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ANALYSIS OF INSTITUTIONAL MECHANISMS AFFECTING
RESIDENTIAL AND COMMERCIAL BUILDINGS RETROFIT

September 1980

Work Performed Under Contract No. AC01-79PE70044

Hittman Associates, Inc.
Columbia, Maryland

U. S. DEPARTMENT OF ENERGY

Division of Buildings and Community Systems

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AFFECTING RESIDENTIAL AND COMMERCIAL
BUILDINGS RETROFIT

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Office of Conservation Policy
Division of Buildings and Community Systems
Washington, D.C.

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EXECUTIVE SUMMARY

In order to realize the full potential that exists for reducing energy usage in the residential and commercial sectors, actions must be taken that will minimize the effect of various institutional mechanisms (barriers) that inhibit buildings retrofit. This study assesses eight such barriers in the residential and commercial sectors and ranks them according to their suitability for federal action designed to minimize their impact on energy conservation retrofit.

The barrier that affords the opportunity to achieve the largest energy savings at the least relative cost is the use by building owners of a first-cost criterion in evaluating prospective retrofit installations. This conclusion applies to both the residential and commercial sector; however, in the commercial sector, an investment criterion that requires payback within two to five years is as suitable a target for federal action as the first-cost criterion.

The eight barriers, ranked in the order of their suitability for federal action in the residential and commercial sectors, are:

<u>Ranking</u>	<u>Sector</u>	
	<u>Residential</u>	<u>Commercial</u>
1	Use of First-Cost Decision Criterion	Use of First-Cost or Short-Term Payback Decision Criteria
2	Lack of Precise or Customized Information	Lack of Precise or Customized Information
3	Lack of Sociological/Psychological Incentives	Inability to Evaluate Retrofit Products

<u>Ranking</u>	<u>Sector</u>	
	<u>Residential</u>	<u>Commercial</u>
4	Fuel Pricing Policies	Lack of Delivery Systems
5	Lack of Delivery Systems	Fuel Pricing Policies
6	Inability to Evaluate Contractor	High Finance Costs
7	Inability to Evaluate Retrofit Products	Inability to Evaluate Contractor
8	High Finance Costs	Lack of Sociological/Psychological Incentives

Initiatives for overcoming each barrier are suggested in the report.

Two additional conclusions are offered:

(1) A program strategy that treats just one barrier is likely to be less effective than a program strategy that treats several major barriers simultaneously. Decisions to retrofit typically entail several steps; barriers exist at each step. A program that treats only one will leave others to act as major restraints on its effectiveness.

(2) Survey evidence indicates that the American public may have recently undergone a substantial change in attitude toward energy conservation possibly brought about by significantly higher energy prices and a sense of uncertainty over oil supplies as a result of the takeover of the U.S. embassy in Iran. If such a change has, in fact, occurred, a unique opportunity exists to promote energy conservation through programs addressed to institutional barriers. It is suggested that, if this change of attitude is confirmed, near-term emphasis be given to existing, effective programs which treat barriers while new programs are being developed.

I. INTRODUCTION

A. Purpose

The U.S. Department of Energy (DOE) has estimated that 30 percent of the energy projected to be used in the residential and commercial buildings sectors in 1990 could be saved if full advantage were taken of existing opportunities and technology to reduce buildings energy usage (U.S. DOE, January 1980, p. H-5.). This potential for reduction in energy usage is the largest both in absolute number and in percentage of the sectors on which DOE focuses its energy conservation activities. (The others are the industrial and transportation sectors.)

Evidence provided to date on the level of energy conservation activity in residential and commercial buildings indicates that enhanced federal action will be necessary if this potential is to be realized by 1990. Even with the large energy price increases experienced in the past seven years and warnings of excessive national dependence on foreign petroleum imports, the public response has been relatively slow. It is less than what is now thought to be achievable given considerations of cost-effectiveness.

Considerable attention has been given to the reasons for this slow reaction. Analyses of building owners' responses to energy conservation appeals indicate that their decisions concerning energy usage are not only a function of price signals and patriotism. They are also a function of investment philosophies, the availability of information, preferred alternative uses of money, expectations of comfort, "inertia" and other factors. Collectively, these factors have been

labeled institutional mechanisms impeding energy conservation, or "barriers." Numerous efforts have been made to identify and study them, and several federal programs are already in effect or in the proposal stage that will address them.

Whether or not these federal actions focus on the more important barriers, however, or even which barriers are the more important ones, does not appear to have been systematically assessed. Such an assessment -- even in a limited form -- would appear to make a valuable contribution to the selection of the next generation of federal actions focusing on these barriers.

This study is addressed to meeting that need. Existing literature on a set of eight selected barriers to buildings retrofit has been reviewed in order to assess:

- (1) Which barrier or barriers in the residential and commercial buildings sectors appear to be having the greatest negative effect (in terms of the energy savings that could be achieved) on owners' willingness to retrofit buildings
- (2) Which barrier or barriers in each sector appear to be most suitable for federal action to accelerate retrofit activity, considering the likely costs and effort entailed in implementing such action.

An additional, but lesser, objective of the study is to explore the quality and quantity of the data available on the impacts of the barriers.

B. Barriers Examined

Barriers to energy conservation in the residential and commercial sectors influence (1) the willingness of building occupants to modify their energy usage habits, and (2) the willingness of building owners/occupants to upgrade the thermal characteristics of the structures within which they live or work and the appliances which they use. This study focuses on the barriers that influence the willingness of building owners/occupants to modify the thermal efficiency characteristics of building structures and heating/cooling systems.* This focus is further narrowed to include only those barriers that impede modifications to existing buildings, i.e., energy conservation retrofit activity. Barriers to retrofit have been chosen over barriers to energy usage because structures account for a larger proportion of the variance in building energy use than does the behavior of the occupants (Burby and Marsden, 1980, p. 23).

Over 40 different barriers were identified from the literature and from an analysis of the factors that go into investment decision processes in general.** From these, the following eight were selected in conjunction with DOE's Conservation Policy Office for examination.

- (1) Fuel pricing policies that in the short term do not provide enough incentive to invest in energy conservation

**Barriers to the installation of renewable resource measures were not included in this focus. The analyses of the individual barriers presented in this study will be relevant to the retrofit of these measures, however.*

***The barriers are listed in Table A-1 of the Appendix.*

- (2) High finance costs
- (3) Inability to evaluate contractor performance
- (4) Inability to evaluate retrofit products
- (5) Lack of well-integrated or one-stop marketing systems (referred to as lack of delivery systems)
- (6) Lack of precise or customized information
- (7) Lack of sociological/psychological incentives
- (8) Use of the first-cost decision criterion (expanded to include short-term payback criterion for the commercial sector).

The impacts of these barriers on energy conservation are separately assessed for the residential and commercial sectors. The residential sector is defined to comprise single-family housing and multifamily housing consisting of any number of units. Mobile homes are excluded because of their relatively small numbers in the total housing stock (6 percent). The commercial sector is defined to include all buildings used primarily for business purposes. This includes retail structures, office buildings, warehouses, theaters, hotels/motels, and terminals. Institutional buildings such as schools, hospitals, and government buildings are excluded from the definition of the commercial sector for the purpose of this study.

C. Data Available

Existing literature was the primary source of information on the barriers under study. A limited amount of original data gathering was performed in connection with the analysis of the first-ranked barriers. To identify relevant literature, an extensive search for barrier-related analyses was performed. This search identified a relatively large number of such studies. Only one was found, however, that systematically assessed the impacts of barriers to energy conservation retrofit. This was a study devoted to the multifamily housing subsector of the residential sector. The study developed packages of incentive-type remedies in the regulatory, financial, economic, information, and educational areas and, using subjectively derived assumptions, quantitatively estimated the energy savings achievable in the subsector as a result of implementing the packages of incentives. These estimates are the equivalent of the energy savings inherent in the removal of a barrier as used in this study. The study also included subjective assessments of what the present analysis describes as the effort required to remove the barrier. Because its results were aggregated across several incentives within an area, however, the findings were of limited use for the present analysis (Real Estate Research Corporation, November 1975).

Several other studies have assessed the relative "importance" of various barriers -- including some of the barriers assessed in this study -- for particular segments of the residential and commercial sectors (e.g., U.S. DOE, May 1979; Opinion Research Corporation, July 1976; Syska & Hennessey, August 1978). Except for the study noted above, however, there appear to have been no other efforts to estimate what proportion of a sector might retrofit were it not for a particular barrier or combination of barriers.

Additionally, the studies which assess the relative importance of barriers are, for the most part, based on local or regional samples or on straw-vote data. Only a few studies contain data which provide a suitable basis for generalizing to the national level (e.g., Milstein, 1977). Local findings have value for policy purposes; they provide valuable insight at relatively low cost into the operation of barriers. Local data cannot, however, be used with assurance in generalizing about the relative importance of barriers at the national level.

In subsequent chapters of the report which analyze each barrier individually, the quality of the information available on the impacts of each barrier is discussed in more detail.

D. Approach to the Analysis

In order to select one or more barriers for government action, it is necessary to compare them. In order to compare them, they must be characterized by some common features or attributes that are considered important to the reasons for the selection. Where the comparison will be made in order to select a barrier that is in some sense "optimal" for government action, measures of the important benefits and costs are needed for each barrier. For this study, four attributes or variables were selected as measures of the benefits and costs that might result if each barrier to retrofit were substantially removed. The eight barriers were assessed, or scored, on each of these four attributes in order to make the comparison. The attributes selected were:

- (1) The energy savings that could be achieved if the barrier were substantially eliminated ("Energy Savings Potential")

- (2) The likely negative impacts (other than governmental costs) associated with removing the barrier ("Non-governmental Costs Associated with Removal of the Barrier")
- (3) The effort, including costs, required by the federal government in order to substantially overcome the barrier ("Ease of Removal")
- (4) The likely benefits, other than energy savings, associated with removing the barrier ("Benefits Other Than Energy Savings").

An additional attribute was chosen in order to meet the objective of assessing the quality of the data available on the impacts of each barrier. The quality of the data was assessed in terms of its apparent validity, reliability, quantity, and the ability to use it for generalizing at the national level. This "Data Quality" attribute was not used in ranking the barriers, however (see Section D.1.b, page A-8 of the Appendix). The scores for each barrier are shown in Table A-3 of the Appendix.

The lack of relevant impact analyses, either quantitative or qualitative, and the scope of the study necessitated that the assessments of the barriers on these attributes be primarily subjective in method. A technique frequently used in making assessments where quantitative data is lacking is the Delphi method. Briefly, this technique calls for: (1) participation by several individuals who either are, or in the course of the study will become, well informed on a subject for which an assessment is required; (2) discussion of the subject and its assessment by the individuals to identify areas of agreement and disagreement; (3) a thorough exploration and mutual resolution, if possible, of the disagreements; and (4) evalua-

tion of the opinions of the individuals and selection of a final assessment (Linstone & Turoff, 1975). This technique was used to assess and score the barriers on the attributes.

The estimated impact of each barrier (in terms of the attributes) in each sector was assessed relative to the estimated impact of the other barriers in the same sector. To do this, the barriers with the least impact and the most impact were selected for each attribute. The other barriers were scored in relation to these. The result is a set of comparative scores, i.e., a relative impact score for each barrier on each attribute. Except where noted in the analysis, each barrier is assumed to be operating independently, i.e., the assessed effect of any barrier assumes the status quo for the other barriers.

The barriers are compared on their attribute scores and ranked using a lexicographic method. This method ranks the barriers in a manner similar to that used to order words in a dictionary. The attributes are first ranked according to their relative importance for the purposes of the study. In this case, the purpose is to select a barrier that is most suitable for government action, i.e., one that will provide the most energy savings benefit at least cost. Then, through an elimination process, the barrier with the "best" scores, starting with its score on the most important attribute, is selected.

This method was chosen because of its ability to rank items scored on an ordinal scale. Its use precluded the need for a further subjective assessment of the degree of "more" or "less" impact that each barrier has. The method is described in more detail in the Appendix. The Appendix also presents the details of its application to this study.

E. Results

1. Most Energy Savings

The analysis concludes that the use of a first-cost decision criterion by residential consumers and the use of first-cost and short-term payback decision criteria by commercial building owners are the barriers having the greatest negative effect, in terms of the energy savings that could be achieved, on the retrofit of buildings. Use of the first-cost decision criterion refers to the propensity of individuals to evaluate purchase decisions on the basis of initial price alone. No consideration is given to any future monetary returns that might result from the purchase. Use of the first-cost decision criterion is expanded for the commercial sector to include use of a short-term payback decision criterion. During investigation of the effect of the first-cost decision criterion in the commercial sector, the short-term payback criterion came up repeatedly as a major concern of property owners. Therefore, the analysis of the first-cost decision criterion was expanded to include this important additional criterion. Quantitative estimates of the savings achievable by removing these barriers were not developed because of a lack of supportable data on which to base the necessary assumptions. The finding, therefore, is comparative and states that, of the barriers examined, the first-cost barrier (including a short-term payback barrier in the commercial sector) has the greatest effect on energy-usage reduction through retrofit.

2. Barrier Ranking

The analysis concludes that the use of a first-cost decision criterion by residential purchasers and the use of first-cost and short-term payback decision criteria by commercial investors are also the barriers which constitute the most suitable targets for federal action. The final rankings for all of the barriers are shown in Table I-1:

TABLE I-1. BARRIER RANKINGS

<u>Rank</u>	<u>Sector</u>	
	<u>Residential</u>	<u>Commercial</u>
1	Use of the first-cost decision criterion	Use of the first-cost decision criterion expanded to include short-term payback decision criterion
2	Lack of precise or customized information	Lack of precise or customized information
3	Lack of sociological/psychological incentives	Inability to evaluate retrofit products
4	Fuel pricing policies that in the short term do not provide enough incentive to invest in energy conservation	Lack of delivery systems
5	Lack of delivery systems	Fuel pricing policies that in the short term do not provide enough incentive to invest in energy conservation
6	Inability to evaluate contractor performance	High finance costs
7	Inability to evaluate retrofit products	Inability to evaluate contractor performance
8	High finance costs	Lack of sociological/psychological incentives

F. Additional Observations

In the course of reviewing the literature, additional observations emerged that are relevant to the development of suitable federal action to eliminate barriers to energy conservation retrofit. In order to assess the impacts of each barrier, the barriers were isolated from one another. In reality, however, the process by which individuals make their decision to retrofit consists of a sequence of events. One event often must occur before another can take place. Barriers can occur at several points in the sequence of events that leads to a single decision.

The barriers examined in this study, in fact, occur at different points in the decision sequence. For example, information on the price of a prospective purchase is a prerequisite to evaluation, and evaluation, in turn, is usually a prerequisite to making a decision to buy. Barriers can occur at each of these steps. As a result, federal action designed to overcome only one barrier, e.g., the first-cost-decision-criterion barrier, even though it is the principal barrier, will not be as effective as federal action that combines several programs designed to overcome several of the barriers that occur in the decision-making process.

This observation is stressed in several of the studies reviewed, most notably Blumstein et al., April 1980, and Real Estate Research Corporation, November 1975. The latter study, which has been mentioned previously as the only study identified that attempted to develop quantitative assessments of barriers to retrofit, estimated that in the multifamily housing subsector, a package of incentives addressed to each of the types of barriers examined (information, fiscal-economic,

and regulatory, would save 34,404 million Btu annually. This estimate is 1.4 times larger than the next highest estimate developed for a package of economic and fiscal incentives. It is seven times larger than the third-ranked package of incentives, those involving information and education (Real Estate Research Corporation, November 1975, p. 71).

The second observation involves timing and policy direction. Many suggestions for specific new initiatives are offered in this report, and other initiatives already proposed are reviewed. Implementation of some of these is needed if the pace of retrofit activity is to be accelerated.

The initiation of new programs is a time-consuming process, however. Recent survey evidence, on the other hand, suggests that the present may be a particularly opportune time for action. This evidence, discussed in Chapter V, indicates that the public may be entering a period in which it will be unusually receptive to programs promoting energy conservation. If so, the effectiveness of federal action to overcome retrofit barriers may be enhanced in the short term if additional emphasis is given now to current, effective programs while new initiatives are being developed.

G. Organization of the Report

Chapters II and III of this report are devoted to the analysis of the barriers judged to be most suitable for federal action in the residential and commercial sectors. These chapters discuss the barriers' relative potential for energy savings, societal effects other than energy effects

likely to occur if the barriers are overcome, the ease with which the barriers can be overcome by federal action, and the quality and quantity of the data used for assessing the impacts of the barriers. In discussing the ease with which the barriers can be overcome, specific suggestions are offered for new initiatives. These suggestions, in combination with existing federal action, become the basis for assessing the costs associated with removing the barriers and the ease with which they can be overcome.

Chapters IV through X are devoted to similar analyses of each of the other barriers. The sequence of chapters corresponds to their ranking in the residential sector. The report concludes with suggestions for further research (Chapter XI). This chapter presents a brief summary of existing research on barriers to buildings retrofit and suggests specific areas of research that will help to further identify and evaluate programs designed to overcome the barriers examined in this study.

The methodology used to assess and rank the barriers is presented in the Appendix. A table of the barriers identified during the preliminary literature search is also included in the Appendix. The Bibliography provides a list of documents that were found to be relevant to the analysis of barriers to energy conservation retrofit.

II. FIRST-RANKED BARRIER -- RESIDENTIAL SECTOR: USE OF FIRST-COST DECISION CRITERION

A. Description

Consumers often perceive that the price of merchandise which has obvious quality and lasting value is too high. The consumer in this situation faces a finite set of choices: (1) put the merchandise back and find something more affordable; or (2) buy the merchandise with cash or credit and cut back on some other desired activity until the extra cost has been paid.

Purchasers of residential energy conservation retrofit items face these choices. The reduction in energy costs available through an energy conservation retrofit usually requires an outlay of from \$25 to \$2,000. Many opportunities cost from \$100 to \$500.* In the case of cost-effective retrofit items, the purchase price will eventually be recovered through the energy cost reduction. It appears, however, that many residential consumers fail to look beyond the initial cost to examine the savings that will result. Others who do look at these savings either decide that the opportunity costs are too great or that they cannot meet the purchase terms. When this happens, these consumers have made their decision concerning the purchase of retrofit products on the basis of initial cost.

*This range includes attic insulation, oil burner replacement, intermittent ignition devices, and storm windows (U.S. DOE, October 1979; Hittman Associates)

This barrier emerged from the analysis as the one most suitable for government action in the residential sector. The barrier can affect the entire sector, but it is likely to have the greatest impact in the single-family owner-occupant subsector.

B. Energy Savings Potential

No research was found that assessed the impact on energy usage of single-family homeowners' reactions to the initial cost of energy conservation retrofit measures. One study was found which assessed the energy savings likely to be realized in the multifamily subsector from the implementation of numerous economic and fiscal incentives designed to stimulate retrofit. The analysis addressed multifamily property owners; tenants were judged to be virtually without economic rationale for retrofit activity. Energy savings due to incentives are the equivalent of the savings inherent in removing a barrier as defined for this study. However, the analysis aggregated remedies for all economic barriers, including low-interest loans and higher fuel/energy prices. Therefore, its results are not directly transferable to the present assessment of the first-cost barrier (Real Estate Research Corporation, November 1975).^{*} Studies have been performed on the reactions of residential consumers in general to the price of energy conservation measures, and there is qualitative evaluation of

**The study estimated, for the multifamily subsector, a potential energy savings of 24,574 million Btu/year for a wide variety of economic and fiscal energy conservation incentives. These savings were much larger than the next highest estimates of 4,915 million Btu/year each for information and educational programs and regulatory changes (the only other barrier types assessed by the study).*

this barrier. The assessment of the relative energy savings potential inherent in the first-cost barrier was inferred from these analyses and several interviews with retailers and installers of retrofit materials in the Washington, DC, metropolitan area.

The discussions with retrofit retailers conducted for this study indicate that there are two types of situations in which consumers make decisions to retrofit a residence. The first of these occurs when a consumer elects to make a retrofit purchase, as when wall insulation is installed. This usually is the case for retrofit of a residence's shell or thermal envelope. The second occurs when a consumer must make a retrofit decision, as when an appliance has stopped operating properly and must be replaced. This situation often accompanies the replacement of space conditioning equipment.* The first situation may also apply when a consumer replaces a space conditioning appliance; however, consumers normally will retain such appliances until the end of their useful lives, at which time they have created the second situation. The available evidence appears to indicate that the impact of the first-cost barrier differs according to the situation. In elective retrofit situations, first cost is very important; in mandatory replacement situations, consumers are beginning to trade off price and energy efficiency.

**Retrofit of the building shell includes ceiling, wall, and floor insulation, weatherstripping, caulking, storm doors and windows, and attic fans. Appliance retrofit includes replacement of air conditioning units, hot water heaters, furnace burners, and furnace units with more efficient units and the installation of automatic ignition devices, clock thermostats, and vent dampers.*

The installation of solar space conditioning equipment falls into the latter category; however, the circumstances for solar installations are more likely to resemble those for shell retrofit than for the replacement of conventional heating and cooling appliances.

The influence of initial cost on retrofit activity in general is indicated in a DOE survey of the results of nine utility-administered retrofit programs. Two of the utilities, one on the East Coast and one on the West Coast, reported that their market research (conducted in 1978 and 1979) identified first cost as a significant impediment to purchase of building retrofit measures including shell measures (U.S. DOE, May 1980, pp. 61, 99). The East Coast utility, Tampa Electric Company, has recently reported separately that first cost and consumer apathy are the two most important barriers it faces in its retrofit program (Air Conditioning, Heating, and Refrigeration News, February 4, 1980, p. 76).

