Welcome to:

Oil Market Basics

A primer on oil markets combined with hotlinks to oil price and volume data available on the Internet

Office of Oil and Gas, Energy Information Administration

Introduction

The development of the Internet has provided a new world of data availability and access. Yet navigating to the information you want can be time consuming. ***Oil Market Basics (OMB)*** is uniquely suited to the strengths of the Internet. In its six chapters' text, it provides an overview of oil markets and how they function. In its graphs, it pictures the trends and patterns discussed. In its more than 400 links, it provides a road map to EIA data and other information on oil markets available on the Web. By design, *Oil Market Basics* does not provide the most current data, but links to the data. For the most current data, start with the Petroleum Division's U.S. Petroleum Information at a Glance.

Oil Market Basics has been designed to be helpful to a variety of potential users. Some with little previous knowledge of how the oil market functions will need a basic orientation. Others, even veterans, may look for long term perspective or quick references to trends. In addition, users at all levels of expertise can use the links to find EIA's oil data more readily and to access articles, analyses, and other sources of information. We hope that our customers will find the combination of the broad perspective and the ability to use the hotlinks to drill down to very specific current data a useful one.

As the statistical agency of record on matters of energy, EIA develops energy data and analyses that enhance the understanding of energy issues on the part of business, government, and the general public. The data used to prepare ***Oil Market Basics*** are all available at the EIA website (http://www.eia.doe.gov). EIA also makes data available in its many hard copy publications and its quarterly CD-ROM "Energy InfoDisc." Furthermore, EIA maintains an automated e-mail system to provide specific data or notification of data availability to those customers who sign up.

We hope you find ***Oil Market Basics*** useful. We look forward to your feedback, as we plan to update the ***Oil Market Basics*** periodically to keep it current and responsive to your needs. Graphs and charts, for instance, will be updated annually, when EIA publishes final annual data.

How to Use *Oil Market Basics*

In surveying petroleum markets and how they work, ***Oil Market Basics*** starts with crude oil exploration and production and proceeds through each feature of petroleum use, processing, distribution, and pricing. The flow of oil from different supply sources through processing, distribution and end use can be depicted in a flow chart.

Getting around. Click on the chapter title at the left to go to that chapter. The basics of oil markets -- the *first principles* -- are available in its text. Each chapter begins with its own detailed table of contents. At the end of each chapter, you can choose to move on to the next chapter, to look at some of the chapter topics in more detail, to look at the chapter's graphs, or to go to the compilation of hyperlinks on the subject. You can also browse the detailed table of the contents for all of ***Oil Market Basics*** at any time by clicking on "Contents" at the left.

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This chapter provides an overview of oil exploration and production and the data that measures these "upstream" activities of the industry. Upstream activities are closer to the source, and "downstream" activities, such as refining and marketing, are closer to the consumer.

Finding oil isn't a single activity. It is a series of steps: identifying a prospect, testing the rock, drilling a well, determining whether the find is commercially viable and estimating the dimensions of the reservoir with further drilling. Production wells are then installed and gathering pipelines are assembled to transport the oil to central points for further shipment.

The upstream sector involves the most investment risk because of the high capital expenditures and great uncertainty that oil will be found. On the other hand, it historically has provided greater rewards in terms of profit and return on investment than other segments of the industry. Recent technological advances have reduced the uncertainties and contributed to the more efficient use of capital, enhancing the industry's success, even in a low-price environment.

What Oil Is and Where It Comes From

According to the most widely accepted theory, oil is composed of compressed hydrocarbons, and was formed millions of years ago in a process that began when aquatic plant and animal remains were covered by layers of sediment -- particles of rock and mineral. Over millions of years of extreme pressure and high temperatures, these particles became the mix of liquid hydrocarbons that we know as oil. Different mixes of plant and animal remains, as well as pressure, heat, and time, have caused hydrocarbons to appear today in a variety of forms: crude oil, a liquid; natural gas, a gas; and coal, a solid. Even diamonds are a form of hydrocarbons.

The word "petroleum" comes from the Latin words *petra*, or rock, and *oleum*, oil. Oil is found in reservoirs in sedimentary rock. Tiny pores in the rock allowed the petroleum to seep in. These "reservoir rocks" hold the oil like a sponge, confined by other, non-porous layers that form a "trap." (See illustration.)

The world consists of many regions with different geological features formed as the Earth's crust shifted. Some of these regions have more and larger petroleum traps. In some reservoir rock, the oil is more concentrated in pools, making it easier to extract, while in other reservoirs it is diffused throughout the rock.

The Middle East is a region that exhibits both favorable characteristics -- the petroleum traps are large and numerous, and the reservoir rock holds the oil in substantial pools. This region’s dominance in world oil supply is the clear result (see graph). Other regions, however, also have large oil deposits, even if the oil is more difficult to identify and more expensive to produce. The United States, with its rich oil history, is such a region. Regional roles in oil supply are discussed more fully below.

Drilling for Oil

To identify a prospective site for oil production, companies use a variety of techniques, including core sampling -- physically removing and testing a cross section of the rock -- and seismic testing, where the return vibrations from a man-made shockwave are measured and calibrated. Advances in technology have made huge improvements in seismic testing.

After these exploratory tests, companies must then drill to confirm the presence of oil or gas. A "dry hole" is an unsuccessful well, one where the drilling did not find oil or gas, or not enough to be economically worth producing. A successful well may contain either oil or gas, and often both, because the gas is dissolved in the oil. When gas is present in oil, it is extracted from the liquid at the surface in a process separate from oil production.

Historically, drilling a "wildcat" well -- searching for oil in a field where it had not yet been discovered -- had a low chance of success. Only one out of five wildcat wells found oil or gas. The rest were dry holes. Better information, especially from seismic technology, has improved the success rate to one out of three and, according to some, one in two. Reducing the money wasted on dry holes is one of the aspects of upstream activity that has allowed the industry to find and produce oil at the prices prevailing over much of the 1990's.

After a successful well identifies the presence of oil and/or gas, additional wells are drilled to test the production conditions and determine the boundaries of the reservoir. Finally, production, or "development," wells are put in place, along with tanks, pipelines and gas processing plants, so the oil can be produced, moved to markets and sold. Once extracted, the crude oil must be refined into usable products, as discussed in the chapter on oil refining.

How Oil Is Produced

The naturally occurring pressure in the underground reservoir is an important determinant of whether the reservoir is economically viable or not. The pressure varies with the characteristics of the trap, the reservoir rock and the production history. Most oil, initially, is produced by "natural lift" production methods: the pressure underground is high enough to force the oil to the surface. Reservoirs in the Middle East tend to be long-lived on "natural lift," that is, the reservoir pressure continues over time to be great enough to force the oil out. The underground pressure in older reservoirs, however, eventually dissipates, and oil no longer flows to the surface naturally. It must be pumped out by means of an "artificial lift" -- a pump powered by gas or electricity. The majority of the oil reservoirs in the United States are produced using some kind of artificial lift.

Over time, these "primary" production methods become ineffective, and continued production requires the use of additional "secondary" production methods. One common method uses water to displace oil, using a method called “waterflood,” which forces the oil to the drilled shaft or "wellbore."

Finally, producers may need to turn to "tertiary" or "enhanced" oil recovery methods. These techniques are often centered on increasing the oil's flow characteristics through the use of steam, carbon dioxide and other gases or chemicals. In the United States, primary production methods account for less than 40 percent of the oil produced on a daily basis, secondary methods account for about half, and tertiary recovery the remaining 10 percent.

Both the varying reservoir characteristics and the physical characteristics of the crude oil are important components of the cost of producing oil. These costs can range from as little as $2 per barrel in the Middle East to more than $15 per barrel in some fields in the United States, including capital recovery. It is interesting to note that technological advances in finding and producing oil have made it possible to bring once-expensive deepwater Gulf of Mexico oil into production for less than $10 per barrel.

The Impact of Upstream Technology

Technology's contribution to finding oil is huge. Technology cannot change geology but, by revolutionizing the information available about the features of a geologic structure, it has enhanced the likelihood of finding oil. A primary benefit is the ability to eliminate poor prospects, thus considerably reducing wasted expenditures on dry holes. In addition, drilling and production technologies have made it possible to exploit reservoirs that would formerly have been too costly to put into production and to increase the recovery from existing reservoirs.

Technology also has contributed to making oil exploration and production safer for the industry and for the environment. Offshore production can be operated from onshore, with automatic shutoff systems to minimize the pollution risk. Infrared photography can pinpoint a trajectory of spilled oil, allowing equipment and personnel to be deployed quickly and effectively, thus minimizing damage.

In addition, technology has been responsible for the rejuvenation of offshore exploration that has taken place beyond the Outer Continental Shelf.

Global Oil Supply by Region

The Mideast remains the largest oil-producing region, as shown in the accompanying graphs. Mideast dominance in oil reserves -- the estimated amount of oil that can be produced from known reservoirs -- is even more pronounced: the region holds about two-thirds of the one trillion barrels of global proved oil reserves (graph), so the region's critical role in world oil supply will continue and will grow. (The United States, by contrast, holds only 4 percent of global proved reserves.) Several core developments have shaped the pattern of regional oil production:

- The higher oil prices of the 1970s and early 1980s (graph) afforded a strong economic incentive to explore for and produce oil, and production rose in many areas. At the same time, oil demand declined -- the expected response to the high prices. Saudi Arabia became the "swing supplier," reducing its production as necessary to balance supply and demand. Its rejection of that role in mid-1985 -- its output had fallen to about 25 percent of its 1980 peak -- brought the full force of the supply/demand imbalance onto markets and resulted in the price collapse of 1986. Prices did not return to the pre-1986 level until the Persian Gulf conflict of 1990-91, and then only briefly. When, in 1998, Asian demand faltered with the region's economies, and northern hemisphere demand faltered with the warm winter, the high production levels resulted in another price collapse. The market reaction in 1998, however, was not the same as in 1986 –- demand did not recover as quickly and supply did not fall as quickly. Hence, the low price period lasted longer and showed lower prices in 1998 than in 1986. In early 2000, oil prices exceeded the levels of the Persian Gulf conflict in nominal terms. Sharp as the price increases were in early 2000, however, crude oil prices remained less than half of the early 1980s peak in terms of real buying power.
- Saudi Arabia (graph), the market-balancer in the early 1980s, has been the world's largest producer during the 1990s. Not only did Saudi Arabia increase its production to fill the gap left by the loss of Iraqi and Kuwaiti supplies after Iraq invaded Kuwait in 1990, but production declined in the other two large producers, the United States and the Former Soviet Union.
- Mideast production would have been higher throughout the 1990s if Iraq's production (graph) had not been constrained by the United Nations sanctions imposed after Iraq invaded Kuwait in 1990. The so-called "Humanitarian Oil Sales" have provided Iraq only limited and closely controlled reentry into world oil markets.
- Mideast production also would have been higher at various times if it had not been for the market-balancing role played with varying degrees of success by the Organization of Petroleum Exporting Countries (OPEC) (use your browser's "Back" button to return to this page). OPEC currently includes Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates and Venezuela. Ecuador and Gabon withdrew their membership at the end of 1992 and 1994, respectively.

- North America (graph)is the second largest producing area after the Middle East. The United States, the second largest producing country in the world, accounts for almost 60 percent of the North American region's total. Canada, the United States and Mexico all have long production histories, and production from mature fields has been declining. However, a new surge in technology has benefited both new field development and more complete production from existing fields.
- North Sea production, off the United Kingdom and Norway, began in the late 1970s. In contrast to predictions from the early 1980s of the imminent decline in the region's production, the North Sea (graph) has yet to see its peak. The region's success with new exploration and production technology, and hence its continuing volume growth, has been a central factor in world oil markets for a decade.
- Production in the Soviet Union peaked at about 12 million barrels a day in the early 1980s (graph), when it was the top world oil producer. The region's demand collapse, in combination with its aggressive production targets set to maintain foreign exchange, masked its rapid production decline in the late 1980s as the Soviet Union broke up. The former Soviet Union has recently been the third-ranked producer, after Saudi Arabia and the United States. One of the most visible new production prospects has been the Caspian Sea in Central Asia, in spite of the enormous logistical and political hurdles involved in getting the oil produced to world markets. (EIA has produced several analyses of these issues. See the links in *Guide to Supply*.)

U.S. Oil Production

Because the United States is the world's largest importer, as discussed in the chapter on Trade, it is easy to forget that it:

- is the oldest major global oil producer;
- is formerly the Number 1 global oil producer;
- is currently the Number 2 global oil producer;
- has produced more oil, cumulatively, than any other country (180 billion barrels from 1918 to 1999);
- has produced more oil, cumulatively, than the current reserves of any country but Saudi Arabia.

Production in the United States has several unusual aspects. One is the private ownership of resource rights. In most major producing countries, the government owns the rights to develop resources. For privately owned property in the United States, the decision to explore for and produce oil is between the landowner and the producing company. The producing company compensates the landowner by the payment of a royalty on each barrel of oil produced. Early in the industry's development, there were few government restrictions. Now, there are overriding rules about well spacing and environmental standards. The only government agency to restrict production volume was the Texas Railroad Commission, which limited production in Texas depending on projected demand and production volumes in other areas of the United States. However, since the early 1970s, there have been no restrictions to production by any government agency.

The private ownership of resource rights contributes to two other aspects unique to production in the United States -- the active participation of thousands of independent producers and the prevalence of the "stripper" well, one producing less than 10 barrels a day. As the industry was developing, many entrepreneurs with limited capital resources, but a high tolerance for risk, joined its ranks and, in fact, discovered some of the largest fields in the United States. Most of the time, their finds were less dramatic, but large enough for a small company to be a success. The company's success was, of course, the landowner's success as well. Many of the wells never flowed with very high volume and, as they aged, volume dropped. Nonetheless, stripper wells are likely to remain in production as long as the price of oil covers the production cost. They currently account for about 75 percent of all wells in production in the United States and produce somewhat less than 900 barrels per day, 15 percent of the total U.S. crude oil production.

Just as oil resources are not evenly distributed around the globe, neither are they evenly distributed throughout the United States. Given the way production data are reported, the biggest production region by far is the U.S. Gulf Coast, and the largest producing state is Texas (graph). The Gulf Coast region is home to two of the most important producing provinces, the Permian Basin, located inland in West Central Texas and Eastern New Mexico, and the Federal Offshore portion of the Gulf of Mexico.

Texas has been the largest producing state since the late 1920s, when it surpassed California. For a time in the late 1980s, Alaska rivaled Texas, as the more mature Texas fields declined and production from the giant Alaskan North Slope fields, begun in 1977, was still approaching its peak level of about 2 million barrels per day. Since that time, however, production from the Alaskan North Slope has fallen rapidly.

Production from the Federal offshore, now about equal to output from the Alaskan North Slope, is limited by policy to California and the western and central Gulf of Mexico. New production areas, or "plays," led to a resurgence in activity in the Gulf of Mexico, the only area with active new leasing. Leasing, drilling, production and the numbers of fields under development all set records in 1997, as the deepwater Gulf of Mexico became the place to be for almost any larger oil company, domestic or foreign. (Links to additional details and graphics on offshore activity.) These new prospective oil producing areas are further offshore, in the much more challenging deepwater. The pace and timing of these deepwater plays, like all other upstream exploration, were impacted by 1998's low prices.

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Demand

This section reviews the ways we use petroleum and the data sources that depict its use. When petroleum products are burned to produce energy, they may be used to propel a vehicle, as would be the case with gasoline, jet fuel, or diesel fuel; to heat a building, as with heating oil or residual fuel oil; or to produce electric power by spinning a turbine directly or by creating steam to spin a turbine. In addition, of course, oil products may be used as a raw material (a "feedstock") to create petrochemicals and products, such as plastics, polyurethane, solvents, and hundreds of other intermediate and end-user goods.

Global Oil Consumption

The industrialized countries are the largest consumers of oil but until 1998 had not been the most important growth markets for some years. The countries of the Organization for Economic Cooperation and Development (OECD), for instance, account for almost 2/3 of worldwide daily oil consumption. In contrast, however, oil demand in the OECD grew by some 11 percent over the 1991-97 period, while demand outside the OECD (excluding the Former Soviet Union) grew by 35 percent. The Former Soviet Union presents a special case. The collapse of the Russian economy that accompanied the collapse of Communism led to a decline in oil consumption of more than 50 percent over the 1991-98 period.

