CHAPTER 8

Regulating Energy Markets

Energy is essential to the U.S. economy, both as a final good and as an input into the production of most other goods. In 2000, energy expenditures equaled $703 billion, or 7.2 percent of GDP. The markets that provide this energy function well and are generally competitive. However, parts of the energy industry have characteristics that are associated with market failures. For example, the large fixed costs required to construct distribution networks for electricity and natural gas make it unlikely that more than one firm would be willing to invest in the infrastructure needed to serve residential customers in a particular area. The distribution company, therefore, may have *market power*, the ability to charge prices significantly above the competitive price level and profitably maintain those prices for a considerable period. Another type of market failure involves *negative externalities*, costs that economic transactions impose on third parties that the parties to the transaction do not face. For example, energy producers and consumers may not fully take into account the fact that burning fossil fuels may cause acid rain or smog.

This chapter discusses economic issues relevant to several different energy markets, including natural gas, gasoline, electricity, and crude oil. The use of these different types of energy involves different market structures and different potential market failures. An important focus of the chapter is on the design of regulations to address market failures in energy markets while minimizing disruptions to the market. The key points in this chapter are:

- Markets generally work well for energy products, which in most ways are like other products in the U.S. economy. While some aspects of energy markets may require regulation, most segments of these markets function well without regulation.
- Federal, state, and local regulations can have conflicting goals. If the conflicting goals are not balanced, competing regulations could lead to worse problems than the market failures the regulations attempt to address.
- Regulations need to be updated as markets evolve over time to ensure that the original goals still apply and that these regulations are still the lowest-cost means of meeting those goals.
- The United States benefits from international trade in energy products.

Market Forces and Regulation in the Market for Natural Gas

Some energy markets require regulation. For example, because of the high cost of natural gas distribution services, the market generally supports only one local distribution company. Thus, the delivery infrastructure, including pipelines and gas meters connected to individual residences, is regulated. However, certain segments of the natural gas industry are amenable to competition. They do not require regulation even though the distribution segment does. Indeed, in many areas of the country parts of the natural gas market have been deregulated. For example, producers of natural gas are no longer subject to price regulation. Furthermore, although prices for transporting natural gas to homeowners are regulated, in some states multiple firms now compete for the right to sell the gas to homeowners. This type of partial deregulation has also been applied to electricity markets; in many areas, local distribution lines are still regulated while generation and retail marketing are deregulated.

The last year has demonstrated how market forces have worked to allocate scarce resources in the natural gas market. Demand for natural gas is highly seasonal, with the greatest consumption by far during the winter heating season. During the summer, a portion of natural gas production is stored for use in the following winter. Natural gas inventories in spring 2003 were unusually low after a colder than normal winter in 2002-2003. This led to large increases in natural gas prices in the spot and futures markets. In turn, these high prices encouraged consumers to switch to other fuels or reduce consumption over the summer, encouraged producers to increase production, and encouraged importers to bring in additional natural gas from outside North America. In combination, these actions resulted in a near-record increase in natural gas inventories in time for the winter heating season. As a result, the United States entered the winter of 2003-2004 with slightly above-average natural gas inventories. High prices have also given firms an added incentive to invest in new projects, such as liquefied natural gas (LNG) facilities, to bring additional supplies of natural gas to the market in the future.

Market Forces and Regulation in Gasoline Markets

Recent and past events in the gasoline market have shown how unexpected shortages affect market prices and how government regulation can make the situation worse. Wage and price controls imposed in the early 1970s to combat inflation included government regulations that kept gasoline prices below the market level. As a result, when oil supplies were disrupted in 1973 and 1979 by geopolitical events in the Middle East, consumers wanted to buy more gasoline than suppliers were willing to supply at the artificially low prices.

Regulations that prevented suppliers from increasing prices meant that consumers had to wait in lines or face limits on the amount of gasoline they could purchase. As a result, some gasoline likely went to consumers who valued it less than other consumers because those who would have cut consumption as prices rose continued to buy gasoline at the artificially low price. Keeping gasoline prices artificially low also reduced the incentive for oil companies to refine new sources of crude oil into gasoline—a supply response that would have lessened the shortfall.

