Chapter VI

Fuel Use Changes and Longer Term Effects

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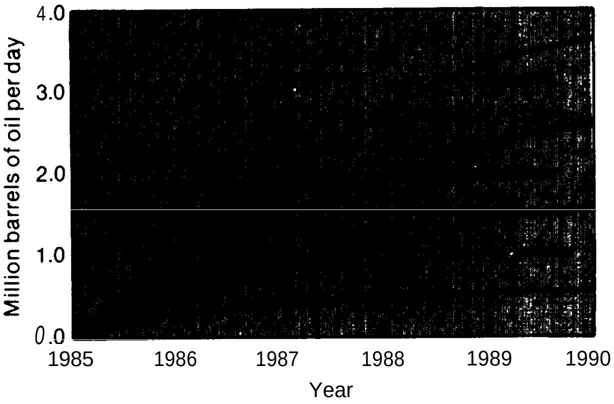
The individual contributions to reducing U.S. oil consumption through fuel switching and increased efficiency of use have been considered elsewhere in this report. In this chapter, the contributions are combined to provide estimates of the overall rate at which oil consumption could be reduced in a crisis. The corresponding changes in the consumption of various fuels are also described, possible alternative scenarios are considered, and the longer term implications of the shifts are discussed.

FUEL USE CHANGES

To estimate the total amount of oil that can technically be displaced through fuel switching and increased efficiency, it is necessary to eliminate any double-counting (i.e., the overlap when the same oil can be displaced by both options), such as when a residence is insulated and converted from oil to natural gas. In gasoline- and diesel-fueled vehicles, there is only a small overlap because the potential for fuel switching (4 percent of fuel use) is small. In the industrial sector, the overlap is only moderate because about two-thirds of the oil that is replaced by increased efficiency and saved by reduced refinery throughput is not used in boilers which are the targets for fuel switching. In the residential and commercial sectors, however, the overlap is much larger because both contributions are significant, and **fuel switching can essentially eliminate** oil use in these sectors in many regions of the country.

Figure 40 shows the composite oil replacement, with double-counting eliminated,[1] in each of the sectors considered and based on the scenarios derived elsewhere in the report. In electric utilities, fuel switching dominates the changes,[2] while in transporation increased automobile fuel efficiency dominates. In the industrial sector, increased efficiency can replace about one-fifth as much oil as fuel switching. In the residential and commercial sectors, about 15 percent of all the oil used in these sectors in 1985 can be replaced by 1990 through increased efficiency alone, while 77 percent of the oil used in 1985 can be replaced through fuel switching and increased efficiency combined.

Figure 40.—Potential Replacement of Oil Through Fuel Switching and Increased Efficiency



SOURCE: Office of Technology Assessment.

In all, over 90 percent of the oil used in utility boilers and over 70 percent of that used in industrial boilers could be replaced by 1990. Other industrial uses of oil could also be reduced significantly. Oil used for transportation could be reduced by about 11 percent, mostly through reduced gasoline consumption. And in most regions of the country, residential and commercial oil use could be nearly eliminated. However, **in New England and the New York/New Jersey region, only about 50 percent of the oil use could be replaced, within a 5-year period. This** would leave the Northeast as the only region consum-

[1] Double-counting was eliminated in the following way. If x is the fraction of a particular type of oil in a given sector that can be replaced with fuel switching and y is the fraction that can be replaced through increased efficiency, then the composite fraction is $z = x + y(1 - x) - y + x(1 - y) = x + y - xy$.

[2] Although there are secondary effects resulting from reduction of electricity use through greater efficiencies, these are accounted for in OTA'S alternative projections for demand for electricity.

ing significant amounts of oil in the residential/commercial sectors in 1990.

In addition to the direct oil savings, increased efficiency by residential and commercial natural gas customers could free up natural gas with the energy equivalent of 0.25 million barrels per day (MMB/D) and the industrial gas customers could save an additional **0.65** MMB/D. If, in addition to these savings, natural gas production or imports could be increased, then additional oil could be replaced by natural gas. The most likely uses for this additional gas would be in small industrial boilers and, perhaps, in some residential and commercial buildings in the Northeast, provided that some additional pipelines were built. OTA did not, however, include this possibility in estimating the oil replacement potential.