A survey performed in 1976 gave strong indication that first cost was the primary decision-making criterion for buildings retrofit purchases and represented the greatest barrier to buildings retrofit (Opinion Research Corporation, July 1976, p. II-2). In 1978, the League of Women Voters found that residential consumers were still responding to higher energy prices in traditional economic fashion; i.e., by modifying their usage practices and buying lower-cost measures rather than investing in the more expensive retrofit measures (League of Women Voters, January 1979, p. 66). Similar results can be inferred from another DOE survey also performed in 1978. Far fewer households claimed to have added expensive storm doors, windows, insulation, and appliances than added weatherstripping, caulking, and plastic coverings (18 percent vs. 32 percent) (U.S. DOE, February 1980a, p. 3).

The impact of initial cost on purchases of more efficient space conditioning appliances is less clear. Recently there have been indications that many customers who know they are going to have to replace a space conditioning appliance and those who are otherwise in the market for a new space condi-

tioning appliance, are selecting the more expensive, more efficient models. Several trade associations and heating and cooling contractors in the Washington, D.C., metropolitan area contacted in connection with this study indicated significant customer interest in comparative energy efficiency ratings of the equipment they are purchasing. The contractors noted that, while customers still compare prices, they also compare energy efficiencies and buy the more energy-efficient equipment -- but not the most energy-efficient equipment. Since it was also the opinion of these contractors that their customers were not performing payback calculations, it appears that customers are beginning to seek a compromise between energy efficiency and first cost. They are still avoiding the highest-priced, most energy-efficient equipment, but are accepting the mid-priced, more energy-efficient equipment.

Evidence of a trend toward more energy-efficient space conditioning appliances is also reported by the space conditioning industry. Shipments of furnaces in 1979 indicated widespread use of the more efficient units. More than 50 percent of all air conditioning units (both new and replacement) shipped that same year were higher-efficiency units (Air Conditioning, Heating, and Refrigeration News, April 7, 1980, p. 12). An informal survey conducted by an energy newsletter in early 1980 produced similar findings (Energy User News, June 19, 1980, p. 1).^{*} It appears that, in the space conditioning appliance market, first-cost is becoming less of a barrier to retrofit.

^{*}Additional survey research conducted in late 1979, and sponsored by the Department of Energy, also found, for the first time, a consistency between the public's attitude toward energy conservation action and actual energy conservation activity (Cambridge Survey Research, Fourth Quarter 1979). The findings of this survey are discussed in more detail in Chapter V.

The only study found that attempted to assess whether different residential subsectors reacted differently to initial cost was an analysis by the Opinion Research Corporation (ORC) of a 1976 survey. Although the ORC analysis and others (cf. FEA, February 1977, pp. 103-105) have observed that owner-occupants of single-family housing and owner-investors in residential housing have different economic motivations, ORC found no difference in the reaction of these two subsectors to initial cost. It was a major deterrent to both (Opinion Research Corporation, July 1976, pp. I-2, I-3, II-1).

The investment outlook of multifamily residential property owners has also been assessed in another pair of studies, one conducted in 1975 and one in 1980 (Real Estate Research Corporation, November 1975; Blumstein et al., April 1980). The earlier study used a literature review as the source of its information; the later one used interviews with four landlords and apartment managers. In both studies, first cost was found to be one of the most important barriers to retrofit in the multifamily subsector. In the 1980 study, each of the owners/managers interviewed referred to the barrier. The earlier study also identified short-term payback -- a value that is dependent upon initial cost -- as a major criterion for investment in retrofit (Real Estate Research Corporation, November 1975, p. 44).

No research was found that assessed the influence of first cost on tenants' retrofit decisions. However, because tenants face other institutional barriers to their retrofit decisions that are far more serious than initial cost, this barrier is not expected to have a major influence on tenants' retrofit purchases at this time. (Tenants' viewpoints are discussed in Real Estate Research Corporation, November 1975, Chapter V, and Institute of Behavioral Science, June 1980, Chapter I.)

The findings reported above indicate that, prior to 1979, there was an almost universal agreement that the price of more efficient -- and more expensive -- retrofit items was the major deterrent to large reductions in residential energy usage. Research on consumer behavior during 1979 and 1980 suggests, however, that residential consumers may now be starting to look beyond the initial cost of a retrofit measure and seeking ways to reconcile their conflicting concerns over the first cost of a retrofit investment and future energy costs. They are not explicitly considering life-cycle costs in making their choice, but rather, appear to be simply compromising between their traditional concern about price and a newly emerging concern over future energy costs. Limited evidence provided by contractors and national trade associations suggests that this trend may be situation-dependent. It appears to apply primarily to customers who think they must replace a space conditioning appliance. Customers shopping for elective upgrading still appear to be deterred by price.

In spite of the apparent emergence of a consumer trend toward more efficient equipment in the replacement appliance market, none of the reported analyses or the contractors interviewed give evidence that consumers are aware of, or are using, life-cycle cost analysis to rationalize their purchase decisions. The effort needed to learn how to perform and then actually to perform such analyses is probably more than the majority of consumers are willing to accept for a one- or possibly two-time purchase decision. Moreover, for such analyses to be valid, data on present household energy usage are required, and collecting this information requires more time and effort than most consumers are willing to spend.

This consideration of the effects of information cost on retrofit is probably most relevant to middle- and upper-income

households. Low-income households are likely to find the opportunity costs posed by higher-priced retrofit measures insurmountable, regardless of the amount of information they have on the proven future benefits of the measures. The low-income homeowner is likely to be deterred by price alone.

In spite of recent indications that first cost may be somewhat less of a deterrent to retrofit than it once was, initial cost and the cost of the information needed to overcome it still stand as major deterrents to residential retrofit. The residential energy savings that could be achieved if this barrier were overcome are considered to be equivalent to the largest savings potentially available from the elimination of any other barrier.

C. Ease With Which Use of the First-Cost Decision Criterion Can Be Eliminated

1. Federal Action

There are several federal programs already in effect or in the proposal stage that address the first-cost barrier. Some of these deal with the barrier directly; others work around it. For retrofit of the building thermal envelope they include:

- (1) A national low-cost/no-cost conservation measures program
- (2) An expanded low-income weatherization program
- (3) Subsidized energy audits under the Residential Conservation Service (RCS) Program

- (4) Time-of-sale building thermal efficiency standards.

Initiatives in the appliance area include:

- (1) A federal matching rebate program for vendors who are willing to offer rebates on their most efficient models of hot water heaters, air conditioners, clothes dryers, refrigerators, and freezers
- (2) An appliance efficiency labeling program
- (3) Mandatory appliance efficiency standards (which, in effect, remove lower-cost, less-efficient options from the market).

The residential energy tax credit provides for a rebate of part of the initial cost of both shell and appliance measures.

For the purpose of assessing the effort needed to remove this barrier, this analysis assumes that each of these programs except the time-of-sale building thermal efficiency standards has been or will be implemented. (The feasibility of the time-of-sale program is currently being evaluated.) Where the programs are now in effect on a regional basis, it is assumed that they will be expanded to the national level.

In addition to these already-proposed initiatives, several others can be suggested. These focus on overcoming the information costs associated with life-cycle or payback cost analysis and on overcoming the budgetary problems associated with high initial costs.

a. Information Costs. A direct approach to reducing information costs might be to create a standard book of tables or nomographs on payback or life-cycle cost comparisons

for each model of selected major space conditioning appliances. This information would be available to consumers only at the point of sale or by phone. It would be provided by sales personnel trained to use the tables/nomographs.

Information costs may be addressed indirectly without going through actual life-cycle-cost-comparison analyses. For example, the compromise between cost and efficiency reported in Section B above is one approach to avoiding information costs. Another approach might require manufacturers to advertise the efficiency ratings of their appliances in a manner similar to that now employed by automobile manufacturers using the Environmental Protection Agency's gas mileage ratings. Inevitably, consumers would compare efficiency ratings and begin to buy the more efficient models. Such a program would result in some purchases that would not be cost-effective for individual purchasers; however, it would increase the number of purchases that would be cost-effective over the lifetime of the measure -- an important objective from the national point of view. (Other suggestions for information programs are included in Chapter IV.)

b. Initial Cost. Two suggestions are made for directly reducing the initial cost of an energy conservation retrofit. Since consumers tend to discount heavily future energy cost savings (Hausman, Spring 1979), they may similarly discount the effect that the residential energy tax credit has on initial cost. Consumer realization of this effect on initial cost might be heightened by increasing the credit and advertising it more actively. Alternatively, DOE might encourage retailers to include more specific information on the dollars that can be refunded for particular items in advertising for those items.

A second suggestion involves a federal appliance rebate program keyed to trade-ups. It would avoid the discount-rate handicap of tax credits and could also cover appliances that do not qualify for the residential energy tax credit. Under this approach, a federal rebate would be credited to the purchase price of a new energy-efficient appliance at the time of purchase if (1) the appliance it replaces is traded in (possibly for scrap), and (2) the efficiency of the replacement appliance exceeds that of the trade-in appliance by a specified amount as determined by manufacturer's data. Retailers could recoup the rebate through a tax credit or a direct refund from the federal government (possibly through state energy offices). This incentive would also promote appliance replacement before the end of its useful life.

2. Effort Required

In combination, the federal initiatives currently proposed or in effect for this barrier entail large costs. Some, such as the time-of-sale transfer standards, entail significant political costs.* The additional suggestions made in this section would add to those costs. Even excluding consideration of the effort needed to implement a time-of-sale program, the costs to the government associated with creating and implementing a successful program to remove the first-cost barrier in the residential sector will be large. For the purposes of this analysis, they have been rated as being equal to the largest effort required to remove any of the barriers examined for this sector.

**Analyses of the potential impacts of time-of-sale standards are currently being circulated in draft form within the government.*

D. Effects Other than Energy Effects That May
Result from Removing the Barrier

Excluding the effects on the real estate industry of a time-of-sale standards program, and all governmental costs of removing the barrier, the remaining non-energy impacts are likely to be small. The increase in demand for energy conservation measures that will result from removal of this barrier will probably be noticeable. However, current production capacity is expected to be adequate to meet it. The effect on inflation and employment should be slight.

The environmental effects resulting from increased energy conservation retrofit activity have been examined for the residential sector in the Environmental Impact Statement for the RCS Program (U.S. DOE, November 1979). These are likely to be greater if the first-cost barrier is removed; however, they are still not expected to be significant.

E. Quality and Quantity of the Data
Used in the Analysis

No research was found that assessed the impact on energy usage of homeowners' reactions to the initial cost of energy conservation retrofit measures. One study assessed the energy savings potential of a variety of economic and fiscal incentives for retrofit in the multifamily housing subsector. This study used a subjectively derived estimate of the percentage of building owners that would respond, and assumptions concerning the per-unit dwelling energy consumption and the amount of energy savings ideally achievable per dwelling.

Its findings were heavily dependent upon the estimates of the number of building owners who would respond. The other directly related data, i.e., the ORC survey, the utility-program survey, and the informal telephone survey conducted for this study, all report consistent information with respect to the barrier's impact on building envelope retrofit activity; however, these were all surveys of vendors or program managers.

Although there are a fair number of analyses to support hypotheses about the effects of the first-cost barrier, none are rigorous enough to confirm scientifically the conclusions reported in this chapter. Therefore, the results presented in this analysis must be considered suggestive.

III. FIRST-RANKED BARRIER -- COMMERCIAL SECTOR: USE OF FIRST-COST AND SHORT-TERM PAYBACK DECISION CRITERIA

A. Description

Preliminary investigation of the first-cost decision criterion barrier for the commercial sector indicated that commercial building owners are very concerned about first cost as it affects their available capital and as an input to investment payback estimations. The payback period of an investment is as important a concern to owners as the initial cost. For those who have investment capital available, it is likely to be more important. As a result, the first-cost barrier has been examined from two perspectives: (1) from the standpoint of a retrofit expenditure costing so much that owners reject the expenditure out of hand, unless it is absolutely necessary for continued operation of the property, and (2) from the standpoint of the shorter payback periods which owners require for contemplated retrofits, often rendering them non-cost-effective from the owner's perspective.

The analysis of the first-cost and payback barriers for the commercial sector focuses on competitive office space (rental office space) and retail shopping centers. These two subsectors were selected because they represent real estate subsectors which respond most sensitively to investment and tax incentives and to marketplace dynamics.

B. Energy Savings Potential

1. Investment Perspective and Role of First Cost/Payback Criteria

These barriers have not been the subject of extensive empirical research for the commercial sector. Investigations have been conducted on the attitudes of competitive office space owners toward conservation investments (A.D. Little, August 1979; Syska and Hennessy, August 1978; Opinion Research Corporation, July 1976); however, no assessments were found of the barriers' relative impacts on energy savings. In order to supplement the literature and gain a better understanding of the barriers' influence on investment decisions made by commercial building owners, six office building and shopping center owners or managers were interviewed for this analysis.* Their comments plus the findings in the available literature suggest that first cost and payback criteria are major barriers to energy conservation retrofit. Commercial building owners have deeply held beliefs about what constitutes a profitable investment, and these beliefs require that first cost and payback be principal considerations in any contemplated retrofit.

The emphasis on first cost and payback appears to derive from the perceived high-risk nature of the commercial building market. Relatively large risks are often involved in developing and managing commercial building space. Partly reflecting this, the investments are often highly leveraged; a comparatively modest equity investment frequently supports a very large mortgage indebtedness. Additionally, investors

*The owners or their representatives were located in Washington, D.C.; Cleveland, Ohio; Phoenix, Arizona; New York, New York; and Columbia, Maryland.

historically have sought to recapture their capital investments in as short a time as possible and have advocated income tax incentives that enhance both income and appreciation (A.D. Little, August 1979, Chapter VI).

Several current tax laws provide such incentives. Depreciation allowances make real estate investment attractive for its income tax shelter potential. Not only can net earnings typically amount to less than allowable depreciation and thus be tax free, but in many cases surplus depreciation credits can shelter income flow from other sources. As a result, real estate is an attractive investment as much for its depreciation benefits as for its income flow and opportunities for value appreciation.

Another federal income tax provision which affects the retrofit investment posture of owners of competitive office space and shopping centers is the treatment of energy costs as deductible operating expenses. For some owners, this has provided an opportunity to show a break-even condition or even an operating loss condition so that the depreciation benefits from one property may be applied entirely to income from other sources. The impact of increased energy costs has also been weakened where landlords have the ability to pass through increased utility costs as part of the rental bill. This allows the landlord to protect his net earnings which, in turn, can be sheltered entirely or in part by depreciation allowances from the same or other properties.

These incentives have worked to strengthen the commercial real estate market, but in the process they have created disincentives to energy conservation retrofit. As a result, investment rationales and perspectives have developed virtually unaffected by considerations of energy availability and cost. Investors have sought and expected to recapture

their equity investments in as brief a period as possible and use every risk-reducing opportunity available. Annual investment returns of 20 to 25 percent made possible by depreciation allowance tax credits have not been uncommon. This has also contributed to expectations of two- to five-year payback periods, with the investor actively seeking new and more secure real estate investment opportunities with his recaptured equity funds.

This investment perspective places severe constraints both on acceptable initial costs for an investment and on a payback criterion. These constraints are compounded by the traditional practice by commercial building owners of financing retrofit improvements out of retained income rather than debt (see Chapter X). This requires that the initial costs of a retrofit be within the level of cash available for investment.

The strength of these constraints emerges from the literature and from comments offered by the owners/ managers interviewed for this study. Payback, in particular, came up repeatedly in the interviews conducted for this study. The required payback period cited most often was three years, with a range of from two to five years. Interviewed owners in both of the commercial subsectors examined often ranked their investment options on the basis of payback; the shorter the payback period, the better.

2. Shopping Centers

Shopping centers are a highly leveraged form of investment. Investors try to recapture their capital investments in as short a time as possible. A long-term life-cycle cost decision criterion does not fit into this kind of investment

philosophy. First cost and payback were emphasized as investment criteria in the interviews conducted with shopping center owners/managers. One shopping center owner had installed a computerized energy monitoring system because it showed a one and one-half- to two-year payback. Another expressed his assessment of equipment retrofit in this fashion:

We concentrate on keeping our equipment running, and we consider more energy-efficient equipment only when there is a need for equipment replacement. Even then, we go with first cost. We'll go for a more costly, more efficient system, but only if the cost differential can be recaptured within three to four years. If it takes longer, we'll go exclusively with first cost. First of all, we don't know if we'll still own the center after that period; we're always ready to sell if the price is right.

Owners of older shopping centers, in particular, are very uncertain about the continued profitability of their investments. Some shopping centers have abbreviated life cycles. The highway strip shopping center gave way to the sub-regional, which gave way to the regional, and now the regional has begun giving way to the super-regional. There is even speculation that the days of the super-regional are numbered because of their remoteness and the higher costs of gasoline. For reasons such as these, there is often a readiness to sell any time the price is right. This contributes to the short time perspective of shopping center owners.

This readiness to sell whenever the price is right would not, in theory, impact longer-term-payback energy conservation retrofits if the value of investment property correspondingly increased. Such is not usually the case, however. In the instance of shopping centers, the efficiency of the heating and cooling system has very little to do with the value of the property. The value is obtained from the volume of trade it can generate and the amount of rent it can yield, which,

as one owner put it, are dependent upon "location, location, and location."

The fact that prospective tenants often judge the rent by factors other than the imbedded utility costs, is another reason why life-cycle cost analysis has such little appeal to shopping center owners. The financial advantages of energy efficient equipment/structural improvements are the result of reduced utility (heating, cooling, hot and cold water) costs. Where utility costs are included in the rent, owners can pass increases through to the tenants. The principal check to such pass-throughs is the loss of tenants, but for some types of properties, the owners are relatively immune from such commercial loss due to energy-related rent increases.

Most shopping center leases are written on the basis of base rent plus a percentage of gross retail income. The greater the volume of sales enjoyed by a retail outlet, the higher the rent. In shopping centers with profitable locations, the relationship of rent to operating expenses may become less important than the relationship of rent to gross sales. The retailer whose gross sales continue to grow and who finds his rents correspondingly increasing will probably seek to renegotiate his percentage of gross sales rather than concern himself with the energy-cost-pass-through reflected in his base rent. The relatively smaller utilities-related increases can more safely be passed through to their customers and clients as part of an inflationary way of life. Where these circumstances exist, the investment advantages that emerge from life-cycle cost analysis have little appeal to shopping center owners.

In less competitive space, however, higher energy costs may cause prospective tenants to shun a building. In such situations, owners may be more sensitive to the levels of the

rent they charge or the amount their tenants have to pay, if individually metered. In Chapter VI, it is shown that commercial building owners as a whole respond somewhat to fuel price increases by reducing their energy usage. This indicates that not all owners feel they can ignore the effect that energy costs might have on their occupancy rates.

Even under these circumstances, however, the reaction appears to be mixed. Some owners of buildings in less desirable locations will retrofit, while others in the same circumstances find reasons not to retrofit. As noted above, the cost of energy conservation retrofit is difficult to recover through resale; therefore, if it is to be recovered, it will usually have to be through rents. Such increases, however, tend to cancel the very rent decreases/maintenance they are designed to make possible. During a set of four interviews with commercial building owners in California, one developer claimed that better energy efficiency would not help him attract tenants to a building if it meant that the rents would be marginally higher (Blumstein, et al., April 1980, p. 362). His observation applied to new commercial buildings and clearly begged the question of higher rents due to higher energy costs; however, it represents an actual perception within the commercial building sector and is found, as well, in the existing buildings subsector in the case of properties that are less competitive. In one of the interviews conducted for this study, an owner of commercial office space in a run-down urban area observed:

We represent one end of the spectrum that probably makes up a large part of the office space inventory. We have an office building in a depressed part of the city. At one time, it was a good commercial property, but it has become a victim of change. We're just holding on; in the winter, our energy bills are higher than our rental revenue. We just spend enough money to keep it running, as we hope

that somebody will take it off our hands. Retrofitting that building would be stupid; we wouldn't know where to start. If we make the building more efficient, we couldn't hold our tenants any better. We just want to get out.

Given perceptions such as these, first-cost and short-term payback become criteria of major importance for retrofit investment analysis, and their alternative, life-cycle costing, becomes virtually irrelevant.

Another reason given in the interviews for requiring short-term payback provides further illustration of the short-term investment perspective that exists in this industry. It also illustrates the interrelationships that exist between several of the barriers examined. As discussed in Chapter V, some people prefer to wait for technological advances to solve the energy problem. Commercial building owners, however, expressed concern that the rapid technological advances in the energy field will make some of the investments that are rational today obsolete before they can pay for themselves. In another set of interviews appearing in the literature, one developer of commercial buildings expressed concern about being the first to install a newly introduced energy-efficient technology and then having to watch the price drop for his competitors as production of the technology increased (Blumstein, et al., April 1980, p. 363).

3. Competitive Office Space

Competitive office space is also a highly leveraged form of investment, and the same investment rules apply as for shopping centers. However, fewer of the building owners interviewed in this subsector placed emphasis on the first-cost or payback barriers in relation to other barriers to retrofit.

Consistent with findings in the sparse empirical literature on commercial sector barriers, competitive office space owners gave emphasis to several other concerns regarding energy conservation retrofit. These included concern over manufacturers' claims of energy cost reduction (see Chapter IX), lack of information about cost-effective retrofit opportunities (see Chapter IV), and partnership agreements and third-party benefits (not examined in this study).

First-cost and payback concerns were mentioned, nonetheless. Three of those interviewed for this study expressed a preference for making retrofit investments out of current income, which makes initial cost a major consideration. This preference for making retrofit investments out of current income also appears in the literature on office buildings (Blumstein, et al., April 1980, p. 362; Syska & Hennessey, August 1978, p. 4; see Chapter X). First cost as a criterion itself also appears in the literature (Blumstein, et al., April 1980, pp. 365, 366; Opinion Research Corporation, July 1976, pp. 12, 32).

