Reducing Vulnerability to Middle East Energy Shocks

A Key Element in Strengthening U.S. Energy Security

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Front cover: A motorist in Oakland, California, passes a gas station billboard showing the price spike that followed Hurricane Katrina in late August 2005. Copyright AP Wide World Photos/Ben Margot

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Executive Summary

HIGH OIL PRICES, instability in the Persian Gulf, and political tensions with key oil-producing countries underscore the cost to the United States of its heavy reliance on oil from tumultuous regions. In the 2004 presidential election, both candidates called for an energy policy to decrease dependence on foreign oil. In his 2005 State of the Union address, President George W. Bush called for legislation that "makes America more secure and less dependent on foreign energy."

One particularly troublesome aspect of the overall energy problem is America's vulnerability to Middle East energy shocks. Building on The Washington Institute's core competence—understanding the dynamics of Middle Eastern politics and the policies most appropriate to advancing U.S. interests in that volatile region—this report examines the level of America's dependence on Middle Eastern energy, the extent of its vulnerability to regional energy shocks, and the policy instruments at the U.S. government's disposal to limit the likelihood of these shocks and reduce their negative impact on U.S. interests.

Vulnerability to Shock: A Strategic Concern

For the next several years, oil markets are likely to remain tight. Tight oil markets make the global economy keenly vulnerable to a disruption in supply. Although some economists argue that markets can respond to any oil supply shock, a sharp rise in prices—like the quadrupling that occurred in the early 1970s—almost surely would send the global economy into a recession.

While a disruption could come from any direction, as shown by Hurricanes Katrina and Rita, the Middle East plays a particularly important role in world energy supplies. Middle Eastern countries (including those in North Africa) account for two-thirds of the world's current proven reserves of oil and more than one-third of current global production. In addition, the same countries have almost half of the world's current proven reserves of natural gas. Oil imports from the Persian Gulf currently account for only about one-eighth of U.S. demand, but even if the United States went to the considerable expense—financial, lifestyle, and environmental—required to cut consumption and boost production so as to become self-sufficient in energy, the Middle East would continue to be crucial to world energy supply and therefore to energy prices. A Middle East supply shock would profoundly affect the world market for all forms of energy; its repercussions would have a direct impact on the American economy and the nation's global interests. It is therefore important to make the U.S. economy more robust against such supply shocks.

For decades, Saudi Arabia, with its spare capacity and enormous reserves, has been the solution to any energy supply crisis. For the foreseeable future, despite its stated policy of ensuring world oil demand is satisfied, Saudi Arabia may be unable to play this role because, given robust world demand, the kingdom may not have sufficient spare capacity to make up for lost production elsewhere. Moreover, the limited life expectancy of both eighty-two-year-old King Abdullah and his designated successor, eighty-one-year-old Crown Prince Sultan, make for uncertain leadership at a time when the problems of al-Qaeda terrorism, socioeconomic disparities, and huge youth unemployment persist in Saudi Arabia.

The Middle East has a number of potential sources of an oil supply shock:

- Al-Qaeda attacks on Persian Gulf and Iraqi oil facilities, which Osama bin Laden has urged on the grounds that they are "the most powerful weapon against the United States"
- An exodus of oil workers occasioned by fear of terrorism, domestic unrest, or swift change in regime policy
- The spread of Iraqi instability into other oil-producing countries

- A confrontation with Iran over its nuclear program or other problematic behavior, including bullying of regional states over control of local energy sources, possibly including an Iranian threat to shipping through the strategic Strait of Hormuz

- Domestic instability or uncertain political transitions, ranging from crises of leadership succession to radical challenges to regimes

U.S. responses to these and other threats would be constrained by U.S. concerns about energy vulnerability. For instance, U.S. efforts to build a strong international coalition to counter Iran's nuclear program are complicated by the fact that Iranian oil exports are viewed as vital to the world energy balance. In a tight market, not only may it be difficult to induce oil-importing countries like China to support U.S. policies, but they may take actions inimical to U.S. interests, such as exporting arms, to foster bilateral ties with problematic oil exporters.

Reducing Vulnerability to Shock: Elements of a Solution

America's role in an integrated world oil market means that a disruption in Middle Eastern supplies affects the United States no matter how much or how little oil it imports. As part of a broad national strategy to reduce dependence on foreign energy supplies, the United States needs to invest in ways to make energy markets less vulnerable to sudden swings and thereby reduce U.S. vulnerability to supply disruption, especially from the Middle East.

There are numerous ways to strengthen America's energy supply system:

- **Organize the energy policy process to integrate all national objectives.** The increasingly rigid U.S. energy system has in no small part been the unintended result of regulatory actions by several government agencies, each of which focuses on a narrow piece of the overall energy picture. The Environmental Protection Agency, for example, has the largest impact on energy consumption of any U.S. government agency, but it is legally required to examine only environmental considerations. The United States needs a more integrated policymaking process in which the government, as a whole, examines the range of tradeoffs among policy goals and adopts a coordinated energy policy. This will require strengthening the role of a lead actor as coordinator of U.S. national policy.

- **Improve information and strengthen coordination.** Flying blind is a good way to get into trouble, and that is what the United States is currently doing regarding oil production, consumption, and stocks. Markets and governments rely on energy statistics to make important decisions; witness, for example, decisions about quota increases made by the Organization of the Petroleum Exporting Countries (OPEC). But the International Energy Agency (IEA) warns that energy statistics are less and less reliable. On several occasions the data either falsely indicated ample supply or fed exaggerated worries about shortages. Little progress has been made on longstanding plans to improve energy data through a joint effort by producing and consuming country governments. A more encouraging aspect of international cooperation has been the progress in extending the world's system of strategic petroleum reserves to China and India. Those countries should be urged to follow through on their announced plans, and oil exporters should be asked to maintain stabilizing stocks near consumer markets.

- **Prepare alternative plans for responding to an energy shock, beyond the use of oil reserves.** In the event that the shock is very large or might be part of a series of repeated shocks, it would be prudent to have in place plans for a variety of modest emergency administrative measures that could be used to moderate surging prices while still relying on price increases as the main mechanism to restrain demand and boost output. Examples would be designating road lanes as carpool lanes, restoring the fifty-five-mile-per-hour cap on speed limits, and encouraging a four-day, ten-hour-per-day workweek.

- **Increase the role of oil reserves.** The U.S. Strategic Petroleum Reserve (SPR) will soon fill the approximately 730-million-barrel capacity of the facilities built twenty years ago, when U.S. oil imports were less than half their present level. The Energy Policy Act of 2005 authorized increasing the SPR to 1 billion barrels, but funds to do so have not yet been appropriated. At the very least, the SPR should be filled at a rate that maintains its size relative to imports. With this increase in capacity, U.S. policy on the use of the SPR should be made more flexible. Rather than directly linking SPR use to a sudden drop in global oil production of several million barrels per day, as is currently stated U.S. policy, U.S. officials should point out that the law establishing the SPR gives the president latitude to use it under a wide variety of circumstances. After all, supply crises can take the form of price spikes as much as physical shortages. The political reality is that strategic reserves may in fact be released in order to calm markets, as was done after Hurricane Katrina in 2005, even though there was only a limited shortfall (hurricane-related refinery closures meant that demand for crude oil fell almost as much as supply). That said, using the SPR to influence oil prices could end up being ineffective or even counterproductive; for one thing, such action could lead OPEC to take countervailing steps.

- **Provide more capacity and more flexibility in each part of the energy supply system.** In some industries, it makes sense to rely on just-in-time delivery from one dedicated source and to have just enough capacity to meet current demand. But that is not a wise way to run the U.S. energy system. Many parts of that system—such as ports, pipelines, and refineries—already operate at close to full capacity and therefore may have problems adjusting to the loss of the usual supply source. Emblematic of the problems of the U.S. energy system is the fact that no new refinery has been built in the United States since 1976. Reversing these trends—encouraging spare capacity and the flexibility to shift gears—will require a wide range of government policies, including tax incentives and regulatory encouragement.

Protecting the Global Energy Infrastructure

The global energy infrastructure is vulnerable to attacks by hostile states and terrorists. Especially worrisome are major bottlenecks in the oil production and distribution system; these include the Strait of Hormuz chokepoint as well as various key facilities, particularly in Saudi Arabia. Disruption at these facilities could have considerable impact on nervous oil traders and, potentially, on physical oil supplies. The following is a set of proposals to strengthen the security of the global energy infrastructure:

- **Promote antiterrorism "best practices" abroad.** The U.S. government and U.S. private industry have been developing best practices to reduce vulnerabilities in the energy infrastructure, in the context of the National Strategy for the Physical Protection of Critical Infrastructures and Key Assets. These best practices include standards and procedures for security assessment and threat deterrence; physical security corresponding to varying threat levels; protection of information and control systems, including from computer viruses; reconstitution of attacked facilities and systems; and location and distribution of critical components in support of response and recovery activities. Much could be done to work with government and energy companies in the Persian Gulf region to share these best practices and to plan for a U.S. role in, for instance, facility reconstitution.

- **Encourage political reform as part of the fight against violent extremism.** The United States has been working with the Persian Gulf monarchies to counter the threat of terrorism, including the threat to foreign oil workers. It is gratifying to see that Saudi Arabia has responded to domestic terrorism by taking more seriously the threat from Islamist extremists, including making progress in blocking financing for terrorists. Yet much more needs to be done. In particular, Saudi Arabia needs to make a more active effort to root out the teaching and preaching of intolerance and incitement to violence. The U.S. govern-

ment needs to press the Gulf monarchies and Iraq on these fronts as well as on the need to deepen and broaden the pace and extent of political, social, and economic reform. Reform will reduce the frustration and despair that provide extremists with grievances to fill the ranks of their supporters. Enlightened leaders recognize that real, substantive reform is a source of strength and provides an additional bulwark against subversive activity and terrorism.

- **Deter attacks by hostile states.** Besides terrorism and domestic instability, the other major source of threats to the energy infrastructure is hostile action by Iran. In the 1980s, Iran attacked neutral oil tankers in the Persian Gulf in a counterproductive attempt to bully the Gulf monarchies. As tensions build about Iran's nuclear program and Tehran's continued support for terrorism, Iran needs to be deterred from reconsidering the option of attacking oil shipping or oil facilities as a means to press the West. Other Gulf countries and oil-consuming nations share a vital interest in ensuring the free flow of Gulf oil. The United States should take the lead in building a broad international coalition pledged to keeping open the Gulf sea lanes and should identify concrete measures—such as military exercises—that can be taken to show the seriousness of this international commitment.

- **Project sufficient military, particularly naval, force.** U.S. military forces have an important role in deterring hostile states and in protecting key energy infrastructure nodes. The U.S. Navy is the main force providing protection at sea in the Persian Gulf, for which purpose it needs to deploy in sufficient force and to exercise regularly with regional navies. At the same time, the United States needs to press Gulf states to commit enough of their own resources to provide at least the first line of defense. Similarly, the U.S. military should work with Gulf states to prepare for protection of the energy infrastructure from air and missile attack.

The Larger Energy Policy Picture

Energy policy has been caught in a political crossfire. It is not the purpose of this report to take a stand on such issues as global climate change, automotive efficiency standards, or gasoline taxes; the concern here is the vulnerability to supply shocks from the Middle East. But it is essential to note that the difficulty in reaching national consensus about energy policy, which has hurt efforts to expand sources of supply and improve energy efficiency, has made the U.S. energy system more fragile, more vulnerable, and more dependent on foreign oil. The Energy Policy Act of 2005 was not as bold as many would have hoped, and some of its subsidies and tax incentives may not be cost-effective. The act did represent modest progress, however. Hopefully it will be possible to broaden and deepen actions that will carry the United States toward less vulnerability to foreign supply shocks. To be sure, few policies will reduce vulnerability quickly; most would have significant impact only after several years. But this lag should be a reason to act now, rather than waiting for the eruption of a crisis in which there are few options and little time to implement them.

Introduction

RECENT HIGH OIL PRICES and continuing political problems in key oil-producing countries highlight the cost to the United States of its heavy reliance on oil from tumultuous regions. In the 2004 presidential election, both candidates called for an energy policy less dependent on foreign oil. In his 2005 State of the Union address, President George W. Bush called on Congress to pass legislation that "makes America more secure and less dependent on foreign energy."

The focus of this report is supply shocks, not dependence on foreign oil. There is a case to be made for heavy U.S. reliance on cheap foreign oil, much of which comes from such stable and reliable allies as Canada and Mexico. There is a good economic argument for using the Middle East's ample oil resources: oil can be produced there at extraordinarily low cost, and the world economy is well served when goods are produced where their cost is lowest. If the world were to replace 20 million barrels per day in Persian Gulf oil exports with oil from alternative sources costing $40 per barrel more to produce, the net loss to the world economy would be $290 billion per year—an impressive sum.

Yet, a good case can also be made that dependence on Middle Eastern oil has come at a high price. In 2004, the United States paid $77 billion more than in 2002 for imported oil—and $127 billion more than in 1998—even though it is hard to say that production costs rose much in that period.[1] The obvious difference was how well OPEC functioned as a cartel to drive up prices and how poorly consuming countries reacted to the cartel's actions. Then there is the considerable military cost for ensuring Persian Gulf stability, which is in no small part due to that region's central role in energy supplies. Eminent economists have argued that these military costs amount to a subsidy of $10 per barrel or more.[2] And some argue that large U.S. oil imports inflate the revenues of the worst governments in the world and reduce the likelihood of political reform and cooperation with the West by oil exporters such as Iran, Saudi Arabia, and Russia.[3] However one comes out on the issue of whether the United States should reduce dependence on Middle Eastern oil, it would be wise to have an insurance policy in the event of a disruption in supplies from that volatile region.

The concept of a "supply disruption" requires some explanation. With the end of 1970s-style government controls, shocks to world oil supply no longer result in lines at gasoline stations: they produce sharply increased prices. Some may argue that markets can therefore handle any oil supply shock. To be sure, the U.S. economy has adjusted to handle smoothly considerable volatility in oil prices, especially when the price increases occur gradually. But were oil prices to suddenly quadruple as they did in 1971–1973 , it would send the world into a recession and impose heavy burdens on the poorest at home and abroad.[4] And the U.S. economy seems better equipped now than in the past to handle substantial prices increase. Whereas some analysts expected that an increase in the price of crude oil in 2005 to $50 per barrel (the actual 2005 average is closer to $60) would reduce U.S. growth by 0.5

1. U.S. petroleum imports were $50.3 billion in 1998, $102.7 billion in 2002, and $179.2 billion in 2004, according to the February 2005 *Monthly Energy Review* of the Department of Energy's Energy Information Administration.
2. For instance, Jeffrey Sachs, "America's Disastrous Energy Plan," *Financial Times*, December 23, 2003, p. 8.
3. For instance, Thomas Friedman, "Fly Me to the Moon," *New York Times*, December 5, 2004, p. WK13.
4. James Hamilton of the University of California at San Diego, the dean of macroeconomists looking at oil and the economy, has pointed out that all but one of the U.S. recessions since World War II have been preceded, typically with a lag of around eight months, by a dramatic increase in the price of crude oil (for a technical discussion of the issue, see James Hamilton, "What Is an Oil Shock?" *Journal of Econometrics* 113, no. 2 [April 2003], pp. 363–398). As explained by Alan Kreuger of Princeton University in his "Economic Scene" column in the *New York Times* (May 27, 2004, p. C2), Hamilton's work suggests that the dramatic price increase in 2003–2004 would only reduce gross domestic output by 0.5 percent because prices in 2003 had been substantially lower than in 2001; otherwise, the effect would have been much higher. A slow oil price increase has less of an impact than a sudden increase because the economy can adjust, as explained in *A Survey of Oil*, a supplement to the *Economist*, April 30, 2005, p. 4. There is a minority opinion among economists arguing that oil has less effect on the national economy; see Robert Barsky and Lutz Kilian, "Oil and the Macroeconomy since the 1970s," *Journal of Economic Perspectives* 18, no. 4 (Fall 2004), pp. 115–134.

percent, or a loss of $55 billion, there is little evidence anything of the sort has happened.[5] Much of the explanation appears to be better U.S. strategy—using a loose monetary policy to stimulate the economy to make up for the impact of higher oil prices. In addition, the 2003–2005 price increase occurred gradually rather than abruptly, which allowed the economy to adjust over time. That said, price increases are more keenly felt in some sectors of the economy and regions of the country. As Alan Greenspan, chairman of the Board of Governors of the Federal Reserve System, warned, "Unless oil prices fall back, some of the more oil-intensive parts of our capital stock would lose part of their competitive edge and presumably be displaced, as was the case following the price increases of the late 1970s."[6] Furthermore, a sharp and sudden reduction in world oil supplies—presumably of at least several million barrels per day for at least a month, if not longer—could have a considerable impact on both oil prices and the economy, even though markets would adjust to bring supply and demand back into balance.

The aim of this study is to address four key questions: What are the prospects of a supply shock in the next few years? How effectively could the world oil supply chain provide a cushion against a sudden drop in output in one region? What realistic scenarios might lead to such a sudden drop? What policy alternatives exist for reducing both the likelihood of a supply shock and the impact of such a shock were one to occur?

It is worth emphasizing that this study focuses on one small slice of U.S. energy policy, not the full scope of energy issues confronting America. That said, the study concludes with a discussion of how the current deadlock over national energy policy—with two main camps roughly divided between philosophies of "low consumption, low production" and "high production, high consumption"—has in effect led to a "high consumption, low production" policy that is the worst possible strategy for energy security. The study suggests how national energy policy could instead be used to reduce vulnerability to supply shocks.

