Chapter 4

Economic Aspects of Oil Replacement Strategies

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INTRODUCTION

Past oil shocks have had severe impacts on the economy, contributing to inflationary pressures and causing widespread unemployment.[1] During the 1970s, the growth rates of the seven major Organization for Economic Cooperation and Development (OECD) countries were cut in half by higher oil, raw material, and food prices and the policy responses to those shocks. In the mid-1980s, Stanford University's Energy Modeling Forum[2] concluded that a sustained oil price shock comparable in size to those experienced during the 1970s would cost $2,000 per U.S. resident when the costs are cumulated over a 4-year period.[3] More recently, some analysts have attributed the recent slowdown in economic activity, at least partly, to the price jump in August through October as tensions mounted in the Persian Gulf over Iraq's invasion of Kuwait, even though these price increases were only temporary.

This chapter discusses the likely economic impacts of a major oil disruption in which all of the 16 million barrels per day (MMB/D) of Persian Gulf oil is removed for 5 years. These effects are compared with a baseline scenario depicting stable oil market conditions. The analysis incorporates price-driven replacement of oil but without additional policy initiatives. A second scenario considers the effect of such a disruption when the Nation simultaneously accelerates the use of oil replacement technologies discussed in chapter 3. The analysis addresses three central issues: 1) the effect of a major disruption on oil prices, 2) the effects of these oil price changes on the U.S. economy, and 3) the effect of an aggressive U.S. oil-replacement policy on mitigating the oil price shock during a major disruption.

Impacts on the prices and on the economy are derived for two time periods-2 years and 5 years after the disruption. Economic impacts are measured in terms of changes in real gross national product (GNP), which is a measure of the Nation's total production of goods and services. In addition, the chapter also reports separate estimates of changes in real national income, which is a broader economic indicator that measures the country's ability to purchase goods and services on the international market. Changes in real national income incorporate both changes in physical production of goods and services and changes in the purchasing power of income received for producing those goods and services.

The analysis reveals four key conclusions:

1. The U.S. economy has achieved significant improvements in oil efficiency over the years. Coupled with today's lower oil prices, this situation has made the U.S. economy less vulnerable to sudden oil price shocks than during much of the 1970s and 1980s.
2. The world economy has become more dependent on oil supplies from the Persian Gulf. This trend increases the economic damage that can result from losing oil supplies from this politically volatile region.
3. The merits of an accelerated oil replacement strategy depend on how the policy is implemented. The strategy will be most effective when it targets least costly options and when it is matched by policies in other countries. It will be least effective when it targets unproven options that turn out to be expensive and when it is adopted unilaterally by one country.
4. Future research in this area should focus on the costs of different technology options as well as the potential for replacing oil use. Two policies replacing the same amount of oil can have very different economic impacts if the incurred costs are dissimilar.

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[1] See e g., those studies reviewed by R.S. Dohner, "Energy Prices, Economic Activity, and Inflation: A Survey of Issues and Results," in K.R. Mork, *Energy 'Prices, Inflation, and Economic Activity* (Cambridge, MA: Ballinger, 1981). For a contrarian view, see Douglas R. Bohi, *Energy Price Shocks and Macroeconomic Performance* (Washington, DC: Resources for the Future, 1989).

[2] The Energy Modeling Forum conducts studies to improve the usefulness of energy models fOr understanding important energy problems. ‘ach study *is* conducted by an ad hoc working group of about 40 individuals from government, business, and universities.

[3] These costs are the undiscounted sum of 4-year losses measured in 1983 dollars. They represent about 12 percent of total GNP for the year, 1983. See also, Energy Modeling Four-m, *WorldOil;* EMF Report 6 (Stanford, CA: Stanford University, 1982); and Energy Modeling Forum, *Macroeconomic Impact ofEnergy Shocks;* EMF Report 7 (Stanford, CA: Stanford University, 1985).

ECONOMIC IMPACTS OF OIL SUPPLY DISRUPTIONS

Oil disruptions contribute to inflationary pressures and create widespread unemployment. These hardships emerge in all economies that rely heavily on oil. It makes little difference whether a country is an exporter or importer of oil; both types of economies have suffered about equally, accounting for other factors.

Why Estimates Vary

While there is general agreement that oil disruptions create economic hardships, there is less agreement about the magnitude of these impacts because a number of factors contribute to how high prices rise and how much economic growth is affected.