Payback was mentioned by one office owner interviewed as his primary investment analysis method. This owner specified three years or less as his criterion. Another had investigated a computerized energy monitoring system for a building and decided not to install it because it would not pay for itself soon enough.

The rent pass-through and equity recovery-and-reinvestment circumstances described in the preceding section also operate for competitive office space owners as barriers to the use of longer-term payback criteria and life-cycle cost analysis.

4. Summary

Available research, supplemented by a limited number of interviews in two commercial subsectors, indicates that commercial building owners continue to make retrofit decisions within traditional real estate investment guidelines which, in turn, militate strongly against adoption of longer-term life-cycle costing investment criteria. First cost and short-term payback are strongly entrenched decision criteria. A premium is placed on rapid recapture of invested equity in order that the funds can be reinvested in additional real estate ventures. Once a venture is completed and tenanted, it is expected to provide a depreciation-protected source of tax-free earnings, and also appreciate in value for potential sale to other investors. The recaptured equity and profit from sale are immediately put back to work in larger and, hopefully, more profitable ventures.

There is only limited evidence that this short-term focus has, as yet, worked to the disadvantage of the owners where energy is concerned. With the exception of depressed locations, energy costs are readily passed through to tenants in the form of higher rents. Within an inflationary economy, the tenants accept such increases as a fact of life, and in turn, pass these on to their customers and clients in the form of higher fees and prices. In depressed locations, owners absorb the increases in energy costs for as long as they can, hoping to sell before they have to raise rents and lose tenants. These owners typically are not interested in retrofit investments of any kind.

The first-cost and short-term payback decision criteria for commercial retrofit investments are major barriers to energy conservation retrofit. The energy savings to be realized in eliminating these barriers are ranked among the

largest available from the removal of any of the barriers examined.

C. Ease With Which the First-Cost and Short-Term
Payback Barriers Can Be Remedied

1. Federal Action

The interview comments summarized above, as well as the available literature, suggest that modification of prevailing attitudes will be difficult to accomplish under current and prospective circumstances. Investment rationales and perspectives have developed over several decades in response to increased demand for commercial building space and high perceived risk. Owners are not likely to respond now to appeals to abandon traditional and proven investment philosophies in order to replace them with new criteria that will more effectively serve national energy conservation goals. Consequently, some of the suggestions that will be offered as remedies entail considerable government expense. The suggestions include tax code revisions, a loan program, utility rate revisions, and changes in state regulatory policies.

a. Tax Code Revisions. The preceding analysis and existing experience (see subsection 2 below) suggest that revision of the Internal Revenue Code might be one of the more effective approaches to stimulating conservation in the commercial sector.

Income tax revisions can take the form of either incentives or levies/constraints. The incentives approach typically involves loss of tax revenue to the national treasury, a particularly sensitive issue during any period of

attempted budget balancing. The use of tax levies/constraints, on the other hand, is usually viewed by business as an unacceptable attempt by government to interfere with its operations.

The following suggested income tax revisions are believed to have potential for removing the first-cost and short-term payback barriers and for encouraging expanded conservation retrofit decisions within at least the two real estate subsectors being studied. The suggestions are not all consistent with one another, since some represent alternatives. Each is offered separately.

(1) Incentives. Tax credits and accelerated depreciation advantages would help to narrow or to eliminate the time-span differential between objective life-cycle costing and the much shorter payback periods which owners have established on the basis of traditional real estate investment philosophies. Suggested possibilities include:

- (a) Enact a "bonus" business expense credit for energy audit expenses incurred by owners of commercial office and retail space. Additionally, provide a graded scale of tax credits for retrofit outlays made in accordance with such audits, with greatest credits accorded to investments with the highest cost and longest payback periods.
- (b) Establish rapid and substantial depreciation allowances for conservation retrofit investments in order to help overcome first-cost barrier constraints. The

greatest benefits might be accorded to retrofit categories that cost the most and which have the longest payback periods.

- (c) Establish a greatly reduced income tax rate on net additional income derived from energy savings accomplished from retrofit outlays. Owner documentation would be required to claim this preferential rate.
- (d) Establish a special tax credit for the costs of installing individual metering or sub-metering in a master-metered commercial building.

(2) Levies/Constraints.

- (a) Enact a constraint making attractive, accelerated depreciation allowances for retrofit investments dependent upon installation within, say, a three-year period. The costs of an audit to select measures could represent a legitimate and deductible operating expense.
- (b) Disallow a certain portion of energy outlays as a legitimate and deductible operating expense.

b. A Loan Program. Despite the fact that owner-investors generally express reluctance to borrow funds for retrofit and prefer to pay for such outlays from current income or cash reserves, a federal program to facilitate retrofit borrowing might help to overcome the barrier by reducing the

initial outlay for large-scale retrofits. There is precedent for such a program in various existing federal programs (e.g., Small Business Administration loan participation and direct loans), and in the issuance by various states of tax-free revenue bonds to support mortgages with below-market interest rates. The Department of Housing and Urban Development's Section 312 rehabilitation program has established precedent for subsidized loans to both residential and commercial structures.

c. Changing Utility Rates and State Regulatory Policies. Federal leadership could be exercised with regard to state energy regulatory policies and utility rate structures. The following changes might be considered:

- (1) Remove current cost advantages for bulk purchase of energy.
- (2) Remove restraints against sub-metering in office buildings.
- (3) Reduce rates or provide rebates for commercial users who can demonstrate energy conservation savings through retrofits.
- (4) Based upon an audit, establish a range of "normal" utility energy use for individual buildings; establish higher rates for energy usage in excess of these budgets.

2. Effort Required

The cost to the government of implementing most of these suggestions is likely to be large. For example, recently

released data on the use by small commercial firms of the energy tax credits made available by the 1978 Energy Tax Act show that the response to such measures -- and the resulting loss to the government in tax revenues -- is likely to be significant. During the first 18 months of the credits, small commercial users (as defined by firms submitting individual Form 1040 tax returns) claimed \$9.3 million in tax credits, and this figure is likely to increase dramatically. In 1979, approximately 2,400 commercial firms claimed \$2.6 million in credits. During the first six months of 1980, 5,200 firms claimed \$6.7 million in credits (Energy User News, August 18, 1980, p. 1). As familiarity with these credits spreads, the credits claimed should increase. Any additional benefits offered as measures for overcoming the first-cost barrier will accelerate this trend.

In addition to the loss of tax revenues, some of the suggestions offered here are likely to meet with resistance from the commercial real estate industry. Accordingly, the effort required to substantially eliminate the first-cost and short-term payback barriers will probably be as large as that required for the most difficult of the barriers examined.

D. Effects Other Than Energy Effects That May Result
from Removing the First-Cost and Short-Term
Payback Barriers

No discussion was found in the literature of the effects other than energy effects that may result from remedying these barriers. If property owner investment perspectives can be altered to encourage borrowing for large-scale retrofit, this could impose a burden upon available credit. To cope with this, as indicated previously, there could be a role for direct federal lending, or for participatory lending.

An additional source of potential credit could be state tax-free borrowings for making conservation loans at below-market interest rates. Such state revenue bond borrowings have been extensively used to support home ownership and subsidized rental housing programs. Prior to the current recession and its disproportionately severe impact upon the housing industry, the Administration had sought to curtail these state borrowings as inflationary in nature. At this point, however, such borrowing and relending would probably be viewed favorably as a stimulant to the lagging construction industry and as a measure to combat unemployment among construction workers.

In any case, on the basis of an unpublished, preliminary assessment of prospective credit availability for large-scale conservation retrofit among single-family properties, it does not appear (1) that there will be a shortage of retrofit credit, (2) that its comparative price will be excessive, or (3) that it will create unacceptable nationwide increases in total credit costs.* Inasmuch as the level of large-scale commercial property retrofit probably would be much less than the level of residential retrofit envisioned in this study, the demand for credit should be less, and the conclusions probably apply as well for the loan proposal suggested in this study. (See also Chapter X of this study.)

Overcoming the first-cost impediments to conservation investment will also create a demand for retrofit equipment and for its installation. This can serve to stimulate the economy and perform as an antirecessionary instrument. Moreover, as indicated earlier, retrofit installation will be

*The study, *"The Administrative Feasibility of a Mandatory Program for Residential Energy Conservation,"* prepared by the Urban Institute for the Department of Housing and Urban Development, is currently undergoing agency review within the government.

directed to the construction industry, which has suffered disproportionately during the current economic downturn. The effect is not expected to be large, however.

None of the available studies or literature suggests that there will be a shortage of materials for expanded production of appropriate retrofit equipment for the commercial sector.

A problem may develop if mandatory constraints are used to overcome first-cost impediments. The office building owner who is in a precarious financial condition and whose property (by virtue of age, condition, or location) has outlived its useful economic life may "walk away" and abandon his property rather than spend more money to retrofit it. Similar experiences have occurred in multifamily rental housing in older American cities. It may, therefore, be in the best interest of the city and of the nation to create exceptions to such constraints in order to preserve this type of property for rental space for "incubator" firms which need low-cost rents in order to grow and expand, or to provide affordable rents for marginal firms which are unable to pay for newer and better space.

E. Quality and Quantity of the Data Used in the Analysis

The unpublished data used in this analysis are essentially qualitative in nature. They represent conclusions drawn from limited respondent samples. Similarly, the owners interviewed for this study constitute a very limited sample. There is general agreement in the literature and among the owners interviewed for this study that first cost and short-

term payback are major impediments to commercial energy conservation retrofit; however, there are no quantitative assessments of the impacts of these impediments.

As a result of these limitations, the findings of this analysis should be considered suggestive. However, the degree of consensus on the importance of the payback barrier generates a fairly large measure of subjective confidence in the conclusions reached concerning the relative impact of that barrier on retrofit activity.

IV. LACK OF PRECISE AND/OR CUSTOMIZED INFORMATION

A. Description

Knowledge of what can and ought to be done to improve the energy efficiency of a building is a prerequisite to any form of energy conservation retrofit. When a building owner either (1) does not have knowledge of what can be done for his or her building, or (2) knows what can be done but does not know what would be cost-effective and cannot or does not want to spend the resources necessary to find out, then this lack of knowledge becomes a barrier to energy conservation retrofit. Both instances were examined for this study.

The lack of precise and/or customized information is a retrofit barrier for owner-occupants, owner-investors, managers, and tenants in both the residential and commercial sectors.

B. Energy Savings Potential

The lack of precise and/or customized information regarding energy conservation investment opportunities emerges from several studies as a major barrier to retrofit in both the residential and commercial sectors. With one limited exception, however, no satisfactory empirical assessment of its impact on the potential for reduction in energy usage was found. (The exception applies to the multifamily housing subsector of the residential sector). Nonetheless, the existing literature suggests that removal of this barrier will generate nearly as much energy conservation retrofit activity as

can be generated by the removal of any of the other barriers examined.

1. Residential Sector

Evidence of homeowners' lack of knowledge about what can be done, how much it would cost, and what the resulting energy cost savings would be, shows up in several studies. In a major overview of residential energy conservation, the Congressional Office of Technology Assessment (U.S. OTA) lists a lack of practical knowledge about how to conserve as one of six primarily institutional barriers to energy conservation (U.S. OTA, July 1979, p. 67).^{*} These barriers were compiled from a large number of studies of attitudes toward energy conservation and energy conservation actions. They affect usage behavior as well as retrofit activity.

Similar evidence that homeowners do not know what they can do or need to do also exists in two Federal Energy Administration (FEA) surveys taken in 1976 and 1977. A national probability sample collected in April 1976 showed that only 13 percent of the residential respondents believed that their houses needed additional insulation (Milstein, October 1976, p. 6). Yet another survey, conducted after the record-breaking cold winter of 1976-1977 when insulating activity might have been expected to increase, disclosed that about 20 percent of

^{*}*The other five barriers are: (1) lack of social pressure or reinforcement for conserving behavior; (2) disparity in effects of the energy problem, as well as in opportunities to conserve among different income groups; (3) conflicts between conservation objectives and other goals such as comfort, convenience, and "fairness;" (4) distrust of information providers and disbelief that shortages are "real;" and (5) complacency caused by faith in a technical solution to future energy supply problems. Several of these are examined in later chapters of this report.*

American residences had no insulation at all and many more had inadequate insulation (Milstein, June 1977, p. 3). Other reports have also noted this lack of basic knowledge about retrofit opportunities among homeowners (Bakke, October 1975, pp. 17, 23; U.S. DOE, May 1980, p. 37; Craig et al., n.d., p. 541).

Few homeowners are able to estimate the cost-effectiveness of those energy conservation measures that may be relevant for their homes. An often-cited study of a group of townhouses in New Jersey suggests that few are able even to guess accurately what the energy costs are for various energy-using activities in their households (Becker et al., June 1979, p. 84). When asked to estimate the cost of caulking and adding six inches of attic insulation, 78 percent of the participating townhouse owners overestimated the cost by \$50 to \$1,550. Conversely, asked to estimate the savings from these installations, almost 56 percent of the participants underestimated the savings. Similar findings were reported in a recent survey of utility-administered retrofit programs (U.S. DOE, May 1980, p. 80).

Given that homeowners in general do not have adequate knowledge about the energy conservation opportunities and benefits that apply to their homes, another study indicates that when their knowledge of energy conservation is increased, they become more likely to modify their energy-usage behavior. This study did not examine retrofit behavior and the reported correlations were weak (less than 0.2); however, if it can be assumed that individuals who have exhausted their options to reduce usage at low cost (i.e., by behavioral changes) will begin to consider retrofit, then people with energy conservation knowledge will be more likely to retrofit than those without it (Burby and Marsden, 1980, p. 51).

Increasing the level of energy conservation information may also help to remove other barriers, thereby adding further to the energy savings potential implicit in this barrier. For example, given more knowledge, a homeowner may feel more comfortable in dealing with retrofit contractors and products (see Chapters VIII and IX) and, perhaps, be more willing to look beyond first costs to consider life-cycle cost criteria (see Chapter II).

The lack of precise information is also a major barrier in the multifamily rental housing sector. A study of 106 apartment owners by the National Apartment Association for the Department of Energy indicated that uncertainty about the cost-effectiveness of different energy conservation alternatives was the major barrier to their investing in retrofit (68 of 106 respondents) (U.S. DOE, May 1980, p. D-7). A recently completed study on energy usage in apartments also found a lack of knowledge among apartment owners; in this case, knowledge concerning the costs and benefits of alternative metering practices (Institute of Behavioral Science, June 1980, p. 27).

A group of researchers at Lawrence Berkeley Laboratory recently interviewed four owners and/or managers of residential rental property in central California. Three of the interviewees mentioned lack of information with which to evaluate the cost-effectiveness of specific options for their property as a reason for not doing more in the retrofit area. One noted that the supposedly low return on these investments dissuaded him from making the effort to learn what the actual return for his property would be (Blumstein et al., April 1980, pp. 359-361).

A 1975 study of incentives for energy conservation, including retrofit, in the multifamily housing subsector

stressed the impact of a lack of information on retrofit. This study covered general, specific or customized, and feedback types of information and estimated that an annual savings of 4,915 million Btu/year due to retrofit could be realized from the implementation of a variety of informational and educational programs (16 types of activity were suggested) (Real Estate Research Corporation, November 1975, pp. 45-46, 59-60, 71).*

The lack of precise or customized information, by itself, is considered to have a major inhibiting effect on residential energy conservation retrofit. This effect is probably greater in the residential subsector represented by single-family housing owners than in the subsectors represented by multi-family housing owners and tenants. Lack of information, by itself, is not likely to have much of an effect on renters who are far more sensitive to the lack of reasonable economic incentives to retrofit. Apartment owners have similarly indicated that they prefer to have information on energy conservation options supplemented by additional economic incentives (U.S. DOE, May 1979, p. D-7).

The facts that the owners of single-family housing, who constitute 68 percent of the residential housing sector, are significantly affected by this barrier, and that information is at least a prerequisite to removing other barriers, suggest that the potential for energy savings resulting from removing the lack-of-information barrier in the residential sector is likely to be nearly as great as the largest potential for savings of the other residential barriers examined.

*This potential ranked a distant second to the energy savings potential estimated for a package of economic and fiscal incentives for the multifamily housing subsector (24,574 million Btu/year).

2. Commercial Sector

Empirical evidence of the existence of this barrier in the commercial sector was found in a study of the attitudes of commercial office building owners in New York City toward energy conservation retrofit (Syska and Hennessy, August 1978). The office building owners had little knowledge of the potential for operating cost savings available through energy conservation retrofit. Only 10 percent of those contacted reported that they were monitoring and comparing their energy usage to that of other commercial properties. Most treated the study as a welcome source of information on a subject they knew little about.

The study also observed that a relatively long period of time is required for a commercial office building owner to absorb enough information to be decisive about energy conservation retrofit (Syska and Hennessy, August 1978, pp. 83-84). The reported lack of widespread energy monitoring, the interest in having information provided, and the lengthy time required for it to be absorbed all suggest that commercial building owners perceive the information costs associated with learning about energy conservation retrofit as being very high.

On the other hand, the group of researchers for Lawrence Berkeley Laboratory mentioned earlier also interviewed five owners, managers, or operators in California concerning their attitudes toward and knowledge of energy conservation opportunities. In this research, only one of the interviewees mentioned a lack of information as an obstacle to investing in energy conservation retrofit; their principal concerns appeared to be costs and the uncertainty of existing savings projections (See Chapters III and IX). A fifth interviewee, an owners association representative, observed that there was

an abundance of energy conservation information available, but it was difficult for individual managers to evaluate it (Blumstein et al., April 1980, pp. 362-364).

Although these two studies provide a meager basis for judgment, the information barrier is thought to have a significant effect on energy conservation retrofit in the commercial sector. The study of New York City office building owners concluded that the removal of this barrier, by itself, would probably lead to retrofit action. The commercial building owners interviewed, contrary to their apartment-owner counterparts, did not feel that additional government-supplied incentives would be necessary. They did observe, however, that such incentives would signal a "sense of urgency" (Syska and Hennessy, August 1978, p. 4). This observation suggests that a psychological "inertia" barrier may be operating in addition to a cost-of-information barrier (see Chapter V).

Another weak indication that commercial building owners/occupants have a tendency to act on information alone is provided by the evaluation of DOE's Energy Extension Service (EES) pilot program. The EES provides energy information services. Users of the EES were asked to evaluate the influence of its information services on their energy conservation actions. A relatively large percentage of small business owners who sought out EES services (35.6 percent) evaluated EES's influence as "major" (the highest category). This was 1.2 times the percentage of the next highest sector reported in this category of influence (U.S. DOE, March 1979, p. 24).

The potential energy savings in the commercial sector resulting from the elimination of this barrier is likely to be nearly as great as the potential for savings existing for any of the other barriers in the commercial sector.

C. Ease with Which Precise and/or Customized
Information Can Be Provided

1. Federal Action

The most effective way to remove this barrier will be actions that provide the building owner with customized retrofit information at low or no cost in money, time, or effort. The customary methods of generating this information are through an energy audit or energy survey. These may be done: (1) entirely by a second party, (2) in part by the building owner and in part by a second party, or (3) entirely by the owner.* The first alternative, performed free of charge, is likely to be the most effective.

DOE currently has a program that will offer most single-family housing occupants and utility customers in two- to four-unit multifamily buildings an energy audit on request. A charge may or may not be made, and the results will be delivered in person. This program, the Residential Conservation Service (RCS) Program, is scheduled to begin in the fall of 1980. It will eventually be expanded to include larger multifamily and small commercial buildings. There are elements of this program which may blunt its effectiveness, however. They include: an unrealistic warranty provision, provision for an audit charge, a labeling requirement, installation standards, and omission of large commercial buildings. Efforts have been made or are being made to reduce the negative effect of some of these elements on the program's ability to attract owner, manufacturer, and contractor interest.

**These three types of audits are usually referred to as Class A, B, and C audits, respectively.*

Other elements of the program (e.g., the lack of coverage for large commercial buildings) are not likely to be rectified. Therefore, concurrently with the RCS Program, the government might productively stimulate complementary approaches to getting customized information to building owners. In some areas, small companies have been or are being formed that will provide energy audits and other retrofit services to residential and commercial building owners. A few larger companies are also offering these services. The government might strengthen the operations of these companies by providing grant funds for technical and sales training for their staffs. A similar policy has already worked successfully for oil dealers using DOE's Fuel Oil Conservation Demonstration Program (U.S. DOE, July 1979), and proposals are already being considered by DOE that would provide utility financing for commercial energy services. Alternatively, the government might encourage these companies by providing them with special tax incentives over a limited period of time.

Another scheme to (1) reduce the investor's cost of acquiring customized information, and (2) help commercial audit companies, would be to permit the audit cost to be deducted as a tax credit by the individual who pays to receive the results of the audit. Such a credit could easily be abused; therefore, as a control, the allowable audit costs might be limited by a ceiling, perhaps \$85, for single-family residences, and for multifamily buildings by an amount that would be a function of the number of units in the building. Ceiling limits for commercial building audits could be based on floorspace.

This suggestion is probably more appropriate for multifamily housing owners and commercial building owners (including large commercial building owners) than for single-family housing owners. The latter respond more readily to the offer

of an audit if the audit is low cost or free of charge (U.S. DOE, October 1979, p. 2-40). If audit companies know that customers can claim a tax credit for the cost of their audit, they are very likely to charge at least the maximum allowed. Single-family homeowners are equally likely to discount heavily the future tax savings and, therefore, not respond even though they will eventually get their money back. Investment property owners, on the other hand, are likely to be receptive to opportunities for future tax benefits and, therefore, less likely to be put off by an expensive audit.