The developed economies use oil much more intensively than the developing economies, and Canada and the United States stand almost alone in their consumption of oil per capita (see graph). For instance, oil consumption in the United States and Canada equals almost 3 gallons per day per capita. (The difference is these countries' transportation sectors, with their dependence on private vehicles to travel relatively long distances.) Oil consumption in the rest of the OECD equals 1.4 gallons per day per capita. Outside of the OECD, oil consumption equals 0.2 gallons per day per capita.

Regionally, the largest consuming area remains North America (dominated by the United States), followed by Asia (with Japan the largest consumer), Europe (where consumption is more evenly spread among the nations), and then the other regions. As the regional graphs illustrate, Asia was the region with the fastest demand growth until the 1998 economic crisis in East Asia. The region's economic upheaval is a central reason for the oil price collapse of 1998.

The United States and Canada use oil more for transportation than for heat and power, but the opposite pattern holds for most of the rest of the world: most regions use more oil for heat and power than for transportation. As a result, global demand for oil is highest in the Northern Hemisphere's cold months. There is a swing of 3-4 million barrels per day (some 5 percent) between the 4th quarter of the year, when demand is highest, to the 3rd quarter, when it is lowest. (The precise amount varies from year-to-year, depending on weather, economic activity and other factors.) While the 4th quarter is not the coldest in any region, estimated demand calculations are swollen by the traditional stock building that occurs during the period.

Demand for crude oil is derived from the demand for the finished and intermediate products that can be made from it. In the short-term, however, demand for crude oil may be mismatched with the underlying demand for petroleum products. This misalignment occurs routinely as a result of stock changes: the need to build stocks to meet seasonal demand, for instance, or the desire to reduce stocks of crude oil for economic reasons. In the longer term, blending non-petroleum additives into petroleum products (such as ethanol or other oxygenating agents into gasoline) can also reduce crude oil demand relative to demand for finished products.

U.S. Consumption by Sector

The use of petroleum products as vehicle fuels is classified as "transportation" use. In the United States, in contrast to other regions of the world, about 2/3 of all oil use is for transportation, as shown in the graph. (In most of the rest of the world, oil is more commonly used for space heating and power generation than for transportation.) Gasoline, in turn, accounts for about 2/3 of the total oil used for transportation in the United States. Other petroleum products commonly used for transportation include diesel fuel (used for trucks, buses, railroads, some vessels, and a few passenger autos), jet fuel, and residual fuel oil (used for tankers and other large vessels).

In the years since the Arab Oil Embargo of 1973/74, transportation has become a more important component of oil demand, as price and policy encouraged the substitution where possible of other fuels for oil. In non-transportation or "stationary" uses -- burning oil for space heating in buildings, such as homes, apartment buildings, stores, and schools, and burning oil for power to run factory equipment, or to generate electricity -- substitution of other energy sources for oil was possible, some of it immediately and some with the turnover of equipment. In transportation uses, in contrast, there is little fuel substitution possible in the short term and only limited potential in the longer term, given current technology. Consumption of oil in these stationary uses -- residential, commercial, industrial and electricity generation -- fell from a peak of 8.7 million barrels daily in 1978 (about 47 percent of total oil use) to a low of less than 6 million barrels per day in the late 1980's and early 1990's. Consumption in these sectors has been 6.5-7.0 million barrels per day more recently.

Thus, while oil continues to account for more than 95 percent of all the energy used for transportation in the United States, oil accounts for less than 20 percent of the energy consumed for other, stationary uses, down from 30 percent in 1973.

U.S. Consumption by Product

Gasoline is the perfect example of a consumer product: available everywhere, purchased often and in easy transactions. Its consumption accounts for almost 45 percent of all oil use (see graph). The dominance of gasoline in the oil mix is not new; gasoline has been the most important oil product since the 1920's. The quest to maximize gasoline production has been the driver in the development of refinery technology and design in the United States, as discussed in the section on refining.

After the Arab Oil Embargo, the implementation of gasoline consumption standards for new passenger cars (the "Corporate Average Fuel Economy" or CAFE standards) was important in moderating gasoline demand growth, even while both the number of cars on the road and the miles they traveled increased. Beginning in the early 1990's, however, the burgeoning popularity of pick-up trucks and sports utility vehicles (SUV's) for passenger travel has sparked new gasoline demand growth. These light trucks and SUV's are not as fuel efficient as standard automobiles and, as they have become more and more popular, have reduced the average fuel economy of cars on the road. (Whereas the fleet averages for light trucks and SUV's must be at least 20.7 miles per gallon, automobiles must average a minimum of 27.5 miles per gallon)

Government mandates in recent years have created a variety of U.S. gasoline grades to meet different regional environmental records. So-called "reformulated gasoline," designed to control ground-level ozone, is largely a phenomenon of the Northeast and some large cities elsewhere in the country. In addition, California requires a special version of reformulated gasoline. Reformulated gasoline accounts for about 30 percent of nationwide gasoline consumption. "Oxygenated" gasoline is required during the cold months in areas where carbon monoxide levels are high. Even during the October - March gasoline season, the special gasoline for these areas accounts for less than 10 percent of the nationwide total. It is important to note that the mandate to supply these different grades regionally and seasonally imposed a significant reduction in distribution flexibility, because gasoline can no longer be interchanged from one region to another, or held over from winter to summer. This lack of flexibility was one of the important contributors to the gasoline price spike experienced during 2000.

Distillate fuel oil use ranks second behind gasoline. Unlike gasoline, which is used almost exclusively in the transportation sector, distillate fuel oil is used in every sector: for home heating fuel, for industrial power, for electric generation, as well as for diesel-fueled vehicles. The largest use of distillate is in the transportation sector. Diesel fuel used in vehicles on the highway -- trucks, buses, passenger cars -- must be low sulfur (no more than 0.05 percent sulfur by weight), an Environmental Protection Agency regulation implemented in late 1993. Distillate fuel oil used off the highway -- for vessels, railroads, farm equipment, industrial machinery, electric generation, or space heating -- is not subject to the low on-highway standard, but as a matter of course contains only a small amount of sulfur, commonly 0.2 percent sulfur by weight. (California has a more stringent standard, requiring that all distillate meet the current low highway specification.) The U.S. Department of the Treasury also requires that the non-highway product be dyed to distinguish it from the taxable on-highway diesel. These requirements also limit distribution flexibility for distillate fuels, requiring segregated storage and transportation, and preventing one product from easing shortages of the other.

The use of distillate fuel oil for home heating was once much more prevalent than it now is. The Mid-Atlantic and, more particularly, New England remain the two regions with an appreciable share of oil-heated single family homes. In other regions, older homes have been converted from oil heat to gas, and oil no longer accounts for a noticeable share of the new home construction market. Thus, the seasonal increase in inventories and demand is largely confined to the Northeast.

Jet fuel is the third-highest product in demand and, like gasoline, is largely confined to use in the transportation sector. (There is also limited use of jet fuel as a stationary turbine fuel, and occasionally it is used to blend into heating oil to stretch supplies during periods of peak demand.) The military formerly utilized a different, naphtha-based product for its planes, instead of the commercial, kerosene-based product. In recent years, however, the military has largely converted to kerosene-based jet fuel.

Residual fuel oil, the heavy fuel used to run boilers for power generation and to propel tankers and other large vessels, once accounted for as much as 30 percent of the oil burned in stationary uses, and 20 percent of all United States oil use. By 1997, those shares had fallen to 7 percent and 4 percent, respectively. Residual fuel oil's heyday, the 1970's, represented a particular time in energy markets. The natural gas supply was constrained by Federal regulation and, although U.S. refiners had little incentive to make the low priced heavy fuel oil, refineries in the Caribbean and Venezuela supplied the East Coast's residual fuel oil for electric power generation, urban space heating in large apartment buildings, and industrial power. The market for residual fuel oil was eroded by a variety of factors, including price competition with (newly available) natural gas and environmental restrictions. Residual fuel oil's use for apartment building space heating is now confined largely to older buildings in New York City, and its use in electric generation is limited largely to a few utilities in Florida and the Northeast.

By now, the major product with the most pronounced seasonal pattern in its consumption is high sulfur distillate, the kind used for home heating, with high consumption periods during the winter months. Its use, concentrated in the Northeast, represents a relatively small share of total consumption in the United States, however. Gasoline demand, which rises in the warmer months, exhibits a shallower swing between the "low" demand season and the "high" demand season. At the low end (generally January/February), estimated gasoline consumption is 7-8 percent below the annual average and, at the high end (July/August), it is some 4 percent above the annual average. See graph.

U.S. Consumption by Region

Different regions exhibit different oil consumption patterns. Population and regional economic activity are two important determinants, but the traditional availability of alternative fuels, petroleum transportation, geography, and a host of other factors are also important. The East Coast consumes the largest volume of oil of the five major regions of the country, as shown in the graph. (For data gathering and analysis, the United States is divided into the five broad regions, the Petroleum Administration for Defense Districts or PADD's delineated in World War II. See map, Appendix A.) On a per capita basis, however, the East Coast, Midwest and the West Coast consume about the same amount, and less than the two other regions, the Gulf Coast and the Rockies. The Gulf Coast, the heart of the U.S. petroleum industry, presents an interesting case, because more than 25% of the Gulf Coast's "consumption" is not use of oil for energy but rather as a feedstock to make petrochemicals, and finally petroleum-based products such as a variety of plastics, polyurethane, and synthetic fibers. The Rockies are another interesting case: the sparsely populated region shows low consumption on an absolute basis, but relatively high regional consumption per capita; high use of transportation fuels to travel long distances makes the difference.

Measuring Oil Consumption

Measuring oil consumption presents a dilemma for public and private analysts. The size and complexity of the market and the number of consumers and suppliers make data collection a daunting task. The EIA, like other governmental agencies and analysts, uses a variety of approaches to measure oil consumption.

In-depth consumer surveys, for instance, can provide a good deal of insight into how people use oil, the characteristics of the fuel-burning equipment they use, and other factors that affect consumption. EIA has undertaken a variety of complex surveys to examine oil consumption, such as the Residential Energy Consumption Survey and the Manufacturing Energy Consumption Survey. These surveys, however, are costly, time-consuming, and of necessity have a long lag before publication. They are not practical alternatives for short-term data collection.

Collecting data from suppliers, a much smaller universe, is a better option for estimating consumption on a routine basis. Here, too, the depth of required/requested information is critically affected by the frequency with which it must be reported. On an annual basis, for instance, EIA collects and publishes detailed sales data such as its Sales of Fuel Oil and Kerosene report, the source for sector-by-sector information on consumption of these fuels. Available on a State-by-State basis, the report's data also feed EIA's multifuel State Energy Data System (SEDS). On a monthly basis, EIA collects sales data for major products from refiners and from prime suppliers, which it publishes in the Petroleum Marketing Monthly (PMM). The prime supplier data, reflecting first sales into a State for local consumption, are published in the PMM on a State-by-State basis.

Finally, for petroleum, as for other goods, EIA also routinely monitors the sources of supply in order to estimate the amount of product delivered to the market. To make the data collection manageable, it focuses on the "primary supply" system -- refiners, importers, pipelines, and marine transporters of petroleum, large storage facilities, and/or storage facilities with access to waterborne deliveries or pipelines. For most refined petroleum products, the balance is:

- Refinery production (output)
- plus imports of the product
- plus or minus the change in inventory
- plus or minus shipments from other domestic regions
- minus exports
- equals Product Supplied

However, while petroleum analysts equate "Product Supplied" with consumption, there is a lag between petroleum delivered into the market and petroleum actually consumed. The product may sit in a tank belonging to a wholesaler, a retailer, or even a consumer before it is used. We cannot capture these small movements and therefore can be surprised by short-term volume fluctuations as these tanks are unexpectedly filled or emptied. Thus, the methodology overstates "demand" when the product moves into wholesaler or retailer storage and understates it during the period when it is actually consumed.

- To Links to Demand Data and Sources
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Trade

This section looks at petroleum trade and transportation. The main oil producing areas are not the same as the main consuming areas. Hence, oil must be moved from regions where supply is greater than demand -- exporting regions -- to regions where demand is greater than supply -- importing regions. The "have/have not" balance results in oil flows from one international region to another, from one country to another, and from one region within a country to another. These flows, dictated by economics, logistics, and temporary imbalances in supply and demand, are central to the efficient operation of the oil market.

Regional Importers and Exporters

As one might expect, the world's three largest consuming regions -- North America, Europe, and Asia-Pacific -- are all importers. All the other regions are exporters.

The Middle East still exports vastly more oil than any other region, despite the strong growth in production in other areas in recent years. This global dependence on Middle East oil makes the geo-political importance of the Middle East readily understandable.

There is less variation among the importing regions. In the decade preceding its 1997-98 financial crisis, Asia-Pacific's economic boom propelled it into the Number 1 spot, with import growth more than double that of any other region's. Even though the United States is the largest individual importer, both net and gross, North America as a region ranks third; because Canada and Mexico are two of the United States' three top oil suppliers, their exports to the United States offset U.S. imports from these neighbors in the regional calculation. (Net imports are gross imports minus gross exports). This has kept North America's import dependency down to not much over 30 percent, half that of the Asia-Pacific region at its 1997 peak. The latter's import dependency, and even its import volume, have declined since then, but not by enough to threaten its position as the world's top importing region. (See discussion of U.S. import dependency below.)

Global Patterns of Oil Trade

Oil Trade: Highest Volume, Highest Value

There is more trade internationally in oil than in anything else. This is true whether one measures trade by how much of a good is moved (volume), by its value, or by the carrying capacity needed to move it. All measures are important and for different reasons. Volume provides insights about whether markets are over- or under-supplied and whether the infrastructure is adequate to accommodate the required flow. Value allows governments and economists to assess patterns of international trade and balance of trade and balance of payments. Carrying capacity allows the shipping industry to assess how many tankers are required and on what routes. Transportation and storage play a critical additional role here. They are not just the physical link between the importers and the exporters and, therefore, between producers and refiners, refiners and marketers, and marketers and consumers; their associated costs are a primary factor in determining the pattern of world trade.

Distance: The Nearest Market First

Generally, crude oil and petroleum products flow to the markets that provide the highest value to the supplier. Everything else being equal, oil moves to the nearest market first, because that has the lowest transportation cost and therefore provides the supplier with the highest net revenue, or in oil market terminology, the highest *netback*. If this market cannot absorb all the oil, the balance moves to the next closest one, and the next and so on, incurring progressively higher transportation costs, until all the oil is placed.

The recent growth in United States dependence on its Western Hemisphere neighbors is an illustration of this "nearer-is-better" syndrome. For instance, Western Hemisphere sources now supply over half the United States import volume (see graph), much of it on voyages of less than a week. Another quarter comes from elsewhere in the area called the Atlantic Basin, those countries on both sides of the Atlantic Ocean. This oil, coming especially that which comes from the North Sea and Africa, and takes just 2-3 weeks to reach the United States, boosts the so-called *short-haul* share of U.S. imports to over three-quarters. Most North Sea and North and West African crude oils stay in the Atlantic Basin, moving to Europe or North America on routes that rarely take over 20 days. In contrast, voyage times to Asia for just the nearest of these, the West African crude oils, would be over 30 days to Singapore, rising to nearly 40 for Japan. Not surprisingly, therefore, most of Asia's oil comes instead from the Middle East, only 20-30 days away.

Mexico and Venezuela have consciously helped the trend toward short-haul shipments. They pro-actively took the strategic decision to make as large and as profitable a market as possible for poor quality crudes, since their reserves are unusually biased toward those hard-to-place grades. Both countries therefore targeted their nearest markets, the U.S. Gulf Coast and the Caribbean, for joint venture refinery investments. They began with refineries that had traditionally run their crudes, and then with refineries that might be upgraded to do so. This policy has turned poor quality crudes into the preferred crude at these sites, significantly increasing the crude oil self-sufficiency of the Western Hemisphere.

