BCS Task 34
(210734)

(EC-77-C-03-1697)
DE-AC03-77CS20205

DOE/CS/20205--T14

MASTER

ENERGY AND ENVIRONMENTAL ANALYSIS, INC.
1111 North 19th Street
Arlington, Virginia 22209
(703) 528-1900

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DOE/CS/20205--

DEVELOPMENT OF A DEMONSTRATION
PROGRAM FOR RETROFIT OF ECRR MEASURES
ON EXISTING DWELLING UNITS

AC03-77CS20205-

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Prepared for:

Division of Buildings and Community Systems
Office of Conservation and Solar Applications
U.S. Department of Energy
Washington, D.C. 20545

Prepared by:

Energy and Environmental Analysis, Inc.
1111 North 19th Street
Arlington, Virginia 22201

Contract No. EC-77-C-03-1697, Task 34

December 8, 1978

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

MGW

TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION.	1
2. STRUCTURAL MAKE-UP AND ENERGY USAGE IN RENTER OCCUPIED HOUSING	4
3. ENERGY CONSERVATION IN RENTER OCCUPIED HOUSING. OPPORTUNITIES AND BARRIERS.	20
3.1 Energy Conservation Opportunities.	20
3.2 Incentives for Energy Conservation	26
3.3 Other Disincentives.	39
4. PROSPECTIVE PROGRAMS.	45
4.1 Issues of Programmatic Significance.	45
4.2 Prospective Approaches	48
4.3 Potential Costs and Benefits of a National Program	58
4.4 Summary.	59
APPENDIX A	65
APPENDIX B	67
APPENDIX C	73

1. INTRODUCTION

This paper will identify those policy measures which could be part of a federal program to encourage energy conservation in renter occupied housing. It is an interim report of an ongoing study conducted by Energy and Environmental Analysis, Incorporated (EEA) for the Department of Energy (DOE) Division of Buildings and Community Systems (BCS).

In recent years, major legislation aimed at reducing residential energy consumption has been introduced. Both the Energy Conservation and Production Act (ECPA) of 1976 and the National Energy Plan contain measures designed to stimulate residential energy conservation.

The Energy Conservation and Production Act (ECPA) became law in August of 1976. Section 509 of ECPA authorized the Secretary of Housing and Urban Development to employ low interest loans, loan guarantees, interest subsidies, grants or other financial incentives to encourage energy conservation and renewable resource (ECRR) applications in the residential sector. The Act authorizes that a demonstration program to test these incentives be implemented with a view toward an ensuing national program.

The Department of Housing and Urban Development neither requested or initiated any programs under Section 509 of ECPA. One reason for their inaction was the expectation that the authority to direct programs pursuant to section 509 would be transferred to the Department of Energy. The program was in fact transferred to the Department of Energy in October of 1977.

By the time the authority to direct programs pursuant to section 509 had passed into the hands of the Department of Energy, the National Energy Plan had already been proposed. (March, 1977) This legislation also called for substantial financial incentives, in the form of large tax credits, to encourage residential energy conservation.

The NEP was debated from March 1977 until its passage in October of 1978. During this time period, the Division of Buildings and Community Systems discerned that, even if passed, the residential energy tax credits in the NEP would be employed almost exclusively by homeowners as opposed to renters. They decided to evaluate the feasibility of the use of financial incentives to encourage renter energy conservation, including the implementation of a program under Section 509 of ECPA aimed at renter occupied housing. Such a program could complement, rather than duplicate, the residential tax credits in the NEP.

In requesting a feasibility study for a program aimed at reducing renter energy consumption, BSC acknowledged that any comprehensive attempt to reduce residential energy consumption must consider renter occupied housing. Of the 74 million occupied housing units in the United States in 1976, 26 million or 35 percent are renter occupied. Residential energy use constitutes approximately 18 percent of national energy consumption. Approximately 28 percent of all residential consumption or 5.5 percent of national consumption, occurs in rented housing. Further, it is probable that a disproportionate share of unrealized cost-effective energy conservation opportunities are found in renter occupied housing. This will be discussed further in the body of this paper.

This paper reports the work done thus far by Energy and Environmental Analysis for the Department of Energy Division of Buildings and Community Systems under contract BSC-034. It will:

- Summarize accumulated data on the renter occupied housing stock and its energy consumption. This includes information on renter energy consumption specific to structure type, functional use, fuel type, and region.
- Outline energy conservation opportunities in renter occupied housing and identify factors which impede the realization of those opportunities. This includes a discussion of the incentives for energy conservation in rented housing.

- Suggest programs that could reduce energy consumption in rented housing. This includes the use of programs authorized by Section 509 of ECPA as well as other approaches.
- Discuss an information and subsidy program for renters in detail, including an identification of the potential costs and energy savings accruing from the program.
- Identify the remaining analytic work to be done on this study.

2. STRUCTURAL MAKE-UP AND ENERGY USAGE IN RENTER OCCUPIED HOUSING

The following section describes the renter occupied housing stock according to its physical characteristics and its energy consumption.

Table 2-1 illustrates the size of the renter occupied housing stock within the entire residential sector. The number of renter occupied units grew by almost six million from 1960 to 1976, to a total of over 26 million units. The percentage of all units that are renter occupied declined slightly, from 38.1 percent to 35.3 percent over this period. Home ownership is positively correlated with income as indicated in Table 2-2. It is, therefore, likely that the decline in the renter occupancy percentage from 1960 to 1976 was partially due to the 43 percent rise in real per capita income over that period. Further, the federal government has stimulated home ownership through a number of policies including tax deductibility of mortgage interest payments, toll-free interstate highways, and a number of mortgage programs.

Table 2-3 illustrates the structural breakdown of the housing stock in 1976. The table classifies each housing unit on the basis of the number of units in the structure in which the unit is located. It indicates that 35.3 percent of all housing units were renter occupied in 1976. The percentage of renter occupied units was lower than this overall average for one unit structures and higher for multi-unit structures.

Table 2-4 provides a more detailed breakdown of the renter occupied housing stock by structural categories. Thirty-five percent of rental units are single family units. Sixty-two percent of all rental units are in structures of four units or less. Of the remaining 38 percent, about half are in structures of less than 20 units while the other half are in structures of 20 or more units.

TABLE 2-1
SIZE OF THE RENTER OCCUPIED HOUSING STOCK
1960 to 1976*

Year	Total Number of Occupied Housing Units	Number of Renter Occupied Units	Percentage of all Units that are Rented Occupied
1960	53,024,000	20,227,000	38.1
1970	63,450,000	23,656,000	37.1
1973	69,337,000	24,684,000	35.6
1974	70,831,000	25,046,000	35.4
1975	72,523,000	25,656,000	35.4
1976	74,004,000	26,101,000	35.3

*SOURCE: U.S. Department of Commerce, U.S. Bureau of the Census, Current Housing Reports, Series H-150-76, Annual Housing Survey: 1976, Part A. Washington, D.C.: U.S. Government Printing Office, 1978.

TABLE 2-2
RENTER OCCUPANCY PERCENTAGE BY
INCOME GROUPS IN 1976

Income (in 000\$)	Number of Units (in 000 Units)	Percentage of all Units (%)	Percentage Renter Occupied (%)
< 3	6,939	(9.4)	57
3-5	7,699	(10.4)	53
5-7	6,946	(9.4)	48
7-9	9,314	(12.6)	46
10-15	14,892	(20.1)	36
15-20	10,910	(14.7)	24
20-25	7,085	(9.6)	18
25-35	6,239	(8.4)	13
35+	3,982	(5.4)	11
All Groups	74,005	100.0	35

SOURCE: U.S. Department of Commerce, U.S. Bureau of the Census,
Current Housing Reports, Series H-150-76, Annual Housing
Survey: 1976, Part C. Washington, D.C.: U.S. Govern-
ment Printing Office, 1978.

TABLE 2-3
RESIDENTIAL HOUSING: 1976

Structure Type	Number of Residential Units (in 000's)	Number of Renter Occupied Units (in 000's)	Percentage Renter Occupied
Mobile Home	3,627	641	17.7%
Single Family Detached	47,718	7,249	15.2%
Single Family Attached	2,895	1,235	42.7%
2-4 Unit Structures	9,259	7,116	76.9%
5+ Unit Structures	10,505	9,859	93.9%
All Structures	74,004	26,101	35.3%

SOURCE: U.S. Department of Commerce, U.S. Bureau of Census,
Current Housing Reports, Series H-150-76, Annual
Housing Survey: 1976, Part A. Washington D.C.:
U.S. Government Printing Office, 1978.

TABLE 2-4

NUMBER AND PROPORTION OF RENTER OCCUPIED UNITS
IN EACH STRUCTURAL CATEGORY IN 1976

Structural Category (Units in Structure)	Number of Units (in 000's)	Percentage of all Rented Units
Mobile Homes or Trailers	640	2.5
Single Family Detached	7,242	27.8
Single Family Attached	1,235	4.7
2-4 Units	7,116	27.3
5-9 Units	3,081	11.8
10-19 Units	2,523	9.7
20-49 Units	1,925	7.4
50+ Units	2,338	9.0
Total	26,101	100.0

SOURCE: U.S. Department of Commerce, U.S. Bureau of the Census,
Current Housing Reports, Series H-150-76, Annual Housing
Survey: 1976, Part A. Washington, D.C.: U.S. Govern-
ment Printing Office, 1978.