2. Effort Required

Based on estimated costs for the RCS Program (U.S. DOE, October 1979) and its forthcoming amendments, and the likely costs of the suggested complementary policies, the effort required to remedy the lack of precise and/or customized information in both sectors was judged to be midway between the effort required to remove the most difficult barriers and that required to remove the least difficult.

D. Effects Other Than Energy Effects That May Result from Removing the Barrier

No discussion of effects other than energy effects that may result from removing this barrier were found in the literature. The increase in demand for energy conservation measures that will result from the removal of this barrier will probably be noticeable. However, unless the demand is accelerated by strong economic incentives and simultaneous elimination of other barriers, it will be spread over several years, making its impact on inflation and employment slight.

A tax credit for energy audits may promote the creation of new businesses and a small amount of additional employment. Since there are a finite number of buildings that can use audit services, this may result in an oversupply of these services and create a short-term business phenomenon that would eventually result in a number of bankruptcies and defaulted bank loans. Inevitably, a few of these new businesses will be unreliable as well and produce consumer dissatisfaction.

The environmental effects resulting from increased energy conservation retrofit activity have been examined for the residential sector in the Environmental Impact Statement for the RCS Program (U.S. DOE, November 1979). They are not expected to be significant. A similar level of environmental analysis has not been conducted for retrofit in the commercial sector; however, the impacts in this sector are also likely to be small.

E. Quality and Quantity of the Data Used in the Analysis

The quantitative data available for assessing the impacts of this barrier are weak. The data used for the residential sector analysis were related more to energy usage behavior than retrofit and were drawn from both national and local surveys. The one exception to this was a 1975 study which assessed the energy savings potential inherent in a variety of information and educational programs for retrofit in the multifamily housing subsector. This study used a subjectively derived estimate of the percentage of building owners that would respond, and assumptions concerning the per-unit-dwelling energy consumption and the amount of energy savings ideally

achievable per dwelling. Its findings were heavily dependent upon the estimates of the number of building owners who would respond. The commercial sector analysis is based almost entirely on a survey of building owners in New York City.

The Milstein studies comparing homeowners' perceptions of their need for insulation to actual need should be reliable at the national level. The same cannot be said for the study of townhouses in New Jersey (although it is often cited) or the New York City office building study (although the authors make an argument that most new office building designs and management theories are represented in New York).

As a result of these limitations, the findings of this analysis should be considered suggestive. The degree of consensus in the literature on the importance of the information barrier, however, generates a fairly large measure of subjective confidence in the conclusions reached concerning the relative significance of this barrier for retrofit activity.

V. LACK OF SOCIOLOGICAL/PSYCHOLOGICAL INCENTIVE

A. Description

Some building owners know that they could save money if they retrofitted their buildings; nonetheless, they refuse to do so. Others do not know that they could save money and appear to be uninterested in learning. These attitudes seem irrational from a traditional economic point of view; however, they are very real from a behavioral point of view. Their source usually lies in a set of values that places high personal utility on nonmonetary goals. Such attitudes have been grouped together and identified as one barrier in this chapter: the lack of sociological/psychological incentives for retrofit. This barrier also includes the operation of sociological/psychological disincentives, i.e., attitudes and social/personal values that actively conflict with retrofit objectives. It refers generally to attitudes, moods, and beliefs that inhibit energy conservation retrofit investment and that have their sources in values other than monetary values.

This barrier can affect all building owners, managers, and tenants in both the residential and commercial sectors. Most of the literature, however, concentrates on single-family owner-occupied households. This may result from the fact that this subsector uses more energy than the other subsectors, or it may result from an assumption that multi-family and commercial building owners respond more readily to traditional economic arguments and are not as inhibited by nonmonetary concerns. Whatever the reason, this lack of coverage of subsectors other than the single-family owner-

occupied households made it difficult to assess the impact of the sociological/psychological barrier on those subsectors.

A distinction has been drawn between sociological and psychological barriers for purposes of tailoring appropriate messages to counteract them. The adjective "sociological" identifies attitudes and beliefs that arise because individuals are aware that they are members of a society and tend to accept the society's values. The adjective "psychological" identifies attitudes and beliefs that are formed more out of individual self-interest. An example of a sociological barrier is the belief that American technological prowess is so great that energy shortages will be solved by technological advances; therefore, there is no urgent need to conserve energy. An example of a psychological barrier is the "inertia" or resistance to change that is built up when one becomes comfortable with a way of life. Inevitably, there are gray areas between these two categories, and the distinction does not merit unusual attention. The two categories have been used only because they suggest different types of remedies (see Section C of this chapter).

B. Energy Savings Potential

No study was found that attempted a rigorous assessment of the impacts of the sociological/psychological barrier. Several reports have correlated variables, such as belief in the energy crisis, to energy-usage practices; however, none were found that relate such beliefs to retrofit activity.

The barrier is often mentioned in the literature for single-family housing and rarely mentioned in the literature on the other subsectors. As previously mentioned, there can

be reasons for this other than an actual lack of impact in these subsectors; however, pending additional research on these other subsectors, the barrier is presumed to have its greatest effect in the single-family owner-occupied housing subsector.

In the residential sector as a whole (considering the predominance of single-family owner-occupied dwellings in this sector), removing the sociological/psychological barrier should produce a relatively large reduction in energy usage when compared to most of the other barriers examined for this sector. In the commercial sector, however, the potential energy savings should be considerably less. The savings for the commercial sector are likely to rank at or near the bottom of a scale of the savings that could be realized from removing other barriers. In the following discussions of the potential energy savings in each sector, the components of this barrier will be classified as sociological or psychological in accordance with the definition given earlier.

1. Residential Sector

The findings summarized in this section apply primarily to the single-family owner-occupant subsector of the residential sector. Since this subsector comprises 68 percent of the dwelling units in the residential sector, it represents by far the major segment of the sector. The multifamily housing subsector is not well represented in the literature on this barrier. One study was found that specifically examined the sociological/psychological barrier in the context of the multifamily-housing-owner subsector. It found the barrier to be unimportant for that subsector (Blumstein et al., April 1980, p. 360).

a. Sociological. Civilization consists of a number of norms, attitudes, and beliefs that combine to help individuals live together. These norms and beliefs aid the individual in dealing with the normal conflicts that exist between personal interest and social interest. Some of them have implications for energy conservation retrofit. One fundamental social norm in times of crisis holds that the individual should be prepared to make a sacrifice for the welfare of the whole society. Americans' belief in the existence of a national energy crisis has been one of the most heavily researched energy-related opinions. The pre-1979 literature was reviewed by the U.S. Congressional Office of Technology Assessment (OTA) in its overview of the potential for energy conservation in the residential sector (U.S. OTA, July 1979, Chapter III). This material, while not directly relevant to retrofit questions, offers some insight into the potential effect of this belief on retrofit.

OTA found that attitudinal surveys revealed a general mistrust of both government's and industry's explanations of the post-1973 energy situation. One national study in 1977 indicated that people felt there was a real need to reduce energy usage, but they also felt the fuel shortages were artificially contrived (Milstein, 1977). The same study showed that there was little or no relationship between such belief and energy-using practices. Other studies have also produced findings that show no relationship or weak relationships between attitudes toward energy conservation and energy-usage behavior (Olsen, n.d., in U.S. OTA, June 1979, p. 66; Becker et al., June 1979, pp. vi, 7; League of Women Voters, January 1979, pp. 3, 66). These findings suggest that until people sense a degree of urgency about the energy situation they will not act on their beliefs that something needs to be done -- whether it be changes in energy-usage practices or retrofit investments. There is, however, evidence from a

national survey conducted during the fourth quarter of 1979, for which DOE was one of the sponsors, that a positive relationship may be developing between belief about the seriousness of the energy problem and energy-usage behavior/retrofit activity. The possibility that the effect of this barrier may be changing is discussed in more detail in Section C below.

Other socially oriented norms and beliefs appear in the literature as impediments to energy conservation retrofit:

- (1) The nation's technological ingenuity will provide a solution to energy shortages; therefore, there is no really urgent need to save energy (U.S. OTA, July 1979, p. 71; Cambridge Survey Reports, Fourth Quarter 1979, p. v.).
- (2) The individual should not voluntarily make personal sacrifices to conserve energy for the good of the nation unless it is clear that others are making similar sacrifices (Milstein, 1977, pp. 12-13).
- (3) Actions by individuals are insignificant in comparison to the national need; individuals cannot produce noticeable savings (Becker, et al., June 1979, p.7).*

*The League of Women Voters, in a series of public workshops and surveys in four communities, found an opposite viewpoint. The League observed that people felt that as individuals they could make a difference, but they were unwilling to act on this belief if it would cost a lot of money (League of Women Voters, January 1979, p. 3).

- (4) In order to avoid the sense of social guilt resulting from an inability or unwillingness to meet a perceived obligation, individuals will avoid having an energy audit performed (U.S. DOE, May 1980, p. 14). If individuals learn that their homes or apartments are energy-inefficient, then there will be a personal and social obligation to act. But it may not be cost-effective to make some residences energy efficient because of design features such as large glass areas. If individuals believe they may be confronted with this knowledge as a result of an audit, they might avoid the audit.

b. Psychological. Individual activity is also governed by norms and attitudes that reflect personal interests. Some of these have an effect on an individual's willingness to retrofit his or her home. The purely personal concern that appears most often in the literature is the concern over the impact of energy conservation commitments on personal comfort and convenience (i.e., life-style). While the relationship between this concern and energy conservation activity is usually assessed for energy-usage practices rather than for retrofit, the results suggest it also has an impact on retrofit.

In 1976-1977, researchers from Princeton University conducted a series of surveys and experiments with a group of townhouse owner-occupants in New Jersey. These studies revealed that preferences for health, comfort, and convenience were correlated to higher energy usage. This is not a surprising finding; nonetheless, it is useful because it suggests that an energy conservation investment will be resisted if it is perceived as requiring a sacrifice of life-style (Becker

et al., June 1979, pp. vii, xv, 8). This suggestion also was supported by a finding which indicated that comfort is more important than future monetary savings. The owners' perceptions of their future financial status were found to be unrelated to high energy usage. This implies that individuals place a higher value on present comfort and convenience than on future monetary savings (Becker et al., June 1979, pp. 14-14a). If retrofit is perceived to be associated with actions that result in a loss of comfort or convenience, whether it does in fact or not, it will be resisted. This unwillingness to renounce comfort and convenience has also been reported in several other studies as a barrier to energy conservation in the residential sector (U.S. DOE, May 1980, pp. 14, 80; U.S. OTA, July 1979, pp. 67, 69; Cambridge Survey Research, Fourth Quarter 1979, p. 204; Craig et al., n.d., p. 546).

Another psychological factor that may reduce an individual's willingness to invest in energy conservation is resistance to change, or "inertia." Although this barrier did not appear as a specific focus of any of the studies reviewed for the residential sector, it was mentioned in several (e.g., Blumstein et al., April 1980, p. 357), and personal contacts between the contractor and a retrofit retailer in New England have indicated its existence. A utility in Tampa, Florida, has described a related barrier, consumer apathy, as one of the two primary barriers it faces in its residential program. (The other is the first-cost barrier. Air Conditioning, Heating, and Refrigeration News, February 4, 1980, p. 76).

c. Summary. None of the studies reviewed directly relate attitudinal variables to retrofit activity in the residential sector. The New Jersey townhouse study came closest to providing this information by correlating several

attitudes with actual energy usage. Nonetheless, the heavy emphasis on personal comfort as a perceived reason for not acting, plus the variety of other beliefs reported in the literature, indicate that the sociological/psychological barrier may have a relatively large inhibiting effect on retrofit activity in the residential sector. This assessment is relative to the potential reductions in energy usage achievable from overcoming the other barriers examined for the residential sector. The impact of this barrier is probably greatest in the single-family owner-occupant subsector; however, only the relative absence of its appearance in the literature on multifamily housing supports this conclusion.

2. Commercial Sector

a. Sociological. No evidence was found in the small amount of literature available on commercial building owners that their decisions to invest in retrofit are influenced by sociological beliefs or attitudes. This could be due either to the lack of research in this subsector or to the very strong orientation of these individuals to economic signals.

b. Psychological. Conservatism and inertia are the principal psychological barriers identified in the commercial sector. The conservatism is usually attributed to uncertainty concerning the multitude of factors that can affect any investment outcome (A.D. Little, August 1979, pp. 12-13, 18; Syska and Hennessy, August 1978, p. 3). This characteristic, therefore, would appear to be a manifestation of "rational" barriers rather than the softer type of barrier being examined in this chapter.

Inertia, or resistance to change, appears as a general characteristic of the commercial building industry in

several studies (A.D. Little, August 1979, passim; Syska and Hennessy, August 1978, p. 4; Schoen et al., 1975, pp. 51, 53). As with the characteristic of conservatism, however, it may be that what has been observed as inertia is, in reality, a rational response to economic uncertainty.

Based on these considerations, almost no evidence was found to indicate that psychological barriers to energy conservation retrofit operate in the commercial sector.

c. Summary. The sociological/psychological barrier is thought to have a very small impact on the commercial sector. Efforts to overcome this barrier should result in a smaller potential for energy savings than the removal of any other barrier examined for the commercial sector.

C. Ease With Which the Sociological/ Psychological Barrier Can Be Overcome

1. Federal Action

Specific attitudes very rarely stand alone. Invariably, they are part of a highly complex network of other attitudes and expectations about what constitutes acceptable behavior and what kind of rewards should be due to the believer. Usually, change in one attitude requires changes in others in order to maintain consistency in the individual's system of beliefs. Attitudes that have become very well integrated are, therefore, very resistant to change.* Effective attitu-

**Researchers at the University of Illinois, for example, have concluded that conservation campaigns aimed at the "deeper life-styles" cannot succeed at present (Hyland et al., 1975, as cited in U.S. OTA, July 1979, p. 69).*

dinal change is accomplished by reeducation. This can be done by persuasion, schooling, or experience. For the purposes of this analysis, the only feasible method is assumed to be persuasion. This requires the use of information programs and advertising.

Energy usage behavior is a result of (1) attitudes about what constitutes acceptable energy usage, (2) expectations about what constitutes the life-style one should be enjoying, and (3) of the ability to satisfy these expectations. Information programs addressed to retrofit will probably be most effective if they treat all three sources of energy usage behavior. To this end, coordinated programs can be designed to (1) establish the acceptability of energy conservation retrofit, (2) disseminate information about the ability to maintain comfort and save money, and (3) provide specific tangible incentives to reduce the cost of retrofit. (The last suggestion is discussed in other chapters of this report.) These programs should be addressed principally to the single-family owner-occupied housing subsector. Possible approaches are discussed below.

a. Acceptability of Energy Conservation Retrofit.

Information programs to establish the acceptability of retrofit might improve their effectiveness if they distinguished between sociological and psychological barriers. Messages created to counter sociological inhibitions will probably be more effective if they use the plural pronouns "we," "us," or "our" to convey the impression that collective outcomes depend on individual actions. Messages designed to counter psychological inhibitions will probably be more effective if they address the concerns of the individual directly without placing those concerns in a larger social context.

Messages addressed to sociological concerns regarding the acceptability of retrofit activity might include:

- (1) Examples showing that individual efforts do make a difference
- (2) Analogies to historical occasions in which long-term collective cooperation, preferably in a non-crisis setting, produced outcomes that generated a sense of national pride.

b. Dissemination of Information about Life-styles and Costs. Messages addressed to personal concerns might be effective in creating the perception that retrofit can both provide future savings and not reduce an individual's level of comfort and convenience. The analysis suggests that such messages probably should stress monetary savings and comfort (see also U.S. OTA, July 1979, p. 67). Possibilities might include:

- (1) Case histories of cost savings from installations in each subsector.
- (2) Personal "testimonials" stressing cost savings and comfort maintenance.
- (3) The use of feedback programs to encourage additional retrofit or provide word-of-mouth experience. Example: each household or commercial establishment's energy utility bill could contain information showing how much energy was used during the same period of the previous year and how much that energy would have cost at present energy rates.

(4) Information on special tax incentives.

Messages addressed to individual concerns should avoid creating a perception that:

- (1) One's home is energy-inefficient.
- (b) Discomfort should be accepted for altruistic reasons.
- (c) Financial sacrifice should be accepted for altruistic reasons.

The timing of messages about energy conservation may be highly relevant to their effectiveness. This is discussed in the next subsection.

2. Effort Required

The ease with which the psychological/sociological barrier can be removed will depend on the degree to which the impeding attitudes have become integrated into the energy users' concept of a proper life-style. The more deeply held beliefs will require greater effort to change. The evidence appears to indicate that the attitudes that constitute this barrier are deeply held.

This implies that frequent repetition of the suggested or similar messages over a period of time will be needed. An effort approaching a "hard sell" will be needed if the removal of this barrier is to be accelerated. Accordingly, the effort required would appear to be almost as great, if not as great, as the effort required to remove the most difficult barriers.

Recent survey findings indicate, however, that certain types of events may reduce the effort that is needed to eliminate this barrier. Results of a late 1979 public opinion survey, for which the Department of Energy shared sponsorship, suggest that certain types of national or international events may offer opportunities to speed up the process of changing attitudes through information programs. This quarterly survey reported in early 1980 that, for the first time in the 3-1/2 years that the survey has covered energy questions, Americans appear to be taking the energy situation seriously (Cambridge Survey Research, Fourth Quarter 1979, pp. 193-194). Based on interviews conducted during the fourth quarter of 1979, all of the survey's indicators on energy show an unprecedented consistency in public attitude and action toward energy conservation. The survey analysts attribute this new concern to the embassy takeover in Iran and the high levels to which fuel prices have recently climbed.

The results of this survey suggest that there may be energy-related events which, if they receive enough publicity, will create, for a time, a uniquely receptive national (or regional) audience for energy conservation information campaigns. If the events are prolonged, they may serve not only to heighten receptivity for a time, but also become issues that challenge existing beliefs and make them more susceptible to permanent change. People become more willing to rethink their values in order to make them consistent with perceived reality. Such events should reduce the amount of effort required to remove the psychological/sociological barrier to energy conservation. Assuming this recent poll accurately describes the present situation, the amount of effort required to remove this barrier is perhaps less now than the literature would indicate.

D. Effects Other Than Energy Effects That
May Result from Removing the Barrier

No discussion of effects other than energy effects that may result from removing this barrier was found in the literature. The increase in demand for conservation measures will probably be noticeable. However, unless the information programs coincide with a particularly salient energy-related event -- as discussed above -- the results will be spread over a number of years, and the impact on inflation and employment will be slight.

Should a significant national, international, or regional event and a strong information program coincide, there is a possibility that supply channels for energy conservation retrofit could become strained, leading to public frustration and higher prices for retrofit materials. Such timing is not thought to be likely unless a specific DOE effort is made to take advantage of such opportunities.

Success in achieving a widespread change in the attitudes that inhibit retrofit may be accompanied by widespread changes in other aspects of individuals' beliefs about energy usage and life-style. Tenants and office renters may begin to demand more control over the energy used in their dwelling/working units in spite of existing constraints on renter action in this area. Appraisers may begin to place greater value on buildings' energy features, resulting in a corresponding increase in the price of energy-efficient housing and office space over the price of less-efficient space.

The environmental effects resulting from increased energy conservation retrofit activity have been examined for the residential sector in the Environmental Impact Statement

for the RCS Program (U.S. DOE, November 1979). They are not expected to be significant. A similar level of environmental analysis has not been conducted for retrofit in the commercial sector; however, the impacts in this sector are likely to be small as well.

E. Quality and Quantity of the Data Used in the Analysis

A considerable amount of quantitative and qualitative data are available on public attitudes toward energy usage (see the bibliography in Farhar et al., June 1979, pp. 259ff). Moreover, much of the quantitative data appear to provide valid and reliable indicators of attitude. However, there is much less data available on retrofit behavior, and the data that exist on self-reported retrofit behavior (the majority of the data) are of questionable validity. Three studies, two of which were national, provided most of the data on which the generalizations about attitudes and retrofit activity were drawn (Milstein, 1977; Becker et al., June 1979; Cambridge Survey Research, Fourth Quarter 1979). That is a relatively high number of relevant quantitative data sources; however, retrofit was not the major concern of these surveys, and the relationships between the sociological/psychological barrier and actual retrofit behavior that have been indicated in the preceding analysis should be considered suggestive.

Most of the existing data apply to the residential sector; virtually no data were found on the effects of this barrier in the commercial sector.

VI. FUEL PRICING POLICIES THAT IN THE SHORT RUN
DO NOT PROVIDE ENOUGH INCENTIVE TO INVEST
IN ENERGY CONSERVATION

A. Description

At the present time, oil and natural gas prices are controlled by the federal government below the marginal cost of their replacement. To the extent that electricity rates disguise the controlled costs of the oil or gas used for its generation, electricity is also priced below its true cost. The below-replacement prices for oil and gas provide a temporary windfall for utility users and, to perhaps a lesser extent, fuel oil users. As such, the prices would appear to inhibit or postpone decisions to undertake effective retrofit. Retrofit decisions are made within the context of current utility and energy prices. To the extent that these are unrealistically low, they contribute to longer payback-period estimations and diminish the attractiveness of retrofit investments. In this regard, they work against national goals of improved buildings energy efficiency and conservation.

Residential and commercial energy prices will gradually rise in response to the depletion of "old oil" and the deregulation of new natural gas. If these prices were to rise more rapidly to the marginal cost of their replacement, however, it is possible that retrofit activity would be accelerated. The barrier examined here considers the impact of not allowing fuel prices to rise more rapidly than is now anticipated.

