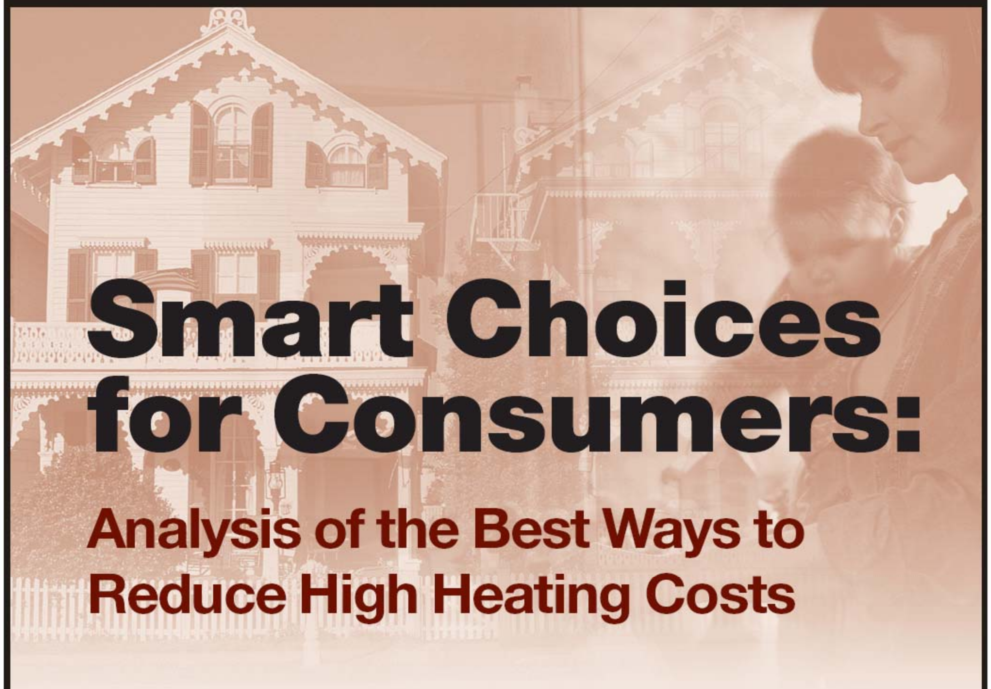
FINAL REPORT



Smart Choices for Consumers:

Analysis of the Best Ways to Reduce High Heating Costs

AN EVALUTION OF THE ECONOMICS OF CONSUMER INVESTMENT OPTIONS: HOME ENERGY EFFICIENCY, UPGRADING EQUIPMENT, AND FUEL SWITCHING

A Technical Support Document by
The Consumer Energy Council of America

NOVEMBER 2005

CECA
CONSUMER ENERGY COUNCIL OF AMERICA

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Over 30 Years of Excellence in Energy Policy Research

Founded in 1973, the **Consumer Energy Council of America (CECA**) is the nation's senior public interest organization focusing on energy issues affecting consumers. CECA is a leading national resource of information, analysis and technical expertise on the social and economic impacts of energy policies. CECA has a primary commitment to ensuring reliable and affordable essential services for all sectors of our nation, with special regard for residential and small business consumers.

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F I N A L R E P O R T

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EXECUTIVE SUMMARY

This study by the Consumer Energy Council of America (CECA) examines the economics of investment options available to residential consumers who are concerned about rising costs for home heating. The study addresses three central questions: given the rising costs of heating fuels: (1) Is there an economic advantage to switching from one heating fuel to another? (2) Is there an economic advantage to replacing an old heating system with a new system? and (3) Are there alternative measures that can be undertaken that will provide significant cost savings for consumers?

In examining these questions, the study analyzes fuel price trends over the past three decades. CECA's analysis shows that since the lifting of price controls on natural gas was initiated in 1978 and the decontrol of oil in 1981, prices of both fuels have converged over time based on the market value of each fuel's energy content. CECA's analysis shows that external factors affect the day-to-day prices of oil and gas, but over the long run, the market brings prices back in line with each other. This trend has continued even throughout the past few years when prices have increased dramatically. Based on the observation of price parity – and considering the strong likelihood that price parity will continue in the future – the study concludes that fuel switching is not a viable option for consumers for the purpose of saving money.

The study further concludes that upgrading existing heating equipment only derives an economic advantage if the replacement system is considerably more efficient than the existing system. This is often the case with boilers and furnaces over 15 years old. Systems that are less than 15 years old typically have higher efficiency levels because mandatory federal appliance efficiency standards had gone into effect. Thus, the calculations show that the potential payback of upgrading from a system less than 15 years old to a new system would be minimal or potentially negative. For systems that are older than 15 years, the savings from efficiency gains could be significant and more than justify the upgrade.

Finally, and perhaps most significantly, the study shows that even with old equipment, there are a number of energy efficiency measures that could produce high returns on the consumer's investment. Investments in some of the measures examined by CECA can even be paid back in less than one year. For the majority of consumers, these efficiency measures represent the potential for the greatest gains in energy savings, as well as the highest returns on investment. The study highlights a number of energy efficiency measures that produce superior returns on the consumer's investment.

I. INTRODUCTION

In 1980, at the end of a turbulent decade of energy shocks, price spikes, and major regulatory changes, the Consumer Energy Council of America (CECA) undertook the first of what would become a series of studies examining the economics of measures to reduce the costs of residential home heating. In the early 1980s, when natural gas and oil prices were just being released from regulation and price controls, many consumers asked whether switching from oil heating systems to natural gas systems would make economic sense. CECA responded with a study examining rates of return on investments in a variety of measures available to consumers, including energy efficiency, equipment upgrades, fuel switching, and even interest-bearing savings accounts.

CECA's 1980 study, *An Analysis of the Economics of Fuel Switching versus Conservation for the Residential Heating Oil Consumer*,[1] examined the differential in current prices between natural gas and heating oil and assessed how those differences in price would impact the economic returns on various investments a residential consumer could make to reduce their heating costs. More importantly, the study examined how deregulation of the oil and natural gas markets would affect long-term prices of both fuels. In 1980, CECA predicted that prices for gas and oil would converge based on each fuel's energy content (i.e., one btu of gas would have an equivalent value to one btu of oil).[2] In the 25 years since the CECA study was first conducted, we have seen oil and gas prices peak and drop at various points in time, but one trend is absolutely clear: prices always return to a market equilibrium based on the energy content of the fuels.

CECA's projection regarding price parity was significant. Because prices of oil and gas track each other over time, CECA was able to examine the economics of fuel switching versus other energy investments, such as energy efficiency measures, weatherization, and upgrading heating equipment. In doing so, CECA's study was able to show consumers which energy investments provided the greatest returns, which investments produced the least returns, and how consumers could use the data to make smart choices for the future.

CECA followed the 1980 study with updated studies in 1989, 1991, 1994, and 2001. In each updated study, CECA revised the numbers to reflect current prices and recomputed the results. While the returns on investments changed based on the revised prices of fuels, the question of fuel switching kept resulting in the same answer: converting to natural gas from oil heat for the sake of capturing the economic value of the price difference between the fuels was not a good economic investment.

- In 1980, CECA predicted that the deregulation of the oil and natural gas markets would lead to price parity between the two fuels within the decade and that consumers would be advised to invest in energy efficiency to reap the greatest savings on energy bills.

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1 Published by the Consumer Energy Council of America, October 15, 1980.

2 Although gas (therms) and oil (gallons) are sold in different units, they can be compared by the actual energy content of each fuel. One gallon of oil has roughly the same energy content as 1.39 therms of gas.

- In 1989, CECA demonstrated that oil and gas prices had converged, and price differences would be transient in the future. The study showed that efficiency measures had superior returns on investment for consumers.

- In 1991, CECA concluded that since heating equipment generally lasts 20 years, in 95 out of 100 cases it made economic sense for consumers to stick with their current heating equipment, regardless of fuel source, and to invest in efficiency.

- In 1994, CECA demonstrated that even with the shock of rising oil prices caused by the Persian Gulf crisis, the market adjusted and price parity was restored. Once again, energy efficiency measures proved to be superior investment options for consumers.

- In 2001, another year of high fuel prices, CECA showed that higher fuel prices made energy efficiency measures even more attractive.

In this 2005 study, CECA again examines cost saving measures for consumers, applying nearly three decades of experience and data analysis. Important factors considered in the current analysis include recent changes in oil and natural gas prices over the four years since CECA's 2001 study was completed, and utilizing the latest information on the performance and costs associated with home energy efficiency options.