The removal of oil supplies from an integrated market will cause prices to rise in order to constrain demand and encourage additional supplies from regions not curtailed by the interruption. One important determinant of how high prices will move is the relative importance of the disruption to total world oil supplies. Another is the responsiveness of oil supplies and demands to price. In addition, the expectations of market participants can be extremely important. During past oil shocks, anticipatory behavior and inventory policies have caused prices to rise substantially, even when the physical volumes removed have been relatively small. It is extremely difficult to evaluate how expectations affect oil prices quantitatively.

Once the oil price increase is known, the size of the economic impacts will depend on a number of factors: the baseline economic conditions before the shock, the stickiness in wages and prices throughout the economy, the policies used to offset either the inflationary pressures or growing unemployment, and the relative importance of oil in economic activity. Moreover, expectations about how the economy adjusts and how policy makers will respond can have an important effect on the ultimate economic impacts.

Two Measures of Economic Impacts

There are many possible measures of the economic impacts of oil price shocks. This chapter reports results for changes in real GNP and for changes in real national income. The major effects causing each impact are discussed briefly below.

Changes in Real GNP

Higher oil prices reduce aggregate economic output in both the short and long run. In the near term, total spending falls, causing the economy to experience widespread unemployment. A key culprit in this process is the stickiness in other prices and wages that prevents price declines for most goods and services. As a result, the oil price shock temporarily causes the economy's general price level to rise more. This development will push interest rates higher, particularly if policymakers fear renewed inflation and hold the money supply unchanged (or even reduce it). Higher interest rates curtail first investments and then additional spending associated with those direct investments through the multiplier effect. Domestic spending may also be lessened as higher prices reduce real wealth and purchasing power. Ultimately, as prices and wages adjust to the higher oil prices, the economy moves back closer to its full employment level. Over the longer run, a sustained oil price increase will cause the productivity of labor and capital to decline because the substitution for oil leaves existing labor and capital with less energy to work with.

Changes in Real National Income

Higher oil prices also harm the economy in another way. Even if total physical production is not changed, the distribution of that output between foreigners and domestic residents is altered. The economy must now allocate more wheat and other exports for paying for oil imports and retain less of these goods for domestic consumption. The Nation's purchasing power over all goods purchased (including imported oil) is reduced by the higher cost of oil. Owing to the conventions of national income accounting, this reduction in real national income is not incorporated by the change in real GNP measured by macroeconomic models.

OTA 1984 Analysis of Responses to a Severe Oil Import Curtailment

In the 1984 study, a world oil supply shortfall of 9 to 10 million barrels per day (MMB/D) over a 5-year period was assumed to result in a 3 MMB/D reduction in oil available in the United States.[4] Nevertheless, U.S. technical oil replacement potential was deemed great enough to replace 3.6 MMB/D of the expected 3 MMB/D decline within a 5-year period.

It was realized, however, that the technical potential might not result in actual reductions if price conditions or policies did not motivate individual decisionmakers to make the requisite capital investments and behavioral adjustments. Thus, two response cases were considered: in the high-response case, the full 3 MMB/D shortfall was replaced by the end of the 5 years; in the low-response case only half of the initial shortfall was replaced within 5 years. In both cases, however, net shortfalls persist throughout the 5 years before the requisite adjustments in oil use are made.

The net oil supply shortfalls were projected to induce significant economic losses over the 5-year period. In the high-response case, the permanent loss of oil imports lowered GNP on the average by about 3.5 percent from its baseline level, with a maximum yearly loss of 5 percent in the second year after the start of the disruption. In the low-response case the average GNP loss was about 6.2 percent, with a maximum yearly loss of about 10 percent also occurring in the second year after the disruption begins. In both cases, the GNP rebounds toward the end of the 5-year period because investments in oil replacement have reduced the burden of high energy costs on the economy.

Although GNP was projected to decline only in the second year after the shortfall begins, the decline in the high-response case was only 1.3 percent from the previous year, while it was 5.2 percent in the low-response case. By comparison, in 1982 the worst recession since the Great Depression resulted in a real GNP decline of 1.7 percent relative to its level in 1981. In other words, the losses projected for the high-response case are within recent historical experience, while those projected for the low-response case were well outside of it.