Gasoline markets also demonstrate how markets react to unexpected changes in supply when prices are not regulated. For example, several refinery problems on the West Coast in recent years have, on occasion, temporarily reduced the supply of California Air Resource Board (CARB) gasoline that meets strict California specifications for reducing air pollution. After these disruptions, prices typically increased quickly, and usually stayed high for only a matter of weeks. These increased prices led consumers to reduce their gasoline consumption.

During supply disruptions that were expected to last a relatively long time, the high prices also led distant refineries to produce and ship CARB gasoline to California. These refiners had to shift their operations to make CARB gasoline instead of their normal product, find an available tanker, and then ship the gasoline to California—a process that takes three weeks or more. High prices rewarded the refiners that were able to get CARB gasoline to California quickly, while refiners whose shipments arrived too late (that is, as prices started to come down again) would lose money. The price spike provided an incentive for distant refiners to risk making and shipping CARB gasoline to California, thus helping to alleviate California's gasoline shortage.

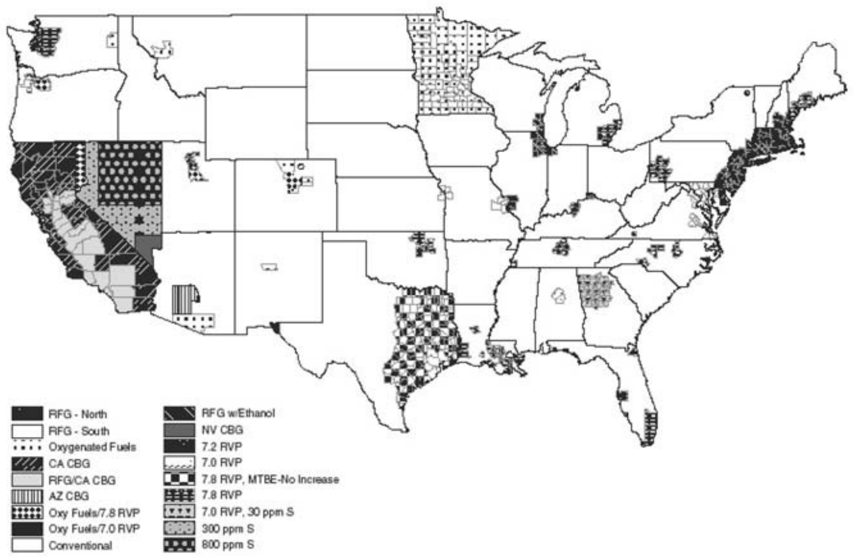
Local and Federal Regulations May Conflict

As illustrated in the example above, not all gasoline sold in the United States is the same. Differences in local specifications are often the result of how local and state governments have responded to the Clean Air Act of 1990. Chart 8-1 shows which areas of the United States have adopted different fuel specifications. Flexibility in how localities address air pollution abatement allows them to implement an approach that best meets their needs. However, different local or regional gasoline specifications add complexity to the national gasoline production and distribution infrastructure, reducing the reliability and availability of gasoline supplies.

The proliferation of fuel varieties produced for various locations (called *boutique fuels*) reduces the number of potential suppliers of each particular fuel and slows the industry response when there are local or regional disruptions to the gasoline supply. Boutique gasoline specifications likely contributed to the price spike in the Midwest in 2000, which occurred after several refineries experienced production problems around the same time that two major pipelines supplying the region went out of service. Chicago and Milwaukee were particularly hard-hit in part because of their local

Chart 8-1 **Required Specifications for Gasoline**

Different local environmental regulations have lead to a patchwork of gasoline specifications.



Note: RFG refers to reformulated gasoline, CBG to cleaner burning gasoline, RVP to Reid vapor pressure, MTBE to methyl tertiary butyl ether, and ppm S to parts per million sulfur.
Source: ExxonMobil, November 2003.

requirements for reformulated gasoline using ethanol. Nearby cities using reformulated gasoline had different specifications, so that existing reformulated gasoline stocks could not be shipped to the area.