A change in trade flow patterns can also be of critical importance to the shipping industry. For example, the Suez crisis of 1957 forced tanker owners back to using the much longer route around the Cape of Good Hope, and resulted in the development of Very Large Crude Carriers (VLCC's) to reduce that voyage's higher costs. The shift to short-haul routes in the 1990's was also critical. Using the growth in world trade volumes as a proxy for demand, tanker owners had been expecting a return to a strong tanker market. But the combination of the surge in short haul imports in the Atlantic Basin and the shift of Middle East exports from the longer United States to shorter Asian voyages led to a sharp decline in average voyage length. This decline was accelerated by the return of Iraqi crude exports, many of which move on the extremely short route from the Black Sea end of the Iraq-Turkey pipeline to the Mediterranean. The tanker owners' outlook was thus fading even before world trade volumes were undermined by the Asian crisis.

Quality, Industry Structure, and Governments

In practice, trade flows do not always follow the simple "nearest first" pattern. Refinery configurations, product demand mix, product quality specifications -- all three of which tie into quality -- and politics can all change the rankings.

Different markets frequently place different values on particular grades of oil. Thus, a low sulfur diesel is worth more in the United States, where the maximum allowable sulfur is 0.05 percent by weight, than in Africa, where the maximum can be 10 to 20 times higher. Similarly, African crudes -- low in sulfur -- are worth relatively more in Asia, where they may allow a refiner to meet tighter sulfur limits in the region without investing in refinery upgrades. Such differences in valuing quality can be sufficient to overcome transportation cost disadvantages, as the relatively recent establishment of a significant trade in long-distance African crudes to Asia shows. The cost of moving oil into a particular market can be further distorted from the principle of nearest first by government policies such as tariffs, as discussed in the chapter on Prices.

In addition, both buyers and sellers may impose restrictions. For instance, the United States prohibits the importation of Iranian and Libyan oil, and the United Nations allows only limited sales of Iraqi oil. On the seller's side, Mexico formerly limited sales to the United States to 50 percent of its exports, reflecting concerns about dependence on the United States specifically and about dependence on one geographic market in general. Saudi Arabia's national security concerns, on the other hand, dictate that it maintain a very high profile as a supplier to the United States market, even at the cost of lower netbacks. Indeed, it was the top United States crude supplier in 1999.

Crude versus Products

Crude oil dominates the world oil trade. The risk-weighted economics clearly favor siting refineries close to consumers rather than close to the wellhead. This siting policy takes maximum advantage of the economies of scale of large ships, especially as local quality specifications are increasingly fragmenting the product market (see Demand). It maximizes the refiner's ability to tailor the product output to the market's short-term surges such as those caused by weather, equipment outages, etc. In addition, this policy also guards against the very real risk that governments will impose selective import restrictions to protect their domestic refining sector.

As noted in the section on Refining, there are a limited number of refining centers that are at odds with this general rule, having been developed to serve particular export markets. These export refining centers -- Singapore, the Caribbean, and the Middle East -- give rise to some regular inter-regional product moves, but they are the exception. The inter-regional products trade is largely a temporary market-balancing function. Some inter-regional flows are extremely short lived, as when extremely cold weather in Europe causes the United States to export heating oil there. A longer-lived example arose when a large proportion of European drivers opted for diesel cars, leaving the region in the late 1990's with surplus capacity to produce gasoline for export to the United States.

Tankers and Pipelines

There are two modes of transportation for inter-regional trade: tankers and pipelines. Tankers have made global (intercontinental) transport of oil possible, and they are low cost, efficient, and extremely flexible. Pipelines, on the other hand, are the mode of choice for transcontinental oil movements.

Not all tanker trade routes use the same size ship. Each route usually has one size that is the clear economic winner, based on voyage length, port and canal constraints and volume. Thus, crude exports from the Middle East -- high volumes that travel long distances -- are moved mainly by Very Large Crude Carriers (VLCC's) typically carrying over 2 million barrels of oil on every voyage. The VLCC's economies of scale outweigh the constraints imposed: they are too large for all the ports in the United States except the Louisiana Offshore Oil Port (LOOP). Thus, they must have some or all of their cargo transferred to smaller vessels, either at sea (lightering) or at an offshore port (transshipment). In contrast, ships out of the Caribbean and South America are routinely smaller and enter ports in the United States directly. Because of such ship size differences, a long voyage can sometimes be cheaper on a per barrel basis than a short one.

Pipelines are critical for landlocked crudes and also complement tankers at certain key locations by relieving bottlenecks or providing shortcuts. The only inter-regional trade that currently relies solely on pipelines is crude from Russia to Europe. Export pipelines are also needed for production from the Caspian Sea region, where the protracted commercial and political debate illustrates the greatest negative for pipelines crossing national boundaries: their political vulnerability.

Pipelines come into their own in intra-regional trade. They are the primary option for transcontinental transportation, because they are at least an order of magnitude cheaper than any alternative such as rail, barge, or road, and because political vulnerability is a small or non-existent issue within a nation's border or between neighbors such as the United States and Canada. (Pipelines are also an important oil transport mode in mainland Europe, although the system is much smaller, matching the shorter distances.)

The development of large diameter pipelines during World War II allowed the development of the vast pipeline network in North America that moves crude oil and product within Canada, from Canada into the United States, and within the United States. Domestically, the 200,000 miles of pipelines account for about two-thirds of all the oil shipments, when adjusted for volume and distance. They move domestic crudes from producing areas like California, the Rockies, and West Texas, and imported crudes from the receiving ports, and transport them to the refining centers. The United States also relies heavily on pipelines to transport petroleum products from refining centers, such as the Gulf Coast, to consuming regions, like the East Coast.

Fungibility is an important factor in transportation economics. Because the oil is broadly interchangeable (fungible), it can be mixed without a significant diminution in value. As environmental mandates have required different regional and seasonal qualities of gasoline, the required batching for transport and segregation for storage has increased substantially. Thus the logistics flexibility inherent in a product's fungibility -- the ability to substitute one shipment for another, to exchange between regions, for instance -- has disappeared. While this is invisible to consumers during normal times, it contributes to market upheavals and price spikes in times of surprises in demand or supply, as during the early driving season in 2000.

Import Dependency

As already noted, the United States continues to sit at the top of the national rankings of importers, now accounting for around a quarter of total world imports. Yet its import dependency, the percentage of demand met by imports, is significantly lower, at about 50 percent, than that of its international partners. Industrialized countries such as Japan and Germany have import dependency levels of 90-100 percent.

The Middle East has long been regarded as politically unstable and its oil supply, therefore, subject to disruptions. U.S. policy makers have viewed its increased dependence on Western Hemisphere supplies and its decreased dependence on the Middle East as a welcome development. (Again, an international contrast: the Asia-Pacific region now relies on the Middle East for almost 90 percent of its imports and hence 50 percent of its consumption.)

As the Middle East holds the majority of the world's oil reserves (see Supply), increasing U.S. dependence on this region had been viewed as the inevitable partner of import growth. In light of the shift toward Western Hemisphere, short-haul import sources, Saudi Arabia is the only significant Middle East supplier left, and then only because of its willingness to trade security for revenue as noted above. Yet, although U.S. dependence on the long-haul Middle East has fallen sharply, this has not made U.S. prices less vulnerable to a disruption in Middle East supplies. Since oil is a global market, the relevant measure for that vulnerability is not U.S. dependence, but world dependence on Middle East oil -- and that has not shrunk.

While interdependence in the Western Hemisphere has been a major United States policy objective, it is important to realize that this combination of size and geographic closeness creates its own short-term vulnerability. Take for instance the case of Hurricane Roxanne, which severely damaged a large part of Mexico's production facilities in the Gulf of Mexico in late 1995. Some 40 million barrels of Mexico's production was eliminated, the vast majority earmarked for refineries along the U.S. Gulf Coast. These refiners, less than a week's sailing time away, had little time to compensate for this sudden hole in their planned supplies.

U.S. Trade Flows

Crude Oil and Products Mix

Crude oil dominates U.S. imports just as it dominates world trade and for much the same reasons (see Crude versus Products, and see graph). Therefore, all of the U.S. leading suppliers are major crude producers. Imports of crude oil, having grown to replace declining domestic production and to meet growing demand, now account for around 80 percent of the total. Product import volumes have stayed relatively stable.

In spite of the seeming stability in product imports, there have been significant structural shifts over the last couple of decades in the mix of products that the United States imports. Residual fuel oil, for instance, formerly accounted for the majority of all product imports, but its share has shriveled into insignificance as utilities and industrial users have switched to other fuels, particularly nuclear and natural gas. In its place, the United States now imports a much higher proportion of petroleum products that are reprocessed or blended by the oil industry, such as the unfinished gasoline and gasoline blending components that are central to reformulated gasoline supply.

Canada is the one country that delivers oil to the United States by pipeline. (Only its relatively new offshore Eastern Canadian production, from fields like Hibernia, depends on tankers.) The vast majority of Canada's crudes are landlocked and rely almost exclusively on trunk-lines from Western Canada that tie into the U.S. transcontinental network to reach their main export markets, which lie all across the Northern Tier of the United States. As domestic production has declined, these Canadian crudes have had a greater reach into the United States.

U.S. Exports

Since the United States is the world's largest importer, it may seem surprising that it also exports around 1 million barrels a day of oil, predominantly petroleum products. Due to various logistical, regulatory, and quality considerations, it turns out that exporting some barrels and replacing them with additional imports is the most economic way to meet the market's needs. For example, the Gulf Coast may export lower quality gasoline to Latin America while the East Coast imports higher quality gasolines from Europe. Exports in the 1990's have been at record highs, the efficiency of the oil market has been increased, and consumers everywhere have benefited.

U.S. Regional Trade

There are significant differences between different parts of the United States in terms of their involvement in and dependence on international trade. Most of these differences are the direct result of the uneven distribution of both production and refining across the United States (see U.S. Supply, U.S. Refining). Thus, as shown in the graph, the East Coast imports over half of all the products that come to the United States, because it is the largest consuming area in the United States but, for historical reasons, it has only enough capacity to meet around 1/3 of those needs from its own refining. It fills the product gap with supplies from other parts of the United States, particularly the Gulf Coast, and with imports. Its limited volume of refining capacity also keeps it a distant third as a crude importer. However, because its local production is so insignificant, its crude import dependency is the highest of all, at almost 100 percent.

The only other region that imports significant amounts of products is the Gulf Coast. Its focus is not, like the East Coast's, on products that can be supplied directly to the consumer, but on refinery feedstocks and blendstocks, to support its role as the main U.S. refining and petrochemical center. That role, plus the need for all the Midwest's non-Canadian crude imports to move through the Gulf Coast's ports and pipelines too, has also led to the Gulf Coast being by far the most important crude oil importing region in the United States, accounting for nearly two-thirds of the total.

The trade among regions of the United States is focused on the eastern half of the country. As shown in the graph, the Midwest and East Coast account for 90 percent of the inter-regional flow, the flow between Petroleum Administration for Defense Districts (map). The Gulf Coast is by far the largest supplier, accounting for more than 80% of the inter-PADD flow. In contrast, the Rockies and the West Coast are isolated, in petroleum logistics terms, from the rest of the country. The easy flow of petroleum from the Gulf Coast to the Midwest and the East Coast mean that incremental supply is more readily available to those markets in the event of a demand surge or supply drop. In contrast, the West Coast, and the California market in particular, cannot so readily attract incremental supplies. Thus, the California refinery outages that occurred in the Spring of 1999, resulted in a large price increase as market players scrambled for additional supply, none of which was available close at hand, or cheaply. The California market's isolation is more than just geographic: the State imposes unique and stringent quality restrictions on both its gasoline and its off-highway diesel, making what otherwise might be available to augment California product supplies unsuitable.

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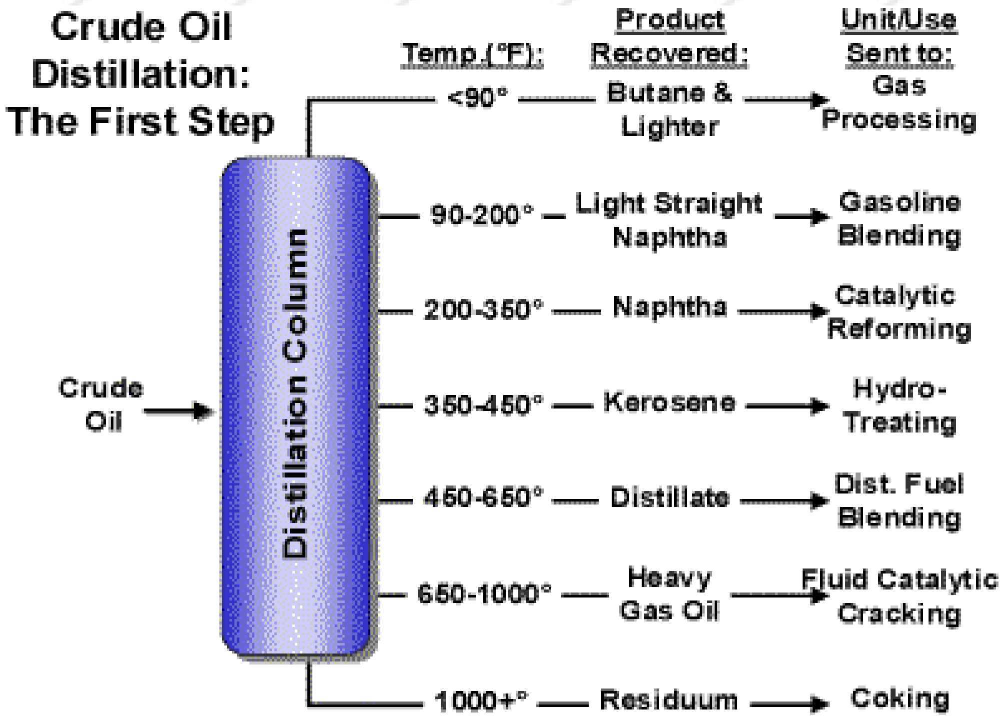
- To Trade Graphs and Charts

- To Next Chapter (Refining)
- To Map of Petroleum Administration for Defense Districts

Refining

This section focuses on refining, the complex series of processes that manufactures finished petroleum products out of crude oil and other hydrocarbons. While refining began as simple distillation, refiners must use more sophisticated additional processes and equipment in order to produce the mix of products that the market demands. Generally, this latter effort minimizes the production of heavier, lower value products (for example, residual fuel oil) in favor of lighter, higher value products (for example, gasoline).

Simple Distillation



The core refining process is simple distillation, illustrated in a stylized fashion at the right. Because crude oil is made up of a mixture of hydrocarbons, this first and basic refining process is aimed at separating the crude oil into its "fractions," the broad categories of its component hydrocarbons. Crude oil is heated and put into a still -- a distillation column -- and different products boil off and can be recovered at different temperatures. The lighter products -- liquid petroleum gases (LPG), naphtha, and so-called "straight run" gasoline -- are recovered at the lowest temperatures. Middle distillates -- jet fuel, kerosene, distillates (such as home heating oil and diesel fuel) -- come next. Finally, the heaviest products (residuum or residual fuel oil) are recovered, sometimes at temperatures over 1000 degrees F. The simplest refineries stop at this point. Most in the United States, however, reprocess the heavier fractions into lighter products to maximize the output of the most desirable products, as shown schematically in the illustration, and as discussed below.

Downstream Processing

Additional processing follows crude distillation, "downstream" (or closer to the refinery gate and the consumer) of the distillation process. Downstream processing is grouped together in this discussion, but encompasses a variety of highly complex units designed for very different upgrading processes. Some change the molecular structure of the input with chemical reactions, some in the presence of a catalyst, some with thermal reactions.

In general, these processes are designed to take heavy, low-valued feedstock -- often itself the output from an earlier process -- and change it into lighter, higher-valued output. A catalytic cracker, for instance, uses the gasoil (heavy distillate) output from crude distillation as its feedstock and produces additional finished distillates (heating oil and diesel) and gasoline. Sulfur removal is accomplished in a hydrotreater. A reforming unit produces higher octane components for gasoline from lower octane feedstock that was recovered in the distillation process. A coker uses the heaviest output of distillation, the residue or residuum, to produce a lighter feedstock for further processing, as well as petroleum coke.