5. Martin Wolf, "How Rising Oil Prices Add to the World Economy's Fragility," *Financial Times*, September 7, 2005, p. 13; Buhsan Bahree, "Why Oil's Surge Hasn't Damped Growth—So Far," *Wall Street Journal*, August 29, 2005, pp. A1, A4; and Andrew Balls, "IMF Forecast: Oil Price Impact 'Surprisingly Moderate,'" *Financial Times*, September 22, 2005, p. 3.
6. Alan Greenspan, "Technology Key to More Oil Supplies in the Future," address to the National Italian American Foundation, Washington, D.C., October 15, 2004.

A Tight World Oil Market

WORLD OIL PRICES rose to record levels during the winter of 2004–2005 and again during the following summer. Previous peaks in 1973–1974 and 1979–1980 would have been higher if stated in terms of 2005 dollars (e.g., the top price in 1979–1980 was was $100 per barrel in 2005 dollars), but the 2004–2005 peaks nevertheless prompted concern, though not panic. Prices reflected the positive news of a surprisingly high level of demand, albeit apparently unrestrained by increased production boosting supply. But the high prices were also a reminder of the vulnerability of oil prices to such negative developments as a supply-cut shock.

The late 2004 forecast of world oil markets prepared by the U.S. Energy Information Administration (EIA) makes dismal reading for anyone who desires cheaper gasoline in the United States and decreased American dependence on Persian Gulf oil. The EIA, part of the Department of Energy, monitors a wide range of energy data and provides information and analysis for the U.S. government. Its key findings were:

> In the short-term, tight markets and political tensions keep world oil prices high. Through 2015, oil will remain the dominant source of worldwide energy use (39 percent of total energy consumption). . . . U.S. dependence on Persian Gulf OPEC countries will increase, but other OPEC and non-OPEC producers will remain important U.S. suppliers.[1]

Calculating on a different timescale, the Paris-based International Energy Agency (IEA) made similar predictions. The IEA was established in 1974 by the Organization for Economic Cooperation and Development (OECD), whose membership consists of the mainly Western industrialized nations, to exchange information and improve systems for coping with oil supply disruptions after the early 1970s OPEC price increase and the Arab oil embargo. Its *World Energy Outlook 2004* made the following predictions:

> Looking forward to 2030, oil will remain the single largest fuel in the primary energy mix, even though its percentage share will fall marginally. . . . Dependence on Middle East oil will continue to grow in the OECD regions and developing Asia. The world's vulnerability to a price shock induced by oil-supply disruption will increase. Growing imports of natural gas in Europe, North America, and other regions from the Middle East and transitional economies of the former Soviet Union will heighten these concerns.

Far from being surprising, the 2005 record oil prices in fact reflect a trend. For the third year running, the winter prices of West Texas Intermediate, the benchmark U.S. crude, have risen sharply. From 1991 to 2003, world oil demand grew each year by about one million barrels per day (b/d), except in 2002 when recession kept demand flat. Increases in U.S. consumption levels slowed in the years prior to 2004, as oil intake hovered between 19.5 million b/d and 20 million b/d from 1999 to 2003. But in 2004, American oil use jumped nearly 500,000 b/d to 20.5 million.[2] Additionally, the year saw world demand growth take off, with an increase exceeding 2.7 million b/d. In 2005, the EIA expected global oil demand to increase by approximately 2.2 million b/d.[3] Whereas U.S. oil demand growth has remained comparatively small, Chinese oil demand has grown rapidly. The growth in Chinese oil demand looks set to continue for the next few years. The EIA forecast is that world energy consumption will grow from 411.5 quadrillion British thermal units (Btu) in 2002 to 553.5 quadrillion Btu in

This chapter makes extensive use of notes from an October 2004 presentation given to The Washington Institute's Energy Task Force by Guy Caruso, administrator, U.S. Energy Information Administration.

1. EIA, *International Energy Outlook 2005*, p. 26; available online (www.eia.doe.gov/oiaf/ieo). Although political tensions in the Middle East remain a source of concern, labor strikes in Venezuela and Nigeria and uncertainty about oil company ownership in Russia have all been of concern to oil markets.
2. *BP Statistical Review of World Energy*, June 2005, p. 9. Available online (www.bp.com/downloads.do?categoryId=9003093&contentId=7005944).
3. EIA, *International Energy Outlook 2005*, p. 26.

2015 and 644.6 quadrillion Btu in 2025 (an increase of 57 percent from 2002 to 2025).[4] Oil looks set to maintain its historical predominance, accounting for almost 39 percent of world energy production.[5] The main reason for oil's preeminent role is that it is by far the most important fuel used in transportation, which accounts for half of all oil consumption and for 61 percent of the total projected increase in oil use from 2002 to 2025.[6]

Demand in the United States, the world's leading economy, will necessarily be a major factor in oil markets. U.S. dependence on imported oil has steadily increased, particularly because of lower U.S. production. In 2004, out of total consumption of 20.5 million b/d, the United States imported 12.9 million b/d. Much of that arrived from non-OPEC countries, including 2.1 million b/d from Canada and 1.6 million b/d from Mexico; only about 2.5 million b/d came from the Middle East.[7] Over time, however, OPEC will provide increasing volumes of oil consumed in the United States.

In addition to robust demand, the other major reason for the recent price increases has been a drop in global spare oil-production capacity. In 2004, this capacity was at its lowest level in thirty years, and the current cushion of 1 million b/d is expected to shrink further by the end of 2005.[8] In recent years, OPEC members have been reluctant to build spare capacity. The low prices (under $10 per barrel) reached in 1999 gave them little incentive—and little means. Half the extra output provided from 2001 to 2004 came from Russia, which has been rebuilding capacity that had fallen dramatically after the collapse of the Soviet Union. But further increases will need extra investment and financing and will be difficult to obtain internationally in the light of the Yukos affair, in which Moscow announced sudden, huge tax claims on the privatized oil company. Several other countries are also constrained from expanding their production: Venezuela, because of the nationalistic fervor of its president, Hugo Chavez; Nigeria, by social unrest; and Iraq, by the postinvasion insurgency.

Middle Eastern oil production has grown slowly in recent years, although in terms of reserve size and, in the case of many countries, low marginal cost, the region is the obvious place to make up for tightness in global supply. The region's potential can be seen from its reserves of proven oil; of the sixteen countries with the largest oil reserves worldwide, eight are from the the Middle East: Saudi Arabia, Iran,[9] Iraq, Kuwait, the United Arab Emirates, Libya, Qatar, and Algeria. That said, Middle Eastern states do not dominate the list of the top oil suppliers. Only six of the world's top fifteen suppliers are from the Middle East: Saudi Arabia, Iran, the United Arab Emirates, Kuwait, Iraq, and Algeria. In addition to the United States itself, the list includes many staunch U.S. allies in the West—Mexico, Norway, Canada, and the United Kingdom—as well as Russia and China.

If the challenge for the future is to increase the size of the world oil-production capacity, the Middle East is poised to dominate. The EIA predicts that global oil supply in 2025 will exceed 2002 levels by 40.8 million b/d,[10] with Saudi Arabia making the biggest contribution and Iraq, Kuwait, and the United Arab Emirates also in the top seven. As for the more immediate future, the EIA predicted that, by 2015, Saudi Arabia will be able to increase capacity by more than four million b/d,[11] while Iraq, the United Arab Emirates, and Kuwait will

4. EIA, *International Energy Outlook 2005,* p. 7. For comparison, 2.1 quadrillion Btu are equivalent to 1 million b/d of oil.
5. EIA, *International Energy Outlook 2004*, p. 2.
6. IEA, *World Energy Outlook 2004*, pp. 9, 58.
7. *BP Statistical Review of World Energy*, June 2005, pp. 9, 18.
8. See Javier Blas, "U.S. Warns OPEC of Need for Further Production Rise," *Financial Times*, April 8, 2005, p. 12.
9. For many years, Iran ranked third in proven reserves to Iraq, but in 2002 it revised its estimates significantly upward. According to the June 2004 *BP Statistical Review of World Energy*, "Proved reserves are generally taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operation conditions." As such, the volume can be reassessed. For many countries, such data is closely held by the government, and there is little means of realistically disputing the figure.
10. EIA, *International Energy Outlook 2005*, p. 29.
11. Recently, a debate has opened regarding the actual size of Saudi oil reserves. Doubts whether they are as large as claimed have been led by U.S. investment banker Matthew Simmons in his book *Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy* (Indianapolis, Ind.: Wiley, 2005).

each increase by more than 1 million b/d. If any of these key Persian Gulf states experiences political instability, the impact on world supply will be significant.

The scale of the challenge facing the world is sketched out in the analysis provided by the *World Economic Outlook*, published in April 2005 by the International Monetary Fund.[12] It calls on OPEC to provide "much better protection" against future price spikes by increasing its spare capacity from 2 million b/d to between 3 million and 5 million. Although Saudi Arabia has announced it is planning to increase capacity to 12.5 million b/d over the next four years, it would be better if this task were shared. As yet, though, no other OPEC producer seems keen to develop more spare capacity. Abu Dhabi, the main oil emirate in the United Arab Emirates, has a small amount of spare capacity. Iraq, with its huge reserves, is thought to be capable of developing spare capacity, but any prospect of this will have to await greater political stability. Many experts doubt whether Saudi Arabia will be able to increase production at the pace needed to meet growing world demand, much less the greater pace needed to increase spare capacity—and the extra Saudi oil is likely to consist of heavier, sulfurous crude that is less attractive to international refiners than are light, "sweet" crude oils.

Putting together the likely robust demand for oil and the tight supply situation, the short-term prospect is that oil prices will remain high. Over the next five to ten years, however, it is not at all clear where prices are headed. In July 2005, the EIA predicted prices of $37 per barrel in 2013 and $48 per barrel in 2025 only in the high oil price case (in 2003 dollars). The conventional economist's response to high prices is to predict increased investment to take advantage of the increased margins. Indeed, by some estimates, projects currently under way will by 2007 add 13 million b/d to world capacity, while demand will grow only about half that much.[13] This suggests that the more plausible range of prices for the next decade would be $20–$40 per barrel.

Oil companies, though, remain cautious about investment, arguing that they are hampered by regulation in the West and by political restrictions in many oil-producing countries. The views of oil companies on future prices are somewhat ambivalent. In January 2004, BP raised its planning price, the assumed price of the widely traded North Sea Brent crude it uses for judging the economic feasibility of a project, from $16 to $20 per barrel, arguing that the average price would remain in the mid-twenties over the next two decades. Yet in October 2004, BP's chief executive, John Browne, stated that the price of crude would remain at $30 per barrel, and possibly higher, for years to come.[14] In early 2005, Chevron Texaco Corporation increased its planning price to $25–$30 per barrel, and its chairman, Dave O'Reilly, warned, "The time when we could count on cheap oil and even cheaper natural gas is clearly ending."[15]

Indeed, it is possible that world oil prices will stay at high levels for the next decade, particularly if international oil companies do not make major investments in expanding capacity. In September 2005, the New York Mercantile Exchange offered a contract for delivery in 2011 valued at more than $60 per barrel. In April 2005, the International Monetary Fund predicted that, in 2005 dollars, oil would stay at $39–$56 per barrel for the next twenty-five years.[16] A further disturbing sign was the February 2005 comment by Saudi oil minister Ali al-Naimi predicting that prices will be in the $40–$50 range for the foreseeable future. This not only had the effect of stabilizing the prize at its higher level, but also produced concern that the kingdom was less able to perform its self-declared role of ensuring that oil reaches the world market in the desired quantities and at a reasonable price. The range spoken of by al-Naimi is well above the level that observers believe prompts more investment in alternatives to oil, thereby undermining Saudi Arabia's future dominance in the oil mar-

12. Available online (www.imf.org/external/pubs/ft/weo/2005/01).
13. *A Survey of Oil*, supplement to the *Economist*, April 30, 2005, p. 8.
14. See "BP: Oil Price Will Stay High," *Sunday Times* (London), January 18, 2004.
15. *A Survey of Oil*, p. 1.
16. *World Economic Outlook*, pp. 169–170.

ket. In September 2005, the OECD reported that high world oil prices are here to stay and that price shocks pose threats to key economies.[17]

However, it is by no means clear that oil prices can be sustained at $60 per barrel. Although options markets suggested that the chances of a big rise in prices were greater than a big fall, an argument can also be made that there will be a gradual return to prices of around $40 per barrel.[18] In August 2005, the New York investment bank Goldman Sachs forecast that a barrel of U.S. light crude would still cost $60 by the end of the decade, while its competitor Merrill Lynch predicted a price of $42 in 2009. The disparity was explained in terms of differences in outlook of investment by oil companies and success in finding new fields and reducing refinery bottlenecks.

Some commentators argue that high prices are the consequence of the increasing difficulty of finding oil. U.S. commodities guru Jim Rogers, pointing out that there had been no great oil discoveries in thirty-five years, predicted in August 2005 that the price of oil would rise to more than $100 per barrel.[19] Yet, the more plausible explanation is that offered in the latest EIA report, namely, "Resources are not expected to be a key constraint on world demand to 2025. Rather more important are the political, economic, and environmental circumstances that could shape developments in oil supply and demand."[20] Oil prices are particularly vulnerable to political shocks. An October 2005 study by Stanford University's Energy Modeling Forum estimated there was an 80 percent chance that surprise geopolitical, military, or terrorist turmoil would remove at least 2 million b/d of oil production in the next ten years.[21] If supply shocks occur, oil prices can rise very rapidly. Oil is considered to be "price inelastic," meaning that oil itself and the products derived from it have no ready substitutes. Therefore, shortages would cause prices to rise steeply. How steeply is impossible to predict; the 2004 rise from around $25 to more than $50 per barrel took most analysts by surprise.

17. Jean-Philippe Cotis, "What Is the Economic Outlook for OECD Countries? An Interim Assessment," OECD press briefing, Paris, September 6, 2005. Available online (www.oecd.org/dataoecd/50/27/35310111.pdf).
18. David Smith, "The Oil Bubble Will Burst and Interest Rates Fall," *Sunday Times* (Economic Outlook) (London), August 14, 2005. Smith's analysis noted that the options markets predicted a one-in-twenty chance of prices being $100 per barrel or more in a year. He also wrote, "The surge in prices has all the characteristics of a classic bubble."
19. "Wall Street Giants See Oil Rising," BBC News, August 19, 2005. Available online (http://news.bbc.co.uk/1/hi/business/4165350.stm).
20. EIA, *International Energy Outlook 2005*, p. 28.
21. Phillip Beccue and Hillard Huntington, "An Assessment of Oil Market Disruption Risks," Energy Modeling Forum, Stanford University, October 3, 2005.

Middle East Oil Shock Scenarios

IN THE MIDDLE EAST, most Arab countries—as well as Iran—produce and export oil; some also produce and export natural gas.[1] As the 1973 Arab oil embargo showed, government policy on oil can affect supply.[2] In addition, as Iran and Iraq experienced during their 1980–1988 war, all Middle Eastern energy exporters are vulnerable to a range of hostile, conventional military action. Since the 2003 overthrow of Saddam Hussein in Iraq, internal sabotage against oil facilities has also dramatically affected both internal supplies and exports. In November 2002, Osama bin Laden specifically referred to oil, criticizing Middle Eastern governments for selling it too cheaply to the United States.

Trouble in Venezuela, Nigeria, and Russia has recently affected world oil supplies as well, but the Middle East's geology and economics make the region unique. Not only does it encompass about two-thirds of the world's oil reserves, but, as a proportion of daily demand, it accounts for about one-third of the world's oil supplies—a statistic made all the more significant because the region's proportion of internationally traded oil is much greater than anywhere else. This is the reason for the market-influencing strength of the Middle East–dominated OPEC oil cartel. It also means that cuts in supply from the Middle East have a disproportionately large effect. Collectively or individually, all Middle Eastern oil and gas facilities are vulnerable to disruptions that would endanger world oil supplies.

Several key factors could provoke an oil supply shock during the next decade:

- Al-Qaeda terrorist attacks on major oil facilities
- The exodus of key foreign oil workers
- The spread of instability from Iraq into other oil-producing countries
- Confrontation with Iran (e.g., over nuclear weapons development or other problematic behavior), perhaps leading to Iranian interference with the passage of oil through the strategic Strait of Hormuz
- Domestic instability or uncertain political transitions, ranging from crises of leadership succession to radical changes in regimes

Terrorist Attacks

In recent years perhaps the most significant threat has come from bin Laden. Oil supplies have been disrupted by political and military action but not, so far, by terrorist action. Bin Laden's views are clear. In his 1996 online "Declaration of War" against the United States and its allies, he claimed, "[Oil] production is restricted or expanded and prices are fixed to suit the American economy." In a similar November 2002 message posted in Arabic on an Islamist website, he declared, "You steal our wealth and oil at paltry prices. This theft is indeed the biggest theft ever witnessed by mankind in the history of the world." He renewed the threat in an audio message in December 2004, released to another website, urging terrorists to

This chapter draws from an October 2004 presentation to The Washington Institute's Energy Task Force by Amy Myers Jaffe of the James A. Baker III Institute for Public Policy, Rice University.

1. In the region from Algeria to Iran, only Israel, Jordan, Lebanon, and the Palestinian territories have zero or insignificant levels of oil production. Gas exports are important revenue earners for Algeria, Egypt, Qatar, and Oman. Iran is also developing its gas export potential. A modest-size gas field has been found off Gaza.
2. On October 17, 1973, Arab oil ministers meeting in Cairo agreed to an embargo that would cut production 5 percent from the previous month's level and continue cutting by 5 percent each month until their objectives—the withdrawal of Israeli forces—were met. On October 20, after the announcement of a U.S. aid package for Israel, Saudi Arabia announced it was cutting off all shipments of oil to the United States. The Netherlands was also included because of its support for Israel. In early November, Arab ministers decided to increase the cuts in production. At their worst, Arab oil cuts amounted to 5 million barrels per day, about 10 percent of world oil production in what was then termed "the free world." As a proportion of internationally traded oil, it amounted to 14 percent.

target oil fields in Iraq and the Persian Gulf to disrupt U.S. access to what he called "cheap oil."