II. COMPARING FUELS

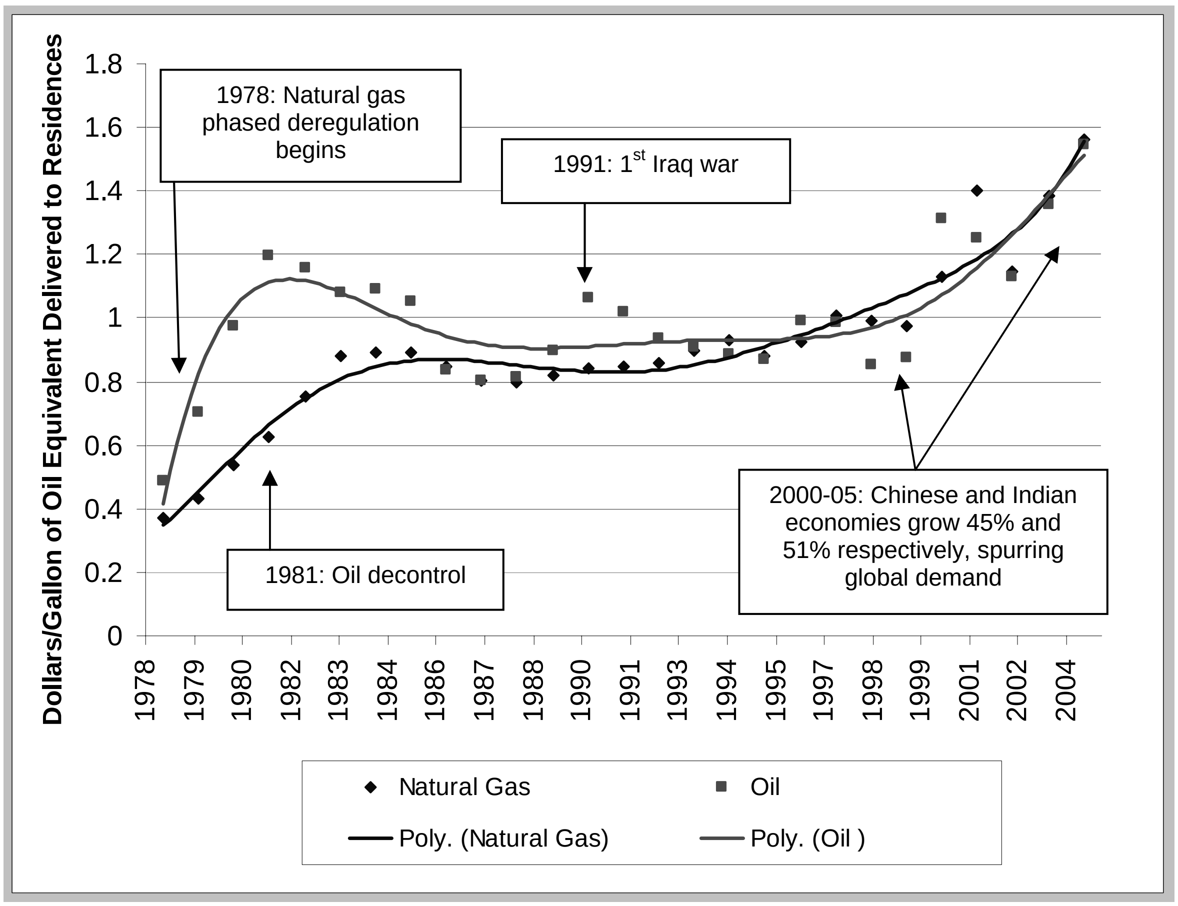
A. Continuing Price Parity

A central point in the original CECA study in 1980 was that switching fuels from oil to gas was not a smart economic choice for consumers because it was based on unrealistic assumptions about how oil and gas prices would behave in an unregulated market. It was CECA's view that, following the deregulation of both oil and gas, price equivalence on an energy content basis would be reached, negating any advantages of capturing price savings from fuel switching. This finding has continued throughout each of the past CECA studies.

The latest data from the U.S. Department of Energy's Energy Information Administration (EIA) supports CECA's early hypothesis. For many years, prices for oil and natural gas were subject to federal prices controls. Phased deregulation of natural gas began with the passage by Congress of the Natural Gas Policy Act in 1978 during President Jimmy Carter's Administration. Oil, which had been subject to price controls imposed under President Richard Nixon's Cost of Living Council's Wage and Price Control program to stem inflation, began to be lifted in 1979 by President Carter and was completed in 1981 when President Ronald Reagan took office. During this early period of decontrol, prices for both fuels began to rise. A number of factors contributed to that rise, including the Iranian revolution in 1979 and President Carter's ban on importing Iranian oil. Since the mid-1980s when parity was achieved, prices of oil and gas have risen and fallen at different points in time, but have returned to parity despite changes in energy policy, geopolitics, and the global macro-economy (see Figure 1).

As with any commodity, it is difficult to predict future price directions with precision. As CECA noted in a July 2005 comprehensive study on projections of future energy consumption,[3] the energy market will probably undergo substantial changes over the life of the furnaces and boilers and other energy efficiency measures discussed in this paper. Chief among these is the introduction of greenhouse gas (GHG) limitations, which will likely soon become a fact in the nine Northeast states that are parties to the Regional Greenhouse Gas Initiative (RGGI).[4] It is far from clear exactly how greenhouse gas reductions will be implemented, or what effect such policies will have on the prices of fuels. However, over two decades of unregulated energy markets have shown that despite price spikes at a particular point in time affecting one fuel or another, the market eventually readjusts and returns to price parity.

FIGURE 1: PRICES OF NATURAL GAS AND OIL SINCE REMOVAL OF PRICE CONTROLS (1978-2004)



Source: EIA, 2005 and World Bank, 2005

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[3] Consumer Energy Council of America. *Projecting Energy Needs for the Stationary Use Sector: An Analysis of the Projected Energy Demands in 2025*, July 2005, p. 13.

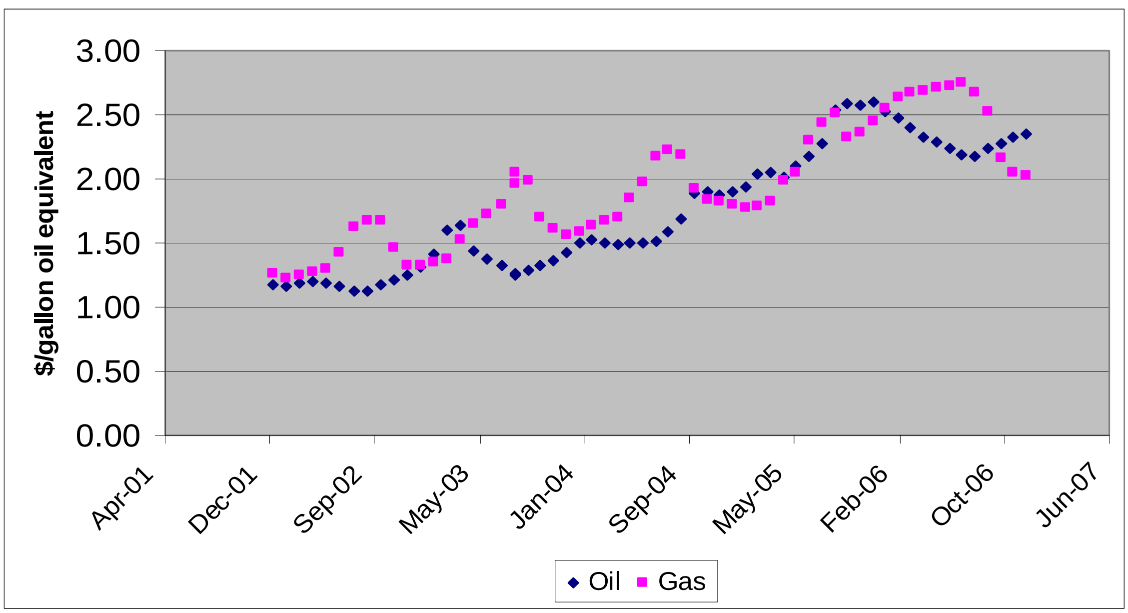
[4] RGGI will cap the amount of heat trapping gases emitted from the electric power sector. Over time the cap will be reduced and power companies will comply with emissions requirements by buying and selling pollution credits. Since the power sector uses the same or similar fuels as residential customers, those customers will likely see changes in prices associated with these measures.