Table 22 compares the consumption of various types of petroleum products, natural gas, and solid fuels (mostly coal and wood) before and 5 years after the onset of the shortfall, assuming that the oil replacement scenario in figure 41 is implemented. Natural gas consumption increases by up to 11 percent, depending on the extent to which efficiency of natural gas use increases, while solid fuel use increases by 13 percent over this period. With respect to oil products, the most dramatic changes are the halving of residual oil consumption (as a percent of total oil consumption), the relative increase in gasoline consumption from **36** to **39** percent, and the reduction in distillate heating oil from 7 to 3 percent of total consumption, Also, diesel fuel as a percent of distillate fuel oil consumption increases from 62 to 81 percent.

Small refiners will have the most difficulty adapting to these changes, since they produce more residual oil and less high-grade diesel and gasoline than the average. However, a comparison of the 1990 product slate with recent domestic production of petroleum products[3] indicates that the larger U.S. refineries could accommodate the changes, provided that a large part of the reduction in residual oil consumption were accommodated through reduced imports of that fuel. (Imports of residual fuel oil in 1982 were 0.8 MMB/D.) The most difficult aspect of the changes may be the increase in diesel production, as a percent of total distillate fuel; and it is unclear to what extent this can be accomplished without a significant reduction in the quality of the diesel fuel produced.

3"Monthly Energy Review, " Energy Information Administration, DOE/EIA-0035(83 /10), October 1983.

Table 22.—Changes in Fuel Consumption Through Fuel Switching and Conservation

	1985 consumption		1990 consumption	
	(M MB/Da)	(percent)	(M MB/Da)	(percent)
Residual	2.2	14	0.9	7
Distillate				
Diesel	1.8[b]	11	1.7[b]	14
Other	1.1	7	0.4	3
Gasoline	5.7	36	4.8	39
Kerosene	0.1	0.8	0.03	0.2
LPG and ethane	1.0	6	0.8	6
Subtotal	11.9	74	8.6	69
Other	4.1	26	3.8	31
Total	16.0	100	12.4	100

	1985 oil-consumption (MMB/D oil equivalent)	1990 consumption (MMB/D oil equivalent)	Percent change
Natural gas[c]	9	9-1o	0-11
Solid fuels[d]	9.3	10.5	13

[a] B = 5.5 • 10^6 Btu.
[b] In 1985 diesel is 62 percent of the distillate oil while in 1990 it increases to 81 Percent.
[c] The range corresponds t. the possible range of 'increases in efficiency of natural gas use. The lower numbers correspond to the case where feasible increases in efficiency of natural gas use are implemented.
[d] Coal and wood.

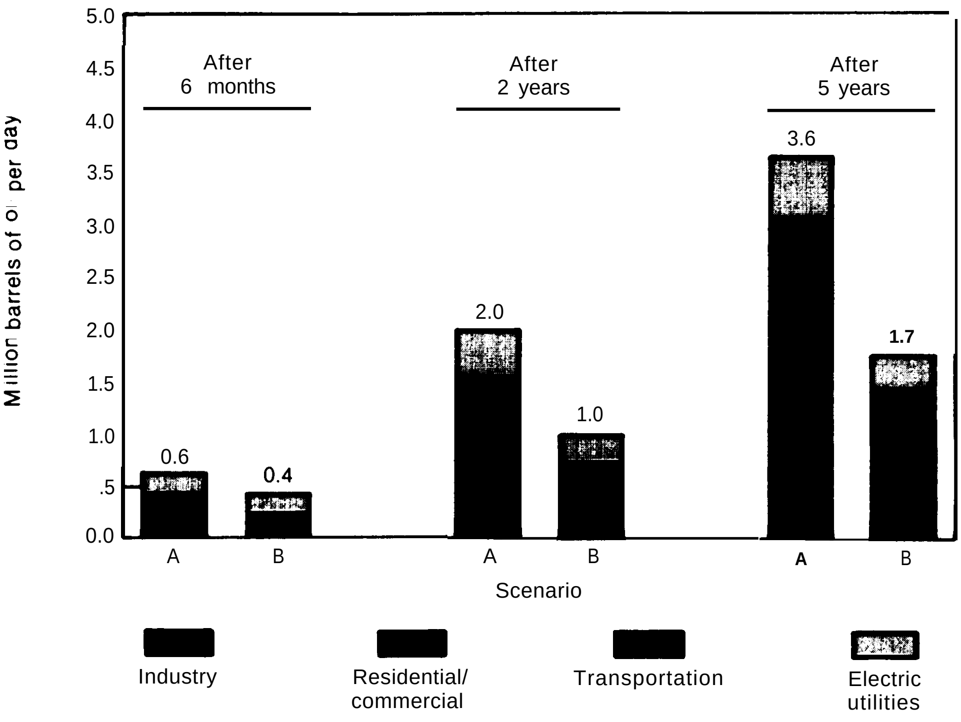
SOURCE: Office of Technology Assessment.