Since the September 11 attacks, bin Laden's followers in al-Qaeda have targeted oil-related facilities on several occasions:

- In October 2002, the French tanker *Limburg* was attacked off the coast of Yemen. It was badly damaged when hit by a small boat packed with explosives.
- In March 2003, the British navy began leading patrols in the Strait of Gibraltar after the discovery of a plot in Morocco targeting tankers passing through the waterway.
- In early May 2004, al-Qaeda terrorists attacked an oil-related industrial complex at the Saudi Red Sea port of Yanbu, targeting foreign workers there.
- In late May 2004, al-Qaeda terrorists attacked a residential compound housing foreign expatriates at al-Khobar on the Saudi Gulf coast.

In addition, there have been incidents of al-Qaeda suspects undergoing underwater training, apparently in preparation for attacks on shipping.

Iraq's oil facilities have also been a principal target of the insurgency, with pipelines and pumping stations being favorite targets. Billowing smoke and flames make for dramatic television pictures, but the damage is comparatively easy to repair. The pumping of oil can often be resumed within twenty-four hours of a break in the pipeline. Damaged pumping stations are harder to replace but, being comparatively easy to protect, are less frequent targets. In 2004, terrorists attempted to attack Iraq's main offshore loading terminal in the northern Persian Gulf using fast boats, but the assault was ineffective because of the vigilance of the terminal's guards.

Terrorists pose particular threats at the world's oil chokepoints—narrow waterways[3] that have previously been noted for their vulnerability to hostile military action by states but that also present tempting targets for terrorists in fast boats. These chokepoints, with 2003 estimated oil flows, include the following:

- The Strait of Hormuz (15–15.5 million b/d) is the passage from the Persian Gulf into the Arabian Sea.[4]
- Bab al-Mandab (3.2–3.3 million b/d) connects the Red Sea with the Gulf of Aden and the Arabian Sea. Closure of this strait would prevent tankers from the Persian Gulf from reaching the Suez Canal, forcing them to take the much longer, and therefore more expensive, route around Africa.
- The Suez Canal and the Sumed Pipeline (3.8 million b/d, two-thirds of which flow via the pipeline) connect the Red Sea and the Mediterranean Sea.
- The Turkish Straits (3 million b/d), including the Bosporus Strait, link the Black Sea and the Mediterranean Sea, passing through the city of Istanbul. The Turkish Straits serve as the largest route for Russian oil exports as well as exports from Kazakhstan.
- The Strait of Gibraltar separates Morocco, in North Africa, from Spain, in Europe. The strait is a major shipping route providing a range of targets.

3. There are also chokepoints on land, such as the Saudi oil treatment facility at Abqaiq, close to the main road between Riyadh and Dhahran, about twenty-five miles from the Persian Gulf coast. Oil pipelines from most of the Saudi oil fields in the region pass through this facility. Oil-loading facilities are similar chokepoints, as Iran found during the 1980–1988 Iran-Iraq War when its Kharg Island facility had to be replicated at points further south in order to diminish the threat of Iraqi air attack.
4. Alternatives to using the Strait of Hormuz are limited. Such routes include the 5 million b/d capacity east-west pipeline across Saudi Arabia to Yanbu and the 290,000 b/d Adqaiq-to-Yanbu natural gas liquids line. Theoretically, the presently closed 1.65 million b/d Iraqi pipeline across Saudi Arabia (IPSA) could also be used, and the 500,000 b/d tapline from Saudi Arabia to the Lebanese Mediterranean coast could be reactivated. A scheme to run a line across the United Arab Emirates to its Gulf of Oman coastline has also been discussed. Extra volumes could also be exported from Iraq to the Turkish Mediterranean port of Ceyhan, although neither the Turkish nor Lebanese options would help meet Asian demand—the principal market for Persian Gulf oil.

- The Strait of Malacca (11 million b/d), the narrow passage between Malaysia and Indonesia[5] that joins the Indian and Pacific Oceans, is the route for oil exports from the Persian Gulf to Asian markets, including China and Japan. At its narrowest, near Singapore, the navigable channel is only 1.5 miles wide and is already a location for piracy.

The Panama Canal is a chokepoint as well, although very little oil passes through it.

The Exodus of Key Foreign Oil Workers

Many oil industry employees are accustomed to working in climatically difficult regions of the world, sometimes in circumstances of physical hardship. Even though oil industries across the Middle East are state-owned—a reflection of nationalist sentiment dating from the 1970s and before—foreign oil workers are often brought in for tasks that are too technically difficult for domestic labor forces. Other foreign workers, usually Asian rather than Western, perform manual-labor tasks. Despite often high relative wages, all foreign workers are mindful of their personal safety and are aware that their skills are also in demand in less politically turbulent parts of the world.

In Saudi Arabia, attacks on foreign workers, though not specifically oil workers, began before the September 11 attacks. Although Islamist militants were widely regarded as responsible, Saudi authorities blamed the initial attacks on arguments between expatriates in the lucrative illegal alcohol trade. (Six Britons, a Belgian, and an American were arrested, though the American was quickly released. The others were accused of causing explosions, and several made televised confessions. They were eventually released in August 2003 after being granted royal pardons.) A string of such attacks has occurred since 2000:

- In November 2000, a British engineer was killed in Riyadh by a bomb placed in his car. Later that month, three British workers and an Irish national were injured by another bomb in Riyadh.
- In December 2000, a Briton was blinded by a bomb in al-Khobar, Saudi Arabia.
- In January 2001, an Irish national living in Riyadh discovered a bomb in his car, which was parked inside a residential compound.
- In March 2001, a bomb injured a Briton outside a bookshop in Riyadh.
- In June 2002, a Briton was killed in Riyadh when a bomb exploded in his car.
- In September 2002, a German was killed by a bomb in Riyadh.
- In May 2003, thirty-five people died when al-Qaeda terrorists simultaneously attacked three expatriate residential compounds in Riyadh.
- In November 2003, a terrorist attack killed seventeen people at a residential compound in Riyadh housing mostly foreign, middle-class Arab expatriates.
- In May 2004, six foreigners were killed in an attack on a petrochemical site in Yanbu, Saudi Arabia. Later that month, twenty-two foreigners were killed when a residential compound in al-Khobar was attacked.
- In June 2004, two Americans were shot dead in Riyadh just days after gunmen killed an Irish cameraman working for the BBC. Another American was abducted in Riyadh and later beheaded.
- In December 2004, the U.S. consulate in Jedda, Saudi Arabia, was attacked, and five non-American staff members were killed.

5. Apart from being a member of OPEC, Indonesia, the world's largest Muslim nation, has increasingly been affected by Islamist terrorism in recent years.

- In March 2005, a British expatriate in Qatar was killed by a suicide bomber at a theater full of expatriates.

The historical lesson is that without access to foreign workers, oil production falls—though this also has to do with access to up-to-date technology and foreign investment and the policy priorities of national governments. For example, oil production peaked in Libya in 1970, the year after Muammar Qadhafi's takeover, and has since declined to half that level. The same applies to Iranian oil production, which was more than 6 million b/d before the 1979 Islamic Revolution but is now less than 4 million. Iraqi oil production also has not recovered from disruptions in the aftermath of the 2003 U.S.-led invasion—although Iraqi production has been notably erratic since Saddam Hussein came to power in 1979, first because of the Iran-Iraq War and second because of international sanctions following the 1990 Iraqi invasion of Kuwait.

The Spread of Instability from Iraq

Although the invasion of Iraq has led to the establishment of a democratic government, tensions have also been inflamed between Muslim and non-Muslim and between Sunni and Shiite in Iraq. Elsewhere in the region there have been knock-on effects. Although democratic reforms and yearnings for broader political participation are positive developments, they have not produced meaningful progress and could therefore lead to a backlash. In Iraq as well as other countries, centuries-old ethnic and sectarian divisions retain the potential to cause civil war or even the collapse of the state.

A particularly worrisome development is the continued influx of foreign jihadist fighters, who have made Iraq the principal arena in which to gain militant fervor and experience in the way that Afghanistan, Bosnia, and Chechnya were in the past.[6] Encouraged by such states as Syria, but also originating in Jordan and Saudi Arabia, these fighters, if they survive, could in time return home to spread instability. For Shiites, although they are political opponents of Sunni jihadists, any instability may serve as an opportunity to right an injustice of decades—the sense that they have been excluded from any local petroleum-based economic prosperity. For example, Saudi Arabia's oil fields are concentrated in the large Eastern Province, where Shiite Muslims, who make up 20 percent of the total Saudi population, form a local majority. Once a significant part of the local oil industry labor force, Shiite numbers were pruned after demonstrations in support of the 1979 Islamic Revolution in Iran. Municipal elections in March 2005 opened a potential new arena for Saudi Shiites; there were victories for local Shiite candidates but also at least one instance of disqualification on tenuous grounds, probably to assuage local Sunni opinion.

In neighboring Bahrain, local activists in the majority Shiite population have been expressing their disappointment at their persistent lack of emancipation despite the promises of King Hamad, a Sunni. Once an oil center—the island is where oil was first discovered on the Arab side of the Persian Gulf—Bahrain is now an important financial and services center, as well as the headquarters of the U.S. Fifth Fleet.

In Iraq itself, mosques and other meeting places of the majority Shiite population have been targeted by insurgents, particularly by supporters of Abu Musab al-Zarqawi, the leader of al-Qaeda in Mesopotamia who serves as a gathering point for foreign jihadists fighting the U.S.-supported Iraqi government.

Across the Arab world, particularly in Saudi Arabia and Jordan, there is a sense that a crescent of Shiite Islam has been created from Iran through Iraq to Syria and Lebanon. Fundamentalist Sunnis, particularly Saudi Wahhabists, believe that this phenomenon must be confronted.

6. The State Department's *Country Reports on Terrorism 2004* (released April 2005; available online at www.state.gov/documents/organization/45313.pdf) noted that "foreign fighters appear to be working to make the insurgency in Iraq what Afghanistan was to the earlier generation of jihadists—a melting pot for jihadists from around the world, a training ground, and an indoctrination center. In the months and years ahead, a significant number of fighters who have traveled to Iraq could return to their home countries, exacerbating domestic conflicts or augmenting with new skills and experience existing extremist networks in the communities to which they return."

The Special Challenge of Iran

As the largest geographic power in the Persian Gulf, Iran dominates the vital waterway, although its military arsenal has yet to recover from the pounding it received at the end of the 1980–1988 Iran-Iraq War, when U.S. forces countered its attacks on neutral shipping. During the diplomatic confrontations over Iran's nuclear program, Tehran has specifically stated that it would retaliate if attacked by either the United States or Israel. Although Tehran has never made its specific retaliatory intentions clear, oil exports in the Gulf are an obvious target.[7] There is little doubt that the United States is militarily capable of countering any such Iranian move in a matter of days. Yet, the acquisition of nuclear weapons would change that balance, which is already being challenged by Iran's arsenal of missiles, including weapons that can reach into Saudi Arabia and the smaller Gulf monarchies. Chinese-supplied antiship missiles have also posed a theoretical threat to Gulf shipping for many years, although they have been countered by the deterrent effect of strikes from U.S. carrier-based aircraft in the region.

Several significant oil and gas fields are located on both sides of the maritime frontiers between Iran and the southern Gulf states. Agreement on exploitation of these reserves is often ambiguous, leaving Iran in a dominant, albeit not all-powerful, negotiating position. Kuwait, Saudi Arabia, Qatar, and the United Arab Emirates have all had to deal with this problem. In the case of the United Arab Emirates, there is also a long-running territorial dispute with Iran dating to Tehran's seizure of the islands of Greater and Lesser Tunb and Abu Musa in 1971.

The diplomatic challenge of dealing with Iran's suspected nuclear weapons ambition is that the world needs Iran's oil. Hence, Iran's oil-exporting potential cannot be threatened using either economic or military sanctions as levers. The situation is different from the 1990s, when the United States imposed sanctions aimed at harming the oil exports of Iran, Iraq, and Libya—at that time, there was a plentiful supply of oil in the world. Alternative economic sanctions are unlikely to be effective unless backed by full international cooperation. Even unspecified threats of retaliation for military action could seriously hamper oil exports, making oil companies wary of risking tankers and causing insurance rates on cargoes to soar. In addition, Iran effectively controls the supply chokepoint of the Strait of Hormuz.

Regime Change, Succession, and Political Transition

One lesson from the history of regime change in oil-exporting Middle Eastern countries over the past thirty years is that exports fall and struggle to recover their previous levels after such change. Although numerous factors are involved, the notion that "all governments need the revenues from oil" is too simplistic and cannot buttress uncertainty in future supply projections. Even leadership change within the same dynasty cannot ensure a continuation of the same energy-exporting policy. Political reform encouraging broader participation may also accompany a changing view of appropriate oil exports.

Key to these considerations is Saudi Arabia, which from 1995 to 2005 had a split leadership, with theoretical supreme power remaining with the increas-

7. "If such an attack takes place, then of course we will retaliate. But I do not think the United States will take such a risk. They know our capabilities for retaliating against such attacks." Hassan Rouhani, secretary-general of Iran's Supreme National Security Council, Reuters, February 6, 2005. In February 16, 2005, testimony to the Senate Select Committee on Intelligence, Vice Admiral Lowell Jacoby, director of the Defense Intelligence Agency, stated, "[W]e judge Iran can briefly close the Strait of Hormuz, relying on a layered strategy using predominately naval, air, and some ground forces. Last year it purchased North Korean torpedo- and missile-armed fast attack craft and midget submarines, making marginal improvements to this capability." Iran's ability to threaten the Strait of Hormuz, as well as the oil facilities of Saudi Arabia and other Gulf states, is discussed in Anthony Cordesman, "Iran's Developing Military Capabilities," Center for Strategic and International Studies, December 2004; available online (www.csis.org/burke/mb/041208_IranDevMilCapMnRpt.pdf). See also Dagobert Brito and Amy Myers Jaffe, "Reducing Vulnerability of the Straits of Hormuz," paper presented at a conference on "Contending with a Nuclear-Ready Iran," Nonproliferation Policy Education Center, March 2004; available online (www.npec-web.org/projects/Iran/Paper040825Iran-BritoJaffe-HormuzStraits.pdf). Ways of reducing dependence on the Strait of Hormuz are discussed in M. Webster Ewell Jr., Dagobert Brito, and John Noer, "An Alternative Pipeline Strategy in the Persian Gulf," James A. Baker III Institute for Public Policy, Rice University, 2000; available online (www.rice.edu/energy/publications/docs/TrendsinMiddleEast_AlternativePipelineStrategy.pdf).

ingly frail King Fahd while most day-to-day control was in the hands of Crown Prince Abdullah. With the death of King Fahd in August 2005 and the accession of King Abdullah, policymaking should become clearer. Yet, the ages of Abdullah and his next-in-line, Crown Prince Sultan (both men are more than eighty years old), mean further change could happen at any time. An additional factor contributing to uncertainty is King Abdullah's failure to appoint a second deputy prime minister, effectively a crown prince in waiting—the first time in thirty years that there has been no one in such a role. This suggests a lack of agreement in the royal family about who should be appointed—Prince Nayef, the interior minister, is thought to have ambitions on the post. The last decade of Fahd's life was marked by reports of policy differences, most notably on foreign participation in the exploitation of gas reserves. So far, though, the royal family has retained a united front on oil export policy.

A rapid turnover of kings in Saudi Arabia would likely lead to uncertain policies. It is not difficult to imagine circumstances whereby a future Saudi king would cut back on oil exports in order to counter pressure from xenophobic Islamists who, influenced by Osama bin Laden, objected to the kingdom's policy of being a reliable supplier to the world market.

Even smooth dynastic change can impinge on oil. Sheikh Khalifa bin Zayed al-Nahyan, who succeeded his late father, Sheikh Zayed bin Sultan, as ruler of Abu Dhabi and president of the United Arab Emirates, has reportedly attempted to reopen a border dispute with Saudi Arabia that was settled in 1974. In the unpublished agreement, Saudi Arabia agreed to forego a claim to an oasis in return for hundreds of square miles of empty sand, now developed as the Shaybah oil field by the Saudis, one of their most modern and lucrative fields.[8] According to Sheikh Khalifa, the 1974 settlement was unfair because Saudi Arabia took advantage of its relative strength.

8. Simon Henderson, *The New Pillar: Conservative Arab Gulf States and U.S. Strategy* (Washington, D.C.: Washington Institute for Near East Policy, 2003), p. 28.

Fuller Planning, More Flexibility

THE SOLUTION to supply vulnerability is not simply American independence from Middle Eastern oil supplies. Even if the United States did not import a drop of oil, the price of oil on the American market would still be set by the worldwide balance of supply and demand. If there were a sudden dramatic drop in oil supply, that would drive up the price in every market, including the United States. The price increase would have many of the same negative impacts on the U.S. economy irrespective of where the oil originated—with the important exception that if the United States were self-sufficient in oil, then the higher prices would be paid to U.S. rather than foreign oil producers; that is, the price increase would not affect the balance of payments. However, that is only true in the highly unlikely case that the United States goes to the considerable expense—financial, lifestyle, and environmental—required to dramatically reduce consumption and increase production. And even then, Middle Eastern supplies would continue to be crucial to world supply. Middle Eastern oil is simply too cheap and plentiful for the world to forego using it. Vulnerability to Middle Eastern oil shocks is a fact of life, not the product of unwise government policy. Rather than chasing the expensive and ineffective goal of U.S. energy self-sufficiency, it is more important to make the U.S. economy more robust against the risks from Middle Eastern supply shocks.