The impact of boutique fuel regulations demonstrates that there may be benefits from standardizing regulations across geographic areas for goods that are sold regionally or nationally. Gasoline markets in the eastern half of the United States are interconnected by pipelines, barges, and tankers. Reducing the number of gasoline specifications could allow for increased flexibility of the gasoline supply system. For example, production lost because of a refinery problem in Chicago could be offset by shipments of gasoline from refiners in other areas. The President's National Energy Plan asked the Environmental Protection Agency (EPA) to study ways to increase the flexibility of the Nation's fuel supply.

While there may be benefits from standardizing regulations across geographic areas, standardization may require some areas to use gasoline that is more expensive than necessary to meet local air-quality standards. The benefits of standardization must be weighed against any increased costs.

Local and State Regulations Lead to Different Market Outcomes

State regulations can also increase the cost of marketing and distributing gasoline to consumers. For example, several states and the District of Columbia have divorcement laws that restrict refiners' ability to own and operate retail stations. These regulations have been found to increase prices at the pump; prices in states with divorcement laws are almost 3 percent higher than they would be without such laws. Similarly, regulations in Oregon and New Jersey ban self-service gasoline sales because of putative safety and environmental concerns. Economists have estimated that gasoline prices in these states are between 2 and 6 cents per gallon higher than they would be without the self-service ban (gasoline prices in New Jersey are lower than in surrounding states because of New Jersey's low gasoline taxes, but prices would be even lower if self-service were allowed).

Market Forces and Regulation in Electricity Markets

While a mix of market forces and well-designed regulation can lead a market with market failures to perform more effectively and efficiently, improper regulation can lead to worse outcomes than even an imperfect market without regulation. The market for electricity is a case in point.

Some existing regulations in the United States have the unintended effect of making the Nation's electricity supply less reliable and more expensive. The same attribute that makes competition in electricity difficult to achieve—provision of electricity over a single network on which the amount of electricity supplied must equal the amount of electricity consumed at every moment—makes the consequences of poorly designed regulation particularly costly. For example, California's rolling blackouts in January 2001 appear to have stemmed in part from regulations that fixed retail electric rates. As a result, there was an insufficient supply of electricity during the daily peak periods of demand. Fixed retail electric rates provided little incentive for consumers to reduce their consumption of electricity during these high-usage periods.

The Evolution of the Electric Industry from Local to Interstate Markets

As the electric industry has evolved from local, largely self-contained systems to a more national, integrated system, the appropriate combination of state and Federal regulations has changed as well. For many years, electricity was provided by integrated utilities—local monopolies that generated power and distributed it to residents and companies in a specific area—that were regulated by state public utility commissions.

Over time, a high-voltage transmission network linking the local monopolies developed. The network was originally designed to boost reliability, but it has also had the effect of reshaping the economics of the electricity market. The existence of this network (called the *transmission grid*) gave rise to a market for wholesale electricity through which utilities could buy electricity generated elsewhere for use by their own customers.

Regulatory changes complemented the technological and structural changes to make the electricity business more competitive. In 1978, new Federal regulations mandated by the Public Utilities Regulatory Policies Act (PURPA) required state-regulated utilities to buy power generated using renewable energy sources and cogeneration plants (plants that produce electricity while producing other products such as steam heating). These regulations led to an expansion of wholesale markets in which regulated utilities bought electricity generated by other firms and demonstrated that independent electricity generators could coexist with existing state-regulated utilities. In the late 1980s, Federal regulators began revising regulations to encourage the development of independent producers more generally. In 1996, Federal regulators began requiring the public utilities that owned transmission lines to make them available to independent electricity generators. Today, more than half of all the electricity generated is exchanged on the wholesale market before it is sold to consumers.

Electricity Regulation in an Evolving Market

Wholesale electricity generation will become more efficient over time as unregulated generating companies add new capacity based on competitive market signals. Market signals will influence both the timing of when new generation capacity is built and the type of fuel these plants will use. For fully regulated electric utilities, these decisions are made with the approval of local or state regulators. Without the discipline of competitive markets, regulated utilities are able to pass increased costs on to consumers regardless of whether the utilities have made the most efficient choices.