Table 2-5 illustrates the make-up of the renter occupied housing stock on the basis of a more compact method of aggregation. These are the categories used in the Department of Energy, Energy Consumption Data Base (ECDB). This data base is currently updated to 1974. Because this data base is the source of much of the energy consumption information contained in this report, an explanation of its sources is appended.

In Table 2-5 the single family attached and mobile home categories are the same as those employed in previous tables, and are defined according to the standard characteristics of those housing types. The single family attached category includes all structures with one or two units that are attached to other structures by one common wall. The multi-family low-rise category encompasses all structures of more than two units but less than four stories. The multi-family high rise category contains all structures of more than two units and four stories or more.

Table 2-6 lists the energy consumption of each of the renter occupied structure categories, expressed in 10^{12} Btu's per year. The table also lists the percentage of all renter energy use falling within each structural category. Residential electricity use is considered in these totals in terms of net consumption at the residence. The last column lists energy consumption on a per unit basis for various types of structures.

Several points should be noted from this table. First, the renter occupied housing stock consumed an estimated 3.627 quads in 1974. This was 28 percent of residential energy consumption and 5.5 percent of national energy consumption. Energy consumption per unit ranged from 119 million Btu's for multi-family low and high rise structures to 172 million Btu's per year for single family detached and attached structures. The average net energy consumption in rental units was 144 million Btu's per year.

TABLE 2-5

NUMBER AND PROPORTION OF RENTER OCCUPIED
UNITS IN EACH STRUCTURAL CATEGORY IN 1974

Structural Category	Examples	Number of Units (000's)	Percentage of Rented Units
Mobile Homes or Trailers		545	2.2
Single Family Detached	Ranch, Split-Level, Two Story	7,110	28.4
Single Family Attached	Townhouse, Row House, Duplex	4,583	18.3
Multi Family Low Rise	Garden Apartment Buildings	9,519	38.0
Multi Family High Rise	Apartment Buildings	3,289	13.1
Total		25,046	100.0

SOURCE: U.S. Department of Commerce, U.S. Bureau of the Census, Current Housing Reports, Series H-150-74, Annual Housing Survey: 1974, Part A. Washington, D.C.: U.S. Government Printing Office, 1976.

TABLE 2-6

ENERGY CONSUMPTION BY RENTERS IN 1974

Structural Category	Total Energy Consumption and Percent Renter Energy Use 10 ¹² Btu (%)	Energy Consumption Per Unit (10 ⁶ Btu)
Mobile Home	86.20 (2.4)	158.17
Single Family Detached	1,162.16 (32.0)	172.43
Single Family Attached	854.11 (23.5)	
Multi-Family Low Rise	1,068.61 (29.5)	119.06
Multi-Family High Rise	456.37 (12.6)	
All Units	3,627.45 100.0	144.83

SOURCE: Energy and Environmental Analysis, Inc., Energy Consumption Data Base, Household Sector, Arlington, Virginia, April 1977.

Table 2-7 illustrates the functional uses for which renters consume their 144 million Btu's per unit per year. Space heating and cooling account for 62 percent of renter energy consumption. These functional uses account for a smaller percentage of energy consumption in the larger, multi-unit structural categories. Water heating is the next largest user of energy, followed by cooking and lighting and appliances.

Table 2-8 illustrates the percentage breakdown of energy consumption by functional use for the various regions of the United States. (The DOE regional divisions are indicated in Figure 2-1.) The table indicates that space conditioning is the most important functional use in each region, but that it can vary from 46.6 percent of energy consumption (West South Central) to 72.0 percent of consumption (West North Central). In regions with lower space conditioning loads, water heating, cooking, lighting, and other appliances become more significant.

Table 2-9 illustrates the percentage of energy requirements met by each major fuel type for each renter structural category. 83.2 percent of all residential energy use are supplied directly by fuels derived from crude oil or natural gas. This does not include the oil and gas used to produce electricity for renter consumption, which would bring the total to over 90 percent. Natural gas is the single most important fuel source, supplying 48.8 percent of national renter requirements.

The national average price of natural gas was \$2.42 per MMBtu in March of 1978. Consumers in regions such as the Southwest where natural gas is available for space conditioning can, therefore, obtain most of their energy at a price 55 percent below the national average. On the other hand, consumers who use electricity for space conditioning pay \$12.12 per MMBtu for this form of energy, almost three times the national average.

The 119 to 172 million Btu's per year consumed by renters cost between \$44 and \$63 per month at March 1978 energy prices. These numbers are obtained by multiplying the average energy consumption by renters by a

weighted average fuel price (\$4.40 per MMBtu)*. The amount paid by a particular unit may differ from these averages depending on fuel type and region.

* The methodology for determining a national average energy price is contained in Appendix C.

TABLE 2-7

FUNCTIONAL USAGE OF ENERGY BY STRUCTURE TYPE *

Structure Type	Space Conditioning	Water Heating	Cooking	Lighting & Appliances	Total
Mobile Home	61.28%	18.90%	13.11%	6.71%	100%
Single Family Detached	69.80%	15.39%	5.10%	9.71%	100%
Single Family Attached	65.28%	20.60%	5.93%	8.19%	100%
Multi Family Low Rise	53.16%	29.39%	7.18%	10.27%	100%
Multi Family High Rise	55.28%	30.41%	5.72%	8.59%	100%
Total Structures	61.79%	22.72%	6.17%	9.32%	100%

SOURCE: Energy and Environmental Analysis, Inc., Energy Consumption Data Base, Household Sector, Arlington, Virginia, April 1977.

TABLE 2-8

PERCENTAGE OF CONSUMPTION FOR EACH FUNCTIONAL USE IN EACH REGION AND NATIONALLY

Region	Space Conditioning	Water Heating	Cooking	Lighting and Other Appliances	All Uses
Northeast	64.75%	23.50%	4.40%	7.35%	100%
Middle Atlantic	60.73%	25.66%	5.50%	8.11%	100%
South Atlantic	49.85%	29.38%	8.21%	12.56%	100%
East North Central	70.38%	17.23%	4.70%	7.69%	100%
East South Central	51.69%	26.34%	8.74%	13.23%	100%
West North Central	71.97%	15.10%	4.34%	8.59%	100%
West South Central	46.35%	23.83%	13.97%	15.85%	100%
Mountain	59.90%	24.45%	5.74%	9.91%	100%
Pacific	60.44%	22.24%	6.78%	10.54%	100%
National	61.79%	22.72%	6.17%	9.32%	100%

SOURCE: Energy and Environmental Analysis, Inc., Energy Consumption Data Base, Household Sector, Arlington, Virginia, April 1977.

Regions and Geographic Divisions of the United States

FIGURE 2-1

U.S. Department of Commerce
BUREAU OF THE CENSUS

TABLE 2-9

RENTER ENERGY CONSUMPTION BY FUEL TYPE *

Housing Type	Oil ^a	Gas	Electricity (net)
Mobile Home	62.55%	21.13%	16.32%
Single Family Detached	32.23%	48.72%	19.05%
Single Family Attached	30.71%	55.37%	13.92%
Multi Family Low Rise	28.89%	52.80%	18.32%
Multi Family High Rise	53.95%	32.84%	13.21%
All Structures	34.33%	48.84%	16.83%

^{a/} Includes Kerosene and LPG

SOURCE: Energy and Environmental Analysis, Inc., Energy Consumption Data Base, Household Sector, Arlington, Virginia, April 1977.

Table 2-10 provides a percentage breakdown of renter energy consumption by fuel type for each of the DOE regions. Natural gas is the predominant fuel source in every region except the Northeast and Middle Atlantic regions where oil is the most important fuel. Crude oil and natural gas and their derivatives meet about 90 percent of energy requirements in all regions (including oil and gas inputs to power plants).

The foregoing data on the renter occupied housing stock reveals several items of importance from the standpoint of a Federal program to reduce renter energy consumption. These are:

- The renter occupied housing stock is a heterogeneous grouping of more than 26 million units. Thirty-five percent of the units are in one unit structures, while 62 percent of the units are in structures of less than four units. The remaining structures fall in a wide spectrum of unit size classifications.
- Energy consumption in renter occupied housing is significant both as a percentage of residential energy use (28 percent) and a percentage of national energy consumption (5.5 percent).
- Energy expenditures by renters amount to significant monthly (\$44 to \$63) and yearly (\$528 to \$756) outlays. These totals can vary significantly across regions and fuel types.
- Space conditioning is the most important functional use of energy by renters, accounting for 61.8 percent of consumption.
- Including inputs to electricity production, about 90 percent of renter energy requirements are supplied by oil and natural gas.

TABLE 2-10

REGIONAL RENTER ENERGY CONSUMPTION BY FUEL TYPE

Region	Distillate Oil	Natural Gas	Net Electricity	Other (Kerosene + LPG)	Total
Northeast	61.65%	22.89%	10.50%	4.96%	100%
Middle Atlantic	45.03%	39.52%	10.87%	4.58%	100%
South Atlantic	19.95%	37.52%	30.61%	11.92%	100%
East North Central	17.80%	64.54%	12.36%	5.3%	100%
East South Central	5.65%	47.85%	33.91%	12.59%	100%
West North Central	16.85%	55.59%	14.39%	13.17%	100%
West South Central	4.43%	52.33%	29.09%	14.14%	100%
Mountain	11.84%	59.48%	19.83%	8.85%	100%
Pacific	6.99%	65.37%	22.82%	4.82%	100%
National	27.23%	48.84%	16.83%	7.10%	100%

SOURCE: Energy and Environmental Analysis, Inc., Energy Consumption Data Base, Household Sector, Arlington, Virginia, April 1977.

