Oil, Gas, or ... ?

AN EVALUATION OF THE ECONOMICS OF FUEL SWITCHING VERSUS HOME ENERGY CONSERVATION

FINAL REPORT

A TECHNICAL SUPPORT DOCUMENT BY

THE CONSUMER ENERGY COUNCIL OF AMERICA

2000 L Street, N.W. ♦ Suite 802 ♦ Washington, DC 20036 ♦ www.cecarf.org

MARCH 2001

Founded in 1973, CECA is the senior public interest organization in the U.S. focusing on the energy, telecommunications and other network industries that provide essential services to consumers. CECA is a leading national and international resource for information, analysis, and technical expertise on a wide variety of public policy initiatives. CECA works with government, industry and public interest organizations, and has become distinguished for building consensus between organizations with divergent interests. The result has been nearly three decades of policy development that has ensured reliable, sustainable and affordable essential services to consumers.

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I. INTRODUCTION

Over the past two decades the Consumer Energy Council of America (CECA) has issued a series of analyses examining the economics of conservation versus fuel switching for residential heating. This report presents the results of CECA's most recent study on the economics of switching from oil to gas compared to the economics of investing in conservation.

In studies conducted in 1980, 1989, 1991, and 1994 CECA/RF asked the question: "Oil, Gas, or …?" and concluded that converting to natural gas from oil heat for the sake of capturing the economic value of the price difference between the fuels was a bad investment for the consumer.

- In 1980, CECA found that in 98 out of 100 cases, it made economic sense to stick with oil and, if an energy-related investment was desired, to invest in conservation.

- In 1989 CECA concluded that it still did not make sense to switch from oil to gas for the sake of trying to capture the benefits of transient price differences.

- In 1991 CECA concluded that in 95 out of 100 cases, it made economic sense to stick with oil, and if an energy-related investment was desired, to invest in conservation.

- In 1994, following the Persian Gulf crisis, CECA/RF again concluded that it did not make sense to switch fuels.

CECA again examines the question by applying nearly three decades of experience and data analysis. Important factors considered in the current analysis include the recent rise in residential oil and natural gas prices that have occurred since January 2000, changes in oil and gas prices over the six years since our 1994 study, and the performance and updated costs associated with home energy conservation options.

II. COMPARING FUELS

A. CONTINUING PRICE PARITY

A central point in the original CECA study in 1980 was our advice to homeowners that switching from oil to gas was not a smart economic choice because it was based on unrealistic assumptions about how oil and gas prices would behave in an unregulated market. We felt that price equivalence would be reached, especially in the Northeast where oil and gas competed head to head, negating any advantages from fuel switching. This point was confirmed in our later study in 1994 where the price gap between oil and gas narrowed very quickly, and following the Persian Gulf crisis oil prices fell below natural gas (ref 6).

In 1994, CECA found that the price difference between the two fuels is small and fuel switching is a very bad investment compared to conservation. Furthermore, US Department of Energy projections showed that gas prices would increase faster than oil prices over the next two decades, and we concluded that fuel switching was a flat out money loser.

The analysis presented in this report, which incorporates recent increases in energy prices, again leads to the conclusion that switching from oil to gas is a bad investment, and many other home energy investments are much better choices for consumers in most cases. In fact, some of these alternative energy investments offer excellent returns on investment, exceeding 60 percent in some cases.

Our present analysis demonstrates that, even under assumptions that are the most favorable to gas, many conservation investments available to consumers yield better rates of return than fuel switching. As concluded in earlier reports, these conservation investments do not gamble on price differences, as fuel switching does. In addition, recent energy price increases lead us to conclude that even in warm climates, like North Carolina, fuel switching is a poor choice for consumers.

B. REGIONAL FUEL PRICES

CECA's past studies have clearly shown that national average prices are not the correct prices to use in economic analyses that focus on consumers who have the option of using either oil or gas. Gas is inexpensive relative to oil only in those regions of the country where little, if any, oil is consumed. In the colder climates of the Northeast, where oil is used, the difference between oil and gas prices is very small. **Figure 1** compares oil and natural gas prices in the states where most of the oil is consumed in the US, based on US Department of Energy data (ref 1,2,3).

Figure 1 shows oil and gas prices in a 13-state region including the Northeast, and demonstrates that price parity has existed for many years, with short periods when gas was both more and less costly than oil. On average, the Department of Energy data indicate that the price of oil has been more than ten percent lower than gas over the past ten years, and 19 percent lower from 1995 through 1999.

In CECA's 1994 report we concluded that oil and gas price comparisons must be relevant to consumers in specific regions of the US, and efforts by some to use nationally averaged prices to convince consumers to switch fuels was thoroughly misleading. This conclusion still holds today. A large percentage of gas is consumed in warmer climates close to gas fields producing relatively low average gas prices. However, in regions where oil is consumed (such as the Northeast, for example), gas prices are much higher and household gas bills are much higher than the national average because of the colder climate.

Table 1 gives a state-by-state comparison of oil and gas prices over the past 20 years for 13 states with significant oil heat. In the 13 states with the largest oil consumption, the average oil and gas prices are nearly equal. In the Northeast, where approximately two-thirds of all the oil is consumed, the price of oil has been lower than gas in recent years.

FIGURE 1:
(Ref 1,2,3)

AVERAGE RESIDENTIAL OIL AND NAT GAS PRICES (CT,ME,MA,NH,RI,VT,DE,MD,NJ,NY,PA,DC,VA)