Differences Between the 1984 and the 1991 Assessments

World Conditions

Although many aspects of the world oil market and oil vulnerability remain qualitatively similar to conditions that existed in 1984, there are some important quantitative differences. The world and the United States still rely heavily on oil as an energy source and a significant fraction of world oil supplies continues to come from the Persian Gulf. On the other hand, because of growth in the U.S. economy (about a 20-percent increase after accounting for inflation), very little increase in oil consumption, and lower oil prices (about 50-percent decline in real terms), the share of U.S. GNP devoted to oil purchases in 1991 has declined to about 40-percent of its value in 1983. This makes any dollar increase in the price of oil cost the United States economy less now than in 1983.

Partially offsetting the moderating effect of a lower share for oil in the economy, is the recent increase in the share of the world's oil coming from the Persian Gulf. This is a result of the increase in the share of oil that is imported by the United States (the U.S. net import share of consumption has increased from about 30 percent of total U.S. oil consumption in 1983 to about 42 percent today) and other oil importers. The concentration of low-cost oil reserves in the Persian Gulf will likely mean steady increases in the Gulf share over the next decade. Since the region is politically unstable, the more oil it produces, the larger the oil supply interruption resulting from any initiating event. And the larger the shortfall, the larger the world oil price increase required to bring world oil supply and demand back into balance.

A final difference in conditions since 1984 is that a large 5-year interruption in oil supplies now seems less likely, owing to the increase in the number of oil exporters as well as the recently demonstrated propensity of the remaining producers to try to makeup shortfalls.

[4] U.S Congress, Office of Technology Assessment, U.S. *Vulnerability to an Oil Import Curtailment: The Oil Replacement Capability*, OTA-E-244 (Washington, D. C.: U.S. Government Printing Office, September 1984).

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Methodology

There were several key differences in the method OTA used to calculate the economic impacts of the oil shortfalls, with and without oil replacement initiatives. These differences were the result of more limited resources and less time available for the 1991 study, changes in world oil and economic conditions, the opportunity to study the impacts of oil shocks since 1984, and the differences in the technical oil replacement analyses used by OTA as inputs. The two most significant differences are the way the responses to the oil supply reductions are represented and the way post-shortfall oil prices are computed. These differences are described here briefly in order to set the stage for the technical analysis that follows.

The 1984 analysis used a multisector input-output model to trace the impact of the oil shortfall on interindustry activity. Industrial and utility boiler oil replacement measures were used to adjust input-output coefficients and sectoral demands directly, while prices were increased until reductions in transport, residential, commercial, and nonboiler industrial uses achieved the remaining required overall shortfall in demand. In the present analysis, all oil demands are aggregated and the replacement policies are assumed to reduce the level of oil demand at any price, reducing the price increase required to rebalance the oil market for a given reduction in U.S. oil supply availability. In this regard the 1984 analysis was more detailed than the present one.

In the 1984 analysis it was assumed that the U.S. share of the world oil shortfall would be that derived from the International Energy Agency's (IEA) emergency sharing rules. Many analysts now believe that since those rules allocate much of the reduction in accordance with preinterruption import shares, those reductions would not be consistent with a market response, which would tend to allocate them more in accordance with consumption shares. In addition, a non-OPEC increase in production would be expected if an OPEC shortfall were to persist over a 5-year period. Thus, in the 1991 analysis, the price of oil is adjusted on a worldwide basis rather than a U.S.-only basis. This tends to make the U.S. oil import reductions smaller, but also makes the U.S. oil replacement policies somewhat less effective in reducing the U.S. economic impacts of the assumed world oil shortfall.

Analysis of the Economic Impacts of an Oil Replacement Strategy, 1991

For this report, OTA did not conduct an extensive analysis of the economic impacts of the 5 MMB/D disruption scenario. Instead, we have based our analysis on a number of other studies of oil markets and the economic impacts of disruptions, including several by Stanford University's Energy Modeling Forum. These studies provide a useful perspective from which to derive approximate estimates of the impacts that might be obtained from more comprehensive modeling of the key energy and economic relationships. The a preach used in this study is briefly described here.[5]

Disruption Size

Since oil is easily traded internationally, the impact of a disruption on any economy (including that of the United States) must be estimated from world oil market conditions. All economies face the same increase in oil prices, which will be governed by the share of world oil production lost during the disruption and how much price increases augment supply and curtail demand after the disruption. The U.S. dependence on oil imports will not directly determine how high oil prices will move in a disruption or in response to a U.S. oil replacement policy.