3. ENERGY CONSERVATION IN RENTER OCCUPIED HOUSING: OPPORTUNITIES AND BARRIERS

The following section identifies the energy conservation opportunities available in renter occupied housing and the factors which mitigate against the achievement of those opportunities. Energy conservation opportunities encompass both the installation of energy conserving equipment and the adoption of energy conserving behavior. Barriers to energy conservation result from the incentives inherent in tenant/landlord contracts and a variety of other factors.

3.1 ENERGY CONSERVATION OPPORTUNITIES

Table 3-1 provides three lists of energy conserving capital equipment available in renter occupied housing. Column 1 lists those energy conservation improvements and renewable resource measures (ECRR measures) that are explicitly approved by the ECPA legislation as eligible for subsidy treatment. Column 2 lists those improvements that are most frequently applicable in the smaller renter occupied structures including single family detached and attached housing. Column 3 lists the most cost effective for apartment buildings. All of the improvements in Columns 2 and 3 could be eligible for subsidy funding under the ECPA mandate.

Energy conservation behavioral modifications are of several types. A renter can reduce space conditioning energy consumption by keeping the thermostatic setting lower in winter and higher in summer, particularly during periods when the housing unit is vacant. Such simple measures as reducing the amount of time windows and doors are kept open can also reduce space conditioning energy consumption. Finally, reductions in excessive, unnecessary, or redundant usage of lighting and appliances can affect energy savings.

Table 3-1
Fundable ECRR Measures
for Houses and Apartments

<u>Listed in the Federal Register</u>	<u>Most Common in Smaller Unit-Size Structures</u>	<u>Most Cost Effective in Apartment Buildings</u>
Ceiling Insulation	Caulking	Roof Insulation
Wall Insulation	Weatherstripping	Pipe and Tank Insulation
Floor Insulation	Storm Windows	Storm Windows
Pipe Insulation	Attic Insulation	Efficient Lighting
Caulking	Wall Insulation	Hot Water Circulating Pump Timer
Weatherstripping		Water Flow Restrictor
Roof Insulation		
Clock Thermostat		
Exterior Insulation		
Storm Windows		
Efficient Lighting		
Water Flow Restrictor		
Oil Burner Atomizer		
Individual Metering		
New Boiler		
Lighting Controls		
Automatic HVAC Control System		
High Efficiency Motor		
Ventilation Fan		
Solar Water Heater		
Air Source Heat Pump		
Water Source Heat Pump		
Solar Space Heating/ Cooling		
Solar Powered Pump		
Skylight		
Solar Electric Photo- voltaic System		
Wind Powered Generator		
Wind Powered Water Pump		
Urban Waste-fired Boiler		
Urban Waste Pyrolysis System		
Agricultural Waste-fired Boiler		
Wood-fired Stove		
Wood-fired Boiler		
Geothermal Space Heating or Cooling System		
Water Powered Generator		

The central issue in any decision on energy conservation is the cost and savings of the proposed action. For capital improvements, the initial capital expenditure or stream of capital and interest payments is compared to the stream of energy savings resulting from the improvement. For behavioral modifications, a degree of inconvenience or loss of comfort is compared to the monetary value of the energy saved.

The costs and benefits of energy conservation improvements can be calculated for specific houses and/or apartment buildings. Such estimates are presented in Table 3-2 and 3-3. They are presented by way of example, and are not meant to be industry-wide averages.

Table 3-2 shows the costs and benefits of energy conservation improvements for single family detached house. The table assumes a 1,200 square foot house in Pennsylvania with an uninsulated attic, poor caulking and weatherstripping, no storm windows, and a weighted average fuel price of \$4.40/MMBtu (see Appendix B). The simple payback criterion is used to evaluate the energy conservation improvements. The costs and benefits of these improvements would approximate those of other structures with similar characteristics in that region.

Table 3-3 shows the costs and benefits of energy conservation improvements in apartment buildings. These are derived from reported conservation improvements undertaken by apartment owners throughout the country. Again, the costs and benefits of the improvements are specific to the particular regions and structures involved. Again, the payback periods of the improvements are reported.

Behavioral modifications can also lead to estimable energy savings. The savings depends on the wastefulness of the renters current habits. Residents of master metered structures have shown the ability to reduce energy consumption substantially once their apartments become individually metered. Installers of energy metering equipment in Texas report

TABLE 3-2

Costs and Benefits of Energy Conservation
Improvements - Single Family Structure

Improvement	Cost	Savings/Yr*	Payback
Caulk U Weather-strip	\$ 74	\$114.43	.65 yr
Storm Windows	300	73.19	4.1 yr
Attic Insulation	657	126.92	5.2 yr
Insulate Frame Walls	894	173.46	5.2 yr

Description of House

House is located in Pittsburgh, PA, and has 12 windows and 2 doors. The caulking and weatherstripping is in poor condition.

The attic is unfinished with a floor, and is uninsulated. It measures 1200 square feet.

The wall space to be insulated measures 200 linear feet.

Description of Retrofit

Rigid plastic storm windows are installed.

Attic insulation is added by a contractor.

Cellulosic fiber is blown into walls by a contractor.

SOURCE: U.S. Department of Housing and Urban Development, Division of Energy, Building Technology and Standards, Office of Policy Development and Research, In the Bank... Or Up the Chimney? A Dollars and Cents Guide to Energy Saving Home Improvements, Second Edition, Washington, D.C.: U.S. Government Printing Office, August 1977.

Table 3-3

Cost and Benefits of Energy Conservation

Improvements - Apartment Buildings

Improvement	Building Description	Cost	Savings	Payback (yrs.)
Roof Insulation	Large complex in Northeast suburb. 80,000 square feet of roof, 16 buildings. FUEL SAVED: NATURAL GAS	\$3456	\$1143	2.6
Insulate Pipes, Tanks	Small Chicago building with 35 feet of 6 inch pipe. FUEL SAVED: NATURAL GAS	\$ 200	\$ 60	2.9
Improve and Maintain Boiler Efficiency	Single boiler in small midwestern building. Efficiency of boiler increased from 78% to 82%	\$ 100	\$ 225	.8
Storm Windows	Installation of 308 storm windows for 16 buildings. FUEL SAVED: NATURAL GAS	\$7700	\$1671	3.8
More Efficient Lights	Southwestern low-rise with 144 units. Change made to more efficient bulbs, selective wattage reduction. FUEL SAVED: ELECTRICITY	\$1623	\$3215	.6

Page Two

Improvement	Building Description	Cost	Savings	Payback (yrs.)
Flow Restrictions	High-rise, 151 unit total electric building in New England. Replaced all 151 showerheads with low flow (2.3 gallons/minute) type. FUEL SAVED: ELECTRICITY	\$1094	\$9570	.1
Hot Water Cir- culating Pump Timer	30 unit low-rise (21000 square feet) FUELS SAVED: ELECTRICITY AND NATURAL GAS	\$ 16	\$ 61	.3

SOURCE: Institute of Real Estate Management, Income/Expense Analysis, Apartments, Condominiums, and Cooperatives. Chicago: Institute of Real Estate Management, 1976.

that a 30 percent energy consumption reduction is likely when tenants begin to pay for their own energy. The Midwest Research Institute reports that master metered tenants use 35 percent more electricity than their individually metered counterparts.

It is not possible, at present, to accurately estimate the energy conservation improvements and savings available for the rented housing sector on an aggregate or average basis. This would require a detailed knowledge of various structural characteristics of the stock, besides unit size, as well as accurate information on the extent to which energy conservation improvements already have been made. Neither of these subjects has been thoroughly surveyed as yet.

Interviews with members of the rented housing industry indicate that cost effective energy conservation opportunities, such as those described in Table 3-2 and 3-3 above, frequently go unachieved in renter occupied housing. Often cited examples of energy waste include the failure of landlords to insulate single family homes and the wasteful energy consumption habits of the tenants of master metered structures. To understand why energy conservation opportunities go unachieved, one must examine the incentives of the various participants.

3.2 INCENTIVES FOR ENERGY CONSERVATION

The incentives for energy conservation in renter occupied housing are detailed below. There are four central conceptual distinctions maintained throughout the discussion. They are:

1. Structure Type - The structural categories are those of the Energy Consumption Data Base (ECBD). They are single family detached, single family attached, multi-family low rise, multi-family high rise, and mobile homes.

2. Decision Makers - Two groups of people make decisions affecting energy conservation in rented housing: tenants and landlords.
3. Conservation Actions - Incentives for installing energy conservation equipment and incentives for engaging in energy conserving behavior may differ in a given housing unit. Because of this, incentives for each of these categories of energy conserving actions are considered separately for each structure type under each metering situation.
4. Energy Metering - The metering mode of a rental unit is an important affector of its energy consumption. Occupants of individually metered units pay their energy bills directly. Occupants of master metered units pay for energy as part of the monthly rent. Some units are master metered for one kind of energy (i.e., space heat) and individually metered for another (i.e., electricity). Because space conditioning is the single largest source of energy consumption in rented housing, the metering situation with regard to it is of utmost importance in determining overall energy consumption.

The tables which follow identify the incentives that exist for energy conserving investments and behavior in renter occupied housing. One table is provided for each structure type. The incentives of both the tenant and the landlord are taken into account. Differences in energy conservation incentives between master metered and individually metered housing are considered.