With these uncertainties in mind, the analysis presented in this report, which considers recent increases in energy prices, again leads to the conclusion that switching from oil to gas is not a smart economic investment for consumers. It is important to recognize that switching from one fuel to another does not result in any commensurate energy savings. The report identifies many home energy investment options which both reduce energy consumption *and* produce positive returns for consumers. In fact, some of the energy investments identified by CECA *offer excellent returns on investment, even paying back the original investment in less than one year.*

CECA's report also shows that with the prices of natural gas and oil at or above $2.00 per gallon equivalent, it makes economic sense to upgrade from older heating equipment to more efficient equipment if significant efficiency improvements can be achieved by doing so. The report shows that a substantial number of households have heating equipment over 20 years old, and calculates that the average efficiency for that equipment is significantly lower than for modern heating equipment. In some cases, upgrading to a high efficiency system offers a payback period on the consumer's investment of as little as four years.

As CECA concluded in its earlier reports, the upgrading options and efficiency investments recommended by CECA are not based on gambling over future differentials in fuel prices, as

FIGURE 2: FUEL PRICES IN NEW ENGLAND AND THE MID ATLANTIC STATES, 2002-07



Source: EIA, Short Term Energy Outlook, September 2005

fuel switching does. They are based, instead, on actually reducing the amount of energy used, which translates directly into reducing the amount of dollars spent for energy.

B. Regional Fuel Prices

Markets unencumbered by regulation would tend to exploit regional differences as traders purchase fuel in low priced areas and sell in higher priced ones. CECA's past studies have clearly shown that *national* average prices are not the correct prices to use in economic analyses that focus on markets in which consumers have the option of using either oil or gas. This stems from the fact that transportation costs and infrastructure limitations affect resource mobility, creating different supply-demand balances in various regions of the country.

In CECA's 1994 report we concluded that oil and gas price comparisons must be relevant to consumers in specific regions of the U.S. where oil and gas compete with one another. This conclusion still holds today. A large percentage of gas is consumed in warmer climates close to gas fields, resulting in relatively low average gas prices. However, in regions where oil is consumed (such as the Northeast, for example), gas prices are higher than in areas closer to the gas fields and household energy bills are considerably higher than the national average because of the colder climate.

Despite these regional differences, CECA projects that over time the prices of the two fuels will likely continue to be close. Indeed, Figure 2 above shows that oil and gas prices in the New England and Mid-Atlantic states demonstrate price parity, with short periods when the price of either fuel was higher or lower than the other. Thus, CECA maintains that consumers seeking to switch fuels to capture any perceived difference in costs are engaging in a risky and speculative investment that is not supported by historical or prevailing energy prices.

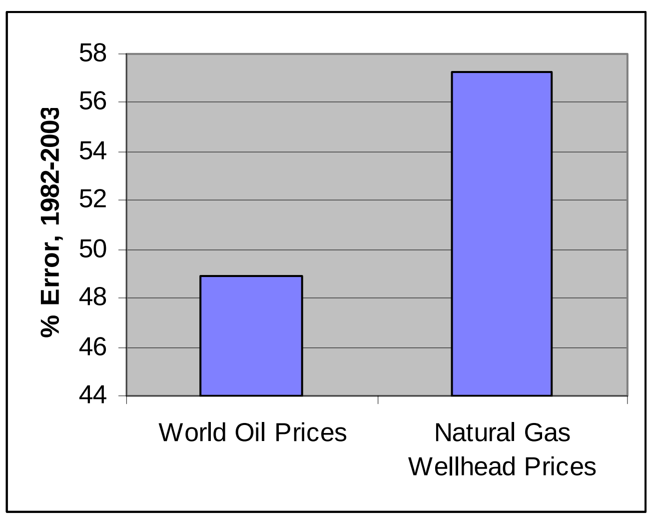
C. Future Prices

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

Assumptions about future energy prices are a key element in any decision to switch fuels. On the other hand, investments in energy efficiency measures reap returns regardless of fuel price differentials. Any decision to switch fuels must assume that the new fuel to be used will be lower in price than the existing fuel for the 20 year estimated life of the new equipment that is purchased at the time of the switch.

As noted above, however, assessing the direction of energy prices is extremely difficult. The Energy Information Administration, which publishes the most widely-referenced long-term fuel projections, has found its price assessments often miss the true price of oil and natural gas by close to 50 percent; in certain years the difference can be even greater, as was the case in 2003 (see Figure 3).

FIGURE 3: AVERAGE ABSOLUTE PERCENT ERROR OF EIA PROJECTIONS



Source: EIA, 2005 Annual Energy Outlook Forecast Evaluation

The uncertainty over future prices rests on the influences of several factors regarding energy prices. These, in turn, affect the urgency and the impact of measures consumers adopt related to heating their homes. Some of the chief variables that may affect energy prices include:

- ***Macro-economic growth:*** Economic expansion, especially of the magnitude currently experienced in China, India, and other Asian economies, draws heavily on energy resources, resulting in the prices of those resources being bid up in the marketplace. Often changes in economic growth are difficult to predict, particularly in the emerging market economies that have served as the engines of recent global economic growth. At the moment there are questions on the pace of the Asian economic growth, leading to additional uncertainties over future energy prices.

- ***Political events and unrest:*** Many oil producing regions are also characterized by political instability and conflict, and energy prices can be both a weapon and a casualty of conflicts. Predicting the onset and effects of these disturbances, particularly over the lifespan of a typical furnace or boiler, is extremely difficult.

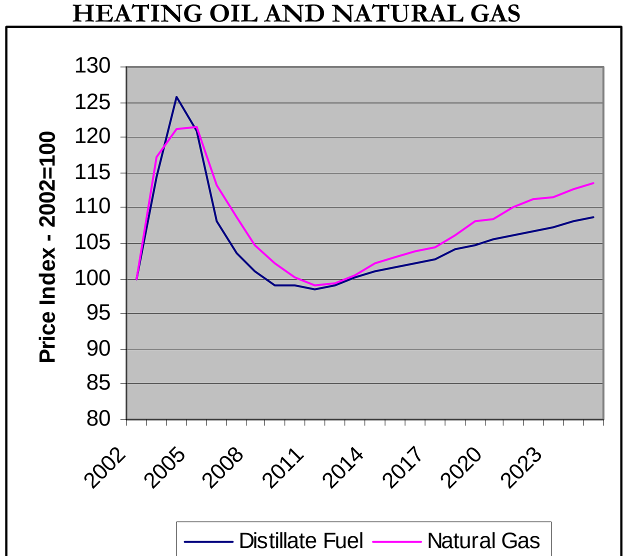
- ***Policy changes:*** Changes to laws affecting the procurement, delivery, and marketing of energy and energy services have strong (and perhaps more predictable) impacts on energy costs. Regulations that can have the greatest impacts address energy market structure and environmental externalities. The recent Energy Policy Act of 2005, for example, requires a number of very significant changes to the energy markets.

Within this context of uncertainty, CECA's projection of price parity will likely characterize energy prices over the next 20 years. The EIA's data suggests that natural gas may in fact exhibit slightly greater rates of price appreciation than will fuel oil, particularly between 2015 and 2025 (see Figure 4). In practical terms this discrepancy is not meaningful, given the historical difficulty in forecasting fuel prices noted above. Application of a discount factor to capture the time value of money would render any small differential extremely insignificant.

As noted previously, price parity is the logical result of free market energy policies. However, while CECA contends that price parity will continue to be the long-term trend, there will be a number of events that could influence the prices in the short term. A few examples of these include the following:

- ***Greenhouse gas regulations*:** As noted above, nine Northeastern states have agreed in principle to adopt a framework to reduce emissions of heat-trapping gases produced by the power sector. A greenhouse gas regime could affect fuel prices in different ways, as different fuels release different levels of carbon during

FIGURE 4: 20-YEAR PRICE OUTLOOK FOR HEATING OIL AND NATURAL GAS



Source: EIA Annual Energy Outlook, 2005

combustion.[5] The transporting of fuels will also be affected, as new regulations will require stricter provisions regarding leakage from pipelines and other forms of transport.

- ***Geopolitical events***: Disruptions in areas producing both natural gas and oil may affect prices of one commodity relative to the other.