B. Energy Savings Potential

1. Residential Sector

A national survey conducted in late 1979, sponsored in part by DOE, indicates that American consumers are beginning to take seriously the need to conserve energy. Greater levels of energy conservation activity, including retrofit, were reported than in previous surveys. A significant portion of this increase in energy conservation activity is attributed by the survey directors to recent large increases in the price of energy (Cambridge Survey Research, Fourth Quarter 1979).

Additional evidence that residential consumers will respond in a significant way to fuel price increases is provided in a recent study of consumer response to residential retrofit programs administered by utilities. The conservation program managers and staff of nine geographically separated utilities were interviewed. For four of the nine programs, the low cost of utilities was identified as a major barrier to retrofit (U.S. DOE, May 1980).*

Fuel price elasticities of demand, while unable to indicate the degree to which residential retrofit activity would change if fuel prices were increased dramatically, can at least offer an indication of the magnitude of consumer response to such increases and an opportunity to examine the no-retrofit-response hypothesis. A low level of response, as indicated by a low negative elasticity, would indicate little response to fuel price increases and provide indication that

*The four programs were in Tampa, Florida; Sacramento, California; Denver, Colorado; and Seattle, Washington.

retrofit will not be accelerated by fuel price deregulation. Conversely, if high, the indicated greater response might include accelerated retrofit activity. A negative short-run fuel price elasticity of demand near -1.0 would indicate that fuel demand decreases over the near term in nearly the same proportion as its price increases. An elasticity of this magnitude would indicate that owners take early major action of some kind to reduce usage of a fuel in response to an increase in its price, and that removal of this barrier might accelerate retrofit as one of these kinds of action. An Oak Ridge National Laboratory (ORNL) study estimates that the short-run own-price household elasticities of demand for the three major residential fuels are: electricity -.468, natural gas -.887, and fuel oil -.511 (ORNL, March 1977, pp. 14-15, 19-21). Elasticities of this magnitude indicate a significant residential response to fuel price changes.*

The analyses reviewed suggest that more rapid deregulation of fuel prices would probably result in relatively major efforts to reduce energy usage through both changes in usage habits and retrofit. The greatest response in the near term would likely be additional changes in usage habits. Retrofit response over the near term due to removal of this barrier would probably be limited by other barriers such as the use of the first-cost decision criterion. (For a similar view, see Noll, April 14, 1980). The potential retrofit energy

*The long-run own-price elasticities developed in this study are larger. For electricity, the elasticity is -1.04, for natural gas -2.08, and for fuel oil -1.28. These indicate that even greater adjustments -- most likely involving equipment changes -- will occur over a period of years if the price remains high. The short-run elasticities are based on 1969-1974 data; the long-run elasticities are based on data for 1951-1974 (ORNL, March 1977, pp. 14-15, 16-18, 35).

savings achievable in the residential sector resulting from accelerated deregulation of fuel prices is judged to be nearly as large as that achievable by the removal of the barrier having the largest potential energy savings.

2. Commercial Sector

The effect of fuel pricing policies in the commercial sector appears to be less pronounced than in the residential sector. As discussed in Chapter III, owners of commercial buildings are able to deduct energy costs from their federal income tax as operating expenses and, therefore, do not feel the full effect of energy cost increases.

The effect is also less pronounced when the owner does not pay the energy costs himself but is able to pass them through to tenants. As discussed in Chapter III, energy costs are often likely to be a relatively small portion of commercial rents, and tenants are less likely to be concerned with energy costs than with some of the other factors that affect their business operating costs.

Given these considerations, a change in fuel pricing policy that would allow energy costs to rise in the short term is not likely to produce an immediate demand for investments to reduce energy usage in the commercial sector. This conclusion suggests that fuel pricing policies are not having a major inhibiting effect on retrofit in the commercial sector.

As discussed in the preceding section, fuel price elasticities of demand, while they cannot confirm this conclusion, can at least offer an opportunity to challenge it. A negative short-run fuel price elasticity of demand near -1.0 would

indicate that fuel demand decreases over the near term in nearly the same proportion as its price increases. An elasticity of this magnitude would indicate that owners take early major action of some kind to reduce usage of a fuel in response to an increase in its price, and that removal of this barrier might accelerate retrofit as one of these kinds of action. Another Oak Ridge National Laboratory study indicates that, instead, the short-run price elasticities of demand for three fuels in the commercial sector are well below -1.0. For electricity the elasticity is -.343, for natural gas -.274, and for oil -.300 (ORNL, December 1978, p. 22). These fuel price elasticities do not offer a strong challenge to the conclusion.*

They do, however, indicate an unambiguous response of some kind to energy price increases. Moreover, it is possible that these elasticities are larger (negatively) at present. The elasticities developed in the above study were based upon data collected for the years 1968 to 1972, before the present energy situation developed. Since 1972, energy costs for buildings have doubled, and in some cases tripled. It is possible that owner response to further increases is probably greater at these price levels. This possibility is given further weight by the results of a study conducted from 1976 to 1978 on energy usage in 1,037 New York City commercial buildings. The study team found that as the price of electricity in New York City rose during the study period to nearly 10¢/kWh, many of the owners of the buildings in the

**The long-run own-price elasticities are considerably larger. For electricity, the elasticity is -.803, for natural gas -.741, and for fuel oil -.758. These indicate that greater adjustments -- most likely involving equipment changes -- will occur over a period of years if the price remains high (ORNL, December 1978, p. 22).*

study began for the first time to seriously consider making energy conservation retrofit investments. The team concluded that, with one caveat, price alone was sufficient to motivate these owners to retrofit. During troughs in the business cycle, however, the team found that price has very little motivational effect (Syska & Hennessy, August 1978, pp. 4-6).*

Based on these considerations, it is estimated that the energy savings that might be achieved in the commercial sector if this barrier were removed are likely to be relatively small but not as small as that assessed for other barriers. The savings are expected to fall somewhat below the mid-point level as compared to savings from removal of the other barriers in the commercial sector.

C. Ease With Which the Fuel Pricing Barrier Can Be Removed

1. Federal Action

At present, the controls on energy prices operate as described in the following subsections.

a. Electricity. Privately owned utilities dominate the electric power field. Two hundred investor-owned electric utility companies account for three-fourths of the electricity-generating capacity in the United States and serve 80 percent of all electric customers.

**It should also be noted that participation in a major energy usage study may have created an atypical readiness in these owners to respond to price signals and other types of energy conservation messages.*

The regulation of these utility companies takes place predominantly at the state level. State regulatory commissions (1) approve a level of total revenue sufficient to cover costs, depreciation, etc., plus provide a fair and reasonable return, and (2) establish the rates at which electricity is to be sold in order to yield this desired amount of total revenue.

Regulators have allowed utility companies to pass through increased fuel costs to their customers. Recently, these increases have been substantial and frequent. Fuel costs increased by 248 percent between 1971 and 1976, as compared to 24 percent between 1965 and 1970 (U.S. OTA, July 1979, p. 121). In spite of these increases, however, the price of electricity generated by oil and natural gas still reflects the controls on those fuels. Since 38 percent of the energy used to generate electricity in 1974 came from these two fuels (U.S. DOE, June 1978, p. 30), electricity rates in many parts of the country still reflect fuel price controls.

b. Natural Gas. Almost two-thirds of all natural gas produced is moved in interstate traffic; therefore, the price is controlled by the Federal Energy Regulatory Commission. The Natural Gas Policy Act of 1978 brought intrastate gas distribution also under federal regulation; this will eventually tend to even out the previously substantial price differentials between interstate and intrastate gas.

Federal control over natural gas prices has kept them below the prices of new natural gas and imported liquefied natural gas. The Natural Gas Policy Act, however, has paved the way for gradual deregulation of the price of new natural gas. Residential gas users will be sheltered initially, with industrial users carrying the initial burden of price

deregulation. When complete deregulation of new natural gas prices occurs in 1985, the price of natural gas will begin to rise for residential and commercial users to its marginal cost of replacement. Until this occurs, however, users will continue to be able to buy "low-priced" gas.

c. Fuel Oil. There is no federal or state control over prices of fuel oil sold to the consumer. The federal government, however, legislates the prices of oil at the wellhead. To the extent that fuel oil delivered to the homeowner's tank contains a fraction of "old oil" whose price is legislated below that of imported or new oil, the cost of fuel oil is below its true replacement cost.

Accelerated removal of these controls involves eliminating them in the near term either by legislation or by taxing the fuels to the level of their replacement cost. Either approach would involve a major legislative effort.

2. Effort Required

The monetary cost to the government of accelerated removal of the fuel pricing barrier is difficult to assess in a study of this scope. Deregulation could be inflationary and might produce increased tax revenues. On the other hand, rapid price increases might drive some firms out of business, forcing layoffs and increased unemployment payments. The impact on gasoline prices might force massive employment shifts and additional temporary unemployment as workers seek reemployment closer to home.

It is likely that some form of fuel subsidy payment would be made to low-income households. Such payments could last for a long period of time.

The use of taxation to raise prices might partially offset the increased costs to the federal budget. The extent of this has not been determined, however.

The political costs are likely to be large. The impacts described in the next section are likely to produce a strong negative electoral reaction to the Congress and Administration that enacted the increases.

Based on these considerations, and assuming that both the residential and commercial sectors would be deregulated simultaneously, the effort required to eliminate the fuel pricing barrier is likely to be the largest of all the barriers examined.

D. Effects Other Than Energy Effects That May Result from Removing the Fuel Pricing Barrier

Accelerated removal of the fuel pricing barrier will have diverse and widespread effects. Some of the major impacts can be anticipated.

Removal of price ceilings from natural gas and petroleum may result in greater exploration and development of new energy sources. It will become feasible to develop known resources which heretofore were uneconomical. As a result, total recoverable national energy resources may be increased, and dependence upon imported energy, with its implications for national security, may be reduced.

As prices for oil and gas rise to their true economic levels, greater use will be made of coal, of which the nation has at least a 500-year supply. The higher price of oil and

gas may make coal liquefaction and gasification economically feasible sooner. However, greatly expanded coal consumption may produce adverse environmental consequences. Higher oil and natural gas prices are also likely to stimulate greater use of solar, wind, hydroelectric, geothermal, and nuclear energy sources. To the extent that nuclear power is made more attractive, higher oil and gas prices will generate increased public controversy and add to the nation's radiological waste disposal pressures.

The development of alternative energy sources will stimulate growth in certain geographical regions of the country and create new patterns of economic development. The far West of the United States has emerged as a prospective center for new energy development. This has created concern, however, about (1) damage to the fragile ecology of these relatively arid states, (2) lack of water resources for fuel conversion processes, and (3) disposal of mining and processing refuse.

If the coal is not converted to oil or gas, its burning could create serious environmental impact in terms of increased levels of carbon dioxide and sulfur dioxide in the atmosphere. The conversion process itself can contribute to this atmospheric pollution.

Substantially increased energy costs, within the perspective of a stable or only modestly increased Gross National Product, will be inflationary and can also mean a decline in the standard of living unless the consumption of energy is correspondingly reduced without significant losses in comfort and amenities. In a paper prepared for the Federal Power Commission (FPC) in April 1975, shortly after President Ford proposed the deregulation of natural gas, it was argued that deregulation need not, however, be inflationary in the longer

term (Seidel and Brown, April 28, 1975). In this paper, it was argued that inflation does not depend on the prices being asked for a specific product as much as on the total cost of all the goods and services that the entire nation wants and needs. If gas prices rise but this results in the purchase of imported oil and fewer drilling rigs, tankers, and strip mines because the higher prices encourage conservation, then the whole economy is shifted to a "more efficient" point on society's "production curve." This means that it costs the whole economy less than it would otherwise in order to achieve the same level of overall production and consumption. If the market is, in fact, made more efficient, then increases in the price of one commodity, like gas, will be compensated by decreases (although slight) in the price of all the goods and services which use the other 99 percent of the consumer's dollar. However, consumer patterns tend to change slowly, and it is likely that deregulation of gas and oil prices will, in fact, cause a major inflationary push in the short term until the effects of conservation practices are felt by the consumer.

The FPC paper stressed the benefits of natural gas price deregulation even if exploration and new production were not significantly stimulated. The price increase could be expected to cause consumers who could use alternative energy sources to shift to these and to cause consumers who were wasting gas to use it more efficiently. The result would be more gas for more users and less chance of gas curtailments with their concomitant increase in imported oil usage by those denied gas. Both individual users and the nation as a whole would benefit from such reduction in oil usage. Comparing the added gas costs to the savings in imported oil, the cost to the nation's consumers (as a whole) under certain worst- and best-case assumptions might range from \$1.82 billion in net

costs to \$7.41 billion in net savings.* The analysis revealed that if tax rebates were judiciously used, the net increase in outlays by residences could be slightly under \$20 per dwelling in the 1980s (Seidel and Brown, April 28, 1975, pp. 6-7). The analysis acknowledged, however, that severe hardships could be imposed on low-income consumers if transfer payments were not administered efficiently.

Deregulations of oil prices will have other effects. Heating oil and gasoline are produced from the same crude stock, the percentage of each produced usually depending upon seasonal demand. Deregulation of oil at the wellhead for heating fuel purposes will automatically deregulate gasoline prices. The national economy is tied to the private automobile. Over 100 million automobiles are used by our approximately 77 million households. Private automobiles account for most of the daily journeys to work. They link our suburban dwellings, which now outnumber our central-city dwellings, with shopping and professional services.

A rapid increase in the price of fuel will force large shifts in the use of the automobile. It is likely that major relocations will occur with attendant changes in land use and land prices. Many families may be forced to make painful sacrifices until they can position themselves nearer to their places of employment.

This summary indicates that, while removal of this barrier may result in relatively large benefits compared to the other barriers examined, the costs to society are likely to be very large.

**The FPC analysis assumed immediate deregulation of new gas plus gas supplied under contract when the contracts expired under their existing terms.*

E. Quality and Quantity of the Data
Used in the Analysis

The data available for assessing the impacts associated with removal of this barrier for all fuels are inadequate. Several analyses of cost impacts under a variety of assumptions, some of which appear no longer to be available, were performed in 1975. These are now outdated. No published analyses were identified that assessed the impacts of the present deregulation programs.

VII. LACK OF A DELIVERY SYSTEM

A. Description

Production, pricing, promotion, and distribution of energy conservation measures for residential and commercial buildings usually occur through different marketing (or logistics) channels. The channels consist of combinations of manufacturers, distributors, installers, and service organizations that are, depending on the product, more or less integrated to meet market or customer needs. One variant of these product "delivery systems" for energy conservation measures is a "one-stop" shopping service. Such a service would offer the consumer, on one visit to the store, the full range of services needed to retrofit his or her home. These services include information, products, financing, installation, quality control, and, if appropriate, maintenance services. To date, there have been few attempts to package and market such a full range of conservation services to residential and commercial consumers (Real Estate Research Corporation, May 1978, p. 16).

Mature product delivery systems result from a manufacturer's competitive marketing strategy aimed at satisfying a customer's needs. Consumers find that gathering information from a number of sources and arranging purchase, installation, and financing is a very time-consuming and complex process. Product delivery systems can eliminate or, at least, reduce these inconveniences for the consumer. As shown in Figure VII-1, the residential/commercial market delivery system for energy conservation measures consists of the following principal components:

Adapted from: Enis, B.M. Marketing Principles. Pacific Palisades, California: Goodyear Publishing Co., pp. 56 and 99.

Figure VII-1. Delivery System for Energy Conservation Measures for Residential and Commercial Buildings Markets

- (1) Product manufacturers
- (2) Marketers and distributors
- (3) Installers and service representatives
- (4) End markets (consumers)
- (5) Lending institutions
- (6) Utilities
- (7) Federal, state, and local government agencies.

Each of these components and all of their participants play a unique role in the sale of each type of energy conservation product. The delivery system for each type of product frequently varies to meet the more specific needs of each segment of an end market.

Based on the preceding model, mature energy-conserving products will have established their own unique delivery systems having the following characteristics: well-established reputation, extensive product information system, mechanisms for financing, and mechanisms for product installation and service. The lack of a delivery system incorporating these characteristics for a product will leave the consumer on his own to acquire and install that product, thereby increasing the effective cost of the product to the consumer. Unless the consumer has a strong need to buy the product, this extra effort may be enough to keep him or her away. In such a case, the lack of a delivery system has acted as a barrier to the purchase of the product.

This study examines the lack of a variant of the full delivery system described above, namely one-stop shopping services which provide:

- (1) Retrofit information, including the conduct of a buildings energy audit
- (2) Product quality control and warranty
- (3) Financing for energy-conserving product purchase and installation
- (4) The installation of measures and an installation guarantee
- (5) Operating, maintenance, and repair services.

B. Energy Savings Potential

The application of a delivery system model to the analysis of energy conservation retrofit markets is a relatively new approach to analyzing the barriers to retrofit. In the absence of mature real-world energy conservation retrofit delivery systems, the assessment of the impact of this barrier is difficult. Indications of what might occur if such delivery systems were in existence can, however, be seen in two sources. One of these consists of an examination of existing consumer investment philosophies/circumstances and speculation on how a delivery system might impact these philosophies/circumstances to stimulate increased retrofit investment. The other consists of examining the utility energy conservation retrofit programs. These approximate, to varying degrees, one-stop shopping services. Their experiences are informative for assessing the effect of a lack of delivery systems.

This barrier was difficult to assess also because it might be interpreted as encompassing the lack of information barrier (Chapter IV). To avoid ranking this barrier as number one by virtue of a definition, it was assumed that the information provided by the hypothesized delivery system would not be adequate to overcome the information barrier unless there was a separate concerted effort aimed at improving the delivery of information. This assumption made it possible to separate the two barriers.

1. Residential Sector

Inasmuch as there are very few commercial energy conservation operations that approximate delivery systems, there is no direct evidence of the impact this barrier might have on retrofit activity by homeowners. On the other hand, there are numerous utility residential energy conservation programs that offer parts of complete delivery systems. The little evidence that is available on these is helpful in assessing the impact that a delivery system might have.

DOE recently compiled information on the operation and results of nine utility energy conservation retrofit programs (U.S. DOE, May 1980). The information available to the utilities varied widely. Some had conducted evaluations; others had not. The results also varied considerably, and the programs were not always similar.

Each of the programs has received significant consumer response. Market data collected by several of the utilities show levels of response to an offer of an in-house audit ranging from a few tenths of a percent of their residential customers to 10 percent. These percentages were not annualized, however, and since the programs had been running for

periods ranging from four months to over three years, it is not possible to provide comparable estimates of the rate of consumer response. Only a few had collected information on follow-up installations. These reported that 25 to 65 percent of those requesting audits followed through with installations (U.S. DOE, May 1980; for another report of one of the utilities' programs, see Air Conditioning, Heating, and Refrigeration News, February 4, 1980, p. 76).

These programs each offered varying portions of what has here been called a delivery system. The consumer response to them indicates that packaging energy conservation retrofit services will, in fact, enhance residential consumer willingness to invest in energy conservation measures.

Although most utility retrofit programs are available to renters also, no information was found specifically on renter response. The circumstances of renters are such, however, that they face strong economic disincentives to invest in energy conservation retrofit. Therefore, they are not likely to respond even if full-scale delivery systems were established.

The potential for energy savings in the residential sector inherent in this barrier is assessed to be about midway on the scale of energy potential attributable to the other barriers examined. Had the assumption concerning the separation of this barrier from the lack-of-information barrier not been used, this barrier would have ranked first in energy savings and overall.

2. Commercial Sector

There is less material available on commercial building owners' responses to packaged energy conservation services than on residential owners' responses. The Tennessee Valley Authority (TVA) operates an energy management service for its commercial and industrial customers. This service provides energy surveys at no direct cost to the requester, financing below the market rate, and inspection of the installations. Commercial and industrial establishments have responded well to this package of services, indicating that delivery systems in the commercial sector will produce positive results (Personal communication, W. Russell Newton, Chattanooga Power Service Center, March 31, 1980).

The data collected by TVA do not specify whether the commercial establishments using their energy management service are building owners or renters. Existing literature on commercial tenants' investment circumstances indicates that they have little financial incentive to retrofit (Webb, June 7, 1980, p. E25; Institute of Behavioral Science, June 1980, p. 24). Therefore, the services offered by a delivery system are not likely to stimulate retrofit by this subsector.

By themselves, delivery systems will probably produce a noticeable increase in retrofit activity in the commercial sector. Unless they are accompanied by concerted efforts to deal with other barriers, however, their impact will not be as great as it could be.

C. Ease With Which the Lack of Delivery System Barrier Can Be Removed

1. Federal Action

The retrofit industry is highly fragmented. Most energy conservation products are marketed through separate manufacturing, distribution, and installation channels. Financing is provided through institutions that are not part of the product and distribution segments of the industry, and quality control is often nonexistent.

There are two courses of action available to the government for promoting the development of one-stop shopping services that will act, in effect, as a type of delivery system for energy conservation measures. It may (1) mandate the creation of these services through agencies over which it has control, or (2) it may promote the establishment and growth of private enterprise efforts to do this.

The former course of action has already been taken with the development of the Residential Conservation Service (RCS) Program. This program requires gas and electric utilities above a certain size (in terms of sales) to create a type of one-stop shopping service. Utility customers are offered information on energy conservation retrofit and an in-house audit. Should they want to follow up the audit with an installation, the utility will offer to help with the arranging, financing, and, possibly, inspection. At present this program, which is scheduled to get underway in the fall of 1980, covers only residential buildings of less than five units (Federal Register, November 7, 1979). It will soon be expanded to include larger multifamily and small commercial buildings.