The key to making energy markets less vulnerable to such shocks is encouraging flexibility so that a shortage from any one source can be compensated for with supply from other sources. Flexibility sounds deceptively simple in principle—just substitute one fuel for another or use strategic reserves. But the energy supply chain has many links, and substitution works only as well as the weakest link in that complicated chain. Unfortunately, almost every one of those links has become rusty and brittle. Making the chain stronger will require a great deal of work.

Integrating National Objectives into U.S. Energy Policy

The increasingly rigid U.S. energy system has in no small part been the unintended result of regulatory actions by several government agencies that are each looking at only a small part of the overall energy picture. The Environmental Protection Agency (EPA) has the largest effect on energy consumption of any government agency, but it is legally required to examine only environmental considerations. As a result, the EPA has not taken into account the energy security impact of its decisions. At times, it has imposed requirements that introduce significant rigidities into the energy supply system that could in turn complicate efforts to adapt if oil supply from an important producer were suddenly cut off. It is difficult to see why the EPA is forbidden by law from taking into consideration whether its actions make the U.S. economy more vulnerable to Middle Eastern supply shocks.

The problem gets worse when different U.S. agencies independently make decisions without taking into account how their actions affect those of other agencies. For instance, the EPA has ordered many changes in gasoline specifications that can only be met by large capital investments in refineries, such as the 1999 requirement to reduce sulfur in gasoline and diesel fuel (sulfur being what makes crude oil "sour" rather than "sweet"). The EPA assumed that the refiners would readily be able to meet the requirement with new investments. But at the same time, the Federal Trade Commission (FTC) was pressing the large oil companies to sell off refineries to smaller firms in the name of increasing competition ("vertical integration," in which one firm owns all aspects of an industry, from producing the raw material to marketing the final product, is one of the classic ways to limit competition and increase prices).[1] There is little evidence that either the FTC or the EPA

1. For an FTC account, see Federal Trade Commission, Bureau of Economics, *The Petroleum Industry: Mergers, Structural Change, and Antitrust Enforcement*, August 2004; available online (www.ftc.gov/os/2004/08/040813mergersinpetrolberpt.pdf). See also the press release announcing the report's publication (www.ftc.gov/opa/2004/08/oilmergersrpt.htm).

paid much attention to how their simultaneous independent decisions would interact, nor to the overall energy-security effect of their actions. As the major oil companies sold off refineries to smaller companies that had trouble raising capital, the United States no longer had ample refinery capacity with the flexibility to shift from one oil supplier to another source. The combination of government policy and a tough economic environment for refineries meant domestic refinery capacity shrank while demand rose. Even as business prospects for refineries improved in recent years, refineries have not been expanding to keep pace with growing demand. The largest U.S. refiner, with 15 percent of national capacity, is Valero, a highly leveraged company whose debt is rated just above junk status.[2]

The U.S. government needs a more integrated decisionmaking process for energy policy, one that considers energy security as well as the environment. Some issues can be resolved by greater coordination across the executive branch using the model of coordinating national security or economic policy. But the problem is made more complex because of the key role of the independent regulatory agencies, not to mention the legal requirements imposed on the executive branch that often refer to only one set of policy goals—such as protecting the environment or promoting competition—without taking into account energy security needs. Devising a better structure for coordinating energy policy will require careful discussion and then legislative changes.

Integrating energy security into energy policy discussions is often a matter of harmonizing policies, but sometimes it will require making tradeoffs among policy goals. That can raise the hackles of the environmentalist community, which points out that raising exaggerated concerns is a classic excuse for avoiding action on environmental concerns. Yet, such tradeoffs need not come at the expense of the environment. For instance, in return for the authority to temporarily suspend certain environmental regulations during a supply shock (so as to permit use of less desirable but more readily available oil), a higher environmental standard could be set to apply in normal times; the greater pollution during the emergency period would be more than offset by the decreased pollution under normal circumstances.

Improving Information, Strengthening Coordination

The International Energy Agency (IEA) has highlighted the importance of information about energy supply and demand. When businesses and governments do not realize a problem is developing, they cannot make the adjustments needed to respond quickly.[3] Indeed, the dramatic oil price increases during the 1979–1980 Islamic Revolution in Iran were due in no small part to panic-buying by consumers reacting to reports that oil inventories were running dry at a time when there was no reliable data on inventories. This led the IEA to establish its monthly oil market report. Its information on global supply, demand, and inventories is used to make important decisions. For instance, OPEC has cited the report's data when explaining its decisions to increase or decrease quotas—which makes it all the more troubling that the data in the monthly reports increasingly must be revised. Getting accurate data for the monthly oil market report is becoming ever more difficult, leading the IEA to warn in its *World Energy Outlook 2004* of a "looming crisis" if steps are not taken to reverse the decline in the quality of energy statistics.[4] The report highlights two problems: state-owned monopolies are being replaced by dozens of independent companies, and governments are demanding that their statisticians provide new, environmentally important data on renewable energy and greenhouse emissions without adequately

2. See Jad Mouawad, "A Fast-Growing Independent Strikes Gold in Oil Refining," *New York Times*, May 18, 2005.
3. Kevin Morrison, "Secret and Unreliable World of Oil Statistics," *Financial Times*, December 15, 2004, p. 22; Claude Mandil (IEA executive director), "Oil: Is the Sense of Crisis Overdone?" *Financial Times*, October 19, 2004, p. 17.
4. *World Energy Outlook 2004* (Paris: IEA, 2004), pp. 549–551. This publication also discusses the Joint Oil Data Initiative (JODI), discussed later in this chapter (the three other international organizations involved are regional organizations for Europe, Latin America, and the Asia Pacific). See also Sally Jones, "IEA Warns of 'Looming Crisis' in Putting Together Energy Data," *Wall Street Journal*, October 27, 2004, p. A10.

funding the collection of such information. An additional factor is the increasing role of China and India in energy markets and their failure to provide timely, accurate data.

In 2001, the United Nations, IEA, OPEC, and three other international organizations agreed to establish a Joint Oil Data Initiative (JODI) to collect data from governments that produce and consume more than 80 percent of the world's oil. But JODI had few visible accomplishments in its first years. Although that seemed to change somewhat in 2005, the record suggests that there will be many difficulties in resolving anomalies and improving accuracy, especially from countries such as China and Russia (which have long been unaccustomed to transparency) and from OPEC members loathe to admit that they are cheating on quotas or unable to produce enough to use their full quotas. Although finance ministers from the G7 nations have discussed this problem in their meetings, it would be useful to involve Russia in the dialogue. Toward that end, the G8 governments could discuss the importance of improving oil data reporting as a means of stabilizing markets.

Furthermore, as the IEA has discussed, JODI should be extended to include standard international statistics on oil reserves. Existing reserve data often takes the form of politically inspired claims or speculation based on inconsistent procedures. The best efforts to produce consistent reserve data are from BP in its highly respected annual *Statistical Review of World Energy,* but a more transparent and better funded source of reserve data is necessary. As IEA executive director Claude Mandil has written, "The assessment of geological resources and reserves is another area of uncertainty and tension in the oil market."[5] An example of the confusion is Canada's tar sands, which have long been known to exist but which were considered uneconomical to exploit, although production from those them is now approximately 1 million b/d. The government of Alberta province claims that its tar sands have proved reserves of 175 billion barrels, second only to Saudi Arabia.[6] By contrast, BP's 2005 edition of the *Statistical Review of World Energy* lists Canada's reserves as totaling only 15 billion barrels. The difference is not academic; if technology has advanced to the point that Canada's tar sands can be fully exploited, then it is quite possible Canada will in fact meet the optimistic projections of increasing its oil output by 2 million b/d in the next decade.

Beyond improving data availability, the other priority for increased international cooperation should be extending the system of strategic petroleum reserves. The IEA treaty is an agreement among its members to hold oil reserves, in one form or another, equal to 90 days of imports.[7] The IEA members in fact hold 40 days of public oil stock and 71 days of industry oil stocks, for a total of 111 days of reserves (3.9 billion barrels). Yet, much of the industry oil stock would be difficult to use in an emergency; some levels of inventories are necessary in any distribution system. Therefore, the stocks available in an emergency would be less than ninety days. More important, the impact of those reserves is undermined by the fact that IEA countries represent only 59 percent of global oil consumption and 23 percent of world oil output. Their share will only decline over time, as China and India increase their share in consumption and OPEC members and Russia increase their weight in production. The IEA strategic reserve needs to be complemented by strategic reserves from two major sets of actors on the global oil scene:

- Developing Asian consumers will by 2025 account for 24 percent of world oil consumption. India and China have both announced intentions to set up stra-

5. Mandil, "Oil: Is the Sense of Crisis Overdone?"
6. Alberta Ministry of Energy, *2003–2004 Annual Report*, p. 15. The February 2005 EIA *Country Analysis Brief–Canada* lists Canada's oil reserves as 179 billion barrels, of which 170 billion are oil sands. Emblematic of the disagreement is that the Canadian Association of Petroleum Producers lists oil sands reserves as 7 billion barrels in one publication (*Industry Facts and Information*) and 175 billion in another (*Canadian Crude Oil*).
7. IEA, "Fact Sheet on IEA Oil Stocks and Emergency Response Potential"; available online (www.iea.org/Textbase/papers/2004/factsheetcover.pdf). Actually, the obligation to hold reserves applies only to the IEA's net oil-importing countries, therefore excluding Canada, Norway, Denmark, and Britain, although the latter two are obligated under European Union rules to hold strategic reserves equal to ninety days' consumption of selected oil products, including gasoline and diesel fuel.

tegic petroleum reserves.[8] India has identified locations for a 36-million-barrel reserve to be ready by 2008, equal to fifteen days of current imports, which it later plans to increase to 108 million barrels. China is building one tank farm and has announced plans to build three more by the end of 2008 at a total cost of $1.6 billion; the Chinese project will have a total capacity of 100 million barrels, equal to twenty days of current imports. There are indications that China intends to increase coverage to thirty days, which would require storage of 300 million barrels by 2010 (imports that year being forecast at 10 million b/d). Both China and India should be encouraged to increase their reserves to ninety days of imports, as in the IEA countries. In addition, there is a need for consultations about the circumstances under which the reserves will be used. Chinese officials have stated flatly that their reserves will be used as a mechanism to manage prices, evidently by allowing use of reserve oil when prices breach some unknown ceiling. For better coordination with China and India, it is worth reconsidering the relationship between the IEA and the Organization for Economic Cooperation and Development (OECD).[9] Rather than structuring the IEA as a part of the OECD, which is only open to the industrial Western nations, it may make sense to encourage participation in the IEA by all major oil-importing countries.

- Oil-exporting nations have a strong interest in ensuring that oil is considered a reliable energy source so that consumers do not shift to alternative fuels. This is particularly true for the two largest producers, Russia and Saudi Arabia, which between them pump more than 20 percent of the world's oil. For years, Saudi Arabia has in effect maintained a strategic reserve by having excess production capacity that could be brought on stream to offset supply shocks. This was dramatically successful in 1990, after the Iraqi invasion of Kuwait knocked both those countries' 5 million b/d of exports off world oil markets; Saudi Arabia alone increased output by about 4 million b/d, and other OPEC countries made up the rest.[10] An important further factor calming the markets was the largely coincidental storage at sea and in the industrial nations of 60 million barrels by Saudi Arabia and Iran, which were trying to position themselves to take advantage of possible demand and price fluctuations largely for commercial reasons.

The main dialogue about the supply shock problem with Saudi Arabia—and secondarily with Russia, Kuwait, and the United Arab Emirates as the other major exporters not in the IEA—should be about the importance of maintaining excess production capacity that can be activated in an emergency. Yet, it would also be useful to point out the advantages for calming market jitters if they were to maintain some oil stocks near consumer markets, either at sea or on land in consumer countries.[11] In 1976, the U.S. Department of the Treasury proposed that Saudi Arabia store oil on U.S. soil for use in an emergency (the Saudis would benefit from being able to sell the oil at a high price in an emergency).[12] Paradoxically, the U.S. government was cool to a 1989 Saudi proposal to lease oil to the U.S. Strategic Petroleum Reserve (SPR) at a cost of a few dollars

8. Consumption figures are from EIA, *Annual Energy Outlook 2005*, p. 41 (excluding IEA member South Korea from developing Asia). India's plans are from Vandana Hari, "India's Crude Use Jumps, But Not for Building Inventories," *Platts Oilgram News*, December 9, 2004; and Ravi Prasad, "India's Strategic Petroleum Reserve Moving Forward," *Global Refining and Fuels Report*, September 29, 2004. China's plans are from "Price Control Plans behind China's SPR," *Petroleum Intelligence Weekly*, January 31, 2005, pp. 1–2.
9. Article 71.1. of the 1974 *Agreement on an International Energy Program,* which established the IEA, states, "This Agreement shall be open for accession by any Member of the Organisation for Economic Co-operation and Development which is able and willing to meet the requirements of the Program." That said, the IEA works closely with other countries. For instance, in January 2004, the IEA and the Indian Ministry of Petroleum and Natural Gas co-hosted a workshop on "Emergency Oil Stock Issues" in New Delhi (see www.iea.org/textbase/press/pressdetail.asp?PRESS_REL_ID=115).
10. Matthew Wald, "No Shortage Seen in Supplies of Oil during a Gulf War," *New York Times*, January 14, 1991, p. A1.
11. For one proposal along these lines, see David Nissen, "Oil Market Reliability: A Commercial Proposal," *Petroleum Intelligence Weekly*, July 25, 2005, pp. 6–7.
12. Patrick Crow, "SPR Questions," *Oil and Gas Journal*, September 11, 1989, p. 28; Thomas Lippman, "Saudis Propose Leasing Oil to U.S.," *Washington Post*, September 12, 1989, p. A6; "Watkins Seeks Authority to Lease Oil for SPR," *Oil and Gas Journal*, February 12, 1990, p. 28; and S. Fred Singer, "Snake Oil in the SPR," *Regulation* 13, no. 2 (Summer 1990).

per barrel, which would have allowed Washington to fill the SPR at a much lower cost than via buying the oil. Negotiations broke down over the details of how to manage such an arrangement, such as whether the United States would have sole right to determine when the oil was used or how to split the profit if the oil was sold at a high price during a crisis (including a U.S. demand that the Saudis pay U.S. tax on the profit).

That approach seems shortsighted. It is in America's interest to allow Riyadh to store oil in the United States, even if the Saudis retain absolute control over that oil, including making decisions about when to release it and keeping any profits from the sale of it. Saudi-owned strategic reserves located on U.S. soil would only be needed if there were a massive crisis that would drain the entire SPR. The most likely situation for such a crisis is one in which the Saudi government is either in chaos or in unfriendly hands, which raises the question of the Saudi-owned reserves' availability. In fact, in such a massive crisis, the U.S. government would tap the Saudi-owned reserves irrespective of who owned them or what commitments had previously been made. Meanwhile, allowing the Saudis to own the reserves in the United States could reassure both Riyadh and U.S. free-market hawks that those reserves will not be used in an effort to influence prices in noncrisis situations. Since Saudi decisionmakers are unlikely to have forgotten the 1989 episode—their ministers serve in the same posts for decades—Washington should state clearly at the highest level that it has changed its mind about a Saudi-controlled reserve on U.S. soil.

There have been proposals over the years about how the United States should manage relations with OPEC as a group, or more generally, how oil-importing and oil-exporting nations should discuss energy policy. The Saudi government has put much political capital into the International Energy Forum, a dialogue of exporting and importing nations that has sponsored nine ministerial conferences since the 1990s and maintained a Riyadh-based secretariat since 2003.[13] Although such dialogue has its benefits, the forum is too large and too public to be the key instrument for U.S.-OPEC relations. The problem will only worsen if Venezuelan president Hugo Chavez goes further down the road of anti-Americanism. Much more important would be quiet bilateral diplomacy with key OPEC members, especially Saudi Arabia.

The main subject of the bilateral energy dialogue with key oil producers, such as Saudi Arabia and Russia, and key oil consumers, such as China, should be the dangers of politicizing oil. Producers and consumers have a common interest in preventing a return to the days when decisions about oil and other natural resources were determined by politics. The old system of "imperial preferences" and closed trading blocs was bad for all involved; for one thing, political barriers to natural resources led to wars. Unfortunately, there is ever more talk about oil not as a commodity but as a strategic weapon. Not only does Chavez hold forth about this, but there was the disturbing November 2004 episode in which China threatened to veto a UN Security Council resolution regarding Darfur, implicitly because of major Chinese investments in Sudan's oil industry. Also of concern has been the way in which Russia has reasserted government control over the oil industry, matching its complete domination of the natural gas industry and raising questions about whether Moscow regards oil and gas principally as geopolitical instruments or as commodities.

While coordination with the major Western oil consumers is generally quite good, environmental standards for oil products could use more work. The balkanization of the U.S. gasoline market, with dozens of slightly different formulations being required for specific localities, is a trend across the globe. That reduces the potential to share the burden in the event of a shortfall in refinery capacity (e.g., in the aftermath of terrorist attacks) or to take advantage of extra capacity that may be available at some refineries. It would be useful to permit more international trade in refined oil by harmonizing environmental standards. Obviously,

13. See the various documents on the International Energy Forum Secretariat website (www.iefs.org.sa).

there must continue to be a variety of different specifications depending on environmental conditions, but it may be possible to use the same standards in an environmentally sensitive area in the United States and in an environmentally similar area in Europe or Asia. The 2005 Energy Policy Act requires that the United States freeze the number of different types of fuel specifications as a solution to the "boutique fuel" problem. As a further step, if there could be an internationally agreed set of specification types, then the market for each particular specification could be larger, permitting more flexibility and efficiency.