In sum, with fuel switching, the consumer gambles on the future price differentials of the two fuels while producing no savings in the amount of energy the consumer uses. Moreover, there is a strong likelihood that these differentials will continue to be minimal as the cost of energy for heating oil and natural gas continues to track one another over time. Importantly, however, given the recent rise in gas and oil prices, energy-saving options become all the more attractive to consumers. As demonstrated in CECA's past studies, energy efficiency is a more attractive option than fuel switching for the vast majority of consumers. *With energy efficiency measures, the consumer's energy consumption is actually reduced, regardless of fuel price differentials. Less energy consumed translates directly into less money paid for energy than would otherwise be the case.*

III. FUEL CONSUMPTION AND EFFICIENCY

A. Fuel Consumption Patterns

Fuel oil use is largely concentrated in 11 Northeastern states (Vermont, Maine, New Hampshire, Connecticut, Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, and Maryland) and the District of Columbia. Together these states consume about 80 percent of all the heating oil sold nationwide.[6] While the analysis presented here will thus be focused primarily on the Northeast, the results of the home heating energy efficiency calculations presented will largely apply to users nationwide.

Economic calculations must start from the household's energy consumption and the use of reasonable estimates concerning various energy efficiency options. A survey conducted by the EIA[7] suggests that a typical house in the Northeast was built before 1939, has less than 2000 square feet of living space, and has either gas or fuel oil heating equipment that is at least 20 years old. The age of the housing stock and heating equipment together present tremendous opportunities to make low-cost energy efficiency investments that can dramatically lower fuel costs. Figure 5 presents a snapshot of the Northeast housing stock.

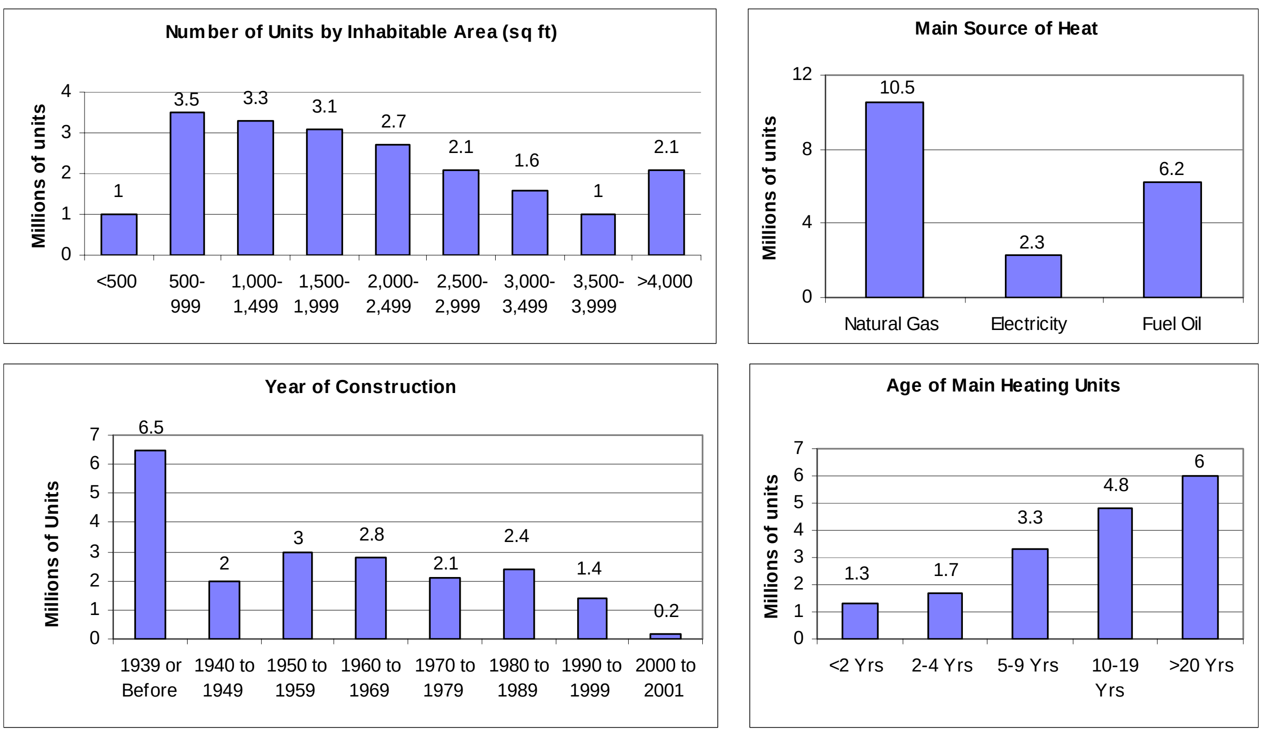
There has been a major change in home heating oil consumption patterns over the past 20 years. Since the initial energy price increases of the 1970s, oil heat equipment efficiencies have increased by as much as one-third, and buildings have become more energy-efficient through increased insulation levels and energy efficient designs.[8] The average efficiency of gas boilers and furnaces sold each year has also increased from about 65 percent in 1978 to 82-84 percent today, while condensing boilers and furnaces reach over 90 percent. To achieve an Energy

[5] CECA, Projecting *Energy Needs* , p. 8.
[6] Energy Information Administration, *Fuel Oil and Kerosene Sales 2003,* November 2004.
[7] EIA, Residential Energy Consumption Survey: Housing Characteristics Tables: 2001 Characteristics.
[8] EIA, *Annual Energy Outlook 2005*, p. 77.

Star rating, a furnace must have an Annual Fuel Use Efficiency (AFUE)[9] of 90 percent and a boiler must have an AFUE of 85 percent.[10] 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.[11]

As in CECA's earlier analyses, we consider costs for two types of houses: an *average efficiency (average use) house*, and a *high efficiency (low use)* house. The average efficiency house is assumed to consume 865 gallons of fuel oil per year, based on recent oil heat industry surveys.[12] Oil consumption by the high efficiency house is approximately 30 percent lower, at 613 gallons per year. This 30 percent reduction is consistent with data from the Household Energy Consumption and Expenditures Survey published by the U.S. Department of Energy.[13] The *average efficiency case* is relevant to consumers who have not replaced their furnace or boiler in the past 15 years and have not installed significant energy efficiency measures. The *high efficiency case* applies to homes with new boilers or furnaces, and homes in which significant energy efficiency investments have already been made. Consequently, the expected return on efficiency investments will be significantly less for those homeowners who have already

FIGURE 5: SNAPSHOT OF NORTHEAST HOUSING STOCK



Source: EIA, 2001 Residential Energy Consumption Survey: Housing Characteristics Tables.

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[9] AFUE measures the amount total fuel energy that the heating unit converts to useful thermal energy.
[10]ACEEE, *Consumer Guide: Condensed Online Version*, viewed October 17, 2005 at http://www.aceee.org/consumerguide/topfurn.htm.
[11] Energy Research Center, Inc., for the Petroleum Marketers Association of America, *Summary Report for Residential Fuel Cost Study,* Attachment 21, March 7, 2000.
[12] The statistical mean consumption for all homes in the Northeast is 714 gallons of oil equivalent per dwelling (source: EIA, 2003 Residential Fuel Consumption Data for the Northeast and 2001 Household Census).

improved their building envelope 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 Efficiency in Houses

When CECA first reviewed the economics of energy-saving measures for home heating 25 years ago, the tools to measure the performance of energy efficiency investments were not as sophisticated as they are today. However, follow-up studies of thousands of installations subsequently produced more accurate information on building energy efficiency options. These are summarized in the earlier CECA reports.[14] 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 efficiency options that were used in previous CECA studies have been updated for the current analysis. *The data in this report is based on the best and most authoritative data available today*. Most cost data comes from RS Means 2005 Construction Cost Data,[15] which includes the costs for labor, materials, tools, overhead, and profit. Energy efficiency savings estimates were taken from the latest research provided by Oak Ridge National Laboratory, the American Council for an Energy Efficient Economy (ACEEE), and energyguide.com. Oak Ridge National Laboratory and ACEEE also provided advice to CECA on the accuracy of the RS Means data. Residential customers that currently heat with oil have a number of efficiency or upgrade options available to them to reduce their expenses. The building energy efficiency 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***

- ***High efficiency furnace or boiler***

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[13] EIA, *Household Energy Consumption and Expenditures 1993*, October 1995.