There are elements of this program which may keep it from being as effective as the type of delivery system envisaged in this chapter. They include: an unrealistic warranty provision, provision for an audit charge, a labeling requirement, installation standards, omission of large commercial buildings, random post-installation inspections for most measures, and the lack of a requirement that the utilities offer to arrange the services themselves (i.e., they may meet the current requirement without accepting a responsibility to arrange the financing, installation, etc., themselves).

Efforts have been or are being made to modify some of these elements to enhance the program's ability to attract owner, manufacturer, and contractor interest. It is not likely, however, that utilities will ever be required to accept accountability, even in theory, for the actual purchase and installation of energy conservation measures in a home. Nor does it seem reasonable that the federal government should mandate any non-governmental organization to accept such accountability in connection with any one-stop shopping service that it may require it to provide. Therefore, the RCS Program and other government programs that provide similar services (such as those established by several states), while definitely positive steps toward the delivery system concept, fall short of the concept envisaged in this study.

Private enterprise, on the other hand, traditionally accepts such accountability (in theory, at least) for its products or services. The one-stop shopping service envisaged in this study would, ideally, provide services similar to those provided by a broker or, perhaps, general contractor. That is, it would accept responsibility for the execution of a contract to provide all, or a specified number, of services in connection with the installation of energy conservation measures.

In some areas, small companies have been or are being formed that will provide some of these retrofit services to residential and commercial building owners. A few larger companies are also offering partial services. The government might strengthen the operations of these companies by providing grant funds for technical and sales training for their staffs. A similar policy has already worked successfully for fuel oil dealers using DOE's Fuel Oil Conservation Demonstration Program (U.S. DOE, July 1979).

Alternatively, the government might encourage these companies by providing them with special tax incentives over a limited period of time, by arranging business conferences at which they could exchange information on their problems and successes and receive information on the latest government action regarding energy conservation retrofit, by providing generic advertising, or by subsidizing their audit programs through transfer payments from utilities.

2. Effort Required

In view of the effort required to implement the RCS Program and that likely to be required to implement its modifications, and in view of the effort likely to be required to promote the development of private one-stop shopping services, a relatively high level of government effort is likely to be required to remove this barrier.

Delivery systems will be most effective if they are implemented in conjunction with strong efforts to overcome other barriers as well. Should such actions be included in the effort to create a one-stop shopping service, then the overall effort required would likely match that of the most difficult-to-overcome barrier.

D. Effects Other Than Energy Effects Resulting from Modification of the Barrier

In addition to energy savings, the development of delivery systems will have other effects on the government and the retrofit industry. Due to the extensive government role in establishing and regulating the programs that approximate one-stop shopping services, additional government employment opportunities will be made available. This will also be true for the agencies or entities that implement the programs. Privately operated one-stop shopping services will also stimulate a small amount of employment.

The increase in demand for energy conservation measures resulting from the operation of one-stop shopping services should be noticeable but not great enough to place excessive strain on current production capacity, unless combined with effective programs to also remove other barriers.

The environmental effects resulting from increased energy conservation retrofit activity by government programs that approximate delivery systems have been examined for the residential sector in the Environmental Impact Statement for the RCS Program (U.S. DOE, November 1979). They are not expected to be significant. A similar level of environmental analysis has not been conducted for retrofit in the commercial sector; however, the impacts in this sector are likely to be small as well.

Businesses attempting to establish themselves as one-stop energy conservation firms probably face a finite, exhaustible market for their services. There remain many buildings that can benefit from retrofit services, and if fuel prices rise in large steps again, many who have already retrofitted their

buildings may re-enter the market. There are only so many homes that can be cost-effectively retrofitted, however. Moreover, private businesses would be competing with utilities offering the RCS Program for these households. Consequently, new enterprises established as one-stop shopping services are likely to have a limited life unless they also offer product sales or maintenance services. The elimination of this barrier may eventually result in a high failure rate among the private businesses established to help overcome it.

E. Quality and Quantity of the Data Used in the Analysis

Little data are available with which to evaluate the impacts of this barrier. That which exists on utility programs is relatively valid as an indication of the response that might be achieved were full-scale delivery systems to be implemented. It is far from what is needed to conduct a rigorous assessment, however. The results of existing utility programs indicate that one-stop shopping services are highly likely to be effective in reducing building energy usage; however, the assessments of the magnitude of this and other effects presented in this chapter should be accepted with caution.

VIII. INABILITY TO EVALUATE CONTRACTOR PERFORMANCE

A. Description

Many retrofit measures such as wall insulation and vent dampers require special equipment or expertise to install and therefore need to be installed by a qualified contractor. Other measures such as ceiling insulation and water heater insulation can be installed by the consumer, although many people prefer to have these measures installed by a contractor also.

There is no dependable contractor selection method in the open market. The consumer who wants to hire a contractor to install a retrofit measure has no easy method for identifying a good contractor. Even sources such as the Better Business Bureau have been criticized as inadequate contractor information sources (N.Y. PSC, March 28, 1978, p. 137).

Consumer protection agencies in many areas receive a large number of complaints each year about insulation contractors. The most commonly filed complaints deal with contractors who accept payments for work they never do or who perform the installation improperly. The large number of complaints have led the states of California, Michigan, and New York to enact licensing programs for insulation contractors (Book of States 1978-79). In addition, many utilities that provide retrofit programs for their customers have experienced problems with quality control. Both the Tennessee Valley Authority (TVA) and the Pacific Gas and Electric Company (PG&E) have experienced high failure rates for post-installation inspection. In the early stages of the TVA Program, contractors were required to return to the site on

approximately 25 percent of all installations (Personal communication, Greg Ferguson, TVA Eastern District Office, May 14, 1979). PG&E experienced a contractor call-back rate of approximately 40 percent in the initial stages of its program (M. Mertz, Pacific Gas & Electric Co., Comments at Public Hearing on the Residential Conservation Service Program, San Diego, California, May 7, 1979). These programs, structured so that contractors are not paid until work has been satisfactorily completed, have been very successful in encouraging residential retrofit.

Other utilities that have undertaken retrofit programs have expressed concern about the adequacy of their contractor screening procedures. Through attendance at the hearings held on the proposed rules for the Residential Conservation Service Program, one of this study's authors observed that many utilities reported a post-installation inspection process to be necessary in order to control the quality of the retrofit installations performed by contractors under their programs.

B. Energy Savings Potential

It is difficult to assess the impact of this barrier on energy conservation in buildings. Nearly all of the information located in the course of this study which supports the statement that contractor selection represents a barrier to retrofit applies to homeowners and does not quantitatively assess the extent to which it affects retrofit. Due to the lack of available specific data, some conclusions have been drawn by looking at the behavior patterns of different consumer types to draw some conclusions about the energy impact of this barrier. Based on this analysis and existing literature, this barrier appears to have a greater impact on homeowners

and small investors who own residential and commercial property for income than on the other residential or commercial subsectors.

1. Residential Sector

The residential sector retrofit market includes single-family homeowners, tenants in residential properties, and owners of multifamily housing. Because owners of multifamily housing appear to have interests similar to those of commercial building owners, this subsector is discussed with the commercial sector retrofit market.

The frequency with which contractor selection presents a barrier to homeowners cannot be determined in actual numbers, but the existing evidence indicates that the contractor selection process does, in fact, represent a barrier to retrofit by homeowners. Participants in energy conservation technology programs sponsored by the League of Women Voters were surveyed to find out why they attended the programs and what areas of the program they would like to see expanded. Identical surveys of two groups of respondents in West Hartford, Connecticut, show that 20 percent of one group and 40 percent of another attended because they needed to know more about methods for installing energy conservation measures. When asked about areas of the program they would like to see expanded, 23 percent in one location and 40 percent in another mentioned aspects of dealing with contractors (U.S. DOE, January 1979, pp. xii-xiii).

A study conducted for the Pennsylvania Department of Community Affairs identified the market characteristics for retrofit and rebuilding services in the oil-heating subsector of the residential market. The study used as a case study the marketing efforts of a heating oil dealer. The study shows

that marketing efforts were successful within the customer base of the heating company. Attempts to reach beyond the company's customer base, however, ran into mistrust and sales resistance (Levine, M.S., August 15, 1979, p. 11).

The experiences of existing utility retrofit programs also indicate that people who want to retrofit are concerned about quality workmanship and feel that they cannot be assured that they will receive a quality product. Strong evidence of this concern exists in the TVA's Home Insulation Program. At one time, the TVA only conducted post-installation inspection of those insulation jobs financed through the TVA.* Many customers who normally would have paid cash took a loan and paid it off in one payment to take advantage of post-installation inspection benefits (Personal communication, TVA Office of Energy Conservation and Rates, November 1979). The experiences of other utilities that market and install retrofit measures have shown that people who had the option to hire their own contractor chose instead to use the services offered by the utility.

Similar data do not exist for renters. Regardless of whether renters pay their own utilities, they are not likely to consider retrofit as an investment under most circumstances. The barrier of contractor selection does not occur early enough in the decision-making process to affect their retrofit activity.

These data present evidence that many homeowners doubt their ability to select and deal with contractors. Retrofit activity by homeowners is therefore likely to increase if the contractor selection process is made more reliable. The

*They now inspect all installations arranged through the TVA.

potential energy savings that could result by removing this barrier are estimated to be approximately midway between the most and the least savings that could be realized by eliminating the other barriers examined for the residential sector.

2. Commercial Sector

The commercial sector includes commercial owner-occupants, commercial renters, and investor-owners of commercial properties. Investor-owners of multifamily residential dwellings are also included in this sector discussion because of the apparent similarity in their thinking. No empirical data were found to indicate that the contractor selection process presents a barrier in the commercial sector. Subjective analyses of the commercial sector indicate that contractor selection does not present much of a barrier to retrofit.

Most commercial owner-occupants are members of a local Chamber of Commerce or other local business organization and are familiar with the reputations of local contractors. In addition, they have more knowledge about prices and are accustomed to making large purchases (Opinion Research Corporation, July 1976, p. 3). Their day-to-day activities give them confidence in their ability to make a good purchase. It is unlikely that this barrier is a significant deterrent to retrofit by commercial owner-occupants.

Commercial tenants, much like residential tenants, have little incentive to retrofit and are not likely to consider a retrofit investment. Moreover, like commercial owner-occupants, they are likely to be aware of the reputations of local contractors and accustomed to making large purchases. If they were interested in retrofit, contractor selection should not present a major barrier to them.

The conclusion that contractor selection is not a deterrent to retrofit by the commercial owner-occupants and renters is also supported by the results of the TVA Commercial and Industrial Energy Conservation Program. This program, which has been highly successful in encouraging energy conservation by business and industry, does not provide assistance in the contractor selection process (Personal communication, W. Russell Newton, Chattanooga Power Service Center, March 31, 1980).

No quantitative or qualitative data exist that look at the attitudes of investor-owners toward contractor selection. The determination of energy savings potential likely to result from removing the barrier in this subsector is subjective but based upon reasoning from commonly accepted assumptions.

Investors who own property for income range from companies with large holdings to individuals who own one or two properties as supplemental income. Individuals who own property for supplemental income may be deterred by contractor selection. These owners are accustomed to hiring plumbers and electricians for regular maintenance and repairs. Trade certification, government registration, and the regular use of their services give property owners sufficient information to judge their reliability and competence. There are no such guidelines or regular need for services from the retrofit industry. Difficulties in identifying good contractors and the elective nature of retrofit activity indicate that contractor selection may be a deterrent to small investors who own property for supplemental income.

The barrier presented to the commercial sector by the contractor selection process appears to be minimal. Removing the barrier is likely to result in minimal energy savings.

C. Ease With Which Consumers' Inability
to Evaluate Contractor Performance
Can Be Removed

1. Federal Action

The retrofit contracting industry is fragmented and dispersed. Any action which is likely to be effective in providing all consumers with a uniform minimum quality of service needs to be carried out at a level high enough to regulate the industry. There are three alternatives:

- (a) State or local licensing of contractors under state authority
- (b) Bonding requirements for contractors
- (c) Requiring some entity to evaluate contractor performance and make the results available.

2. Effort Required

These options would be difficult and costly to implement for two reasons. First, some form of legislation would be needed to provide the authority for regulating the retrofit industry, and standards for evaluating contractors' reliability and bonded performance would need to be established. Secondly, enforcement would be difficult and costly since the industry is fragmented and is likely to be opposed to regulation.

If the barrier is, in fact, not effective in the commercial sector, less effort may be required to establish an

acceptable level of reliability. Perhaps bonding would be all that is needed.

D. Effects Other Than Energy Effects That May
Result from Modification of the Barrier

Any effort to license contractors or evaluate the quality of their performance in order to provide information to the public will result in some impacts on the industry. Either remedy will require individual contractors to verify their competency and reliability. This may be done through manufacturer certification, training, insurance standards, and agreements to comply with standard practice codes. This represents some cost to the industry, although these costs may be small and may be offset by an improved public image.

Some long-term benefits may also result from such a program, including a lower number of contractor complaints and less litigation over contracts.

Retrofit activity is likely to increase, but the additional employment and effect on inflation will probably be negligible.

The environmental effects resulting from increased energy conservation retrofit activity have been examined for the residential sector in the Environmental Impact Statement for the RCS Program (U.S. DOE, November 1979a). They are not expected to be significant. A similar level of environmental analysis has not been conducted for retrofit in the commercial sector; however, the impacts in this sector are likely to be small as well.

E. Quality and Quantity of the Data
Used in this Analysis

Empirical data on consumer confidence in their ability to select reliable contractors are almost nonexistent. One study conducted by the League of Women Voters briefly addressed this area. All the other data used were indirectly related and were applied with some modification. Therefore, the results of this analysis, while they are consistent with numerous comments and journalistic accounts, should be considered with caution.

IX. INABILITY TO EVALUATE OR CONTROL THE QUALITY OF RETROFIT PRODUCTS

A. Description

Retrofitting a building with energy conservation measures entails the introduction of new materials into or onto the building structure. This can create uncertainties for both the building owner and building occupants about:

- (1) The safety of the materials, e.g., resistance to fire
- (2) The health impacts of the materials, e.g., odor
- (3) The ability of the materials to perform as claimed, e.g., provide a reduction in energy costs
- (4) The long-term resistance of the materials to deterioration, e.g., resistance to moisture penetration and continued effectiveness
- (5) The effect of the materials on the buildings' appearance, e.g., the appearance of an attic fan on the roof.

When uncertainties such as these arise and the information needed to deal with them is not available, the building owner is faced with the choices of: (1) taking the time to find the answers, (2) taking a chance on installing the measures without knowing as much as he or she would like to know about them, or (3) not installing the measures at all. When this happens for an owner who is interested in installing cost-

effective measures in his or her building, but the effort to find the answers is thought to be too great, then this inability to evaluate or control the quality of retrofit products becomes a barrier to energy conservation retrofit. This barrier can affect all building owners, managers, and tenants in both the residential and commercial sectors.

B. Energy Savings Potential

No research was found that specifically addressed this barrier. It was occasionally mentioned in general discussions of barriers in both the residential and commercial sectors, and sometimes it can be inferred from anecdotal comments made in the literature. Beyond these occasional references, however, there does not appear to be any good quantitative basis for assessing the energy savings that could be realized if owners found it easier to have confidence in the performance of the energy conservation materials they wanted to install.

The material that does exist indicates that success in removing this barrier, by itself, probably will not result in a high level of energy savings in the residential sector compared to that achievable in removing several other barriers analyzed for this sector. On the other hand, in the commercial sector, success in removing this barrier is likely to produce a level of savings that will rank somewhere in the middle of the scale of savings that could be realized by eliminating the other barriers analyzed for the same sector.

1. Residential Sector

Empirical evidence of the existence of this barrier in the residential sector was found in a study of nine residential energy conservation retrofit programs administered by utilities. Of the nine utility programs examined, one utility said it considered its post-installation inspections to be one of the most important aspects of its program from the customer's viewpoint (U.S. DOE, May 1980, p. 26). Most post-installation inspections focus on the quality of the installation (see Chapter VIII) and offer only a visual inspection of the products installed; however, it is likely that residential consumers perceive the post-installation inspection as also providing confirmation of the quality of the materials used. Therefore, this observed interest in the post-installation inspection has been assumed to indicate homeowners' concern over the quality of the installed products also.

The aforementioned utility's reported opinion of the importance of post-installation inspections in the residential sector was strongly worded but not matched by any of the other eight utilities surveyed. None of the other studies on barriers to residential retrofit that were reviewed emphasized the quality of the installed retrofit products. This barrier, therefore, is not considered to have a major effect on residential retrofit and the potential energy savings resulting from eliminating it are likely to be small relative to the potential for savings existing in some of the other barriers.

This conclusion applies to owner-occupants of single-family detached and attached homes and to tenants. For want of better information, it may also be applied to the owners of multifamily residential housing and owner-investors in single-family housing; however, consideration of their investment objectives suggests that these investors may react to

this barrier more like commercial building owners. No direct evidence was found to confirm this. Indirect evidence was found, however, to suggest that this may be true.

2. Commercial Sector

Empirical evidence of the existence of this barrier in the commercial sector was found in a study of the attitudes of commercial office building owners in New York City toward energy conservation retrofit. Many of the interviewed owners expressed concern about the reliability of new energy conservation equipment and questioned the credibility of the claims made for it. As a general rule, they preferred to wait until someone else had tried new material or equipment and the results were known before they tried the new items in their own buildings (Syska and Hennessy, August 1978, p.3).

The same preference showed up in a series of four interviews with commercial building managers, owners, and operators in California. One owner expressed apprehension at "being laughed at" if he prematurely accepted a new technology recommended by the government and it did not perform as claimed, or became obsolete before it could pay for itself (Blumstein et al., April 1980, p. 363).

These two owners are not necessarily representative of the nation; however, the concern is consistent with the generally accepted observation that commercial building owners have very conservative investment philosophies (A.D. Little, August 1979, pp. 1, 35; Schoen et al., 1975, pp. 49-53).

This conservative attitude of building owners has its strongest expression in the requirement for short-term paybacks,

however (see Chapter III). Eliminating the owners' doubts about the quality of the product is not expected to produce the savings in energy that the easing of this aspect of the conservative investment policy outlook might produce. Therefore, it was judged that the potential energy savings available from eliminating the commercial owners' inability to evaluate retrofit products will be about midway in magnitude between the most energy and the least energy that can potentially be saved by removing some of the other barriers examined.

Apartment owners appear to share the same concerns about product performance as commercial building owners. The results of a survey of apartment owners conducted by the National Apartment Association indicates that many who have invested in energy conservation retrofit are not happy with the results. They feel the measures did not produce the savings claimed for them. Table IX-1 illustrates this in the perceptions of relatively low effectiveness of some of the installed measures.

TABLE IX-1. PERCENTAGE OF APARTMENT OWNERS WHO
PERCEIVED MEASURES THEY INSTALLED TO BE EFFECTIVE

<u>Measure Installed</u>	<u>Percentage of Owner- Installers Perceiving the Measure to be Effective*</u>
Insulation	54
Furnace modification	50
Individual metering or submetering	43
Storm windows	39
Clock thermostats	38
Weatherstripping	31

Source: National Apartment Association Survey and Booz, Allen & Hamilton, Inc. (U.S. DOE, May 1979; Exhibit D-6).

*The sum of the percentages is greater than 100 because owners could identify more than one measure as being effective.

Although these results do not directly indicate that apartment owners, who are normally classified in the residential sector, are as skeptical as their commercial counterparts, it does indicate that they are alert to the same concerns. If perceptions such as these become widely known, the barrier will become more salient for multifamily building owners.

C. Ease With Which the Inability to Evaluate
or Control the Quality of Retrofit
Products Can Be Removed

1. Federal Action

Information programs can be used to deliver messages designed to reduce the uncertainties associated with:

- (a) Safety
- (b) Health impact
- (c) Long-term resistance to deterioration
- (d) Aesthetic impact.

It has been assumed for the purposes of assessing the ease with which this barrier may be remedied, that these messages can be effectively delivered to homeowners, renters, and landlords through existing or new energy conservation advertising programs targeted on general audiences in the regions where each measure is likely to be cost-effective.

Skepticism concerning the performance of retrofit products also can be addressed through information programs. The available evidence indicates, however, that customized information of the type provided by building energy audits is likely to be more effective than advertising. Owners of commercial buildings and multifamily rental housing, in particular, appear to need the type of customized information provided by an energy audit (see Chapter IV).

Building energy audits, in most cases, will be performed on the initiative of the building owner or manager. In order to stimulate this initiative on the part of commercial and rental housing building owners/managers, messages describing the value of audits and case histories of successful installations might be placed in the journals that reach these audiences.

Another approach that will aid in stimulating interest in energy audits as well as help to alleviate concern over the quality of retrofit products is promotion through exhibits and demonstrations. Although the sight of insulation or weatherstripping being installed, or an exhibit of clock thermostats, does not convey much information about quality and safety, individuals watching such demonstrations and exhibits are likely to gain a greater sense of confidence in their knowledge of these products and be more open to subsequent messages about them or audits for them.

Demonstrations and exhibits can be tailored to specific audiences. Landlords represented by the Building Owners and Managers Association, the National Apartment Association, or Apartment Owners and Managers Association hold annual conventions. Opportunities to reach a portion of the general homeowner and renter audience are available at the more than

1,800 state, district, and county fairs held annually around the country. Exhibits or demonstrations sponsored by DOE or through state energy conservation programs can be used to help overcome skepticism concerning the quality of retrofit products.

2. Effort Required

Based on the approaches suggested above, the government effort required to eliminate the inability to evaluate or control retrofit products in both sectors was judged to be midway between the effort required to remove the most difficult barriers and that required to remove the least difficult.

