3. Consumer Markets: History, Patterns, and Outlook

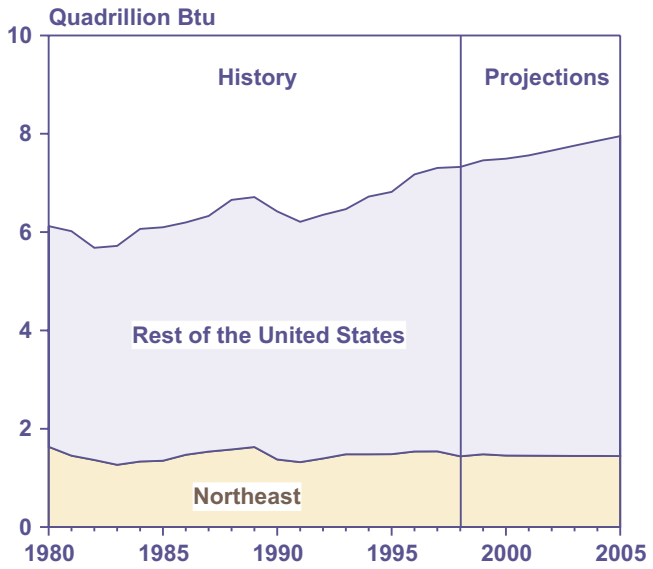
Introduction

This chapter provides the historical background of energy use trends and energy mix in the Northeast. The purpose of the analysis is to estimate the size of the distillate fuel oil market in the residential, commercial, industrial, and electricity generation energy sectors; to estimate how much of that might be switchable to different fuels; and to estimate what the absolute size of conversions might be if all large-volume nonresidential customers currently using distillate fuel oil switched to other fuels.

Until about 50 years ago, the mix of fuels in the residential and commercial sectors included a much larger proportion of coal than it does today. The coal share of energy use in those sectors has declined as the electricity and natural gas shares have increased. In the Northeast, the oil share of energy use relative to the natural gas share in all sectors is higher than in the rest of the Nation, primarily because petroleum products are more competitively priced and natural gas pipeline capacity to the Northeast is smaller than capacity for other urban centers, such as Chicago (in the Midwest Census region).[28] Several factors have contributed to that condition. First, the cost of adding new pipeline capacity to the Northeast is relatively high, because the region is distant from U.S. gas supply sources. Second, natural gas has historically been considered a scarce and premium fuel that should be reserved for nonindustrial and non-electricity generation uses, reducing financial incentives to build new pipelines for those users. Third, the Northeast is readily accessible to ships carrying distillate and cheap residual fuel oil. Because residual fuel oil is relatively cheap—often between 70 and 90 percent of the crude oil price—and readily accessible to the electricity generation market, most of the switchable oil-steam units in the Northeast use residual fuel oil when they cannot have natural gas, or when natural gas is too expensive.

The Northeast is heavily dependent on distillate fuel oil, but the dependence is masked by the quantity of distillate fuel oil used for transportation (Figure 11). When transportation uses are removed, the dependence becomes more obvious (Figure 12). In the Northeast, residential use of distillate fuel oil dominates all other stationary uses (Figure 13). In 1997 (the most recent year for which historical data are available), residential use of distillate fuel oil represented about 68 percent of all stationary distillate fuel oil use in the region.

Figure 11. U.S. Distillate Fuel Oil Consumption, 1980-2005



Note: One quadrillion Btu is equivalent to about 172 million barrels of distillate fuel oil.

Sources: **History:** Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999). **Projections:** Energy Information Administration, *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999).

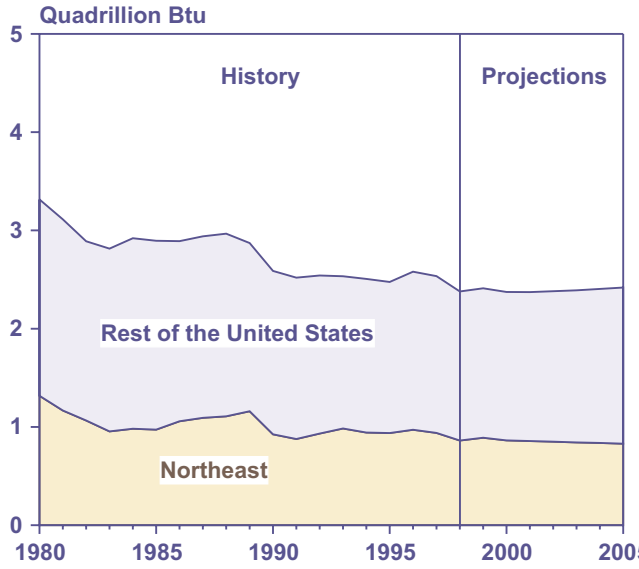
Residential Sector Heating Fuel Choice

Highlights

- Residential distillate fuel oil use in the Northeast has declined by about 20 percent since 1980, as natural gas availability, energy efficiency, and warmer-than-average winter temperatures have decreased the amount of heating oil consumed in the region.
- Since 1992, heating oil prices in the Northeast have been lower on average than natural gas prices, allowing heating oil to retain market share in the region, although natural gas provides heat for 65 percent of all new single-family homes built in the

[28]The Midwest Census region is composed of Ohio, Indiana, Illinois, Iowa, Michigan, Wisconsin, Minnesota, Missouri, Kansas, Nebraska, North Dakota, and South Dakota.

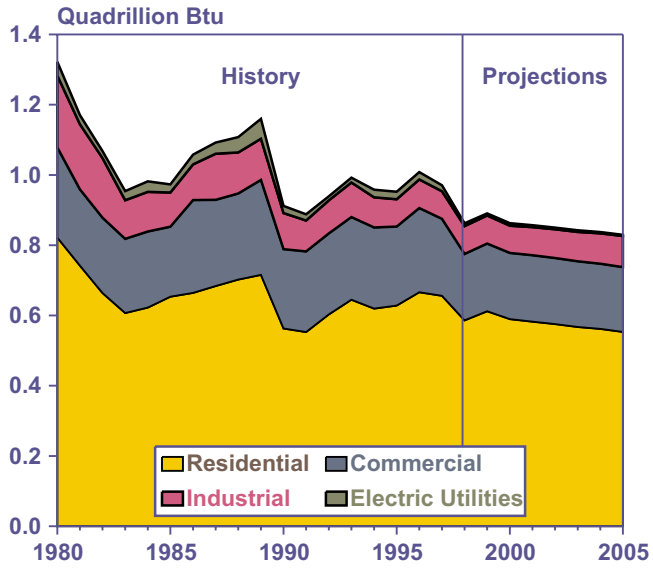
Figure 12. U.S. Distillate Fuel Oil Consumption, Excluding Transportation, 1980-2005



Note: One quadrillion Btu is equivalent to about 172 million barrels of distillate fuel oil.

Sources: **History:** Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999). **Projections:** Energy Information Administration, *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999).

Figure 13. Northeast Consumption of Distillate Fuel Oil, Excluding Transportation, 1980-2005



Sources: **History:** Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999). **Projections:** Energy Information Administration, *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999).

region, and thousands of residential customers switch from distillate fuel oil to natural gas each year.

- EIA's *Annual Energy Outlook 2000* (*AEO2000*) projects that average distillate fuel oil prices in the Northeast will remain below average natural gas prices through 2005, even in the high world oil price case.
- An illustrative example, using actual residential billing data for heating oil and natural gas in Long Island, NY, indicates that total heating fuel costs over the past 20 years were nearly $1,800 lower for this household heating with oil and using a 550-gallon underground storage tank than if it had heated with natural gas.

Recent Trends and Current Use of Distillate Fuel Oil in the Residential Sector

Heating oil accounted for about 8 percent of all energy delivered to the U.S. residential sector in 1997, and 73 percent of the total home heating oil was consumed in the Northeast Census region.[29] While the total heating loads served by distillate fuel oil and natural gas are comparable between the Midwest and Northeast regions, the shares of the two fuels were radically different in 1997: distillate fuel oil use for heating in the Midwest region was about 15 percent of that in the Northeast, and natural gas use for heating in the Midwest region was about 124 percent higher than in the Northeast. Households in the Northeast traditionally have relied on oil for heating because of the lower availability of natural gas and the competitive price of heating oil.[30]

Over the past 20 years residential oil use in the Northeast has declined as natural gas pipelines have been built, allowing newly constructed and existing homes to choose natural gas instead of heating oil. Figure 14 summarizes residential-sector distillate fuel oil consumption in the Northeast, the Midwest, and the rest of the United States over the past 20 years and its projected use through 2005. The effects of record warmth in the Northeast during the winters of 1990 and 1998, as well as a more "normal" winter in 1993, are easily discernible.

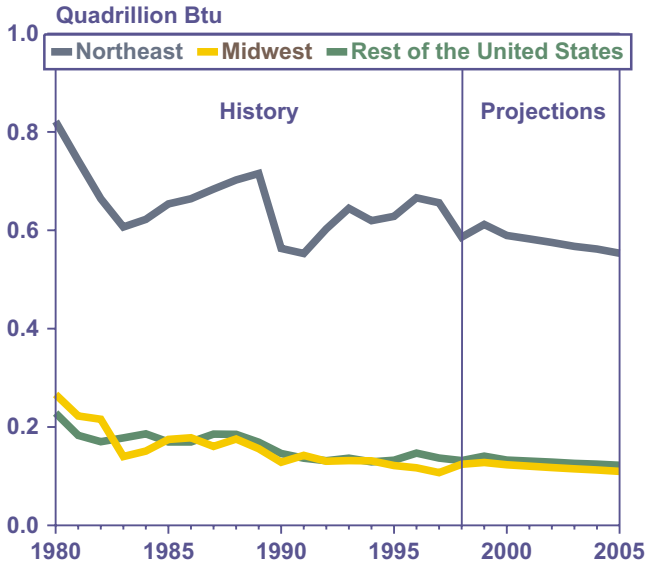
Residential consumption of distillate fuel oil in the Northeast has decreased by about 20 percent since 1980, and the number of heating oil customers has fallen by more than 10 percent.[31] Gains in furnace and building shell efficiency and generally warmer winters have

[29]Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999).

[30]Energy Information Administration, *A Look at Residential Energy Consumption in 1997*, DOE/EIA-0632(97) (Washington, DC, November 1999).

[31]Energy Information Administration, Residential Energy Consumption Survey (RECS) data for 1980 and 1997.

Figure 14. Distillate Fuel Oil Use in the Residential Sector, 1980-2005



Note: One quadrillion Btu is equivalent to about 172 million barrels of distillate fuel oil.

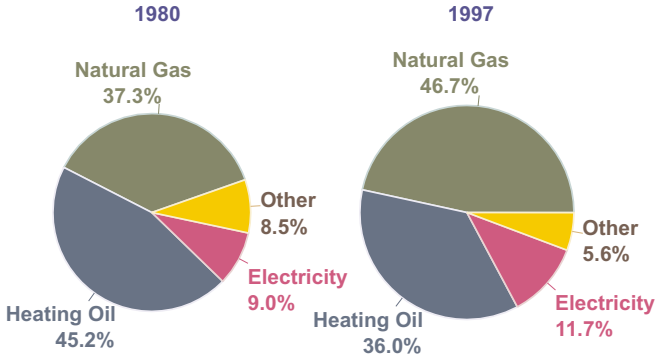
Sources: **History:** Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999). **Projections:** Energy Information Administration, *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999).

combined to decrease residential distillate fuel oil consumption relative to its 1980 level. Since 1993, however, the number of heating oil customers in the Northeast has remained relatively constant, and oil has maintained a 30-percent share in the heating market for new single-family homes,[32] offsetting the number of customers switching to gas over the same period. From 1982 to 1998, more than 1.6 million oil customers switched to natural gas nationwide. In 1998, it was reported that 13,255 oil customers (0.2 percent) in the Northeast switched to gas, nearly 82 percent less than the number of oil customers that switched to natural gas in 1992.[33] Figure 15 shows the changes in heating fuel shares between 1980 and 1997.

Projections to 2005

Many factors contribute to heating fuel choice, including fuel availability, but fuel costs tend to be more important in times of price volatility. Perceived reliability of supply can also become an important criterion for fuel equipment choices, as was illustrated by the gas curtailments in the 1970s. Figure 16 shows heating oil and natural gas prices for the Northeast Census region from 1980 to 2005. Although the prices for the two fuels are competitive over most of the period, it is clear that oil prices have been lower since 1992, and they are projected to remain slightly lower through 2005.