As noted above and in the section on demand, U.S. demand is centered on light products, such as gasoline. As shown in the graph, refiners in the United States more closly match the mix of products demand by using downstream processing to move from the natural yield of products from simple distillation, illustrated earlier, to the U.S. demand slate, illustrated here. After simple distillation alone, the output from a crude oil like Arab Light would be about 20 percent of lightest, gasoline-like products, and about 50 percent of the heaviest, the residuum. After further processing in the most sophisticated refinery, however, the finished product output is about 60 percent gasoline, and 5 percent residuum.

Crude Oil Quality

The physical characteristics of crude oils differ. Crude oil with a similar mix of physical and chemical characteristics, usually produced from a given reservoir, field or sometimes even a region, constitutes a crude oil "stream." Most simply, crude oils are classified by their density and sulfur content. Less dense (or "lighter") crudes generally have a higher share of light hydrocarbons -- higher value products -- that can be recovered with simple distillation. The denser ("heavier") crude oils produce a greater share of lower-valued products with simple distillation and require additional processing to produce the desired range of products. Some crude oils also have a higher sulfur content, an undesirable characteristic with respect to both processing and product quality. For pricing purposes, crude oils of similar quality are often compared to a single representative crude oil, a "benchmark," of the quality class.

The quality of the crude oil dictates the level of processing and re-processing necessary to achieve the optimal mix of product output. Hence, price and price differentials between crude oils also reflect the relative ease of refining. A premium crude oil like West Texas Intermediate, the U.S. benchmark, has a relatively high natural yield of desirable naphtha and straight-run gasoline (see graph). Another premium crude oil, Nigeria's Bonny Light, has a high natural yield of middle distillates. By contrast, almost half of the simple distillation yield from Saudi Arabia's Arabian Light, the historical benchmark crude, is a heavy residue ("residuum") that must be reprocessed or sold at a discount to crude oil. Even West Texas Intermediate and Bonny Light have a yield of about one-third residuum after the simple distillation process.

In addition to gravity and sulfur content, the type of hydrocarbon molecules and other natural characteristics may affect the cost of processing or restrict a crude oil's suitability for specific uses. The presence of heavy metals, contaminants for the processing and for the finished product, is one example. The molecular structure of a crude oil also dictates whether a crude stream can be used for the manufacture of specialty products, such as lubricating oils or of petrochemical feedstocks.

Refiners therefore strive to run the optimal mix (or "slate") of crudes through their refineries, depending on the refinery's equipment, the desired output mix, and the relative price of available crudes. In recent years, refiners have confronted two opposite forces -- consumers' and government mandates that increasingly required light products of higher quality (the most difficult to produce) and crude oil supply that was increasingly heavier, with higher sulfur content (the most difficult to refine).

Other Refinery Inputs

In addition to crude oil that runs through a simple distillation, a variety of other specialized inputs, usually to downstream units, enhance the refiner's capability to make the desired mix of products. Among these products might be unfinished (partly refined) oil, or imported residual fuel oil used as input to a vacuum distillation unit. The supply pattern for "reformulated gasoline" or RFG, the mandated low-pollution product first required in 1995, includes an important share of blending components that are classified as refinery inputs. These blending components include oxygenates but consist mainly of products that could be classified as finished gasoline in other jurisdictions or products that require little additional blending to be classified as finished gasoline. While they are counted as "refinery inputs," they are brought to saleable specifications in terminals and blending facilities, not in conventional refineries.

U.S. Refining Capacity

U.S. refining capacity, as measured by daily processing capacity of crude oil distillation units alone, has appeared relatively stable in recent years, at about 16 million barrels per day of operable capacity (graph). While the level is a reduction from the capacity of twenty years ago, the first refineries that were shut down as demand fell in the early 1980's were those that had little downstream processing capability. Limited to simple distillation, these small facilities were only economically viable while receiving subsidies under the Federal price control system that ended in 1981. Some additional refineries were shut down in the late 1980's and during the 1990's, always, of course, those at the least profitable end of a company's asset portfolio. At the same time, refiners improved the efficiency of the crude oil distillation units that remained in service by "debottlenecking" to improve the flow and to match capacity among different units and by turning more and more to computer control of the processing. Furthermore, following government mandates for environmentally more benign products as well as commercial economics, refiners enhanced their upgrading (downstream processing) capacity. As a result, the capacity of the downstream units ceased to be the constraining factor on the amount of crude oil processed (or "run") through the crude oil distillation system. Thus crude oil inputs to refineries ("runs") have continued to rise, and along with them -- given the stability of crude oil distillation capacity -- capacity "utilization" rose throughout much of the 1990's (again, see graph). Utilization -- the share of capacity filled with crude oil -- reached truly record levels in the last half of the decade, nominally exceeding 100 percent for brief periods.

As with most aspects of the U.S. oil industry, the Gulf Coast is by far the leader in refinery capacity, with more than twice the crude oil distillation capacity as any other United States region. (The difference is even greater for downstream processing capacity, because the Gulf Coast has the highest concentration of sophisticated facilities in the world.) As discussed in the section on Trade, the Gulf Coast is the nation's leading supplier in refined products as in crude oil. It ships refined product to both the East Coast (supplying more than half of that region's needs for light products like gasoline, heating oil, diesel, and jet fuel) and to the Midwest (supplying more than 20 percent of the region's light product consumption.)

There are seasonal patterns in refinery input. In the United States, refinery runs mirror the overall demand for products -- lower in the colder months and higher in the warmer months. In addition, as they move out of the gasoline season in the early autumn and then as they move into the next gasoline season in the late winter, refiners routinely perform maintenance. The duration and depth of the cutback in refining activity during each maintenance season is affected by a variety of factors, including the relative strength of the market for refined products. Therefore, when stocks are high and demand slack, the refinery maintenance season is likely to be longer and deeper. Refinery activity will also respond to the market's need (and hence relative prices) for product, with changes in the level of crude oil throughput as well as emphasis on one product over another.

World Refining Capacity

Broadly speaking, refining developed in consuming areas, because it was cheaper to move crude oil than to move product. Furthermore, the proximity to consuming markets made it easier to respond to weather-induced spikes in demand or to gauge seasonal shifts. Thus, while the Mideast is the largest producing region, the bulk of refining takes place in the United States, Europe or Asia.

There have historically been a few exceptions, concentrations of refining capacity that were not proximate to consuming markets. A refining center in the Caribbean, for instance, supplied heavy fuel oil to the U.S.

East Coast where it was used for power, heat, and electric generation. As the demand for this heavy fuel oil, or residual fuel oil, waned, so did those dedicated refineries. While the Caribbean refineries, as well as refineries in the Middle East and in Singapore, were built for product export, they are the exception. As such, most refineries meet their "local" demand first, with exports providing a temporary flow for balancing supply and demand. (See the section on Trade.)

The largest concentration of refining capacity is in North America (in fact, the United States), accounting for about one-quarter of the crude oil distillation capacity worldwide, as shown in the graph, and as discussed more fully below. Asia and Europe follow as refining centers. As also shown in the graph, North America (again, the United States) has by far the largest concentration of downstream capacity -- the processing units necessary to maximize output of gasoline. The gasoline emphasis of course mirrors the demand barrel and hence refinery output in the different regions, since no other global region uses as much of its oil in the form of gasoline as North America does.

Refinery Profitability and Industry Structure

In general, refining has been significantly less profitable than other industry segments during the 1990's, as shown in the accompanying graph. Gross refinery margins -- the difference between the cost of the input and the price of the output -- have been squeezed at the same time that operating costs and the need for additional investment to meet environmental mandates has grown, thus reducing the net margin even further. In addition, much of the investment made during the 1980's was designed to take advantage of the differential between the dwindling supply of higher quality crude oils and the growing supply of heavier and higher sulfur crudes. When that differential narrowed, however, the financial return on those investments declined. Refining margins peaked in the late 1980's.

During the 1990's the role of independent refiners (those without significant production) has grown substantially, largely as the result of refinery purchases from integrated companies (the "majors") seeking to streamline and realign their positions. Furthermore, the independent refiners, like the majors, are in a period of consolidation; the mergers and acquisitions are having a significant impact on refinery ownership (although not overall refined product supply).

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Stocks

This section looks at stocks, another critical component in getting oil from producer to consumer and in balancing oil markets globally, regionally, and locally.

Why Stocks Are Important

According to the Energy Intelligence Group's 1997 report, "How Much Oil Inventory is Enough?," there are 7-8 billion barrels of oil tied up worldwide in industry and government stocks (inventories) at any given time. (The estimate excludes consumer stocks.) Why so much? Mostly, because stocks are needed to keep the global supply system operating. They can be thought of as a huge pipeline stretching from the wellhead to the consumer, filling the tankers, the pipelines, the railcars, and the road tankers, and linking all the markets and all the segments of the industry together. They are thus the key to the oil industry's proven ability to deliver the right product to the right location at the right time.

Only around 10 percent of this vast stockpile is typically available to the industry to use as and when it pleases. Although minor in volume terms, these stocks -- sometimes described as "discretionary" -- can affect the industry in major ways, because this subset of total stocks indicates whether markets have too little, too much, or just the right amount of oil. Thus, when stocks are low in a particular market, prices there are likely to be relatively high, encouraging extra supply or reducing demand (whether through fuel switching or other means). Vice versa, when a region's stocks are high, prices are likely to be relatively low in that market. For example, if distillate is in short supply on the U.S. East Coast so that distillate stocks there are low, then the price for East Coast distillate rises relative to distillate prices in other markets, like Europe; relative to other products, like gasoline; and also relative to crude oil. Stocks, particularly projected stocks, are thus viewed as a leading indicator of prices and are one of the most closely watched aspects of the oil market.

It is hard for the industry to follow global stocks as closely as it would like, because the data have large gaps. The United States is the only country to publish comprehensive weekly stock data. The data's uniqueness and timeliness make them market movers, albeit temporary ones, nearly every week, in spite of the fact that they provide only a snapshot, based on preliminary information.

The United States, with its huge and widely dispersed oil market, has by far the largest commercial stocks, some one billion barrels. The Gulf Coast holds the greatest part of the crude oil stocks, as shown in the accompanying graph, but the East Coast, with its high consumption and limited local supply, has the greatest finished product inventories.

Most of the world's storage capacity is owned by the companies that produce, refine, or market the oil. There is also a small but important proportion that is owned by independent operators, who make their living by renting it to third parties. These facilities are located predominantly at the world's main trading hubs, like Rotterdam, Singapore, New York Harbor, and the Caribbean, and are an important element in making those hubs successful and viable. The volumes in independent storage can be a key indicator of what is happening to discretionary stocks. These data are, therefore, also greatly sought after by the industry but if they are outside the United States often lie outside the more formal data collection systems.

Stocks Are Seasonal

World oil stocks follow a seasonal pattern in which they are typically drawn down rapidly in the middle of the winter and re-built rapidly in the spring, creating a tendency for world oil prices to be strongest in the fall and weakest in the spring. This stock seasonality stems from world oil demand being much more seasonal than world production. Stock swings are most pronounced in those Northern Hemisphere heating fuels -- heating oil, propane, and kerosene -- that drive world oil demand seasonality. Crude stocks are also seasonal, being drawn when refiners push their runs up to peak levels and built when refiners schedule maintenance at their plants. But, since Asia's refining system has its peak output in the winter, with maintenance scheduled for the summer, while North America's system is summer-peaking, with maintenance scheduled for late winter or early fall, much of the regional seasonality in crude oil stocks cancels out at the world level. (The pattern for the United States is illustrated in the Energy Information Administration's weekly graphs for crude oil and petroleum products, gasoline, and distillate fuel oil. Use your browser's "back" button to return to this page.) Thus, global product stocks tend to be much more variable than crude oil stocks. With refineries growing more flexible and demand becoming less seasonal, stocks are becoming less seasonal too.

Strategic Stocks

The Arab Oil Embargo of 1973 initiated efforts among oil import-dependent nations to build government-controlled stocks of oil -- known as *strategic stocks* -- as a buffer against severe supply interruptions. These strategic stockpiles, the largest of which is the U.S. Strategic Petroleum Reserve, or SPR (use your browser's "back" button to return to this page), now account for a significant fraction of the world's inventories. There has been only one strictly emergency use of strategic stocks, and it was small: during the 1991 Gulf Conflict, the United States sold 4 percent of its SPR stocks.

The International Energy Agency's oil-sharing rules, designed to share the burden of an oil supply shortage, require that each participating nation hold stocks equal to 90 days of imports. Most of the participants meet the requirement with industry-owned stocks that can be commandeered in an emergency. Only the United States, Japan, and a few other nations also hold government-owned stockpiles, stored separately.

Costs and Profits

Holding inventory costs money. How much it costs varies, depending on the type of oil being stored, how much storage is available, whether the storage is owned or has to be rented, the price of the oil, and the cost of borrowing money. In all cases, the cost of holding inventory can rapidly become significant compared to the average margins achieved by refiners, marketers, distributors, and other oil industry participants that might need or want to hold inventory. Based on average prices in the first half of the 1990's, holding crude oil for a year would cost a company about $1.50/barrel if it had its own storage and $4/barrel if it had to rent storage tank space. For gasoline, the corresponding costs would be $2 and $6/barrel. Thus, storing gasoline in rented tank space costs roughly 1 cent per gallon per month. Companies, therefore, try to operate their supply and distribution systems in ways that keep their inventories as efficient as possible.

The trend in the more mature economies, like that of the United States, toward consolidation of the industry through mergers and acquisitions has helped in this regard. Every gas station, terminal, refinery, etc., must have some oil in inventory. As consolidation has led to facilities being closed, the minimum amount of oil needed to keep the system operating has fallen.

But stocks should not be viewed just as a cost of doing business. Stocks can also be a way to make money; they represent a profitable investment. Such stocks are truly discretionary stocks. They are built or drawn in response to prices, and particularly in response to the difference between today's prices and expectations about where prices will be in the future -- the *forward price curve*. The widespread availability of financial instruments, like futures contracts, has greatly encouraged discretionary stock movements, partly by making the economic signals inherent in the forward price curve easy to see, but especially by reducing the risk of building stocks in a surplus market.

When prices for oil today are lower than prices for oil in the future -- a sign of oversupply -- the market is said to be in *contango*. If the contango is wide enough to cover the costs of holding stocks, namely storage and working capital, then a company can lock in a profit on the stocks if it, first, sells oil in the futures market while simultaneously putting the same volume of oil into storage in the futures contract's delivery area, and then, subsequently either delivers the stored oil against the contract or sells the stored oil and buys an offsetting futures contract. Discretionary stockbuilding occurs disproportionately in the U.S. Northeast, particularly around New York, and in Northwest Europe, especially in the Antwerp-Rotterdam-Amsterdam (ARA) area. That is because the world's two active families of product futures contracts are based on these delivery areas: the NYMEX on New York Harbor and the International Petroleum Exchange on the ARA area.

The opposite of a contango is *backwardation*. A backwardated market has prices for oil today that are higher than prices for oil in the future -- a sign that supplies are tight. Backwardation implies that oil in storage will be worth less later, even if holding it were cost-free. The situation, therefore, creates an incentive for companies to reduce their stocks, which adds supply to the market and helps to correct the indicated shortfall.

There are many other situations that also cause companies to adjust their discretionary stocks because the risk, although not as low as it can be with building on a contango, is judged to be much lower than the potential reward. Three examples: when prices are at unusual levels by historical standards; when prices are moving fast; and when governments' oil-related fiscal policies are expected to change. In all three case, stocks can be viewed as a buffer that enables a company to change the timing of its purchases, with the high probability that this will lower its costs and, therefore, improve its bottom line. Consumers sometimes do the same thing. For example, if the tax on gasoline at the pump is expected to increase on January 1st, motorists rush in on December 31st and buy early.