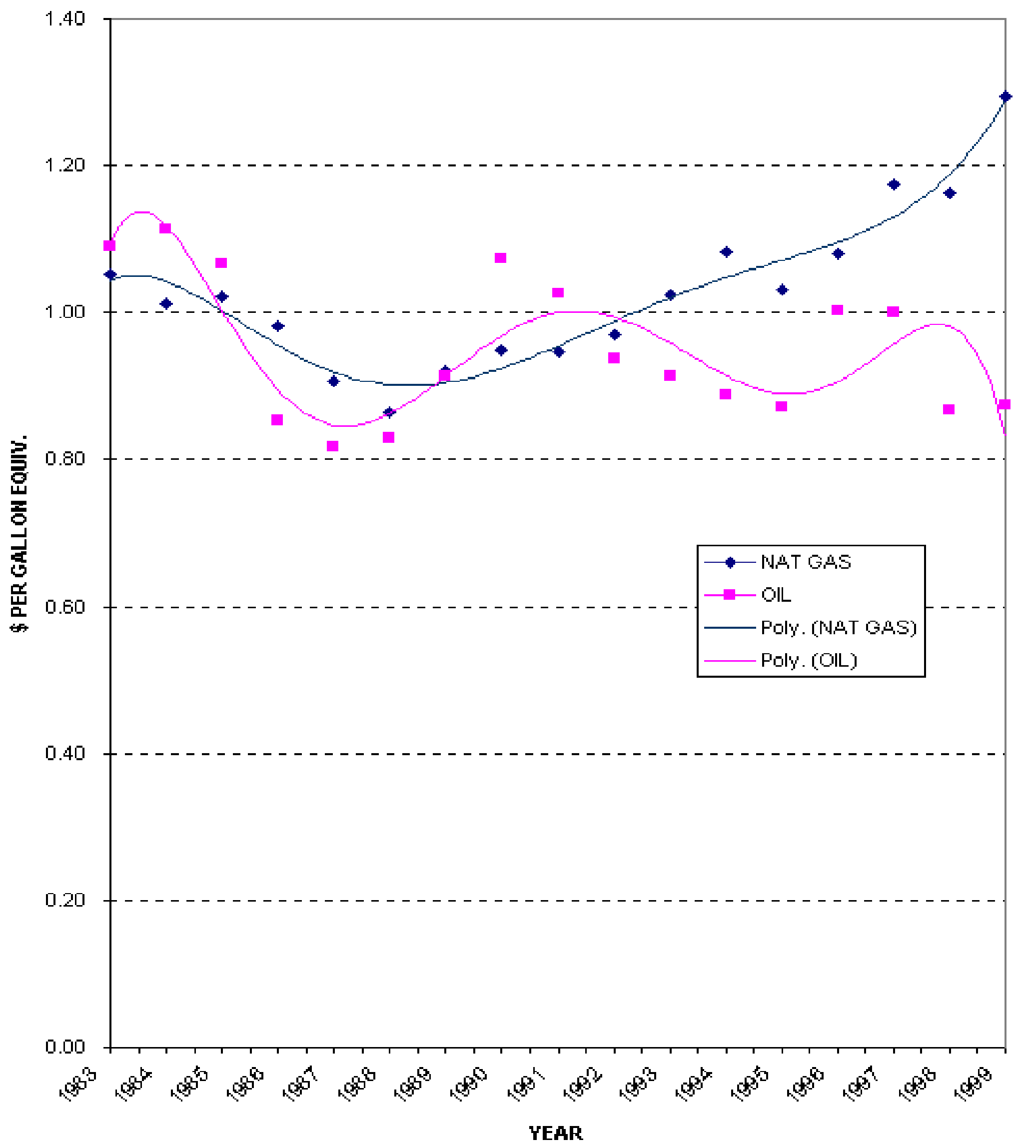

TABLE 1:
(Ref 1,2,3)

RESIDENTIAL GAS AND OIL PRICES - 1983 TO 1999

$ PER GALLON OR EQUIVALENT

YEAR	13 STATES		CT		ME		MA		NH		RI		VT	
	GAS	OIL	GAS	OIL	GAS	OIL	GAS	OIL	GAS	OIL	GAS	OIL	GAS	OIL
1983	1.05	1.089	1.31	1.091	1.32	1.028	1.12	1.091	1.01	1.041	1.17	1.105	0.91	1.129
1984	1.01	1.112	1.18	1.121	1.29	1.039	1.05	1.116	0.95	1.084	1.01	1.114	0.85	1.119
1985	1.02	1.065	1.23	1.080	1.22	0.997	1.05	1.070	0.96	1.024	1.06	1.067	0.85	1.077
1986	0.98	0.854	1.19	0.890	1.15	0.744	1.00	0.821	0.95	0.759	1.00	0.828	0.85	0.866
1987	0.91	0.817	1.11	0.834	1.08	0.747	0.89	0.806	0.88	0.765	0.92	0.825	0.84	0.811
1988	0.86	0.829	1.06	0.853	0.98	0.777	0.87	0.821	0.85	0.782	0.89	0.836	0.76	0.826
1989	0.92	0.915	1.11	0.929	0.96	0.894	0.96	0.926	0.92	0.893	0.96	0.939	0.76	0.905
1990	0.95	1.073	1.16	1.098	1.02	0.989	1.05	1.084	1.00	1.028	0.97	1.086	0.78	1.070
1991	0.95	1.027	1.18	1.062	0.92	0.960	1.09	1.030	0.96	0.916	1.03	0.999	0.84	1.019
1992	0.97	0.938	1.21	0.947	0.94	0.871	1.07	0.925	1.02	0.856	1.03	0.912	0.90	0.921
1993	1.02	0.913	1.27	0.919	1.01	0.826	1.12	0.897	1.03	0.828	1.10	0.893	0.83	0.904
1994	1.08	0.888	1.37	0.890	1.05	0.818	1.20	0.870	1.07	0.792	1.23	0.885	0.93	0.876
1995	1.03	0.872	1.35	0.864	0.99	0.787	1.22	0.844	0.96	0.779	1.08	0.874	0.92	0.853
1996	1.08	1.004	1.36	0.986	1.06	0.972	1.20	0.976	1.00	0.940	1.14	0.986	0.86	0.969
1997	1.17	1.000	1.39	0.963	1.14	0.942	1.27	0.960	1.14	0.942	1.29	0.989	0.86	0.987
1998	1.16	0.866	1.43	0.831	1.09	0.788	1.27	0.818	1.09	0.788	1.29	0.868	0.88	0.873
1999	1.15	0.873	1.42	0.854	1.01	0.813	1.25	0.832	1.03	0.769	1.28	0.857	0.97	0.854
AVG 15 YR	**1.02**	**0.929**	**1.25**	**0.93**	**1.04**	**0.86**	**1.10**	**0.91**	**0.99**	**0.86**	**1.09**	**0.92**	**0.86**	**0.92**
AVG 5 YR	**1.12**	**0.923**	**1.39**	**0.90**	**1.06**	**0.86**	**1.24**	**0.89**	**1.05**	**0.84**	**1.22**	**0.91**	**0.90**	**0.91**

TABLE 1: CONTINUED
(Ref 1,2,3)