D. Effects Other Than Energy Effects That May Result from Removal of the Barrier

No discussion of effects other than energy effects that may result from removing this barrier was found in the literature. The increase in demand for energy conservation measures that will result from the easing of this barrier is not expected to be large enough to significantly affect employment. Inevitably, a few consumers who set aside their belief in "caveat emptor" as a result of efforts to ease this barrier will be disappointed; however, the number of such occurrences should be small if the information programs and exhibits are adequately designed.

The Environmental Impact Statement for the RCS Program examined the environmental effects likely to result from an even larger increase in energy conservation retrofit activity than is expected to result from removal of this barrier.

(U.S. DOE, November 1979). Inasmuch as the impacts of the RCS Program were judged to be not significant, the impacts due to removal of this barrier are not expected to be significant. A similar level of environmental analysis has not been conducted for retrofit in the commercial sector; however, the impacts in this sector are likely to be small as well.

No significant detrimental effects -- either primary or secondary -- are expected as a result of removing this barrier.

E. Quality and Quantity of the Data Used in the Analysis

No quantitative data were found that estimated any of the effects that might result from the inability to evaluate or control the quality of retrofit products. The non-quantitative data available consisted of two series of interviews in one city and a metropolitan area and a comment by one of nine utilities surveyed on their energy conservation retrofit programs. The data used for commercial building owners appear to be valid, on a regional basis, for the interpretation drawn here. For the residential sector, somewhat more interpretative liberty was taken in drawing relevant conclusions from the results of the utility retrofit program survey.

There is a lack of comprehensive qualitative or quantitative data on this barrier. The existing data are judged inadequate as a basis for making valid generalizations at the national level about the effects of consumers' inability to evaluate retrofit products. The results presented in this chapter are therefore suggestive.

X. HIGH FINANCE COSTS

A. Description

Retrofitting residential and commercial buildings with energy conservation materials entails a decision to pay for them either by borrowing or using cash reserves and income flow. If consumers prefer to pay for retrofit installations primarily with borrowed funds, but decline to borrow because the financing costs (interest rates) are perceived to be too high, then these costs become a barrier to retrofit.

B. Energy Savings Potential

No research was found that directly assessed the impact of high finance costs on the consumer's willingness to retrofit. It can be demonstrated, however, that in the residential sector, relatively few home improvements priced in the range of typical energy conservation retrofit installations are paid for with borrowed funds other than credit cards. In the commercial sector, evidence concerning the other barriers examined in this study indicates that owners are more concerned with these other barriers to retrofit than with finance costs. When commercial owners do invest in energy conservation retrofit, they prefer to use cash. High finance costs, while they may be a deterrent to borrowing in general, do not appear to have a special impact on consumers' willingness to retrofit buildings with energy-conserving measures.

1. Residential Sector

Home improvements of a magnitude corresponding to most cost-effective retrofit options usually are paid for either with cash or financed on credit cards. Loans are infrequently used except for the more expensive items.

U.S. Census findings show that individual outlays for home improvements and repairs have been modest and have increased with income. In 1976, households with incomes between \$10,000 and \$15,000 which undertook home improvements spent an average of \$475. Households with incomes over \$25,000 spent an average of \$822 (A.D. Little, September 1977, p. 91). Of the improvements undertaken during 1975-1976, approximately 17 percent involved borrowing. The amount borrowed, \$5 billion, was less than three percent of the total outstanding consumer credit of \$186.2 billion (A.D. Little, September 1977, pp. 8, 13).

Energy conservation retrofit is often less expensive than home improvement work in general. Typical outlays for insulation or furnace burner replacement run from \$200 to \$500. Caulking, hot water heater jackets, and clock thermostats are less than \$100 (U.S. DOE, October 1977). Data on home improvement financing indicate that homeowners typically prefer to use cash or credit cards to pay for such amounts. A 1977 Federal Reserve Board survey of expenditures for large housing additions and repairs shows that median expenditures for large additions and repairs amounted to approximately \$750. In the cases where credit was utilized to pay for such large improvements, 84 percent of the homeowners used credit cards. Only 16 percent of those financing the purchases used other sources of credit, and this was mostly for the more costly improvements -- those which had a median cost of \$1,200 (Federal Reserve Board, 1978, pp. 64-65).

Another indicator suggests the limited role high interest rates presently play in the decision to borrow for retrofit purposes. Many banks have established a \$1,000 minimum for consumer loans (Real Estate Research Corporation, May 1978, p. 54, Chapter 8). In areas where this limit exists, borrowing will not be a factor in most retrofit decisions. Therefore, the rate on these loans will affect very few types of retrofit activity.*

There is a substantial segment of the residential sector that probably cannot qualify for credit and might be reluctant to use it if they could. Based on the unpublished 1978 Annual Housing Survey, 11.2 percent of all homeowners had annual incomes below \$5,000. An additional 9.2 percent had incomes between \$5,000 and \$8,000. These homeowners with annual incomes less than one-half of the national median of \$16,800 amount to one-fifth of all homeowners. These homeowners would likely have difficulty obtaining and repaying financing under most available terms.

Renters are not likely to retrofit their apartments or homes and therefore are not likely to be affected to any significant degree by high finance costs. They face other barriers, including lack of an economic incentive, that are far more difficult to surmount. Moreover, tenants as a group have incomes much lower than those of homeowners. According to 1978 Census data, the median tenant income was \$9,300, a little more than half the median income for homeowners.

**Minimum loan limits are established as a result of the finance costs incurred by lending institutions in providing loans. In this sense, high finance costs (to lenders) are indeed preventing consumers from having one option for borrowing for retrofit (credit cards are still available). (Real Estate Research Corporation, May 1978, Chapters 5 and 8). This aspect of the impact of finance costs on retrofit decisions was not evaluated.*

Owners of residential investment property, like their tenants, face economic incentive barriers to retrofit that are more serious than high finance costs. Often the tenant would get the economic benefit of the landlord's investment. Inasmuch as energy conservation improvements are not always fully reflected in resale price, the added equity investment that is often necessary to obtain the improvement loan may not appreciate at a rate equal to that of the original investment. Consequently, owner-investors in residential housing tend to avoid borrowing for retrofit, and high interest rates are not likely to have a major impact on them.

The preceding analysis is based on data derived from the home improvement financing field. There is a limited amount of data available from the energy conservation home lending field, which similarly suggests that interest rates are not a major determining factor in a homeowner's decision to retrofit. A study performed for DOE in 1978 on bank financing for residential energy conservation, produced evidence that banks which offered special energy conservation retrofit loans during 1973-1974 -- some at a discount -- consistently had a very low consumer response (Real Estate Research Corporation, May 1978, Chapters 5 and 8). Michigan Consolidated Gas Co., has been offering 12 percent loans to its 900,000 residential customers for ceiling insulation retrofit since October 1973. As of June 20, 1980, of an estimated 275,000 insulation installations in its service area, less than 1 percent (1,336) have been financed through the utility's loan program (Personal communication, R. McGarvey, Michigan Consolidated Gas Co., September 15, 1980; see also Blumstein et al., April 1980, p. 360).

Based on the foregoing, it appears (1) that borrowing is not the preferred mode of paying for retrofit installations in the residential sector, and (2) that when such installa-

tions are financed it is usually by homeowner-occupants who use credit card financing. Therefore, the added energy savings that could be achieved as a result of significantly reducing interest rates on loans for residential retrofit is expected to rank among the smallest available from removal of the other barriers examined.

2. Commercial Sector

There is less data available for the commercial sector with which to assess the impact of high interest rates than for the residential sector. Examination of the motivations of commercial building owners indicates that short-term payback and the availability of cash are prerequisites for retrofit investment in most commercial properties (A.D. Little, August 1979; Syska and Hennessy, August 1978; Blumstein et al., April 1980, p. 362). (For a more complete discussion of these criteria, see Chapter III.) Typically, commercial building owners prefer to avoid further borrowing in order to retrofit.

These factors provide little basis for generalizing about commercial owners' reaction to high interest rates. They do, however, suggest that finance costs are not among their principal concerns when evaluating retrofit investments. Based on this consideration, the reduction of finance costs will probably do little to stimulate retrofit activity in the commercial sector. The increase in energy savings should be correspondingly small.

In spite of the foregoing assessments, special loan programs may serve to stimulate retrofit for reasons other than low finance costs per se. There is a possibility that consumers will look upon special, low interest rates for

retrofit installations as a "bargain" and abandon their demonstrated preferences in order to take advantage of the perceived opportunity. The experience of some utility loan programs is also interesting in this regard. Some state and utility retrofit programs have offered special interest rates, and, contrary to Michigan Consolidated Gas Company's experience, they have been used relatively often. Such response to utility loan programs does not indicate, however, that it was the special interest rate, per se, that overcame the owners' previous reasons for inaction. These programs offer, as well, incentives to counter other barriers to retrofit. For example, the Tennessee Valley Authority experienced numerous retrofit installations financed through its special loan program; however, many of these loans were paid off in one payment. Apparently, many homeowners financed their installation because they wanted the post-installation inspection and guarantee of contractor performance that came with the financing (see Chapter VIII). There is also a possibility that very attractive loan programs such as that offered in the Northwest by Pacific Power and Light are perceived as sources of almost-free capital and overcome the barrier -- not examined in this study -- that is raised when there are other, more attractive competing uses for investment funds.

These possibilities -- that consumers who otherwise would not borrow will look upon special low interest rates as a special bargain or as free capital and, as a result, will become more interested in borrowing for retrofit -- have not been assessed.

C. Ease With Which Barriers Created by High Finance Costs Can Be Removed

1. Federal Action

Special low interest rates for retrofit loans are the most direct form of action to eliminate the effect of this barrier. There is considerable precedent for such action both in the retrofit area and in the home improvement area in general. Oregon has, since 1977, offered loans at lower-than-market interest rates for retrofit purchases. Lending institutions are reimbursed for the lost revenues through a special state tax credit. In New York State, under its Home Insulation and Energy Conservation Program, utilities offer financing for retrofits at their overall rate of return -- a figure that is well below most home improvement loan interest rates.

Some banks have similarly offered below-market-rate loans for energy conservation purchases. Many utilities offer loans for retrofit at interest rates that are well below market, and a few even offer free loans. At least one, Pacific Power and Light, permits qualified borrowers to defer loan repayment until their home is sold. (For a summary of nine utility retrofit finance programs, see U.S. DOE, May 1980.)

There are precedents for low-interest loans in the home improvement market as well. The Department of Housing and Urban Development, for example, offers Section 312 rehabilitation loans for residential properties, both single-family and multifamily. The Farmers Home Administration makes available home improvement loans at interest rates adjusted to borrower income. The Small Business Administration, under its program of assistance to natural disaster victims, provides below-market-rate-of-interest loans.

Individual states have issued federal income tax free revenue bonds whose proceeds have been used to finance home purchase by moderate-income families and also to finance federally subsidized projects to serve lower-income families.

These precedents constitute options for federal action to overcome obstacles to retrofit posed by high finance costs.

2. Effort Required

Federal action to subsidize loans for retrofit will require a federal budget allocation. Depending upon the magnitude of the subsidy, the costs could be sizable. Based on the analysis in Section B, however, the demand for and long-term use of low-interest loans is not likely to be high.

Assuming that the demand for the loans will be low because finance costs are not one of the principal deterrents to retrofit, the effort required to overcome this barrier should be low.

D. Effects Other Than Energy Effects That May Result from Removing the High Finance Cost Barrier

It is likely that lending institutions which administer low-interest loan programs will be reimbursed for any resulting loss of income by federal or state subsidies. Oregon provides such reimbursement through state tax credits. The recently enacted federal law providing for a Solar Energy and Energy Conservation Bank (Energy Security Act, Conference Report No. 96-824, Title V, Subtitle A) illustrates the

federal government's intention to ensure that lending institutions have the opportunity to maintain their fair rate of return on such loans. The diversion of loan business to utilities which offer free or low-interest energy conservation loans is not likely to harm lending institutions significantly because of the normally low level of business they conduct in this area.

There should be a relatively small increase in demand for retrofit products as a result of the removal of this barrier. Its removal should not be inflationary or increase employment or have a significant effect on the environment.

E. Quality and Quantity of the Data Used in the Analysis

No quantitative data were found on the impacts of high finance costs on consumers' willingness to retrofit. Valid evidence was, however, available on residential consumers' propensity to borrow for home improvements in general. This evidence provides a strong indication that consumers tend not to borrow or, when they do borrow, to use credit cards to finance home improvement purchases of the magnitude typical of retrofit investments. A very limited amount of data concerning energy conservation retrofit loan offers, supports this indication. Since this finding permitted a conclusion that fluctuations in the commercial lending rate would have little effect on residential consumers' willingness to retrofit, the data would appear to provide reasonably adequate support for the overall assessments of the effect of high interest rates on residential retrofit decisions.

Very weak indirect evidence was found to support the conclusions for the commercial sector. These were derived primarily by deduction from knowledge of the other factors that affect commercial owners' willingness to retrofit.

Overall, the data supporting the assessments for the residential sector are of better quality than the data available for assessing several of the other barriers in this sector. For the commercial sector the data are inadequate.

XI. SUGGESTIONS FOR FURTHER RESEARCH

A. Overview of Existing Research on Barriers to Building Energy Conservation Retrofit

A relatively large number of studies have addressed the subject of barriers to energy conservation in residential and commercial buildings. Of those that examine barriers to retrofit, only one was found that systematically assessed the impacts of barriers to retrofit. This was a study devoted to the multifamily housing subsector of the residential sector (Real Estate Research Corporation, November 1975). The others devote varying degrees of analytic effort to barriers affecting retrofit. Many of them are limited to identifying the barriers and examining their operations in a hypothetical sense (e.g., Blumstein et al., April 1980; Charles W. Williams, February 1975; U.S. FEA, February 1977). Others offer assessments of the "most important" barriers (e.g., Opinion Research Corporation, July 1976; U.S. DOE, May 1979; Syska & Hennessy, August 1978). With the one exception noted, none were found that explicitly attempt to assess the magnitude of the impacts associated with the barriers in either sector or of any efforts to remove them.*

*Researchers at Lawrence Berkeley Laboratory have similarly noted the lack of systematic analysis of the barriers to energy conservation action. Their review covered all types of energy conservation barriers (Blumstein et al., April 1980, pp. 356, 370). An econometric project to quantify the energy usage impacts of barriers operating against the purchase of selected energy-using consumer durables was recently begun at Brookhaven National Laboratory (Brown, n.d.).

In general, those studies that assess the relative "importance" of barriers do not reflect a barrier's impact on energy conservation. The one or more barriers identified as "most important" in these studies appear to have been selected on the basis of the frequency with which they were mentioned or the emphasis placed upon them by respondents during interviews (e.g., Syska & Hennessy, August 1978, pp. 2-5; Opinion Research Corporation, July 1976, pp. 12,32). "Importance" in these studies, therefore, usually refers to the percentage of respondents mentioning the barrier, not to the actual effect of the barrier on specific energy conservation activities or energy usage. Any subsequent conversion of frequency counts into energy impacts becomes a highly speculative process.

The multifamily housing study mentioned above developed its estimates of potential energy savings by developing packages of incentive-type remedies in the regulatory, financial, economic, information, and educational areas and, using subjectively derived assumptions, quantitatively estimated the energy savings achievable in this subsector as a result of implementing the packages. It ranks the packages of incentives on the basis of energy savings potential but also notes that other attributes should be considered in developing a final ranking. Some of the tradeoffs resulting from these attributes are described (Real Estate Research Corporation, November 1975).

The data used in the existing studies were collected using three types of procedures:

- (1) National probability/cluster sampling
- (2) Regional probability/cluster sampling

(3) Non-systematic or straw-vote sampling.

The method used most often where barriers are the principal subject of the study is the non-systematic survey. Systematic surveys which permit statistical inferences to the national or regional level are mostly attitude surveys. Those that address selected barriers (e.g., Opinion Research Corporation, July 1976; Real Estate Research Corporation, November 1975) do not include any data on the specific energy conservation measures whose installation might be constrained.

Most of the existing research focuses on the barriers affecting energy conservation in the residential sector. Within this sector, the majority of the work is concerned with the single-family homeowner. The commercial buildings subsectors have received the least coverage.

B. Suggestions for Further Research

From the foregoing overviews, it is apparent that additional research would help to answer some of the questions associated with removing the barriers to energy conservation retrofit. In the residential homeowners subsector, the barriers are well identified and explained. Those having the greatest identification in the retrofit market in general are indicated by respondent frequency counts. In the residential subsector comprising buildings owned by landlords, and in the commercial subsectors, the barriers similarly are identified; however, less work has been done in these subsectors to explain the operation or relative importance of the barriers. In all subsectors there is a lack of research on the impacts of the barriers on energy usage.

The decisions to fill any of these gaps in the available information on barriers will be made in the light of competing demands for research resources. Several suggestions may be offered that should contribute in a cost-effective way to improved federal programs to lower the barriers to energy conservation retrofit. The suggestions are associated with each barrier and are offered in the same order as the barriers are discussed in the preceding chapters. This ordering is the equivalent of a rough ranking of importance for the suggestions.

1. Use of First-Cost Decision Criterion - Residential Sector

The costs of successfully removing this barrier are such that some form of careful evaluation would seem justified before any program entailing rebates or other forms of treasury payments were authorized. This might be accomplished through a well-designed evaluation of the impact of the first-cost barrier on residential retrofit decisions, or it might be accomplished through secondary analysis of private market research data on how consumers respond to price signals, if access to such data could be obtained.

Suggestive results might be obtained less expensively through a regional sample that compares homeowners that do and do not respond to programs that provide free information on retrofit payback. Such research would include homeowners who respond and subsequently purchase retrofit measures.

It would also be useful to find out if consumers are, in fact, beginning to respond to rising energy costs with purchases of the more energy-efficient appliances. Such research findings might suggest that greater programmatic emphasis be placed on encouraging the purchase of the more expensive

shell retrofit measures or elective replacement of inefficient appliances.

An evaluation of the residential energy tax credit program could be conducted to provide an indication of the effectiveness of that program before considering an increase in the credit. Data are being collected by the Energy Information Administration in a series of Residential Energy Consumption Surveys that eventually will permit inferences about the effectiveness of that program without the use of expensive evaluation efforts. It will be at least two years before the necessary information is available, however.*

There is a lack of data on the impact of the first-cost barrier on multifamily housing. There are several other important considerations affecting retrofit decisions in this subsector and it may be useful to develop a better understanding of their relative strengths. To sort out these considerations, an examination of the different investment perspectives, if any, of the various classes of multifamily housing property ownership might be conducted.

2. Use of First-Cost/Short-Term Payback Decision Criteria -- Commercial Sector

In view of the cost of developing and implementing remedies for these barriers in the commercial sector and in view of the relatively large benefit likely to be realized if they are substantially eliminated, the first-cost and short-term payback barriers would appear to merit carefully designed

*See Hittman Associates, Major Models and Data Sources for Residential and Commercial Sector Energy Conservation Analysis, Section E, prepared for the Department of Energy, June 1980.

impact assessments. The expense of such a study or studies would seem to be justified by the public funds that would be saved if it were found that the barriers did not have the potential for energy savings suggested by this analysis.

Other research could be designed to develop a better understanding of how the barriers operate. For example, at present, there are only suggestions of which segments of the owner universe would affirmatively respond to improved taxation and depreciation incentives or the magnitudes at which such incentives must be provided in order to overcome traditional investment biases. Research to provide a better understanding of these factors would provide a better basis for designing specific programs aimed at these barriers.

To this end, an examination of different investment perspectives, if any, among various classes of ownership of competitive office space and of shopping centers might be conducted. An alternative approach to the same objective might review construction permits in a representative metropolitan area to ascertain which office buildings and shopping centers undertook large-scale conservation retrofit investments during a recent period, perhaps the preceding 12 to 18 months. The owners and managers would be interviewed to determine the bases upon which these investment decisions were made. Answers might be sought to questions such as: To what extent was life-cycle costing employed? How were the investments paid for? What alternative financial vehicles would have been preferred if they had been available? What additional incentives would be considered necessary before more extensive (and expensive) conservation investments would be considered?

3. Lack of Precise and/or Customized Information

There is a need for basic research on the effects of this barrier. Valid research designs probably could be developed on a regional basis that would not be too expensive given the potential for energy savings that might be achievable. Audit activity is gaining momentum nationally, however, and by the time a valid and reliable research design could be performed, it is likely that audit programs will already be in place. It might, therefore, be better to devote new research to finding ways of making the audit programs more effective.

From the point of view of firms providing energy conservation audits, such research might address:

- (a) The problems of starting and operating an energy services company that provides audits
- (b) The characteristics of building owners in each subsector who respond to offers of energy audits
- (c) The characteristics of those who act on audit findings
- (d) The reactions of building owners to the different types of audits available
- (e) The types of audits that produce the most retrofits
- (f) The types of promotional campaigns that produce the most requests for audits in specific regions.

From an engineering point of view, such research might include investigation of the relative accuracy and cost

effectiveness of the three types of audits. Additionally, the relative accuracy and cost-effectiveness of several model audits within each type of audit might be evaluated, leading to the promulgation of a model audit approach for each type of audit. This research could also take into consideration generic classes of buildings.

The estimation of the infiltration rate is one of the most important yet least reliable parts of any audit. Infiltration can account for up to half the heating load for a single-family detached house. Techniques and equipment for improving the accuracy of infiltration estimates are being developed at Princeton University; however, the difficulty in making these estimates is such that, even with specialized equipment, alternative approaches may be worth consideration. Many auditors currently use rough estimates based on the estimated air flow per unit length of an opening of a given size. As an alternative, a one-time statistical research effort might develop estimates of the infiltration in common types of buildings of a certain volume, number of doors, number of windows, age, family size, etc.