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Prices

The chapters on Supply, Demand, Refining, Trade and Stocks describe the oil market and how it is connected between regions of the world and between regions of the United States. Market balance for one product is also connected to the market balance for another. These region-by-region and product-by-product supply and demand patterns interact to establish the price level for crude oil and its products. The interaction is constant and usually invisible to anyone not directly involved in the oil industry. As a general rule, the thousands of transactions that take place simultaneously are completed without fanfare. The price fluctuations are small, and of interest only to the buyers and sellers within the industry.

This steady-state stability can be -- and has been -- disrupted by a number of factors, suddenly bringing oil prices to the headlines. Demand surges, refinery outages, and supply cutbacks can all cause price run-ups. Some, like refinery outages, logistics snags or demand surges in a cold snap, cause a price spike -- prices shoot up initially and then recede again when the supply and demand balance has been reestablished. Others, like the crude oil price declines experienced during 1998 or the crude oil price increases experienced during 2000, take longer to return to the underlying price trend.

This chapter attempts to describe the broad factors that go into pricing day-to-day and those that, at the extreme, can cause a market upheaval. By design, it does not go into great detail on this complex subject. The EIA has written extensively on the subject of prices and price changes, addressing specific market upheavals as well as routine market fluctuations; see Price Data and Links.

Overview: Costs plus Market Conditions

Prices of oil, like those of other goods and services, reflect both the product's underlying cost as well as market conditions at all stages of production and distribution.

The pre-tax price of gasoline (or any other refined oil product) reflects:

- its raw material, crude oil
- transportation from producing field to refinery
- processing that raw material into refined products (refining)
- transportation from the refinery to the consuming market
- transportation, storage and distribution between the market distribution center and the retail outlet or consumer.
- market conditions at each stage along the way, and in the local market.

The price of crude oil, the raw material from which petroleum products are made, is established by the supply and demand conditions in the global market overall, and more particularly, in the main refining centers: Singapore, Northwest Europe, and the U.S. Gulf Coast. The crude oil price forms a baseline for product prices. Products are manufactured and delivered to the main distribution centers, such as New York Harbor, or Chicago. Product supplies in these distribution centers would include output from area refineries, shipments from other regions (such as the Gulf Coast), and for some, product imports. Product prices in these distribution centers establish a regional baseline. Product is then re-distributed to ever more local markets, by barge, pipeline, and finally truck. The fact the oil markets are physically inter-connected, with supply for a region coming from another region, means that of necessity even local gasoline prices feel the impact of prices abroad.

Oil prices are a result of thousands of transactions taking place simultaneously around the world, at all levels of the distribution chain from crude oil producer to individual consumer. Oil markets are essentially a global auction -- the highest bidder will win the supply. Like any auction, however, the bidder doesn't want to pay too much. When markets are "strong" (when demand is high and/or supply is low), the bidder must be willing to pay a higher premium to capture the supply. When markets are "weak" (demand low and/or supply high), a bidder may choose not to outbid competitors, waiting instead for later, possibly lower priced, supplies.

There are several different types of transactions that are common in oil markets. Contract arrangements in the oil market in fact cover most oil that changes hands. Oil is also sold in "spot transactions," that is, cargo-by-cargo, transaction-by-transaction arrangements. In addition, oil is traded in futures markets. Futures markets are a mechanism designed to distribute risk among participants on different sides (such as buyers versus sellers) or with different expectations of the market, but not generally to supply physical volumes of oil. Both spot markets and futures markets provide critical price information for contract markets.

Prices in spot markets -- cargo-by-cargo and transaction-by-transaction -- send a clear signal about the supply/demand balance. Rising prices indicate that more supply is needed, and falling prices indicate that there is too much supply for the prevailing demand level. Furthermore, while most oil flows under contract, its price varies with spot markets. Futures markets also provide information about the physical supply/demand balance as well as the market's expectations.

Seasonal swings are also an important underlying influence in the supply/demand balance, and hence in price fluctuations. The strongest seasonal influence is in product prices, because demand for refined product exhibits more pronounced seasonal patterns than demand for crude oil. The prices of refined products relative to crude oil tend to be highest as the products move into their high demand season -- late spring for gasoline, late autumn for heating oil. The seasonal pattern in actual product prices may be less obvious, because so many other factors are at work.

The overall supply picture is of course also influenced by the level of *inventories*. When stocks in a given market are high as discussed in the chapter on Stocks, they represent incremental supply immediately available, so prices tend to be weak. The opposite is true in a low stock situation.

Price *change* patterns can vary between regions, depending on the prevailing supply/demand conditions in the regional market, especially in the short-term. Refinery outages or logistics problems in Chicago will lead to rapid price increases in the Midwest without matching increases on the East Coast. Both geography and the unique quality of the gasoline required by the California Air Resources Board contribute to the volatility of gasoline prices there. Sources for additional supply are limited and distant, so any unusual increase in demand or reduction in supply gets a large price response in the market.

That price response, and the differences in regional price movements, are critical to the way the oil market redistributes products to re-balance after an upheaval. The price increase in one area calls forward additional supplies. These new supplies might come from other markets in the United States, or from incremental imports. They may also be augmented by increased output from refineries. The volume and source of the relief supplies are interwoven. The farther away the necessary relief supplies are, the higher and longer the likely price spike. See the example of re-adjustment in the Northeast.

Price spikes were an important feature of oil markets during 2000, including the Northeast's heating oil price runup in January and February, and the Midwest's gasoline price spike in May and June. The Energy Information Administration has analyzed these market upheavals extensively, testifying before Congress, publishing reports, and providing routine updates on its website.

All other things being equal, cost differences are important factors in regional prices. For instance, *state excise taxes*, *product quality*, *distance and ease of distribution* are all important when comparing prices between regions, states and even within states. These factors will lead to higher prices (or lower) in a given area on a day-in, day-out basis. (These differences are also important in comparing prices in the United States with those abroad.)

Ultimately, oil prices can only be as high as the market will bear. They may be higher in areas with higher disposable income, where real estate values, wages and other measures of economic activity indicate that the market is more robust. If they rise higher than the market will bear, however, consumers will seek substitutes or downsize their cars and make other adjustments that reduce their consumption. If the local area offers unusually high profits, competitors will quickly enter the market, finally pushing prices down.

Gasoline Prices: An Example

On a pre-tax basis, crude oil prices are the most important determinant of petroleum product prices, and often the most important factor in price changes as well. Crude oil prices reflect an overall market balance -- when crude oil prices are low, reflecting an oversupply, product prices will also be low; when crude oil prices are high, reflecting undersupply or high demand, product prices will also be high. When the price of crude oil moves up or down on a sustained basis, the change will be reflected in product markets, all other things being equal. The crude oil price increase was solely responsible for the increase in pump prices between the driving season of 1998 and the driving season of 1999, as shown in the illustration. (The illustration also demonstrates that in the low price environment of July 1998, the gasoline and other excise taxes accounted for the largest share of the price of gasoline at the pump. Taxes are discussed in a separate section.) Crude oil prices were again the largest factor in the increase between July 1999 and July 2000, accounting for about two-thirds of the increase in the pump price. In contrast, the gross retail margin -- the difference between a retail dealer's cost to purchase the gasoline and the price at which the dealer can sell the gasoline -- actually dropped by one-third between mid-1998 and mid-1999, righting itself again between mid-1999 and mid-2000. The gross refining and distribution margin stayed unchanged between mid-1998 and mid-1999, but increased between mid-1999 and mid-2000. Thus, it is useful to repeat that the price of petroleum products to consumers reflects costs plus market conditions, and those market conditions may augment or prevent a penny-for-penny passthrough of cost increases at any stage of the market.

This illustration is highly simplified. Moving gasoline to the approximatelt 200,000 retail outlets throughout the United States has required the development of an intricate distribution infrastructure. This complexity of the market structure is reflected in the "classes of trade" (different contract arrangements at different levels in the distribution chain) that are unique to the gasoline market. There are other unique features in other oil product markets. The Energy Information Administration has analyzed regional markets and price patterns in a number of publications.

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Graphs and Charts

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- U.S. Oil Inventories by Region, December 31, 1999

Appendix

- A - Map of Petroleum Allocation for Defense Districts

Links to EIA Data and Other Web Resources

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- STOCKS DATA AND SOURCES
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Appendix A

Petroleum Administration for Defense Districts

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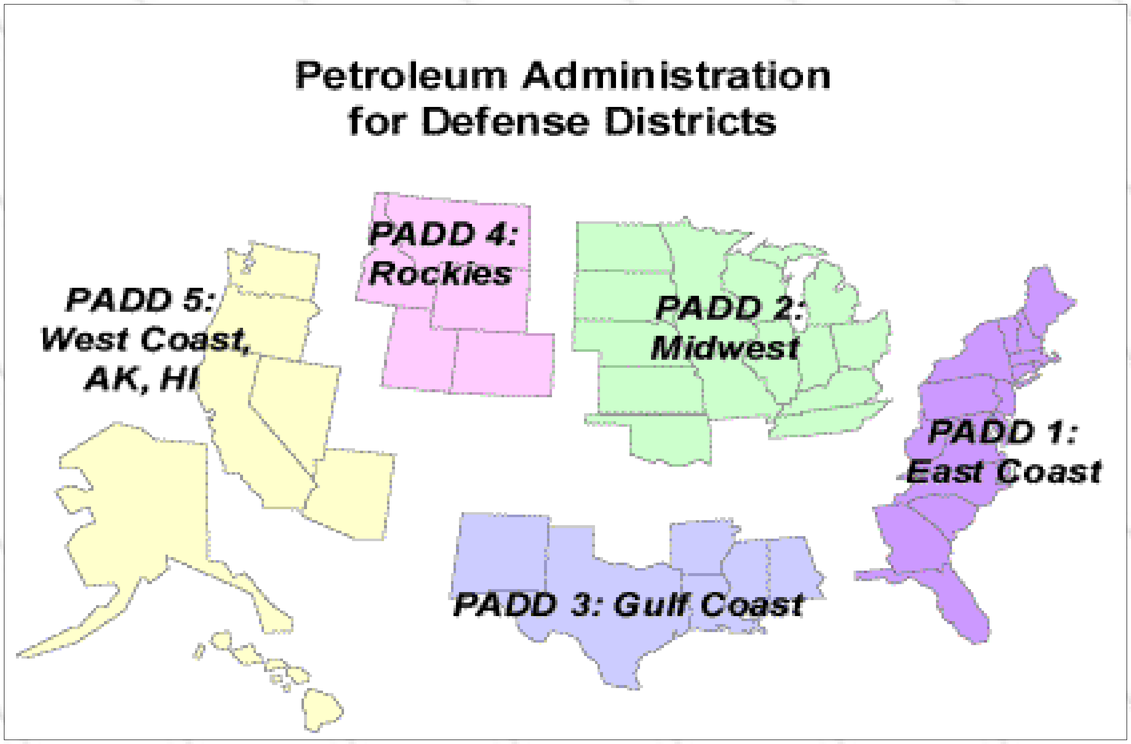

PADD's were delineated during World War II to facilitate oil allocation.

Appendix B

Links to Environmental Sources

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Some sources listed below link to non-EIA sites and data. These links are provided solely as a service to our customers, and therefore should not be construed as advocating or reflecting any position of the Energy Information Administration. In addition, EIA does not guarantee the content or accuracy of any information presented in linked sites.

U.S. Government Links

Environmental Protection Agency (EPA)
Energy Information Administration (EIA)
Department Of Energy (DOE)
U.S. Geological Survey (USGS)
National Climate Data Center (NOAA)
National Aeronautics and Space Administration (NASA)
State Department, Bureau of Oceans, Environment, and Science

Other Organization Links

National Petroleum Council

International Events

The United Nations' establishment of the Intergovernmental Panel on Climate Change (IPCC) (1988)
The United Nations' Framework Convention on Climate Change (FCCC) (1992)
The United Nations Sponsored Kyoto Protocol (1997)
EIA -- Impacts of the Kyoto Protocol on Energy Markets and Economic Activity (*pdf)
OECD – Kyoto Summit

Global Climate Change

United Nations -- Climate Change Secretariat
EPA -- Key Climate Change Topics
EPA -- Publications
EPA -- List of recommended reading and links
EPA -- Links to other global warming sites
EIA: --Index to Environmental Publications and Data
Natural Resources Defense Council --Global Warming
NOAA -- Environmental Data

Where can I find information on global warming? -- Global Warming Links

Acid Precipitation (SO_2 and NOx)

EPA -- Acid Rain Page
EPA -- Publications

EIA -- Index to Environmental Publications and Data
National Science and Technology Council -- National Acid Precipitation Assessment Program Biennial Report to Congress
USGS -- Report on the effects of the Clean Air Act Amendments on Acid Rain

Smog (Ground-Level Ozone)

EPA -- Urban Air
EPA -- Publications
EIA -- Index to Environmental Publications and Data

Fuel Quality

EPA -- Reformulated Gasoline
EIA -- The Impacts of Increased Diesel Penetration in the Transportation Sector

U.S. Oil Flow, 1999

(Quadrillion Btu)

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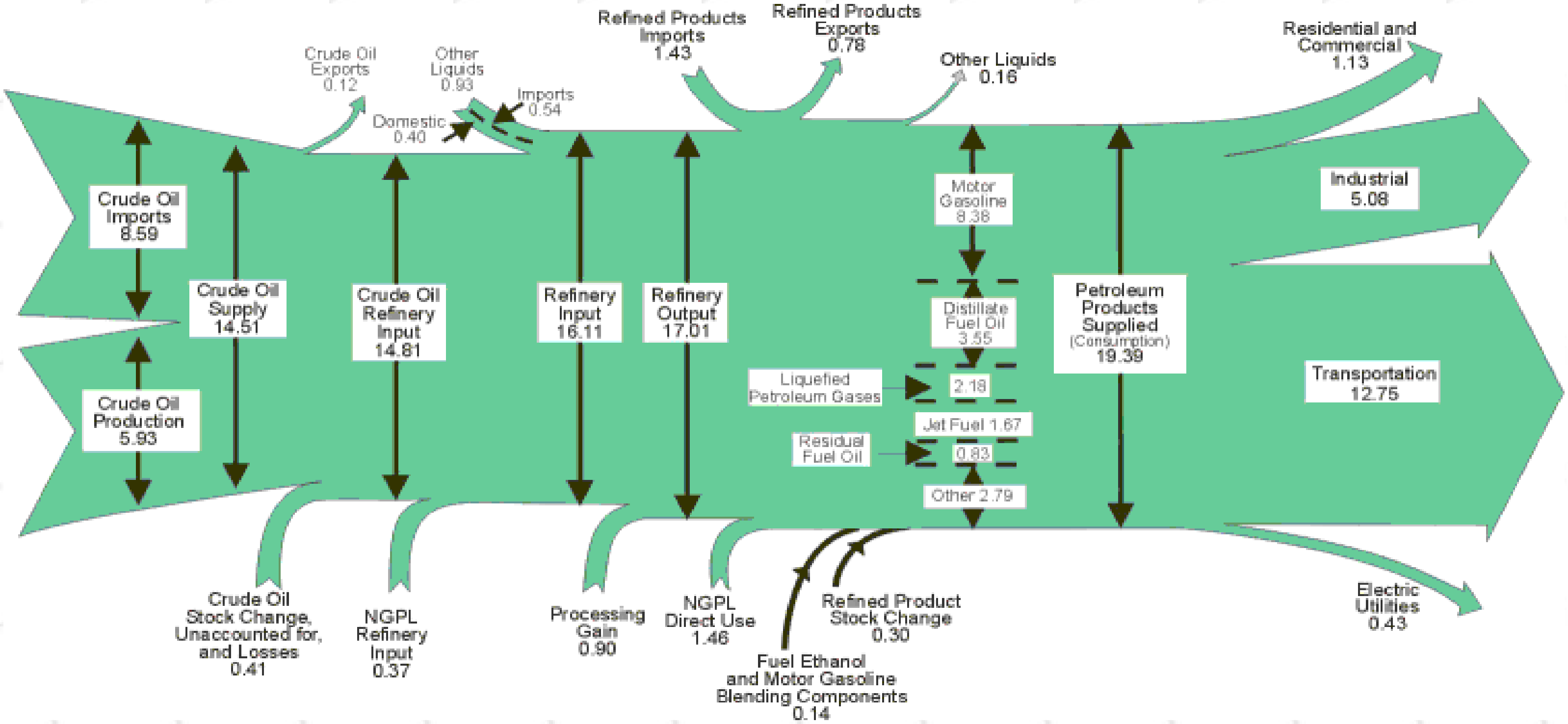