This situation means that the economic impact of a disruption must be determined from world rather than U.S. oil market conditions. It is assumed that all of the 16 MMB/D of Persian Gulf oil is lost to the world market for an extended period of 5 years. The lost production represents almost a 30-percent shortfall for a world oil market using 53 MMB/D in the second year, although the shortfall will be partly offset by the increase in world oil supplies from non-OPEC regions induced by the higher prices of the sustained disruption. Accordingly, the U.S. economy will share proportionately in this world shortfall of 30 percent, unless supply and demand responses to prices vary significantly across countries. For purposes of this analysis, we estimate that an initial 16 MMB/D disruption removes about 4 MMB/D of oil from the U.S. economy, after accounting for the expected production offsets from supply regions outside OPEC. Ignoring this additional supply response will lead to an

[5] The details of the analysis are contained in Hillard G. Huntington and John P. Weyant, "Economic Impacts of U.S. Oil Replacement Policies: Methodology and Results for the OTA Anal ysis," OTA contractor report, April 1991.

overestimate of the economic losses resulting from the disruption. Note that this total shortfall of 4 MMB/D is less than that assumed in the oil disruption scenario used in chapter 3, which assumes no additional imports from alternative suppliers.

The responses of supply and demand to price and income were chosen on the basis of a number of studies of these parameters, with particular emphasis given to a 1991 Energy Modeling Forum study on international oil supplies and demands.[6]

Changes in Real GNP

The mechanisms through which oil prices can affect the economy are numerous and are best represented by a fully articulated model of the national economy. In this chapter, we provide an estimate of the impact through the use of a single parameter linking oil price changes with declines in real GNP. This parameter has been chosen on the basis of past simulations of more than a dozen models in a previous Stanford Energy Modeling Forum (EMF) study.[7] Oil expenditures as a share of GNP are currently about 40 percent' of their share in 1983 (when the EMF study was conducted) at a price of about $17 per barrel (bbl). As a result, the earlier EMF estimates of these elasticities have been scaled down accordingly. In the current analysis, a 10-percent sustained oil price increase is assumed to reduce the level of real output (GNP) by 0.4 percent after 2 years and by 0.2 percent after 5 years. The impact becomes smaller over time, reflecting the economy's increased capacity for adjusting to less oil.

Changes in Real National Income

Changes in real national income include changes in physical output (GNP) as well as changes in the purchasing power of the income received for producing those goods and services.[8] The latter has been estimated as the changes in the Nation's oil import bill due to higher oil prices. They are calculated from changes in the oil price (see above) and from the levels of U.S. production and consumption both before and after the disruption. Adjustments in oil demand and supply levels as a result of the disruption are derived from estimates of the response of supply and demand to price changes, available from the Energy Modeling Forum study on international oil supplies and demands mentioned above.

Results

The lost oil production and its effect on oil prices for the disruption scenario are summarized in the first two columns of table 4-1. Although there exists considerable uncertainty about how high oil prices would rise during a disruption, these estimates are representative of others made for similarly sized oil disruptions.

The sustained disruption would push oil prices from an assumed $22/bbl in the baseline, held constant over the next 5 years, to about $50/bbl after 2 years and to about $44/bbl after 5 years.[9] Prices in the very short run, of course, could be considerably higher, particularly since these estimates ignore such issues as oil trading and stockpiling dynamics.

A second scenario combines the sustained disruption with an aggressive U.S. policy toward replacing oil use. Based on the deployment schedule provided in the technical analysis of the oil-replacement technologies, the policy is assumed to reduce U.S. oil use by 1.4 MMB/D at any oil price in the second year and by 3.0 MMB/D in the fifth year. It is assumed that the policy does not displace any oil consumption that would ordinarily be curtailed as a result of the higher prices of a disruption and that it successfully targets the most cost-effective opportunities within this subset of technologies. These assumptions give the oil replacement policy its most favorable impact on oil prices. As shown in the last two columns of table 4-1, the oil replacement policy causes the world oil price to rise less than in the initial scenario. As with the disruption-only case, these effects must be calculated from world oil rather than U.S. market condi-

[6] Energy Modeling Forum, *International Oil Supplies and Demands*, EMF Report 11 (Stanford, CA, Stanford University, 1991).

[7] Energy Modeling Forum, *Macroeconomic Impact of Energy Shocks*, EMF Report 7 (Stanford, CA, Stanford University, 1985).