In single family detached rented housing, individual metering prevails in the overwhelming majority of cases. That is why Table 3-4 considers only the individually metered mode. Box A indicates that the incentive to install energy conserving equipment is limited from the tenant's point of view and indirect from the landlord's point of view.

TABLE 3-4

RENTER ENERGY CONSERVATION INCENTIVES

INCENTIVES FOR ENERGY CONSERVATION
IN SINGLE FAMILY DETACHED HOUSING

CONSERVATION ACTIVITY

	CONSERVATION ACTIVITY	
	INSTALL ENERGY CONSERVING EQUIPMENT	ENGAGE IN ENERGY CONSERVING BEHAVIOR
INDIVIDUALLY METERED	<p>A</p> <p>Limited Incentive for Tenant</p> <p>Indirect Incentive for Landlord</p>	<p>B</p> <p>Direct Incentive for Tenant</p>
MASTER METERED	<p>C</p> <p>Not Applicable</p>	<p>D</p> <p>Not Applicable</p>

Percent of rented housing units: 28.4%

Predominant metering mode: Individual

SOURCE: Energy and Environmental Analysis, Inc.

There are two reasons why the incentives for installing energy conservation equipment are limited from the tenants point of view. The first reason is that the tenant often expects to move from the dwelling before he can recover his investment in energy conservation improvements. If the payback period of the investment exceeds his expected duration of occupancy in the dwelling, the tenant will rationally opt to not invest.

Consider a rented single family detached house which could install various energy conservation improvements costing \$600 and saving an annual \$150 in energy bills. In this example the payback period is four years. Only a tenant intending to remain in a rental unit for longer than 4 years would consider these improvements.

Most renters do not intend to remain in a dwelling unit very long. This is illustrated in Tables 3-5 and 3-6. Table 3-5 indicates that 53 percent of the renters interviewed during 1976 had moved into the unit since 1975. Table 3-6 shows that between 29 and 52 percent of unfurnished apartments are occupied by new tenants each year, in the most recent year for which this data is available.

A second factor limiting a tenant's incentive to install energy conservation equipment is his inability to recapture the investment by selling it when he moves. Most energy conservation improvements are impractical and/or uneconomical to move to another location, so a renter like a homeowner must leave the improvements in the house when he moves. The tenant, however, unlike the homeowner has no prospects of recapturing his investment in a higher selling price of the house.

Finally, a tenant simply may not have the money to install energy conservation equipment. The median income of tenants in one unit structures was \$9,300 in 1976. Lack of capital limits spending whether the tenant has the incentive or not.

TABLE 3-5
YEAR HOUSEHOLD HEAD MOVED INTO UNIT
(from 1976 survey)

Year	Number (in 000's)	Percentage
1975 or later Past 12 months	14,079 9,924	53 (38)
April 1970 to 1974	6,882	26
1965 to March 1970	2,643	10
1960 to 1964	1,152	4
1950 to 1959	762	3
1949 or earlier	582	3
ALL YEARS	26,101	100

SOURCE: U.S. Department of Commerce, Bureau of Census, Current Housing Reports, Series H-150-76, Annual Housing Survey: 1976, Part A. Washington, D.C.: U.S. Government Printing Office, 1978.

TABLE 3-6

1975 TURNOVER RATIO OF UNFURNISHED APARTMENTS
(Institute of Real Estate Management Members)

Building Type	Percentage of New Tenants in 1975
Elevator	29%
Low Rise 12-24 Units	33%
Low Rise 25+ Units	43%
Garden	52%

SOURCE: Institute of Real Estate Management, Income/Expense Analysis, 1976 Edition, Chicago, 1976.

Box A in Table 3-4 indicates that the landlord has only an indirect incentive to install energy conservation equipment in a rented house in which the renter pays utilities. This is because, with the tenant paying utilities, energy savings dollars go directly to the tenant. The landlord can only get a return on his investment by charging a higher rent. Although a more energy efficient house is worth more to a renter, the landlord may be reluctant to change the status quo, either because he thinks it is not worth the trouble or because he thinks prospective renters are much more sensitive to monthly rent than energy bills.

Box B in Table 3-4 indicates that a tenant in a single family detached house who pays his own energy bills has a direct incentive to curb energy consumption through his behavior. His situation is similar to that of a homeowner in that he is trading a loss of comfort or convenience for a direct reduction in his monthly bills. As energy prices rise, his incentive to engage in energy conserving behavior increases.

Boxes C and D in Table 3-4 are labeled "Not Applicable." This is because the single family detached renter occupied housing stock is overwhelmingly individually metered.

Table 3-7 illustrates incentives for landlords and tenants to conserve energy in mobile homes. Two central points emerge from this table. First, the incentives for energy conservation in mobile homes are virtually identical to those in single family detached housing for the same reasons cited above. Second, the availability of capital is likely to be lower for mobile home renters than renters of single family detached houses. This is because the incomes of these people are lower than the income of renters of single family detached houses. The median income of mobile home renters in 1976 was \$6,900 as compared to \$9,300 for renters of single family detached housing.

TABLE 3-7
 RENTER ENERGY CONSERVATION INCENTIVES
 INCENTIVES FOR ENERGY CONSERVATION
 IN MOBILE HOMES
 CONSERVATION ACTIVITY

METERING MODE	CONSERVATION ACTIVITY	
	INSTALL ENERGY CONSERVING EQUIPMENT	ENGAGE IN ENERGY CONSERVING BEHAVIOR
INDIVIDUALLY METERED	A Incentive and Capital Availability Limited for Tenant Indirect Incentive for Landlord	B Direct Incentive for Tenant
MASTER METERED	C Not Applicable	D Not Applicable

Percent of rented housing units: 2.2%

Predominant metering mode: Individual

SOURCE: Energy and Environmental Analysis, Inc.

Table 3-8 illustrates incentives for energy conservation in single family attached housing. This housing type is part individually metered and part master metered.

Box A in Table 3-8 indicates that incentives to install energy conservation equipment in individually metered single family attached housing are similar to those in mobile homes and single family detached homes. The tenant's incentive is limited because of his expected tenure of occupancy and his inability to capture the value of the equipment in resale. He may also have insufficient capital available to him. The landlord's incentives are indirect since he does not pay the energy bills. However, there are some cases where the landlord is a resident in a housing unit above, below, or adjacent to the tenant occupied unit. Some of the improvements he installs can end up saving energy for the adjacent structure. There, the incentive is more direct.

Box B in Table 3-8 indicates that the tenant has a direct incentive to engage in energy conservation behavior in individually metered single family attached housing. The tenant pays energy bills and must balance the loss of comfort and convenience against the benefit of lower energy bills.

Box C in Table 3-8 indicates that landlords in master metered single family attached housing have a direct incentive to install energy conserving equipment. This is generally true in master metered rented structures. The landlord in these structures received payments for energy as part of the contract rent of the tenant. However, the landlord is the person who actually pays the bills. He can pocket any reduction in energy bills that he receives because of installing energy conserving equipment. He need not pass energy savings back to the tenant. The landlord, therefore, simply compares the capital cost of energy conservation improvements to the annual energy savings resulting from the improvements.

TABLE 3-8.

RENTER ENERGY CONSERVATION INCENTIVES

INCENTIVES FOR ENERGY CONSERVATION
IN SINGLE FAMILY ATTACHED RENTAL HOUSING

		CONSERVATION ACTIVITY	
		INSTALL ENERGY CONSERVING EQUIPMENT	ENGAGE IN ENERGY CONSERVING BEHAVIOR
METERING MODE	INDIVIDUALLY METERED	<p>A.</p> <p>Limited Incentive for Tenant</p> <p>Indirect Incentive for Landlord in most cases</p>	<p>B.</p> <p>Direct Incentive for Tenant</p>
	MASTER METERED	<p>C.</p> <p>Direct Incentive for Landlord</p>	<p>D.</p> <p>Little Incentive for Tenant</p>

Percent of rented housing units: 18.3%

Predominant metering mode: Individual

SOURCE: Energy and Environmental Analysis, Inc.

TABLE 3-9

RENTER ENERGY CONSERVATION INCENTIVES

INCENTIVES FOR ENERGY CONSERVATION
IN MULTI-FAMILY LOW RISE HOUSING

		CONSERVATION ACTIVITY	
		INSTALL ENERGY CONSERVING EQUIPMENT	ENGAGE IN ENERGY CONSERVING BEHAVIOR
METERING MODE	INDIVIDUALLY METERED	<p>A</p> <p>No Opportunity for Tenant</p> <p>Limited Incentive For Landlord</p>	<p>B</p> <p>Direct Incentive for Tenant</p>
	MASTER METERED	<p>C</p> <p>Direct Incentive for Landlord</p>	<p>D</p> <p>No Incentive for Tenant</p>

Percent of rented housing units: 38.0%
 Predominant metering mode: Master
 SOURCE: Energy and Environmental Analysis, Inc.

TABLE 3-10
 RENTER ENERGY CONSERVATION INCENTIVES
 INCENTIVES FOR ENERGY CONSERVATION
 IN MULTI FAMILY HIGH RISE
 CONSERVATION ACTIVITY

METERING MODE	CONSERVATION ACTIVITY	
	INSTALL ENERGY CONSERVING EQUIPMENT	ENGAGE IN ENERGY CONSERVING BEHAVIOR
INDIVIDUALLY METERED	A Not Applicable	B Not Applicable
MASTER METERED	C Direct Incentive for Landlord	D No Incentive for Tenant

Percent of rented housing units: 13.1%

Predominant metering mode: Master

SOURCE: Energy and Environmental Analysis, Inc.