Effects of Regulation on Transmission Capacity

Regulations in the electricity market continue to impose barriers to competition and greater efficiency. Today's regulatory structure may not encourage regulators in one jurisdiction to take into account the full effects of their actions on the rest of the transmission grid because the regulatory system is based on an industry structure that no longer exists. For example, the transmission grid crosses state boundaries, so what happens in one state affects the residents of other states. However, state regulators might not consider the costs and benefits of their actions on citizens of other states. As a result, regulation of the transmission grid has not kept up with changes in the market.

Extensive blackouts in the Northeast and Midwest in August 2003 and in the West in August 1996 demonstrated the potential costs of not updating and coordinating Federal, state, and local regulations. Despite the growing demand for electricity and the growing demand for transmission capacity to satisfy the wholesale market, construction of new transmission facilities has declined by about 30 percent since 1990. The current mix of regulations has facilitated increased use of transmission capacity, but has not done enough to encourage companies to invest in building new capacity. For example, some state and local regulations have discouraged the construction of new local facilities, thus encouraging increased transmission from more distant locations.

State deregulation may also give local utilities the incentive to import lower cost electricity from generators in other states. The growth of interstate transmission of electricity has increased the need for Federal, state, and local governments to coordinate their regulations that affect the interstate transmission grid.

Another problem with existing regulation is that state and Federal regulators approve transmission rates to provide the owners of transmission lines a fixed rate of return, but the chosen rate may not be high enough to encourage firms to invest in sufficient new transmission capacity. One factor that is not fully considered in rate-of-return calculations is the lengthy and uncertain permitting process that requires companies to deal with multiple regulators. Because these costs are not fully accounted for, the effective rate of return often is too low to attract investment. Such regulatory uncertainties are just one of many factors that make investing in new transmission capacity risky. Higher rates of return may be needed to spur investment.

Insufficient investment in new transmission capacity is not the only problem stemming from improper regulation of rates of return. Such regulation may also prevent investment from being channeled to areas that most need new transmission capacity. Higher prices for use of the most congested parts of the grid would reduce transmission over these parts of the grid and send a signal to potential investors to expand capacity in those areas. Grid operators in some parts of the country now use locational marginal pricing to set prices in different locations based on both the cost of generation and the cost of congestion. Areas that are served by congested transmission lines pay higher prices reflecting the cost of such congestion.

Congestion in the transmission grid leads to both lower reliability and less competition. The lack of competition results from the low-cost generators' inability to send power to high-cost areas, forcing the high-cost areas to use less efficient, locally-produced electricity. Adding new transmission capacity between low-cost and high-cost areas could increase prices in low-cost areas in the short run. However, these price increases would likely lead to new generating capacity being built in low-cost areas, reducing prices back toward existing levels.

Regulations That Require Updating

As electricity markets have become more competitive, Federal regulations designed to prevent utilities from abusing their government-granted monopoly power may have ceased to serve the public interest. For example, the Public Utilities Holding Company Act (PUHCA) was originally passed in the 1930s to limit the size and type of operations in which a public utility may engage, including the types of companies that can own utilities. Today, these limits may actually increase prices to consumers by preventing utilities from engaging in activities that could make their businesses more efficient. These limits also may prevent public utilities from expanding their operations in ways that would increase competition in other parts of the country.

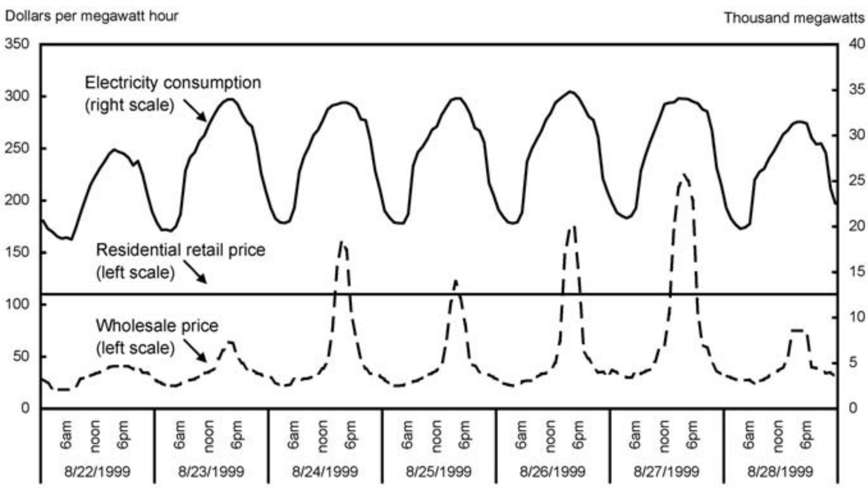
The evolution of the electric power industry from a natural monopoly to an increasingly competitive market calls for regulations that facilitate rather than hinder efficiency and innovation. The Federal Energy Regulatory Commission (FERC) is working on new regulations for wholesale electricity markets with the goal of having market forces encourage the lowest-cost generators to provide electricity.