RESIDENTIAL GAS AND OIL PRICES - 1983 TO 1999

$ PER GALLON OR EQUIVALENT

DE		MD		NJ		NY		PA		DC		VA	
GAS	OIL	GAS	OIL	GAS	OIL	GAS	OIL	GAS	OIL	GAS	OIL	GAS	OIL
0.89	1.060	1.00	1.103	1.00	1.079	1.06	1.121	0.87	1.058	1.09	1.170	0.95	1.087
0.90	1.096	1.00	1.135	0.98	1.110	1.03	1.155	0.88	1.079	1.08	1.187	0.94	1.105
0.95	1.046	0.98	1.088	1.01	1.059	1.04	1.113	0.90	1.023	1.07	1.143	0.95	1.063
0.95	0.850	0.93	0.914	0.99	0.902	1.00	0.911	0.86	0.814	1.01	0.931	0.87	0.866
0.85	0.793	0.86	0.866	0.89	0.843	0.93	0.852	0.81	0.769	0.95	0.918	0.79	0.795
0.81	0.801	0.79	0.870	0.85	0.848	0.88	0.863	0.78	0.778	0.94	0.916	0.78	0.805
0.86	0.882	0.85	0.938	0.88	0.918	0.97	0.958	0.83	0.851	1.00	0.986	0.89	0.870
0.83	1.058	0.87	1.119	0.89	1.088	1.00	1.125	0.89	1.026	0.97	1.078	0.91	1.106
0.79	0.997	0.83	1.084	0.91	1.040	0.99	1.113	0.91	0.997	0.95	1.122	0.92	1.011
0.83	0.923	0.87	1.000	0.93	0.939	1.02	1.028	0.89	0.890	1.02	1.057	0.90	0.928
0.90	0.899	0.95	0.981	0.94	0.924	1.10	1.001	0.92	0.863	1.14	1.045	1.01	0.893
1.00	0.894	0.94	0.950	0.96	0.895	1.18	0.966	1.00	0.857	1.12	1.000	1.03	0.853
0.89	0.870	0.89	0.936	0.98	0.888	1.13	0.955	0.96	0.826	1.08	1.010	0.97	0.844
0.96	0.984	1.02	1.063	0.96	1.024	1.20	1.066	0.99	0.953	1.24	1.178	1.07	0.952
1.13	0.984	1.13	1.057	1.07	1.033	1.31	1.065	1.12	0.950	1.26	1.174	1.16	0.948
1.20	0.858	1.12	0.902	0.99	0.892	1.29	0.948	1.14	0.814	1.20	1.022	1.15	0.856
1.16	0.884	1.13	0.906	1.00	0.911	1.23	0.967	1.12	0.819	1.17	1.011	1.16	0.870
0.94	**0.91**	**0.94**	**0.98**	**0.95**	**0.95**	**1.08**	**1.00**	**0.94**	**0.88**	**1.07**	**1.04**	**0.97**	**0.91**
1.07	**0.92**	**1.06**	**0.97**	**1.00**	**0.95**	**1.23**	**1.00**	**1.07**	**0.87**	**1.19**	**1.08**	**1.10**	**0.89**

In fact, the largest oil heating states show a clear price advantage for oil through most of the past ten years or more. This includes the post Iraq invasion period which was followed by five years of steadily dropping oil prices.

Tracking of fuel prices has shown that oil and gas are simply commodities whose price fluctuates in the residential market. While one fuel may have a slight short-term price advantage, CECA believes that at any given point in time, the price of the two fuels is likely to continue to be close. That is why consumers should not base their decisions on short-term price fluctuations.

C. FUTURE PRICES

Recent increases in oil and gas prices are having a major impact on home heating costs and decisions regarding energy conservation investments. This sudden rise in home energy costs is the primary reason that CECA decided to revisit its analysis of home conservation options.

Historic energy price patterns offer important information for projecting future oil and gas prices. Price parity still appears to be a reasonable assumption for upcoming years. While price projections often prove to be inaccurate over the long-term (ref 6 - CECA, 1994), we applied recent US Department of Energy projections for oil and gas prices to complete this analysis.

US DOE's Short-Term Energy Outlook published on October 6, 2000 (ref 4) was the basis for residential oil and gas prices for 1999, 2000, and 2001. Oil and gas prices for a 13-state region in 1999 where oil is a significant heating fuel were as follows (ref 1,2,3):

- Oil price in 1999 (for 13 state region) of $ 0.88 per gallon
- Gas price in 1999 (for 13 state region) of $ 1.15 per gallon equivalent

As per discussions with US DOE analysts (ref 13), we applied the projected percentage increase in oil and gas prices to the 1999 values to estimate future prices in the region. The Short-Term Energy Outlook projected the following increases:

- Oil price increase of 49% from 1999 to 2000, and 40% from 1999 to 2001
- Gas price increase of 14% from 1999 to 2000, and 30% from 1999 to 2001

Based on average prices in 1999 published by the US Department of Energy, and applying US DOE's projected escalators, the expected average prices of oil and gas are as follows:

- Average **oil** price in 2000 of **$ 1.31** per gallon
- Average **oil** price in 2001 of **$ 1.23** per gallon
- Average **gas** price in **2000** of **$ 1.31** per gallon equivalent
- Average **gas** price in **2001** of **$ 1.50** per gallon equivalent

Based on the average oil and natural gas prices for 1995 to 1999 and fuel price projections for 2000 and 2001, a series of calculations were completed to evaluate the internal rate of return and payback periods for a range of energy saving investments as well as for fuel switching. Again, the assumption of oil and gas price parity is used for these analyses even though oil prices have been lower than gas over the past five years. The four cases included are: average oil prices from 1995 to 1999 ($0.92), average oil price projections for 2000 and 2001 ($1.27), average of oil and gas prices 1995 to 1999 ($1.02), and average of oil and gas prices 2000 to 2001($1.33).

While oil prices increased at a faster rate in 2000, natural gas prices are expected to increase at a faster rate in 2001 according to US DOE projections (ref 4). In fact, natural gas commodity prices have increased dramatically since mid-year 2000, from about $2.50 to $9.00 per million BTU. Therefore, the US Department of Energy projections may underestimate actual gas price increases. Given the recent rise in gas and oil prices, energy-saving options become all the more attractive to consumers. As revealed by CECA's past studies, conservation is a more attractive option than fuel switching for the vast majority of consumers. With conservation, the consumer's energy consumption is actually reduced. With fuel switching, the consumer gambles on the future price differentials of the two fuels.

D. OTHER FACTORS

For the vast majority of oil heating customers, price differences do not justify fuel switching. Because the expected lifetime of furnaces and boilers is approximately 20 years, only about 5 percent of heating units need to be replaced each year. Once fuel price parity is achieved, any economic edge that one fuel claims over the other becomes very small. Decisions to replace a piece of equipment or change fuels will depend on other issues, including the remaining life of the existing equipment, its efficiency, installation costs, hookup charges, and the energy conserving/consuming characteristics of the building and its occupants.

As economic differences diminish, matters of taste play a larger role in the consumer's decision. The consumer may prefer the feel of one kind of heat over another, worry about the safety of one fuel over another, prefer dealing with a regulated utility, or prefer to deal with a local small business or a variety of competitors. Even though these considerations are highly subjective, there is little economic loss or gain one way or the other.

III. FUEL CONSUMPTION PATTERNS AND CONSERVATION

A. FUEL CONSUMPTION PATTERNS

In CECA's 1988 consumer analysis, reasonable assumptions were used regarding a household's energy consumption, based on US Department of Energy data. Switching fuels does not change other characteristics of the building, and it does not alter consumer behavior patterns. Therefore, economic calculations must start from the household's energy consumption and the use of reasonable estimates concerning various conservation options.

