of space conditioning energy use in the purchasing decision. Since the complex calculations to estimate energy consumption are beyond the average building purchaser's ability to perform, a comparative analysis, not unlike the EPA fuel economy information for autos, should be prepared by the seller or his representative.

The calculational procedures and underlying assumptions must be uniform to permit valid comparisons. Although a variety of information on a building's characteristics may be disclosed, the most useful figure to a potential building buyer is the estimated design conditioning cost (EDCC) for the first year

of ownership. This figure is preferred because it can be accurately calculated using verified computer algorithms and estimated fuel price information. Estimated design conditioning costs are different from actual costs because the occupants' highly variable, behavioral actions, which are beyond the control of builders, are included in the latter. A first year of ownership calculation is preferred to an annualized figure over the building life cycle because of future fuel price uncertainty for a particular locality.

Provided with an EDCC estimate, a potential buyer can compare one building's thermal integrity with another and weigh this factor against other decision-making determinants. At the same time, builders will have a marketing tool to enhance the salability of energy-conserving buildings and will have feedback on their structures' thermal efficiency. This feedback, in turn, will enhance communication among builders and design professionals to encourage the transfer of energy conserving technology from researchers to practitioners.

Technology Transfer Program

The Technology Transfer Program is an educational program to facilitate the exchange of building technology among researchers and practitioners. Because most builders are small entities, they must rely on external sources for information. Developing a comprehensive program to assure the flow of research information from the government laboratory to the practitioner deserves greater attention. Such a program should not only present technical information on the thermal performance of various practices, but also develop and disseminate marketing tools and techniques. Builders' and other actors' acceptance of such a program may be very high if the program material is well developed and appropriate for their particular localities. Material for such a program is available from the BEPS program, HUD demonstration homes, DOE appropriate technology grants and many other sources.

Mass Media Campaign

A mass media campaign is suggested to provide the Americans with the needed focus to conserve energy. The facts of the country's historical energy use and the planet's resource limits to provide continuing supplies must be

presented in a factual, unbiased program to counteract conservation indifference. The mass media program is seen as a three-pronged effort to 1) focus the nation's attention, 2) motivate the citizenry, and 3) disseminate information.

The first task is to focus national attention on energy concerns. Largely because of inconsistency among information sources, Americans are unsure of the energy situation. An historical examination of U.S. fuel consumption and rate of resource discovery and depletion would most likely do much to indicate the uncertain energy future to Americans. This presentation by a credible team of respected scientists and engineers, backed by government officials, should provide a credible base upon which to build an energy conservation/education program. This initial effort should concentrate only on undisputed historical data. A series of prime time television documentaries might be appropriate. The promotion and preparation of these programs should be as professional as possible. To protect the program's credibility, controversial and uncertain areas should be avoided. Since the material must be as objective and unbiased as possible, use of an international multidisciplinary non-profit organization to prepare the material is suggested.

Energy Extension Service (EES)

Expansion of the EES is currently being recommended from a 10-state pilot program to a nationwide effort. Such an expansion could provide comprehensive presentation of energy information. The EES could be charged with providing monitoring for the Truth in Energy Act, local technology transfer programs, and local mass media outreach efforts. The effectiveness of the EES in the pilot program is well established. A large part of its effectiveness stems from its personal interface with the public. The national media program will serve to inform the public of services available and how to establish contact. Although the EES currently concentrates on retrofit activities, its scope could be easily increased to include information for new home buyers.

3.4 COSTS AND EFFECTIVENESS

Table 7 presents the estimated cost for each of the four information programs--Truth in Energy Act, Technology Transfer, Media Campaign, and Energy Extension Service. The estimates are preliminary and are intended to provide the reader with ballpark figures for comparative purposes only. Actual program costs may differ. The figures are in 1980 dollars.

Estimating the cost of a Truth in Energy Act is difficult because of the many ways the program could be developed and implemented. For our purposes, the program involves the development and validation of a home energy rating system to provide consumers, realtors, and lenders with information about the energy integrity of new buildings. DOE has already begun to develop the computer software for this task. We estimate an additional \$500,000 will be needed in staff and computer time to refine and validate existing software. We estimate an additional \$500,000 will be needed to disseminate the software to realtors or lenders. Total cost of this program is approximately \$1 million.

The cost of the mass media campaign depends upon the cost of TV time. It is unclear whether or not the networks would broadcast the energy series as a public service or as a commercial advertisement. We estimate a cost of \$1 million to produce and package a series of 10 short programs at ten minutes apiece. This assumes a production cost of approximately \$10,000 per minute. This cost is comparable with other government film productions. If network time is purchased at commercial rates of approximately \$50,000 a minute in prime time, TV time would cost approximately \$5 million.

The technology transfer program is estimated to cost approximately \$2 million annually. This estimate is based upon an expenditure of \$40,000 per state per year, which is sufficient funding to offer approximately 20 day-long seminars per year for building professionals. Overall supervision and administration of the program are provided by the EES.

The cost of expanding the EES to 50 states is estimated to be \$100 million, allowing an average of \$2 million per state. The services provided would be far-reaching and would include retrofit as well as new construction. For this estimation 50% of the budget is assumed to serve both purposes equally

(general education) with the remainder split between each end user. Thus, \$25 million is estimated to be the incremental cost of the EES providing new building construction services.

Thus, the total estimated costs of all four information programs are estimated to be approximately \$30 million, as shown in Table 7. The effectiveness is largely a function of the organization and professionalism of the informational program. Since the program will impact not only new construction practices but also general consumer attitudes toward conservation and general awareness of energy issues, a strict quantification of effectiveness is impossible. However, since the program will focus attention on the energy consumption of structures, analogous to the way EPA's fuel economy estimates affect car purchasing, a similar minimum of 20-25% efficiency increase can be expected. The educational program's impact on behavioral activities to conserve energy as well should be sufficient to increase efficiency in both design and use by approximately 50%. This level of energy savings possibly can be achieved by supporting self-adjusting market forces rather than additional governmental regulatory activity.

These estimates are rough. More analysis of these programs is required before the cost-effectiveness of these programs can be reliably determined.

TABLE 7. Informational Program Cost Estimates

<u>A. Truth in Energy Act</u>	<u>1000 K</u>
1. Developmental Research	500K
2. Implementation	500K
<u>B. Technology Transfer Program</u>	<u>2000 K</u>
1. Cost of Professional Time	
<u>C. Mass Media Campaign</u>	<u>1000-6000K</u>
1. Material Development	500K
2. Advertising, Presentations	500K
3. T.V. Time	(5000K) - possibly public service
<u>D. Energy Extension Service Expansion</u>	<u>25,000 K annually</u>
1. 2000K per State	
Total Cost	29,000-34,000 K

4.0 TAX INCENTIVES

Tax credits are a possible method for inducing individuals and firms to make energy-conserving investments in buildings. If tax credits are to be effective, the following conditions are necessary:

1. Economic considerations are a major factor in the decision to make the investment.
2. The investments to which the credit apply are clearly definable and the credit should primarily affect those investments that it is designed to affect.
3. The tax credit reduces the effective investment cost sufficiently to precipitate a decision to invest.