Preparing Alternative Response Plans

The treaty establishing the IEA set out two mechanisms for responding in the event of an oil shortfall equal to 7 percent of the normal imports of the IEA members. Article 13 establishes that each IEA member "shall implement demand restraint measures sufficient to reduce its final consumption by an amount equal to 7 percent of its final consumption during the base period."[14] The U.S. government has shown little interest in this mechanism. It has preferred the Article 16 mechanism, whereby a country "may substitute for demand restraint measured use of emergency reserves held in excess of its emergency reserve commitment." The treaty defines that commitment as maintaining stocks—commercial or governmental—equal to ninety days of imports. Since U.S. commercial stocks alone exceed that level, the entire SPR is available for use in place of the Article 13 requirement.

It would be prudent to have alternative plans, however; after all, the SPR could be exhausted during a particularly large supply shock (such as a suspension of Saudi oil exports) or a longlasting shock, or there might be concern about recurring shocks (such as repeated terrorist attacks on key facilities). The most obvious alternative is to let the price rise, which is the most powerful and efficient way to reduce demand and also has the advantage of encouraging additional energy production. But in the event of a sudden and dramatic crisis, the necessary price rise could be quite large. To use economic jargon, the "price elasticity"—the degree to which the amount consumed declines as the price rises—appears to be low and dropping, as an increasing proportion of oil is used for transportation, a sector in which there are few short-term substitutes for oil. Furthermore, a large price increase could have an intolerable impact on some of the most vulnerable members of society—for instance, low-income workers who have to drive long distances to get to work. It would therefore be prudent to examine in advance the options for saving oil in an emergency through persuasion and administrative measures. It is not clear how much work has been done on this within the U.S. government, but it is quite clear that there has not been much discussion of the alternatives with the interested public.

In fact, there are a variety of administrative measures well short of a rationing system that could conceivably reduce oil demand. The IEA estimates that about 2 million b/d—equal to more than 15 percent of U.S. oil imports—could be saved in the United States at a cost to the government budget of less than $10 billion through a variety of administrative measures:[15]

- Restriping existing road lanes for carpool use, providing preferential parking for carpoolers, and promoting other carpooling measures could save about 720,000 b/d
- Enforcing a fifty-five-mile-per-hour speed limit could save 650,000 b/d

14. IEA, *Agreement on an International Energy Program,* November 18, 1974, as amended. Under Article 14, if the shortfall is 12 percent, then each participating country shall implement demand restraint measures sufficient to reduce consumption by 10 percent.
15. IEA, *Saving Oil in a Hurry: Measures for Rapid Demand Restraint in Transport*, review draft, February 28, 2005. The report also estimated that 1.3 million b/d could be saved by instituting an odd/even driving ban, in which on odd days of the month, only those private cars with license plates ending in odd numbers could drive, and similarly for even days. It also investigated a variety of other possible measures, from cutting public transit fares to inflating tires more, but found that each measure had less impact than the steps discussed above. A rather misleading article about the report appeared on the front page of the *Financial Times* (Javier Blas and Kevin Morrison, "IEA Seeks Emergency Oil Plan," April 1, 2005). See also Jad Mouawad and Simon Rimero, "Unmentioned Energy Fix: A 55 M.P.H. Speed Limit," *New York Times*, May 1, 2005, p. 24.

- Using various measures and incentives to encourage companies to adopt telecommuting practices could save 450,000 b/d

- Mandating a four-day, ten-hour-per-day workweek could save 330,000 b/d

To be sure, the IEA acknowledges that these estimates are only approximate; indeed, its draft report provides a broad range for the estimated impact of each measure. And the cost to society would greatly exceed the cost to government budgets, as the measures would add to commuting time and generally inconvenience the public. In fact, it may be difficult to persuade private firms to expand use of telecommuting or four-day workweeks. At the same time, an argument in favor of demand-restraint measures is that during a severe oil crisis, the very announcement they are being adopted could have a dampening effect on what would otherwise be surging oil prices. If every IEA member country implemented the four measures listed above, the total savings could be 3.8 million b/d, which would be more than enough to offset the total loss of exports from any country other than Saudi Arabia or Russia.

Despite the strong preference in recent U.S. administrations in favor of relying on market-driven price rises to curtail demand and stimulate supply, Washington is likely to be driven to consider other policy responses in the event that price spikes reach a level the electorate finds painful. In the wake of Hurricane Katrina, President Bush issued a call for voluntary consumer conservation, which was hardly the focus of his earlier statements on energy matters; indeed, it was more reminiscent of the same Carter-era policies that many in Bush's political base ridicule.[16] Had the price increases gone further, there could well have been pressure for additional measures. It would only be prudent, then, to use the current interval as an opportunity for careful study of the most effective and least costly administrative means of reducing oil consumption.

Increasing the Role of Oil Reserves

As 78,000 b/d continue to be added to the SPR, it is approaching the 727-million-barrel design capacity of its current facilities, although it is possible that the actual capacity may be above design.[17] The 1975 Energy Policy and Conservation Act (EPCA) set a U.S. policy to establish a reserve of up to 1 billion barrels of petroleum, but that goal was changed in 1978 to 750 million barrels. The 2005 Energy Policy Act reinstates the original 1-billion-barrel goal. When that goal was set in 1975, however, it was equivalent to 172 days of imports, which were then 5.8 million b/d. Current U.S. oil imports are 12 million b/d or more, meaning that 1 billion barrels are equivalent to only 83 days of imports; by that measure, the 727 million barrels in the SPR are equivalent to only 61 days of imports. Oil industry stocks bring total U.S. oil stocks up to about 150 days of imports, which is well above the 90-day IEA target; however, it would be difficult to use most of the oil industry stocks in an emergency. Considerable inventory is needed to keep distribution systems functioning. Since 2000, there has also been a 2-million-barrel Northeast Heating Oil Reserve to guard against weather-related delays in shipping heating oil to the part of the country that uses it most.

The 2005 Energy Policy Act authorized raising the SPR to 1 billion barrels, but it did not provide funding for the increase. If the current SPR fill rate of 78,000 b/d were sustained, the SPR would not reach the 1-billion-barrel target until 2015. In that year, the EIA forecasts that oil imports will be 15.5 million b/d, such that the SPR would cover 65 days of imports, compared to 61 days at present.[18] In other words, if phased

16. Bruce Shulman, "Embattled Bush Takes a Page from Carter's Playbook," *Washington Post*, October 2, 2005, p. B1; and Elisabeth Bumiller, "If You Can't Take the Heat Get Out of the West Wing," *New York Times*, October 3, 2005, p. A12 . For conservative criticism of Bush's proposal due to its similarity to Carter's policy, see "Refining Incapacity," *Wall Street Journal*, September 28, 2005, p. A16.
17. Information about the SPR is drawn from the Department of Energy website (www.fossil.energy.gov/programs/reserves/spr), especially "Quick Facts about the Strategic Petroleum Reserve" and "Drawdowns of the Strategic Petroleum Reserve," and from Robert Bamberger, "Strategic Petroleum Reserve," Congressional Research Service Issue Brief, updated January 7, 2005. Note that the volumes going into the SPR depend on the price of oil and other factors.
18. By 2015, U.S. oil consumption is forecast to be 24.2 million b/d, and U.S. oil production 9.7 million b/d (EIA, *International Energy Outlook 2005*, pp. 93, 157).

in over the next decade, the authorized—but as yet unfunded—increase in the SPR would be sufficient to maintain more or less the same degree of protection as at present, without providing much additional protection. If the United States hopes to achieve greater protection against a Middle East supply shock, then the SPR should grow at a more rapid rate than U.S. oil imports. If the SPR fill rate were doubled to 160,000 b/d, then by 2015 the SPR would have 1.3 billion barrels, equal to 84 days of imports. Doubling the fill rate of the SPR would increase U.S. oil imports by less than 1 percent, which is not enough to have much impact on world oil markets—although world markets could be affected if a higher fill rate for strategic reserves were implemented by all IEA members, China, and India.[19] The financial burden would be heavier: if oil prices average $50 per barrel, the cost of the additional oil would be $1.5 billion per year, to which would have to be added the cost of expanding the storage facilities. That is a sizeable sum, but it is worth bearing in mind the price imposed on the U.S. economy by fluctuating oil prices: the price increase from 2002 to 2004 meant the nation's oil import bill rose by $77 billion. There is some reason to think that the very existence of substantial reserves helps mitigate price spikes by reducing the uncertainty premium incorporated into the oil price, although whether this happens depends on the credibility of government policy and the reaction of commercial stockholders.

The circumstances under which SPR oil would be released have been the subject of considerable controversy. Important policymakers in each of the past few administrations have insisted that the SPR be used only if there is a sudden drop in global oil production of several million barrels per day. This is similar to Article 17 of the treaty establishing the IEA, which requires that "whenever any Participating Country sustains or can reasonably be expected to sustain a reduction in [its oil supplies] by an amount exceeding 7 percent of [its usual consumption], allocation of available oil to that Participating Country shall take place" based on a formula in the treaty for sharing the pain.[20] By contrast, the 1975 EPCA authorizes SPR release whenever there is a "severe energy supply interruption," which it defines in two ways, including one based on whether the president determines there is "a severe increase in the price of petroleum products . . . likely to cause a major adverse impact on the national economy." EPCA also authorizes a drawdown of up to 30 million barrels if there are any "domestic or international energy supply shortages of significant scope or duration." It is interesting to note that in 1984 the IEA also adopted a program for the use of strategic reserves, known as the Coordinated Emergency Response Measures, for situations that do not meet the strict treaty requirements.

It is hard to see what is gained by announcing in advance that the president will not use the full authority afforded him by law but will instead only authorize SPR release when there is a large physical shortfall of oil supplies. Secure in the knowledge that there will be no SPR release, market traders are freer in a time of crisis to speculate that prices will go up. By contrast, if U.S. policy on SPR use were more ambiguous, market traders would have to factor in the possibility of an SPR release. Greater ambiguity could act to dampen price speculation. That was, arguably, the impact of the only release of SPR oil to date (other than a 1985 test sale), which came as fighting began in the 1991 Gulf War. After the IEA activated its Contingency Plan on January 17, 1991, the United States advertised the sale of 30 million barrels; crude oil prices fell $10 per barrel the next day and stayed at the new lower level, below $20 per barrel. One could also argue, however, that the price drop came not as a result of the SPR release but because markets saw how quickly and easily the U.S.-led allied force was advancing, which relieved anxiety about a prospective supply disruption.

19. If China and India follow through on announced plans to add 100,000 b/d and 50,000 b/d, respectively, to strategic reserves at the same time that the United States increased its fill rate by 80,000 b/d, that would mean 230,000 b/d increased demand even before any increase in reserve filling by Europe and Japan.
20. IEA, *Agreement on an International Energy Program,* November 18, 1974, as amended.

The political reality is that strategic reserves may in fact be released in order to calm markets and demonstrate that the government is taking a situation seriously. Consider the 2005 SPR release after Hurricane Katrina. Even though hurricane-related refinery closures meant that demand for crude oil fell almost as much as supply,[21] there was great political pressure for an SPR release, and that release arguably had a calming effect on market expectations, thereby tempering price increases.[22]

Besides releases of oil, the SPR law authorizes exchanges in which oil is provided to companies in return for their promise to return more oil later. In practice, such exchanges are similar to releases. Some of the six exchanges made to date—such as the 1996 exchange after Arco's pipeline from the Texas Gulf coast to Oklahoma was temporarily shut—have been in response to temporary, acute shortages caused by weather and accidents. But it is difficult to see the 2000 exchange as anything other than an attempt to hold down prices. In October 2000—shortly before the U.S. presidential elections—there was considerable political rhetoric about the high price of gasoline, which Republicans blamed on new EPA regulations. The pressure to produce more gasoline caused refineries to reduce production of heating oil, the price of which then soared 67 percent compared to the previous year. Explaining that he was acting to reduce heating oil prices in line with a longstanding federal objective of protecting low-income heating oil consumers from high prices, President Bill Clinton authorized the release of 30 million barrels from the SPR through exchanges. It is not clear what impact this ultimately had on prices.[23]

Strong arguments can be made both in favor of and against more active use of SPR exchanges to influence oil prices. As discussed earlier, with the end of government controls on prices, supply crises no longer necessarily translate into physical shortages as they did in the 1970s. Instead, a supply crisis is more likely to take the form of a price spike. That argument supports use of the SPR as a tool to calm fevered price speculation stemming from a political crisis. But the grave risk is that once the SPR is available for influencing price, some politicians will demand using it every time prices rise above the level they consider appropriate. For example, in 2004, some U.S. senators proposed legislation calling for SPR exchanges to reduce prices, and many politicians opposed filling the SPR that year on the grounds that the additional oil demand was putting upward pressure on world prices. The risk is that the SPR would be rapidly drained (and not refilled) by successive efforts to keep oil prices artificially low. That outcome becomes all the more likely once OPEC policy is factored in. In recent years, OPEC has been very sensitive to Western commercial oil stockpiles, adjusting OPEC quotas downward when commercial stocks rise because it is afraid that a stock buildup indicates that prices will weaken. If SPR releases are ordered for the explicit purpose of affecting prices, then the OPEC attitude toward commercial stocks could extend to the SPR. OPEC could decide that it would cut quotas to offset any SPR release designed to influence price. In that case, using the SPR would not accomplish the stated goal but would instead drain the nation's strategic reserve.

While using the SPR to influence price is inappropriate and ineffective over the long term, exchanges can be useful for a quite different goal, namely, lowering the cost of filling the SPR. To that end, the government should consider a policy allowing companies to withdraw barrels from the SPR provided they agree

21. As of early September 2005, Gulf of Mexico oil production was reduced by nearly 900,000 b/d due to Hurricane Katrina. Four Gulf Coast refineries with the same capacity of nearly 900,000 b/d were shut and unlikely to be operating for months. See EIA, "Hurricane Katrina's Impact on the U.S. Oil and Natural Gas Markets," September 6, 2005 (available online at http://tonto.eia.doe.gov/oog/special/eia1_katrina_090605.html); and "U.S. Refining Faces Months of Dislocation," *Petroleum Intelligence Weekly*, September 12, 2005, p. 3.
22. On September 6, 2005, the Department of Energy issued a notice of sale for 30 million barrels of SPR crude oil, but only 11 million barrels were actually pumped ("U.S. Strategic Petroleum Reserve: Hurricane Katrina Drawdown and Sale," available online at www.fossil.energy.gov/programs/reserves/spr/SPRDrawdown2005_AwardSummary_All.pdf). The twenty-six IEA member countries also decided to take collective action to release crude oil and gasoline (see www.iea.org/Textbase/press/pressdetail.asp?PRESS_REL_ID=155).
23. In addition to the previously mentioned Department of Energy documents that give the bare facts, see Eric Pooley, "Who's Right about Oil?" *Time* 156, no. 14 (October 2, 2000); and Sarah Emerson, "SPR Drawdowns Trigger Law of Unintended Consequences," *Oil and Gas Journal*, December 10, 2001, p. 24.

to return substantially more barrels in the future. Consider that in the 2000 exchange, 30 million barrels were released and 34.5 million barrels were returned. Such exchanges would make more sense than the practice of the past twenty years, which has been to fill the SPR when oil prices are high and then reduce it when prices are low. The resolve needed to fill the SPR can be mustered only when the energy security problem appears on the political radar due to high prices, whereas when prices are low, it is tempting to sell oil in order to reduce the budget deficit (in fiscal years 1995–1997, for example, 28 million barrels of SPR oil were sold at an average price of less than $19 per barrel to generate revenue; the average price paid for all the oil in the reserve as of 2004 was $25 per barrel).[24]

A policy of exchanges to fill the SPR would have some impact on oil prices and could be subject to political pressures, as in 2000. Indeed, many of the oil analysts who advocate more active SPR management also support using the reserve to influence prices.[25] But the experience of South Korea, South Africa, and other countries that actively manage their strategic petroleum reserves in order to take advantage of low prices suggests that there are ways to design an exchange policy that is politically neutral and oriented toward saving money rather than influencing prices. To be sure, it would be inappropriate to swap more than a limited portion of the SPR at any one time, since the SPR should always contain enough to respond to a shortfall from sudden unexpected political problems.

In any case, the physical expansion of SPR storage capacity should be designed to increase the flexibility of the reserve. It is not clear how quickly SPR oil could be pumped out. Some observers think there would be problems using more than 2 million b/d, despite Department of Energy assurances that 4.4 million b/d can be pumped out. Also, some questions have been raised about how feasible it would be to repeatedly cycle oil in and out of the salt domes in which SPR oil is now kept. It will be important to ensure that the new storage capacity, which will be needed in the future, is indeed capable of being repeatedly filled, drained, and refilled. The decision about how actively to use the SPR should not have to be determined by the physical characteristics of the SPR storage facilities.

Important as the SPR is, energy security also depends on the level of commercial oil stocks. The news here is not good. In this era of just-in-time delivery, companies are under general pressure to reduce their stocks and therefore the amount of capital that has to be tied up in inventory. Adding to that pressure has been the peculiar fact that for the past five years, the price of oil for future delivery has been lower than the spot price—a condition known as backwardation. Over the past five years, markets have continuously bet that oil prices are heading downward. They have been systematically wrong for a long time—hardly an encouraging indicator of their ability to forecast prices. Indeed, the poor track record of the market should sound a note of caution for any proposal to rely on markets to ensure U.S. oil security. In any case, when oil for future delivery is cheaper than current prices, it is probably a bad idea to hold oil stocks, given that the price of the oil will decline.

