## Chapter I

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The U.S. economy and energy supply system were jolted by two oil supply disruptions during the decade of the 197'0s. In each case, deliveries of liquid fuels were restricted or unreliable for several months after the onset of the disruptions, and oil prices rose rapidly. Following these initial instabilities, deliveries became more reliable; but petroleum prices remained permanently higher[1] than before the disruptions, a situation that is economically equivalent to a permanent reduction in petroleum supplies. Thus, both disruptions can be characterized as resulting in a temporary period of instability, but a permanent reduction in oil supplies.

The disruptions and supply shortfalls during the 1970s have created substantial economic problems for the United States and changed U.S. thinking about the importance to the United States of energy and of a stable energy supply. The recessions and inflation during that period were due in part to the large, permanent oil price increases. in addition, the dependence of the United States and its allies on imported oil has intensified the already critical strategic problem of the Middle East, and the United States has invested and is continuing to invest considerable sums of money to establish a strategic petroleum reserve capable of cushioning any further shocks.

Another response to the higher oil prices has been the considerable change in oil use in the United States. Oil demand in 1983 was down about 20 percent from the peak year of 1978, and U.S. net oil imports dropped from about 8.6 million barrels per day (MMB/D) in 1977 to about 4.3 MMB/D in 1983. This change is a result of conservation and fuel switching, as well as reduced and changed economic activity. Because of these substantial import reductions, which have also occurred in other oil-importing nations, the amount of oil exported from the Middle East has declined by about 10 MMB/D since 1978. Indeed, the decline in world demand has been considerably larger than the loss of oil exports from Iran and Iraq resulting from the Iran/Iraq War.

Given these conditions, the natural question is how much should the United States be concerned about the possibility of another curtailment of oil supplies to this country. The problem is still very serious. Despite their large drop, oil imports are still a significant fraction (about 30 percent) of total U.S. oil demand. And even though the U.S. economy is considerably more energy efficient, continued economic growth is still heavily dependent on a steady supply of energy at relatively stable prices. In addition, the responses constructed so far to deal with a possible future shortfall are only able to cushion the shock and relieve supply restrictions over a period of about a year or so. Judging from the previous disruptions, however, a future shortfall is likely to be, in effect, permanent. Finally, there are circumstances under which the supply of oil could again be dramatically reduced. For example, a major war in the Middle East could destroy the production capacity of the large producers for several years. Indeed the war between Iran and Iraq has significantly reduced those countries' export capability for the last 5 years and there are signs that this war could spread to other parts of the Persian Gulf.

To investigate possible U.S. responses to a sudden and permanent reduction in oil supplies to the United States, OTA has assessed the nonmilitary technological measures that could be taken to replace large amounts of oil within 5 years after the onset of a supply shortfall. This assessment does not explicitly address emergency management strategies (e.g., a drawdown of the Strategic Petroleum Reserve and private oil stockpiles) designed to minimize the initial instabilities following a disruption, although such measures would be needed. **Rather, it focuses on an evaluation of the rates that energy technologies could be deployed to replace the lost oil following a shortfall and on the economic impacts and**

[1] **Following the 1973-74 disruption, real oil prices rose by about 120 percent and remained at that level. After the 1979 disruption, real oil prices peaked in 1981 at 120 percent higher than their 1978 level. By early 1984, 5 years after the onset of the disruption, 011 prices remained at about 60 percent above their 1978 level, Economic recovery from the current recession is likely to put some upward pressure on oil prices in the years ahead.**

**potential market clearing price of oil associated with different rates of deployment.**

Initially, OTA considered a wide variety of technologies for reducing U.S. oil consumption, including technologies for switching from oil to other fuels and for increasing the efficiency of oil use. The technologies that show the most promise for replacing large quantities of oil within 5 years after the onset of a supply shortfall (assumed to begin in 1985) were then considered in more detail. Potential deployment rates for these latter technologies were derived, based on historical peak rates of deployment, estimates of production capacities for the needed equipment, assumptions about U.S. oil consumption in 1985, and other relevant factors. An alternative deployment scenario was then also derived, based on more pessimistic assumptions about the rates of investment in the energy technologies.

To study potential economic impacts, it is necessary to specify the magnitude of the potential oil supply shortfall. Since OTA is primarily interested in studying the effects of oil replacement technologies, the postulated shortfall should be relatively large, so that it cannot be accommodated solely through relatively minor economic and behavioral adjustments. One such possibility might be the cessation of oil exports from the Persian Gulf countries. As of mid-1983, these countries exported a little more than 9 MMB/D, down from about 14.4 MMB/D in 1981 (mostly due to a reduction in Saudi Arabian production).[2] Since the U.S. accounts for about one-third of the non-Communist world oil consumption, the U.S. share of a 9 MMB/D world oil shortfall would be about 3 MM B/D.[3] Other scenarios are possible, ranging up to a U.S. shortfall of nearly **5** MMB/D, if Persian Gulf exports return to their 1981 levels;[4] but 3 MMB/D is more plausible and is adequate to illustrate the effects of deploying the oil replacement technologies. **Consequently, for the purposes of this analysis we have assumed that the U.S. oil shortfall would be 3 MMB/D starting in mid-1985.**