The influence of energy costs on choices related to conservation investments is uncertain. Some evidence indicates that consumers intuitively make purchases that are consistent with life-cycle cost minimization (Hausman 1979) but this has not been shown in buildings. The evidence of current building practice indicates that life-cycle cost-minimizing trade-offs of capital investment and energy consumption are more the exception than the rule. Costs related to the energy-conserving functions of building components and equipment may be difficult to differentiate from other costs, and nearly impossible in the case of passive solar techniques. In addition, tax credit availability for energy-conserving investment could lead building purchasers to respond to the decrease in effective capital cost, as well as in life-cycle costs, by increasing investment in other aspects of the building.

In the next section existing tax incentives related to energy conservation in buildings are described. The following section addresses estimation of the the tax credit that would be required to induce people to invest in energy-efficient housing. The limitations of the present information base are discussed as they affect estimation of tax credit requirements. Finally, the possible costs of a tax incentive program are presented.

4.1 EXISTING TAX INCENTIVES FOR ENERGY CONSERVATION

Prior to passage of the Energy Tax Act of 1978 (P.L. 95-618) neither significant tax incentives nor disincentives pertaining to energy conservation faced homeowners. Energy expenses were not deductible and capital investments were nondepreciable for private residences. The tax act changed this situation by allowing a tax credit for a portion of the capital cost of two kinds of investments in the taxpayer's principal residence:

1. energy conserving retrofit of structures built prior to April 20, 1977
2. property that permits use of either solar or wind energy in new or existing structures.

While this legislation affects renewable energy investments, it does not apply to conservation investments in newly constructed buildings. Senator Packwood of Oregon and others have proposed an amendment to the tax act that would extend the credit for renewable resource investment to other than principal residences and raise the maximum credit allowable from \$2200 to \$5000. This amendment does not apply to strictly energy conserving investment in new buildings.

None of the provisions of the Energy Tax Act of 1978 apply to conservation or renewable energy source use for space conditioning in new commercial buildings. Under the present tax code, the utility bills of a commercial building are a portion of business operating expenses and are deducted from gross income prior to tax computation. With a tax rate of almost 50% most businesses do not feel the impact of energy costs or conservation benefits as severely as homeowners do. One of the most effective ways to reduce energy consumption in the commercial sector might be to limit or eliminate the deductibility of energy expenses. However, such action is probably undesirable due to both economic and political impacts.

The existing tax code's incentives for energy consumption could be offset by increasing incentives for energy-conserving investment by firms. This change could be accomplished by extending the Investment Tax Credit to cover energy-conserving equipment and structural components of buildings or by

allowing rapid depreciation for such investments (OTA 1980). These types of tax incentives could be made to apply to those buildings that are designed to conform to BEPS. The major drawback to this approach lies in the difficulty of identifying those building cost components that are strictly related to energy conservation.

An alternative to tax credits for purchasers of energy-efficient structures' could be tax credits offered to builders to create a construction incentive for such buildings. In 1976 in California a tax credit that allows builders to claim a credit of the lesser of 10% of cost or \$1000 was instituted for solar energy devices (Bock 1977). Whether the builder's profits are increased by the tax credit or the credit is passed on as saving to the consumer depends on the elasticity demand for energy-efficient buildings. The amount of tax incentive required to stimulate builders to construct energy-efficient buildings depends on the complex set of market conditions that determine their costs and revenues. Information upon which to base calculation of the required incentive is lacking, as is information on the effectiveness of stimulating the energy conservation through tax credit presently available in California.

4.2 COSTS AND EFFECTIVENESS

To determine the costs and effectiveness of reaching energy conservation levels through a tax credit stimulus, several facts must be known:

1. the trade-off between capital investment and energy consumption for both residential and commercial buildings under a full range of climatic conditions
2. the rate of return on investment required by the homebuyer or firm for a decision to invest
3. the rate of return that the building owner can expect without tax credits, given local construction costs and fuel prices.

Because reliable information on investment and energy consumption trade-offs in commercial buildings is currently unavailable, the analysis is limited to the residential sector. A range of return rates on investment is considered

to approximate the range of investment opportunities at different risk levels that are generally available to individuals. Unfortunately, information that would allow analysis of the rates of return individuals can obtain under local climatic and price conditions has not yet been developed. As a result the following tax incentive estimates are for a sample of ten cities with a wide range of climatic conditions but are based on national average construction and fuel costs. Thus, the estimates can only be a rough indication of the tax credits required to achieve BEPS energy conservation levels in residences.

Table 8 presents estimated tax credits required to provide homeowners with 3, 5, and 10% real rates of return on conservation investment. These estimates are based on the 20% first cost increase plus the annual principal and interest payment increases that would result from the life-cycle cost-minimizing level of conservation investment. The purchaser is assumed to expect to own the home for five years and would not consider the effect of the investment on resale value.

One of the interesting findings of this analysis is that in most regions of the country the real rate of return to BEPS investment levels in electrically heated homes with average or higher electricity prices is greater than 20%. Since very few opportunities exist for individuals to obtain that high a real rate of return in alternative investments, it is most likely that a tax credit is not needed to increase individuals' tendencies to make such investments. Lack of cost and savings information may explain the amount of construction currently under way with less than optimal conservation investment.

Because natural gas prices are so much lower than electricity prices, more than 4 years is generally required for the fuel savings to affect the investment and show a positive rate of return. At a 5% real rate of return, which is higher than the rate currently available on long-term money market investments, the tax credit required ranges from \$24 to \$149. The amounts do not vary systematically with climatic severity because electricity prices are important in determining the optimal investment in climates with significant cooling loads. The average credit required in these ten cities is \$67 (see Table 8).

TABLE 8. Tax Credits Required to Give Building Owners Various Real Rates of Return on Conservation Investment Over a 5-Year Ownership Period

City	Fuel	Increased Down Payment \$	Increased Annual Capital Cost \$	Tax Credit for Each Rate of Return		
				3% \$	5% \$	10% \$
Minneapolis	Elec	231	47	0	0	0
	Gas	231	47	0	0	28
Chicago	Elec	239	49	0	0	0
	Gas	180	37	27	37	55
Portland	Elec	269	55	0	0	0
	Gas	210	43	101	107	121
Washington, DC	Elec	129	49	0	0	0
	Gas	180	37	90	96	107
Atlanta	Elec	286	38	0	0	0
	Gas	181	37	36	44	62
Fresno	Elec	256	52	0	0	0
	Gas	170	35	28	36	53
Burbank	Elec	152	31	0	0	0
	Gas	76	16	78	78	78
Phoenix	Elec	256	52	0	0	17
	Gas	256	52	143	149	163
Houston	Elec	256	52	0	0	0
	Gas	104	21	19	24	34
Fort worth	Elec	256	52	0	0	0
	Gas	256	52	94	103	123

NOTE: Tax credit estimates are based on EIA price projections Federal Register, April 30, 1979. Capital cost estimates are based on the Economic Analysis (PNL 1979).

The value of foregone tax revenues, which would result from allowing a tax credit for all new residences (equal to the average amount necessary to provide a 5% real rate of return on investment in gas-heated homes), is shown in Table 9. If the credit applied solely to the 40% of new homes that are gas-heated and only 80% of purchasers took advantage of the credit, the value of tax revenues lost in 1980 would be about \$26 million. This loss would result in energy savings of 4.7×10^{12} Btu due to the tax credit, at a cost of $\$1 \times 10^{-5}$ per Btu saved. Application of the tax credit only to gas-heated residences assumes that electricity costs are sufficient incentives for conservation in all-electric homes.