[14] Consumer Energy Council of America, *Oil, Gas, or …? Technical Support Document for An Evaluation of the Economics of Fuel Switching Versus Home Energy Conservation*, March 2001; Consumer Energy Council of America, *Oil, Gas, or …?: Technical Support Document for a Consumer Decision Making Guide on Fuel Switching and Home Energy Conservation*, January 31, 1994; Consumer Energy Council of America, *Technical Support Document for a Consumer Decision Making Guide on Fuel Switching and Home Energy Conservation*, 1991; Consumer Energy Council of America, *A Technical Support Document for a Consumer Decision Making Guide on Fuel Switching*, Washington DC, 1989; Consumer Energy Council of America, *An Analysis of the Economics of Fuel Switching Versus Conservation for the Residential Heating Oil Consumer*, October 5, 1980.

[15] RS Means, *Means Building Construction Cost Data 2005 Book,* 64th Ed., 2005.

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 17 percent.[16] The cost of a flame retention burner retrofit is based on recent publications by the heating oil industry and is consistent with cost data in the earlier CECA analyses.[17] The flame retention burner retrofit is included in the equipment/building shell combination packages.

Programmable 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 five degrees F is assumed. Research by ACEEE indicates that this saves about 10 percent.[18] The cost for this option is based on two zone thermostats including installation. CECA notes that estimates of actual energy savings vary widely, depending upon the extent to which consumers actually use the automatic setback feature. Consumers can double their energy savings – to 20 percent – by setting the thermostat back 10 degrees, while failure to use the thermostat correctly may negate any savings.

The resulting combinations of efficiency measures are presented in Table 1. Importantly, energy efficiency upgrades are not only compelling investments economically, they also produce valuable non-economic benefits. Reducing drafts in a home may save in fuel consumption and at the same time make the house more comfortable.

TABLE 1: COST OF INSTALLATION AND HOUSEHOLD ENERGY SAVINGS FROM EFFICIENCY MEASURES

Efficiency Measure	Cost	Energy Savings
House Doctor	$632	10%
Ceiling Insulation	$754	16%
Wall Insulation	$1,738	12%
Flame Retention Oil Burner	$895	17%
Automatic Thermostat	$150	10%
Burner + House Doctor	$1,527	27%
Burner + Ceiling Insulation	$1,649	33%

Source: Booz Allen Hamilton Analysis, 2005

[16] Brookhaven National Laboratory, *The Oilheat Combustion R&D Program – Stakeholders, Accomplishments, and Future Potential*; Climate Solutions, *Upgrading your Heating System*; and National Oilheat Research Alliance, *Gold Book for Oilheat Dealers*, 2004.
[17] *Oilheating*, Oilheating's Merchandising News, Prices/Index for Oilheating Equipment, October 2000, p. 45.
[18] Thorne, Jennifer, ACEEE, telephone conversation, October 12, 2005

C. Energy Savings 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 replacing an old furnace or boiler with a new unit utilizing the same fuel source. We analyzed replacement of older, 60 percent AFUE[19] furnaces and boilers and newer, 80 percent AFUE units. We analyzed the value of replacing the 60 percent and 80 percent efficiency units with a new unit in the 82-84 percent AFUE range. This is slightly higher than the minimum efficiency required by federal regulations for new heating equipment.[20] We also considered upgrading to a 90 percent efficient furnace or one which qualifies for an Energy Star rating for comparison. For boilers we examined units rated at 84 and 95 percent AFUE. The costs and estimated energy savings associated with replacement boilers and furnaces are captured in Table 2.

TABLE 2: REPLACEMENT FURNACES AND BOILERS

High Efficiency Gas Equipment (replacing existing gas unit with higher efficiency gas unit):				
			Efficiency Gains	
		Cost	**Low (60%)**	**High (80%)**
Furnaces				
	82%/84% AFUE	$2,100	28%	4%
	90% AFUE	$3,300	33%	11%
Boilers				
	84% AFUE	$3,500	29%	5%
	95% AFUE	$5,500	37%	16%
High Efficiency Oil Equipment (replacing existing oil unit with higher efficiency oil unit):				
			Efficiency Gains	
		Cost	**Low (60%)**	**High (80%)**
Furnaces				
	82%/84% AFUE	$2,295	28%	4%
	90% AFUE	$4,500	33%	11%
Boilers				
	84% AFUE	$3,300	29%	5%
	95% AFUE	$4,300	37%	16%

Source: Booz Allen Hamilton Analysis, October 2005

[19] The National Oilheat Research Alliance suggests that older units (those installed 15 years ago or more) may exhibit AFUEs ranging from the high 30s to 80 percent. See National Oilheat Research Alliance, *Efficient Oilheat, an Energy Conservation Guide* 2004: p. 104. As the performance of the existing unit will dramatically impact the economics of installing a new one, CECA recommends consulting with a home heating specialist to determine the existing unit's performance before investing in a new system.

[20] U.S. Department of Energy, Title 10 –Energy, Chapter II – Department of Energy, Subchapter D – Energy Conservation, Part 430 – Energy Conservation Program for Consumer Products, DOE/CE-0220, UC-95d.

The installed cost of the 82-84 percent efficient *gas furnace* is estimated to be $2,100, based on RS Means data and a survey of home heating contractors. Similarly, the cost for the 90 percent efficient *furnace* is estimated to be $3,300. The installed cost of the 84 percent efficient gas *hot water boiler* is estimated to be $3,500, also based on RS Means data. Similarly, the estimated cost for the 90 percent efficient *hot water boiler* is $5,500. *Oil furnaces* cost about $2,300 for the 82-84 percent AFUE units and $4,500 for the 90 percent AFUE units. *Oil-fired boilers* can be purchased at 84 percent AFUE and 95 percent; costs are estimated to be $3,300 and $4,300, respectively. Note that the equipment costs vary widely based on equipment firing rates, manufacturer, efficiency, and other variables.

Costs are based on equipment rated at approximately 140,000 BTUs per hour input. These figures include installation costs, labor, contractor profit, and associated hardware. *Individual estimates may vary due to local labor rates and specific conditions within the house and consumers are advised to obtain precise costs.*

D. Upgrading Existing Equipment

Manufacturers state that boilers and furnaces have useful life expectancies of about 20 years.[21] As a result, many consumers own perfectly serviceable equipment. However, as highlighted earlier in this report, statistics compiled from the Energy Information Administration show that a sizable portion of heating systems in the Northeast are over 20 years old. Research from the ACEEE demonstrates that there is a wide range of efficiencies of older heating units, with many older models achieving efficiencies of only 55-60 percent.[22] Therefore, a logical question for the purpose of this study is whether or not it makes economic sense, given today's high energy costs, for a consumer to upgrade their heating equipment in order to capture savings through a more efficient model.

Recognizing the wide disparity between the efficiencies of older units and newer ones, CECA's analysis considered the economic viability of upgrading from a system more than 15 years old versus upgrading from a system less than 15 years old. While 20 years is the anticipated life expectancy of heating equipment, CECA chose 15 years as the cutoff between new systems and old systems specifically because all new heating equipment for oil and gas – both furnaces and boilers – that have been installed since the early 1990s are mandated to have AFUE ratings of between 78-80 percent.[23] This means that even the lowest rated piece of equipment that is less than 15 years old would not be significantly different than the average equipment on sale today, which, as mentioned above, is 82-84 percent.

By breaking the analysis of the existing equipment into two categories – newer than 15 years and older than 15 years – CECA's study provides a clearer assessment of the economic viability of upgrading equipment, switching fuels, and installing energy efficiency measures.

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[21] Todreas, Ian L. *One If By Land: Erie Ellington Leads the Way in Energy Efficient Lighting*, Energy Star Residential Fixture Showcase, 2005: p.1.

[22] ACEEE, *Consumer Guide: Condensed Online Version,* viewed at http://www.aceee.org/consumerguide/topfurn.htm, October 17, 2005.

[23] U.S. Department of Energy, Energy Efficiency and Renewable Energy Program, *Understanding the Efficiency Ratings of Furnaces and Boilers*, viewed at http://www.eere.energy.gov/buildings/info/homes/understanding.html, October 17, 2005.

E. Fuel Switching

CECA considered two fuel-switching options in its analysis. One option considered converting an older oil heating system by replacing the existing oil burner with a gas burner. The second option considered replacing the entire boiler or furnace and converting the oil system to new gas heating equipment (see Table 3).