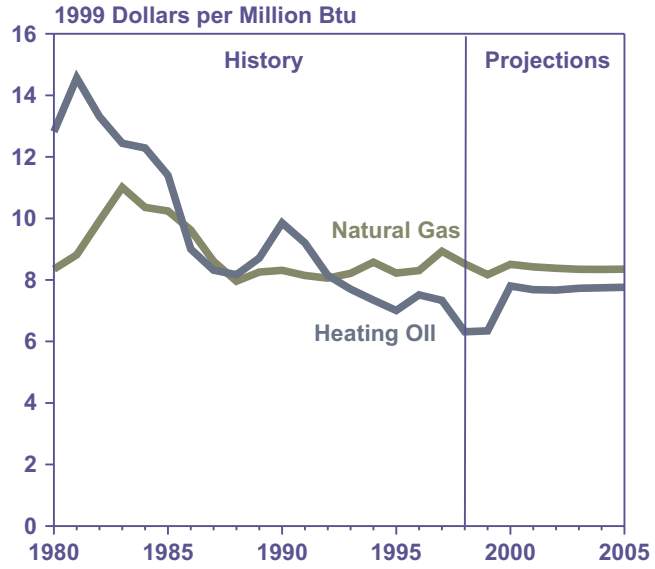
Figure 15. Residential Heating Fuel Shares in the Northeast Census Region, 1980 and 1997



Note: The "Other" category includes kerosene, liquefied petroleum gas (LPG), renewables, and a small amount of coal.

Source: Energy Information Administration, *Residential Energy Consumption Survey*, DOE/EIA-0632(97) (Washington, DC, 1980 and 1999).

Figure 16. Residential Fuel Prices in the Northeast Census Region, 1980-2005



Sources: **History:** Energy Information Administration, *State Energy Price and Expenditure Report 1995*, DOE/EIA-0376(95) (Washington, DC, August 1998). **Projections:** Energy Information Administration, *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999).

If higher world oil prices were expected through 2005, as in the *AEO2000* high world oil price case, heating oil prices would still be projected to remain below gas prices in the Northeast. With world oil prices reaching $24.48 per barrel (1999 dollars) by 2005 in the high world oil price case ($20.75 in the reference case), residential heating oil prices in the Northeast would reach $8.37 per

[32] U.S. Census Bureau, *Current Construction Reports—Characteristics of New Housing: 1998*, C25/98-A (Washington, DC, July 1999).

[33] American Gas Association, *Residential Natural Gas Market Survey 1998* (Washington, DC, December 1999).

million Btu ($7.65 per million Btu in the reference case), while natural gas prices would reach $8.48 ($8.24 in the reference case). The price gap in 2005 between heating oil and natural gas narrows in the high world oil price case; however, the residential heating oil price still is projected to remain below the natural gas price.

Historical Heating Costs: An Illustration

About 7.1 million households heat with oil in the Northeast Census region, which accounts for 75 percent of distillate-heated households in the United States.[34] Although retail heating oil is more susceptible to price volatility than natural gas, it has remained cost-competitive with natural gas over the past 20 years. During periods of high oil prices, however, a question arises as to why households in the Northeast choose not to convert from oil for space heating, especially in cases where gas is available to the households and is used for other applications, such as water heating and cooking. Of the 7.1 million homes that heat with oil in the Northeast, 2.4 million (34 percent) have gas service.[35] Additional customers in the Northeast with no gas service into their homes are sufficiently close to gas distribution lines to have gas service installed at little or no cost but choose to heat with oil and cook with electricity instead. To examine the question, an analysis of energy bills for a house located in Long Island, NY, is provided below.[36]

The primary motivation for heating with oil rather than natural gas is economic, although perceptions of safety and reliability also play a role. Furnaces can last for 30 years or more, limiting the opportunity to switch fuels, especially since few homeowners retire heating equipment before it needs to be replaced. Even if gas service is already available in a home, a new furnace with installation can cost well over $2,000—a significant economic barrier to conversion. Leaving that consideration aside, this case deals only with fuel costs, based on oil and gas bills collected from the homeowner.[37]

The study house uses oil for heating, with a 550-gallon below-ground storage tank. A tank of this size allows for oil purchases at lower prices during the summer months. The homeowner provided monthly oil usage readings, measured on the last day of each month, which were cross-referenced with documented oil deliveries for verification. The oil price in a given period was taken as the price per gallon that was paid for a delivery of oil until the full amount of the delivery was used, as determined from the usage readings and confirmed subsequent to the oil deliveries. The oil price and consumption data were converted to energy (Btu) equivalents to facilitate a comparison with a natural gas furnace of similar efficiency characteristics. Gas bills were provided for each 2-month billing cycle over the entire 20-year period. Given that the home was billed on a water heating schedule with low gas consumption, and because data for a comparable gas-heated home were not available for the entire period, the analysis assumed that the gas price would be discounted by 35 percent at higher usage rates (a declining tail block rate structure), which was estimated from partial billing data for a home in the same service territory with natural gas heat. Table 2 shows oil and gas prices as well as heating costs for the study household over the past 20 years.

Oil prices in the Northeast have generally been lower than gas prices, particularly over the past decade. The latest oil delivery, priced at $1.40 per gallon ($10.09 per million Btu) on January 21, 2000, during the peak of the recent oil price spike, was only 5 percent more expensive than the estimated price for natural gas over the same period ($9.63 per million Btu). Assuming the same efficiency for oil and gas heating, over the past 20 years (through March 28, 2000), nearly $1,800 (1999 dollars) in heating costs have been saved by the homeowner. For the 1999-2000 heating season (October 1, 1999, through March 28, 2000), heating costs for oil were $349, as compared with an estimate of $563 if the home had been heated with natural gas.

Even if oil and gas prices remain at their respective January 21, 2000, levels through 2005, annual heating costs for the study household would be $773 using oil and $737 using natural gas. Over the 6-year period (2000-2005), a total of $216 in fuel costs would be saved by heating with gas. At a cost of $2,000 for a new gas furnace, the simple payback period would exceed 50 years, much too long for such an investment to be made. Moreover, it is unlikely that such winter fuel price differentials would be sustained through 2005.

Whereas it is not feasible for residential customers to purchase natural gas in the summer months when prices are low and store it for later use, distillate fuel oil can be purchased and stored in oil tanks until needed. (On the other hand, degree-days and/or actual fuel levels must be accurately monitored to avoid running out of oil during cold winter months, whereas natural gas needs no

[34]Energy Information Administration, *A Look at Residential Energy Consumption in 1997*, DOE/EIA-0632(97) (Washington, DC, November 1999).

[35]Energy Information Administration, *A Look at Residential Energy Consumption in 1997*, DOE/EIA-0632(97) (Washington, DC, November 1999).

[36]Tables B1-B10 in Appendix B provide a historical comparison of residential equipment, fuel use, and expenditures for a variety of categories.

[37]Oil and gas bills were provided to EIA for the period from October 1978 through March 2000 for a customer of Long Island Power Authority.

Table 2. Residential Home Heating Case Illustration

Year	Distillate Fuel Oil Price (1999 Dollars per Million Btu)	Natural Gas Price (1999 Dollars per Million Btu)	Household Heating Cost with Natural Gas (1999 Dollars per Household)	Household Heating Cost with Distillate Fuel Oil (1999 Dollars per Household)
1980	11.39	7.30	366.55	571.84
1981	11.52	6.62	330.38	575.36
1982	12.17	7.15	361.16	614.14
1983	12.37	8.11	480.31	732.62
1984	9.57	7.82	454.32	556.25
1985	8.62	7.78	469.10	520.27
1986	7.65	7.60	496.63	499.58
1987	4.87	7.40	477.54	313.85
1988	5.85	7.46	521.24	409.07
1989	5.44	7.25	466.39	350.21
1990	6.08	7.33	408.94	338.97
1991	8.04	7.08	429.39	487.59
1992	6.09	7.75	578.05	454.77
1993	5.98	8.34	643.09	460.84
1994	5.46	9.84	747.90	414.85
1995	4.45	10.24	751.01	326.63
1996	4.95	10.77	815.45	374.59
1997	6.15	10.39	674.47	399.21
1998	5.77	9.86	614.14	359.26
1999	4.01	9.99	615.05	247.08

Source: Oil and gas billing records provided to EIA by the homeowner.

such monitoring.) For a residential fuel oil customer, concerns about oil supply and relatively high prices can be mitigated by well-timed fuel oil purchases, installation of a large fuel oil storage tank, and "cap" pricing contracts that place an upper limit on fuel oil prices for a small premium.[38] For residential users, above-ground 275-gallon tanks cost about $500, and 550-gallon tanks (which must be buried) cost about $2,000.

Transparent and timely data and information to home heating fuel consumers facilitate good planning and decisionmaking and improve market responses to potential price surges in the heating fuel market. The operational efficiency of the energy market is also likely to be enhanced by such market transparency.

Conservation Options

There is limited additional conservation potential in the Northeast residential sector with respect to distillate fuel oil consumption. Since 1980, distillate fuel oil consumption per household using oil has declined by more than 10 percent, reflecting efficiency gains in both equipment and building shell characteristics. Because most distillate fuel oil use is for space heating, fuel conservation can be achieved by adjusting thermostats down during the winter months or by installing setback thermostats, which automatically alter the thermostat setting either for times when the house is unoccupied or when higher settings are not needed. More expensive efficiency options, such as newer furnaces, better insulation, and multi-paned windows, can also help mitigate the per-unit consumption of distillate fuel oil.

There is little, if any, opportunity for renewable energy sources to replace distillate use in the residential sector. The use of ground-source or water-source heat pumps can be considered renewable resources; however, electricity is needed to power the equipment, ventilation system, and pump, where appropriate. Solar energy can provide heat for part of the household load, but low insolation values[39] and high costs restrict widespread use of this technology in the Northeast.

Commercial Sector Fuel Choice

Highlights

- In the Northeast, consumption of distillate fuel oil in the commercial sector has declined from 18 percent of commercial fuel use (257 trillion Btu or about 44 million barrels of distillate fuel oil) in 1980 to 12 percent (219 trillion Btu or about 38 million barrels) in

[38] Chapter 5 describes pricing options for distillate fuel oil at the wholesale and retail level in greater detail.

[39] Insolation is the rate of delivery of direct solar energy per square unit of horizontal surface area, often expressed in annual number of kilowatthours per square foot. Insolation values determine the viability of photovoltaics for a particular location.

1997. In 1997, the commercial sector consumed about 22 percent of all nontransportation distillate fuel oil used in the Northeast.

- *AEO2000* projects that the declining trend in commercial distillate fuel oil use will continue through 2005, even in the low world oil price case.
- The maximum potential for Northeast commercial distillate fuel oil use that could be switched to another fuel in one week or less, without new equipment or retrofits, is about 50 trillion Btu (about 8.6 million barrels)—23 percent of the region's commercial distillate fuel oil use and 3 percent of its total distillate fuel oil use, based on 1997 consumption data.

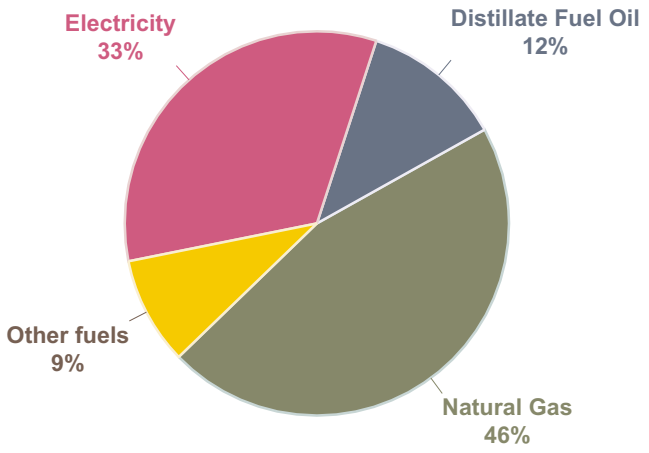
Recent Trends and Current Use of Distillate Fuel Oil in the Commercial Sector

Distillate fuel oil use by commercial establishments in the Northeast is relatively small and declining. Northeast distillate fuel oil use in 1997 for all purposes totaled more than 1.5 quadrillion Btu (about 260 million barrels). Commercial distillate fuel oil consumption in the region has declined from 18 percent (257 trillion Btu or 44 million barrels of distillate fuel oil) of total commercial energy consumption in 1980 to 12 percent (219 trillion Btu or 38 million barrels) in 1997. In 1997, the commercial sector in the Northeast consumed about 1.8 quadrillion Btu of energy, or 12 percent of the region's total fuel use. Electricity and natural gas currently dominate Northeast commercial fuel use, followed by distillate fuel oil with a 12-percent share of energy delivered to the commercial sector (Figure 17).