Demand Response to Electricity Production Costs

Many residential electric rates today are fixed throughout the day at a level based on the average cost of generating and delivering electricity to the residential customer. The cost of producing electricity, however, is not fixed throughout the day. Instead, electricity generators constantly adjust production to meet demand hour by hour or even minute by minute. As a result, the marginal cost of electricity production—the cost to produce one extra unit of electricity—varies widely over the course of a day. Wholesale prices reflect this, with lower prices in the middle of the night (a period of low demand) and higher prices in late afternoon (a period of peak demand). Under the current regulatory structure, however, many consumers are charged the same rate regardless of the wholesale cost of electricity so that utilities cannot raise prices to reflect the true cost of generation. As a result, local regulated utilities must have access to enough generating capacity to meet peak demand, as well as enough transmission and distribution capacity to get the electricity to all customers. Chart 8-2 illustrates the fluctuations in electricity consumption and wholesale prices over a week in August 1999. During the week illustrated, the regulated utilities were at times forced to sell electricity at a loss because wholesale prices rose above the fixed retail rate.

It is not cost-effective to store large quantities of electricity. Therefore, the requirement that electric utilities meet all demand at fixed retail prices

Chart 8-2 **Hourly Electricity Consumption, Wholesale Prices, and Retail Prices in California**
The volume and wholesale price of electricity consumed fluctuate throughout the day, while retail prices are fixed, so that residential consumers have no economic incentive to change their consumption as costs change.



Note: Residential retail price is the monthly average for August 1999.
Sources: California Energy Commission, California Power Exchange, and Department of Energy (Energy Information Admistration).

means that they must build enough capacity to meet the highest peak demand during the year. They also need to maintain reserve capacity to offset any supply lost due to generation or transmission problems. Some of this capacity is only required during the relatively few hours of the year when demand peaks, for example, on the hottest days in August.

Without the ability to increase retail prices during peak demand to encourage consumers to cut their energy consumption, insufficient generation capacity would lead to a rationing of supply, for example, rolling blackouts. While some electric utilities offer time-of-day pricing, a system in which retail rates are higher during periods of peak demand, these prices do not vary with the actual cost of generating electricity on a particular day. These programs reduce the average peak demand but do not provide the needed incentives to cut power usage on days with extreme peak demand.

Some consumers also receive lower rates in exchange for allowing the electric company to interrupt their service if wholesale costs increase above a certain level. There are some programs that allow the utility to cut off all of a consumer's power, while others simply allow the utility to turn off the consumer's air-conditioning. There are also typically limits on how long or how many times the utility can cut off power. These programs to reduce peak electricity usage thus represent only a partial implementation of variable pricing.

A reduction in peak demand achieved through variable pricing would allow regulated utilities to build less generation, transmission, and distribution infrastructure. Because they cannot increase retail prices, these utilities use other means to reduce peak demand, such as rebates to consumers who purchase energy-efficient appliances or incentives to improve weatherization of homes. While these programs reduce peak demand by increasing energy efficiency, they do not use the market to determine which ways of cutting electricity demand would have the lowest cost. Furthermore, as electricity markets evolve, there may no longer be one firm that can capture all of the benefits from reducing peak demand. As a result, these programs may not be able to continue because individual companies have less incentive to implement them.