Unpublished information provided by the Internal Revenue Service (IRS) indicates that 11% of individual taxpayers availed themselves of the tax credit for residential retrofit expense (IRS 1979). The total value of credits allowed was over \$570 million. Since the tax credit was made available just shortly before the end of 1978, the response cannot be taken as a true indication of the credit's impact on conservation investment. Therefore, no empirical basis exists for an estimate of tax credit effectiveness in stimulating energy-conserving investments.

TABLE 9. Cost Estimates of Tax Incentives for All Single-Family Residences (in 1978 Dollars)

<u>Year</u>	<u>Annual Additions to Housing Stock, M</u>	<u>x \$167</u>	<u>Cost of Tax Credit, M</u>
1980	1.19		79.7
1985	1.13		75.7
1990	1.09		73.0
1995	1.03		69.0
2000	0.99		66.3

Source: Isakson and Haney 1977.

5.0 MORTGAGE AND FINANCE PROGRAMS

To outline and assess the Mortgage and Financing Provisions presented in this chapter, a brief review of the real-estate financing process is necessary. The major actors in this process are: 1) lenders, 2) regulators, 3) appraisers, 4) builders, and 5) consumers. These actors interact through a complex web of exchanges that ultimately determine the location, type, quality, energy-efficiency and price of new building construction. The federal government's role in this process is crucial and will be discussed as it applies to each actor's activities.

5.1 THE FEDERAL ROLE IN THE REAL ESTATE FINANCING PROCESS

Lenders, probably the most important actors in the mortgage market, can be conveniently divided into three major groups: 1) those who originate loans and operate in the primary mortgage market 2) those who purchase mortgages in the secondary mortgage market for portfolio investment 3) federal government agencies.

The first group of lenders includes savings and loan associations, commercial banks, mutual savings banks, and mortgage companies. Of these, savings and loan associations handle the most significant volume of mortgages. In 1978, savings and loans held 37% of the total outstanding mortgage debt, including 46% of residential mortgages and 18% of commercial mortgages. Commercial banks, next in significance, held 18.5% of total outstanding mortgage debt in 1975, including 16% of residential mortgages and 30% of commercial mortgages (U.S. Department of Commerce 1979).

The second group of lenders includes life insurance companies, private pension funds, public retirement funds, and real estate investment trusts. Of these, life insurance companies are the most significant. In 1978 they held 12% of total outstanding mortgage debt, including 29% of commercial mortgages and 7% of residential mortgages (U.S. Department of Commerce 1979).

The third group of lenders, federal agencies, participates in both primary and secondary mortgage markets. Two active participants in the secondary

mortgage market are the Federal National Mortgage Association (FNMA, commonly called Fannie Mae) and the Federal Home Loan Mortgage Corporation (FHLMC, commonly called Freddie Mac).

The FNMA is a privately owned but federally sponsored credit agency, which borrows funds to purchase mortgages primarily from mortgage bankers. Most of FNMA's purchases are FHA insured - VA guaranteed mortgages.

The FHLMC is owned by the Federal Home Loan Bank Board and was established in 1970 to aid FNMA in developing the secondary mortgage market. The FHLMC primarily purchases conventional mortgages, most of which were originated by saving and loan associations.

Federal activity in the secondary mortgage market began in 1938 when Congress established FNMA. Over the years, FNMA and FHLMC have helped to establish purchase procedures to demonstrate that mortgages can be successfully bought and sold in the secondary market; they have provided needed liquidity to the market at critical times and have increased the total money flow to mortgage markets.

A third federally sponsored credit agency is the Government National Mortgage Association (GNMA, commonly called Ginnie Mae). The GNMA is part of the Department of Housing and Urban Development (HUD) and purchases mortgages originated in HUD's subsidy programs. It also guarantees certificates, which represent pools of mortgages and are sold to investors.

Other agencies involved in mortgage markets include the Federal Housing Administration (FHA) and the Veterans Administration (VA). The FHA insures and the VA guarantees mortgages originated by other lenders. The Farmers Home Administration lends money directly, but primarily to low income, rural residents. The Federal Loan Banks also lend money directly and are a major source of farm mortgage loans.

Government regulators comprise the second group of actors in the real estate financing process. Each of the lenders discussed above, including the

(a) For a more detailed account of federal secondary mortgage market activity, see Isakson and Haney 1977.

federal agencies, is subject to regulation by local, state, and federal entities. For instance, federally chartered saving and loan associations are under the jurisdiction of the Federal Home Loan Bank Board, which also oversees FHLMC. State chartered banks, insurance companies, and mortgage companies are generally regulated by state commissions.

The federally sponsored credit agencies are under the jurisdiction of the following entities. FHLMC is directed by the Federal Home Loan Bank Board, and FNMA, FHA and GNMA are under the regulation of HUD's Secretary, perhaps the most significant federal regulator, particularly of housing. This supervision gives the Secretary jurisdiction over the Minimum Property Standards (MPS), which are promulgated by FHA and have substantially influenced building construction. In addition to being regulated, these agencies also serve as quasi-regulators. For example, the appraisal report sheets and underwriting guidelines used by FHLMC and FNMA have been influential in standardizing these procedures throughout the mortgage industry.

Real Estate Appraisers comprise the third important actor group in the real estate financing process. Whenever a mortgage loan is originated, an appraisal is required. Depending on which is lower, lenders are required to loan a particular percentage of the sales value or appraised value of a real estate property. Consequently, appraisers exert strong influence on the economics of mortgage loans. The greater the extent to which appraisers include buildings' energy efficiency in their calculations, the more likely are consumers and lenders to take those buildings' life-cycle costs into account, which should increase the propensity to invest in energy-saving materials and equipment.

Appraisers are real estate professionals who can work as private consultants, serve on the staff of lending institutions, or work for the federal government. Clearly, any federal policies aimed at reducing the energy consumption of new buildings must include provisions to either educate appraisers or induce them to take energy conservation into account.

Builders and consumers, the last two actors, have relatively straightforward roles in the real estate financing process. Builders must interact with designers and architects to construct and offer new buildings for sale.

Builders purchase materials, appliances, heating equipment, etc. - energy-efficient or otherwise - to meet consumer demands.

Figure 1 broadly illustrates the range of interactions among these major actors. This figure and the preceding discussion greatly oversimplify a complex network of exchange and decision making. Other federal policy making activities (notably fiscal and monetary policy) can affect the real estate financing process directly. Consequently, extreme care must be taken in formulating policies aimed at one aspect of this complex financing process - namely improving the energy-efficiency of new residential and commercial buildings.

FIGURE 1. Major Actors In Real Estate

Source: Isakson and Haney 1977, p. 29.

5.2 EXISTING PROGRAMS

Part 3 of the National Energy Conservation Policy Act, P.L. 95-619, (NECPA) concerns secondary financing and loan insurance for energy-conserving improvements and solar energy systems added to existing housing. Through their mortgage market activities FNMA and GNMA were given authority to insure such loans and GNMA was given standby authority to purchase loans for energy-conserving improvements. Also, FHLMC and FNMA were instructed to provide secondary financing for these loans.