There has been a major change in home heating oil consumption patterns over the past 20 years. Since the initial energy price increases of the 1970s, oil heat equipment efficiencies have increased, and buildings have become more energy-efficient through increased insulation levels and energy efficient designs. The average efficiency of oil furnaces has improved from about 76 percent to approximately

86 percent or higher, based on the US Department of Energy efficiency-labeling program for appliances and publications by the Gas Appliance Manufacturers' Association (ref 13,14). The average efficiency of gas furnaces sold each year has also increased from about 65 percent in 1978 to the low to mid 80 percent range today. In addition, improved insulation, doubled paned windows, and other design features have improved the energy efficiency of homes. As a result of these changes, the average oil consumption in homes has decreased over the past 20 years by approximately 40 percent (ref 5).

As in our earlier analyses, we consider costs for two types of houses: an average efficiency house, and a high efficiency house. The **average efficiency** house is assumed to consume **865 gallons of fuel oil a year**, based on recent oil heat industry surveys (ref 5). Oil use by the **high efficiency** house is approximately 30 percent lower at **613 gallons a year**. This 30 percent reduction is consistent with data from the Household Energy Consumption and Expenditures Survey published by the US Department of Energy (ref 15). The average efficiency case is relevant to consumers who have not replaced their furnace or boiler in the past ten years, and have not done much conservation investment. The high efficiency case applies to homes with new boilers or furnaces, and homes in which energy conservation investments have already been made. Consequently, the expected return on conservation measures will be significantly less for those homeowners that have already improved their house or equipment efficiency. Since annual energy costs are lower in the more efficient homes, the potential cost savings through added energy-saving options is, therefore, lower.

B. ENERGY CONSERVATION IN HOUSES

When CECA first reviewed the economics of fuel switching over 20 years ago, the economics of conservation investments was not yet fully developed. However, follow-up studies of thousands of installations were subsequently available to produce more accurate information on building energy conservation options. These are summarized in the earlier CECA reports (ref 6,7,8,9). Past CECA estimates have proven to be reasonably accurate with regard to energy savings and installed costs for various energy-saving options.

The cost estimates for various energy conservation options that were used in the past by CECA have been updated for the current analysis. These have been updated using the Consumer Price Index and Producer Price Index published by the U.S. Bureau of Labor Statistics, and by comparison with recent equipment costs. The base year for the prices for energy conserving measures was 1994 (for the last CECA analysis) and they have been updated to the year 2000. For the Northeast urban area, where the majority of heating oil is consumed, the Consumer Price Index increased by 6.5 percent for household furnishings and operations. This factor was used to adjust the costs for conservation measures that were used in the 1994 study. Also, equipment suppliers and service companies were contacted to evaluate current costs for energy-saving options (ref 19). Residential customers that currently heat with oil have a number of conservation or conversion options available to them to reduce their expenses. The building energy conservation options in the current analysis include the following six categories:

- **House doctoring**, which includes reduced air infiltration and low-cost measures such as water heater insulation and shower head flow restrictors,

- **Ceiling insulation,**
- **Wall insulation**,
- **Flame retention oil burner** to replace outdated models,
- **Automatic set-back thermostats**, and
- **High efficiency oil furnace or boiler.**

The building conservation measures include three elements: house doctor, ceiling insulation, and wall insulation. Larger packages of measures, which include combinations of the basic measures, are also considered. Package I is projected to lower energy consumption and costs by 18 percent with an installed cost of $1930. Package II, a more extensive set of conservation measures, is expected to lower energy consumption and costs by 20 percent at a cost of $2270. These packages were originally derived in the analysis for the 1994 CECA study (ref 6).

Installing a new flame retention oil burner to replace older and less efficient models is a proven energy-saving measure. Research by Brookhaven National Laboratory has clearly demonstrated that a flame retention burner can reduce energy consumption in homes, on average, by 16 percent (ref 16). The cost of a flame retention burner retrofit is based on recent publications by the oil heat industry, and is consistent with costs included in the earlier CECA analyses (ref 10). The flame retention burner retrofit is included in the equipment / building shell combination packages.

Automatic setback thermostats reduce energy use by lowering the house temperature at night while the occupants are sleeping. The thermostats then automatically re-adjust so that the desired space temperature is achieved when occupants arise in the morning. For this analysis a single setback each day of 10 degrees F is assumed. Research by Honeywell (ref 20) and Brookhaven National Laboratory (ref 16) indicate typical energy savings of 9.5 percent. The cost for this option is based on two zone thermostats including installation.

Replacing the existing oil or gas boiler or furnace with a new high efficiency model using the same fuel is also evaluated. The resulting combinations of conservation measures are presented in Table 2.

TABLE 2:

CONSERVATION AND FUEL SWITCHING COSTS AND ENERGY SAVINGS

	COST $	PERCENT ENERGY SAVINGS
House Doctor:	570	13.00
Ceiling Insulation:	650	16.00
Wall Insulation:	1,360	15.00
Larger Package 1:	1,930	18.00
Larger Package 2:	2,270	20.00
Flame Retention Oil Burner:	580	16.00
Automatic Thermostat	350	9.50
Burner + House Doctor:	1,190	27.00
Burner + Ceiling Insulation:	1,540	29.00

High Efficiency Oil or Gas Equipment (using the existing fuel source):

FURNACES		AVG CASE	HIGH EFF
80% AFUE:	1,860	32.00	19.00
90% AFUE:	2,690	40.00	28.00
BOILERS			
80% AFUE:	3,320	32.00	19.00
90% AFUE:	4,260	40.00	28.00

NOTE: (1) Applies to average efficiency house
(2) Oil furnace and boiler savings based on replacing an outdated and low efficiency model that is more than 20 years old.

TABLE 2: CONTINUED

Fuel Switching

	COST $	PERCENT ENERGY SAVINGS	
GAS CONVERSION BURNER	1,600	0.00	
SWITCHING TO GAS FURNACE			
Low Cost:	500	(added to new equipment cost)	
High Cost:	1,000	(added to new equipment cost)	

<u>High Efficiency Natural Gas Equipment</u> (with $500 or $1000 added for conversion)

FURNACES		AVG CASE	HIGH EFF
80% AFUE:	2,360 to 2,860	32.00	19.00
90% AFUE:	3,190 to 3,690	40.00	28.00
BOILERS			
80% AFUE:	3,820 to 4,320	32.00	19.00
90% AFUE:	4,760 to 5,260	40.00	28.00

NOTE: Oil furnace and boiler savings based on replacing an outdated and low efficiency model that is more than 20 years old.

C. ENERGY CONSERVATION WITH HIGH EFFICIENCY EQUIPMENT

CECA also examined whether the consumer is economically better off investing in fuel switching or investing in higher efficiency heating equipment. First we looked at the economics of installing an 80 percent efficient (AFUE) furnace. This is slightly higher than the minimum efficiency required by federal regulations for new heating equipment (ref 13). We also considered a 90 percent efficient furnace for comparison.