4. Lack of Sociological Incentive

Considerable research exists on attitudes toward energy conservation and energy issues. Somewhat less information is available on buildings energy-usage behavior. A fair amount is available on retrofit actions reportedly taken, and DOE has begun a series of surveys to collect more (the Residential Energy Consumption Survey series). In spite of this considerable survey activity, however, few surveys have collected data on both attitudes and buildings energy usage or retrofit activity. Only three studies were found that could generalize about such relationships from empirical data (Milstein, 1977;

Becker et al., June 1979; Cambridge Survey Research, Fourth Quarter, 1979).

Such relationships need to be established in order to evaluate the impact of the sociological/psychological barrier on retrofit decisions and to evaluate programs aimed at removing the barrier. It is suggested that research be undertaken to evaluate these relationships, focusing on the relationships between specific attitudes and actual retrofit behavior. Data from such research would help both government and retailers develop messages that are more effective in breaking through this barrier.

5. Fuel Pricing Policies that in the Short Run Do Not Provide Enough Incentive to Invest in Energy Conservation

In view of the existing programs of phased decontrol of natural gas and oil prices, events may have overtaken the need for further research on this barrier. The programs remain controversial, however, and certainly before any action is taken to accelerate fuel price deregulation, it is recommended that a research design be carefully formulated and implemented to assess the energy savings potential of this barrier and the social impacts of removing it. In particular, for the residential and commercial sectors, it would be helpful to develop elasticities of demand for all major residential and commercial retrofit measures with respect to the prices of natural gas and heating oil. Such measures would be very useful in assessing the residential and commercial energy savings potential in accelerated fuel price deregulation.

6. Lack of a Delivery System

Before greater commitments to the stimulation of private one-stop shopping services are undertaken, a careful evaluation of the extent of the retrofit market should be made. Such estimates are in existence; these might be compared with the rate of response to utility RCS Programs (and the charges for RCS services) to assess the depth of the market and the potential for profitability.

Given the fact that contractors in the home-improvement market are viewed with distrust (see Chapter VIII), one region with a large market potential might be selected for an evaluation of private one-stop shopping company operations to assess consumer acceptance before additional effort is committed to this approach.

Evaluation of the RCS Program will also help to evaluate the effectiveness of delivery systems in accelerating retrofit. One-stop shopping services are likely to be at least as effective in their market areas as the RCS Program proves to be in a utility's service area or home heating supplier's market area, provided the costs for service are comparable. The results of the RCS Program, therefore, may suggest the minimum level of effectiveness that private one-stop shopping services offering comparably priced services can expect in their market areas.

7. Inability to Evaluate Contractor Performance

The benefits achievable from a rigorous evaluation of the impacts of this barrier probably will not justify the expense of conducting it. Research might more profitably be direct toward identifying and analyzing approaches that have

successfully reduced consumer fraud by contractors in the past.

Some states have established programs to license insulation contractors. The effect of these programs on the quality of service being provided is not yet known. It might be useful to survey consumer protection agencies in several states with and without licensing programs to determine their effect on contractor performance. The survey should also examine specific requirements for licensing in order to evaluate their effectiveness in screening contractor performance.

Data of this nature would give states with licensing programs and those considering them guidelines for amending or developing requirements and enforcing them.

8. Inability to Evaluate or Control the Quality of Retrofit Products

A valid research design to assess the effects of this barrier would be very expensive. In view of the relatively small energy savings likely to result from its removal, a national-level research effort would not appear to be justified. Useful results might be obtained if the barrier were simply assumed to exist, and the results of specific programmatic interventions for it were tested. A pilot program including a pre-test and post-test might be developed for a major city. Interviews could be used to assess the effectiveness of the program and the resistance of the barrier to change. The results of such a pilot program might then be used to suggest the potential effectiveness of a national program.

For the purposes of overcoming commercial owners' skepticism about manufacturers' claims of performance, cases of successful retrofit in the commercial sector could be identified through case research. These cases could be analyzed for the factors that made them successful, and written up for dissemination through trade journals and newsletters. Given knowledge of the factors that promote success, commercial building owners as a group might feel more confident in their ability to select a good retrofit investment.

9. High Finance Costs

Given the apparently low potential for energy savings inherent in the elimination of this barrier, additional research would not appear to be warranted. Extensive provisions have been made, however, for special loan rates in many of the energy conservation retrofit programs implemented to date. Therefore, opportunities exist to better evaluate the impact of below-market interest rates on consumers' willingness to retrofit. In order to assess the value of continuing or expanding these programs, it would be useful to conduct formal evaluations of their impacts.

Such evaluations should be carefully designed to permit the identification of other promotional effects that these low-interest loan programs might have. For example, these loan programs may include non-financial benefits such as post-installation inspections that are contingent upon the receipt of a loan. Also, just the offer of low-interest loans may create a consumer perception that a loan with easy repayment terms effectively eliminates the competition for available capital between energy conservation retrofit purchases and other purchases because it serves, in effect, as a source of windfall capital. Such loan offers may also symbolize a

sense of urgency or seriousness about energy conservation such that, as a result, consumers become more willing to invest in energy conservation retrofit.

Evaluations of such programs might also provide a method of assessing whether the empirically demonstrated consumer tendency for not borrowing in the range typical of residential retrofit purchases is actually the result of minimum-loan policies. If commercial loans cannot be obtained for less than \$1,000, then clearly the data will show that homeowners do not borrow for home improvements costing less than \$1,000. These evaluations might determine whether the low-interest, low-level-of-assistance loans currently being offered by utility programs are stimulating a latent demand for loans in this range.

Other research might profitably inquire into:

- (a) Why consumers do or do not borrow to make retrofit purchases
- (b) The effect of eligibility criteria on borrowing for retrofit
- (c) The existing experience of lending institutions which have offered low-interest energy conservation loans.

APPENDIX - METHODOLOGY

A. General Approach

The general methodological outline for the study involves:

- (1) Identifying the institutional barriers that inhibit buildings energy conservation retrofit in the residential and commercial building sectors
- (2) Identifying the literature that discusses or assesses these barriers
- (3) Developing a methodology for analyzing and ranking the barriers according to their suitability for government action
- (4) In-depth review of the literature and evaluation of the barriers in terms of their impacts, corrective action, the subsectors affected, and the data available.

At the beginning of the task, a preliminary literature review was conducted to identify the institutional barriers. A list was established of as many barriers as could be found. From this list, eight were selected for further analysis and ranking under the task.

In order to accomplish the ranking, the eight barriers had to be compared on common characteristics. To do this, a set of attributes representing variables that were relevant to the study's objective was developed. This set included,

for example, attributes representing the potential savings that could be realized if the barrier were eliminated and the ease with which elimination of the barrier could be achieved. The attributes are described in more detail in Section D below.

A scale was developed for each of the attributes, taking into consideration the nature of the data available. Each barrier was analyzed and, using these scales, scored on the attributes. A methodology was developed for comparing the barriers on these scores and, using the comparisons, the barriers were ranked.

This general approach is described in more detail in the following sections.

B. Identification of the Institutional Barriers to Buildings Retrofit

The considerable literature that exists on barriers to energy conservation retrofit, especially since 1974, provided the basic source of information for this study. To help insure that the list of barriers was as comprehensive as possible, in addition, a schema of the retrofit decision process was developed so that the factors that come into play at each step of the decision process could be identified. Figure A-1 presents this schema.

To ensure comprehensive coverage, an institutional barrier was defined as anything that prevents or delays a decision to invest resources in building materials or appliances that, when installed, are expected to result in cost-effective energy savings. This definition explicitly includes economic barriers to retrofit.

TABLE A-1. CONSERVATION RETROFIT BARRIERS TO ENERGY

		Barriers analyzed	
CATEGORIES OF BARRIERS	SPECIFIC BARRIERS	CATEGORIES OF BARRIERS	SPECIFIC BARRIERS
1. Lack of delivery systems	a. Shortage of contractors for given measures		c. Financing costs
	b. Lack of advertising		i. High interest rates
	ii. Small contractors		ii. Short-term money market costs
2. Lack of appropriate incentives	c. Utility inactivity in retrofit programming	4. Competition for capital	a. Peer pressure for competing investments
	d. Oil dealer inactivity in retrofitting programs		b. Competing investments for lenders (lenders follow market)
	e. Lack of contractor/dealer/interest in small-ticket conservation items		c. Lack of "dedicated" lender
3. High capital costs for installation	f. Utility resistance to government retrofit programs	5. Lack of ability to calculate costs vs. benefits or use of inappropriate methods	a. Lack of state/community information programs
	g. Lack of integrated one-stop energy conservation services(delivery systems).		b. Lack of do-it-yourself knowledge
	h. Fragmentation of retrofit industries		c. Lack of precise or customized information
	a. Master-metering of apartments and offices (third party payment of utilities)		d. Conflicting statements about need to conserve energy
	b. Third party receipt of benefit from investment		e. Confusion as to which decision rule to use
	c. Fuel pricing policies that maintain low fuel prices		f. Uncertainty about future
	d. Projections that show slow increase in fuel prices		i. Income
	e. Marginally improved energy efficiency of proposed investment		ii. Frequently changing information
	f. Short-term investment holdings or tenancy prevent recovery of costs		g. Lack of knowledge about sources of capital
	g. Having invested once, dissatisfied with results or do not feel need to invest again		h. Lack of awareness of income tax benefits
	h. Sociological/psychological disincentives		i. Lack of education or knowledge of how to estimate costs & benefits, sources of capital
	j. Disbelief in energy crisis		j. Cost of customized information
	ii. Trust in technological cure		k. Use of inappropriate decision criterion
	iii. Belief that comfort/convenience will be lost		i. First cost
	iv. Resistance to change, "inertia"		ii. Short-term payback
	a. Product costs	6. Lack of public confidence in anyone or any group to give guidance on conservation	a. Mistrust of sponsor or performer of evaluation
	i. Research		b. Reluctance to go into debt
	ii. Production		
	- Regulatory; labeling, health, env. testing		
	iii. Factor costs		
	- National availability		
	iv. Marketing		
	b. Installation costs	7. Lack of uniform quality control on goods and services related to retrofit	a. Inability to evaluate contractor performance
	i. Building codes		b. Inability to evaluate product
	ii. Zoning codes		c. Resistance by appraisers to giving appropriate value to retrofit installations
	iii. Factor costs		d. Lack of product or installation warranty
	iv. Permit/licensing costs		
	- Bonding costs		

C. Literature Search

The study was designed to use the extensive literature available on barriers to buildings energy conservation and to collect original data only if needed. A search for this literature was conducted using the following sources:

- (1) The contractor's library and staff resources
- (2) Conservation Policy Office staff
- (3) DOE program managers
- (4) DOE Library
- (5) DOE RECON system
- (6) The Department of Housing and Urban Development Library
- (7) DOE's Energy Abstracts for Policy Analysis.

The results of this search are presented in the Bibliography to this report.

D. Methodology for Analyzing and Ranking the Barriers

1. Analysis of the Barriers

a. Attributes. The objective of the study is to rank institutional barriers in an order of suitability for govern-

ment action. This required that the barriers be considered from several points of view. For example, the potential for energy savings that exists in eliminating a barrier is a variable of prime importance, but any costs incurred during or resulting from elimination of the barrier also must be taken into consideration.*

To reflect these considerations, a set of attributes, or variables, was developed by which each barrier could be compared on features that were important for assessing the potential for government action. The attributes selected for this purpose were:

(1) Energy Savings Potential. This attribute describes the energy savings that are potentially available if the barrier's impact on energy conservation retrofit were removed.

(2) Non-governmental Costs Associated with Removal of the Barrier. This attribute describes the cost impacts, both monetary and otherwise (e.g., environmental effects), that are likely to occur if the barrier were removed. It includes any cost impacts on the sponsoring institution, e.g., loss of income to a lending institution due to uncompensated lower interest rates or non-guaranteed loan defaults, but does not include the government effort and cost associated with eliminating the barrier.

*The need to examine the impacts on non-energy concerns when assessing options for federal action to remove energy conservation barriers is discussed in Blumstein, et al., 1980, pp. 369-370. The authors advise sensitivity to the impacts on economic growth, income distribution, employment, land use patterns, lifestyle, and individual freedoms.

(3) Ease of Removal. This attribute describes the effort likely to be required by the federal government to develop and implement programs to remove the barrier. It includes consideration of political interests and treasury costs.

(4) Benefits Other Than Energy Savings. This attribute describes the benefits other than potential energy savings that are likely to occur if the barrier were removed. It includes, primarily, potential increases in employment.

(5) Data Quality. This attribute describes the validity (do the data actually provide good indicators of what they are being used to indicate?), reliability (using the same measuring instrument, would another researcher get the same results?), and quantity of the data available on the barrier.

b. Attribute Scales. In order to compare the barriers, each one was characterized, or scored, on the attributes. A scale, or set of scores, was developed for each attribute for this purpose.

Since the data available on the barriers are, for the most part, qualitative and subjectively derived, a decision had to be made regarding the type and categories of scores that would be used for each attribute. The preliminary review of the literature and available data indicated that the available quantitative data were inadequate for producing supportable quantitative estimates of the impacts of the barriers for any of the attributes. Comparative, or ordinal, estimates of the impacts could, however, be developed. Accordingly, ordinal scores were established for each attribute scale.

The lack of quantitative data also made it unrealistic to establish a zero datum for the ordinal scales; therefore, the categories for the ordinal scores were created to indicate relative impact.* To do this, the barrier(s) with the least impact and the barrier(s) with the most impact were selected for each attribute. The other barriers were scored relative to these.

The scores for each attribute are shown in Table A-2.

c. Characterizing the Barriers. The barriers were subjectively scored on the attributes using a modified Delphi methodology. Members of the task team became thoroughly familiar with particular barriers; then several team meetings were held in which each barrier's potential impacts were described and debated. Following the last of these meetings the barriers were scored on each attribute. Each barrier was assumed to be operating independently, i.e., the assessed effect of any barrier assumed the status quo for the other barriers. A week was allowed to pass during which the team continued its study, and another meeting was held. During the second meeting, the barriers were again reviewed and a consensus was reached on the final scores for each barrier.

The scores for the residential and commercial sectors are independent of each other. A barrier's score on an attribute for a sector was determined only by its relative impact in that sector. The barriers' scores on each attribute for the residential and commercial sectors are shown in Table A-3.

**The scale for Data Quality is an exception. The data were evaluated on their adequacy as a basis for generalization about impacts of the barriers. The case of totally inadequate data could be identified.*

TABLE A-2. ATTRIBUTE SCORES

Energy Savings Potential

Most* savings
More savings
Mid-point savings
Less savings
Least* savings

Costs Associated With Removal

Least cost
Less cost
Mid-point cost
More cost
Most cost

Ease of Removal

Least effort
Less effort
Mid-point effort
More effort
Most effort

Benefits Other Than Energy Savings

Most benefit
More effort
Mid-point effort
Less benefit
Least benefit

Data Quality

Good quality

(adequate for generalization)

Moderately good quality
Mid-point quality
Moderately poor quality
Poor quality

(questionable as a basis for
generalization)

*More than one barrier can hold a "most" or "least" score.

TABLE A-3. CHARACTERIZATION OF THE BARRIERS ACCORDING TO THE ATTRIBUTES

Barrier	Attributes					
	Sector	Energy Savings Potential	Nongovernmental Costs Associated With Removal	Ease of Removal	Benefits Other Than Energy Savings	Data Quality
1. Lack of Integrated One-Stop Energy Conservation	RESIDENTIAL	Midpoint savings	Least cost	More effort	Midpoint benefit	Poor quality
	COMMERCIAL	Midpoint savings	Least cost	More effort	Midpoint benefit	Poor quality
2. Lack of Customized or Precise Information	RESIDENTIAL	More savings	Least cost	Midpoint effort	Least benefit	Moderately poor quality
	COMMERCIAL	More savings	Least cost	Midpoint effort	Least benefit	Moderately poor quality
3. Use of First-Cost Decision Criterion	RESIDENTIAL	Most savings	Least cost	Most effort	Midpoint benefit	Moderately poor quality
	COMMERCIAL	Most savings	Less cost	Most effort	Midpoint benefit	Midpoint quality
4. High Financing Costs	RESIDENTIAL	Least savings	Least cost	Least effort	Least benefit	Moderately poor quality
	COMMERCIAL	Least savings	Least cost	Least effort	Least benefit	Poor quality
5. Inability to Evaluate Contractor Performance	RESIDENTIAL	Midpoint savings	Less cost	Most effort	Less benefit	Moderately poor quality
	COMMERCIAL	Least savings	Less cost	Less effort	Less benefit	Moderately poor quality
6. Fuel Pricing Policies that Maintain Low Fuel Prices	RESIDENTIAL	More savings	Most cost	Most effort	Most benefit	Poor quality
	COMMERCIAL	Less savings	Most cost	Most effort	Most benefit	Poor quality
7. Inability to Evaluate Retrofit Products	RESIDENTIAL	Least savings	Least cost	Midpoint effort	Least benefit	Poor quality
	COMMERCIAL	Midpoint savings	Least cost	Midpoint effort	Least benefit	Poor quality
8. Lack of Sociological/Psychological Incentives	RESIDENTIAL	More savings	Less cost	More effort	Least benefit	Moderately poor quality
	COMMERCIAL	Least savings	Less cost	Less effort	Least benefit	Poor quality

The choice of a Delphi method for scoring the barriers was dictated by the lack of available quantitative data on the barriers' impacts and the decision not to generate quantitative indicators synthetically.

2. Ranking the Barriers

a. Methodology. A lexicographic method was selected to rank the barriers after the decision was made to use ordinal data to characterize the barriers. Because ordinal data will not permit the degree of "more" or "less" to be assessed, a method had to be selected that would allow comparisons to be made without the use of interval scales. Lexicographic methods appeared to meet this requirement best.

Lexicographic methods rank items in the same manner as words are ranked, or ordered, in a dictionary. First, the attributes that are considered important to the objective of the ranking are assigned an order of relative importance based on their relevance to the objective of the ranking. This determines the order in which they will be compared. For example, energy savings potential was considered more important to the attainment of the Department of Energy's objectives in removing the barriers than ease of removal. Therefore, during the comparison, the barriers were compared on this attribute first. Then, the scores for each attribute are assigned to an ordinal scale indicating which score is "better." For example, the barriers having the most potential for energy savings are "better" for the purpose of selecting barriers for federal action than those having little potential for energy savings. When the attributes and scores have been thus ordered, the items are compared attribute by attribute until, through a process of elimination, the item(s) having the "best" score, starting with the most important attribute,

is selected. The remaining items can then be ranked in reverse order of their elimination.

The comparison/selection process is as follows. The first or most important attribute of an item (analogous to the first letter of a word) is considered first, and only the items with the "best" -- or best available -- score on this attribute are selected. This set of items, or as in the case of this study, barriers, is then reduced by selecting next only those that have the best, or best available, score on the second-ranked attribute. The items ranking best on the third-ranked attribute are then selected and so on until the single item or subset of items has been selected that has the best available scores on all attributes.

The single barrier selected by this method was ranked as the barrier having the greatest potential for government action. The barriers that were eliminated from this original set of barriers were ranked behind it in the reverse order of their elimination.

This first stage of the procedure considered only those barriers that scored highest on the most important attribute. The barriers having the next highest score on the most important attribute were considered next, and so on until all the barriers had been ranked.

The major disadvantage of the lexicographic method is the very heavy emphasis it accords to items that ranked "best" on the most important attribute (in this case, potential energy savings). The method places a very heavy weight on the score of this attribute. This disadvantage was weighed carefully against the advantage of performing a numerical benefit-cost analysis using subjectively estimated attribute

weights and scores. Benefit-cost analysis has the advantage of producing an unequivocal choice in its final calculation, although the steps that precede this calculation often contain very questionable assumptions and estimates. A benefit-cost analysis was attempted to compare the methods; unfortunately, the literature was found to be inadequate for supporting informed judgments on the attribute scores. Consequently, a numerical benefit-cost methodology was judged to be less supportable than the lexicographic method, in spite of the latter's peculiar disadvantage. Since the ranking appears to be reasonable in terms of the study's objectives and the existing literature, the method's drawback does not appear in this application to have produced inappropriate results.

b. Order of Importance of the Attributes. The attributes were ordered according to their relative importance for the objective of the study, i.e., for selecting a suitable barrier for government remedial action, as follows:

- (1) Energy Savings Potential
- (2) Non-governmental Costs Associated with the Removal of the Barrier
- (3) Ease of Removal
- (4) Benefits Other than Energy Savings
- (5) Data Quality.

Data quality was eventually dropped from the ranking methodology because it could not be separated analytically from the other attributes. It is an important attribute, however, and is discussed in the text.

Comparing and ranking the barriers using this order of importance and the lexicographic method discussed in the preceding subsection produced the final ranking shown in Table A-4.

TABLE A-4. BARRIER RANKING FOR GOVERNMENT ACTION

<u>Ranking</u>	<u>Sector</u>	
	<u>Residential</u>	<u>Commercial</u>
1	First-Cost Decision Criterion	First-Cost Decision Criterion
2	Lack of Precise Information	Lack of Precise Information
3	Lack of Sociological/Psychological Incentives	Inability to Evaluate Products
4	Fuel Pricing Policies	Lack of Delivery Systems
5	Lack of Delivery Systems	Fuel Pricing Policies
6	Inability to Evaluate Contractor	High Finance Costs
7	Inability to Evaluate Products	Inability to Evaluate Contractor
8	High Finance Costs	Lack of Sociological/Psychological Incentives

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