Although distillate fuel oil represents only a relatively small proportion of total commercial sector energy use in the Northeast region, commercial use of distillate fuel oil in the region represents nearly half (49 percent) of U.S. commercial distillate fuel oil use. Nationally, distillate fuel oil's share of commercial sector energy consumption has declined steadily from 11 percent in 1983 to about 6 percent in 1997. The commercial fuel oil share in the Northeast has been more volatile than the national commercial consumption share, but overall it has decreased at nearly the same rate as the national share, from 18.5 percent in 1983 to 12.1 percent in 1997 (Figure 18). The factors that contributed to the declining trend in fuel oil use in the commercial sector, both nationally and in the Northeast, include increased natural gas infrastructure (pipelines and distribution systems), increased gas supplies to all markets, increasingly competitive natural gas prices, and improving equipment efficiencies.

To estimate the potential for reducing commercial sector distillate fuel oil use in the Northeast, it is necessary to understand how commercial consumers use distillate fuel oil. The latest available survey of commercial building end-use consumption is EIA's 1995 Commercial

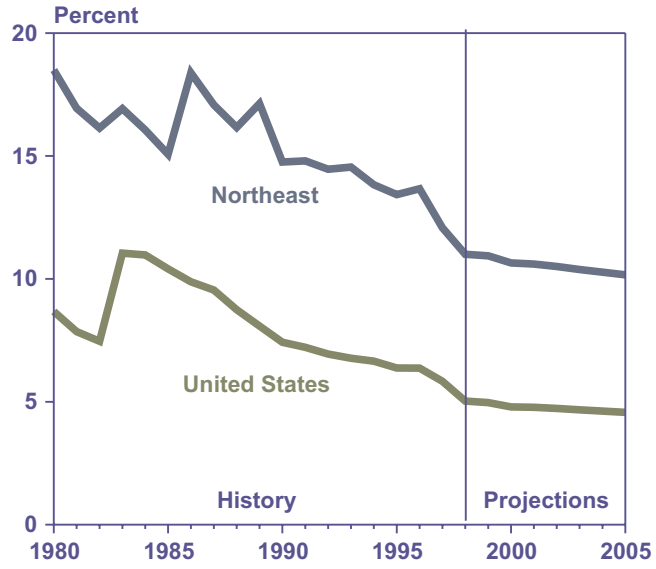
Figure 17. Commercial Delivered Energy Consumption in the Northeast Census Region by Fuel, 1997



Note: Other fuels include liquefied petroleum gas (LPG), residual fuel oil, kerosene, motor gasoline, coal, and renewables.

Source: Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999).

Figure 18. Distillate Fuel Oil Share of Commercial Fuel Use, 1980-2005

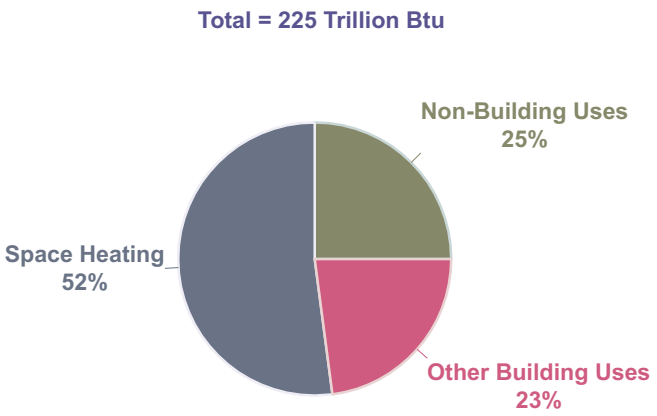


Sources: **History:** Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999). **Projections:** Energy Information Administration, *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999).

Buildings Energy Consumption Survey (CBECS95).[40] The survey covers only energy use in buildings; any non-building energy uses, such as water treatment and sewer services, are not included. For this reason, the CBECS95 estimate of fuel oil use in commercial buildings in the Northeast is about 25 percent lower than the commercial distillate fuel oil use reported for the region in EIA's *State Energy Data Report*.[41]

The CBECS95 estimates of 1995 fuel oil use in commercial buildings totaled approximately 235 trillion Btu (about 41 million barrels) for the United States and 168 trillion Btu (about 29 million barrels) for the Northeast.[42] CBECS95 estimates for fuel oil use in commercial buildings in the Midwest Census region are very low by comparison, totaling 16 trillion Btu (about 2.8 million barrels). Fuel oil accounted for 16 percent of total fuel use in commercial buildings in the Northeast in 1995, a decline from 20 percent of total fuel use in 1983 (according to CBECS83). According to the CBECS95 estimates, 116 trillion Btu of fuel oil (about 20 million barrels) was used in 1995 to heat commercial buildings in the Northeast. The remainder was used for a variety of other building uses, such as water heating, cooking, and electricity generation (Figure 19).

Figure 19. Commercial Sector Distillate Fuel Oil Consumption in the Northeast by End Use, 1995



Source: Energy Information Administration, 1995 Commercial Buildings Energy Consumption Survey, Public Use Data, web site www.eia.doe.gov/emeu/cbecs/.

The switchable portion of the market is the portion that can easily change fuels to serve demand (e.g., for space heating) and, potentially, have an immediate effect on fuel prices without installing new equipment or retrofits. In a well-functioning market, the ability to switch fuels should act to reduce the gap between retail oil and gas prices. Assuming that customers who can switch heating fuels can also switch fuel sources for other end uses,[43] a total of 116 trillion Btu (20 million barrels distillate fuel oil equivalent) of energy use in commercial buildings in 1995 could have been provided either by oil or by natural gas (Figure 20). In 1995, more than half of that total (64 trillion Btu) was provided by natural gas, representing the maximum potential natural gas consumption in commercial buildings in the Northeast that could have been switched to distillate fuel oil use without new equipment or retrofits.

Fuel switching among commercial establishments that have identified themselves as dual-fuel capable usually does not occur except under special circumstances. Many use the alternate fuel capability as a backup and as a means to negotiate better primary fuel prices. However, large and prolonged price differences between distillate fuel oil and natural gas can also cause fuel switching and conversions, as shown during several episodes in the 1980s. Conversions occur most often when equipment fails and new equipment is required.

The CBECS95 survey provides an estimate of total fuel oil consumption in buildings that use fuel oil for their main heating fuel. Fuel oil use is also estimated for buildings that can switch their main heating fuel source within a week's time, the CBECS survey criterion (Table 3). No information is available about the ability to switch fuel sources for other end-use services; however, assuming that commercial consumers who can switch their main heating fuel can also switch fuel sources for other end-use services (e.g., water heating), the maximum switchable distillate fuel oil use in 1995 for the Nation as a whole was 12 percent of total commercial distillate fuel oil consumption, or 9.8 million barrels. The maximum switchable percentage in the Northeast commercial sector was 23 percent (about 8.9 million barrels), reflecting the relatively high level of distillate fuel oil use in the region. In 1997, commercial distillate fuel oil use in the Northeast was 219 trillion Btu, of which about 50 trillion Btu would have been switchable to natural gas (based on the 1995 data and the above assumptions). A key question is whether switching from distillate fuel oil to another fuel would make sense, in terms of either

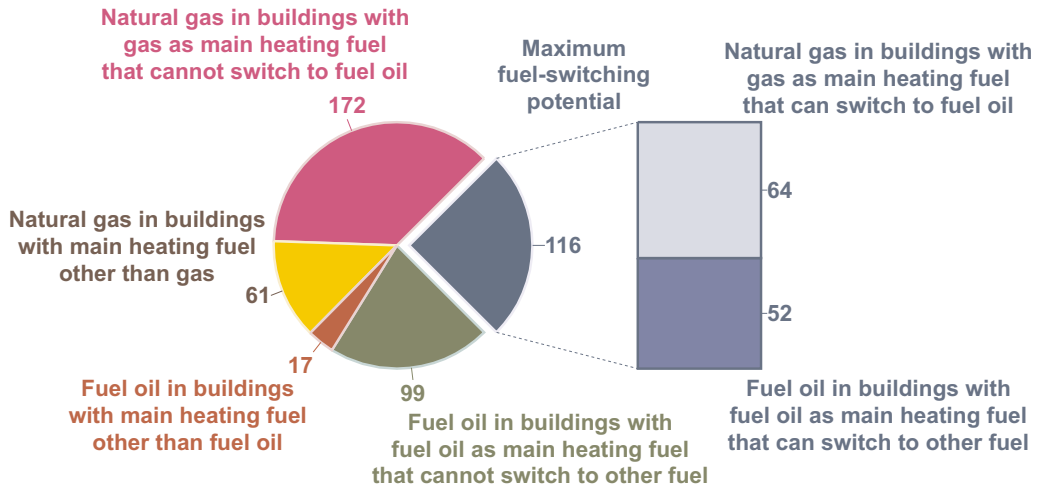
[40] As with any sample survey, the results of CBECS95 contain a certain measure of error associated with individual data points. Point estimates are presented here for discussion purposes; however, for use in an analysis, survey results should be presented as a range of values with an associated probability.

[41] Energy Information Administration, *State Energy Data Report 1997*, DOE / EIA-0214(97) (Washington, DC, September 1999).

[42] Fuel oil estimates from CBECS95 consist primarily of distillate fuel oil but may include small amounts of residual fuel oil and kerosene.

[43] As such, this is an optimistic estimate of fuel-switching potential. The fuel-switching potential would be 35 to 40 percent lower if switching were limited to fuel use to provide heating.

Figure 20. Natural Gas and Distillate Fuel Oil Use in Commercial Buildings in the Northeast and Maximum Fuel-Switching Potential, 1995 (Trillion Btu)



Source: Energy Information Administration, 1995 Commercial Buildings Energy Consumption Survey, Public Use Data, web site www.eia.doe.gov/emeu/cbecs/.

Table 3. Commercial Buildings Fuel Oil Consumption, 1995
(Trillion Btu)

Fuel Oil Consumed for All Purposes	United States	Northeast
Commercial sector, including non-building uses	460	225
Buildings using fuel oil for any purpose	235	168
Buildings using fuel oil as main heating fuel	196	151
Buildings using fuel oil as main heating fuel that can switch fuel	57	52

Sources: Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97)(Washington, DC, September 1999) and Energy Information Administration, 1995 Commercial Buildings Energy Consumption Survey, Public Use Data, http://www.eia.doe.gov/ emeu/cbecs/.

economic or reliability considerations, for commercial consumers.

Projections to 2005

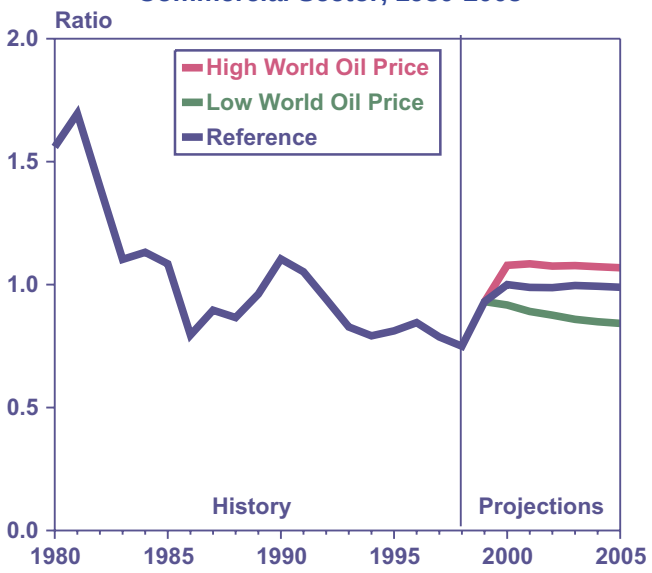
In the *AEO2000* reference case, the projected prices for distillate fuel oil to commercial consumers in the Northeast are about the same as those projected for natural gas from 2000 through 2005 (Figure 21), reaching $5.66 and $5.72 (1998 dollars) per million Btu, respectively, in 2005. This assumes, of course, that the world oil market will work freely, without the coordinated production limits that have occurred in 1999 and early 2000. Northeast commercial distillate fuel oil demand in the reference case is projected to decline by 2.4 percent per year from 1997 to 2005, dropping to 184 trillion Btu by 2005, with a corresponding decline in fuel share to 10 percent of commercial fuel use. Higher fuel oil prices could accelerate that decline. Natural gas use in the Northeast is projected to increase by 0.2 percent per year in the reference case.