Source: [*Annual Energy Review*, 2000](#)

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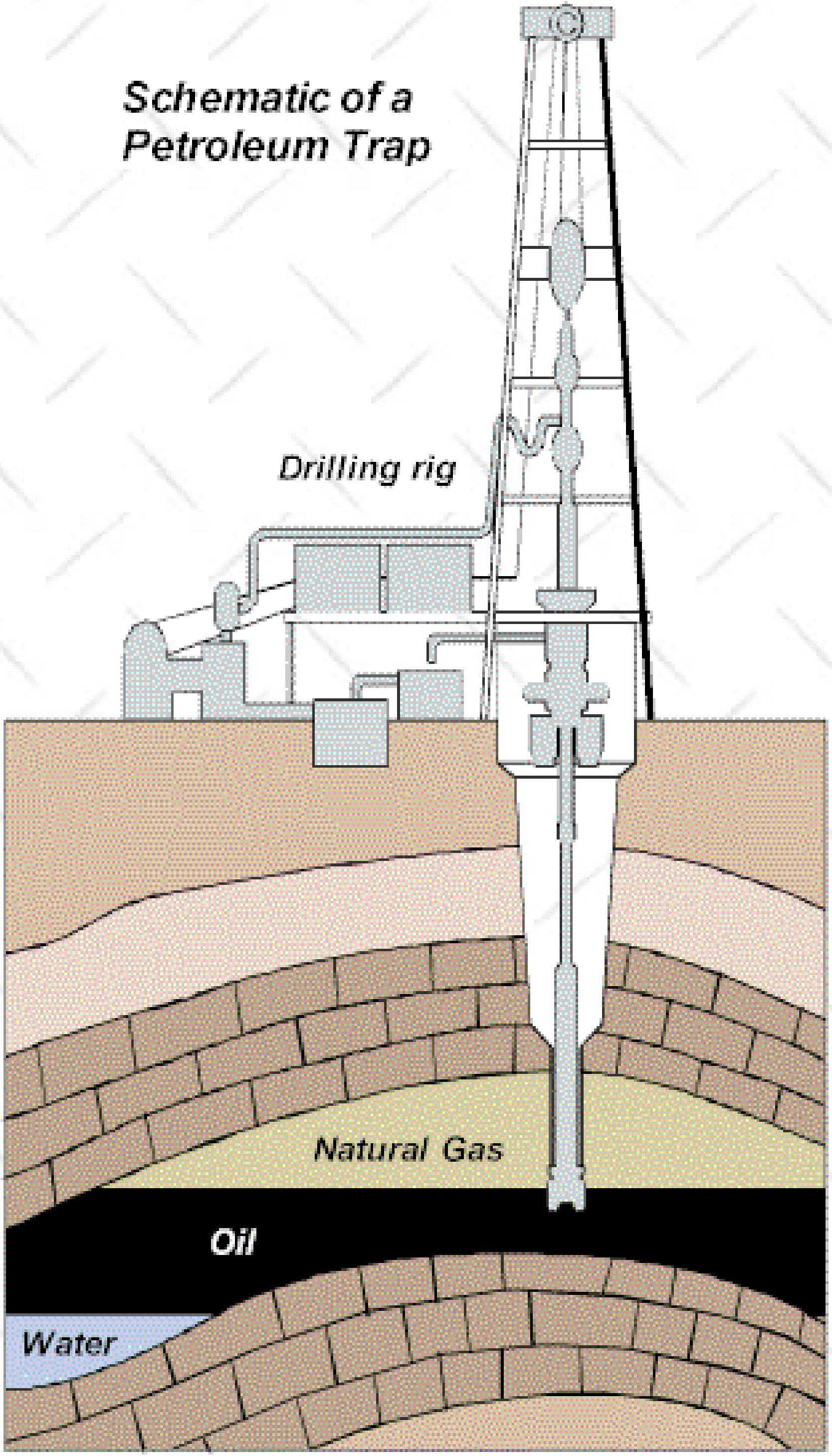

Upstream Technology

Technology's contribution to finding oil is huge. It cannot change geology, but by revolutionizing the information available on the features of a geologic structure, it has enhanced the likelihood of success. A primary benefit is the ability to eliminate poor prospects, thus wasted expenditure on dry holes. In addition, drilling and production technologies have made it possible to exploit reservoirs that would have formerly been too costly to put into production and, as described above, to increase the recovery from existing reservoirs.

The new power of oil exploration technology comes first from the revolution in computing power. The enhanced capability to process data has, for instance, allowed seismic testing to move from 2-dimensional to 3-dimensional. While seismic testing has been important for decades, even 2-D seismic was economically feasible only for large companies for a long time. New computing power has both enhanced the results of seismic testing and made it accessible to the full spectrum of companies.

Seismic exploration, broadly speaking, creates a picture of the subsurface by recording vibrations as they bounce back from geologic formations. Offshore, the vibrations come from vessels towing a sonar array that "shoots" with compressed air. Onshore, the vibrations come from specially designed trucks that "thump" the ground (and formerly, from a dynamite explosion). The difference between 2-D and 3-D seismic lies in the number of vibrations from which meaningful information can be calibrated. With 2-D, geophones along a line of vibrations provided a picture that was a cross-section -- a slice -- of the rock formation. With 3-D, the geophones cover a grid, not just a line. With thousands of times more data points, scientists can map a cube, creating a 3-dimensional computer image of the formation. While 3-D seismic is many times more expensive than 2-D, it allows companies to avoid unlikely prospects, and hence wasting money on unsuccessful wells.

Technology has also contributed a variety of tools to identify and exploit reservoirs or portions of reservoirs that are less accessible, small and/or compartmentalized, incompletely drained, or porous. Advanced imaging, used widely in medicine, also helps find and produce oil more efficiently, and has advanced the recovery of subsalt reservoirs (those lying beneath a "sheet" of salt, commonly offshore). Multiple zone completions, where oil flows into the wellbore at points along the pipe, instead of just at the bottom, helps drain reservoirs more economically. Horizontal drilling both enhances the accessibility and allows more efficient extraction from some reservoirs. New drillbits can penetrate harder rock. In the offshore, as discussed more fully below, subsea platforms allow safer and more economic development of remote fields.

Technology has also contributed in making oil exploration and production safer for the industry and for the environment. Offshore production can be operated from onshore, with automatic shutoff systems to minimize the pollution risk. Infrared photography can pinpoint a trajectory of spilled oil, allowing equipment and personnel to be deployed effectively to minimize damage.

Technology has also been responsible for the rejuvenation of offshore exploration that has taken place beyond the Outer Continental Shelf.

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World Oil Reserves by Region, December 31, 1999

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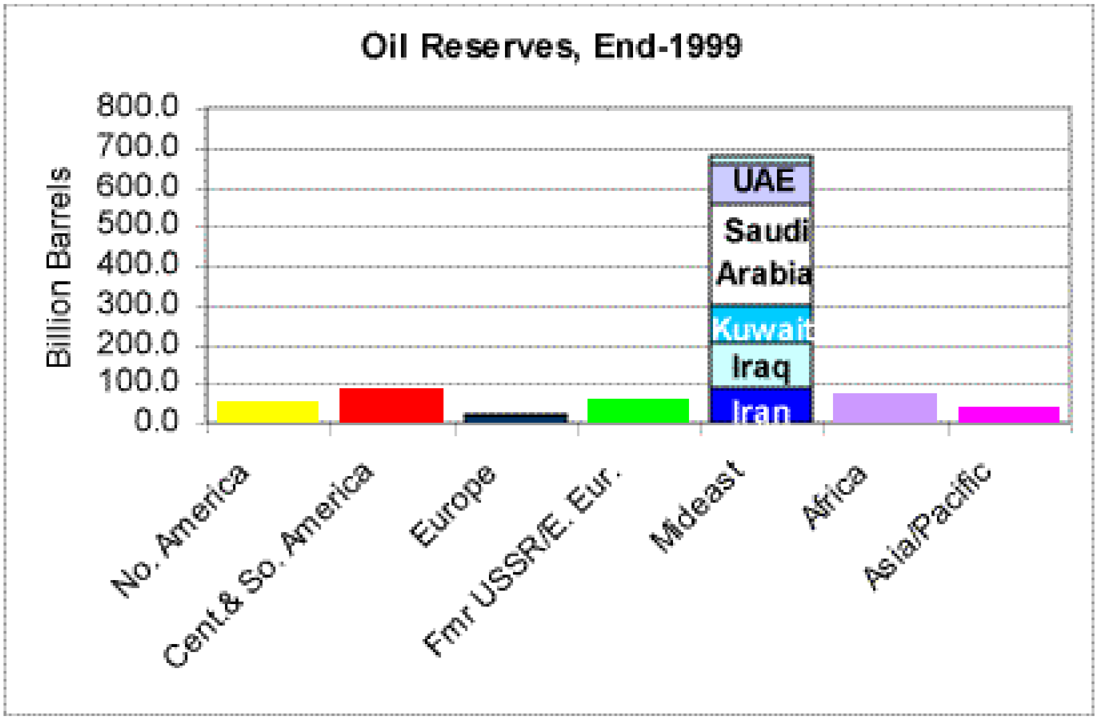

Source: *Oil & Gas Journal,* 12/27/99.

Reserves and Resources

"Proved reserves" are estimates of the amount of oil recoverable from known reservoirs under current economic and operating conditions. Total global proved reserves have been estimated at approximately 1 trillion barrels since the late 1980's, because additions to reserves from new discoveries and from revisions to previous estimates have approximately matched the annual volume of oil produced (or withdrawn).

Proved oil reserves reflect only a fraction of the oil that a reservoir may hold, and say nothing of reservoirs that have not yet been evaluated. Historically, only some 30 percent of the total oil in a reservoir -- the "original oil-in-place" -- was recoverable. As pressure declines in the reservoir, the oil becomes costlier and costlier to produce until further production becomes uneconomic, as discussed in the section on oil production. However, as discussed in Upstream Technology, recent advances now allow greater recovery from old reservoirs.

"Recoverable resources" is a broader category, encompassing estimates of both proved and undiscovered volumes that would be economically extractable under specified price-cost relationships and technological conditions. By definition, there is a lower level of certainty attached to resource estimates than to proved reserve estimates.

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Federal Offshore

Production from the Federal offshore, now about equal to output from the Alaskan North Slope, is limited by policy to California and the western and central Gulf of Mexico. New production plays in the Gulf of Mexico, the only area with active new leasing, led to a resurgence in activity there. Leasing, drilling, production and numbers of fields under development all set records in 1997, as the deepwater Gulf of Mexico became the place to be for almost any larger oil companies, domestic or foreign.

The important characteristic of these new plays is their water depth. When production in the Gulf of Mexico peaked in the mid-1980's, it came almost exclusively from the waters over the Continental Shelf. The new plays are further offshore, in the much more challenging deepwater. Production is already occurring in water depths of one mile. Recent discoveries suggest that this water depth record could be extended to a mile and a half in the next couple of years, by which time drilling could have moved out to waters two miles deep.

As noted throughout the Supply chapter, technology has been the key to opening up these new production plays. New deepwater production options such as tension leg platforms (TLP), spars, compliant towers, and subsea completions have allowed companies to do what was deemed impossible until quite recently -- operate in deep water, while three technological advances have been particularly important in making new discoveries economically viable: 3-D seismic, horizontal and directional drilling, and multi-lateral completions.

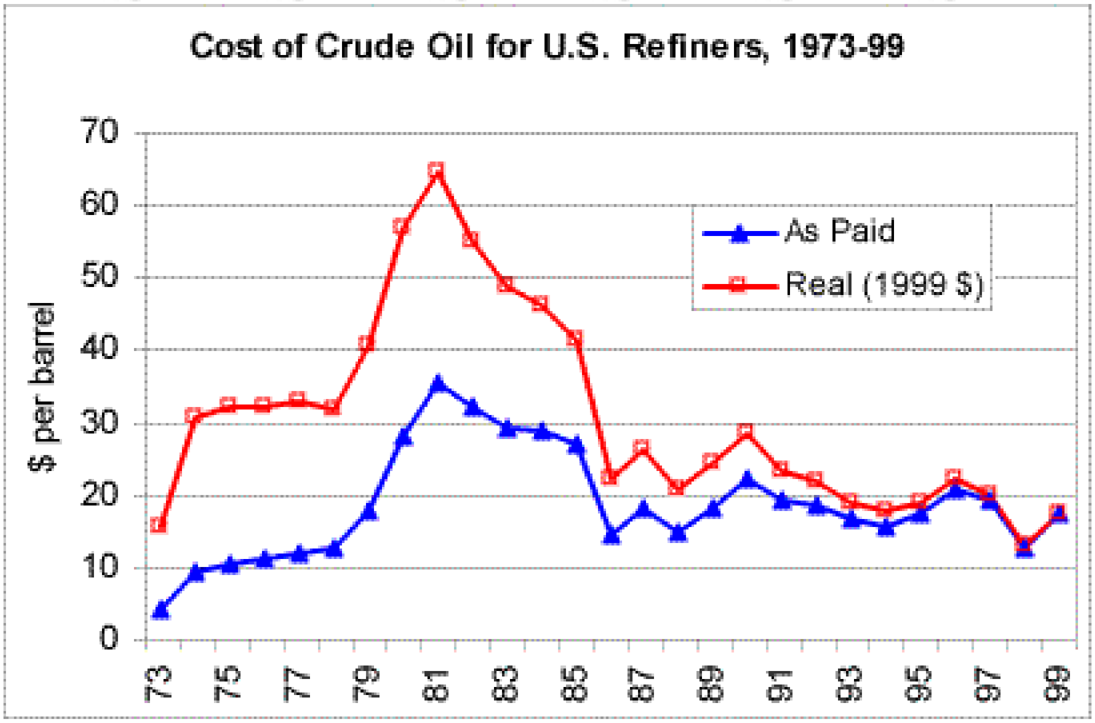
The number of discoveries that it makes sense to develop in the deepwater Gulf of Mexico has been further increased by royalty relief that is worth at least $2.00-$3.00 a barrel on initial production and by an unexpected bonus: an unusually high level of production per well for the United States. Instead of a stripper well's 10 barrels, or even a Gulf of Mexico shallow water well's 1,000 barrels, daily production rates of 10,000 barrels have been common and as high as 30,000 barrels have been achieved. As a result, the number of new fields coming onstream annually in the deepwater jumped to 15-20 from a lifetime average of 2.

This surge was widely expected to double deepwater Gulf of Mexico production to 2 million barrels per day by the year 2000 or shortly thereafter, turning the Gulf in total into the preeminent oil producing region of the United States. Such growth would slow or even temporarily halt the long term decline in United States production, curb the rate of growth of United States crude oil imports, and have a significant impact on crude markets throughout the Gulf Coast and the Midwest. The pace and timing of these deepwater plays, like all other upstream exploration, was impacted by 1998's low prices.

- Back to Supply Chapter
- To Reservoirs and Traps
- To Schematic of a Petroleum Trap
- To Reserves and Resources
- To Upstream Technology
- To additional details and graphics on offshore activity

Cost of Crude Oil to U.S. Refiners, 1973-1999

To Supply Chapter   To Supply Graphs



Source: *Monthly Energy Review* Database

Supply Links

Publication and Table Guide to (Production) Data from EIA's Petroleum Division
Also see EIA's U.S. Crude Oil and Natural Gas Resources and Reserves, U.S. Crude Oil Exploration and Production and the sources listed below

Data Frequency/ Geographic Coverage		Petroleum Supply Monthly		Petroleum Supply Annual		Weekly Petroleum Status Report
		Current	History	Current	History	Current
Weekly		NA	NA	NA	NA	S1, 10
Monthly	U.S.	2	S2	S2	S2	
	PAD Districts	6, et al.		6, et al.		
	States	26		26		
Year-to-Date	U.S.	S2, 3	S2			
	PAD Districts	7, et al.				
	States	26				
Annual	U.S.	S2	S2	S2	S2	
	PAD Districts			6, et al.		
	State			26		

Other Supply Data

Most sources listed below link to non-EIA sites and data. These links are provided solely as a service to our customers, and therefore should not be construed as advocating or reflecting any position of the Energy Information Administration. In addition, EIA does not guarantee the content or accuracy of any information presented in linked sites.