Current programs that attempt to reduce peak demand still leave customers unaffected by changes in the cost of production until shortages and interruptions in service result. If retail prices were allowed to increase, consumers could decide to cut their consumption (possibly to zero). This approach could improve overall welfare by reducing the number of peaking plants needed; that is, it may be less costly to curtail demand than to add to supply by building expensive generation capacity that is rarely used. However, for variable pricing to be completely implemented, new meters and smart appliances may be needed so that consumers can acquire the information and technology needed to adjust their usage as electricity prices change.

Energy and Trade

The United States benefits greatly from global trade in energy markets. Gasoline and diesel fuels refined from crude oil are currently the most widely used transportation fuels. By importing petroleum, U.S. firms are able to continue to supply gasoline and diesel at real prices comparable to historical averages, even as environmental regulations have increased the costs of refining. Adjusted for inflation, gasoline prices are much lower than at their peak in 1981. However, this beneficial trade requires reliance on imports that could be subject to supply disruptions.

Because crude oil is traded throughout the world, its price is affected by global changes in supply and demand. Disruptions to the supply of oil from areas that do not supply the United States would affect domestic prices of oil even if U.S. imports are not directly affected. Indeed, domestic prices of oil would be affected even if the United States produced all of its oil domestically (unless petroleum exports were prohibited). The outcome is the same because the price of oil is set in global markets.

Meeting all U.S. energy needs from domestic sources would require significant changes to the U.S. economy, including changes in the types of transportation fuels used by Americans. The costs of these changes would probably exceed the costs resulting from periodic unexpected increases in the global price of oil. This is suggested by the fact that prior oil market disruptions did not lead to such structural changes in the U.S. economy. Moreover, oil markets have undergone tremendous changes since the 1970s that likely reduce the risks to the U.S. economy from a disruption in crude oil production and imports.

U.S. Energy Sources

Most energy consumed in the United States is produced in North America. In 2002, the main energy sources were petroleum (39 percent), natural gas (24 percent), coal (23 percent), and nuclear power (8 percent). In 2002, roughly 80 percent of U.S. energy needs were met by North American sources, including 59 percent of crude oil, 99 percent of natural gas, 100 percent of coal, and roughly 45 percent of uranium for nuclear power generation. Petroleum is the main energy source that the United States imports in significant amounts from outside North America. Hence, discussions of energy security focus on imports of crude oil. In the future, analysts expect the United States to import more natural gas, but there are many potential suppliers.

The United States also imports a large share of uranium from outside North America, but there are sufficient North American reserves of uranium that could be used if less-expensive foreign sources were not available. Furthermore, uranium fuel represents a relatively small portion of the cost of nuclear electricity generation. Also, most uranium is produced in stable parts of the world, with Canada and Australia producing about half of the world's total.

Changes in the Oil Market

A disruption in crude oil production in an area that does not supply the United States would still affect the United States by raising oil prices in the worldwide market. However, the power of the Organization of the Petroleum Exporting Countries (OPEC), or of any one country, to affect world oil prices is less today than it was in the past. OPEC's influence on the market has fallen with the decline of its market share from 55 percent in 1973 to 39 percent in 2002. Other evidence of the diversification of sources of crude oil is that in 1973, the top eight producing countries produced 75 percent of the world's oil, while in 2002 the top eight producing countries produced only 54 percent. Access to a greater number of sources of oil reduces the impact of a disruption in any one region on the world oil price. In addition, the increased sophistication of financial markets for oil and related products has made it easier to hedge oil price risks. With financial instruments such as futures contracts, firms are better able to avoid having potential disruptions in the crude oil market lead to substantial immediate cost increases from their energy inputs.

Another significant difference between today and the 1970s is that the United States no longer has price controls on gasoline and oil. During the oil shocks of the 1970s, Federal government mandates kept consumer prices artificially low and dampened the amount of gasoline conservation that otherwise would have occurred in response to increased prices. As a result, people wanted to consume more gasoline than suppliers were willing to supply at the artificially low price leading to shortages in the United States.