New furnaces and boilers of comparable efficiency and costs are available for both oil and gas as the heating fuel. 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 and can vary widely. Even in cases where the gas utility subsidizes the consumer's hookup costs, as may be the case in highly competitive fuel markets, the consumer must factor other conversion costs into the equation. Such costs include the value of the unused oil in the tank, removal or deactivation of the oil tank, additional installation charges, cleaning or re-lining of the chimney, and the costs of other modifications which might be necessary.[24] Some of the measures required for conversion (such as chimney relining) are mandated by local building codes. CECA's research indicates that the average consumer might incur significant costs, in addition to the cost of the new boiler of furnace, when converting from oil to gas and must evaluate these costs carefully.

TABLE 3: CONVERSION COSTS FOR FURNACES AND BOILERS

	Low Cost[25]	**High Cost[26]**
Furnace		
82%/84% AFUE	$3,600	$6,100
90% AFUE	$4,800	$7,300
Boiler		
84% AFUE	$5,000	$7,500
95% AFUE	$7,000	$9,500

Source: CECA, October 2005

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.[27] 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 $1,050, according to RS Means and a survey of installers. Some additional costs may be incurred, such as modifying the flue in the vent system, chimney cleaning, or possible relining of the existing chimney. These costs are not included in this

[24] Energy Information Administration, Facility Energy Services, *Calculation of Energy Costs, Cost Savings and Payback Periods for Residential Heating Equipment*, November 1993.
[25] Estimated conversion cost of $1500 plus cost of heating equipment.
[26] Estimated conversion cost of $4,000 plus cost of heating equipment.
[27] The Hydronics Institute, *I=B=R Ratings for Boilers, Baseboard Radiation and Finned Tube (Commercial), and Indirect-Fired Water Heaters*, January 1, 1994.

current analysis because the gas conversion burner does not produce a positive return on investment even without considering these additional costs.

In the second conversion scenario, as shown in Table 3, the consumer replaces the oil furnace or boiler with a gas furnace or boiler. When the new piece of equipment is purchased, conversion costs may be significant because the gas heating system may not be compatible with the existing installation. Although there are a number of measures that may be necessary when converting, CECA's research shows that the following three conversion measures are necessary for virtually all conversions.

- ***Gas piping*** from the gas main to the house and then to the heating equipment. If the house already has gas, then the pipes have to be installed to the furnace or boiler. The cost 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 for the consumer to ask.

- ***Relining 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 harmful conditions. Relining the chimney will prevent flue blockages and possible exposure to harmful exhaust gases. Some local and state codes require cleaning or re-lining the chimneys for all oil to gas conversions.

- ***Fuel tank removal or retirement of the tank*** is another measure that must be undertaken and the added conversion cost must be considered. The oil must be removed and disposed of and the tank must be removed or retired in place in compliance with local code guidelines. In addition to the cost of removing the tank, the value of the unused oil remaining in the tank is lost.

Based on a survey of contractors,[28] CECA has placed the range of costs for conversion at $1,500 as a low estimate and $4,000 as a high estimate. This assumes costs of $500-$1,500 to remove the oil tank, $500-$1,500 to lay a gas line either from the street to the meter and to the heating equipment or from the point of entry to the heating equipment if the house already utilizes gas (e.g., for cooking), and $500-$1,000 to line the chimney. These are the three principal modifications needed to convert most homes from oil heat to natural gas. CECA emphasizes that estimates for this work vary widely and that its survey of cost projections varied from as little as $700 to as high as $8,000, depending on the existing installation and the specific requirements of the site.[29] CECA has assumed in its calculations that the new heating equipment will last for 20 years.[30]

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[28] Booz Allen Hamilton analysis, October 2005.

[29] Facility Energy Services, *Calculation of Energy Costs, Cost Savings and Payback Periods for Residential Heating Equipment,* Submitted to the U.S Department of Energy, Energy Information Administration, November 1993.

[30] Sources for this estimate included Collaborative Engineers (an engineering consulting firm), Keyspan Energy (a major natural gas supplier), T.E. Lawson (a heating oil equipment installer), and information in previous CECA studies.

If work in addition to the three primary modifications is needed, conversion costs could rise above CECA's estimates of $1,500 and $4,000. Possible additional measures associated with conversion from oil to gas include the following:

- ***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.

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

- ***Draft inducers or power vents*** are sometimes required for new high efficiency gas systems, 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 from several hundred dollars 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 necessary. These costs are equal to or higher than the cost of the new heating equipment. Consumers are advised to get complete estimates of all costs if considering switching fuels.

F. Environmental and Energy Security Considerations

Measures that consumers take to reduce energy consumption provide significant benefits in addition to reducing energy costs. These benefits include environmental benefits and national security benefits. Research by Brookhaven National Laboratory over the past 20 years has demonstrated that particulate emissions from oil burners have dropped by a factor of seven over the past 20 years. Also, low sulfur fuel oil is becoming more prevalent as a home heating fuel, further diminishing air emissions. *Measures that reduce consumption of any fuel can provide important benefits that cannot be achieved by switching from one fuel to another.* 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 for both fuels, 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 to replace it with a BTU of gas. Both oil and gas are depleting natural resources that are interchangeable for many applications. Energy efficiency extends available resources and increases supply relative to demand for home heating. Energy efficiency reduces the nation's vulnerability to imports from politically unstable sources of supply.

Energy efficiency helps to offset future price spikes that are the result of shortages of both oil and natural gas.

IV. OTHER METHODOLOGICAL ASSUMPTIONS

A. Model Assumptions

Tables 1-3, discussed above, summarize equipment cost estimates and percent energy savings. The basic assumptions behind the underlying economic analysis are captured in Table 4 below. For the current study, estimates were based on a recent survey of industry experts and published materials. Research by the Lawrence Berkeley Laboratory[31] shows that such measures as house doctoring and installation of flame retention oil burners need to be replaced within the 20-year time frame of CECA's economic analysis. Research for this study indicates that both measures need to be replaced every 10 years. The cost of replacement of these measures at the recommended intervals is reflected in the financial assumptions. The other measures do not need replacement within the time frame of the economic analysis.

TABLE 4: ASSUMPTIONS FOR DATA

Initial Energy Consumption of House (Annual)		
Average Efficiency	865 Gallons Of Oil	(120 Million BTU)
High Efficiency	613 Gallons Of Oil	(85 Million BTU)
Efficiency of Heating Equipment		
Newer than 15 Years	80% AFUE	
Older then 15 Years	60% AFUE	
Life Span of Investments		
House Doctor	10 Years	
Burners	10 Years	
Efficiency Measures	20 Years	
Furnaces or Boilers	20 Years	
Fuel Price Cost		
Gallon of Oil Equivalent	$2.00	
Period of Analysis	20 Years	

Source: CECA, October 2005

For the purpose of CECA's analysis, parity in fuel prices is assumed based on historical trends of the convergence of oil and natural gas and based on the market value of the fuel's energy

[31]Lawrence Berkeley Laboratory Applied Science Division, *Measured Energy Savings and Economics of Retrofitting Existing Single-Family Houses: An Update of the BECA-B Data Base*, February 1991.

content. While external factors affect the day-to-day prices of oil and gas, in the long run the market brings prices back in line with each other. This trend has continued even throughout the past few years when prices increased dramatically (refer back to Figure 1). This analysis is based on the strong likelihood that price parity will continue in the future. CECA utilizes a price of $2.00/gallon of oil equivalent as the average price of energy. This figure is based on the EIA's latest assessment of the cost of fuels delivered to the consumer, inclusive of state taxes, for the past two heating seasons, as well as projections through December 2006.[32] CECA notes that prices of oil delivered to the consumer have in fact been considerably higher than $2.00 recently, reaching into the range of $2.50, partially in response to the damage caused to drilling platforms by Hurricanes Katrina and Rita.[33] While these costs are significant, it is uncertain whether these costs will remain at this level or drop back to pre-hurricane levels. With this in mind, CECA determined that it would be appropriate to take a conservative approach by using pre-hurricane prices for the analysis. Considering the fact that savings derived from energy efficiency measures increase as fuel prices rise, consumers should be aware that if prices remain high, the savings would actually be even greater than those computed in this study.

B. Method of Analysis

The various measures described above are compared utilizing their internal rates 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 net present value of the project's savings over the project's time frame. *The measures with the highest IRRs are preferred.* Since house doctoring and flame retention burner measures are assumed to need replacement after 10 years, CECA has factored in a one-time replacement cost to provide for a 20-year period of analysis.