Two alternative oil price cases in *AEO2000* illustrate the changes that might accompany higher or lower world oil prices. High world oil price assumptions (relative to the reference case) yield projected distillate fuel oil prices that are higher than commercial natural gas price projections in the Northeast through 2005. The opposite is projected under low world oil price assumptions (Figure 21). Varying world oil price assumptions result in corresponding differences in commercial distillate fuel oil use compared to the reference case (Figure 22). Although low oil prices yield 9 percent more Northeast commercial distillate fuel oil use in 2005 relative to the reference case, consumption is still projected to decline at a rate of 1.8 percent per year from 1997 through 2005. Commercial distillate fuel oil consumption is projected to be 6 percent lower than in the reference case in 2005 under the high world oil price assumptions, declining by 3.1 percent per year. Neither of these cases indicates how rapidly the market might actually change in the event of more frequent price surges for either fuel oil or natural gas.

Conservation Options

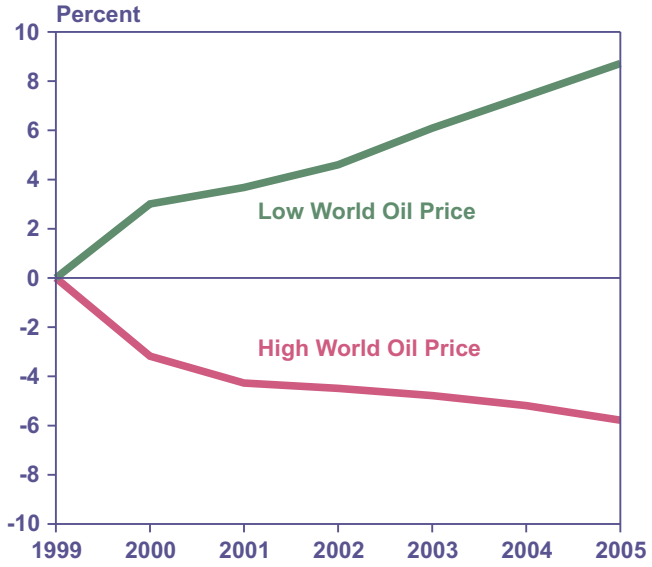
Conservation measures provide another method for reducing distillate fuel oil use in the commercial sector. The potential for additional conservation in distillate fuel oil use in the commercial sector includes both

Figure 21. Ratio of Distillate Fuel Oil Price to Natural Gas Price in the Northeast Commercial Sector, 1980-2005



Sources: **History:** Energy Information Administration, *State Energy Price and Expenditure Report 1995*, DOE/EIA-0376(95) (Washington, DC, August 1998). **Projections:** Energy Information Administration, *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999).

Figure 22. Projected Distillate Fuel Oil Use in the Northeast Commercial Sector: Percent Change from Reference Case in Low and High World Oil Price Cases, 1999-2005



Note: One quadrillion Btu is equivalent to about 172 million barrels of distillate fuel oil. Six quadrillion Btu is equivalent to about 1 billion barrels of distillate fuel oil.

Source: Energy Information Administration, *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999).

short-term and long-term options. Immediate avenues for conservation are limited to actions related to energy management, such as reductions in heating during off-hours and reductions in hot water use. Permanent efficiency improvements provide opportunities for conservation over time, lessening the impact of any future fuel price volatility on the business that implements the improvements. Efficiency options include the purchase of new, efficient equipment and the installation of improved building shell measures, such as higher levels of insulation and windows that minimize heat loss. Conservation measures already employed by commercial businesses contributed to the significant decline in distillate fuel oil use observed since 1980. The potential for additional conservation is limited to the implementation of additional energy management practices and efficiency measures beyond those already in place.

Limited opportunities exist in the commercial sector to displace distillate fuel use with renewable energy sources. Solar energy systems are currently more expensive than systems fueled by electricity or fossil fuels, even with net metering available to photovoltaic systems in many Northeastern States. Also, solar systems generally offset part of a commercial building's energy needs, with systems that run on electricity or fossil fuels required to meet the remaining load. Ground-source heat pumps provide another avenue for renewable energy to displace some distillate use, although some of the reduced distillate use would be offset with electricity requirements for heat pump operation. Unless solar and ground-source heat pump technologies are already in place, they would not be considered as cost-effective short-term fuel-switching options.

Industrial Sector Fuel Choice

Highlights

- Industrial distillate fuel oil consumption is a small part (5 percent) of the total Northeast distillate fuel oil market.
- More than half of industrial distillate fuel oil consumption in the Northeast is off-road diesel (41 trillion Btu of 79 trillion Btu).
- The maximum fuel-switching capability for industrial distillate fuel oil users in the Northeast without new equipment or retrofits is 9 trillion Btu (or 1.6 million barrels of distillate fuel oil), less than 1 percent of the region's total distillate fuel oil consumption.
- Based on the *AEO2000* high world oil price case, a 10-percent increase in distillate fuel oil prices would reduce industrial distillate fuel oil consumption in the Northeast by 2 trillion Btu (about 2.3 percent or

about 345,000 barrels) in 2005 relative to the reference case projection.

Recent Trends in Industrial Distillate Fuel Oil Consumption

The industrial sector includes manufacturing, agriculture, mining, and construction. The industrial share of U.S. distillate fuel oil consumption has fallen since the mid-1980s, to about 16 percent in 1997 from about 22 percent in 1985,[44] although the actual quantity consumed has been relatively stable at about 1.1 quadrillion Btu. Total U.S. distillate fuel oil consumption has risen from about 6 quadrillion Btu in 1980 to about 7.2 quadrillion Btu in 1997 (Figure 23). Distillate fuel oil is a minor fuel in the industrial sector, representing only 4 percent of total energy consumption in 1997 (Figure 24).

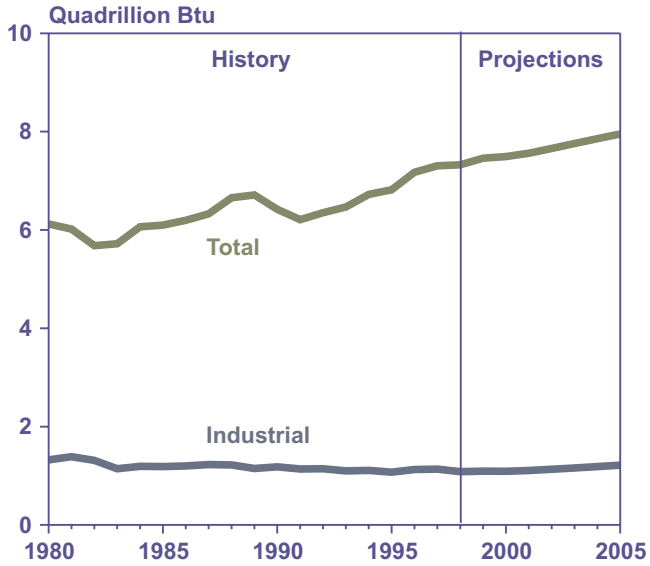
In the Northeast, industrial distillate fuel oil consumption is a small part (5 percent) of the total regional market for distillate fuel oil. The 79 trillion Btu (about 14 million barrels) of industrial distillate fuel oil use in the Northeast during 1997 amounted to only 3 percent of industrial delivered energy in that region. The fraction of total Northeast distillate fuel oil consumption represented by the region's industrial distillate fuel oil consumption mirrors the national relationship, although the industrial share of total Northeast distillate fuel oil consumption (5 percent in 1997) is substantially less than the industrial share of U.S. total distillate fuel oil consumption (16 percent) because of the relatively large share of residential distillate use in the Northeast.

Manufacturing and Nonmanufacturing Distillate Fuel Oil Consumption

Further disaggregation of industrial distillate fuel oil consumption is required to assess the prospects for reducing distillate fuel oil consumption by increasing consumption of substitute fuels. Within the manufacturing component of the industrial sector, there is some ability to switch boiler fuels, whereas in the nonmanufacturing component (agriculture, mining, and construction) the substitution possibilities are limited. In the latter components, distillate fuel oil is primarily used in farm equipment and other off-road vehicles rather than as a heating source.

Nonmanufacturing distillate fuel oil consumption (primarily diesel fuel) has accounted for about two-thirds (747 trillion Btu in 1997) of nationwide industrial distillate fuel oil consumption in recent years (Table 4). In the Northeast, however, consumption is almost evenly split between the two components, with 41 trillion Btu (about 7.1 million barrels) in the nonmanufacturing segment and 38 trillion Btu (about 6.6 million barrels) in

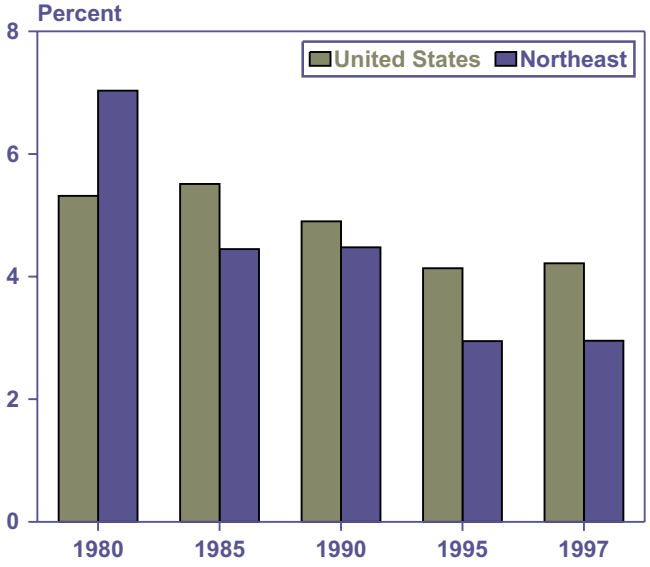
Figure 23. Total and Industrial Distillate Fuel Oil Consumption in the United States, 1980-2005



Note: One quadrillion Btu is equivalent to about 172 million barrels of distillate fuel oil. Six quadrillion Btu is equivalent to about 1 billion barrels of distillate fuel oil.

Sources: **History:** Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999). **Projections:** Energy Information Administration, *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999)

Figure 24. Distillate Fuel Oil Share of Industrial Delivered Energy Consumption in the United States and the Northeast, 1980-1997



Source: Energy Information Administration, *State Energy Data Report 1997*, DOE/EIA-0214(97) (Washington, DC, September 1999).

[44]Energy Information Administration, *Fuel Oil and Kerosene Sales 1998*, DOE/EIA-0535(98) (Washington, DC, August 1999), and earlier issues.

the manufacturing segment. Consequently, potentially switchable industrial distillate fuel oil consumption in the Northeast in 1997 was 38 trillion Btu or 6.6 million barrels, or 2.5 percent of the region's total distillate fuel oil consumption. Of that amount, however, only 24 percent was actually switchable (i.e., the consumption was by industrial concerns that either had equipment with dual-fuel capability or had second boilers that could actually be fired up to operate in place of the other fuel).

Industrial Distillate Fuel Oil Switching Potential

Data on fuel switching in the manufacturing sector for 1994 are available from EIA's 1994 Manufacturing Energy Consumption Survey (MECS94). MECS94 shows total U.S. manufacturing distillate fuel oil consumption of 152 trillion Btu (Table 5), including 42 trillion Btu for boiler fuel and 51 trillion Btu for direct process energy. Onsite transportation accounted for 35 trillion Btu, and facility heating, ventilation and air conditioning (HVAC) accounted for another 7 trillion Btu. (On-site transportation involves movement of materials within a plant site, not transportation among different sites.)

The pattern for the Northeast is similar (Table 6), except for facility heating. In the Northeast, MECS reported 41 trillion Btu of distillate fuel oil consumed for all purposes. Boiler fuel accounted for 15 trillion Btu. The

Table 4. Industrial Distillate Fuel Oil Consumption, 1994-1998
(Trillion Btu)

	1994	1995	1996	1997
United States				
Manufacturing	388	358	379	388
Nonmanufacturing	720	717	749	747
Total	**1,107**	**1,075**	**1,128**	**1,135**
Northeast				
Manufacturing	45	40	40	38
Nonmanufacturing	41	38	42	41
Total	**86**	**78**	**82**	**79**

Source: Energy Information Administration, *Fuel Oil and Kerosene Report 1998*, DOE/EIA-0535(98) (Washington, DC, August 1999), and earlier issues.