In addition, mortgage limits for housing built or retrofitted with solar energy systems were increased by up to 20%. Specifically, FHA was authorized to increase up to 20% the amount by which it insures loans to cover a residence's increased cost due to the installation of solar energy systems.

While most of the above provisions apply to retrofitting existing buildings, they can be easily extended to either new housing or new commercial construction. If GNMA, FNMA, and FHLMC were authorized to guarantee, insure, or purchase mortgages for energy-efficient buildings, thus improving the secondary market for such loans, an incentive for constructing energy-efficient buildings would be established.

Also, the provision that increased FHA Mortgage limits by up to 20% could easily be extended to other energy-conserving improvements like passive solar design, triple-pane windows, or increased insulation. One problem, however, concerns establishing an acceptable methodology for evaluating the extent to which energy-conserving improvements add to property value. If federal mortgage market activities are to be effectively used for conserving energy in new building construction, then tractable definitions of the market value of energy-efficient features must be developed, adding considerably to the costs of implementing such policies.

A second set of mortgage and finance provisions exists in DOE's Financing and Real Estate programs (FRE). The centerpiece of this effort is training seminars directed at real estate brokers and appraisers through their national

associations (i.e., The National Association of Real Estate Brokers and the Society of Real Estate Appraisers). Future programs are planned for bankers, realtors and credit unions.

Another FRE activity is a federal assistance program designed to improve energy conservation awareness within the federal agencies dealing with the real estate market. Through this program, DOE has provided FNMA and FHLMC with assistance concerning the energy conservation impacts of their activities.

A third FRE activity concerns innovative financing methods. This program is being developed in cooperation with various local groups to provide consumers with convenient financing for energy-conserving improvements and energy-efficient new construction. According to DOE, (1979, pp. 12-13) pilot programs based on a home improvement loan program implemented in Minneapolis - St. Paul are planned for Atlanta and San Antonio. In this latter program, residents were encouraged to seek advice on the economics of financing energy conserving home improvements from 14 participating saving and loans and banks. The Minnesota Energy Agency and the Minnesota Housing Finance Agency (MHFA) also participated in the program; MHFA allocated \$5 million to subsidize loans at interest rates between 1 and 8% to low and moderate income homeowners.

While each of the above FRE activities should eventually lead to energy savings, the process will be slow. Because most of the programs have been instituted recently, sufficient evidence is not available to assess their effectiveness.

A final set of existing policies involves recent activities undertaken by the FHLMC and FNMA. Steps have been taken to revise appraisal reports sheets to include the energy-consuming characteristics of residential housing. Figure 2 is FHLMC's revised appraisal report sheet, which was issued in July, 1979. The revisions include questions that delineate the extent of insulation, its quality, the value it adds to the home and its value relative to other homes on the market.

Another recent change by FNMA and FHLMC concerns mortgage underwriting practices. A typical rule-of-thumb in use by lenders for evaluating loan applications requires monthly housing expense-to-income ratios to be about 25%.

RESIDENTIAL APPRAISAL REPORT

File No.

	Borrower	Census Tract	Map Reference	
To be completed by Lender	Property Address City _____ State _____ Zip Code _____	County _____		
	Legal Description Sale Price \$ _____ Date of Sale _____ Loan Term _____ yrs Property Rights Appraised ☐ Fee ☐ Leasehold ☐ De Minimis PUD			
	Actual Real Estate Taxes \$ _____ 1st Lien charges to be paid by seller \$ _____ Other sales concessions _____			
	Lender Count _____	Address _____		
	Appraiser _____	Instructions to Appraiser _____		
NEIGHBORHOOD	Location _____ Urban Suburban Rural _____ Good Avg. Fair Poor _____			
	Built Up _____ Over 25% _____ Under 25% _____			
	Growth Rate _____ Fast Slow _____			
	Property Values _____ Increasing Stable Declining _____			
	Demand Supply _____ Shortage Over Supply _____			
	Marketing Time _____ Under 6 Mos. 4 - 6 Mos. Over 6 Mos. _____			
	Present Land Use _____ 1 Family _____ 2-4 Family _____ Apts _____ Condo _____ Commercial _____			
	_____ Industrial _____ Vacant _____			
	Change in Present Land Use _____ Not Likely _____ Likely (Y) _____ Taking Place (N) _____			
	Planned Development _____ City Plan _____ Town _____ Village _____			
SITE	Foundation Condition _____ Single Family Price Range \$ _____ to \$ _____ Per Sq Ft _____ Predominant Value \$ _____			
	Single Family Age _____ yrs to _____ Predominant Age _____ yrs			
	Note: FHLMC/FNMA do not consider race or the racial composition of the neighborhood to be reliable appraisal factors. Comments including those factors, favorable or unfavorable, affecting marketability (e.g., public parks, schools, view, noise)			
	Diagrams _____	Sq Ft or Acres _____ Corner Lot _____		
	Zoning classification _____ Highest and best use _____ Present use _____ Other (specify) _____	Present improvements _____ do not conform to zoning regulations _____		
	Other (Describe) _____			
	Free _____ Street Access _____ Public _____ Private _____			
	Tax _____ Surface _____			
	Water _____ Maintenance _____ Public _____ Private _____			
	San Sewer _____ Storm Sewer _____ Curb Light _____ Drainage _____			
Underground Flt & Tol _____ Subway _____ Street Lights _____				
Is the property located in a HUD identified Special Flood Hazard Area? ☐ No ☐ Yes				
Comments: Favorable or unfavorable conditions having any apparent effect on opportunity, encumbrances or other adverse conditions				
IMPROVEMENTS	Existing _____ Proposed _____ Under Constr. _____ Not Units _____	Type, dist, cuplet, semi-det, etc. / Design (cottage, split level, etc.)	Exterior Walls _____	
	Yrs. Ago Actual _____ Effective _____	No. Stories _____		
	Floor Material _____ Tiles & Underpinning _____ None _____ Window Type _____	Stairs Stair _____ Screen _____ Combination _____	Insulation _____ None _____ Floor _____ Walls _____	
	Manufactured Housing _____ Basement _____	Door Draft _____ Finished Ceiling _____		
	Foundation Walls _____ Outside Entrance _____ Sump Pump _____	Finished Walls _____		
	Concrete Foundation _____ Concrete Slab _____	Finished Floor _____		
	Status on Grade _____ Level Space _____ Evidence of _____ Dampness _____ Termites _____ Settlement _____			
	Comments _____			
	ROOM LIST	Kitchen _____ Living _____ Dining _____ Kitchen _____ Den _____ Family Rm _____	Hv. Hrs _____ Bedrooms _____ No. Baths _____ Laundry _____ Other _____	
		Bathroom _____		
Toilet Room _____				
Bed Room _____				
Finished area above grade contains a total of _____ rooms _____ bedrooms _____		Baths _____ Unfinished Area _____	Sq Ft Built Area _____ Sq Ft _____	
Kitchen Equipment _____ Refrigerator _____ Dishwasher _____		Jan. Closet _____ Change Rm _____ Washer _____ Dryer _____	Adequate _____ Inadequate _____	Good Avg. Fair Poor _____
HEAT Type _____ Fuel _____		Central _____ Other _____		
Floors _____ Hardwood _____ Carpet _____				
Walls _____ Drywall _____ Plaster _____				
Room Finish _____ Carpet _____ Average _____ Fair _____ Poor _____				
INTERIOR FINISH & EQUIPMENT	Bath Floor _____ Ceramic _____			
	Bath Wall/Ceil _____ Ceramic _____			
	Special Features (including energy efficient items) _____			
	ATTIC _____ Yes _____ No _____	Storage _____ Drop Star _____ Seattle _____		
	Finishes (Describe) _____	Finished _____ Matted _____		
	CAR STORAGE _____ Garage _____ Busin. _____ Attached _____ Detached _____	Car Port _____		
	No Cars _____ Adequate _____ Inadequate _____ Condition _____			
	PROPERTY RATING			
	Quantity of Construction (Materials & Finish) _____			
	Condition of Improvements _____			
Room sizes and layout _____				
Closets and Storage _____				
Insulation adequacy _____				
Humidity, adequacy and condition _____				
Fireplaces, adequacy and condition _____				
Kitchen Cabinets, adequacy and condition _____				
Compat. ability to Neighborhood _____				
Durability, reliability _____				
Appeal and Marketability _____				
Yrs Est. Remaining Economic Life _____ to _____ Exp. ann if less than Loan Term _____				
FIREPLACES, PATIOS, POOL, FENCES, etc. (describe) _____				
COMMENTS: Including Note Final re physical inadequacies, repairs needed, modernization, etc. _____				