Box D in Table 3-8 shows that the tenant has little incentive to engage in energy conservation behavior in master metered structures. From the tenants point of view, he has paid for energy in his monthly rent bill. He receives no benefit from conserving energy by behavioral changes such as keeping the thermostat down or the windows closed in the winter. He receives no penalty if he does not do these things. Master metered tenants virtually regard energy as having no marginal cost.

Tables 3-9 and 3-10 illustrate energy conservation incentives in multi-family low rise and multi-family high rise units respectively. Both of these structure types are predominantly master metered, particularly multi-family high rise.

Boxes A through D in Tables 3-9 and 3-10 contain the same information as those in previous tables. Significantly, incentives are weakest with regard to energy conserving capital expenditures in individually metered structures and behavior modifications in master metered structures. The latter of these two problems is most significant in the largest unit-size structures since they are predominantly master metered.

Two central conclusions can be garnered from the above discussion:

1. One principal area in which incentives are not optimal is the area of conservation equipment installation in individually metered rented housing. This pertains to all structures that are individually metered, including the majority of single family detached, single family attached, and mobile rental units as well as some units in the larger structures.
2. A second principal area where incentives are not optimal is the area of energy conserving behavior in master metered structures. This is the predominant metering mode in the multi-family low rise and multi-family high rise categories. A shift to individual or submetering would be necessary to give tenants the incentive to conserve.

3.3 OTHER DISINCENTIVES

There are several other factors in addition to those discussed above which inhibit energy conservation activity in rented structures.

Inconvenience

Many landlords simply do not want to bother with energy conservation. This is particularly true of landlords renting structures, such as single family detached housing, in which energy bills are paid by the tenant. A landlord renting such a structure would have to raise the rent to pay for energy conservation improvements. This would put the landlord in the position of explaining to the tenant that the tenant is better off with a rent increase, since a reduction in energy bills will more than offset the increase. Landlords often feel that this whole process is not worth the trouble.

A shift to individual or submetering involves a different hassle. In this situation, rents are usually reduced and the tenant receives a rent and energy bill instead of a rent bill only.

Although his total payments may be no larger, the tenant may be upset by the inconvenience of two bills and the end of a presumed era of "free energy." The landlord may face the problem of a number of discontented tenants in the buildings.

Uncertainty

Energy conservation savings differ from building to building, from region to region, and from year to year. A landlord may not be able to obtain information specific to his particular building and region. Owners of single family units may be skeptical of savings estimates published in conservation promotional materials. Combined with other disincentives, uncertainty of savings information can be a telling disincentive.

Information for Prospective Tenants

Landlords who rent individually metered units may be renting an energy inefficient product. The prospective tenant, however, has only highly

imperfect means of obtaining information on a unit's energy consumption. Unlike other products, the energy efficiency of rented units is not labelled. Without such information, landlords with energy inefficient dwellings are not penalized in their ability to rent them.

Rent Control

Rent control statutes can act as deterrents to energy conservation. A landlord of individually metered units may want to install energy conservation improvements and raise rents accordingly. This action may be beneficial to the tenant since the energy conservation investment lowers his energy bills by more than the rent increase. However, the landlord may be prohibited from raising the rent at all if he is in a rent controlled area. Table 3-11 lists the number of housing units in areas with rent control laws.

TABLE 3-11
 NUMBER OF UNITS IN AREAS
 WITH RENT CONTROL LAWS - 1970

STATE	NUMBER OF UNITS
Alaska	39,263
Connecticut	349,875
Maine	90,597
Maryland	484,100
Massachusetts	748,000
New Jersey	867,238
Washington, D.C.	188,834
New York	3,116,678
Miami Beach Florida	717,490
All Units	6,602,075

Percentage of all rental units in areas
 with rent control laws: 28%

SOURCE: Monica R. Lett, Rent Control: Concepts, Realities, and Mechanisms. New Brunswick: Center for Urban Policy research, 1976, and U.S. Department of Commerce, U.S. Bureau of Census, Census of Housing: 1970, Volume 1, Housing Characteristics for States, Cities, and Counties, Part 1, U.S. Summary. Washington, D.C.: U.S. Government Printing Office, 1972.

Barriers to Individual or Submetering

Section 3.3 discussed the lack of incentive of residents of master metered structures to conserve energy in their behavior. One remedy to this problem is a shift from master metering to individual or submetering.* A number of factors can make such a shift difficult to accomplish.

One barrier to master metering stems from the technological development and related economics of metering equipment. Of the various central space conditioning systems listed in Table 3-12, only electrical systems can be individually metered economically at the present time. As the table indicates, the vast majority of space heating equipment is not electric. Individual meters for other systems are currently being improved, but none have been marketed on a large scale as yet.

Submetering is often an attractive alternative to individual metering. This will be discussed further below. Many states, however, have laws or policies limiting or prohibiting submetering. These are listed in Table 3-13. Recently, some states, including Texas, Virginia, and Maryland, have repealed submetering bans.

* With individual metering, the tenant pays for energy directly to the utility company. With submetering, the landlord installs meters which he reads. His tenants are billed individually for their energy consumption using a formula devised by the landlord, but regulated by the public utility commission.

TABLE 3-12

HEATING EQUIPMENT IN RENTER OCCUPIED STRUCTURES
(number of units in 000's)

Structure Type	Warm Air Furnace	Steam or Hot Water	Built-in Electrical Units	Floor, Wall or Pipeless Furnace	Other*	None
(units in structure)						
5-9	1,132	1,060	270	321	257	40
10-19	978	839	367	196	125	19
20-49	559	942	241	120	45	17
50+	592	1,287	366	35	18	40
Total	3,261 (37%)	3,128 (35%)	1,244 (14%)	672 (8%)	445 (5%)	116 (1%)

* Room heaters with or without flue, fireplaces, stoves, or portable heaters.

SOURCE: U.S. Department of Commerce, U.S. Bureau of the Census, Current Housing Reports, Series H-150-76, Annual Housing Survey 1976, Part A. Washington, D.C.: U.S. Government Printing Office, 1978.

TABLE 3-13
STATE SUBMETERING PROVISIONS

STATES	ALLOW METERING
Alabama	Yes
Alaska	No law
Arizona	Yes
Arkansas	Yes
California	No
Colorado	Yes
Connecticut	Yes
Delaware	Limited
Washington, D.C.	No
Florida	No
Georgia	Yes
Hawaii	Yes
Idaho	Yes
Illinois	No
Indiana	No
Iowa	No
Kansas	No
Kentucky	No
Louisiana	Yes
Maine	No
Maryland	Yes
Massachusetts	No
Michigan	No
Minnesota	No
Mississippi	No
Missouri	No
Montana	No
Nebraska	Yes
Nevada	Yes
New Hampshire	Yes
New Jersey	No
New Mexico	Yes
New York	No
North Carolina	No
North Dakota	No
Ohio	Yes
Oklahoma	No
Oregon	Yes
Pennsylvania	Yes
Rhode Island	No
South Carolina	No
South Dakota	No
Tennessee	No
Texas	No
Utah	No
Vermont	No
Virginia	Limited
Washington	No
West Virginia	No
Wisconsin	No
Wyoming	Yes

SOURCE: Booz Allen and Hamilton, Alternative Metering Practices: Implications for Conservation in Multi-family Residences, September 1978.

4. PROSPECTIVE PROGRAMS

The Department of Energy Division of Buildings and Community Systems is considering whether to initiate a program to overcome the disincentives described in Section 3 and reduce renter energy consumption. The following section discusses a number of issues of programmatic significance, considers several concepts which could form the basis for demonstration programs under Section 509 of ECPA, and discusses the potential costs and benefits of a national program stemming from the demonstration efforts.

4.1 ISSUES OF PROGRAMMATIC SIGNIFICANCE

Before discussing specific prospective programs, a number of central issues of programmatic significance should be reviewed.

4.1.1 A Program to Reduce Energy Consumption in Renter Occupied Housing Should be Considered

The data and analysis in Sections 2 and 3 of this paper suggest several reasons why a program to reduce energy consumption in renter occupied housing should be considered:

- o Renter energy consumption is significant both as a proportion of residential energy consumption and as a proportion of national energy consumption. Twenty-eight percent of residential energy consumption and 5.5 percent of national energy consumption occurs in renter occupied housing.
- o Including inputs to electricity production, approximately 90 percent of the energy consumed by renters is supplied by oil and gas.
- o It is likely that a disproportionate share of unachieved, cost effective energy conservation opportunities are found in renter occupied housing. This situation exists because incentives for energy conservation in renter occupied housing are frequently weak and indirect, and because of a variety of other barriers to renter energy conservation.

4.1.2 Existing Programs are Unlikely to Affect Renter Energy Consumption

There are two Federal tax credits that could encourage energy conservation in renter occupied housing: the business investment tax credit and the residential energy conservation credit. Neither of these credits are likely to affect energy consumption in renter occupied housing.

A tenant can claim the residential energy tax credit, but he is not likely to do so. As explained in Section 3, tenants are unlikely to consider investing in energy saving capital equipment in the individually metered smaller unit-size structures because their expected duration of occupancy is limited and they cannot recover the capital costs of the investment through resale. If they do not invest in energy conserving capital equipment, they are unlikely to use the credit. Tenants in the larger, multi-family structures are generally not in a position to improve those dwellings through capital expenditures. Landlords cannot use the residential energy tax credit because the law stipulates that the credit can only be claimed at a person's principal residence.