Table 5. U.S. Manufacturing Energy Consumption, 1994
(Trillion Btu)

End Use	Total	Electricity	Residual Fuel Oil	Distillate Fuel Oil	Natural Gas	Liquefied Petroleum Gas	Coal	Other
Boiler Fuel	3,669	28	313	42	2,396	15	875	—
Process Fuel	5,460	2,075	106	51	2,872	54	302	—
Nonprocess Uses								
Facility HVAC	588	217	5	7	351	5	3	—
Onsite Transportation	59	4	—	35	1	19	—	—
Generation	351	—	5	4	335	1	6	—
Other	281	236	4	3	39	0	0	0
Not Allocated	6,107	96	9	9	148	4	13	5,828
Total Inputs	**16,515**	**2,656**	**441**	**152**	**6,141**	**99**	**1,198**	**5,828**

Source: Energy Information Administration, *Manufacturing Consumption of Energy 1994*, DOE/EIA-0512(94) (Washington, DC, December 1997), ftp://ftp.eia.doe.gov/pub/consumption/industry/m94_11b.wk1.

Table 6. Northeast Manufacturing Energy Consumption, 1994
(Trillion Btu)

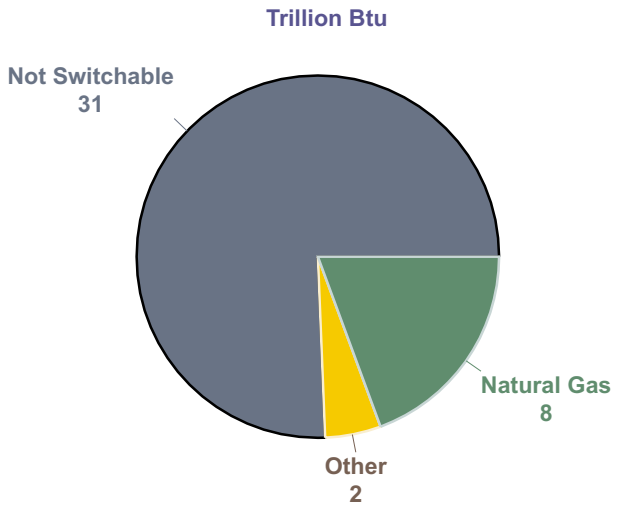
End Use	Total	Electricity	Residual Fuel Oil	Distillate Fuel Oil	Natural Gas	Liquefied Petroleum Gas	Coal	Other
Boiler Fuel	407	2	119	15	174	2	95	—
Process Fuel	566	236	25	13	250	11	31	—
Nonprocess Uses								
Facility HVAC	97	31	3	5	57	1	*	—
Onsite Transportation	8	1	—	4	*	3	—	—
Generation	13	—	W	1	12	W	*	—
Other	47	37	4	1	5	0	0	—
Not Allocated	487	14	2	3	18	1	3	446
Total Inputs	**1,626**	**321**	**153**	**41**	**517**	**18**	**130**	**446**

*Less than 0.5 trillion Btu.
W = Withheld to avoid disclosure of individual establishment data.
Source: Energy Information Administration, *Manufacturing Consumption of Energy 1994*, DOE/EIA-0512(94)(Washington, DC, December 1997), ftp://ftp.eia.doe.gov/pub/consumption/industry/m94_11b.wk1.

Northeast, with 5 trillion Btu of distillate fuel oil used for facility HVAC, accounted for 70 percent of the distillate fuel oil consumed for this purpose at all U.S. manufacturing sites.

Some portion of the distillate fuel oil consumed in the manufacturing sector—primarily, the boiler fuel usage—can be switched to other fuels, such as natural gas. Switching may involve the use of dual-fired boilers, changes in utilization rates, or the activation of standby boilers. In 1994, 27 trillion Btu of the total 152 trillion Btu of U.S. manufacturing use of distillate fuel oil (18 percent) could be switched within 30 days to other fuels, including 20 trillion Btu that could be switched to natural gas,[45] and the remainder to other fuels like coal, electricity or residual fuel oil. In the Northeast, 10 trillion Btu of the total 41 trillion Btu of manufacturing distillate fuel oil use (24 percent) could be switched to other fuels, including 8 trillion Btu that could be switched to natural gas (Figure 25). Except for planned seasonal variation, there is little economic reason to switch to distillate fuel oil, because its price tends to be significantly higher than the price of natural gas. The gas price tends to be lower because the dual-fuel switchable candidates in the industrial sector use interruptible gas contracts or purchase delivered gas during off-peak periods. Residential customers must pay undiscounted rates. In the Northeast, distillate fuel oil averaged $5.44 per million Btu and natural gas averaged $4.09 per million Btu in 1997.[46]

Figure 25. Potential Switching Capability from Distillate Fuel Oil Use in the Northeast Manufacturing Segment, 1994



Source: Energy Information Administration, *Manufacturing Consumption of Energy 1994*, DOE/EIA-0512(94) (Washington, DC December 1997).

From the manufacturing share of total industrial distillate fuel oil consumption and the percentage of manufacturing distillate fuel oil that is switchable, the potential maximum amount of distillate fuel oil that could be switched can be calculated. The manufacturing share of total U.S. industrial distillate fuel oil use in 1994 was 35 percent (Table 4), and the switchable fraction was 18 percent. This implies that the maximum switchable fraction of U.S. industrial distillate fuel oil consumption was 6 percent.

In the Northeast, the manufacturing share of industrial distillate fuel oil consumption in 1994 was higher, at 48 percent (Table 4), as was the switchable fraction, at 24 percent. Those numbers imply that the maximum switchable fraction of total industrial distillate fuel oil use in the Northeast was 12 percent in 1994. In 1997, industrial distillate fuel oil consumption in the Northeast was 79 trillion Btu (13.6 million barrels). Consequently, the maximum switchable amount of distillate was approximately 9 trillion Btu or about 1.6 million barrels. In comparison, overall distillate fuel oil consumption in the Northeast was 1,540 trillion Btu in 1997. Therefore, at most 0.5 percent of distillate fuel oil consumption in the Northeast could be freed up if the switchable industrial fuel market did not use any distillate fuel oil. If all of that potential reduction occurred during the coldest 2-week period of the winter—an unlikely event—then the increased supply of distillate fuel oil might have a moderating effect on distillate fuel oil prices. In a period of increasing differences between distillate fuel oil and natural gas prices, the industrial sector is likely to react by switching fuels to the extent possible; however, contractual arrangements that limit natural gas consumption in some situations (e.g., service that may be interrupted or curtailed at preset temperature cutoffs in exchange for lower service costs) would reduce the actual switching potential to something less than the maximum switching capability.

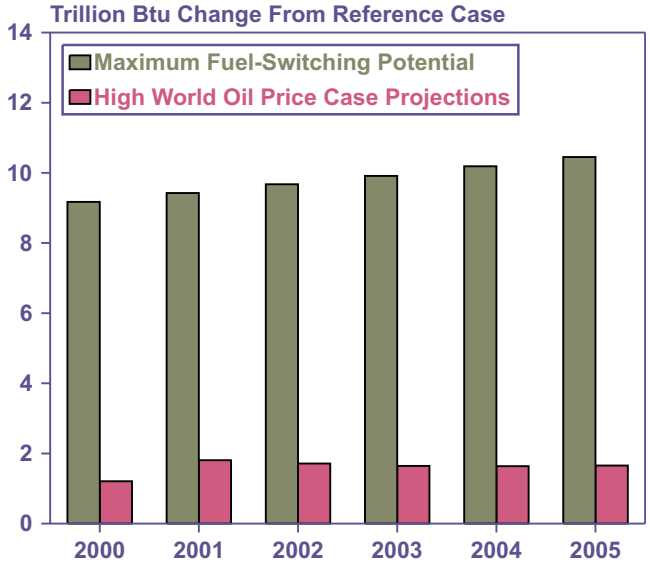
Projections to 2005

The *AEO2000* projections can be used to assess the sensitivity of industrial demand to alternative energy prices. In the reference case, industrial distillate fuel oil consumption in the Northeast is projected to increase by 1.1 percent per year from 1997 to 2005. In the high world oil price case, industrial distillate fuel oil prices are about 10 percent higher than in the reference case, and in the low

[45]The MECS94 fuel-switching tables give the maximum amount of distillate fuel oil that could be switched to a given other fuel. The sum of the individual quantities exceeds the amount of switchable distillate fuel oil. The calculations in the text subtract the maximum amount that could be switched to natural gas from the amount of switchable distillate fuel oil to impute the quantities for the other fuels (coal, electricity, residual fuel, etc.).

[46]Calculated from *AEO2000* Supplement Tables 1, 2, 11, and 12. See web site www.eia.doe.gov/oiaf/aeo/supplement/index.html.

Figure 26. Maximum Potential for Industrial Sector Switching From Distillate Fuel Oil Use in the Northeast and Projected Switching Under High World Oil Price Assumptions, 2000-2005



Sources: Energy Information Administration, *Manufacturing Consumption of Energy 1994*, DOE/EIA-0512(94) (Washington, DC December 1997), and *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999).

world oil price case results they are about 17 percent lower than in the reference case. In the high world oil price case, industrial distillate fuel oil consumption is projected to be 2 percent (about 2 trillion Btu) less than in the reference case. As noted earlier, the maximum switchable percentage in the Northeast is 12 percent of total industrial distillate fuel oil consumption. Figure 26 compares the maximum switchable amount (10 trillion Btu or 1.7 million barrels in 2005) with the amount that is projected to be switched as result of a 10-percent increase in the price of distillate fuel oil (about 2 trillion Btu or 0.34 million barrels).

Conservation Options

There is limited additional conservation potential in the industrial sector. Industrial distillate fuel oil consumption per unit of output fell by 40 percent from 1980 to 1997.[47] In 1997, industrial distillate fuel oil energy intensity was 0.28 thousand Btu per dollar of output, while industrial total delivered energy intensity was 6.81 thousand Btu per dollar of output. In the manufacturing component of industrial demand, distillate fuel oil is used mainly as a boiler fuel. Little, if any, additional boiler capacity designed primarily to consume distillate is likely to be built. Maintenance of existing distillate capability to facilitate seasonal fuel switching is likely to continue; however, most industrial distillate consumption is in the nonmanufacturing segment, where it is used as motor fuel in farm and construction equipment. This equipment becomes more fuel efficient over time, but fuel consumption is strongly related to the precise type of agricultural or construction activity being undertaken. Further, because peak agriculture and construction activities do not occur in the winter, additional fuel conservation in these activities is unlikely to make available significant additional quantities of distillate at times of high residential demand.

In the Northeast, the pulp and paper industry consumed 54 trillion Btu of pulping liquor and 30 trillion Btu of other biomass residues during 1994. This industry consumed 2 trillion Btu of distillate fuel oil, and its total energy consumption was 305 trillion Btu in the region during 1994. The lumber industry consumed 12 trillion Btu of biomass and 1 trillion Btu of distillate, and its total energy consumption was 22 trillion Btu in the region during 1994. Little, if any, additional pulping liquor or biomass residues would be available for short-term fuel switching.

Other Options Cutting Across All Sectors

In addition to the flexibility available through current fuel-switching capabilities, additional flexibility can be developed over the next 5 years through incremental consumer investments that can further reduce dependence on home heating oil. Two kinds of investment can be made: those that enhance the efficiency of existing equipment and buildings, and those that replace existing capital stock (or planned additions to stock). Additional new investments over the next 5 years are expected in the Northeast, including electricity generation investments that could result in greater use of alternate fuels and greater electricity generation efficiency, pipeline and distribution investments that could provide greater access to natural gas for end users, and investments in new industrial and building equipment.

The efficiency of existing stock that has not already been upgraded can sometimes be increased through maintenance efforts, such as insulating steam pipes or installing a more efficient burner head in a boiler. Even where the efficiency improvements are not to oil-burning equipment, increases in the efficiency of electricity production from other fuels may reduce some of the pressure on distillate fuel oil stocks.

Cutting across all sectors is the potential for growth in distributed energy resources, such as heat or electricity at or near the site of consumption. Distributed energy resources have the potential to relieve electricity transmission bottlenecks and lower the costs of electricity, heating, and cooling services—particularly when the

[47] Energy Information Administration, *State Energy Data Report 1997*, DOE / EIA-0214 (Washington, DC, September 1999).

load is well matched to the optimal operating conditions of the distributed energy source. However, through 2005, distributed energy resources are limited by their economics and operational difficulties in integrating with the electricity grid system.