When prices are not regulated, large swings in oil prices do not disrupt the economy nearly as much. For example, between June 15, 1998, and November 27, 2000, the price of West Texas Intermediate (WTI) crude oil more than tripled from $11.69 to $36.24 per barrel without throwing the economy into disarray. These price increases did not cause major economic disruptions for two main reasons. First, energy consumption per 1996 dollar of real GDP has dropped 43 percent, from 18,360 British thermal units (BTU—a measure of the energy content in fuels) per dollar in 1973 to 10,450 BTU per dollar in 2001. Second, market signals have worked to increase the flexibility of U.S. energy markets, allowing them to adjust and adapt to market changes. This is why market forces work better to allocate goods than command-and-control measures such as price controls.

Another change from the 1970s has been the expansion of the strategic reserve of crude oil that can be used during severe disruptions to the oil market. Created in 1975, the Strategic Petroleum Reserve held 634.7 million barrels as of December 2003—enough oil to replace U.S. crude oil imports from the Persian Gulf for approximately 287 days. While maintaining the Strategic Petroleum Reserve entails storage and inventory costs, holding reserves to increase energy security is less likely to distort the market than other measures, such as attempting to replace U.S. oil imports with more expensive sources of energy.

Trade in Oil and Price Stability

In considering whether it is worth taking steps to decrease U.S. reliance on petroleum imports from outside North America, it is useful to compare the movement of oil prices with the prices of other commodities in which the United States is self-sufficient. It turns out that having a supply of a commodity in the United States or North America is not an assurance of stable prices. Numerous factors affect both the supply and the demand of goods so that commodities such as natural gas, wholesale electricity, and many agricultural goods also exhibit price volatility even when supplied wholly from North American sources.

Relying on imported oil reduces the United States' overall expenditures on energy. Without crude oil imports, the cost of gasoline and other petroleum products (or alternative transportation fuels) would be higher. Therefore, the United States would have to devote a greater portion of its resources to paying for the costs of energy, especially for transportation, than is the case today. Without petroleum imports, it would be necessary to use significantly less gasoline and more transportation fuels made from corn, soybeans, or other agricultural products, or liquid fuels from coal, natural gas, oil sands, or oil shale. Under current technologies, these substitutes all cost substantially more to produce than gasoline from crude oil.

The Evolution of Energy Markets

Energy sources have changed as society's needs have evolved over time. Wood was replaced by coal, which was replaced by petroleum. Eventually, the energy market may evolve to include substantial energy production from new sources, such as renewable energy, hydrogen, or nuclear fusion. Government policy can help move this evolutionary process forward by encouraging research in new energy technologies. However, forcing the transition to new technologies before the market signals that old technologies should begin to be phased out could involve tremendous costs to society.

Market signals have already altered U.S. energy consumption. In response to higher crude oil prices, U.S. crude consumption fell by 21 percent between 1978 and 1983 even as real GDP grew by 7.8 percent. Demand shifted towards coal, which experienced the smallest price increase of any major fuel, and away from oil and natural gas, which experienced the greatest increases. Even with the increased consumption of coal, total U.S. energy consumption declined 1.8 percent annually between 1978 and 1983. This decrease occurred despite the longer-term upward trend of energy consumption, which averaged 1.1 percent annually between 1971 and 2001. Energy conservation programs and other nonmarket forces may have been responsible for some of the reduced demand for energy. However, at least 80 percent (and probably more) of the demand reduction can be attributed to higher prices and overall changes in the economy.