VALUATION SECTION

Purpose of Appraisal is to estimate Market Value as defined in Certification & Statement of Limiting Conditions (FHLMC Form 439/FNMA Form 1004B) If submitted for FNMA, the appraiser must attach (1) sketch or map showing location of subject, street names, distance from nearest intersection, and any detrimental conditions and (2) exterior building sketch of improvements showing dimensions.

Measurements	No. Stories	Sq. Ft.	ESTIMATED REPRODUCTION COST	NEW	OF IMPROVEMENTS
✓	✓	✓	Dwelling	Sq. Ft. @ \$	\$
✓	✓	✓	Extras	Sq. Ft. @ \$	\$
✓	✓	✓	Special Energy Efficient Items		
✓	✓	✓	Porches, Patios, etc.		
✓	✓	✓	Garage/Car Port.	Sq. Ft. @ \$	\$
✓	✓	✓	Site Improvements (Driveway, Landscaping, etc.)		
Total Gross Living Area (List in Market Data Analysis below)			Total Estimated Cost New		\$
Comment on functional and economic obsolescence			Less Physical	Functional	Economic
			Depreciation \$	\$	\$
			Depreciated value of improvements		\$
			ESTIMATED LAND VALUE		\$
			(If leasehold, show only leasehold value)		\$
			INDICATED VALUE BY COST APPROACH		\$

The undersigned has received three recent sales of properties most similar and proximate to subject and has considered these in the market analysis. The description includes a dollar adjustment reflecting market reaction to those items of significant variation between the subject and comparable properties. If a significant item in the comparable property is superior to, or more favorable than, the subject property, a minus (\$) adjustment is made, thus reducing the indicated value of subject. If a significant item in the comparable is inferior to, or less favorable than, the subject property, a plus (\$) adjustment is made, thus increasing the indicated value of the subject.

ITEM	Subject Property	COMPARABLE NO. 1	COMPARABLE NO. 2	COMPARABLE NO. 3
Address				
Proximity to Subj.				
Sales Price	\$	\$	\$	\$
Price/Living area	\$	\$	\$	\$
Date Source				
Date of Sale and Time Adjustment				
Location				
Site/View				
Design and Appeal				
Quality of Const.				
Age				
Condition				
Living Area Room	Total B-rms., Baths	Total B-rms., Baths	Total B-rms., Baths	Total B-rms., Baths
Count and Total				
Gross Living Area	Sq. Ft.	Sq. Ft.	Sq. Ft.	Sq. Ft.
Basement & Bani				
Finished Rooms				
Functional Utility				
Air Conditioning				
Garage/Car Port				
Porches, Patios, Pools, etc.				
Special Energy Efficient Items				
Other (e.g., fire places, kitchen equip., remodeling)				
Sales or Financing Concessions				
Net Adj. (Total)	Plus Minus \$	Plus Minus \$	Plus Minus \$	Plus Minus \$
Indicated Value of Subject	\$	\$	\$	\$
Comments on Market Data				

INDICATED VALUE BY MARKET DATA APPROACH \$

INDICATED VALUE BY INCOME APPROACH (If applicable) Economic Market Rent \$ Multiplier Gross Rent Multiplier \$

This appraisal is made as of the date of the subject to the square, alterations, or conditions listed below completion per plans and specifications.

Comments and Conditions of Appraisal

Final Reconciliation

Construction Warranty () Yes () No Name of Warranty Program Warranty Coverage Expires

This appraisal is based upon the above requirements, the certification, contingent and limiting conditions, and Market Value definition that are stated in FHLMC Form 439 (Rev. 10-78) FNMA Form 1004B (Rev. 10-78) filed with a true and correct copy of this appraisal attached.

ESTIMATE THE MARKET VALUE, AS DEFINED, OF SUBJECT PROPERTY AS OF 19 to be \$

Appraiser(s) Review Appraiser (If applicable) Did Not Physically Inspect Property

FIGURE 2. FHLMC's Revised Appraisal Report Sheet

Source: U. S. Government Federal Home Loan Mortgage Corporation 1979.

If the sum of monthly principal, interest, taxes, and insurance payments (PITI) exceeds 25%, then the lender views the prospective homebuyer as likely to default on the mortgage.

In March 1979, FNMA and FHLMC announced an increase to about 33% in rule-of-thumb expense-to-income ratios for energy-efficient homes. This move was designed to encourage lenders to consider the fact that energy-efficient homes have higher first-costs than conventional homes. If energy expenses and life-cycle costs are not explicitly included in loan evaluations, then changes in expense-to-income ratios are one way to equalize the first-cost difference between energy-efficient and conventional homes.

However, a workable definition of what constitutes an energy-efficient home is required for many of the above-mentioned policies to be effective. This requirement creates difficulties because regional variation in prices, climate, and construction practices make defining an energy-efficient home difficult. One alternative is for lenders to develop their own definitions. Currently, FNMA is seeking to hire a "high-level" energy specialist to help formulate such a definition. Unless these definitions are developed with regional climatic and energy-price differences in mind, their acceptance cannot be insured in the market place.

5.3 PROPOSED PROGRAMS

The following proposed policies are intended to offer a broad range of alternative federal actions. While some proposed policies may seem slightly irrelevant, they are presented to give the reader a sense of the broad range of opinion in the literature.

A bill currently receiving active consideration by the House Banking Committee calls for the creation of a solar bank. As proposed, the bank could either subsidize interest on loans and mortgages made by private lenders or directly reimburse a portion of the principal to lenders. Because the legislative intent is to promote solar energy use in houses, apartments, and commercial buildings and to conserve energy, the banks' charter should be able to be revised to include other energy-conserving improvements.