Electricity Generation Sector Fuel Choice

Highlights

- Utility and nonutility generators in the United States, excluding traditional cogenerators, consumed about 32.6 million barrels of distillate fuel oil (190 trillion Btu) in 1998 for nontransportation uses, or 2.6 percent of the Nation's total distillate fuel oil consumption. In the Northeast, 35 trillion Btu or about 6 million barrels of distillate fuel oil was used to generate about 0.5 percent of the region's total electricity generation. However, when weather conditions are severe, causing high demand and natural gas delivery problems (as in December 1989) or high natural gas prices, the impact of electricity generators on the distillate fuel market can be larger.
- Overall, a small amount of oil is used in the production of electricity today, and its use is expected to decline further.
- Of the oil that is used, the vast majority is residual fuel oil rather than the distillate fuel oil that can be used by consumers to heat their homes.
- Even in the Northeast, where oil use in electricity production is more important than in the rest of the country, about 0.5 percent of the power generated annually comes from distillate fuel oil.
- If distillate fuel oil were unavailable, power companies would most likely turn to natural gas as the replacement fuel.
- Other options could include increasing imports from outside the region, instituting demand management programs in the winter, and improving distillate fuel oil purchasing and storage practices to reduce the possibility that power companies will be buying it when consumers need it for home heating.

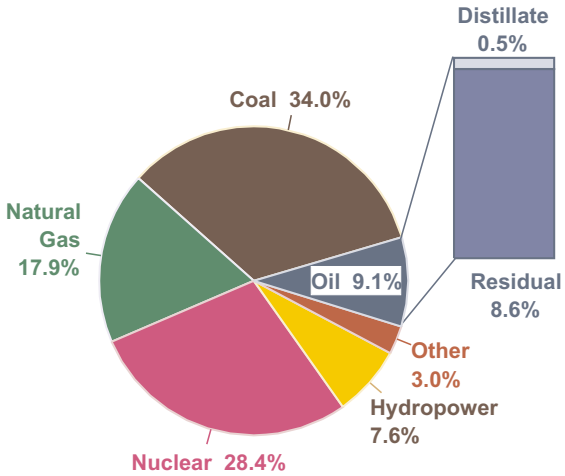
Recent Trends in Oil Use for Electricity Generation

The majority of the electricity produced in the United States is generated from coal, followed by nuclear, natural gas, and hydroelectric power. Generation from these four fuels accounted for more than 94 percent of total U.S. electricity generation in 1998[48] (52 percent coal, 19 percent nuclear, 15 percent natural gas, 9 percent hydropower) (see Appendix D). Other fuels, such as oil and nonhydroelectric renewables, played a very small role. The vast majority of oil used for electricity generation was, and continues to be, residual fuel oil, not distillate. In the Northeast, oil-based generation was somewhat greater than hydropower (Figure 27).

In 1998, oil accounted for less than 3.4 percent of total U.S. electricity generation. The role played by oil has declined substantially since the mid-1970s and early 1980s (Figure 28). In the 1980s, electricity generation from coal and nuclear (and later in the decade natural gas) increased to meet the increasing demand for electricity and to displace oil-based generation. The move away from oil-based generation was based on several factors, including the changing economics and reliability of coal supply for generation, the nervousness created in the market by the oil shocks of the 1970s, improvements in the national gas supply infrastructure, and the increasing economic competitiveness and perceived reliability of gas supply and generation technologies. In 1980 the share of total electricity generation produced from oil was just under 11 percent, but it has dropped almost continuously since then. The share of generation coming from oil for utility and nonutility generators differs only slightly. In 1998, oil accounted for only 2.6 percent of utility generation and 4.1 percent of nonutility generation.

The share of U.S. electricity generation coming from distillate fuel oil[49]—the type of oil used by consumers to

Figure 27. Electricity Generation by Fuel in the Northeast, 1998

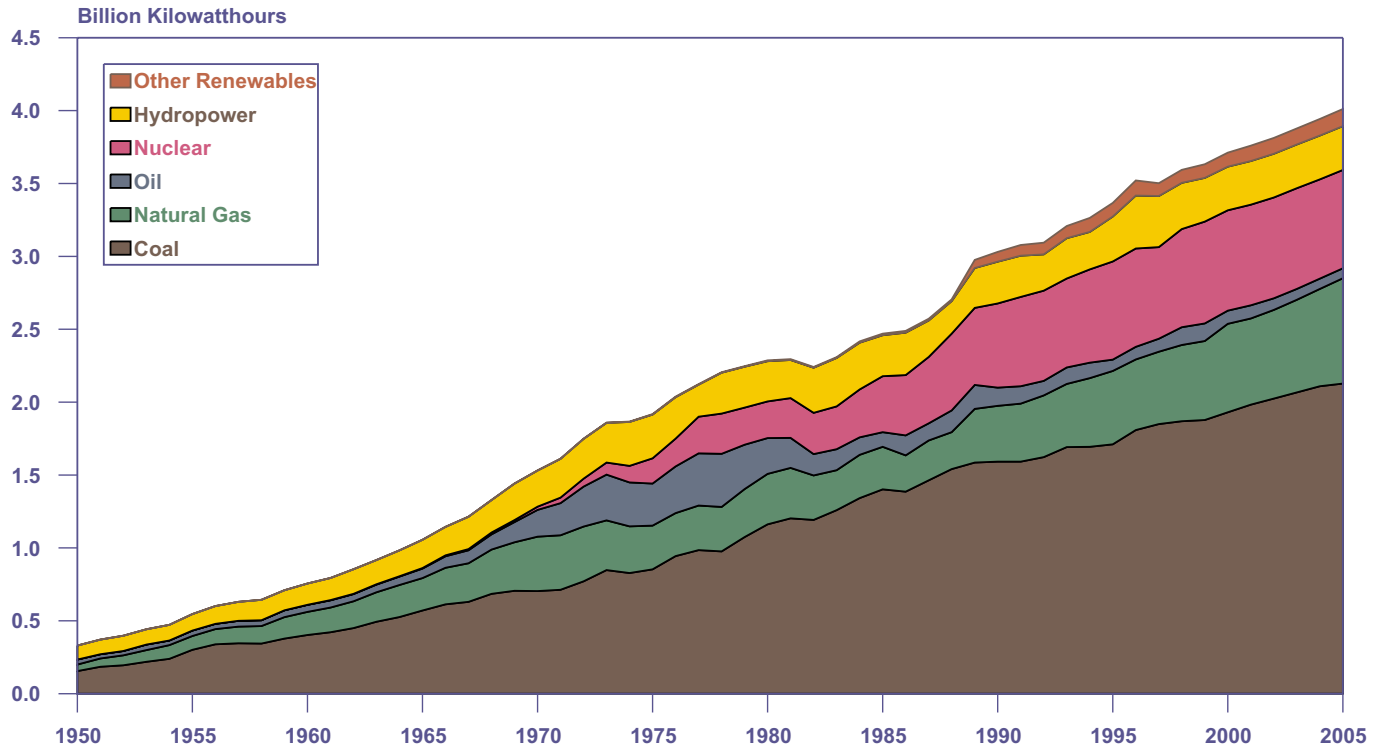


Sources: Energy Information Administration, Form EIA-759, "Monthly Power Plant Report"; Form EIA-860B, "Annual Electric Generator Report—Nonutility"; and Form EIA-867, "Annual Nonutility Power Producer Report."

[48] 1998 is the last year for which both utility and nonutility generator data are finalized.

[49] Distillate fuel oil used for electricity generation is also referred to as "light oil."

Figure 28. U.S. Electricity Generation by Fuel, 1950-2005



Sources: **History:** Energy Information Administration, Form EIA-759, "Monthly Power Plant Report"; Form EIA-860B, "Annual Electric Generator Report—Nonutility"; and Form EIA-867, "Annual Nonutility Power Producer Report." **Projections:** Energy Information Administration, *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999).

heat their homes—is much smaller. The vast majority of the oil used by power plants is residual fuel oil. For utilities, only 0.3 percent of total generation came from distillate fuel oil in 1998 and 1999, down from 0.6 percent in 1980. The trend for nonutility generators is similar. Nonutility generators do not report their distillate fuel oil generation directly, but their fuel consumption data for 1998 show that only 20 percent of the oil they consumed was distillate fuel oil (see Appendix D). As a result, their generation from distillate fuel oil is approximately 0.6 percent of their total generation.

Distillate fuel oil is not economically competitive with other available generation fuels. Typically, it is used in small amounts in steam plants for flame control and in relatively inefficient combustion turbines and internal combustion engines when the demand for electricity is high and other fuels are unavailable to generate it. Such plants tend to be run intermittently and are not good investment opportunities for natural gas suppliers or pipeline developers. Distillate fuel oil can be used in many of the new turbines and combined-cycle plants in the construction pipeline, but the relative price and environmental advantages of gas are expected to make natural gas the fuel of choice in almost all cases. For example, in 1998, with very low overall oil prices, distillate fuel oil delivered to power plants cost $3.19 per million Btu, but natural gas was much less expensive at $2.34 per million Btu. Over the next 5 years, the price gap is expected to persist and could widen.

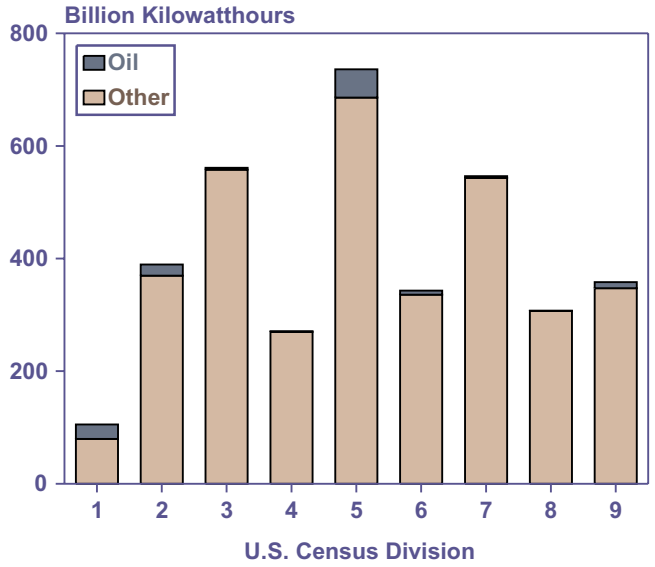
Total U.S. utility consumption of distillate fuel oil in 1998 was just over 22.0 million barrels (128 trillion Btu) (see Appendix D), or 1.6 percent of total distillate fuel oil consumption. For nonutility generators, distillate fuel oil consumption totaled 10.5 million barrels (61 trillion Btu) in 1998 (1998 is the last year for which nonutility generator data are available).[50] Utility and nonutility generators together consumed 32.6 million barrels (190 trillion Btu) of distillate fuel oil in 1998, or 2.6 percent of total distillate fuel oil consumption.

The use of oil in the electricity generation sector varies by region of the country (Figure 29 and Appendix D). The largest quantity of oil is used in Census division 5, the South Atlantic.[51] In terms of the share of generation, however, Census division 1, New England, is by far the highest with a 24-percent share in 1998. Other than Census division 1, only divisions 5 and 2 produced more than 5 percent of their generation from oil. Each of these

[50] Nonutility generator consumption data include data for cogenerators, small power producers, and independent power producers. Some of this consumption is typically reported in the industrial sector.

[51] Includes Delaware, Maryland, the District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida.

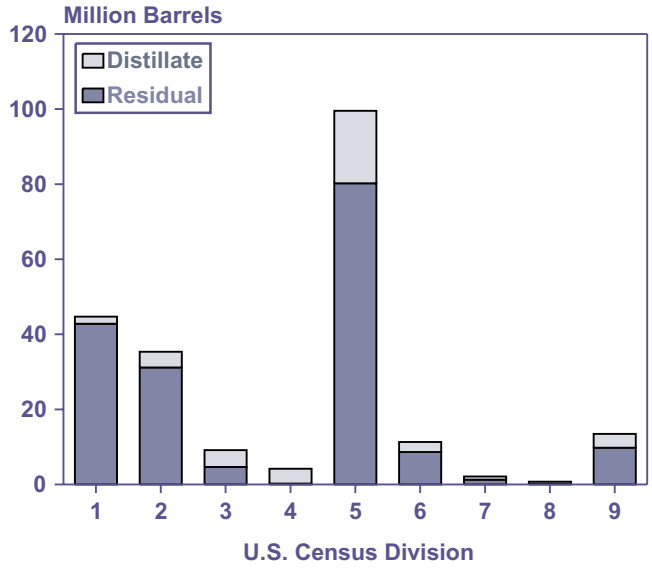
Figure 29. Electricity Generation from Oil and from All Other Fuels by Census Division, 1998



Note: U.S. Census divisions: 1 = New England (CT, ME, MA, NH, RI, VT); 2 = Middle Atlantic (NJ, NY, PA); 3 = East North Central (IL, IN, MI, OH, WI); 4 = West North Central (IA, KS, MN, MO, NE, ND, SD); 5 = South Atlantic (DE, DC, FL, GA, MD, NC, SC, VA, WV); 6 = East South Central (AL, KY, MS, TN); 7 = West South Central (AR, LA, OK, TX); 8 = Mountain (AZ, CO, ID, MN, NV, NM, UT, WY); 9 = Pacific Contiguous (CA, OR, WA); 10 = Pacific Noncontiguous (AK, HI).