The installed cost of the 80 percent efficient (gas or oil) warm air furnace is estimated to be $1860, based on a recent survey of equipment costs (ref 19), and the 1994 CECA study corrected for changes in the Producer Price Index from 1994 to 2000. Similarly, the cost for the 90 percent efficient furnace is $2690. The installed cost of the 80 percent efficient (gas or oil) hot water boiler is estimated to be $3,320, based on recent industry surveys (ref 10) and past CECA studies corrected for changes in the Producer Price Index. Similarly, the estimated cost for the 90 percent efficient hot water boiler is $4,260. Note that the equipment costs vary widely based on equipment firing rate, manufacturer, efficiency, and several other variables. Costs are based on equipment rated at approximately 140,000 BTU per hour input. Also, the cost for installing the equipment can vary over a wide range. The installed equipment costs used in this analysis are estimated average values based on recent surveys and past CECA research.

Energy cost savings for new boilers and furnaces are based on prior CECA studies, and are consistent with extensive research by Brookhaven National Laboratory on conservation options for oil and gas heating equipment.

D. FUEL SWITCHING

Two fuel-switching options were considered in Table 2. One option is converting an older oil heating system by replacing the existing oil burner with a gas burner. The second option is to replace the entire boiler or furnace and convert the oil system to new gas heating equipment.

New furnaces and boilers of comparable efficiency and costs are available for both oil and gas. Past CECA studies have shown that the incremental cost of converting from one fuel to another must be considered carefully. Hookup costs may be considerable. Even if the gas company subsidizes hookup costs, as is often the case in highly competitive fuel markets, other conversion costs must be factored into the equation. Such costs include the value of the lost oil, removal or deactivation of the oil tank, additional installation charges, cleaning or re-lining the chimney, and other potentially costly modifications (ref 11). CECA cautions that the average consumer could incur substantial additional costs above the cost of the boiler of furnace when converting from oil to gas and must evaluate these costs carefully.

The first case included in this analysis is installation of a conversion gas burner. The efficiency of the heating system may drop by several percentage points when an oil burner is replaced by a gas burner (ref 17). This is demonstrated by typical efficiency differences as published by boiler and furnace manufacturers for the two fuels. The cost for the conversion using a gas burner is estimated to be $1,600, based on a recent survey of equipment costs. Some additional costs may be incurred, such as modifying the vent system flue, chimney cleaning, or possible relining of the existing chimney. But these costs are not included in this current analysis because the gas conversion burner does not produce a positive return on investment in any event.

In the second conversion scenario, the consumer replaces the oil furnace or boiler with gas equipment. When the new piece of equipment is purchased, hidden costs may be high because the gas heating system may not be compatible with the existing installation. During the last two CECA surveys in 1991 and 1994, sensitivity analyses were conducted and modest conversion costs of $500 and $1000 were assumed. We have used those estimates again though research shows that these additional costs could exceed $3000 or even $5000, and could be as high as $8,000, depending on the existing installation and the efficiency of the new gas furnace that is selected (ref 11). For example, some state and local codes call for re-lining the chimney whenever a house is converted from oil to gas. This alone could cost $2,000 to $3,000 or more, depending on the size of the chimney and the type of liner that is used. This new heating equipment is assumed to last for 20 years.

As seen below, CECA's estimates in the economic analysis of $500 and $1000 for the added costs of conversion are very conservative. Added costs associated with conversion from oil to gas include the following:

- Gas piping from the gas main to the house and then to the heating equipment. This is highly variable from house to house, but can add hundreds of dollars to the final installed cost if the house is located far from the gas main. In addition, a gas meter, regulator, and valves are required. Some gas utilities offer partial rebates to lower this added cost, so it is important to ask.

- The exhaust vent pipe must be replaced because oil systems use an "atmospheric damper" while gas equipment uses a "draft diverter". Also, some installation codes require that a double-walled flue connector be used with the new gas heating equipment.

- Chimney upgrades are frequently required when a new gas heating appliance is installed. Existing chimneys are often over-sized and the new gas heater cannot operate satisfactorily or efficiently with the existing chimney. Water vapor in the gas burner's exhaust can condense in the chimney causing damage and creating potentially dangerous conditions. Some local and state codes require cleaning or re-lining of chimneys for all oil to gas conversions. This is required to prevent possible flue blockages caused by loosening existing debris that has accumulated over time. This type of flue blockage has been linked to fatal carbon monoxide poisoning incidents after fuel switching. Re-lining or re-building can cost $1,000 to $3,000, and up to $5,000 or more depending on the size and condition of the existing chimney.

- Fuel tank removal or retirement is another added conversion cost that is sometimes overlooked. The oil must be removed and disposed of, and the tank must be removed or retired in place following local code guidelines. This can cost several hundred dollars. In addition, the value of the oil is lost.

- Condensate pumps and drains are needed for some of the mid- to high efficiency gas heaters. A portion of the water vapor in the exhaust gases can condense and must be removed. This equipment can cost $100 or more.

- Draft inducers or power vents are sometimes required for new high efficiency gas heaters, because the exhaust gas temperature is too low to produce sufficient chimney draft. This can add several hundred dollars to the final installed cost.

- Sound vibration dampers and sound insulation are required in homes where high efficiency "pulse combustion" equipment is installed. This can add several hundred to more than one thousand dollars to the final installed cost.

The total added costs of conversion could add up to $5,000 to $8,000 if all these modifications are included. This is equal to or higher than the cost of the new heating equipment.

Again, it is important to emphasize that this analysis uses very conservative added costs for conversion of only $500 and $1000. **Consumers are advised to get complete estimates of all costs before approving a fuel-switching project**.

IV. OTHER METHODOLOGICAL ASSUMPTIONS

A. MODEL ASSUMPTIONS

Tables 2 and 3 show the basic assumptions behind the underlying economic analysis. Table 2 summarizes equipment cost estimates and percent energy savings. For the current study, estimates were based on a recent survey and values used in past CECA studies that were corrected for changes in the Consumer Price Index. Table 3 shows other assumptions used in the economic calculations. Research by the Lawrence Berkeley Laboratory (ref 21) shows that only house doctoring measures need to be replaced within the 20-year time frame of our economic analysis. We assume replacement every ten years for house doctor measures. The other measures do not need replacement within the time frame of the economic analysis.

For the purpose of this analysis, **parity in fuel prices is assumed**. This assumption slightly biases the model against heating oil, both in terms of historic and projected fuel prices. Oil has typically sold for less than natural gas in recent years based on US DOE data. Four different fuel price projections are used, two pessimistic and two optimistic, to determine how the attractiveness of various conservation and conversion measures changes under changing price scenarios. The pessimistic (and probably most realistic) assumptions place oil at $1.27 per gallon, or at $1.33 per gallon when averaged with equivalent natural gas prices projected by the US DOE for 1999 to 2001. The optimistic scenarios have heating oil prices returning to levels more commensurate with pricing over the past five years of $0.92. This increases to $1.02 per gallon when averaged with the price of gas and assuming price parity.

B. METHOD OF ANALYSIS

The various measures described above are compared utilizing their internal rate of return (IRR) over a 20-year period. This is the assumed life of the projects. ***Note that the internal rate of return is the discount rate that equates the initial cost of the project to its present value over the project's time***

frame. The measures with the highest IRR are preferred. The exception is the house doctoring measures, which are assumed to need replacement after ten years.