All measures are assumed to have a zero salvage value. This may understate the value of the recommendations since it undervalues the efficiency 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. In addition to the IRR analysis, the payback period of each of the measures is calculated. Payback periods clearly illustrate the relative advantages of energy efficiency compared to conversion approaches, and provide an easy means of determining how long it takes for consumers to "get their money back" from these investments. The payback period is defined as the number of years required to recover the initial costs for equipment or for installation of efficiency measures from the annual energy cost savings. *In general, shorter payback periods are better economic investments.*

C. A Note about Tax Benefits

One feature of energy efficiency upgrades is that the returns – in the form of savings to the consumer – are tax-free. As a result, when comparing the energy efficiency IRRs with returns on traditional investments (such as interest bearing bank accounts, mutual funds, bonds, or stocks), the returns on energy efficiency are higher because tax must be paid on interest,

[32] EIA, *Short Term Energy Outlook,* September 2005, p. 10.
[33] *Ibid.*

coupon payments, capital gains, or dividends (unless they are tax-free investments). This reduces the true return on the traditional investment. For example, if a consumer is subject to a 30 percent marginal tax rate and invests $1,000 in a stock that is later sold for $1,100, the return would ostensibly be 10 percent. However, the consumer will owe $30 in taxes, reducing the true value of the investment to seven percent. With savings on energy bills, by contrast, the consumer would owe no tax and would retain the full value of the return on investment.

V. RESULTS

A. Internal Rates of Return

The results of the various IRR and payback period analyses are presented in Tables 5, 6, 7, and 8. Table 5 captures the IRRs and payback periods for the efficiency measures; Table 6 contains those for replacement furnaces and boilers using the same fuel type, and Tables 7 and 8 present results for fuel switching for furnaces and boilers, respectively. 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 for the various energy efficiency packages are substantially higher given today's higher fuel prices.

Energy efficiency investments are by far the best economic choices for consumers. There are a series of efficiency measures that are significantly more attractive economically than upgrading to 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 efficiency measures 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, house doctoring, and ceiling insulation, that produce rates of return many times greater than fuel switching.

Packages of measures can also add up to significant savings, particularly when the efficiency of fuel combustion is enhanced with heat loss prevention measures, as is the case with the burner plus house doctor and the burner plus ceiling insulation packages.

The rates of return on energy efficiency investments, assuming a $2.00 per gallon equivalent price, produce returns on investment in the 12 to 124 percent range for an average efficiency home, and up to 25 percent when replacing an old, inefficient unit with a new, high efficiency unit using the same fuel source. These options are much more attractive than most investments available to consumers. If a new furnace or boiler is needed, it makes sense to buy a high efficiency model as recommended in previous CECA analyses. The added costs incurred by fuel switching make conversion a much less attractive economic option than energy efficiency investments.

In addition to energy efficiency measures, upgrading from older, low-efficiency equipment to newer, high-efficiency systems is also an excellent economic choice for consumers. Some combinations of upgrades are better than others, but for systems over 15 years old, consumers are advised to have their systems evaluated by professional technicians to determine the AFUE level. If the AFUE is 60 percent or lower, then the IRR for upgrading can be as high as 25 percent.

1. Efficiency Investments

The present analysis begins with the first scenario of a homeowner with average fuel use of 865 gallons a year as shown in Table 4. It is immediately clear from the results in Table 5 that simpler is better, as the most attractive efficiency measures are, in general, the least expensive. In addition, the attractiveness of energy efficiency investments increases with fuel use. Automatic setback thermostats are an especially attractive investment for the average use house, providing a return on investment of 124 percent. The returns can, in fact, be much higher. Individuals who set back their thermostat by 10 degrees instead of five degrees, as assumed in these calculations, will save double the money projected. Ceiling insulation is another excellent investment, with returns estimated at 41 percent. Flame retention burners, costing $895, show a compelling IRR of 34 percent. House doctoring, with a 27 percent return, is an easy and relatively low-cost way to reduce energy bills, particularly in older houses with drafty windows and doors. The 12 percent return associated with wall insulation is relatively less attractive, owing to the increased cost of the measure and the fact that less space in the walls makes heat leakage less likely.

Combination packages show attractive returns. The combination of both ceiling insulation and the flame retention burner is estimated to cost $1,649 and yields an IRR of 38 percent; the combination of house doctor and flame retention burner is estimated to cost $1,527 and generates a 31 percent return on investment. Although the rates of return for the installation of new, higher efficiency equipment are positive, they are lower than simple efficiency measures.

The high efficiency (low consumption) house, which uses 613 gallons of oil per year, shows lower rates of return for each measure. These findings apply as well in average efficiency homes in warmer climates such as states south of the Mid-Atlantic region. For these homes, the relative results do not change. The most economically attractive strategies remain the same – the automatic setback thermostat (90 percent), ceiling insulation (30 percent), flame retention burner (24 percent), and house doctoring (18 percent) produce the greatest return on investment for consumers. Many of the more substantial and costly measures become less economical, however, in the high efficiency (low consumption) home. Likewise, the installation of a new boiler or furnace (using the same as the existing fuel) provides only single digit rates of return. If oil prices were to return to lower levels, a number of these projects would have returns that fall below those for a good tax-free investment, assumed to be around three percent.

2. Upgrading Existing Systems

Recognizing that older heating systems are less efficient than newer systems, CECA's analysis considered the economic viability of upgrading a system that is *more than 15 years old* as well as a system that is *less than 15 years old*. As highlighted earlier in this report, statistics compiled from the Energy Information Administration show that a sizable portion of heating systems in the Northeast are over 20 years old, meaning that many consumers may be in a position to realize savings from upgrading their equipment. This report also pointed out that beginning approximately 15 years ago, all new heating equipment for oil and gas – both furnaces and boilers – are required to have AFUE ratings of between 78-80 percent.[34] For consumers who already have higher efficiency equipment, the savings from further upgrading their equipment would be minimal.

CECA's analysis further concludes that upgrading existing equipment only generates an economic advantage if the system is over 15 years old or in need of replacement. For those systems that are newer than 15 years old (and therefore already more than 80 percent efficient), CECA's study shows that the payback for upgrading to a new system is low and is not a good investment option (see Table 6). For systems that are older than 15 years (about 60 percent efficient), CECA's analysis shows that the savings from efficiency gains could be significant and justify the upgrade.

3. Fuel Switching

CECA's analysis suggests that conversion to gas from heating oil by simply replacing the existing oil burner with a gas burner is uneconomical. No economic gain is produced when fuel price parity is assumed. The IRR 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 appears unlikely in the foreseeable future, 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 period analyses. Tables 7 and 8 tabulate internal rates of return for two cases: added conversion costs of $1,500 and conversion costs of $4,000 for both furnaces and boilers. As stated earlier, actual costs may be higher. Using the lower conversion cost of $1,500 and assuming the average fuel use home with 865 gallons a year, IRRs range from negative to 15 percent. In cases where the IRR is positive, the gains are from the increase in the efficiency level of the new equipment over the old, not from any cost savings due to switching fuels, since parity pricing of fuels is assumed in CECA's analysis. In cases where the new gas unit replaces an old oil unit, the returns are higher than money in the bank, but because of the additional conversion costs, the returns are lower than replacing the old oil equipment with new oil equipment, and much less attractive than many other options available to the consumer. A consumer would thus be economically better off purchasing a new oil burner and spending the $1,500 minimum conversion costs on other measures with significantly higher returns, shorter payback periods, and actual reductions in energy consumption.

When the higher conversion cost of $4,000 is assumed in the calculation, the IRRs are even less attractive, never attaining more than nine percent. Also, since actual conversion costs may amount to $5,000 or higher, consumers are well advised to get firm cost estimates if considering fuel conversions. The added costs for fuel switching may be incurred if modifications are required to reduce the risk of flue blockage and exposure to exhaust gases.

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[34] U.S. Department of Energy, Energy Efficiency and Renewable Energy Program, "Understanding the Efficiency Ratings of Furnaces and Boilers," viewed at http://www.eere.energy.gov/buildings/info/homes/understanding.html, October 17, 2005

The results of CECA's analysis demonstrate that economic savings are not enough to justify switching from oil to gas. However, CECA recognizes that personal preferences may play a significant role in the consumer's decision to stay with oil or switch to gas. The consumer may have a personal preference for one kind of fuel over another or have a preference for dealing with a regulated utility or individual heating oil dealer for the delivery of the fuel. These preferences have a definite value in the minds of consumers. CECA recommends that consumers weigh the conversion costs against of the value they place on their personal preferences if making a decision to switch fuels on other than economic grounds.