The existing 10 percent investment tax credit does not apply to energy conservation equipment installed by apartment owners. The NEA initially contained provisions to allow inclusion of business insulation in the investment tax credit, but this provision was removed from the Conference Report.

4.1.3 The Efficiency and Equity of a Renter Subsidy May Compare Favorably to the Residential Energy Conservation Tax Credit

In assessing the validity of a Federal subsidy for renter energy conservation, it is appropriate to compare such a program to a comparable existing program on the basis of efficiency and equity. "Efficiency" in this context measures the rate at which Federal dollars produce energy

savings. "Equity" measures the distribution of the benefits of a program across income groups. There is reason to believe that a renter subsidy* would compare favorably to the residential energy conservation tax credit on both of these dimensions.

To estimate a subsidy program's efficiency, one must compare the total number of claimants of a subsidy to the number of claimants who would have invested in energy conservation improvements without the subsidy. This is necessary because only energy savings resulting from improvements which would not have been made without the subsidy, can be incrementally attributed to the subsidy. There is reason to believe that a renter subsidy would be superior to the residential energy conservation tax credit in the NEA in light of this comparison.

For reasons stated above, tenants are unlikely and landlords unable to claim the recently enacted residential energy conservation tax credits. Owner-occupiers will be the principal claimants of the credit. Yet the owner occupied housing stock is not currently subject to the weak and indirect energy conservation incentives evident in the renter occupied housing stock. In other words, the credit in the NEA will be claimed by a population that is already highly motivated to conserve. The hypothetical renter credit will impact on a population that is currently less motivated. While the NEA may subsidize a high proportion of people who would have invested in energy conservation in any event, this is likely to be less true for a renter subsidy.

There is a second reason why a renter program may be a more efficient way to convert Federal dollars into energy savings. Since the incentives for energy conservation are currently less strong in rented housing, it is probably that for an average unit, there are more high payback improvements still available in the rented sector. Therefore, the energy savings from a given dollar value of investments and associated subsidy payments will be greater in that sector.

* In this section, we consider a hypothetical 15 percent grant or tax credit of up to \$300 per unit for energy saving capital investments or individual or submetering equipment purchases in renter occupied housing. The subsidy could be claimed by either the tenant or the landlord.

A renter program could also redress the inequity of the residential energy conservation credit in the NEA. The homeowners who will take advantage of the NEA credit are predominantly higher income people. This was illustrated in Table 2-2. Since a renter program would improve the houses of lower income people, this imbalance will be redressed to the extent that tenants, as opposed to landlords, realize lower energy costs.

4.2 PROSPECTIVE APPROACHES

The foregoing data and analysis suggest that programs such as those authorized under Section 509 of ECPA should be considered. Possible approaches for adapting the subsidies contained in ECPA to the renter occupied housing stock are outlined below. Specific programmatic details will be the subject of future reports.

4.2.1 Smaller Unit-Size Structures

One potential target focus for a Section 509 program would be the stimulation of energy conservation capital investments in the smaller unit-sized, individually metered structures.

Such a program should involve information dissemination and a subsidy. The information dissemination portion of the program would inform tenants and landlords that they both can benefit from the landlord's installation of energy conserving equipment. The subsidy portion of the program would improve the payback on investment.

Table 4-1 and 4-2 demonstrate that the tenants and landlords of a smaller unit-size structure can mutually benefit by the landlord's installation of energy conserving equipment.

Table 4-1 illustrates conditions in the rented home before energy conserving capital equipment is installed. The tenant pays a \$250 monthly rent and \$63 per month for energy for a total of \$313. The landlord receives \$250 per month from the tenant.

A renter program could also redress the inequity of the residential energy conservation credit in the NEA. The homeowners who will take advantage of the NEA credit are predominantly higher income people. This was illustrated in Table 2-2. Since a renter program would improve the houses of lower income people, this imbalance will be redressed to the extent that tenants, as opposed to landlords, realize lower energy costs.

4.2 PROSPECTIVE APPROACHES

The foregoing data and analysis suggest that programs such as those authorized under Section 509 of ECPA should be considered. Possible approaches for adapting the subsidies contained in ECPA to the renter occupied housing stock are outlined below. Specific programmatic details will be the subject of future reports.

4.2.1 Smaller Unit-Size Structures

One potential target focus for a Section 509 program would be the stimulation of energy conservation capital investments in the smaller unit-sized, individually metered structures.

Such a program should involve information dissemination and a subsidy. The information dissemination portion of the program would inform tenants and landlords that they both can benefit from the landlord's installation of energy conserving equipment. The subsidy portion of the program would improve the payback on investment.

Table 4-1 and 4-2 demonstrate that the tenants and landlords of a smaller unit-size structure can mutually benefit by the landlord's installation of energy conserving equipment.

Table 4-1 illustrates conditions in the rented home before energy conserving capital equipment is installed. The tenant pays a \$250 monthly rent and \$63 per month for energy for a total of \$313. The landlord receives \$250 per month from the tenant.

TABLE 4-1

Hypothetical Energy Consumption and
Conservation Characteristics of a Rented
Single Family House

Annual Energy Consumption	172 MMBTU / Year
Average Energy Price	\$4.40/MMBTU
Annual Energy Expenditure	\$757 / Year
Monthly Energy Expenditure	\$63 / Month
Monthly Rent	\$250 / Month

Potential Energy Conservation Improvements:

Total Capital Cost	\$600
Annual Energy Savings	\$150
Payback Period	4 years

Total Monthly Expenditures by Tenant:

Rent	\$250 / Month
<u>Energy Bills</u>	<u>\$ 63 / Month</u>
Total Monthly Expenditures	\$313 / Month

Total Monthly Receipts by Landlord:

Rent	\$250 / Month
------	---------------

TABLE 4-2

Hypothetical Energy Consumption and
Conservation Characteristics of a Rented
Single Family House
After Conservation Improvements Are Installed

Annual Energy Consumption	138 MMBTU / Year
Average Energy Price	\$4.40/MMBTU
Annual Energy Expenditure	\$607 / Year
Monthly Energy Expenditure	\$50 / Month
Monthly Rent	\$260 / Month

Total Monthly Expenditures by Tenant:

Rent	\$260 / Month
<u>Energy Bills</u>	<u>\$50 / Month</u>
Total Monthly Expenditures	\$310 / Month

Total Monthly Receipts by Landlord:

Rent	\$260 / Month
------	---------------

Table 4-2 illustrates conditions in the home after the conservation improvements have been installed. The landlord installs \$600 worth of improvements. He demands a 20 percent before tax return on his investment, so he raises rents by 120 per year or \$10 per month. The tenant's \$10 per month rent increase is more than offset by his \$13 per month decrease in energy bills, so his total monthly expenditures decline by \$3 per month.

It is clear from the above example that both the landlord and tenant would rationally choose the energy conservation investment. If the landlord demands a 20 percent gross return on investment, any conservation investments with a payback of less than five years can result in a mutually beneficial arrangement between the tenant and the landlord. Stated more generally, both tenants and landlords can mutually benefit whenever the payback period on energy conservation improvement is lower than the reciprocal of the gross return on investment demanded by the landlord.

The above example has important implications from the standpoint of a Federal program aimed at overcoming the lack of conservation incentives in individually metered, small unit-size structures. First the landlord must have information showing him that he can benefit from spending money for capital improvements in a house in which the tenant pays the utilities. Second, the tenant must have sufficient information on his energy costs to realize how much more rent he should be willing to pay for an energy efficient house. Therefore, a program's primary focus would be to inform tenants and landlords that the kinds of arrangements described in Tables 4-1 and 4-2 are available and profitable. This information could be disseminated by the State energy offices or the utilities.

A second focus of the program would be a subsidy of some type. A cash grant for energy conservation capital expenditures would be one form of

subsidy, approved specifically in Section 509, that is appropriate for these arrangements. The administering agency would be responsible for disseminating information, ensuring that tenant-landlord arrangements are well-informed and cost effective, and distributing grant funds.

4.2.2 Multi-Unit Structures

A second pilot program could be aimed at reducing energy consumption in the larger unit-size, master metered structures. The most effective way to reduce energy consumption in master metered structures is to shift them to individual metering or submetering. People consume less when their consumption incurs costs at the margin. As reported above, public and private sources project energy consumption differentials of 30 percent or more between comparable individually metered and master metered structures.

Tables 4-3 and 4-4 illustrate that a shift from master metering to individual metering can be beneficial to both the tenant and the landlord. Table 4-3 describes a master metered unit. The unit consumes 119 MMBtu's per year costing \$44 per month. The tenant pays \$250 per month rent of which the landlord receives \$206 after paying the energy bills.

Table 4-4 describes the apartment after it has shifted to individual metering. The landlord lowers rent to \$210, but pays no energy bills and therefore, actually increases his receipts by \$4 to \$210 per month. The extra \$4 per month or \$48 per year gives him a 24 percent before tax return on his investment. The tenant pays a lower rent and picks up his monthly energy bill. The tenant, however, reduces energy consumption by 25 percent so that his total monthly payments, including rent and energy bills, are \$7 less than they were previously.