All projects are assumed to have a zero salvage value. This produces a conservative set of recommendations since it undervalues the conservation measures that may produce additional useful benefits beyond the 20-year time frame. It also overvalues fuel switching because the salvage value of the existing heating unit is ignored. If salvage values were included, they would only reinforce the conclusions of this analysis. The initial computations do not include the tax benefits of conservation measures (returns actually are in tax-free dollars). Tax benefits occur because the energy cost savings that are produced are non-taxable. Numbers are then presented that compare investment in equipment and other upgrades with a taxable investment. The assumed marginal tax rate will be **30 percent**. In addition to the IRR analysis, the **Payback Period** of each of the measures is calculated.

Payback figures clearly illustrate the relative advantages of conservation and conversion approaches, and provides an easy means of determining how long it takes for one to “get one's money back" from these changes. The payback period is defined as the number of years required to recover the initial equipment costs from the annual energy cost savings. <u>Shorter payback periods</u> are better investments.

TABLE 3:
ASSUMPTIONS FOR ECONOMIC ANALYSIS

INITIAL ENERGY CONSUMPTION OF HOUSE (annual)

AVERAGE	865 gallons of oil	(120 Million BTU)
HIGH EFFICIENCY	613 gallons of oil	(85 Million BTU)

LIFE SPAN OF INVESTMENTS

HOUSE DOCTOR	10 YEARS	
BURNERS	10 YEARS	
CONSERVATION MEASURES	20 YEARS	
FURNACES OR BOILERS	20 YEARS	(ref 18)

FUEL PRICES

OIL HISTORIC (95 –99)	$0.92 / GAL	($ 6.63 /MMBTU)
OIL PROJECTED (99-01)	$1.27 / GAL	($ 9.16 /MMBTU)
AVERAGE OIL AND GAS (95-99)	$1.02 / GAL	($ 7.35 /MMBTU)
AVERAGE OIL AND GAS (99-01)	$1.33 / GAL	($ 9.59 /MMBTU)

FINANCIAL ASSUMPTIONS

PERIOD OF ANALYSIS	20 YEARS
MARGINAL TAX RATE	30 PERCENT

V. RESULTS

A. INTERNAL RATES OF RETURN

The results of the various IRR analyses are presented in **Tables 4 and 5**. Table 4 shows Internal Rates of Return excluding tax benefits, while Table 5 includes the impact of tax benefits. These results are similar to those in past CECA analyses. While the general ranking of the options is similar to past studies, rates of return are substantially higher given today's higher fuel prices.

Conservation investments are by far the best choices. There are ranges of conservation measures that are much more economically attractive than installing a new heating unit or converting from oil to gas. In particular, if a consumer does not need a new furnace or boiler, then there are many conservation alternatives that have a much better return on investment than fuel switching. These include improvements to the existing furnace (such as a new **flame retention burner**), and improvements to the building (such as a **setback thermostat** or **house doctoring**) that produce rates of return that are twice or four times as high as fuel switching.

The rates of return on conservation investments, assuming the higher fuel costs, produce returns on investment in the 30 to 60 percent range, and up to 70 percent for a new oil burner, when tax benefits are included. These options are much more attractive than many other investments available to most homeowners. If a new furnace or boiler is needed, it makes sense to buy a high efficiency model as recommended by past CECA analyses. The added costs incurred by fuel switching make conversion a less attractive option than conservation investments.

1. Conservation Investments

The present analysis begins with the first scenario of a homeowner with average fuel use of **865 gallons a year** and excluding tax benefits as shown in **Table 4**. It is immediately clear that simpler is better, as the most attractive conservation measures are, in general, the least expensive. **House doctoring**, at $570, has an internal rate of return ranging from **16.61** percent (with oil at $0.92) to **32.80** percent (with oil at $1.33). **Setback Thermostats** ($350) produce IRRs of **27.27** percent to **45.37** percent as the fuel price rises from $0.92 to $1.33 a gallon for the average fuel use house. Similarly, installing **ceiling insulation** (at a cost of $650) has an internal rate of return that ranges from **23.95 percent** to **39.44 percent**, depending on the price of oil. The more aggressive conservation projects (Package I and Package II) produce lower returns, with IRRs mostly in the single digits. The best economic strategy of all, the installation of a **flame retention burner** ($580), has rates of return as high as **46.5 percent**. The combination of both **house doctoring and the flame retention burner**, costs $1190 and yields IRRs that range from **21.5 percent to 35.2 percent**. The range in IRRs is primarily the result of the fuel price range that is evaluated. Although the rates of return for the installation of new, higher efficiency equipment are attractive, they are lower than simple conservation measures.

The high efficiency house, which uses 623 gallons of oil a year, shows much lower rates of return. These findings apply as well in average efficiency homes in warmer climates such as states south of the Mid-Atlantic region. For these low-usage homes, the **relative** results do not change at all. The dominant strategies remain the same - the flame retention burner, automatic setback thermostats, ceiling insulation, and house doctoring produce the greatest return for consumers. Many of the more substantial and costly measures become uneconomical, however, in the low-use home. Even at the higher fuel price of $1.33 per gallon, the larger conservation packages have IRRs of only 4.93 percent for Package 1 and 4.19 percent for Package 2. Likewise, the acquisition of a new boiler or furnace (using the same fuel) provides only single digit rates of return (with the 80 percent efficient boiler now providing a **negative** rate of return, regardless of the price of oil). If oil prices return to the $0.92 to $1.02 range, a number of these projects have returns that fall below those for a good tax-free investment, assumed to be around three percent.

2. Fuel Switching

Conversion to gas from heating oil by simply replacing the existing oil burner with a gas burner is uneconomical. No efficiency gain is produced (in fact the efficiency drops about three percent based on manufacturer's data) when fuel price parity is assumed. These IRRs cannot be calculated, since the outlay does not produce corresponding savings. Therefore, there is no return on investment based on price parity. Note that additional calculations by CECA in 1994 showed that even with a 10 percent price advantage for gas, which is unlikely for the long term, the economics are still unfavorable when compared to other options. Therefore, there is no return on the investment for installing a new gas burner.

Switching fuels by replacing an existing boiler or furnace is also not highly ranked based on the current IRR and Payback analyses. Table 4 tabulates internal rates of return for two cases: added conversion costs of $500 and conversion costs of $1000. As said earlier, these are very conservative costs. Using the lower conversion cost of $500, and for the average fuel use home (865 gallons a year), IRRs range from 10.18 percent to 17.64 percent. The returns are higher than money in the bank, but even for this very low conversion cost of $500, are less attractive than many other options available to homeowners. For high efficiency houses, this drops to – 0.99% to 3.07 percent. These returns are also lower than those achieved when buying a new oil furnace of comparable efficiency.