ALTERNATIVE SCENARIOS

A number of assumptions were made in order to derive the scenario for the technical oil replacement potential, shown **in figure 40. The most important of these were that: 1) an increment of 2 trillion cubic** feet per year (TCF/yr) of natural gas would be available through increased efficiency of natural gas use, increased domestic production, and/or increased imports; 2) oil users would invest **in replacement technologies at the rate that they could be supplied; and 3) economic recovery** in the United States would increase oil consumption to 16 MMB/D by 1985, up from 15.1 MM B/D in 1983. In addition, it was assumed that priority would be given to conversions from oil to solid fuels over conversions from gas to solid fuels in large industrial and utility boilers. In the following OTA considers variations on these assumptions and indicates the resultant changes in the amounts of oil replaced.

It is possible that capital shortages, unfamiliarity with alternative fuel technologies, uncertainty about future fuel prices and demand for industrial products, as well as a general reticence to make large investments during an (at least temporary) economic downturn, would limit investments to well below that which is technically feasible, unless additional incentives were provided. The failure to invest in increased efficiency of natural gas use could also lead to lower incremental supplies of natural gas. In order to illustrate the effect of a slower investment rate, OTA formulated another scenario (to be called scenario B, as distinct from the technically feasible response, scenario A). In this slower response scenario, it is assumed that oil users will invest in oil replacement technologies at one-third the rate that is technically feasible, that incremental natural gas availability would be one-third of the 2 TCF/yr assumed in figure 41, and that new car sales would drop to 5 million units per year. Together, these changes would reduce the amount of oil replaced at the end of 5 years from 3.6 MMB/D to 1.7 MMB/D, as shown in figure 41.

Figure 41 .—Potential Reductions in Oil Consumption



SOURCE. Off Ice of Technology Assessment

Another variation on the basic scenario could occur if U.S. oil consumption does not reach 16 MMB/D by 1985. The most important changes in oil consumption (as compared to that assumed in deriving the above scenarios) would probably be reduced consumption in utility boilers and in industry. This would reduce the amount of oil that could be replaced in utility boilers (0.6 MMB/D in scenario A) and through increased efficiency of industrial processes (O. 15 MM B/D in scenario A). On the other hand, switching from oil to gas in industrial boilers was limited by natural gas availability; and even if the amount of oil consumed in industrial boilers were lowered by 25 percent through reduced use, the oil replacement potential from industrial boilers would be nearly the same as was derived in scenario A (0.7 MMB/D), In all, changes under this variation might reduce the oil replacement potential to about **3.1** MMB/D; but the reduced demand for oil (in 1985) would also tend to reduce the severity of an international oil shortfall and would thereby reduce the amount of oil that would have to be replaced in the United States.

A final area to consider is the potential competition for the equipment and engineering manpower needed to convert large oil- and gas-burning utility and industrial boilers to solid fuels. In OTA's scenarios, it has been assumed that the oil-consuming boilers would have priority; but the rise in gas prices accompanying the oil shortfall and the increased demand for gas would also provide incentives to convert large gas-fired boilers to solid fuels. **OTA's** analysis indicates that equipment and manpower would be sufficient to convert industrial boilers consuming **0.2** MMB/D and utility boilers consuming roughly 0.3 to 0.4 MMB/D[4] of oil to solid fuels within 4 years of the onset of an oil disruption (including a 2-year delay before the first conversions would be complete). At this point, the estimated market for conversions of large oil-fired boilers would be saturated. Consequently, in the fifth year, large gas-burning boilers consuming the energy equivalent of **0.2** to **0.3 MMB/D** could also be converted. Beyond this level, however, demand for the equipment and manpower needed for gas-fired boiler conversions within the 5 years could reduce the number of oil-fired boiler conversions that could be completed; but it seems likely that the total amount of oil that could be replaced would still be around **3.2** MMB/D or more.

[4]This number is imprecise because both boiler conversions and completion of new powerplants currently under construction will contribute to the replacement of oil used in utility boilers; and there is no precise way to allocate the fraction attributable solely to boiler conversions. The estimate given is based on the relative capacity of converted boilers to that of new powerplants. However, if less capacity is converted, the amount of oil replaced will not drop in proportion to the reduction in converted capacity, because the last increments of nonoil capacity would be used primarily to satisfy winter and summer peak demand, and their yearly capacity factors would be small. Of course, the same thing would apply to new powerplants that may not be completed.