Drilling Data and Statistics **To Supply Chapter**

Drilling Rigs in Use (World data from International Association of Drilling Contractors)
Rig counts, geophysical activity and other industry data (World data from *World Oil*)
Rig counts (from Baker Hughes)

Reserves Data and Information **To Supply Chapter**

Proved Oil Reserves (World data from British Petroleum)
Petroleum Reserves Definitions (Society of Petroleum Engineers)

World Production Data and Information **To Supply Chapter**

Annual World Production (from British Petroleum)
Country Analysis Briefs from EIA (for example, see Saudi Arabia, Iraq, Kuwait, Mexico, and Canada as well as reports on producing regions such as the Persian Gulf, North Sea, and the Caspian Sea)

Exploration and Production Economics **To Supply Chapter**

"Comparative Cost of Drilling and Equipping Wells" (Louisiana Mid-Continent Oil & Gas Assoc.)

Deepwater Development **To Supply Chapter**

Ram-Powell Tension Leg Platform (from Shell Oil Company)
Mensa Subsea Development (from Shell Oil Company)
The Gulf of Mexico's Deepwaters .. America's New Frontier (from the Minerals Management Service)
Deepwater Development Systems in the Gulf of Mexico (from the Minerals Management Service)

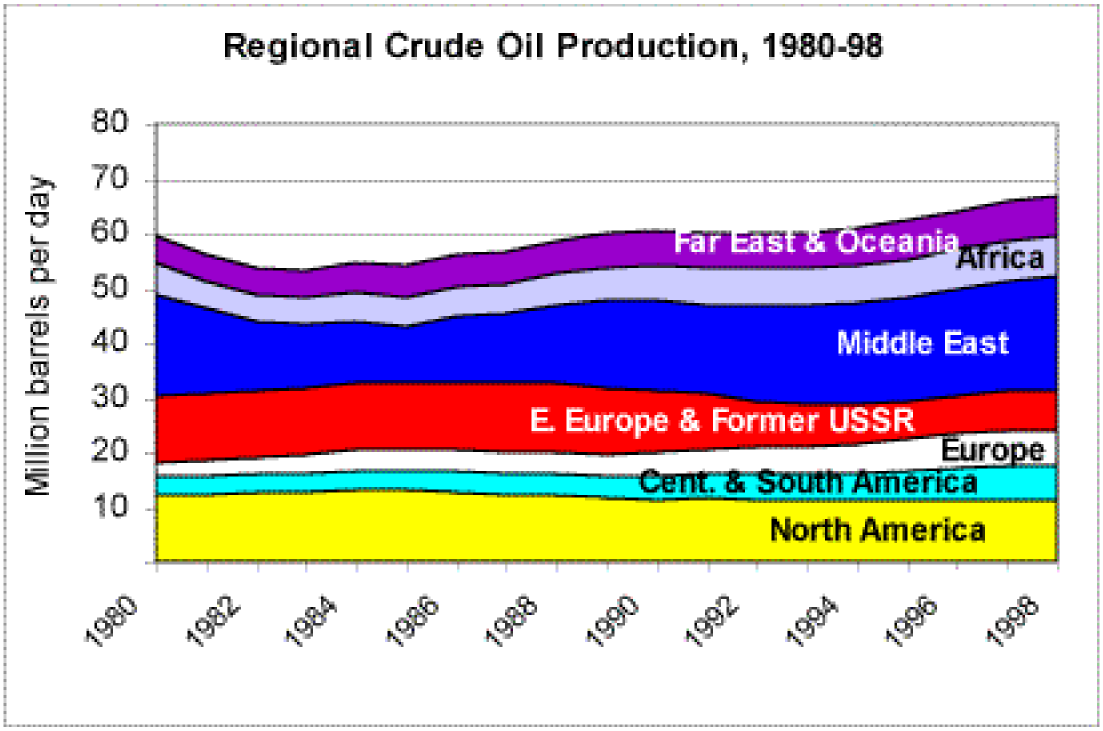
Other Articles and Analyses **To Supply Chapter**

- Back to Supply Chapter
- To Schematic of a Petroleum Trap
- To Upstream Technology
- To Federal Offshore
- To Reserves and Resources
- To Supply Graphs and Charts
- **To Appendices:**
  - A - Map of Petroleum Administration for Defense Districts
  - B - Links to Environmental Sources
- Return to Table of Contents

World Oil Production by Region, 1980-1998

Click on regional area to see detail

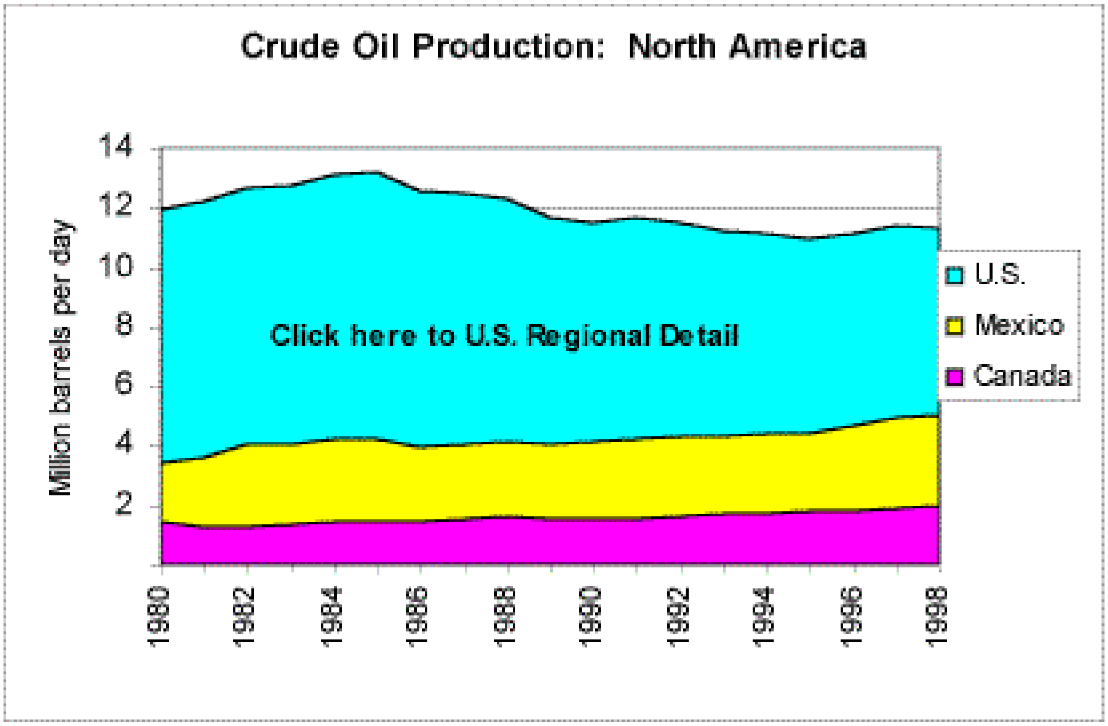
To Supply Chapter   To Supply Graphs



Source: *International Energy Annual,* Table 2.2

North America

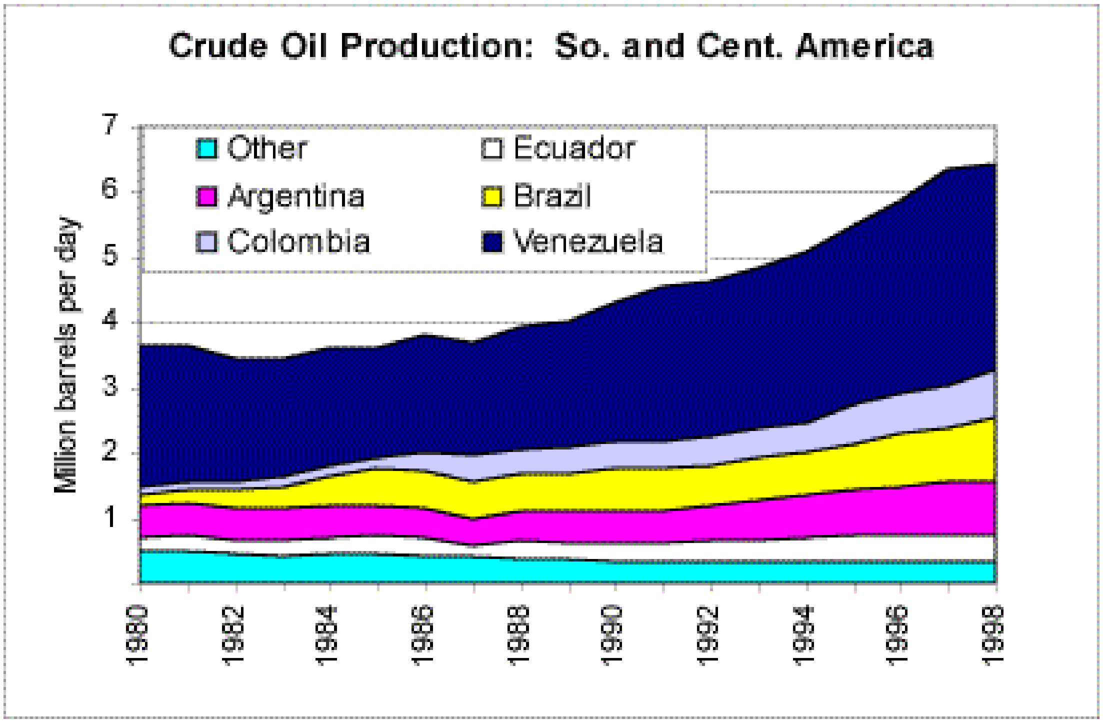
Back to World Graph   To Next Graph (Cent. & So. America)   Back to Supply chapter



Source: *International Energy Annual,* Table 2.2

Central and South America

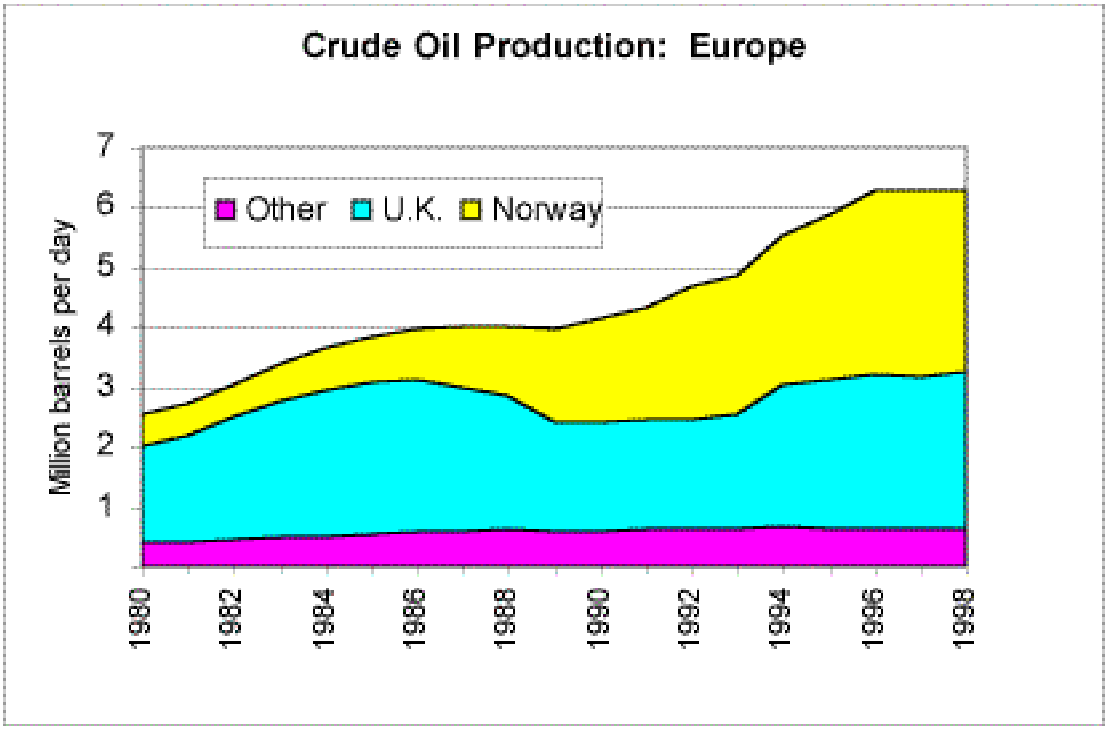
Back to World Graph   To Next Graph (Europe)   Back to Supply chapter



Source: *International Energy Annual,* Table 2.2

Europe

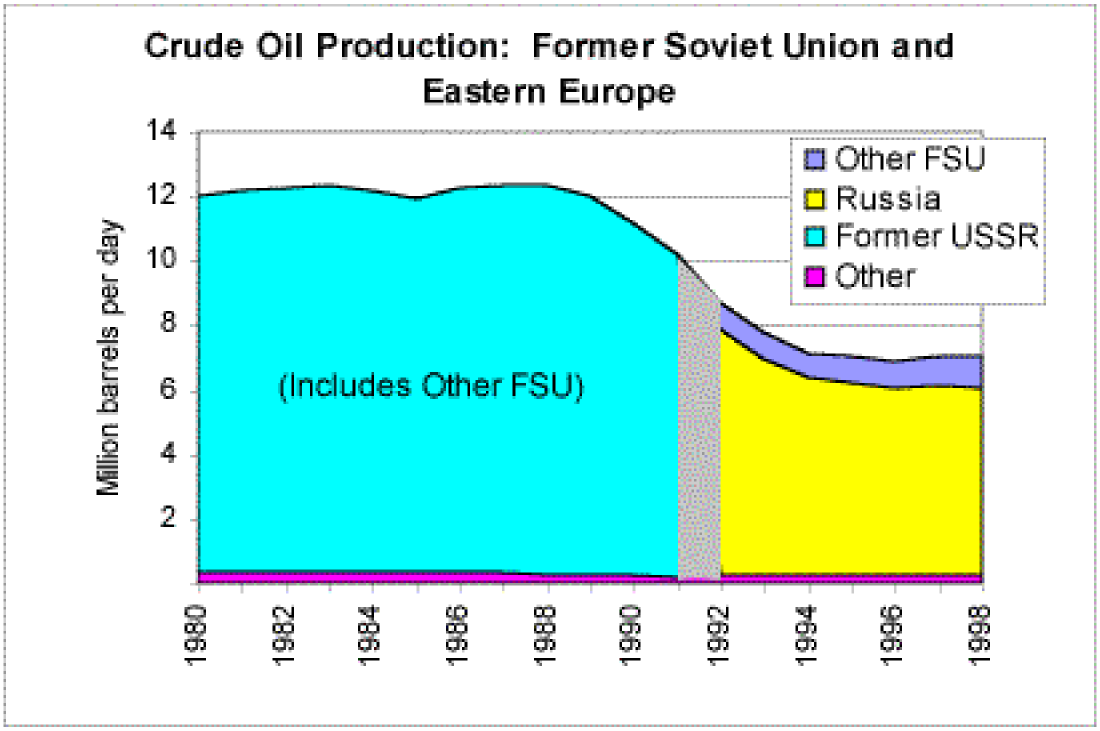
Back to World Graph   To Next Graph (Fmr. Soviet Union)   Back to Supply chapter