When the higher conversion costs of $1,000 are used, the IRRs are even less attractive, ranging from 7.14 percent to 13.42 percent for the average fuel use case, and –2.85 percent to 0.86 percent for the low fuel use or higher efficiency house. These are not favorable rates of return. Also, bear in mind that actual conversion costs can be $5,000 or higher, so consumers are well advised to get firm costs <u>before</u> proceeding with any fuel conversions. The added costs for fuel switching may be incurred if adjustments are required to reduce the risk of flue blockage and exposure to dangerous exhaust gases including carbon monoxide. These higher conversion costs, although not factored into the present analysis, negatively impact the rates of return produced by fuel switching.

3. Conservation Investments Including Tax Benefits

Table 5 shows that factoring in tax benefits does not change the <u>relative</u> rankings of the various measures, although it significantly raises the IRRs. House Doctoring now has an IRR of 50.46 percent when heating oil prices reach $1.33. Likewise, the IRR for installing ceiling insulation rises to 58.25 percent, and the rate of return on flame retention burners is superior at 70.23 percent. Clearly, these are extremely attractive options for the consumer. Although the numbers are lower for low-use houses, even under these circumstances, these measures are attractive investments for consumers. For example, flame retention burners offer a 41.26 percent return for oil at $1.33 a gallon.

B. PAYBACK PERIODS

Payback figures illustrate the number of years it takes for an investment to return its full cost, without incorporating discount rates to control for the time-value of money. The payback figures presented in **Table 6** are calculated without the tax advantages that arise from investing in these measures. Note that incorporating tax benefits would significantly shorten the payback periods. Typically, one would look for a payback period of less than 10 years, since investments that take longer to return the initial expenditure are seldom attractive to consumers. In fact, past research at Brookhaven National Laboratory indicates that consumers are most interested in paybacks of three to four years or less. The payback period for House Doctoring ranges from 3.8 to 5.5 years, depending on the price of heating oil. Likewise, ceiling insulation pays for itself in 3.5 years if oil is at $1.33 per gallon or just over five years with oil at $0.92 per gallon. Clearly, wall insulation, Package I, Package II, and boiler upgrades are unattractive, except at the very highest fuel prices. The best option, the flame retention burner, pays for itself in just 3.2 years (with oil at $1.33) or 4.6 years (with oil at $0.92).

C. APPLYING THE RESULTS

While there will continue to be periodic fluctuations in the prices of residential oil and natural gas, CECA believes price parity is still the best long-term assumption, as discussed and presented in earlier CECA studies. As the price of all heating fuels increases, and home heating costs rise, investing in energy conservation measures is the best option for most homeowners, now and in the future. In fact, as the prices of both oil and gas continue to increase, energy conservation investments become more and more valuable. This is clearly demonstrated by the results of this analysis, which shows the strong impact of rising fuel prices on both Internal Rates of Return and Payback Periods. **Conservation is clearly an attractive investment option for residential consumers.**

In several of the states with warmer climates that use heating oil, such as North Carolina, homeowners can also benefit from conservation investments. While energy use is lower than in other regions where oil heat is popular, the rising fuel prices make conservation investments attractive because fuel cost savings are higher. Table 5 shows the Internal Rates of Return for a house using 613 gallons of oil a year, which is more typical for warmer climates. As discussed earlier, many of the conservation options remain viable, especially the lower cost measures.

VI. CONCLUSIONS

This analysis has demonstrated that the best economic strategy for most homeowners who want to lower their home heating costs is to pursue conservation measures, such as house doctoring, ceiling insulation, or flame retention burners. These yield higher returns than more costly measures. The tax-free returns on these measures greatly exceed many alternate tax-free options available to consumers, and it makes sense economically. Fuel switching does not make economic sense, as the IRRs of this type of investment are negative, or lower many than other investment options.

The typical lifetime of a boiler or furnace is approximately 20 years (ref 18). Therefore, in any given year only about one out of every 20 consumers needs to replace their furnace or boiler. From an individual homeowner's point of view, the choices are clear.

- For 95 percent of consumers who do not need a new furnace or boiler, conversion makes no economic sense. Investing in the energy conservation options presented in this study is the clear choice for lowering energy bills.

- For the one out of 20 consumers who need a new furnace or boiler, the best advice is to purchase a high efficiency model. This will produce the lowest fuel costs and reduce air pollutant emissions by reducing annual fuel consumption.

Other factors that influence the choice of fuel include environmental concerns, national security, and international competitiveness. Research by Brookhaven National Laboratory over the past 20 years has demonstrated that both residential oil and gas burners produce low air pollutant emissions. Particulate emissions from oil burners have dropped by a factor of seven over the past 20 years and are now approaching natural gas emissions levels. Also, low sulfur fuel oil is beginning to gain favor as a home heating fuel, further diminishing the difference in air emissions between oil and gas. Residential oil and gas burners are both low emitters. Therefore, the following conclusions are clear:

- From an environmental perspective, it is much better to conserve a BTU of oil than to replace it with a BTU of gas. Because air emissions are similar, air pollutant emissions are reduced more by conserving a BTU of fuel than by replacing a BTU of oil with gas.

- From a national security perspective it is also better to conserve a BTU of oil than replace it with a BTU of gas. Both oil and gas are depleting natural resources that are interchangeable for most application. Energy conservation extends available resources and increases supply relative to demand for home heating. This is important to help offset future price spikes that are the result of shortages of both oil and natural gas.

TABLE 4:
INTERNAL RATES OF RETURN (%)
(without Tax Benefits)

Measure	0.92	1.27	1.02	1.33
	Price of Oil and Gas ($ per Gallon Equiv.)			
House Doctor ($570)				
Average Use	16.61	30.35	20.48	32.80
Low Use	6.09	15.84	8.93	17.49
Ceiling Insulation ($650)				
Average Use	23.95	36.97	27.47	39.44
Low Use	14.98	23.26	17.32	24.73
Wall Insulation ($1360)				
Average Use	6.93	12.25	8.49	13.14
Low Use	2.43	6.61	3.68	7.28
Package I ($930)				
Average Use	4.62	9.31	6.01	10.08
Low Use	0.54	4.33	1.68	4.93
Package II ($2270)				
Average Use	3.89	8.40	5.23	9.14
Low Use	-0.87	3.61	1.04	4.19
Flame Ret. Burner ($580)				
Average Use	27.89	43.44	32.00	46.46
Low Use	17.57	27.06	20.21	28.78
Setback Thermostat ($350)				
Average Use	27.27	42.44	31.31	45.37
Low Use	17.19	26.48	19.78	28.16
Burner & House Dr. ($1190)				
Average Use	21.49	33.05	24.65	35.21
Low Use	13.31	20.87	15.45	22.19
Burner & Ceil. Insul, ($1540)				
Average Use	16.69	25.75	19.22	27.38
Low Use	9.91	16.19	11.72	17.26
80% Furnace ($1860)				
Average Use	14.04	22.84	16.99	24.28
Low Use	1.54	5.54	2.74	6.17
90% Furnace ($2690)				
Average Use	11.81	18.78	13.81	19.99
Low Use	1.76	5.76	2.97	6.44