LONGER TERM EFFECTS

Five to ten years after the onset of the shortfall, a number of additional things would happen. Some enhanced oil recovery projects begun after the onset of the shortfall would begin to produce oil (an increment of almost 1 MMB/D) and some synthetic fuels plants might begin producing (perhaps 0.5 MMB/D after 10 years). These projects might be delayed, however, because they would have to compete for some of the same resources, such as for engineering and construction firms and boilers and particulate control systems, that are needed for some of the fuel switching that would occur during the initial 5-year period. (Needless to say, this competition could also delay the fuel switching projects.) Nevertheless, it is probable that new and potentially large sources of liquid fuels would begin to appear.

Because of the decline in conventional U.S. oil production, however, total domestic supplies of liquid fuels could still be dropping. In particular, OTA has projected that, under more or less normal circumstances and with 1.5 to 2.5 MMB/D of enhanced oil recovery, U.S. oil production in the year 2000 would drop to 4 to 7 MMB/D,

'*World Petroleum Availability (1980-2000)-A Technical Memorandum* **(Washington, DC: U.S. Congress, Office of Technology Assessment, OTA-TM-E-5, October 1980).**

down from a little over 10 MMB/D in 1983. Although the drop could be reduced somewhat through increased exploration and development of conventional oil, more enhanced oil recovery, and synthetic fuels production, it is far from certain that these measures would be adequate to prevent a significant drop in the domestic supplies of liquid fuels. Furthermore, since U.S. oil consumption in 1990 would be 12 to 13 MM B/D (after the replacements in fig. 40), oil imports could still be a significant fraction of U.S. oil supplies in 2000, unless additional measures are taken in the 1990s to reduce oil consumption.

Aside from the environmental impacts, which are described in chapter IV, the principal longer term consequences of fuel switching will be inflationary pressures on natural gas and food and an acceleration of the shift to non petroleum fuels. If natural gas production falls sharply in the 1990s, the increased dependence on gas brought about by oil replacement will greatly increase natural gas prices and/or imports. But, if production capacity remains at current levels or higher, or a slower drop in production is coupled with feasible increases in the efficiency of natural gas use, price pressures will be lower and a more orderly transition to increased use of coal, electricity, and renewable can occur.

As with oil, there is considerable uncertainty about future supplies of natural gas. OTA estimates that conventional natural gas production in the United States could range from 9 to 19 TCF/yr in the year 2000.[6] The higher limit is greater than the 1982 consumption of 17.8 TCF and considerably above the 1983 consumption of about 16 TCF. In addition, there may be significant supplies of unconventional natural gas, although OTA has not completed its assessment of the potential from these sources. Thus, there is a possibility that natural gas production could be maintained at recent levels through the year 2000, but this is far from certain.

Supplying the grain feedstocks for .5 billion gal/yr of ethanol production (capable of replacing about 0.1 MM B/D of oil) will lead to increases in farmland and food prices, which will persist as long as the feed stocks are supplied. Although the level of the change cannot be calculated precisely, most estimates indicate that U.S. food costs would be about $20 billion/yr higher with this level of ethanol production than they would be otherwise. (This compares to total civilian expenditures for farm foods of about $300 billion/yr.) On the other hand, if ethanol production is kept below about 2 billion gal/yr, the impact on food prices probably will be relatively small because most of the increased grain production could be accommodated by replacing soybean with corn production. In this case, the total area of farmland under intensive cultivation would not have to increase as sharply (per gallon of ethanol produced) as would be necessary for the higher level of ethanol production.[7]

Finally, over the long term, the forced reduction in oil consumption and the replacement of oil with nonpetroleum fuels and increased efficiency will accelerate the transition that must occur in the 1990s (as domestic oil production falls) if the United States is not to remain heavily dependent on imported oil.

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[6] *U.S. Natural Gas Availability: Conventional Gas Supply Through the Year 2000–A Technical Memorandum* (Washington, DC: U.S. Congress, Office of Technology Assessment, OTA-TM-E-12, September 1983).

[7] *Energy From Biological Processes* (Washington, DC: U.S. Congress, Office of Technology Assessment, OTA-E-124, July 1980); and *Energy From Biological Processes, Volume II: Technical and Environmental Analyses* (Washington, DC: U.S. Congress, Office of Technology Assessment, OTA-E-128, September 1980).