[8] The real national income results also include some estimates of the cost of the oil replacement policy, which requires capital and other inputs to be diverted from other sectors to reduce oil use beyond the level that would be selected by market participants responding to price alone. The reduction in national income caused by this shift is not incorporated in the earlier estimates of the real GNP loss, which were a function of oil price changes only. It is estimated that the oil replacement policy would require that an additional $13.7 billion of national income be spent during the second year, and an additional $19.7 billion in the fifth year. These costs could be substantially higher if the oil replacement program targeted investments that turned out to be more expensive.

[9] All prices are in constant 1990 U.S. dollars.

Table 4-l—Disruption Size and Oil Price Impacts
MMB/D and Prices in 1990 $/barrel

	Sustained oil disruption		Disruption with oil replacement	
	Second year	Fifth year	Second year	Fifth year
Supply disruption:				
World oil supply*	16.0 MMB/D	16.0 MMB/D	16.0 MMB/D	16.0 MMB/D
U.S. replacement policy	0.0 MMB/D	0,0 MM B/D	1.4 MMB/D	3.0 MM B/D
Net world shortfall	16.0 MM B/D	16.0 MMB/D	14.6 MMB/D	13.0 MMB/D
Percent of world*	30.2%	29.3%	27.5%	23.8%
Oil price increase	125.8%	97.5%	11 4.8%	79.2%
Disrupted price	8 . . . . $49.7	$43.5	$47.3	$39.4
Baseline price	$22.0	$22.0	$22.0	$22.0

● Excluding U. S. S. R., People's Republic of China, and Eastern Europe.
NOTE: MMB/D = million barrels per day

SOURCE: Hillard G. Huntington and John P. Weyant, "Economic Impacts of Oil Replacement Policies: Methodology and Results for the OTA Analysis," OTA contractor report, April 1991.

tions because oil can be easily traded between regions. The policy of replacing 1.4 MMB/D of U.S. oil use reduces the net world shortfall of the disruption to 14.6 MMB/D, or about 27.5 percent of world baseline consumption of 53 MMB/D in the second year. Oil prices after 2 years rise from $22/bbl to about $47/bbl in this case. Relative to the disruption-only case, the U.S. policy reduces the price shock by an additional $2.40/bbl after 2 years and an additional $4/bbl or so after 5 years. The incremental effects of the policy are relatively modest because the U.S. policy is relatively small in the context of world oil production and consumption.

Table 4-2 contains the estimates of losses in real GNP and real national income in both scenarios. Real GNP would be sharply reduced by a sustained disruption of Persian Gulf oil, declining 5 percent below its baseline after 2 years and 2 percent below after 5 years. The GNP loss after 2 years would be substantially larger than those experienced during past oil price shocks. The National Petroleum Council estimated GNP losses to be 2.7 percent from the 1973 disruption and 3.6 percent from the 1979 shock.[10] An accelerated U.S. oil replacement policy would mitigate the losses from a sustained disruption somewhat, but the level of GNP would still fall by 4.6 percent and 1.6 percent, respectively, for these two years. The incremental effect of the policy would be to restore about 0.4 percent of real GNP in each year.

The broader measure of real national income shows larger losses from a disruption than does real GNP, because it incorporates the effect of higher oil prices on domestic purchasing power. Conclusions about the effectiveness of the oil-replacement policy, however, remain similar to those based on the real GNP results. In the second year of the sustained disruption, real national income would be 6.3 percent lower than the baseline without the oil replacement policy and 5.6 percent lower with the oil replacement policy. By the fifth year, real national income would be 3.0 percent lower without the policy and 2.1 percent lower with the policy.

These results suggest that the policy could provide some modest benefits in both real output and real national income, depending on how it is implemented. We have attributed to the policy its largest impact on oil prices because it is assumed to displace only oil use that would not already be displaced by higher prices during a disruption. In addition, it is assumed that the policy targets only the most cost-effective opportunities for replacing oil that remain after the disruption. While these assumptions have represented the policy in its most favorable form, the analysis has not incorporated any potential economic gains from removing barriers that result in inefficient use of energy, labor, and capital. It is unclear whether oil replacement policies would lead to such gains, but if they do, they would produce additional benefits that

locational petroleum Council, Factors Affecting U.S. Oil and Gas Outlook (Washington, DC: February 1987).