A pilot program to encourage this shift would also consist of both an information dissemination segment and a subsidy. The information component would, again, be aimed at convincing both tenants and landlords

TABLE 4-3

Energy Consumption Characteristics
of a Hypothetical Multi Family Master
Metered Unit

Energy Consumption	115 MMBTU / Unit
Average Energy Cost	\$4.40/MMBTU
Monthly Energy Costs to Landlord	\$44 / Month
Monthly Rent Paid by Tenant	\$250 / Month

Total Monthly Expenditure of Tenant:

Rent	\$250 / Month
------	---------------

Monthly Income of Landlord (Considering only Rent & Energy)

Rent	\$250
<u>Energy Bills</u>	<u>44</u>
Rent Less Energy Bills	\$206

TABLE 4-4

Energy Consumption Characteristics
of Hypothetical Multi Family
Unit, After Individual Meter Installed

Energy Consumption	89 MMBTU / Unit
Average Energy Cost	\$4.40/MMBTU
Annual Energy Cost to Tenant	\$391 / Year
Monthly Energy Cost to Tenant	\$33 / Month
Monthly Rent Paid by Tenant	\$210 / Month
Installed Cost of Submeter	\$200

Total Monthly Expenditure by Tenant:

Rent	\$210
<u>Energy Bills</u>	<u>\$ 33</u>
Total Monthly Expenditures	\$243

Monthly Income of Landlord (Considering only Rent & Energy)

Rent	\$210
<u>Energy Bills</u>	<u>\$ 0</u>
Rent Less Energy Bills	\$210

of the economic benefits involved; (such as those illustrated in Tables 4-3 and 4-4) while the subsidy could increase those benefits. The subsidy in this case may be a loan subsidy of some kind, since the total investment in meter equipment required of landlords may be large enough to require outside financing (i.e., \$150 or more per unit). Low interest loans, interest subsidies, and loan guarantees are all specifically sanctioned in Section 509. Administrative participation by utilities and/or State energy conservation offices could also be employed in this pilot program.

4.2.3 Energy Contracting

An innovative concept was tried by an energy consulting firm in Atlanta, Georgia. This company offered to install free energy conservation equipment in a building, if the building owner would continue to pay the same level of energy bills that he had paid in the past. The monthly energy payments would go to the contracting firm which would pay the actual, lower, bills, and pocket the difference as compensation for the energy conservation improvements. After a specified number of years, the conservation equipment would be given to the building owner and he would begin paying his own, lower energy bills.

This arrangement guarantees the building owner that he will pay no more than he is paying at present for energy, and that after a specified number of years he will own energy conservation equipment which will reduce his energy bills. The energy consulting firm is taking a risk that its analysis is right, but has the potential to make more profit than it could with improvements installed on a fixed fee basis.

A pilot program could be set up to stimulate the development contracting companies that offer arrangements of this type. Since these firms finance the equipment they install, a loan guarantee or subsidy may be useful for them.

4.2.4 Energy Information

The possibility of requiring energy labelling on apartment buildings and houses should be considered. The idea has precedent in that energy labelling is currently required on a number of appliances. As stated above, advance information on the energy consumption characteristics of a rented unit will make renters willing to pay more for an efficient unit, and thereby constitute a strong incentive for landlords to maintain thermally efficient units.

Energy labelling of dwelling units can be either simple or complex. Simple energy labelling would require landlords to supply historical fuel bills of previous tenants to prospective tenants. Complex labelling would require an estimate of the physical volume of energy required per degree day to maintain a specified internal level of comfort. While complex labelling is a theoretically more perfect form of information, simple labelling would be far easier to administer and much more intuitively understandable to prospective tenants.

A pilot program could test the concept of energy labelling in a selected region. ECPA subsidies could be used to fund and monitor the results of the program. This effort would be coordinated with ongoing projects involving DOE and real estate trade associates in this area.

In the next months, EEA will assemble the data necessary to specifically define pilot programs and project their impacts. Programs will be defined in terms of:

- o target structure types,
- o target ECRR measures,
- o region,
- o type of grant or subsidy,
- o grant amount or subsidy, percentage, and
- o administrative mechanisms.

Preliminary program design and potential impact assessments will be reported to DOE by EEA in mid-January.

4.3 POTENTIAL COSTS AND BENEFITS OF A NATIONAL PROGRAM

Any or all of the pilot programs described in Section 4-2 could evolve into a national program. Below, the potential costs and benefits of a massive national program involving a 15 percent* subsidy for renter energy conservation improvements is identified. A wide variety of assumptions were tested. Further analytic work will allow a considerable narrowing and refining of the assumptions.

To project the costs and benefits of a national subsidy program, one must estimate the following parameters:

- o Market Penetration - The number of rental units which will be improved during the period in which the program is in effect must be estimated.
- o Conservation Expenditures and Energy Savings - For each unit claiming the subsidy, it is necessary to estimate an average expenditure level and an average level of associated energy savings.

* This percentage is congruent with that of the current residential energy conservation tax credits.

- o Energy Savings Attributable to the Program - Within each market penetration case, energy savings as the result of the energy conservation improvements undertaken by the target population are estimated. However, not all of these energy savings can be attributed to the Federal program, since some of the improvements would have occurred without the program.

These, and all other analytic assumptions are summarized in Table 4-5.

Table 4-6 provides estimates of the costs and energy savings attributable to a tax credit and information dissemination program. Three market penetration levels are considered. Program costs are reported for each level of market penetration. Within each market penetration level, three assumptions on the attribution of energy savings to the program are tested. For each market penetration and attribution level, the annual physical volume and dollar value of energy savings are reported.

Tables 4-7 and 4-8 summarize the data in Table 4-6. Table 4-7 lists the cost of the program under various market penetration assumptions. These cost estimates range from \$210 million to \$1.120 billion. Table 4-8 reports that anywhere from 11 to 619 trillion Btu can be saved by the program depending on what percentage of the renter occupied housing stock undertake energy conservation improvements, and what percentage of the energy savings that result from the improvements are attributed to the Federal program.

There is a wide variance around the cost and savings estimates for this program. The remaining analytic work under this contract will be aimed, in part, at accumulating the data necessary to make these projections with greater accuracy.

4.4 Summary

Section 4 of this paper discussed a variety of issues of programmatic significance, identified several approaches that could form the basis of

TABLE 4-5

ANALYTIC ASSUMPTIONS

Category																									
Market Penetration	Three levels were considered 15%, 40%, 80%																								
Savings Attributable To Program	Three levels were considered 10%, 50%, 100%																								
Subsidy	A 15% tax credit was assumed																								
Energy Price	A weighted average energy price of \$4.40/MMBTU was assumed (see Appendix B)																								
Energy Conservation Costs and Savings Per Participating Housing Units	<table><tr><th>Structure Type</th><th>Cost (\$)</th><th colspan="2">Annual Energy Savings (\$)(MMBTU)</th></tr><tr><td>Mobile Homes</td><td>200</td><td>65</td><td>15</td></tr><tr><td>Single Family Detached</td><td>600</td><td>150</td><td>34</td></tr><tr><td>Single Family Attached</td><td>400</td><td>100</td><td>23</td></tr><tr><td>Multi-Family High Rise</td><td>200</td><td>130</td><td>30</td></tr><tr><td>Multi-Family Low Rise</td><td>200</td><td>130</td><td>30</td></tr></table>	Structure Type	Cost (\$)	Annual Energy Savings (\$)(MMBTU)		Mobile Homes	200	65	15	Single Family Detached	600	150	34	Single Family Attached	400	100	23	Multi-Family High Rise	200	130	30	Multi-Family Low Rise	200	130	30
Structure Type	Cost (\$)	Annual Energy Savings (\$)(MMBTU)																							
Mobile Homes	200	65	15																						
Single Family Detached	600	150	34																						
Single Family Attached	400	100	23																						
Multi-Family High Rise	200	130	30																						
Multi-Family Low Rise	200	130	30																						

TABLE 4-6

STRUCTURE TYPE	(1000's) # OF UNITS	CONSERVA- TION EXPENDITURE PER UNIT	15% MARKET PENETRATION							40% MARKET PENETRATION							80% MARKET PENETRATION						
			SUBSIDY COST (MILLIONS \$)	100%		50%		10%		SUBSIDY COST (MILLIONS \$)	100%		50%		10%		SUBSIDY COST (MILLIONS \$)	100%		50%		10%	
				\$ 10 ⁶	10 ¹² BTU	\$ 10 ⁶	10 ¹² BTU	\$ 10 ⁶	10 ¹² BTU		\$ 10 ⁶	10 ¹² BTU	\$ 10 ⁶	10 ¹² BTU	\$ 10 ⁶	10 ¹² BTU		\$ 10 ⁶	10 ¹² BTU	\$ 10 ⁶	10 ¹² BTU	\$ 10 ⁶	10 ¹² BTU
MOBILE HOMES	640	\$200	\$ 2.88	6.24	1.418	3.12	0.709	0.624	0.1418	\$ 7.68	16.64	3.782	8.32	1.891	1.664	0.378	\$ 15.36	33.28	7.564	16.64	3.782	3.328	0.7564
SINGLE FAMILY DETACHED	7,242	\$600	\$ 97.767	162.9	37.032	81.47	18.516	16.29	3.703	\$260.712	434.52	98.752	217.26	49.376	43.45	9.875	\$ 521.424	869.04	197.5	434.52	98.752	86.90	19.75
SINGLE FAMILY ATTACHED	4,793	\$400	\$ 43.137	71.895	16.342	35.948	8.1705	7.189	1.634	\$115.032	191.72	43.578	95.86	21.789	19.17	4.357	\$ 230.064	383.44	87.156	191.72	43.578	38.344	8.7156
MULTI-FAMILY LOW RISE	10,370	\$200	\$ 46.665	202.22	45.957	101.11	22.979	20.22	4.5957	\$124.440	539.24	122.55	269.62	61.276	53.924	12.255	\$ 248.880	1078.5	245.11	539.24	122.55	107.85	24.511
MULTI-FAMILY HIGH RISE	3,055	\$200	\$ 13.747	59.573	13.539	29.786	6.7695	5.957	1.3539	\$ 36.660	158.86	36.104	79.43	18.052	15.886	3.6109	\$ 73.320	317.72	72.208	158.86	36.104	31.772	7.208
TOTAL	26,100		\$ 204.796	502.828	114.288	251.434	57.144	50.28	11.428	\$544.524	1340.98	304.766	670.49	152.384	134.094	30.475	\$1089.048	2681.98	609.538	1340.98	304.766	268.194	60.941