B. Payback Periods

Payback periods 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 periods for energy efficiency measures are also presented in Table 5, and the payback periods for upgrading equipment are presented in Tables 6, 7, and 8. 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. This may explain why past research at Brookhaven National Laboratory indicates that consumers are most interested in payback periods of three to four years or less.

Given current energy prices, several measures fall well within these boundaries. Programmable thermostats, because of their relatively low costs, can pay back in less than one year. Flame retention oil burners and ceiling insulation require only three to four years for the investment to be paid back, while the house doctor package offers a four- to five-year payback. Replacement of old, inefficient furnaces with new equipment using the existing fuel type can also be attractive investments. Once payback is achieved, the consumer's savings continue to mount year after year.

C. Applying the Results

While there will continue to be periodic fluctuations in the prices of delivered residential heating oil and natural gas, CECA believes, as in its past studies, that price parity is still the best long-term assumption. As the price of all heating fuels increases and home heating costs rise, CECA advises that investing in energy efficiency measures is the best option for most consumers, now and in the future. Energy efficiency measures assure that less energy is used. Less energy used means the consumer pays less for energy than they would without the efficiency measures. In fact, as the prices of both oil and natural gas continue to increase, energy efficiency 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. Energy efficiency is clearly an attractive investment option for residential consumers.

In several states with warmer climates (North Carolina, for instance) that use heating oil, homeowners can also benefit from efficiency measures. While energy use is lower than in other regions where oil heat is popular, the rising fuel prices make energy efficiency investments attractive because fuel cost savings are higher. Tables 7 and 8 show 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 efficiency options remain viable, especially the lower cost measures.

VI. CONCLUSIONS

This analysis has demonstrated that the best economic strategy for most consumers who want to lower their home heating costs is to install energy efficiency measures, including programmable thermostats, ceiling insulation, flame retention burners, and house doctoring. These measures yield higher returns than more costly measures. The tax-free returns on these measures greatly exceed many other investment options available to consumers and make sense economically. Fuel switching as a cost-saving option does not make economic sense since the IRRs for this type of investment are either negative or are lower than many other investment options available to the consumer. Importantly, no energy is saved in the process.

The typical life expectancy of a boiler or furnace is approximately 20 years.[35] Therefore, for many consumers there will be little need to replace an existing unit. In previous studies CECA has indicated that since heating equipment is estimated to last 20 years, in any given year only five percent (1/20) of heating equipment needs to be replaced. However, as the study released by the EIA after CECA's 2001 analysis indicates, about one in three heating units in the Northeast is more than 20 years old. As a result, the scope for efficiency enhancement through replacement of old, inefficient boilers and furnaces may be greater than previously thought. From an individual homeowner's point of view, the choices are clear.

- *For consumers with a furnace or boiler less than 15 years old, conversion does not make economic sense. Investing in the energy efficiency options presented in this study is the clear choice for lowering heating bills.*

- *For consumers who need to replace their furnace or boiler, the best advice is to purchase new high efficiency equipment. This will reduce annual fuel consumption and result in lower heating costs.*

- *For consumers who have heating equipment that is over 15 years old, and who have determined that their equipment's AFUE rating is 60 percent or lower, purchasing new high efficiency replacement systems can reduce annual fuel consumption considerably and result in lower heating bills.*

[35] American Society of Heating, Refrigerating, and Air-Conditioning Engineers, *1991 ASHRAE Handbook*, *Heating, Ventilating, and Air-Conditioning Applications*, Chapter 33, Table 2, 1991.

TABLE 5: EFFICIENCY MEASURES
INTERNAL RATES OF RETURN (%) AND PAYBACK PERIODS (YRS)
For Average Efficiency House (Average Use) and
High Efficiency House (Low Use)

Measure	IRR (%)	Payback Period (YRS)
Setback Thermostat ($150)		
Average Use	124%	1
Low Use	90%	2
Ceiling Insulation ($754)		
Average Use	41%	3
Low Use	30%	4
Burner & Ceil. Insulation ($1649)		
Average Use	38%	3
Low Use	28%	4
Flame Retention Burner ($895)		
Average Use	34%	3
Low Use	24%	4
Burner & House Doctor ($1527)		
Average Use	31%	4
Low Use	21%	5
House Doctor ($632)		
Average Use	27%	4
Low Use	18%	5
Wall Insulation ($1738)		
Average Use	12%	8
Low Use	9%	10

Source: Booz Allen Hamilton Analysis, October 2005

TABLE 6: REPLACEMENT FURNACES AND BOILERS
INTERNAL RATES OF RETURN (%) AND PAYBACK PERIODS (YRS)
For Average Efficiency House (Average Use) and
High Efficiency House (Low Use)

	Existing Units			
	IRR (percent)		Payback Period (years)	
Gas Replacement Units	**Low Efficiency (60%)**	**High Efficiency (80%)**	**Low Efficiency (60%)**	**High Efficiency (80%)**
82%/84% Replacement Furnace				
Average Use	25%	Negative	4	0
Low Use	19%	Negative	6	0
90% Replacement Furnace				
Average Use	19%	3%	6	16
Low Use	14%	1%	8	19
84% Replacement Boiler				
Average Use	15%	Negative	7	0
Low Use	11%	Negative	9	0
95% Replacement Boiler				
Average Use	12%	1%	8	18
Low Use	8%	0%	11	0
Oil Replacement Units	**Low Efficiency (60%)**	**High Efficiency (80%)**	**Low Efficiency (60%)**	**High Efficiency (80%)**
82%/84% Replacement Furnace				
Average Use	23%	Negative	5	0
Low Use	17%	Negative	6	0
90% Replacement Furnace				
Average Use	13%	0%	7	0
Low Use	9%	Negative	10	0
84% Replacement Boiler				
Average Use	15%	Negative	7	0
Low Use	11%	Negative	9	0
95% Replacement Boiler				
Average Use	12%	1%	8	18
Low Use	8%	0%	11	0

Source: Booz Allen Hamilton Analysis, October 2005

TABLE 7: FUEL SWITCHING - FURNACES
INTERNAL RATES OF RETURN (%) AND PAYBACK PERIODS (YRS)
For Average Efficiency House (Average Use) and
High Efficiency House (Low Use)

	Existing Units			
	IRR (percent)		Payback Period (years)	
	Low Efficiency Oil (60%)	High Efficiency Oil (80%)	Low Efficiency Oil (60%)	High Efficiency Oil (80%)
Gas Conversion				
Gas Burner only (1,050)	NONE	NONE	NONE	NONE
Gas Furnace with $1,500 Conversion Cost				
82%/84% Gas Furnace ($3,600)				
Average Use	14%	Negative	7	0
Low Use	10%	Negative	9	0
90% Gas Furnace ($4,800)				
Average Use	12%	Negative	8	0
Low Use	9%	Negative	10	0
Gas Furnace with $4,000 Conversion Cost				
82%/84% Gas Furnace ($6,100)				
Average Use	9%	Negative	9	0
Low Use	7%	Negative	12	0
90% Gas Furnace ($7,300)				
Average Use	8%	Negative	10	0
Low Use	6%	Negative	13	0

Source: Booz Allen Hamilton Analysis, October 2005

TABLE 8: FUEL SWITCHING - BOILERS
INTERNAL RATES OF RETURN (%) AND PAYBACK PERIODS (YRS)
For Average Efficiency House (Average Use) and
High Efficiency House (Low Use)

	Existing Units			
	IRR (percent)		Payback Period (years)	
	Low Efficiency Oil (60%)	High Efficiency Oil (80%)	Low Efficiency Oil (60%)	High Efficiency Oil (80%)
Gas Conversion				
Gas Burner only (1,050)	NONE	NONE	NONE	NONE
Gas Boiler with $1,500 Conversion Cost				
82/84% Gas Boiler ($5,000)				
Average Use	9%	Negative	9	0
Low Use	4%	Negative	15	0
95% Gas Boiler ($7,000)				
Average Use	8%	Negative	10	0
Low Use	4%	Negative	15	0
Gas Boiler with $4,000 Conversion Cost				
82/84% Gas Boiler ($7,500)				
Average Use	7%	Negative	14	0
Low Use	2%	Negative	17	0
95% Gas Boiler ($9,500)				
Average Use	6%	Negative	14	0
Low Use	2%	Negative	17	0

Source: Booz Allen Hamilton Analysis, October 2005

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