Table 4-2--Comparison of U.S. Economic Impacts of a Sustained Oil Disruption and an Oil Replacement Strategy

	Sustained oil disruption		Disruption with oil replacement	
	Second year	Fifth year	Second year	Fifth year
Percent change in the level of:				
Real GNP $......	-5,070	–2.0%	-4.6%	–1 .6%
Real national income ...	-6.3%	-3.0%	-5.6%	–2.1%

NOTE: Changes in real GNP, as conventionally measured in the national income accounts, represent changes unphysical output. Changes in real national income includes changes in the purchasing power of the income received from producing that output

SOURCE: Hiliard G. Huntington and John P. Weyant, "Economic Impacts of Oil Replacement Policies: Methodology and Results for the OTA Analysis," OTA contractor report, April 1991.

have not been incorporated here because they are difficult to quantify. A more refined evaluation of the oil-replacement costs would require additional information on the cost effectiveness of different oil replacement strategies as well as an estimate of how much of the oil replacement is induced by higher prices during the disruption and how much remains to be implemented even after the higher prices.

The estimates of the economic impact of a disruption are sensitive to several key assumptions. The reported losses would be higher when: 1) oil demands and supplies are less responsive to price, or 2) the impact of oil prices on real GNP is larger. However, the relative costs of implementing an accelerated U.S. oil replacement policy during a sustained disruption are quite insensitive to these assumptions. Instead, the relative merits of the policy depend critically on assumptions about how it is implemented. It will be most effective: 1) when the policy is targeted toward the least costly technologies, and 2) when the policy is adopted simultaneously by all countries rather than implemented unilaterally.

Further Research

A more comprehensive evaluation of the oil replacement policy would require three analytical components:

1. a representation of world oil markets and their responses to changed conditions,
2. a model of the U.S. economy that can incorporate some data on alternative technologies, and
3. a detailed assessment of oil replacement technologies that developed estimates of how much oil could be replaced at successively higher costs.

The world oil market conditions have been represented quite simply in the current analysis by extracting key parameters from more extensive studies of these models. An alternative approach would be to base the analysis of world oil conditions on a single model, like the Energy Information Administration's Oil Market Simulator (OMS) system. Given that both approaches are readily available, this aspect of the analysis would not require extensive further development.

For estimating the economic impacts on the U.S. economy, a macroeconomic model that represents the relationship between inputs and outputs in individual industries could be used.[11] Such a framework allows the technical characteristics of the major oil replacement options to be explicitly represented. Many macroeconomic models focus on aggregate economic conditions and do not include a detailed accounting of industrial input needs.

[11] Two suitable approaches are the input-output framework, which is embedded in the INFORUM model used in OTA's 1984 analysis, and the general equilibrium approach, which has been pioneered by Professor Jorgenson in his Dynamic General Equilibrium Model (DGEM). See D. Jorgenson, "Econometric and Process Analysis Models for Energy Policy Assessments,"" m R. Amit and M. Avriel (eds.) *Perspective of Resource Policy Modelling: Energy and Minerals* (Cambridge, MA: Ballinger, 1982).

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Finally, it is important that future estimates of the oil replacement potential carefully consider not only the amount of oil replaced but also the costs of implementing these technologies, using consistent economic assumptions across the various options. When oil prices rise during a disruption, some options will be chosen in response to the new market conditions and, therefore, no new policy initiatives will be needed. Other options will not be chosen even at the higher prices. A more comprehensive analysis of an oil replacement policy must differentiate between these two types of opportunities.

CONCLUSION

Future oil disruptions will continue to pose a serious threat to U.S. economic activity. Although the U.S. reliance on oil to power its economy has declined over the last two decades, the world has become increasingly more dependent on oil supplies from the Persian Gulf, and virtually all experts expect this dependence to grow over time.

As estimated in this chapter, real GNP would be sharply reduced by a sustained disruption of Persian Gulf oil, declining 5 percent below its baseline after 2 years and 2 percent below after 5 years. An accelerated U.S. oil replacement policy would mitigate the losses due to a sustained disruption somewhat, but the level of GNP would still fall by 4.6 and 1.6 percent, respectively, for these 2 years. The incremental effect of the policy, therefore, is to restore about 0.4 percent of real GNP in each year.

Implementation issues remain critical to the potential success of an accelerated oil replacement policy. The policy would provide more economic benefits than estimated here if the U.S. action were coord–inated with similar policies in other countries. It would be less effective than estimated here if the policy failed to target the most cost-effective technologies.