ASSUMPTIONS: 15% Subsidy

\$4.40 Weighted Average
Fuel Price

ASSUMED ENERGY SAVING/UNIT

MH	\$ 65	14.773
SFD	\$150	34.09
SFA	\$100	22.73
MFL	\$130	29.545
MFH	\$130	29.545

TABLE 4-7

TOTAL COST OF PROGRAMS
UNDER SEPARATE MARKET PENETRATIONS

Market Penetration	Cost of Program (In \$1,000,000)
15%	\$210
40%	\$559
80%	\$1.120

TABLE 4-8

ANNUAL ENERGY SAVINGS OF THE PROGRAM
UNDER DIFFERENT MARKET PENETRATION
AND ATTRIBUTION ASSUMPTIONS
(IN 10^{12} BTU/YEAR)

Market Penetration	Percent of Energy Savings Attributable to the Program		
	10%	50%	100%
15%	11.61	58.07	116.14
40%	30.97	154.86	309.71
80%	61.93	309.71	619.43

demonstration programs, and presented a range of potential costs and benefits of a national program. In the remainder of this study, EEA will define and estimate the impacts of several pilot programs. This analytic work, and possibly the programs themselves, will allow DOE to design and assess the impact of a national program.

APPENDIX A

SOURCES OF THE EEA ENERGY CONSUMPTION DATA BASE (ECDB)

Primary sources of the ECDB are either U.S. Department of Commerce, Bureau of the Census documents; Department of the Interior, Bureau of Mines statistics; or trade association publications. The Bureau of the Census Current Population Reports, Population Estimates and Projections (1969, 1970, 1973-1977) listed the number of households within each state and the percentage of households using a particular appliance within each income class. Percentages of households using fuel for space heating, cooking, and water heating were derived from the 1970 Census of Housing. The 1970 Census of Housing details the characteristics of the housing stock within each state and regionally, broken down by plumbing, heating equipment, financial information, and fuel usage. Percentages of households using fuel for air conditioning within each region and income class are given in the Bureau of the Census Consumer Buying Indicator (1967, 1971) and in the 1974 Survey of Purchases and Ownership. The 1970 Census of Housing, along with unpublished cross-indexed data from the Department of Commerce, also specified the amount of energy consumed in space heating and air conditioning broken down regionally by housing type, type of heating system, and fuel type. Energy consumption figures for all other uses broken down by housing type, fuel type, state, and region were provided by the American Gas Association, Edison Electric Institute, and the Bureau of Mines. Statistics from the American Gas Association were published in its Annual Survey, Househeating Survey, Gas Utilities Industry (1974-77 and 1973-76) which is a record of new customers added (and added from other fuels), anticipated growth, and fuel price comparisons and the AGA Gas Facts which, among other facts, tabulates transmissions, production, utilization, and sales. Edison Electric Institute contributed statistics from the Historical Statistics of the Electrical Utility Industry Through 1970 and from the EEI Statistical Yearbook which

records sales, revenues, average residential use, sales, and other statistics. Now published by the Department of Energy as Energy Data Reports, the Bureau of Mines Mineral Industry Surveys provided information on supply and demand conditions for fuels as well as general industry information. Fuel price information also was provided by the above three organizations.

APPENDIX B
RENTER ENERGY CONSUMPTION
DATA FOR BCS TASK 034
FLOW CHART AND DESCRIPTION

I

ECDB

II

For each structure type,
the amount of energy
consumed for each
functional use

For each structure type,
the amount of fuel
consumed for all
functions (by fuel type)

For each structure type,
the amount of fuel
consumed for space
heating (by fuel type)

III

RENTERS
For each structure type,
the amount of energy
consumed for each
functional use

RENTERS
For each structure type,
the amount of fuel con-
sumed for all functions
(by fuel type)

RENTERS
For each structure type,
the amount of fuel con-
sumed for space heating
(by fuel type)

IV

RENTERS
For each structure type,
the % of energy con-
sumed for each functional
use

RENTERS
For each structure type,
the % of each fuel con-
sumed for all functions

RENTERS
For each structure type,
the % of each fuel con-
sumed for space heating

V

RENTERS
For each region and
nationally, the % of
energy consumed for each
functional use

RENTERS
For each region and
nationally, the % of
each fuel consumed for
all functions

RENTERS
For each region and
nationally, the % of
fuel consumed for space
heating

VI

RENTERS
% of all renter energy
consumed nationally by
each structure type

RENTERS
% of each fuel consumed
nationally by each
structure type

RENTERS
% of each fuel consumed
nationally for space
heating by each
structure type

The following description of the renter energy consumption data for BCS Task 034 corresponds to the progression of the attached flow chart.

I. The initial data for this series come from the 1974 ECDB (Energy Consumption Data Base) compiled for DOE by EEA. The ECDB tabulates the energy use in each of the nine U.S. census regions and nationally. Regionally and nationally, the ECDB breaks down energy consumption

- by housing type:

- 1) mobile homes
- 2) single family detached - a one-family home that has open space on all four sides
- 3) single family attached - a one-family home that has one or more walls extending from ground to roof that divide it from adjoining structures, e.g., townhouses, rowhouses.
- 4) multi-family low rise - a structure defined in the census as two to four units or +5 units and less than three stories high.
- 5) multi-family high rise - a structure that has more than five units in it and is four or more stories high.

- by fuel type: coal

kerosene (other than jet fuel)
distillate oil (including diesel)
liquefied petroleum gases
natural gas
electricity (net)
other energy
total all energy

- by functional use: space heating clothes drying
space cooling refrigeration
water heating other appliances
cooking total all functional uses
lighting

- by income: for the purposes of this data series, the data is drawn from the category of "all income levels"

II. From the ECDB, three primary data tables are derived. Regionally and nationally, the data tables detail:

- 1) For each structure type, the amount of energy consumed for each functional use.
- 2) For each structure type, the amount of each fuel consumed for all functions.
- 3) For each structure type, the amount of each fuel consumed for space heating.

III. Using information from the 1974 Annual Housing Survey, the remaining portion of this data series is derived which concerns only renter occupied housing. Step III (1-3), calculated from the data in Step II (1-3), indicates an identical breakdown of energy and fuel consumption for renter occupied housing only.

IV. Percentage breakdowns of Tables III (1-3) are tabulated nationally. These breakdowns include:

- 1) For each structure type, the percentage of energy consumed for each functional use.
- 2) For each structure type, the percentage of each fuel consumed for all functions.
- 3) For each structure type, the percentage of each fuel consumed for space heating.

V. Statistics were compiled from the data in Step III (1-3) comparing energy usage between regions. These tabulations detailed:

- 1) For each region and nationally, the percentage of energy consumed for each functional use.
- 2) For each region and nationally, the percentage of each fuel consumed for all functions.
- 3) For each region and nationally, the percentage of each fuel consumed for space heating.

VI. Statistics were also compiled from the data in Step III (1-3) comparing the amount of energy consumed nationally by each structure type. These statistics include:

- 1) The percentage of all renter energy consumed nationally by each structure type.
- 2) The percentage of each fuel consumed nationally by each structure type.
- 3) The percentage of each fuel consumed nationally for space heating by each structure type.

APPENDIX C

WEIGHTED AVERAGE FUEL PRICE PER MILLION BTU

National average prices of fossil fuels consumed for residential use were found in the Department of Energy Monthly Energy Review (October 1978). The national average residential electricity price per kilowatt hour was obtained from the Department of Energy Energy Data Reports - Electrical Statistics (March 1978). Regional price data for natural gas and for other fossil fuels came from the AGA Gas Facts 1977 and the Department of Energy Monthly Energy Review (October 1978) respectively. The Federal Power Commission's Typical Electric Bills 1977 provided regional electricity price data. Conversion figures from the Oak Ridge National Laboratories Buildings Energy Use Data Book enabled the prices per unit of volume measurement to be converted to a price per million BTU.

National fuel prices per million BTU (March 1978)

Natural Gas (Dry)	\$2.421
Residential Heating Oil	\$3.504
Electricity	\$12.116
LPG	\$2.644
Kerosene	\$3.888

Weighting the fuel prices by the percentage of each fuel consumed by renters for all functional uses involved using the percentages derived in the ECDB.

Percentage of each fuel consumed by renters for all functional uses

Natural Gas (Dry)	48.84%
Residential Heating Oil	27.23%
Electricity	16.83%
LPG	4.20%
Kerosene	2.90%

The summation of each fuel's price multiplied by its percentage of total energy consumption yields the weighted national average fuel price of \$4.40 per million BTU.