Responding to these pressures, commercial oil stocks have been declining. Private stocks in the OECD countries covered seventy-two days of consumption in 1982

24. When filling the SPR resumed in fiscal year 1998, a complex exchange program was used involving payment in kind of the royalties due to the federal government from oil companies producing offshore in the Gulf of Mexico. This arrangement avoided the necessity of congressional outlays to finance the purchase of oil, and it was a way to resolve a dispute with producers about valuation of oil at the wellhead.
25. See for example Stephen Hanke, "Over a Barrel," *Wall Street Journal*, October 21, 2004, p. A18; and Philip Verleger Jr., "Energy: A Gathering Storm?" in ed. C. Fred Bergsten, *The United States and the World Economy: Foreign Economic Policy for the Next Decade* (Washington, D.C.: Institute for International Economics, 2005), pp. 230–231, 240–242 (available online at www.iie.com/publications/chapters_preview/388/7iie3802.pdf). Verleger has written often and eloquently about exchange programs. Besides offering a cheaper way to fill the SPR, such programs could also provide an alternative investment mechanism for traders who believe that oil prices are going to decline, decreasing the likelihood that investors would drive down the price on futures markets to the point that the price for future delivery was below the current price—a situation termed "backwardation." Backwardation is a disincentive against private companies accumulating stocks (because markets are betting that the value of those stocks will drop over time), so if an exchange program makes backwardation less likely, then private companies would be less reluctant to add to their private stocks. In that way, the exchange program would both increase private stocks above what they would otherwise be and also fill the SPR at low cost.

but only fifty days in 2003.[26] It is not clear how much of the commercial oil stocks are necessary just to keep the energy system functioning, but it is possible that the industry has been reducing inventories to a level close to this minimum—in effect, each firm hoping that others will be able to adjust output quickly enough to meet most of the fluctuations in demand, such as the typical increased demand for gasoline in the summer months when people drive to vacation spots.

U.S. government policy has not encouraged commercial firms to hold oil stocks—quite the contrary. As described previously, the FTC-required sale of refineries by the oil majors has increasingly left refineries in the hands of firms that have difficulty raising the funds needed to finance inventory accumulation. Inventories became so small that, in September 2004, some refineries blamed their shutdown after Hurricane Ivan on the next week's sharp drop in deliveries; that is, it seems they were holding no more than one week's inventory of crude.[27] Some combination of regulatory requirements and tax incentives could be used to encourage private firms to hold stocks in excess of commercial need. Japan and most European countries use these mechanisms rather than government-owned stockpiles to provide much, if not all, of their strategic oil reserves. Before embarking on any expansion of the SPR, a careful study should be made of the relative costs of government-run strategic stockpiles compared to privately run stockpiles.

Providing Greater Capacity and Flexibility

Companies have strong incentives to hold down costs, and therefore they may (1) cut inventory, relying on "just-in-time delivery"; (2) maximize efficiency by designing facilities to take full advantage of the exact specifications of inputs, which can require making use of supplies from one dedicated source; or (3) hold down investment requirements by fine-tuning capacity to exactly meet demand without any excess. These measures can make excellent sense for individual companies. But when the entire energy supply chain is run on that basis, the result is a U.S. economy highly vulnerable to supply shocks. In the event of a supply disruption, companies do not have the inventory to buffer against a shortfall; they are unable to make use of fuel from a different supplier; and they do not have the extra capacity to increase their output so as to permit burden shifting. These problems affect most aspects of the system, including tankers, ports, pipelines, refineries, refined product distribution systems, electrical generating facilities, and power transmission lines. It is not clear that these systems have adequate spare capacity and sufficient ability to shift from using normal supply sources in a manner that would provide a cushion against Middle East supply shocks.

The current energy infrastructure is too rigid and too close to full-capacity use. For instance, when oil prices soared in 2004, Saudi Arabia tried to moderate prices by making more oil available. But the only extra oil it could produce was heavier, sour crude that refineries lacked the capability to process efficiently into transportation fuels. As a result, Saudi crude was forced to go begging for purchasers, even when offered at a discount of $15 per barrel compared to light, sweet crude.[28]

Moreover, the refining shortage will only get worse. Since 1981, the number of refineries in the United States has fallen from 321 to 149. Despite expansion of remaining facilities, the total capacity of U.S. refineries has fallen from 18.6 million b/d to 17.2 million b/d. Consequently, refineries that operated at only 69 percent capacity in 1981 now operate at 93 percent capacity.[29] The United States is increasingly relying

26. On OECD stocks, see IEA, "Fact Sheet: IEA Stocks," and Verleger, "Energy: A Gathering Storm?" p. 240.
27. There are different interpretations of what happened in this episode; see EIA, *This Week in Petroleum*, September 22 and September 29, 2004; and Verleger, "Energy: A Gathering Storm?" p. 235.
28. Wendy Zellner, "Crude Lessons about Oil," *Business Week*, November 22, 2004, p. 86; "Heavy/Light-Discount Boost for Refiners," *Petroleum Economist*, March 7, 2005, p. 35.
29. Stated another way, idle capacity in 1981 was 5.8 million b/d; today, it is 1.2 million (EIA, "Table 5.9: Refinery Capacity and Utilization, 1949–2003," in *Annual Energy Review 2004*; available online at www.firstgov.gov/fgsearch/resultstrack.jsp?sid=184914120&url=http://www.eia.doe.gov/aer/pdf/pages/sec5.pdf). See also "US Refiners Remain Wary of Expansion," *Petroleum Intelligence Weekly*, March 28, 2005, p. 5; and Sheila McNulty, "Ageing Refineries Add to US Woes at the Petrol Pumps," *Financial Times*, June 7, 2004, p. 14. The most recent statistics are from EIA, International Energy Data-

on imports of refined oil products, which now make up 10 percent of U.S. consumption. At the same time that America is becoming more dependent on foreign refineries, global refinery capacity is coming under serious strain; what was once 20 million b/d in excess refinery capacity is gone. The situation may worsen if there is inadequate investment in new refining capacity to meet the burgeoning Asian oil demand; the IEA estimates that in 2005, world oil demand will grow 1.8 million b/d while world refining capacity will grow only 1 million b/d.[30] And most Asian refineries are no more capable than American ones of handling the heavy, sour crude that becomes available when demand for oil soars. In late 2004, China was so actively bidding for the limited supply of light, sweet crude that its actions may have added $10 per barrel to the price of that oil.

Compounding these problems, a substantial increase in oil imports would require more capacity at U.S. ports for large tankers, while building a new oil-handling facility would require investing many years in a difficult and contentious regulatory approval process. And once on land, the oil would have to be transported, which would require greater capacity in the U.S. pipeline system. It would be useful for the pipeline network to replicate the built-in redundancy and capacity to handle traffic surges seen on the internet or within the interstate highway system.

The consumption side of the oil business is at least as rigid and inflexible as the supply side. Because of slight differences in federal and state regulatory requirements, the gasoline sold in Chicago cannot be sold in downstate Illinois, and yet a third type of gasoline is mandated for the Illinois suburbs of St. Louis.[31] To quote the EPA, "If there is a disruption [in the supply chain] such as a pipeline break or refinery fire, it becomes difficult to move gasoline supplies around the country because of constraints created by these boutique fuel requirements." While the 2001 National Energy Policy proposed "exploring ways to increase the flexibility of the fuels distribution" system to minimize problems from boutique fuels, the problem has grown worse in light of regulations established to deal with additional types of pollutants. The result is that markets are increasingly served by a small number of refineries that are set to produce just the mix needed in that area.

The same problems that afflict the oil supply chain are also present for most of the rest of the energy system, which reduces the ability to shift to other fuels when oil is in short supply (admittedly, though, there is only limited scope for such fuel-shifting because as much as 90 percent of oil is used in areas where there are few practical alternatives in the short term, including the 70 percent used in transport). Complicated regulatory procedures—made worse by "not in my backyard" attitudes—impede adequate capacity for importing natural gas or transporting coal by rail or barge. Uncertainty about how regulations will change, compounded by ill-designed regulatory reforms and inadequate policing of corporate misdeeds, has exacerbated problems in electricity. For example, the vulnerability of California's electrical grid in 2001 to shortages, real and manipulated, could be repeated elsewhere.

To some extent, the current tight capacity constraints are part of a normal business cycle that will be reversed as high prices encourage investors to build more capacity. This process can occur with considerable speed. Consider the oil tanker market. The cost

base, June 29, 2005 (available online at www.eia.doe.gov/pub/international/iealf/table36.xls). In addition, *BP Statistical Review of World Energy 2005* placed U.S. refinery capacities at 17.042 million b/d in 2004, a year that is missing from the EIA's "Table 5.9." BP also included "refinery throughputs," which held at levels of 15.304 million b/d in 2003 out of a full capacity of 16.894 million b/d, and 15.479 million b/d in 2004 out of a full capacity of 17.042 million b/d (p. 16).

30. See Kevin Morrison, "Lack of Refining Capacity Puts Pressure on Supplies of Oil," *Financial Times*, March 12, 2005, p. 6; John Vautrain, "Asia Leads World in Refined-Product Demand Growth," *Oil and Gas Journal*, December 6, 2004, p. 56; "Refiners at the Limit on Sulfur," *Argus Global Markets*, September 27, 2004, p. 3; and "China Leads Race to Secure Sweet Supply," *Argus Global Markets*, September 13, 2004, p. 2. There are some encouraging countertrends, such as the large, privately owned Reliance Industries refinery in India, which can process heavy Persian Gulf crudes into gasoline that meets the specifications for New York City; see Keith Bradsher, "A Former Gas Station Attendant's Big Bet on a Refinery Has Paid Off," *New York Times*, February 18, 2005, p. C4.
31. *Study of Unique Gasoline Fuel Blends ('Boutique Fuels'), Effects on Fuel Supply and Distribution and Potential Improvements*, Environmental Protection Agency Staff White Paper (EPA420-P-01-004), October 2001, p. ii. See also pp. 85–100 for a listing of the then-applicable variations in gasoline type depending on location and time of year, designed to meet both federal and state requirements relating to several pollutants.

of shipping oil rose from about 65¢ per barrel in early 2002 to $3 per barrel in late 2004, which was eight times the break-even price. The forecast for 2005 was equally grim: shipyards were said to be operating at full capacity in terms of building new tankers, but the 20 million deadweight tons due for delivery were expected to be exceeded by the 25 million tons set to be scrapped in order to comply with International Maritime Organization rules requiring the phasing out of single-hull tankers in favor of spill-resistant dual-hull tankers.[32] In spite of this forecast, the tanker shortage disappeared in early 2005, and rates plummeted.

Hopefully, the tightness in other parts of the energy supply chain will be reversed as quickly and easily as was the tanker shortage. But it is inappropriate to formulate government policy on the basis of the most optimistic hopes. It would be wiser to hedge against the risk of a Middle Eastern supply disruption by encouraging spare capacity and the flexibility to shift gears. The 2005 Energy Policy Act included a variety of tax incentives and regulatory changes designed to encourage more investment in energy infrastructure. Particularly welcome were provisions to break regulatory logjams that tie up for years decisions about new liquefied natural gas terminals and electricity transmission lines. That said, it would be best if energy security objectives were clearly established as policy goals that need to be factored into such decisions.

32. "Tight Supply, Top Rates Boost Tankers," *Petroleum Intelligence Weekly*, November 8, 2004, pp. 4–5; "Tanker Freight Market: The Devil Is in the Data," *Petroleum Economist*, October 11, 2004, p. 34; Heather Timmons, "Got Oil? Now Try to Find Tankers to Carry It," *New York Times*, June 9, 2004, pp. C1, C14; and Jad Mouawad, "A Tanker Shortage Contributes to Rising Oil Costs," *New York Times*, October 20, 2004, p. C1. The data apply only to the 1,400 tankers with a capacity of 500,000 barrels or more, out of the total global fleet of 3,600 tankers; however, the 435 very large crude carriers (VLCCs), each of which can carry 2 million barrels or more, transport a third of world oil shipments.

Protecting the Global Energy Infrastructure

THE GLOBAL ENERGY infrastructure is vulnerable to attacks by hostile states and terrorists. In the Persian Gulf region, there are several major bottlenecks in the oil production and distribution systems, such as the Strait of Hormuz and various key facilities, particularly in Saudi Arabia.[1] It is not appropriate to speculate in a public document about which targets would be the most devastating to attack. Suffice it to say that there are certain key nodes crucial to the functioning of the energy industry that, if knocked out, could have considerable impact on nervous oil traders and physical oil supplies.

The key elements of a strategy for protecting the energy infrastructure are promoting antiterrorism best practices abroad; encouraging political reform as part of the fight against violent extremism; deterring hostile state attack; and projecting sufficient military, especially naval, forces.

Promoting Antiterrorism Best Practices Abroad

Protecting energy infrastructure from terrorist strikes has been a major U.S. concern since the September 11 attacks. The U.S. government, along with U.S. industry, has been developing best practices to reduce vulnerabilities in the American energy infrastructure in the context of the National Strategy for the Physical Protection of Critical Infrastructures and Key Assets.[2] These include standards and procedures for:

- Security assessment, including analyzing vulnerabilities, improving security plans, and developing specific action plans to improve threat deterrence
- Physical security corresponding to varying threat levels, including hardening sites
- Protection of information and control systems, including from computer viruses
- Development of strategies to reduce vulnerabilities, including establishing a coherent, industrywide picture of risks, identifying the appropriate level of redundancy for critical components and systems, and formulating requirements for new facilities
- Reconstitution of attacked facilities and systems, including convening advisory task forces involving construction firms, equipment suppliers, oil engineering firms, and all relevant government agencies; identifying key bottlenecks; and developing plans for workarounds if needed
- Location and distribution of critical components in support of response and recovery activities, including identifying required equipment and personnel; ensuring that they will be available when needed by stockpiling equipment and implementing on-call systems; and developing and practicing plans for getting them to the affected sites in an emergency

To date, efforts to protect energy infrastructure have been almost entirely geared toward the American system, but attacks in the Persian Gulf could have a worldwide effect that would hurt the United States as well. The U.S. government could do much to share its infrastructure-protection best practices with governments and energy companies in the Gulf region (e.g., through joint commissions and exchange programs). Washington could facilitate the U.S. oil industry's efforts to share its experience in responding to heightened concern about terrorism after the September 11 attacks, which has been the subject of several important reports.[3] Both

1. See "What If? Terrorists Are Now Targeting Saudi Arabia's Oil Infrastructure; How Bad Could Things Get?" *The Economist*, May 27, 2004.
2. Released by the White House in February 2003; the document is available online (www.tsa.gov/public/interweb/assetlibrary/National_Strategy_for_Physical_Protection_of_Critical_Infrastructures_2003.pdf).
3. The American Petroleum Institute's April 2003 *Security Guidelines for the Petroleum Industry* outlined methods for developing a security plan, including establishing standards for a security vulnerability assessment with guidelines for production operations, pipelines, maritime transport, refineries, product

in conjunction with Gulf states and on its own, the U.S. government should develop plans for an American role in facility reconstitution in the event of catastrophic terrorist attack on key energy nodes.

It is worth emphasizing how seriously Saudi Arabia has taken infrastructure protection. The Saudi oil industry has many redundancies, so that if one facility is disabled, others can substitute. Much effort is devoted to facility protection as well. According to Nawaf Obaid, a Saudi national security and energy consultant, "At any one time, there are up to 30,000 guards protecting the country's oil infrastructure, while high-technology surveillance and aircraft patrols are common."[4] This includes 5,000 guards employed by the Saudi Arabian Oil Company (Saudi Aramco), a specialized brigade of the national guard, the Petroleum Installation Security Force, and units of Saudi Arabia's antiterrorist special forces.[5] Yet, it is by no means clear whether the results are commensurate with the effort expended. Moreover, the May 2004 attacks in the Yanbu petrochemical complex in western Saudi Arabia (in which six Westerners were killed in a gruesome manner) and in al-Khobar, in the heart of the kingdom's oil-producing region (in which twenty-two foreigners were killed in a walled residential compound housing many oil industry executives), highlighted the vulnerability of the foreign workers who have been so important to the oil industry. In both incidents, the Saudi police response was heavily criticized by Western residents of the kingdom.

Encouraging Political Reform to Combat Violent Extremism

The United States has been actively working with the Gulf monarchies to counter the threat of terrorism, including the threat to foreign oil workers. It is gratifying to see that Saudi Arabia has recently been taking the threat from Islamist extremists more seriously, including through efforts to halt financing for terrorists.[6]

Much more needs to be done, however, especially with regard to rooting out the teaching of hatred and incitement to violence. Washington must press the Gulf monarchies on these fronts, as well as on political, social, and economic reform, if it hopes to reduce the frustrations and despair that feed radical violence. The September 11 attacks showed the United States that its most vital national security interest lies in promoting reforms that give the Arab world's young people hope that they can bring about change within the framework of their systems without violence. Rather than being at odds, the U.S. reform agenda in the region reinforces American security objectives, including counterterrorism.