Sources: Energy Information Administration, Form EIA-759, "Monthly Power Plant Report"; and Form EIA-860B, "Annual Electric Generator Report—Nonutility."

Figure 30. Utility and Nonutility Generator Oil Consumption by Census Division, 1998



Note: U.S. Census divisions: 1 = New England (CT, ME, MA, NH, RI, VT); 2 = Middle Atlantic (NJ, NY, PA); 3 = East North Central (IL, IN, MI, OH, WI); 4 = West North Central (IA, KS, MN, MO, NE, ND, SD); 5 = South Atlantic (DE, DC, FL, GA, MD, NC, SC, VA, WV); 6 = East South Central (AL, KY, MS, TN); 7 = West South Central (AR, LA, OK, TX); 8 = Mountain (AZ, CO, ID, MN, NV, NM, UT, WY); 9 = Pacific Contiguous (CA, OR, WA); 10 = Pacific Noncontiguous (AK, HI).

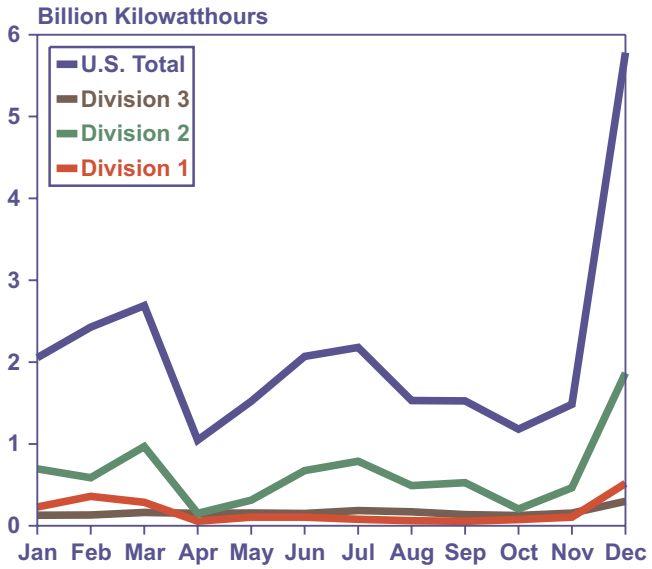
Sources: Energy Information Administration, Form EIA-759, "Monthly Power Plant Report"; and Form EIA-860B, "Annual Electric Generator Report—Nonutility."

regions relies more heavily on older oil and gas steam plants than do other regions. In the Midwest region (Census division 3), the region just to the west of the Northeast, the share of generation coming from oil was only 0.6 percent in 1998.

In all U.S. regions, the vast majority of the oil used for electricity generation is residual fuel oil rather than distillate fuel oil (Figure 30). In the Northeast (the combination of Census divisions 1 and 2 in this report), only 6 percent of the total generation from oil comes from distillate fuel oil. If all the distillate fuel oil used to produce electricity in the Northeast were shifted to some other fuel, distillate fuel oil consumption would be reduced by 6.1 million barrels (35 trillion Btu), an average daily reduction of just 17,000 barrels per day (0.1 trillion Btu). More important, however, is the amount of distillate fuel oil consumed during the peak winter months of December through February, when distillate fuel oil pricing is an issue. For example, December 1989 saw record distillate fuel oil consumption levels for electricity generators in the Northeast, reaching 77,000 barrels per day. Such short-term, rapid changes in demand can cause rapid and significant price changes.

Although the use of distillate fuel oil for electricity generation is relatively limited on an annual basis, seasonal variations in use can influence the prices paid by heating oil consumers. In most years, the use of distillate fuel oil for electricity generation peaks in summer, when consumers' need for power is greatest. In extremely cold winters, however, distillate fuel oil use for generation can also rise, as occurred in December 1989 (Figure 31). In a typical year, distillate fuel oil consumption in the electricity generation sector in the Northeast average approximately 17,000 barrels per day; however, in December 1989 it averaged nearly 77,000 barrels per day. Average temperatures in December 1989 were much colder than normal. In the North, the colder-than-normal month significantly increased the demand for natural gas by firm service customers (primarily in the residential and commercial markets). In the gas-producing regions of the South, unusually cold temperatures caused some wells to freeze, reducing production during the period of critically high demand, particularly in the Northeast. Gas prices rose sharply as a result, and significant numbers of industrial and electricity generation customers were forced to switch fuels, mostly to residual and distillate fuel oil.

Figure 31. Electric Utility Generation from Distillate Fuel Oil by Census Division and Month, 1989



Note: U.S. Census divisions: 1 = New England (CT, ME, MA, NH, RI, VT); 2 = Middle Atlantic (NJ, NY, PA); 3 = East North Central (IL, IN, MI, OH, WI).

Source: Energy Information Administration, Form EIA-759, "Monthly Power Plant Report."

In 1989, at the national level, nearly 23 percent of the annual utility use of distillate fuel oil ful oil occurred in December. The winter increase in usage was even more pronounced in Census division 1 (New England) where more than 25 percent of the annual utility use occurred in December. Still, distillate fuel oil accounted for only 0.4 percent of total utility generation nationally in 1989 and only 1.3 percent in New England. In December 1989, distillate fuel oil accounted for 2.8 percent of total utility generation in New England.

In terms of the overall distillate fuel oil market in the Northeast, the electricity generation sector is a relatively small player. On an annual basis, electricity generation accounts for only 2 to 3 percent of the region's total market for distillate fuel oil (excluding transportation uses). However, when weather conditions are severe and natural gas is unavailable or expensive, the use of distillate fuel oil for electricity generation can be more important. In 1989, with a very cold winter, the electricity generation share of annual distillate use in the Northeast was nearly 5 percent, and in December 1989, 24 percent of electric utility generation was from distillate fuel oil. As mentioned above, electric utility consumption of distillate fuel oil in December 1989 averaged 77,000 barrels per day, much higher than the typical yearly average of 17,000 barrels per day.[52]

In the future, oil is expected to play a comparatively minor and decreasing role in the U.S. electricity generation sector. In *AEO2000*, generation from oil is projected to account for less than 2 percent of total generation by 2005 and less than 1 percent by 2020. Existing oil-fired generators are expected to be used less, and some are expected to be retired. In addition, new natural-gas-fired combustion turbines and combined-cycle plants are expected to account for more than 90 percent of new capacity additions. As the new plants are built, they will be used not only to meet growing demand but also to displace the generation from older oil-fired plants—particularly in regions like the Northeast that currently use relatively large amounts of oil for electricity generation.

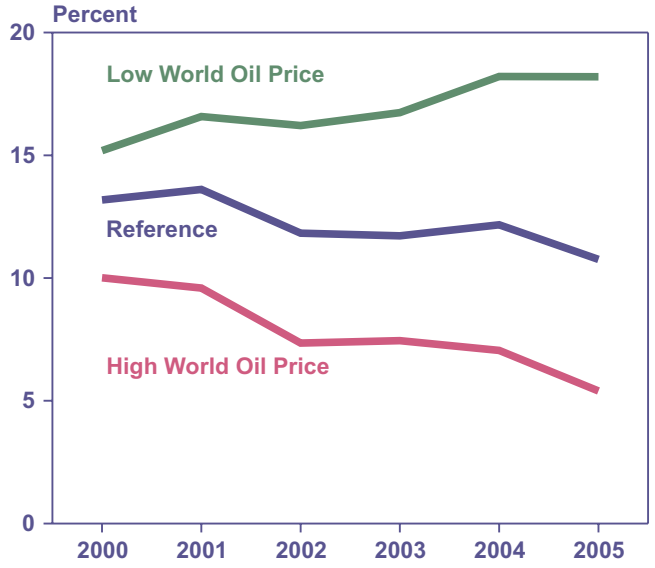
If oil prices were much lower than expected, as in the *AEO2000* low world oil price case ($14.90 per barrel in 2020), the share of generation from oil could stay near the current level of 3 to 4 percent of total generation. Although no new oil-fired plants would be built, existing oil plants would continue to be used. Still, however, the vast majority of the oil used would be residual fuel oil (heavy oil) rather than distillate fuel oil (light oil).

Projections to 2005

Over the next few years the use of oil for electricity generation is expected to continue to fall. New oil plants are simply not economically competitive with other options, and the utilization of existing plants is expected to decline as new gas-fired plants are added to meet demand growth. The older oil and gas steam plants in the Northeast are expected to be prime candidates for retirement as new, more efficient plants are brought on line. In the *AEO2000* reference case, approximately 20 percent (4 gigawatts) of the existing oil and gas steam capacity in the Northeast (here defined as the combination of the New York and New England power pools) is expected to be retired by 2005. As a result, the share of generation from oil declines from just over 2.4 percent in 2000 to 1.7 percent by 2005 at the national level and from 13.2 percent to 10.8 percent in the more oil-intensive Northeast (Figure 32). As mentioned above, the share of generation from distillate fuel oil remains well below 1 percent in all years. As new turbine-based systems (simple combustion turbines and combined-cycle plants) are added, it is possible that they could turn to distillate fuel oil when gas is not available. Most of the new gas plants are expected to be heavily utilized, making it economically attractive to develop the gas infrastructure needed to meet their needs.

[52]The 1989 values are for utilities only. Monthly data for nonutility generator consumption in 1989 are not available.

Figure 32. Projected Oil Shares of Electricity Generation in the Northeast, 2000-2005



Source: Energy Information Administration, *Annual Energy Outlook 2000*, DOE/EIA-0383(2000) (Washington, DC, December 1999).

Fuel Supply Options for Electricity Generators

Electricity generators in the Northeast (both utilities and nonutilities) using natural gas as their primary fuel have been reluctant to commit contractually to firm (365-day) gas service because of the high transportation costs for such service. As an alternative, a power generator might buy natural gas on the interruptible market and either build a short-duration storage facility for distillate (or residual) fuel oil or shut down the generator when gas service is actually interrupted and either dispatch another plant or import power from an adjacent region. Another alternative might be to contract for a variety of semi-firm services (for up to 365 days) but allow a local gas distribution company the right to call on the gas for a specified number of days. Because the winters have been warm for most of the past 20 years, interruptible gas service has effectively turned into firm service without the higher costs. There is little incentive under these circumstances for generators to commit to costlier firm service options. Recent anecdotes suggest that the reliability of natural gas supply and the added cost of carrying a full inventory of distillate fuel oil or residual fuel oil (which has often remained unneeded) have tempted some electricity generators not to maintain adequate inventories of replacement fuel in storage through the winter. If so, their need to buy oil supplies on the spot market when gas supplies were interrupted may have contributed to this year's distillate fuel oil price surge.

Possibilities for reducing the use of distillate fuel oil by electricity generators in the Northeast include increasing interregional transmission capacity and building new generating capacity to displace existing capacity. Given the high costs and long lead times involved in natural gas pipeline capacity expansion projects, that option may not be economical. New natural-gas-fired generating plants can be brought on line in 1 to 2 years, and many are already planned. Other new capacity options (coal, wind, biomass, and solar) are much less economical and normally take longer to bring on line. In addition, because wind and solar plants are not dispatchable,[53] they are not likely to be good substitutes for plants that use distillate fuel oil.

In *AEO2000*, the levelized cost for new plants in 2005 averages 3.5 cents per kilowatthour for gas combined cycle, 4.1 cents per kilowatthour for coal, 5.9 cents per kilowatthour for wind, 7.0 cents per kilowatthour for nuclear, and 20.2 cents per kilowatthour for solar photovoltaic. In addition, because wind and solar generating plants are not dispatchable, they may not be good substitutes for plants that use distillate fuel oil. Although new nuclear power plants are currently too costly to compete with either coal or natural gas combined-cycle plants, and nuclear construction lead times are too lengthy to have an impact by 2005, it may be possible to increase the utilization rates of existing nuclear units in the winter period to reduce distillate fuel oil use during the winter months. However, the current utilization rate for nuclear power plants in the Northeast exceeds 80 percent, and the opportunities for significant additional contributions appear to be minimal.