A frequently mentioned proposal, commonly referred to as PITI + U, includes utility costs in calculation of expense-to-income ratios by lenders.^(a) By including energy costs in the calculation of monthly housing expenses, a more realistic assessment of mortgage eligibility can be made. For example, if a conventional home and a highly insulated home are identical in all respects (i.e., location, neighborhood, public services, etc.) except energy efficiency, then first-costs are likely to be higher and life-cycle costs lower for the energy-efficient home. Rational lenders will therefore find purchasers of energy-efficient property a better risk and less likely to default on their mortgage payments.

A similar proposal calls for a decrease in the percentage of downpayment required for energy-efficient homes. Energy-efficient homes, all factors equal, will tend to have higher first costs than conventional homes. If a 20% downpayment is required for both, then homebuyers of energy-efficient properties will be penalized. However, if purchasers of energy-efficient properties are allowed a lower percentage downpayment, the penalty can be softened.

Another proposal calls for direct federal interest rate subsidies to purchasers of energy-efficient properties. The impacts of this policy depend upon whether first costs or life-cycle costs are the prime consideration in purchasing a property. All factors equal, the consumer will purchase a \$60,000 home before a \$62,000 home. However, going back to the example,^(b) if the second home is energy-efficient, then costs over the house's lifetime may be less.

If homebuyers are assumed to be mainly concerned with first costs, since life-cycle savings may not be apparent for several years, (depending on the payback period for the energy conserving improvements,) then the federal loan subsidy should be large enough to offset the higher first costs of energy-efficient properties, thus equalizing the monthly payments between the two homes (see Table 16). However, if homebuyers are assumed to be mainly

(a) This policy is a more direct method to achieve the result sought by FNMA and FHLMC when they revised their underwriting guidelines.

(b) A numerical example is presented in detail in Section 4.4, Table 15.

concerned with life-cycle costs, then energy-efficient homes, all other factors equal, will be less expensive than conventional homes. Therefore, a loan subsidy program will not have as strong an impact on purchase decisions.

Another proposal calls for giving priority to those FHA/VA applications that involve energy-efficient properties. Again, a critical requirement for implementing this proposal is a tractable definition of an "energy-efficient home." Also, to be most effective, this priority system would have to be rigidly enforced at each step of the FHA/VA application process.

Other proposals call for HUD to expand several of its programs to include incentives for energy-conserving improvements. For example, low-income housing programs like the Community Block Grant Program, the Home Improvement Loan Program, or the Experimental Housing Program could include energy-conservation provisions (OTA 1980, p. VIII-7 to VIII-28).

The Veterans Administration has no formal system for promoting energy conservation in its home loan guarantee programs. Because they follow HUD's MPS, any initiatives to increase the energy efficiency of the properties they guarantee is HUD's responsibility. However, because VA guaranteed mortgages are already heavily subsidized, a great opportunity to subsidize energy efficiency does not appear to exist here.

5.4 COSTS AND EFFECTIVENESS

The mortgage and finance provisions cost-effectiveness assessment has two parts. The first part is an overall assessment of the provisions' probable effectiveness, based upon information from a literature search. The second part is a more detailed analysis of the most promising provisions in direct comparison to BFPS.

Note that these assessments are preliminary. While a literature search did reveal several sources of information, most of the policies reviewed have not been in effect long enough to allow data collection and analysis. Consequently, the overall analysis is primarily qualitative.

This lack of data severely constrained the more detailed assessment of specific provisions presented in the second part of this section. To derive

quantitative measures of effectiveness, several simplifying assumptions were made. Given these assumptions, the results presented are useful only for comparative purposes and are not comprehensive estimates of actual costs and energy savings.

Not only does little cost and effectiveness information exist about the policies under study, but data concerning recent building construction practices are scarce also. To accurately determine the costs and effectiveness of these mortgage and finance provisions, or any nonregulatory strategy in comparison to BEPS, more information about recent builder, lender, and consumer activities is required. Recent surveys indicate that both the supply of and demand for energy-efficient buildings have steadily increased since 1976 (Professional Builder 1978), but the underlying factors that cause this trend have yet to be quantified. Until this process is more clearly understood, assessment of the cost-effectiveness of nonregulatory alternatives to BEPS can at best be only a rough approximation.

Overall Assessment

In this section several relevant studies are summarized and their results are used to assess the mortgage and finance provisions presented in the previous section. The best information on the probable effectiveness of these provisions comes from a 1977 report entitled "Lender Impacts Upon Energy Conservation in Buildings, Development and Assessment of Alternative Government Actions," (Isakson and Haney). Isakson and Haney surveyed 1700 lenders for opinions concerning alternative federal policies. Table 10 summarizes the results of that survey and clearly indicates that education and information programs consistently received favorable ratings. In fact, the study's authors concluded that lenders generally were most receptive to policies that required the least government interference. The most highly rated policy called for including energy costs when calculating expense-to-income ratios. This provision is examined in detail in the second part of this section.

While lender opinions are important, knowing how quickly policies will be adopted once enacted may be more important. Table 11 summarizes likely penetration rates for four of the fourteen policies listed in Table 10. These

TABLE 10. Lender Opinions Concerning Elements of Alternative Government Actions^(a)

	<u>Element</u>	<u>Mean Response</u> ^(b)
1	Include utility costs when calculating PITI ratio ^(c)	2.121
2	General education of borrowers ^(c)	2.209
3	Education of lenders ^(c)	2.242
4	Appraisal forms recognize energy efficiency ^(c)	2.687
5	Energy standards in local building codes	2.680
6	Lenders educate borrowers	3.059
7	Energy standards on loans sold to FNMA and FHLMC ^(c)	3.751
8	Government insurance or guarantee ^(c)	3.816
9	Energy standards on all loans with government guarantee or insurance	3.861
10	Interest rate subsidy to lender ^(c)	4.207
11	Government guarantee on state-approved loans	4.293
12	Subsidy to borrowers through lenders	4.518
13	Lump sum subsidy to lender	4.653
14	Allocate credit to energy-efficient loans	4.846

(a) SOURCE: Isakson and Haney 1977, p. xii, Table 1.

(b) Ranked on a scale of 1 to 6 where 1 represents "definitely agree" and 6 represents "definitely disagree."

(c) Included in the list of proposed or existing policies.

TABLE 11. The Overall Effectiveness of Each Recommended Government Action

<u>Recommended Government Action</u>	<u>% Permanent Real Estate Loans Affected Each Year</u>	
Furnish Lenders with Energy Information	46.6	(15 to 90)(a)
Include Utility Costs in Expense-to-Income Tests	40.6	(5 to 50)
FHA/VA Processing Priority	25.0	(5 to 50)
Federal Tax Credit/Guarantee	44.4	(5 to 50)

(a) Figures in parentheses represent the range of responses.

Source: Isakson and Haney 1978, p. 130, Table VII-4.

rates were calculated by Isakson and Haney through a series of in-depth group interviews with lenders from all over the U.S.

Isakson and Haney use these penetration rates in combination with an econometric forecast of housing starts^(a) and a multiple regression equation to estimate the impact of four federal actions upon loan activity. Table 12 summarizes their results for single-family houses.