Based on this hypothesis, on assumptions about the rate that oil stocks would be drawn down, s and on the technical analysis, OTA modified and used a macroeconomic model of the U.S. econ-

[2] Exports in 1981 are based on production of 16 MMB/D and consumption of 1.6 MMB/D by these countries ("BP Statistical Review of World Energy 1981 ," British Petroleum Co., Britannic House, Moor Lane, London E2CY 9BU.). Mid-1983 exports are based on production of 10.5 MMB/D ("Monthly Energy Review, " DOE/EIA-0035(83/10), October 1983) and an assumed consumption of 1.4 MMB/D.

[3] If U.S. oil prices are allowed to rise to world levels during the shortfall and U.S. price elasticity of demand is the same as in other countries in the world, then each country's consumption would drop in proportion to its consumption before the shortfall. The elasticity of oil demand in the United States, however, may be greater than in most other industrialized countries because U.S. energy use is generally less efficient. Furthermore, because U.S. consumer oil prices are generally lower than in other industrialized countries, the percentage increase in U.S. oil prices could be larger than elsewhere. If so, the reduction in U.S. oil consumption could be proportionately greater than in other industrialized countries. On the other hand, the fact that about two-thirds of the U.S. oil consumption is domestically produced means that the flow of capital out of the country to pay for imported oil would be significantly less (relative to gross national product) than in many other industrialized countries. Thus, the drop in industrial output and the consequent relative reduction in oil consumption in some of these countries could be larger than in the United States.

[4] As mentioned in the text, Persian Gulf countries exported about 14.4 MMB/D in 1981. With a world oil shortfall of this size, then under the International Energy Agreement (IEA) the United States would have to reduce its consumption by about 3.4 MM B/D (less the emergency reserve drawdown obligation). In that year, however, the U.S. oil use was 32.9 percent of world oil consumption (excluding U. S. S. R., China, and Eastern Europe). Consequently, in the absence of the IEA allocations and market pricing of oil in the United States, the U.S. share of a 14.4 MMB/D world shortfall would be 0.329 X 14.4 = 4.7 MMB/D. For a 10 MMB/D world oil shortfall, the U.S. share would be 2.5 MMB/D under the IEA and 3.3 MMB/D in the absence of IEA allocations. The corresponding numbers under a 5 MMB/D shortfall are 1.4 MMB/D and 1.6 MMB/D, respectively. (These calculations are based on 1981 production and consumption figures from "BP Statistical Review of World Energy 1981 ," British Petroleum Co., Britannic House, Moor Lane, London E2CY 9BU and the text and sample calculation in "Agreement on an International Energy Program (as amended to 19th May, 1980)," International Energy Agency.) Despite the fact that adherence to the IEA would provide the United States with larger supplies of oil than would the free market (after initial adjustments), the IEA may nevertheless be viewed initially by the public as being unfair to the United States. Since the United States imports most of its oil from sources other than Persian Gulf countries, a cessation of oil exports from the Persian Gulf would not have a large immediate effect on U.S. imports. Under the IEA, however, the United States would have to divert some of its imports to other IEA member countries. Although the international oil market would eventually divert larger amounts of our imports to these other IEA member countries, the initial, organized diversion may still be viewed with some suspicion in the United States.

[5] In both scenarios, the Strategic Petroleum Reserve (SPR) and private oil stockpiles are assumed to be drawn down at a rate starting at 1.5 MMB/D and dropping to 0.75 MMB/D after 1 year, 0.38 MM B/D after 2 years, and zero at the end of the third year. Consequently, OTA has assumed stocks totaling almost 700 million barrels of oil would be used, of which over half currently is in the SPR, At mid-1983 rates of filling the SPR (0.24 MMB/D), the SPR would reach about 525 million barrels by mid-1 985.

omy[6] to estimate plausible economic impacts of the oil shortfall with different rates for deploying the oil replacement technologies. The difference in the economic impacts associated with the two technology deployment scenarios then served as a principal measure of the effects of deploying these technologies.

In the next chapter, the major issues and findings of the assessment are summarized. Chapter III presents a brief history and current profile of energy and oil use in the United States. Chapters IV and V summarize the technical analyses of the oil replacement potential through fuel switching and conservation, respectively; and chapter VI combines these analyses into overall scenarios, examines the overall changes in fuel use, discusses possible variations on the scenarios, and briefly describes the longer term effects of deploying the technologies. The final chapter gives a description of the economic model and discusses the macroeconomic effects, including the results of the modeling and other relevant economic considerate ions.

[6] Inter-Industry Forecasting Model of the University of Maryland.