The leaders of countries like Saudi Arabia would be much stronger if they were to open up their political systems and broaden the base of those systems. The narrow base of their rule threatens their stability. The gravest threat to the Gulf monarchies is radical revolutionaries claiming to act in the name of Islam, and the best way to stop them is by opening up the political system. The political liberalization urged by the United States is in the best interests of the existing regimes. The Western interest is to promote reform, not revolution, in the Gulf. The process of democratization must begin first with civic freedoms and liberties, such as free press and political parties; with these in place, the habits of criticism and compromise will grow. Once those institutions are established, it would be appropriate to initiate elections for positions of limited importance (e.g., on municipal councils or advisory bodies) in order to allow new leaders to emerge and gain experience with parliamentary practice. Over time, elected bodies could take on more importance, and elections

distribution, and information technology. The National Petroleum Council's *Securing Oil and Natural Gas Infrastructures in the New Economy* (June 2001) focused on information technology protection.

4. Nawaf Obaid, "Attacks Highlight Threats to Saudi Infrastructure," *Jane's Intelligence Review*, June 2004, pp. 4–5.
5. See Anthony Cordesman and Nawaf Obaid, "Saudi Petroleum Security: Challenges and Responses," Center for Strategic and International Studies, December 2004.
6. Matthew Levitt, "Charitable Organizations and Terrorist Financing: A War on Terror Status-Check," paper presented at the workshop "The Dimensions of Terrorist Financing," University of Pittsburgh, March 19, 2004. Available online (www.washingtoninstitute.org/templateC07.php?CID=104).

could be held for more and more important positions in government. There is a danger in a gradual process of democratization—namely, that the existing power elites will claim to be making reforms when they are in fact only creating the facade of reform without any real content. The promising recent stirrings of democracy in the Middle East provide an opening to urge Gulf monarchies to pick up the pace of reform.

One important area of reform entails giving young people education that prepares them for the work force, rather than overemphasizing religious teaching to the point that graduates are unemployable. An increase in the number of locals who can take over oil industry jobs previously performed by expatriates will also reduce the vulnerability of the oil industry to an exodus of foreign workers in the event of a terror campaign. Already, 86 percent of the workers at Saudi Aramco are Saudi nationals, and Saudis fill many of the technically demanding skill positions.[7] To be sure, foreign nationals still fill essential positions, but they do not dominate the industry as they did in decades past. And even if terrorism causes Westerners to flee, many of them could be replaced by expatriate workers from other countries—already, almost as many of Saudi Aramco's workers come from Asia as from Europe and North America combined.

Deterring Hostile State Attack

Besides terrorism and domestic instability, the major source of threats to the energy infrastructure is the possibility of hostile action by Iran. In the 1980s, in a counterproductive attempt to press the West to stop opposing its invasion of Iraq, Iran attacked oil tankers in the Gulf, clandestinely scattering mines in Gulf waters and executing occasional airstrikes and speedboat attacks on tankers. As tensions build with respect to Iran's nuclear program and its support for terrorism, Tehran should be deterred from once again considering an attack on oil shipping or oil facilities as a means to pressure the West.

Persian Gulf countries and oil-consuming nations alike have a vital interest in ensuring the free flow of Gulf oil. The United States should build a broad international coalition committed to keeping Gulf sea lanes open and protecting against Iranian aggression directed at other Gulf oil producers. A substantive military contribution from other major oil-consuming nations could have a significant deterrent effect on Iran, which in the past has shown its reluctance to become an international pariah. Indeed, when confronted by a demand orchestrated by Britain, France, and Germany in 2003, Iran agreed to suspend uranium enrichment even though it had no treaty obligation to do so. There is good reason to believe that an equally firm and broad international commitment to keep the Gulf sea lanes open would persuade Iran against attacking oil shipping no matter the circumstances—not even as a response to an airstrike on Iranian nuclear facilities, whether executed by the United States or another nation.

An international commitment to keeping the Gulf sea lanes open might take the form of an international agreement. But it should also include concrete actions, such as sales of advanced weapons, possibly including precision-guided munitions and antisubmarine warfare systems, from Western nations to Iraq and the Gulf monarchies. Particularly important will be enhancing the number, capability, and effectiveness of antimissile systems around the region, which would increase protection for vital energy installations and other potential targets. The United States and its allies could also propose more active combined exercises, which would include regional forces and be aimed against the Iranian threat, such as minesweeping and convoy operations. European allies, Japan, and Australia could be asked to rotate forces into the Gulf with the specific goal of deterring Iranian attack. Such forces could include coastal patrol forces for offshore facilities like oil terminals. The United States could similarly augment its deployments to the Gulf to include, for instance, naval antimissile systems.

7. Of Saudi Aramco's 53,594 employees at the end of 2003, 46,365 were Saudi nationals and 7,589 were expatriates (Saudi Aramco, *Annual Report 2003*). At the end of 2002, 6.4 percent of its employees were from North America or Europe, while 6.0 percent were from Asia (Saudi Aramco, "Electronic Media Kit").

It would also be worth considering extending an explicit U.S.—or Western—security umbrella over Gulf states against any Iranian threat, especially if Iran were to achieve ambiguous nuclear weapons status. To some extent, such a security umbrella might demonstrate to Iran that it gains little if any advantage from its nuclear program. More important, a security umbrella would help reassure allies, making them less likely either to bend to Iranian pressure or to consider proliferating on their own.

Projecting Sufficient Naval Force

Ever since its increased deployment in the Persian Gulf during the reflagging of Kuwaiti tankers in the waning days of the Iran-Iraq War, the U.S. Navy has been the main protective force at sea in the Gulf. The responsibility of protecting oil tankers from terrorist attacks in Gulf waters therefore falls heavily on the U.S. Navy. Indeed, some shippers have already sought U.S. military escorts in the Gulf, and the navy is considering these requests.[8]

Terrorist attacks at sea are a particularly acute problem. Tightened onboard ship security regulations, such as those implemented by the United States in July 2004, should be mandated for all tankers.[9] Even more troubling is the threat from suicide bombers in small boats, such as the thousands of dhows that ply the Gulf waters. The October 2002 attack in Yemeni waters on the French tanker *Limburg,* executed by a small boat laden with explosives, blew a hole in the ship's side through which 100,000 barrels of oil leaked. Despite this heavy cost, the attack reinforced the lesson learned from direct missile and bomb hits during the Iran-Iraq War: that it is extremely difficult to blow up an oil tanker, as distinct from causing spills and containable fires. Yet, oil platforms and oil-loading terminals (which are located offshore and connected by pipelines to facilities on land) are more valuable—and potentially more vulnerable—targets, as illustrated by the April 2004 attack on the Basra oil terminal, stationed offshore. Concern also exists that terrorists might use an oil or gas tanker, especially a liquefied natural gas (LNG) tanker, as an instrument for a terrorist attack.[10]

The U.S. Navy and Coast Guard have been working on the problem of countering terrorist attacks against maritime oil assets. In doing so, they have deployed significant forces to the Gulf, including approximately thirty navy ships and six coast guard cutters. They are searching for more effective ways to protect oil terminals, offshore platforms, and tankers, ranging from high-technology sensors to chain curtains or security fences that run for miles around facilities. This area will merit a significant commitment of research and development funds in the short term.

The principal Gulf maritime counterterrorism burden will continue to fall on the United States, given that the navies of the Gulf states are not up to handling the terrorism challenge on their own. They should be pressed to contribute, however, particularly with regard to security for ports and oil terminals. The United States should also ask other major oil-consuming nations to contribute to the effort, both to share the burden and to demonstrate the breadth of international commitment to keeping the Persian Gulf sea lanes open.

8. Chip Cummins, "As Threats to Oil Facilities Rise, U.S. Military Becomes Protector," *Wall Street Journal*, June 30, 2004, pp. A1, A5. Cummins also provides information about U.S. Navy and Coast Guard counterterrorism efforts in the Gulf.
9. See Timmons, "Got Oil?"
10. See Jonathan Medalia, "Port and Maritime Security: Potential for Terrorist Nuclear Attack Using Oil Tankers," Congressional Research Service Report, December 7, 2004; and Mike Hightower et al., *Guidance for Risk Analysis and Safety Implications of a Large Liquified Natural Gas (LNG) Spill Over Water*, Sandia National Laboratories Report (SAND2004-6258), December 2004. The latter report concludes that the threat of fire from vapor released by an attack on an LNG tanker would most likely be limited to a 500-meter range but could extend to 2,500 meters.

The Larger Energy Policy Picture

ENERGY POLICY has been caught in a political crossfire. The Energy Policy Act of 2005, the first explicit piece of energy policy legislation since 1992, took great effort to produce and mandate only modest steps on many important matters. Energy policy is entangled in the contentious issues of global climate change and the environmental impact of U.S. energy production—issues far wider in scope than the question of vulnerability to supply shocks from the Middle East. But no firewall separates the broader problems from the narrower issue of supply shock vulnerability. The interconnections are complicated. For instance, some proposals to counteract global warming, such as reducing energy consumption, would help energy security. Others, such as reducing consumption of coal, the energy source with which America is best endowed, would hurt it. These details make it particularly important that any decisions about global climate change factor into the energy security implications.

Over the past decade, the two main camps in the energy policy debate could roughly be characterized as the low-consumption, low-production camp and the high-consumption, high-production camp. Neither approach is ideal for energy security. More recently, a trend has emerged that emphasizes alternative fuels and energy conservation as a way to reduce reliance on foreign energy and simultaneously combat global warming.[1] Many proposals from this emerging camp bear a family resemblance to the policies adopted after 1973—namely, regulatory actions and subsidies designed to promote conservation and alternative fuels. By the mid-1980s, such policies were largely abandoned or sharply reduced in scope. It is worth studying why they lost political support. Surely part of the reason was that they were overly intrusive and did not make sufficient use of market forces in promoting their objectives. In addition, a national energy strategy must strive to hold down energy costs for consumers, which these approaches did not do.

The longstanding deadlock over national energy policy has had the unintended effect of keeping consumption high and domestic production low, making the U.S. energy system increasingly fragile and dependent on foreign oil. This dynamic has not served the interest of any side in the debate about energy and the environment. Nearly every proposed national energy strategy would make the country less vulnerable than it is now to foreign supply shocks—whether as a deliberate goal or as a side effect of policies recommended for other reasons. To be sure, there are real differences in the energy security impact of the different proposed national energy strategies. But the greatest difference is that between the pernicious impact of the current deadlock and the positive effect of forging a consensus so that new policies can be implemented.

The two broad areas most critical for energy security are domestic energy production and energy efficiency.[2]

Increased U.S. Energy Production

Even if great strides are made in energy efficiency and the economy moves toward less energy-intensive activities, U.S. energy consumption will inevitably increase as U.S. population and economic output grow.[3] Consider the record of the last three decades. In 1973, the

1. One group advocating this approach is Set America Free (www.setamericafree.org), which has drawn much positive press from political conservatives (e.g., Max Boot, "The 500-Mile-Per-Gallon Solution," *Los Angeles Times*, March 24, 2005); see also Greg Schneider, "An Unlikely Meeting of the Minds," *Washington Post*, March 31, 2005, pp. E1, E12. For criticism of this approach, see Jerry Taylor and Peter Van Doren, "High-Octane Amnesia," *Wall Street Journal*, April 12, 2005, p. A22.
2. President Bush has summarized the challenge as follows: "A sound energy bill must meet four objectives: it must promote conservation and efficiency, increase domestic production, diversify our energy supply, and modernize our energy infrastructure. And as we pursue all these goals, we will also uphold our responsibility to be good stewards of the environment" (remarks delivered at Franklin County Veterans Memorial, Columbus, Ohio, March 9, 2005).
3. See Lewis Lehrman, "Energetic America," *Weekly Standard*, September 29, 2003, pp. 25–29. For an argument that strong policy initiatives could actually reduce energy consumption in future decades, see Irving Mintzer et al., *U.S. Energy Scenarios for the 21st Century*, Pew Center on Global Climate Change, July 2003.

U.S. economy used 17,440 British thermal units (Btu) of energy per dollar of gross domestic product; in 2003, this figure had fallen to 9,440 Btu. Nevertheless, total U.S. consumption of energy rose from 76 quadrillion Btu to 98 quadrillion over that period.[4] Given the reality that energy consumption will rise, increasing U.S. energy production is an essential part of making America less dependent on foreign energy.[5]

A principal barrier to increasing U.S. oil, gas, and coal output has been the environmental damage that can result from energy production. Because the public has an interest in promoting both environmental protection and energy security, it is appropriate to use public resources to finance research into more environmentally friendly ways to produce energy. For similar reasons, it is appropriate to finance research and development on nontraditional energy sources with public funds. However, it will be important to consider carefully how to structure government subsidies so as to avoid repeating the fiasco of the Synthetic Fuels Corporation in the 1980s. At the time, the U.S. government, eager to reduce dependence on foreign oil, poured more than one billion dollars into an unsuccessful effort to produce gasoline from coal at commercially competitive prices.[6] The U.S. government has a bad track record at selecting technologies for energy production; to the maximum extent possible, it should rely on investors prepared to share costs in making such decisions.

It would seem wise to fund research in a variety of promising fuel sources rather than to prejudge the case about which particular technology will offer the best mix of environmental, economic, and security advantages. At present, a broad political consensus supports a multibillion-dollar federal research program into hydrogen fuel technology.[7] Perhaps hydrogen fuel will turn out to be a winner, but several other technologies may be more successful at attracting the necessary investment funds. The government's role should be to provide seed money and research funds for all the promising technologies, not just for one. Four technologies to consider can be explained as follows:

- The costs of turning coal into diesel fuel, too high in the 1980s, may have dropped enough to become profitable at current oil prices; if so, that could make America's ample coal reserves available for vehicle transport.

- Organic waste can be used to produce diesel fuel. This method could become economical if waste disposers had to pay "tipping charges" equal to the cost to society of dealing with the waste.[8]

- Bioethanol, a byproduct of catalysts that break down cellulose, would allow conversion into ethanol of rice straws, prairie grass, and similar agricultural products.

- Shale oil is abundant in the United States. A 2004 report produced for the Department of Energy concluded, "It is possible to initiate an oil shale industry by 2011 with an aggressive goal of two million b/d by 2020. Ultimate capacity could reach ten million b/d."[9]

4. EIA, *Annual Energy Review 2003*, p. 13. The data regarding energy consumption are adjusted for inflation. In contrast to the sharp reduction since 1979, energy intensity (Btu per dollar of gross domestic product) barely declined from 1949 to 1973.
5. The contrary view is illustrated in the *New York Times* editorial "Energy Follies" (April 30, 2005, p. A26), which attacked President Bush for ignoring the fact that "if we are to reduce oil imports, we must find substitutes for gasoline or use less of it." The piece described proposals to increase oil production as "deceptions."
6. Roger Noll and Linda Cohen, *The Technology Pork Barrel* (Washington, D.C.: Brookings Institution, 1991). The inappropriateness of government subsidies for "alternative fuel boondoggles" is a theme of *Wall Street Journal* editors; see, for example, "$60 Oil," June 29, 2005, p. A14.
7. In his 2003 State of the Union address, President Bush announced the Hydrogen Fuel Initiative, a $1.2 billion commitment over five years to accelerate hydrogen-related research. Joseph Romm argued an opposing view in *The Hype about Hydrogen* (Washington, D.C.: Island Press, 2004, p. 188): "Hydrogen is no panacea. In the next three decades, it offers little or no prospect of helping the United States reduce its greenhouse gas emissions. Hydrogen will contribute significant reductions by 2050 *only* if we dramatically change the energy path we are now on" (emphasis in the original).
8. See R. James Woolsey, "Implications of U.S. Dependence on Middle East Oil," *PolicyWatch* no. 882 (Washington Institute for Near East Policy, July 7, 2004; available online at www.washingtoninstitute.org/templateC05.php?CID=1760); and R. James Woolsey and Richard Lugar, "The New Petroleum," *Foreign Affairs* 78, no. 1 (January–February 1999), pp. 88–102. On hybrids, see "Why the Future Is Hybrid," *The Economist*, December 4, 2004, pp. 26–30.
9. Harry Johnson et al., *Strategic Significance of America's Oil Share Resource*, vol. 1 (Office of the Deputy Assistant Secretary of Energy for Petroleum Reserves, March 2004), p. 23.

Each of these fuels faces serious questions with regard to its economic viability and environmental impact (some would release significant global warming gases), but all merit further research as long as the private sector is prepared to commit substantial funds alongside government funding. The 2005 Energy Policy Act included provisions for government support, in one form or another, for many nonconventional fuel sources.