Comparing the first four columns in Table 12 with the fifth column illustrates the potential impact of federal action in this area. Under each of the four federal policies, dramatic increases in loans made for energy-efficient homes are realized. Those increases seem to demonstrate that when the surveys were done in 1976, lenders were generally ignorant of the effects of energy conservation policies on real estate market activities. Otherwise, the differences between columns one through four and column five would have been so dramatic.

Another study that was useful for making an overall assessment of federal mortgage and finance policies is entitled "Methodology to Measure the Impact

(a) This forecast was performed by Wharton Econometric Forecasting Inc. and is also used in the second part of this section.

TABLE 12. Impact of Recommended Government Actions (If Initiated Individually Second Quarter, 1977) Upon Long-Term Single-Family Loan Originations (amounts in thousands)

Loans Made on Energy-Efficient Homes Under:

Year	Quarter	1(a)	2(b)	3(c)	4(d)	None
1976	3	\$ 1,213	\$ 1,213	\$ 1,213	\$ 1,213	\$1,213
	4	1,060	1,060	1,060	1,060	1,060
1977	1	1,150	1,150	1,150	1,150	1,150
	2	1,991*	1,991*	1,991*	1,991*	1,991
	3	1,906	1,906	2,788**	1,906	1,906
	4	1,690	5,548**	5,522	1,690	1,690
1978	1	1,722	8,047	7,469***	1,722	1,722
	2	5,029**	15,221***	11,416	2,699	2,699
	3	7,127	19,788	18,779	5,479**	2,110
	4	7,046	20,782****	18,556	5,557	1,850
1979	1	8,424		19,637****	7,846	1,862
	2	13,274			26,316***	2,894
	3	12,485***			26,991****	2,604
	4	18,372				2,239
1980	1	21,458****				2,233

Source: Isakson and Haney 1977, p. 148, Table VIII-7.

- (a) Furnish lenders with relevant energy information.
- (b) Change all expense-to-income tests of credit worthiness to include utility costs.
- (c) Applications on energy-efficient properties processed by FHA/VA before all other (energy-inefficient properties) applications.
- (d) Federal income tax credits for all losses on foreclosures associated with loans on energy-efficient buildings.

Recommendations:

- *initiated.
- **begins to take effect.
- ***reaches full effect.
- ****impacts over 75% of originations.

of Rising Energy Related Household Costs on Single-Family Residential Mortgage Activity: Application to Nine SMSAs" (Booz, Allen and Hamilton 1977). The authors of this study used FEA energy cost projections to model the impact of rising energy costs on mortgage default rates, presented in Table 13.

The results seem to indicate that rising energy costs will significantly affect mortgage default rates. Column 4 of Table 13 also seems to indicate that some form of federal policy can lessen that impact, although not significantly. Determining the effects of each mortgage and finance provision considered on mortgage default rates would be very useful. Analysis of BEPS and several nonregulatory alternative policies for impacts on mortgage default rates may be an area for future research.

Figure 3 is useful for this overall analysis because it lists average expense-to-income ratios for the past nine years. The table clearly indicates that lenders have adjusted to rising housing costs and interest rates by allowing PITI ratios to increase, primarily in response to general inflationary conditions, not rising energy costs. In fact, the Washington Post reported

TABLE 13. Incremental Default Rates Related to Cost Increases
- Percent of 1975 Mortgagor Population-

<u>SMSA</u>	<u>Scenario I</u>	<u>Scenario II</u>	<u>Scenario II with Retrofit Standards</u>	<u>Historical Experience Default Rate (%)</u>
Atlanta	3.3	5.6	5.4	0.7
Baltimore	0.1	0.7	0.4	0.2
Boston	0.2	0.7	0.6	0.3
Buffalo	0.5	1.7	1.3	0.1
Chicago	1.5	2.7	2.6	1.0
Dallas	9.7	12.4	12.1	0.8
Detroit	1.5	2.4	2.3	0.6
Los Angeles	0.7	1.3	1.2	0.7
Philadelphia	5.6	8.6	8.3	0.4

SOURCE: Booz, Allen and Hamilton, Inc. 1977, p. VI-7, Table VI-2.

FIGURE 3. Average Expense-To-Income Ratios

*Source: Washington Post September 16, 1979, p. C-6. Data Resources Inc.

that if utility charges are considered, the 1978 average percentage is nearly 50% of income in the Washington D.C. area (Hausman 1979).

In light of this increase in PITI ratio, the recent changes in underwriting guidelines introduced by FNMA and FHLMC are likely to have little impact. By increasing the typical expense-to-income ratio from 25% to 33%, FNMA and FHLMC have done little more than to keep up with inflation in construction costs relative to other costs. In fact, a closer examination of these secondary mortgage market activities was rejected for this study on that basis.

In the following section, the costs and effectiveness of two of the more promising provisions presented previously are estimated and compared directly to BEPS. One provision calls for changing expense-to-income tests of credit

worthiness to include energy costs (commonly called PITI + U). The other provision offers mortgage rate subsidies - perhaps through a "solar bank" - to purchasers of energy-efficient properties.

A common basis for assessing and comparing these policies was established by making several simplifying assumptions. As a result, the estimates presented in Tables 14, 15, and 16 are for comparative purposes only and are not intended to be estimates of future conditions.

In Table 14 an energy-efficient home is compared to a conventional home on a cost basis. The energy-efficient home is defined on the basis of minimized life-cycle costs (PNL 1979, pp. 6.25-6.28).^(a) If consumers, builders

TABLE 14. Comparison of Conventional Home with an Energy-Efficient Home^(a) (1978 dollars)

	Conventional Home	Energy Efficient Home ^(b)
Sales Price	\$60,000	\$61,500
Down Payment	20%	20%
Mortgage Rate (real)	3%	3%
Taxes Plus Insurance (per year)	2% of sales price	2% of sales price
Mortgage Period	30 years	30 years
Monthly Payment (PITI)	\$301.87	\$309.41
Monthly Energy Costs	\$50.00	\$37.77
Monthly Expenses (PITI+U)	\$351.87	\$345.22
Life-Cycle Costs	\$109,892.85	\$107,289.20

(a) Homes identical in every respect except energy efficiency.

(b) A home that meets the BEPS data average for ten U.S. cities and applies only to electrically heated homes.

Source: Pacific Northwest Laboratory 1979, p. 6.25-6.28, and Tables A.11 and A.12.

(a) Any home that is built to minimize life-cycle costs is by definition consistent with BEPS.

TABLE 15. Building Starts and Loan Origination Projections
for Single-Family Residences (1978-1981)(a)

	<u>Starts</u>	<u>Loan Originations(b)</u>
1978	988,700	\$47,000,000,000
1979	904,200	43,000,000,000
1980	902,500	43,000,000,000
1981	1,090,600	52,000,000,000

(a) Projections were made in 1976 and are used here for comparative purposes only.

(b) Loan origination estimates are based on the assumption that the average home sells for \$60,000 and has an 80% mortgage.

Source: "Lender Impacts Upon Energy Conservation in Buildings, Development and Assessment of Alternative Government Actions." 1971, Table VIII-2.

and lenders base their home buying/building decision on first costs, then the conventional home will be built, financed, and sold. The sales price is lower; the downpayment is lower; taxes and insurance are lower, and monthly payments are lower.

However, in this example once energy costs are considered, the decision changes. Monthly expenses and life-cycle costs are lower for the energy-efficient home. If lenders and consumers are made aware of energy costs, builders must respond to the demand for energy-efficient buildings.