Although not likely to have a notable impact in the near term, over the longer run renewable energy sources could reduce some of the demand for petroleum and other fossil fuels in New England's electricity production. New England is moving to increase the use of renewable sources for electric power, including biomass (such as from wood chips), landfill gas from municipal solid waste, solar power (both solar photovoltaics for direct electricity production and solar thermal water heating to reduce electricity demand), and wind. Connecticut, Maine, and Massachusetts all have enacted renewable portfolio standard (RPS) programs requiring increased use of renewable energy sources after 2000. Massachusetts and Rhode Island have "green power" programs allowing customers willing to pay a premium to purchase electric power generated from new renewable energy sources. A leading-edge biomass gasification-to-electricity facility using wood chips is being tested in Vermont. In addition, most New England States offer tax incentives to encourage renewables and allow consumers to sell unneeded power generated

[53] An electricity generator is "dispatchable" if it can be called on to generate electricity as needed.

from renewable sources back to their utilities at the same prices the utilities charge them for retail service (referred to as "net metering"). Use of solar photovoltaics is especially encouraged in order to reduce electric power demands during peak air conditioning times. To the extent that these programs are successful, renewables will be able to reduce New England's dependence on fossil fuels. Nevertheless, because New England is not well endowed with most renewable resources, generating electricity from them is—and will remain—more costly than using fossil fuels in most instances. Therefore, additional renewables will likely remain minor contributors to New England electricity supply well beyond 2005.

An alternative to reducing distillate fuel oil use, might be to improve the purchasing and storage practices of electricity generators, so that they would not be competing with homeowners when unexpected cold weather strikes. Options for doing this include improving the distillate fuel oil delivery channels to power plants and increasing their storage capacity.

Northeast Distillate Fuel Oil Market Summary

The estimates of fuel-switching capability in the various end-use sectors described in this chapter are approximations derived from EIA's MECS, CBECS, and electric power survey data for discrete years. The data are also aggregate in nature. Several factors contribute to the uncertainty of the estimate of the size of the dual-fuel market, including the use of data from a survey sample to represent a whole set of establishments and the use of survey data that are not designed to address the specific questions being analyzed here (how consumers make fuel choices, what consumer options are or what they perceive them to be, what the specific capability to use alternate fuels is, etc.). Further, because energy consumption is not measured at the daily or even the weekly level for any fuel, the precise interaction of spot prices with other factors, such as deliverability constraints, fuel consumption, and stock in storage, can only be approximated. Special circumstances, such as the status of equipment that uses other fuels or year 2000 (Y2K) concerns, may determine actual fuel choices in some periods that appear to be inconsistent with cost considerations.

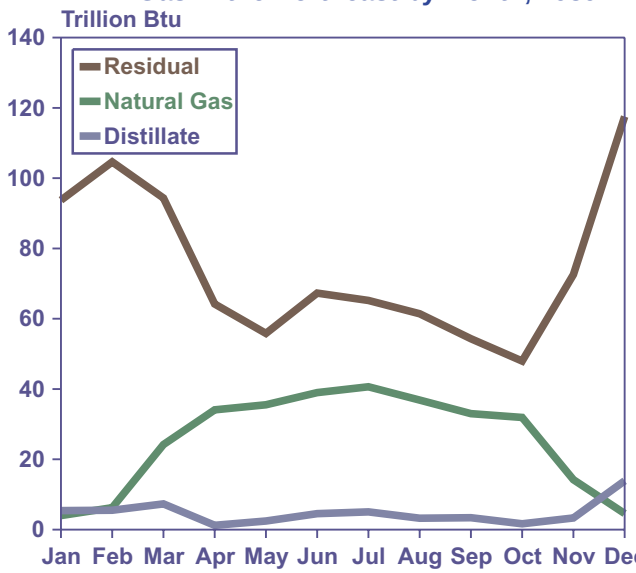
The practical capability to switch year-round distillate-only consumption to different fuels depends on a variety of factors, including the time frame, the rate of physical retirement of equipment, interest rates, equipment and fuel choices and their associated characteristics, and specific performance and reliability requirements (for example, uninterrupted fuel supply 24 hours per day, 7 days per week, may be required, or equipment shutdown may be an acceptable alternative). Typically, large energy-using equipment (such as boilers, heating systems, and generators) is replaced only when it breaks down. Exceptions occur when the energy cost of production has to be brought down to remain competitive or when environmental constraints on effluents or emissions impose a sufficiently large externality cost to warrant retirement.

To take advantage of episodic price differences between fuels, large energy-using establishments usually install a dual-fuel-switching capability, usually between natural gas and either residual fuel oil or distillate fuel oil. If they have not done so, it usually means that conversion from distillate-only equipment is either not economical or not feasible. Most of the fuel-switching capability in the Northeast is between residual fuel oil and natural gas, not distillate fuel oil and natural gas. Figure 33 shows the switching by utilities that took place among natural gas, distillate fuel oil, and residual fuel oil in 1989, when December distillate fuel oil consumption was the highest on record, at about 2.4 million barrels.

Fuel-Switching Potential

The size of the maximum potential of 1997 distillate fuel oil consumption that could be switched to other fuels in a relatively short time frame can be estimated from information in the preceding sections of this chapter. Considering the estimated maximum potential switchable amounts from the commercial and industrial sectors, and assuming that all utility use of distillate fuel oil in the winter is switchable, a total maximum potential of

Figure 33. Electric Utility Consumption of Distillate Fuel Oil, Residual Fuel Oil, and Natural Gas in the Northeast by Month, 1989



Source: Energy Information Administration, Form EIA-759, "Monthly Power Plant Report."

Table 7. Northeast Estimated Switchable and Conversion Potential

Sector	Maximum Annual Switchable Volume (Million Barrels)	Daily Switchable Volumes If Consumption Were Restricted to December-February (Thousand Barrels per Day)	Conversion Potential If All Distillate Use by Large Users Were Converted to a Different Fuel (Million Barrels)
Commercial	8.6	86	20.0
Industrial	1.6	16	6.5
Electricity Generation[a]	2.9[b]	31[b]	7.1
Total	**13.1**	**133**	**33.6**

[a]Because usually only one-third of distillate consumption for electricity generation occurs in the winter months (December, January, and February), the consumption shown is the estimated winter use portion, assuming that 40 percent of the year's distillate use might occur in the winter of an unusual year.
[b]Winter only.
Source: Tables in this chapter.

76 trillion Btu (13.1 million barrels per year), or about 5 percent of overall distillate fuel oil consumption in the Northeast in 1997 could be switchable (Table 7). We know, however, that not all utility demand for distillate fuel oil is switchable; that about 1.4 million barrels per month is distillate-only generation;[54] and that for commercial and industrial applications, most of the switchable demand is likely to occur during the heating season.

The methodology used to estimate the maximum switchable quantities was as follows:

- For the commercial sector, it was assumed that all distillate fuel oil used in a building is switchable (including the fuel oil used for water heating and other uses) if distillate fuel oil was the building's primary heating fuel but it was reported that it could be switched to another fuel. Because applications other than space heating can account for 30 percent or more of a building's distillate fuel consumption, this component of the switchable estimate is likely to be high.

- Second, it was assumed that 90 percent of the heating oil requirements occur in the three contiguous winter months (December, January, and February). Because both November and March also contain substantial heating degree-days, the allocation of 90 percent of the distillate consumption into 90 days also overestimates consumption.

- Finally, because the direction was that we should look only at large-volume users or industrial users for conversion to a different fuel, less than 50 percent of the commercial market would qualify, largely offsetting those natural gas customers who can switch to distillate fuel oil.

The first three factors overestimate the switchable distillate volumes in the commercial sector. The overestimation is intended to compensate for the use of consumption data for 1997, which was a normal year, because we are concerned with years that are as much as 10 percent colder than normal years during the three winter months. For example, if we assume that: (1) only 85 percent of the distillate is consumed in the three coldest months (instead of 90 percent), (2) 90 percent of the switchable distillate use in buildings with reported fuel-switching capability (not the 70 percent implied earlier), (3) distillate consumption in the commercial sector stops declining under normal weather conditions, and (4) there is a 10 percent colder than normal winter in the Northeast, then our estimate of commercial and industrial sector distillate fuel consumption during the three winter months would be overestimated by at least 5 percent, and probably more. The treatment of the industrial sector is similar, with 90 percent of the 9 trillion Btu (1.6 million barrels) defined as switchable allocated to the three winter months.

For the electricity sector, the switchable amount was estimated from a recent normal historical year and then increased by slightly more than 14 percent for 2005 under normal weather conditions. Since the *AEO2000* projects declining distillate usage, this overestimates consumption under normal weather conditions. We then applied 40 percent of the total annual consumption to the winter period. Taken together, these adjustments mean that in a severe winter, distillate consumption during a three-month winter period of colder than normal weather could be about 42 percent higher than consumption during a normal winter. The normal distribution of distillate fuel oil use for electricity generation is almost evenly divided between the three periods: summer (June, July, August), winter (December, January and February), and the rest of the year. Under these conditions, distillate fuel oil consumption could increase by about 133 thousand barrels per day or more in the Northeast. The peak-day usage could actually be higher. Whether such short-term increases cause price surges also depends on the duration of distillate fuel oil demand, stock levels, imports, and other production and delivery factors. If such a sharp distillate fuel oil

[54]Because natural gas prices are lowest from April through August, any distillate fuel oil consumption during those months can be roughly attributed to increased electricity demand and the inability to burn natural gas—that is, to the use of distillate-only generators.

demand increase occurred during a very cold period and during a severe supply-demand imbalance, the short-term incremental demand could significantly raise what might already be high distillate fuel oil prices to residential customers, as occurred in the winter of 1999-2000.

Northeast distillate fuel oil consumption in the 1990s for utility and independent power producers (see Appendix D) ranged from about 19 trillion Btu (3.3 million barrels) to about 41 trillion Btu (about 7.1 million barrels) annually. Data for 1998, the most current year for which regional utility and nonutility consumption data are available, show the Northeast with about 35 trillion Btu (about 6 million barrels) of distillate fuel oil consumption. Distillate fuel oil consumption for electricity generation could rise as high as 40 trillion Btu by 2005, or more if large amounts of combined-cycle capacity are added and a cold winter occurs. Peak-month distillate fuel oil consumption was about 2.4 million barrels in December 1989 (about 77,000 barrels per day) and occurred because of the extraordinary gas situation and extreme weather. More normal winter weather would result in peak-month distillate fuel oil consumption of less than 0.6 million barrels or less than 19,000 barrels per day.

The likelihood that all electricity generated from distillate fuel oil use could actually be switched to another fuel is small. Distillate fuel oil is expected to be used by utilities primarily when natural gas is unavailable. Some of the units that burn distillate fuel oil are older, inefficient diesel-fired units that have no pipeline gas access and are used only intermittently. At least 1.4 million barrels per month of such capability exists in the Northeast, and the economics of delivering gas to these relatively small, intermittent users may preclude the possibility of switching them to gas. The rest of the Northeast's distillate fuel oil use for power generation is attributed to dual-fired turbines or combined-cycle units that can use either distillate fuel oil or natural gas. Distillate fuel oil consumption in the winter period averages about 33 percent of the year's total but can rise to 40 percent under unusual circumstances. Northeast distillate fuel oil consumption in the three coldest winter months, when natural gas may not be available, has the greatest potential impact on distillate fuel oil prices. Based on these assumptions, no more than 2.9 million barrels is switchable during the winter months. The maximum estimate of 50 trillion Btu (about 8.6 million barrels) for annual switchable potential in the commercial sector is also optimistic, because it was assumed that consumers who can switch their heating fuel can also switch fuels for all other uses.

Conversion of Distillate Fuel Oil Use to Other Fuels

If all the distillate fuel oil used for manufacturing and utility purposes in the Northeast were displaced, at most 79 trillion Btu (13.6 million barrels) of distillate fuel oil would be freed for use by residential consumers. Adding all the distillate fuel oil used for heating in the commercial sector raises the total in this extreme case to about 195 trillion Btu (33.6 million barrels) of fuel oil. The manufacturing total includes all uses, ranging from boiler use and direct process use to onsite transportation and facility HVAC uses, some of which are not practical for conversion. In addition, the total includes distillate fuel oil use by manufacturing concerns that reported they could not switch boiler fuels without replacing their existing boilers, an uneconomical decision under the range of distillate fuel oil and natural gas prices considered. The caveats raised in the previous paragraph concerning the commercial and utility potential apply here as well. The complete conversion of distillate fuel oil use to other fuels, particularly to natural gas, is infeasible and probably unnecessary in view of completed or planned natural gas pipeline construction over the next 2 years and the availability of less costly consumer management and price hedging instruments for heating oil customers (see Chapters 4 and 5 of this report).