While security concerns center on energy to be transported, electricity generation represents another energy security issue. At present, two-thirds of the nation's electricity comes from energy sources with which the United States is amply endowed—namely, coal and nuclear power.[10] In the last decade, however, natural gas has been used for almost 90 percent of new electricity generation capacity, an approach encouraged by regulators partly for environmental reasons and partly based on economics.[11] Even with considerable investment and an opening of fields previously ruled out for environmental reasons, U.S. natural gas resources are simply inadequate to meet growing demands. In recent decades, the increasing gap between gas consumption and production has been alleviated almost entirely by imports from Canada, but in future years, Canadian production will no longer be able to fill this gap. As a result, the United States will rely largely on LNG imports to meet its natural gas consumption needs. By 2030, imports of LNG will account for 15 percent of all U.S. gas consumption.[12] This LNG will often come from the same volatile countries that import oil; indeed, the IEA estimates that 5 percent of all U.S. natural gas consumption in 2030 will come from the Persian Gulf. In other words, if the United States continues to use natural gas to meet its growing electricity demands, it will increase its reliance on OPEC energy. This development aptly illustrates why the United States needs an energy policy process that more effectively factors security implications into regulatory decisions. The United States does not want to find itself in the same situation as Germany, so dependent on one set of natural gas suppliers (in Germany's case, Russia) that energy concerns appear to affect every aspect of bilateral relations.[13]

The security risk associated with increasing reliance on foreign energy for electricity production could be avoided if a consensus is developed on how to expand the use of coal and nuclear energy. Increasing domestic production of these energy sources should not be a problem; indeed, American coal reserves are the largest in the world, ample for more than 200 years of consumption. The issue instead surrounds environmental problems that arise from the use of coal and nuclear materials for energy production. To make better use of the former resource, U.S. policy encourages the proliferation of clean coal technology.[14] More than 100 new coal-fueled plants have been announced, taking advantage of coal's typical fuel cost of 2¢ per kilowatt-hour compared to 5¢ per kilowatt-hour in a natural gas power plant.[15]

By contrast, in the past twelve years, only one nuclear power plant has opened in the United States, and that plant had been under construction since 1972.[16] If an environmentally sound way can be found

10. Of the 99 quadrillion Btu of energy consumed in the United States in 2003, 23 quadrillion came from coal and 8 quadrillion came from nuclear power. In addition, 23 quadrillion came from natural gas, 39 quadrillion from petroleum, and 6 quadrillion from all other sources, including hydroelectric, wood, and other renewable sources (*Monthly Energy Review*, February 2005, p. 7). The United States holds 25 percent of the world's coal reserves, which is sufficient for 258 years of production at current rates (*BP Statistical Review of World Energy* 2004, p. 30).
11. On the dangers implicit in current U.S. policies regarding natural gas, see Robert Samuelson, "Our Next Shortage," *Washington Post*, June 17, 2004, p. A29.
12. IEA, *World Energy Outlook 2004*, pp. 130–143.
13. See Bertrand Benoit and John Thornhill, "Fear That Gas Supply Gives Russia Too Much Power over Europe," *Financial Times*, January 12, 2005, p. 3.
14. In 2003, Washington launched a ten-year, billion-dollar initiative (cofinanced by the government and industry sources) to build a prototype clean fuel plant in order to establish the technical and economic feasibility of producing electricity and hydrogen from coal while capturing and sequestering the carbon dioxide generated in the process. In addition, the 2005 Energy Policy Act includes a substantial tax credit for investment in clean coal facilities. See Kenneth Stier, "Dirty Secret: Coal Plants Could Be Much Cleaner," *New York Times*, May 22, 2005, p. BU3.
15. Simon Romero, "Fuel of the Future? Some Say Coal," *New York Times*, November 20, 2004, pp. B1, B3.
16. Watts Bar 1 began commercial operation in May 1996; construction began in December 1972. The last nuclear power plant to begin commercial operation before Watts Bar was Comanche Peak 2, in April 1993 (EIA, "U.S. Nuclear Reactor List: Operational"; available on the EIA website, www.eia.doe.gov). While no nuclear power plants are currently under construction in the United States, twenty-five plants are being built abroad, mainly in Asia.

to increase reliance on nuclear power, this development would have the twin benefits of reducing U.S. dependence on imported natural gas and reducing carbon dioxide and other emissions from coal-burning power plants, already a serious problem. While the nuclear industry has made great strides in developing safer power plant designs—which should reduce worries about the possibility of more accidents like that on Three Mile Island—little progress has been made in resolving the problem of waste disposal.[17] The delays in opening the high-level nuclear waste storage site at Yucca Mountain, Nevada, have been in part technical, but politics has played a considerable role, too. Should nuclear power remain blocked, a sound energy policy formulation process must include a means to weigh the relative risks created by dependence on foreign energy.

Increased Transportation Energy Efficiency

It is not realistic to rely on gasoline taxes as the main way to enhance energy security. Aside from the political problems caused by higher taxes, gasoline price changes have relatively little impact on consumption for existing motorists. Take an average consumer who drives 12,000 miles per year at 20 miles per gallon. That consumer will use 600 gallons of gasoline per year, and an increase of even $1 per gallon will cost only $600, not enough to make a dent in a country with an average family income of $53,000.[18] Even the impact of high oil prices on new-car purchases is not as great as some might think.

In a ten-year time frame, flexible-fuel vehicles, which can burn up to 85 percent alternative fuels, may have some impact on energy demand. Today, about 3 million vehicles—out of 225 million vehicles on the road—can run on flexible fuels, though most owners of these vehicles use only gasoline.[19] Flexible-fuel vehicles are quite different from the more ambitious and expensive approach embodied in hybrid cars such as the Toyota Prius, which have both an internal combustion engine and an electric motor.

In general, the most effective way to slow the growth in gasoline consumption is to increase automobile fuel efficiency.[20] Another approach is to make greater use of diesels, which have a fuel economy about 30 percent better than gasoline-powered cars. In Europe, more than 40 percent of all newly registered cars have modern diesel engines, which, unlike older models, are not noisy and dirty.

Increasing the efficiency of the average vehicle will take years. So too will increasing domestic energy production. Significant headway simply cannot be made on either front during the first two to three years of a new policy; indeed, it is unlikely that any policy proposals would have much impact in the first five years. Such a delay can discourage politicians: the costs of forging consensus on complicated issues must be paid up front, but the benefits only become obvious well down the road. And the brutal reality is that none of the national energy policy proposals discussed here would do much to reduce our vulnerability to a Middle Eastern supply shock; were such a shock to occur, no national energy policy, no matter how high a priority

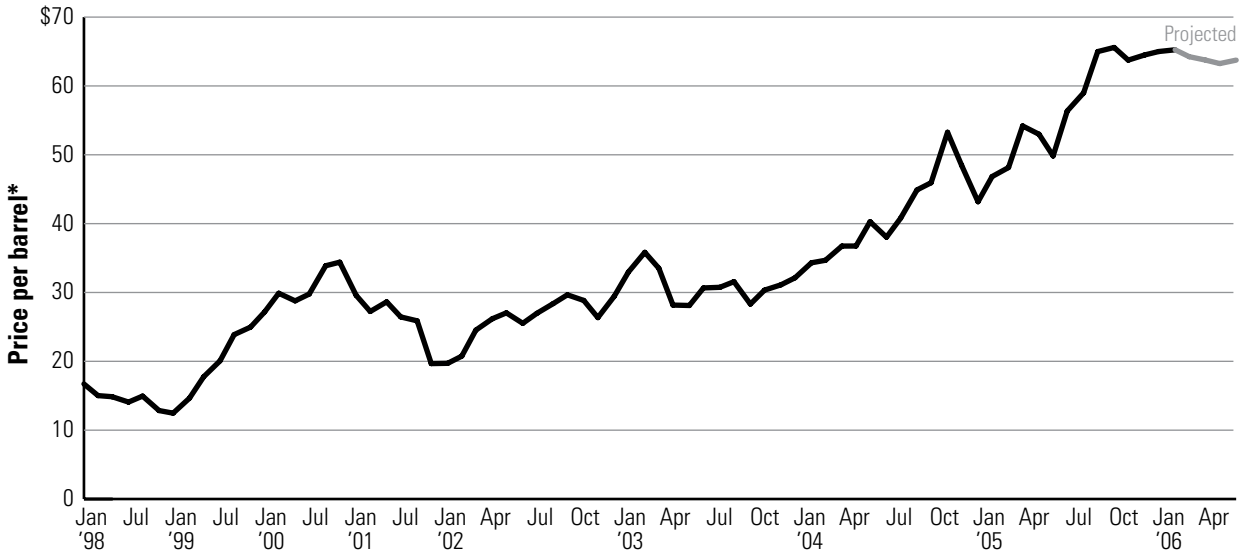
17. See Kathryn Kranhold, "Nuclear-Power Industry Sees Signs of a U.S. Revival," *Wall Street Journal*, November 9, 2004, pp. A1, A14; Matthew Wald, "When It Comes to Replacing Oil Imports, Nuclear Is No Easy Option, Experts Say," *New York Times*, May 9, 2005, p. A14; and Felicity Barringer, "Old Foes Soften to New Reactors," *New York Times*, May 15, 2005, pp. 1, 21.
18. In 2002, the median income of family households was $52,704 (U.S. Census Bureau, *Income in the United States: 2002*, September 2003, p. 9).
19. Only 10 million gallons of E-85 (a fuel that is 85 percent ethanol, 15 percent petroleum) were sold in 2003, out of 140 billion gallons of total fuel sales for vehicles. By contrast, E-10—which consists of 10 percent ethanol—made up about 30 percent of vehicle fuel sold. See Dirk Lammers, "E-85 Fuel Yet to Catch On," Associated Press, October 12, 2004; and "Making the Switch: What Impact Will Ethanol Have on Equipment?" *National Petroleum News* 96, no. 6 (June 2004), p. 48.
20. This paper is not the appropriate place to weigh the relative merits of increasing the Corporate Average Fuel Economy (CAFE) standards for new cars versus other means, such as a "scrap and replace" program (easy financing for efficient cars for owners who scrap clunkers) or a "feebate" program (tax rebates for efficient vehicles financed through tax surcharges on inefficient vehicles). The latter two programs are advocated in the Rocky Mountain Institute's 2004 publication *Winning the Oil Endgame: Innovations for Profits, Jobs, and Security*, which also recommends use of advanced composite and lightweight steel in vehicle construction. One problem with relying on CAFE standards is that billions of dollars turn on the exact wording of the implementing regulations, with the result that much effort is devoted to fighting about wording rather than improving vehicle performance. For a summary on the importance of CAFE regulation wording, see Petroleum Industry Research Foundation, "Energy Policy: A Few Steps Forward," August 2005, pp. 6–8; available online (www.pirinc.org/download/energypolicy.pdf).

it were given, could substantially mitigate that shock in the first two years.

The long lag between adoption of a national energy policy and its actual impact should not be used as an excuse to delay action. Quite the reverse: the long lag means that policy changes should begin now, before there is an acute crisis. If new policies are introduced soon, then—with luck—they will be in place and fully effective if and when a crisis does come. Even if a crisis hits while the new policies are being phased in, their partial implementation will provide some cushion and help the economy adjust. The old adage that you should repair the roof before the rains come, when clear skies give the false impression that no repairs may actually be needed, is also the wisest strategy for an effective energy policy.

Appendices

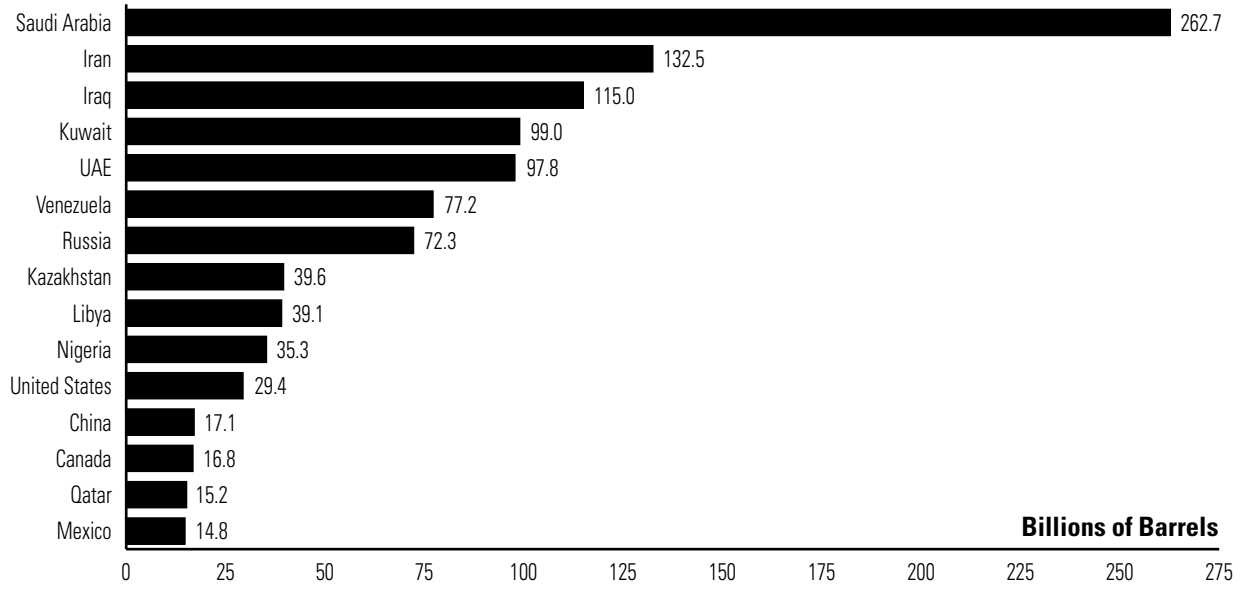
Figure 1. Crude Oil Prices, 1998–2006



Source: Adapted from Energy Information Administration, "Short-Term Energy Outlook," October 12, 2005. Available online (www.eia.doe.gov/emeu/steo/pub/contents.html).

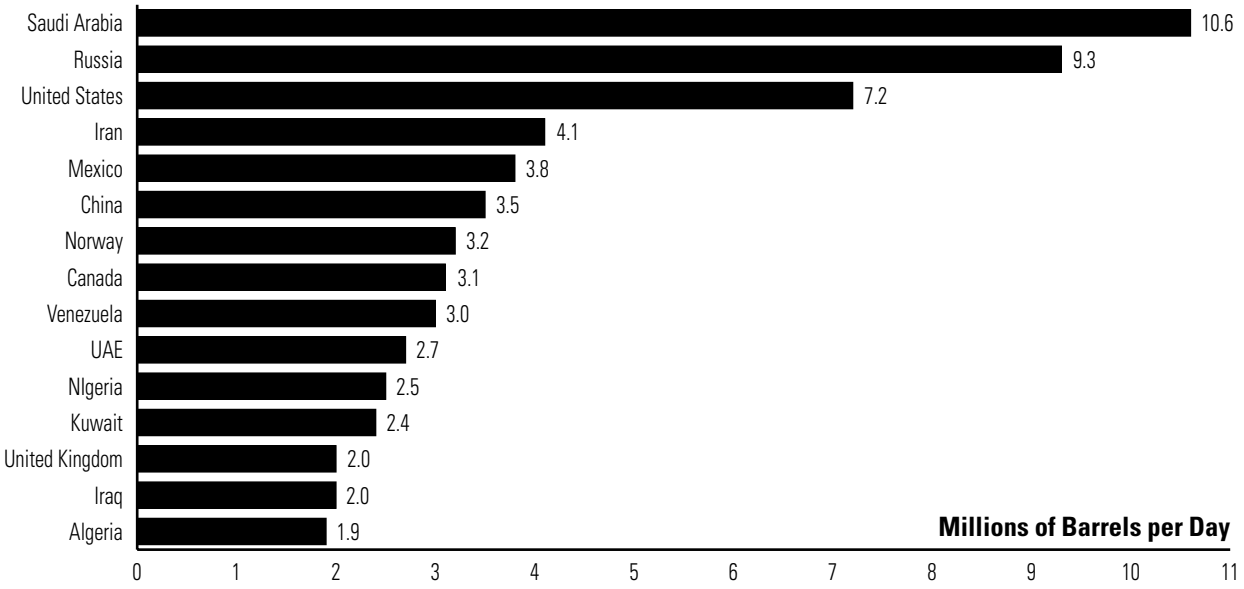
* West Texas intermediate spot price.

Figure 2. Proven Oil Reserves by Country, 2004



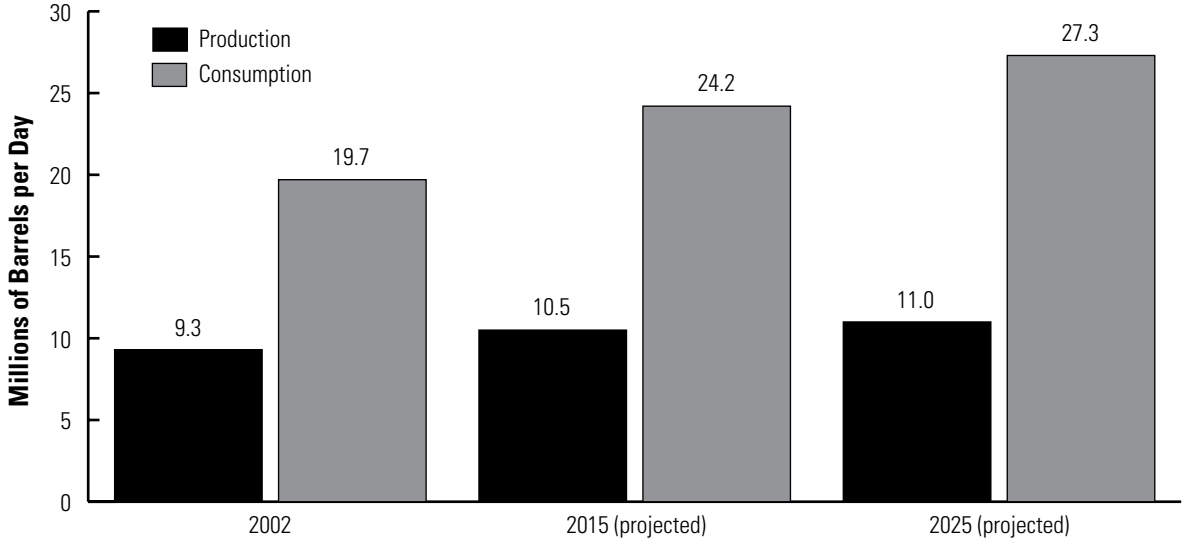
Source: Data obtained from *BP Statistical Review of World Energy*, June 2005, p. 4.

Figure 3. Leading Oil Producers, 2004



Source: Data obtained from *BP Statistical Review of World Energy*, June 2005, p. 6.

Figure 4. U.S. Oil Production and Consumption



Source: Adapted from Energy Information Administration, *International Energy Outlook 2005*, appendices A and E, July 2005.

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