To evaluate a loan subsidy, Table 14 must be examined in a different way. In particular, life-cycle costs are ignored and the question of what mortgage rate will equalize the monthly payments for a conventional home and an energy-efficient home is asked. This rate can be solved for using standard cash-flow analysis techniques. For the example presented in Table 14, the subsidy on the mortgage of the energy-efficient house must be 0.19% (i.e., the real rate of interest that equalizes monthly payments is 2.81%).

TABLE 16. Most Promising Mortgage and Finance Provisions
Compared to BEPS for 1981(1)

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
	Projected Single Family Starts 1981	Percentage of Starts Affected	No. of Energy- Efficient Homes Built in 1981 Due to Policy	Average Energy Saved Per Home (10 ⁶ Btu)	Energy Saved in 1981 Due to Policy	Cost of Policy (millions \$)	Average \$ Cost Per Btu Saved
PITI + U	1,090,600	40%	436,200	12.44	5.4×10^{12}	10.9	2×10^{-6}
Loan Rate Subsidy	1,090,600	50%	654,400	12.44	8.1×10^{12}	497.0	61.4×10^{-6}
BEPS	1,090,600	80%	872,500	12.44	10.8×10^{12}	20.7	2×10^{-6}

NOTES: Column 1 All Figures are for 1981 to provide a common basis for comparison. These numbers are comparative rather than absolute estimates.
 Column 2 PITI + U percentage from Table 11, page 18; subsidy percentage assumed; BEPS percentage assumed.
 Column 4 Derived from PNL 1979, Table A.11. Applies only to electrically heated homes and is an average for 10 U.S. cities.
 Column 5 Assumes all energy-efficient homes are electrically heated. This may be unrealistic but does not affect the comparative aspect of this analysis.
 Column 6 1978 \$. These costs refer only to those incurred by the federal government. They include administrative and implementation costs.
 Column 7 This was calculated by dividing the data in Column 6 by Column 5.

The choices facing consumers, lenders, and builders under these policies are as follows. Under PITI + U, life-cycle costs determine buying decisions and thus result in the construction of buildings that minimize life-cycle costs. Under a loan subsidy scheme, consumers are indifferent between energy-efficient homes and conventional homes since their monthly payments are the same. Consequently, energy-efficient homes would always be more desirable and builders would then respond with energy-efficient buildings. This response assumes that lenders would lower the downpayment percentage for buyers of energy-efficient homes and thus equalize the amount of the downpayment, probably because of the lower default rates due to lower energy costs.

These scenarios are based upon several crucial simplifying assumptions. One concerns the builder response to policies that affect only lenders and consumers. Builders are assumed to respond instantaneously and easily to these policies. Given the competitive structure of the building industry, this assumption is fairly reasonable.

Another assumption concerns the range of consumer choice. In reality, each house has a different set of characteristics. Houses differ by number of rooms, age, location, proximity to shopping, transportation, and public services, energy efficiency, etc. Houses are assumed to be identical in every respect except one set is energy-efficient and the other is not. Furthermore, the level of energy efficiency is assumed to be the same (i.e., all homes are insulated to the point that minimizes life-cycle costs).

Table 15 summarizes a series of projections of building starts (Isakson and Haney 1977, Tables VIII-2 and VIII-4). Table 16 presents the result of cost and effectiveness comparison and is based upon Tables 11, 14, and 15, and several other sources, all of which are documented.

In Table 16 the amount of energy saved due to each policy as reported in Column 5 results directly from the percentage assumed in Column 2. As stated in the Note for Column 2 in the table, the PITI + U percentage was found in Table 11; the BEPS percentage is consistent with figures used in the economic impact assessment of BEPS (PNL 1979, p. iv) and the loan subsidy percentage was selected because it was between the other two.

The differences between the percentages presented in Column 2 are crucial and are intended to reflect the differences in policy approaches. BEPS affect builders directly, while the finance provisions affect builders indirectly through consumers. Therefore, the percentage of housing starts affected by the more direct policy should be higher.

In Column 6 of Table 16 a very rough estimate of policy costs is presented. By assuming that energy costs for each new house could be estimated for \$25.00, PITI + U costs were calculated, including overhead, computer time, and labor.^(a) The loan rate subsidy cost was calculated using the 0.19% value, which equalized monthly payments in the example presented in Table 14. This value was multiplied by the loan origination projection for single-family homes in 1981, as presented in Table 15. The BEPS enforcement costs are reported in Column 7 and include plan review costs and inspection costs (PNL 1979, p. 5.2.3, Table 5.17).

Rough estimates of cost-effectiveness are reported in Column 7 of Table 15. Average cost per Btu saved was equal for BEPS and PITI + U and higher for loan subsidies. These results are only applicable to the penetration rates projected. Information was not available from which to estimate what would be required to affect 80 to 100% of homes by the PITI + U and loan rate subsidy alternatives. The cost estimate for a loan subsidy program grossly exceeds what appears politically feasible. When the House Banking Committee approved creation of a Solar Bank in late September 1979, they authorized \$155 million for loan subsidies for 1981 (Wall Street Journal September 19, 1979). This amount is less than one-third of the amount needed to achieve results comparable to BEPS.

Since this report's analysis is limited to single-family housing, total policy costs and total energy savings are underestimated. Information was not available from which to ascertain whether inclusion of multifamily housing and commercial buildings would increase the cost of each policy alternative proportionally.

(a) Assumes 30% overhead rate, \$25 per hour wage rate.

6.0 RECOMMENDATIONS

The major recommendation of this report is to gather additional information before implementing mandatory energy performance standards. Further information is required in several areas before it can be determined whether or not there are nonregulatory policies more desirable than mandatory standards. This report is a rough first step toward making that determination.

The following major information gaps were found:

1. Recent evidence suggests that building practices are changing rapidly. Time lags for collecting their data have hindered its use for policy making. For instance, are current market conditions requiring more energy-efficient designs without government interference?
2. Too little is known about the relative importance of various building attributes (size, location, energy-efficiency) to builders, lenders, and consumers. For instance, what are the tradeoffs, if any, among these attributes? Also, how do government programs affect these attributes and influence purchasing decisions?
3. Information is needed regarding the tradeoff between capital investment and fuel saving and more thorough life-cycle cost and cash flow data are needed for commercial, industrial, as well as residential buildings.
4. Performance evaluations are lacking for most existing federal programs designed to stimulate energy conservation.

To close these information gaps and to better ensure that the government adopts the most appropriate energy conservation policies, the following steps are recommended.

1. Carefully examine whether or not and to what extent building construction practices are changing over time. Determine the major reasons for these trends.

2. Determine the impact of rising space conditioning costs on these building practice trends. Determine what government actions can best influence those trends.
3. Determine optional building energy efficiency for commercial, industrial, and residential buildings. Make sure that regional variations in space-conditioning costs, climatic conditions, and building codes are taken into account.
4. Determine the cost and feasibility of a building energy-use labeling program for new and existing buildings as a means of increasing the purchaser's information.
5. Evaluate existing building technology research programs and determine what basic R&D needs to be performed.
6. Examine the potential for coordinating various federal, state, local, and municipal government energy conservation information programs.

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