TABLE 4: CONTINUED
INTERNAL RATES OF RETURN (%)
(without Tax Benefits)

	Price of Oil and Gas ($ per Gallon Equiv.)			
	0.92	**1.27**	**1.02**	**1.33**
80% Boiler ($3320)				
Average Use	5.05	9.86	6.47	10.65
Low Use	- 4.02	-1.18	-3.27	-0.27
90% Boiler ($4260)				
Average Use	4.70	9.42	6.10	10.20
Low Use	0.61	4.42	1.76	5.02
GAS CONVERSION:				
Gas Burner only (1,050)	NONE	NONE	NONE	NONE
Gas Furnace:				
For **$500** Conversion Cost:				
80% Gas Furnace ($2,360)				
Average Use	10.18	16.55	12.02	17.64
Low Use	- 0.99	2.52	0.07	3.07
90% Gas Furnace ($3,190)				
Average Use	8.89	14.82	10.61	15.82
Low Use	- 0.11	3.56	1.00	4.14
For **$1,000** Conversion Cost:				
80% Gas Furnace ($2,860)				
Average Use	7.14	12.53	8.71	13.52
Low Use	- 2.85	0.36	- 1.87	0.86
90% Gas Furnace ($3,690)				
Average Use	6.86	11.93	8.22	12.80
Low Use	- 1.58	1.83	- 0.55	2.36

TABLE 4: CONTINUED
INTERNAL RATES OF RETURN (%)
(without Tax Benefits)

	Price of Oil and Gas ($ per Gallon Equiv.)			
	0.92	**1.27**	**1.02**	**1.33**
Gas Boiler:				
For **$500** Conversion Cost:				
80% Gas Boiler ($3820)				
Average Use	3.26	7.63	4.56	8.34
Low Use	- 5.40	- 2.54	- 4.52	- 2.10
90% Gas Boiler ($4760)				
Average Use	3.30	7.67	4.60	8.38
Low Use	- 0.56	3.03	0.53	3.60
For **$1,000** Conversion Cost:				
80% Gas Boiler ($4320)				
Average Use	1.81	5.85	3.02	6.50
Low Use	- 6.41	- 3.67	- 5.56	- 3.25
90% Gas Boiler ($5260)				
Average Use	2.11	6.22	3.34	6.88
Low Use	- 1.56	1.85	- 0.52	2.39

TABLE 5
INTERNAL RATES OF RETURN (%)
(with Tax Benefits)

	Price of Oil and Gas ($ per Gallon Equiv.)			
	0.92	**1.27**	**1.02**	**1.33**
Measure				
House Doctor ($570)				
Average Use	27.38	46.78	32.64	50.46
Low Use	13.81	26.35	17.38	28.55
Ceiling Insulation ($650)				
Average Use	34.04	54.20	39.27	58.25
Low Use	21.47	33.03	24.63	35.18
Wall Insulation ($1360)				
Average Use	11.15	17.87	13.08	19.03
Low Use	5.76	10.76	7.24	11.59
Package 1 ($1930)				
Average Use	8.35	14.12	10.03	15.09
Low Use	3.57	8.01	4.89	8.73
Package II ($2270)				
Average Use	7.48	12.98	9.09	13.90
Low Use	2.88	7.16	4.15	7.85
Flame Ret. Burner ($580)				
Average Use	39.87	65.00	46.25	70.23
Low Use	24.99	38.65	28.66	41.26
Burner & House Dr. ($1190)				
Average Use	30.48	47.91	35.06	51.34
Low Use	18.29	29.59	22.10	31.29
Burner & Ceil. Insul. ($1540)				
Average Use	23.77	36.69	27.27	39.13
Low Use	14.87	23.09	17.18	24.55
80% Furnace ($1860')				
Average Use	21.08	30.09	24.18	34.52
Low Use	4.73	9.46	6.13	10.23
90% Furnace ($2690)				
Average Use	17.30	26.66	19.91	28.35
Low Use	4.98	9.77	6.04	10.65

TABLE 5: CONTINUED
INTERNAL RATES OF RETURN (%)
(with Tax Benefits)

	Price of Oil and Gas ($ per Gallon Equiv.)			
	0.92	**1.27**	**1.02**	**1.33**
Measure				
80% Boiler ($3320)				
Average Use	8.87	14.80	10.60	15.81
Low Use	-1.77	1.60	- 0.75	2.13
90% Boiler ($4260)				
Average Use	8.46	14.25	10.15	15.23
Low Use	3.66	8.12	4.98	8.84
GAS CONVERSION				
Gas Burner Only	NONE	NONE	NONE	NONE

TABLE 6:
PAYBACK PERIODS (IN YEARS)

	Price of Oil and Gas ($ per Gallon Equiv.)			
	0.92	**1.27**	**1.02**	**1.33**
Measure				
House Doctor ($570)	5.5	4.0	5.0	3.8
Ceiling Insulation ($650)	5.1	3.7	4.6	3.5
Wall Insulation ($1360)	11.4	8.3	10.3	7.9
Package I ($1930)	13.5	9.8	12.2	9.3
Package II ($2270)	14.3	10.3	12.9	9.9
Flame Ret. Burner ($580)	4.6	3.3	4.1	3.2
Burner & House Dr. ($1190)	5.5	4.0	5.0	3.8
Burner & Ceil. Insul, ($1540)	6.7	4.8	6.0	4.6
80% Furnace ($1860)	7.3	5.3	6.6	5.1
90% Furnace ($2690)	8.5	6.1	7.6	5.8
80% Boiler ($3320)	13.0	9.4	11.8	9.0
90% Boiler ($4260)	13.4	9.7	12.1	9.3

TABLE 6: CONTINUED
PAYBACK PERIODS (IN YEARS)
FOR AVERAGE EFFICIENCY HOUSE (865 GALLONS PER YEAR)

	Price of Oil and Gas ($ per Gallon Equiv.)			
	0.92	**1.27**	**1.02**	**1.33**
GAS CONVERSION:				
Gas Burner Only ($1,050)	NONE	NONE	NONE	NONE
For $500 Conversion Cost:				
80% Gas Furnace ($2,360)	9.3	6.7	8.4	6.4
90% Gas Furnace ($3,190)	10.0	7.3	9.0	6.9
80% Gas Boiler ($3,820)	15.0	10.9	13.5	10.4
90% Gas Boiler ($4,760)	15.0	10.8	13.5	10.3
For $1,000Conversion Cost:				
80% Gas Furnace ($2,860)	11.2	8.1	10.1	7.8
90% Gas Furnace ($3,690)	11.6	8.4	10.5	8.0
80% Gas Boiler ($4,320)	17.0	12.3	15.3	11.7
90% Gas Boiler ($5,260)	16.5	12.0	14.9	11.4

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