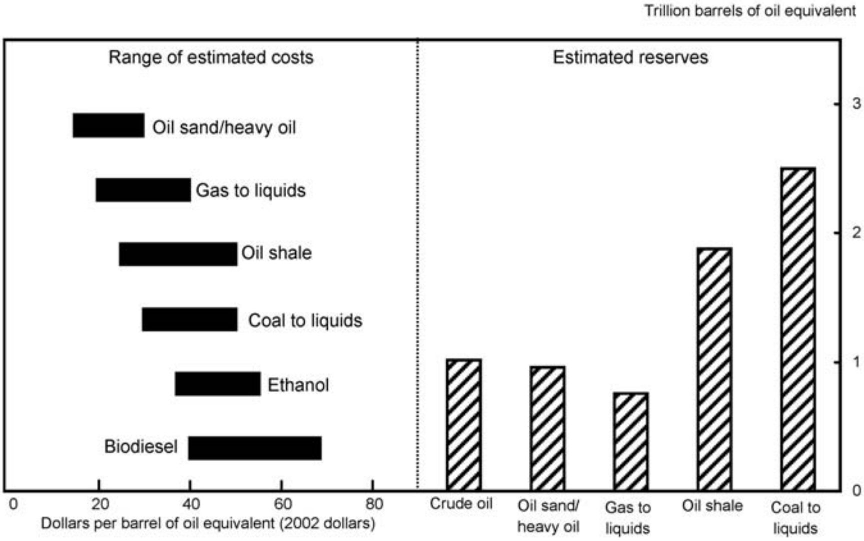
Market signals have also triggered a great deal of innovation to lower the cost of finding and extracting oil. For example, three-dimensional seismic technologies have lowered the cost of finding oil, and directional drilling has lowered the cost of extracting oil so that reserves that were not viable in the past can be extracted profitably today. Similarly, technological advances have lowered the cost of extracting oil from oil sands so that production from oil sands is competitive at today's oil prices. As a result, at least one industry publication has classified a portion of Canada's large oil sand deposits as proved oil reserves; estimates of Canada's proved oil reserves are now second only to those of Saudi Arabia.

The technology exists to convert large North American reserves of oil sands, oil shale, natural gas, coal, wood, and agricultural products into liquid fuels such as gasoline, diesel, methanol, and ethanol. Some of these processes are now prohibitively expensive, but these fuels could compete with fuels produced from crude oil if oil prices increased or if research and development lowered their production costs. Chart 8-3 illustrates the range of estimated costs of producing synthetic fuels that could compete with oil in the market for liquid fuels. For example, at a price for oil of $20 a barrel, liquid fuels from oil sands and natural gas may be able to cover production costs, while oil shale, coal, ethanol, and biodiesel would not be viable sources. Higher prices could eventually make these alternatives commercially viable. Note that the extraction process for some of these fuels may have adverse environmental consequences that could limit their use and that some of these processes yield low-sulfur fuels that may burn more cleanly than fuels produced from crude oil. The chart does not consider either the costs of the externalities or the benefits of the cleaner fuels.

There is a role for government in subsidizing research and development into new energy sources. For example, hydrogen shows strong potential as a possible future fuel, though many technological hurdles must be overcome

Chart 8-3 **Production Costs and Reserves of Alternative Transportation Fuel Sources**

Synthetic fuels have the potential to become commercially viable if the price of oil increases sufficiently. Energy reserves not traditionally used as a source of liquid fuels would become available at this point.



Note: Ethanol and biodiesel reserves are assumed to be infinite. Crude oil reserves are included for comparison.
Sources: Department of Agriculture, Department of Energy, and Council of Economic Advisers.

before it becomes practical for everyday use. Even if hydrogen became a feasible energy source, there would be still more problems to be resolved before the technology became economically competitive. Government subsidies for research and development may aid the private market in developing technology to produce, transport, and use hydrogen economically as a fuel. However, market forces should decide when commercial adoption of hydrogen as an energy source will be competitive.

Policy makers should avoid forcing commercialization of new energy sources before market signals indicate that a shift is required. One potential problem with forcing this process is that technological breakthroughs may lead to alternatives that are not seriously considered today. Premature adoption of new technologies would raise energy costs before the need arises, causing society as a whole to spend more on energy than needed, a misallocation of resources that would hurt the U.S. economy. For example, forcing adoption of energy sources other than oil to gain complete energy independence would be prohibitively expensive; it would require tremendous reductions in the use of energy derived from crude oil through the use of alternative energy sources that are far from competitive.

Conclusion

Regulations can improve the performance of energy markets by addressing market failures such as externalities and market power. However, it is essential to design regulations to address these potential market failures without reducing the benefits from markets. An added complication occurs when the goals of local and Federal regulators conflict. Regulators should adjust the rules as markets evolve and ensure that the regulations' goals are achieved. Finally, regulators should be careful not to adopt regulations that cause more harm than the potential market failure.