Source: *International Energy Annual,* Table 2.2

Former Soviet Union

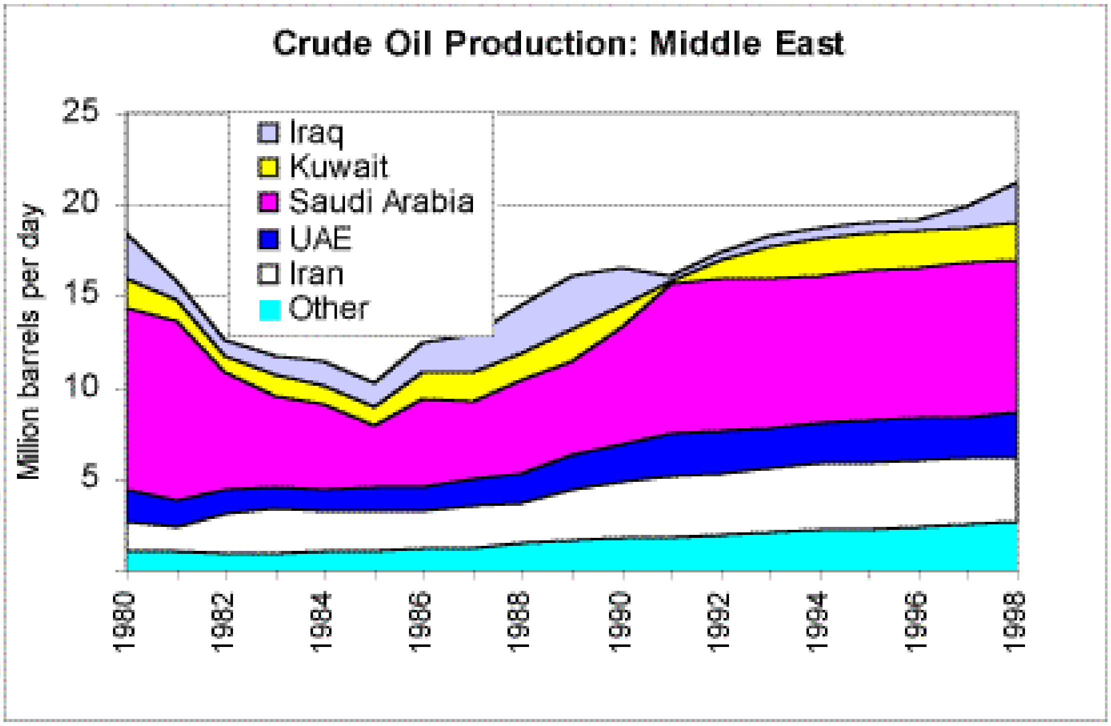
Back to World Graph   To Next Graph (Mideast)   Back to Supply chapter



Source: *International Energy Annual,* Table 2.2

Mideast

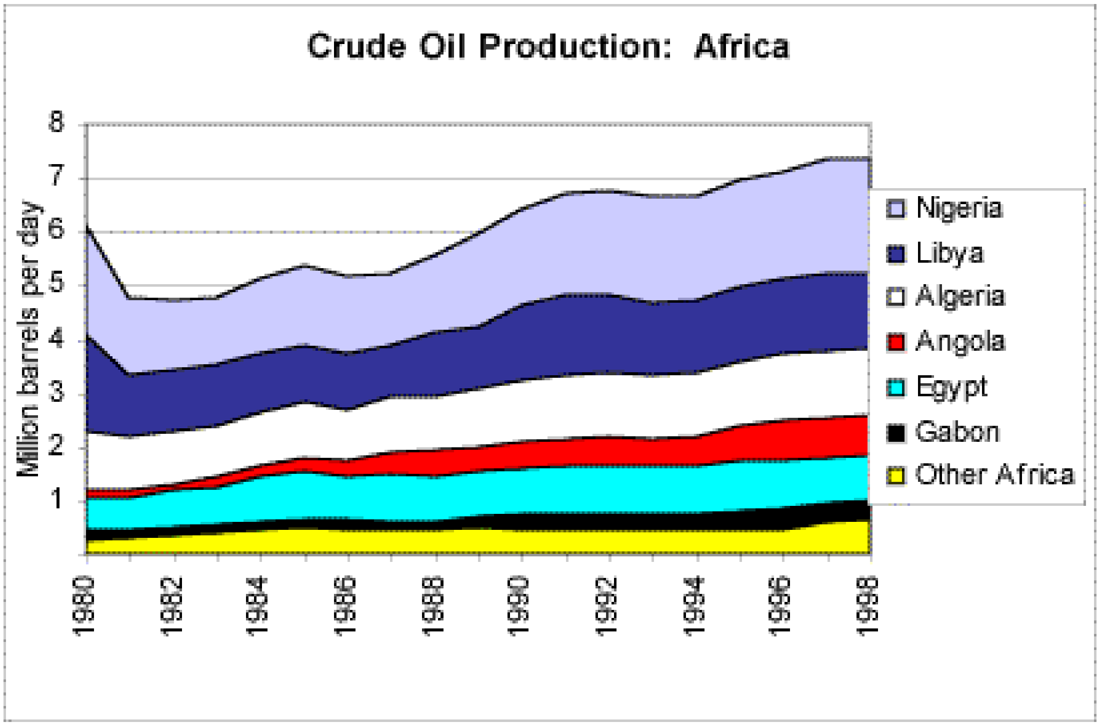
Back to World Graph   To Next Graph (Africa)   Back to Supply chapter



Source: *International Energy Annual,* Table 2.2

Africa

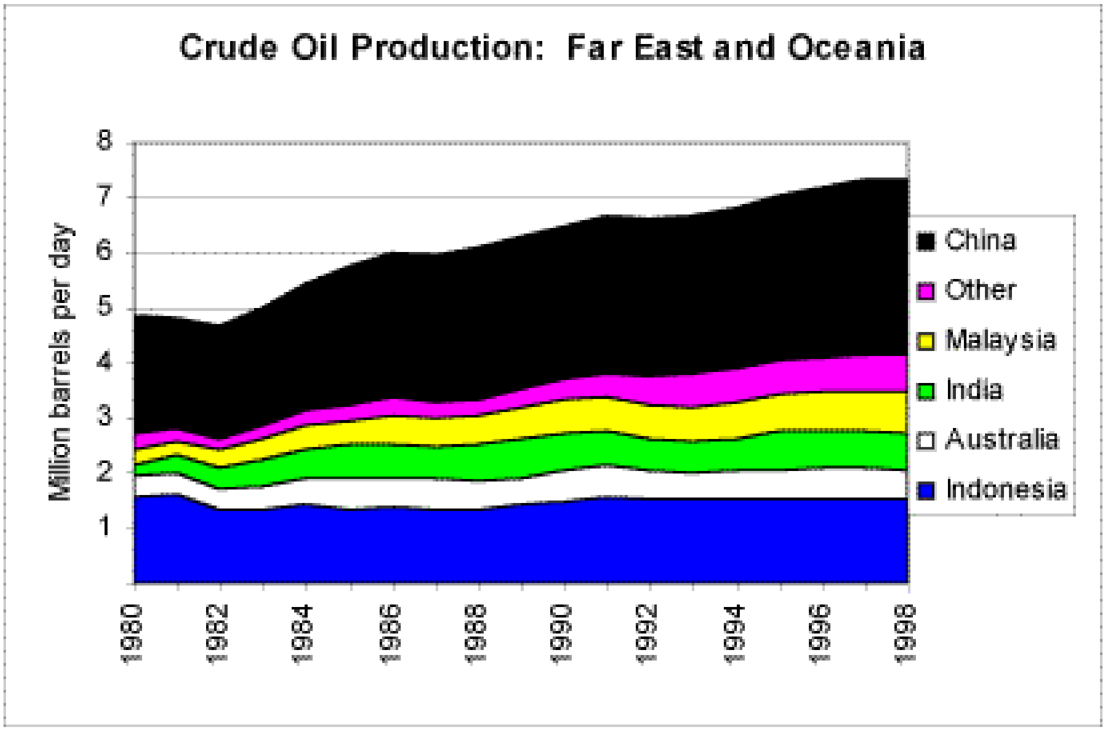
Back to World Graph To Next Graph (Far East) Back to Supply chapter



Source: *International Energy Annual,* Table 2.2

Far East

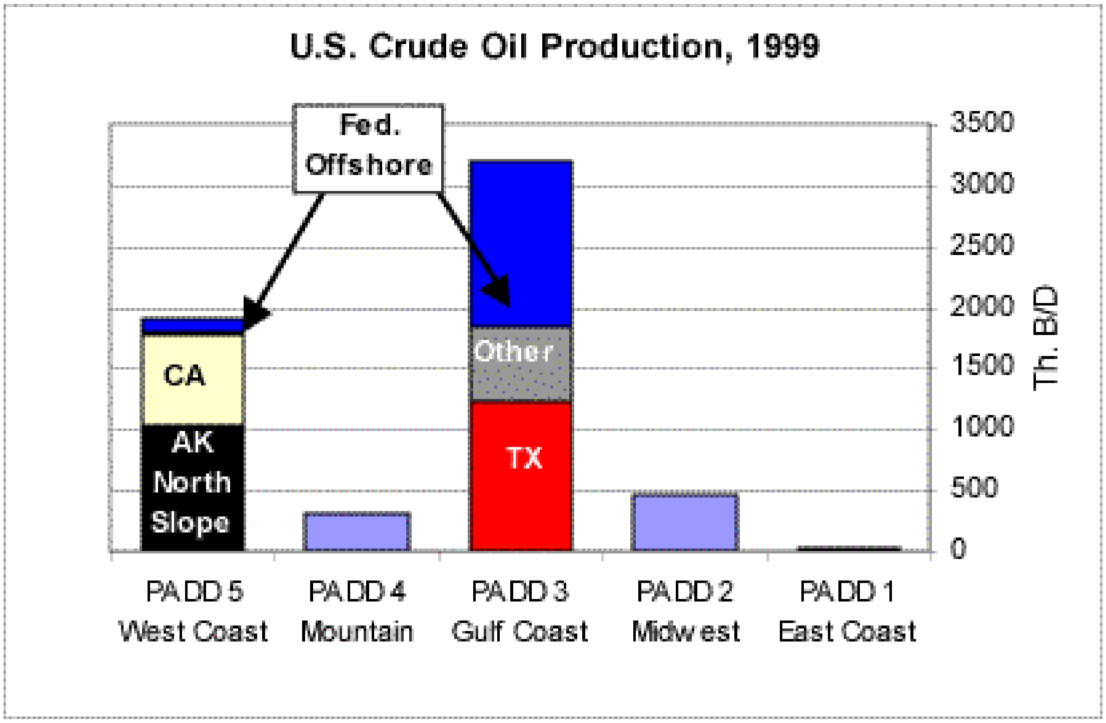
Back to World Graph   Back to Supply chapter



Source: *International Energy Annual,* Table 2.2

U.S. Oil Production by Region, 1999

To Supply Chapter To World Production Graph To Supply Charts
To Map of PAD Districts

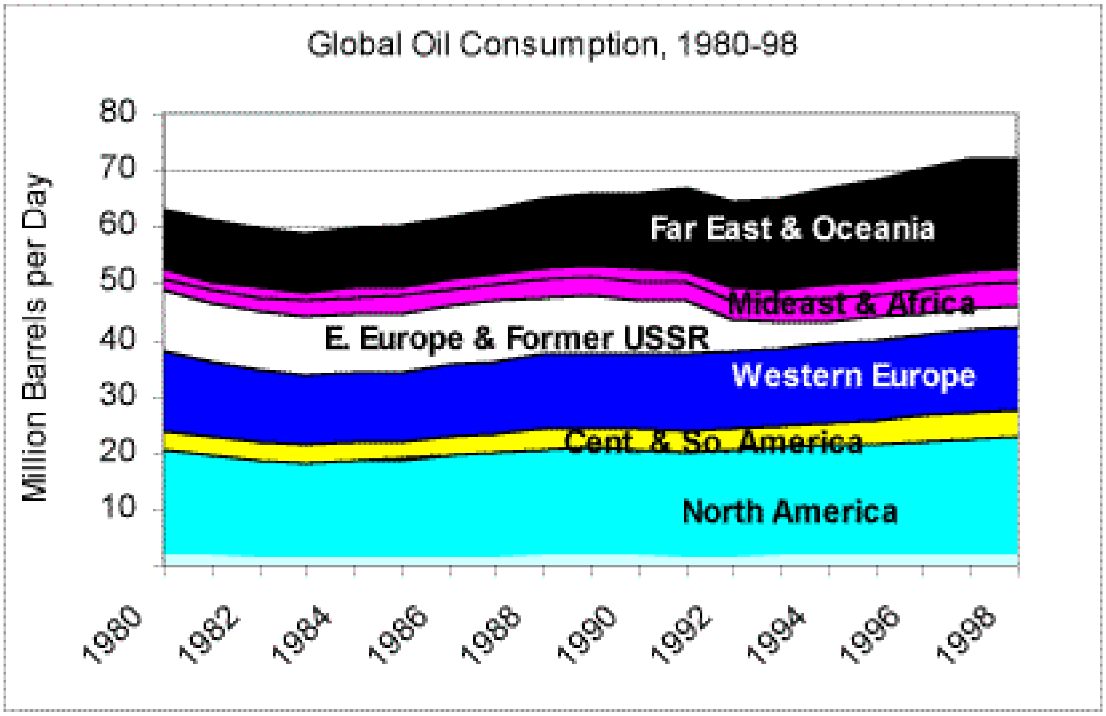


Source: *Petroleum Supply Annual,* Table 14

World Oil Demand by Region, 1980-1998

Click on Regional Area to See Detail, or

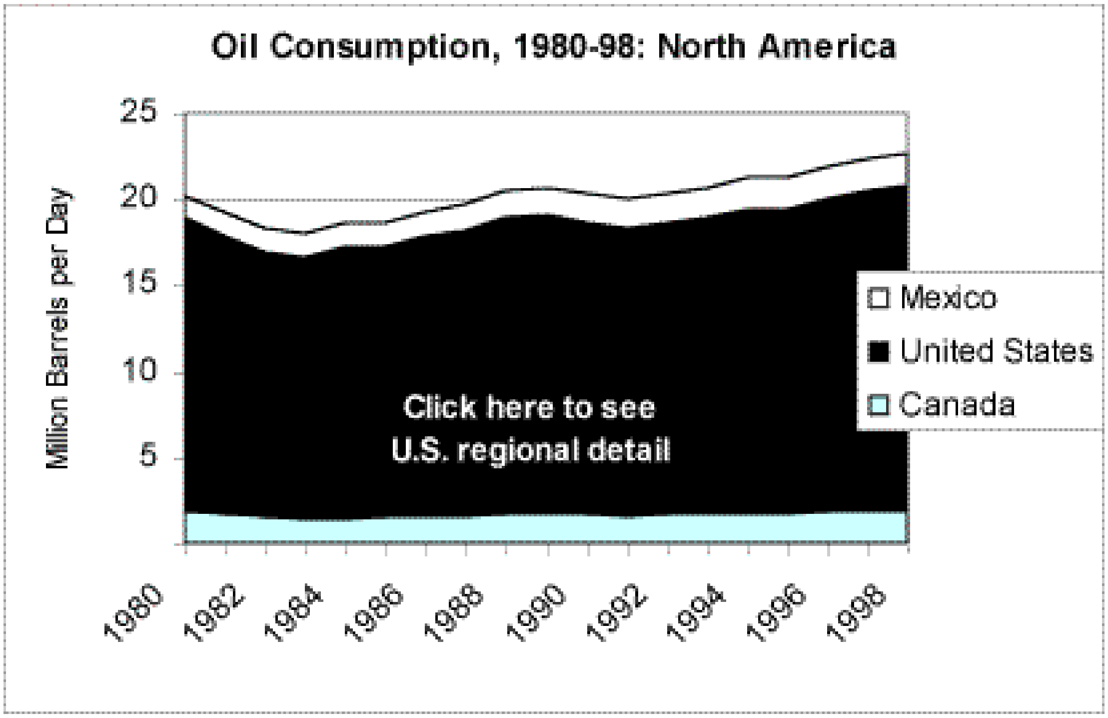
Click here to return to Demand chapter



Source: *International Energy Annual,* Table 1.2

North America

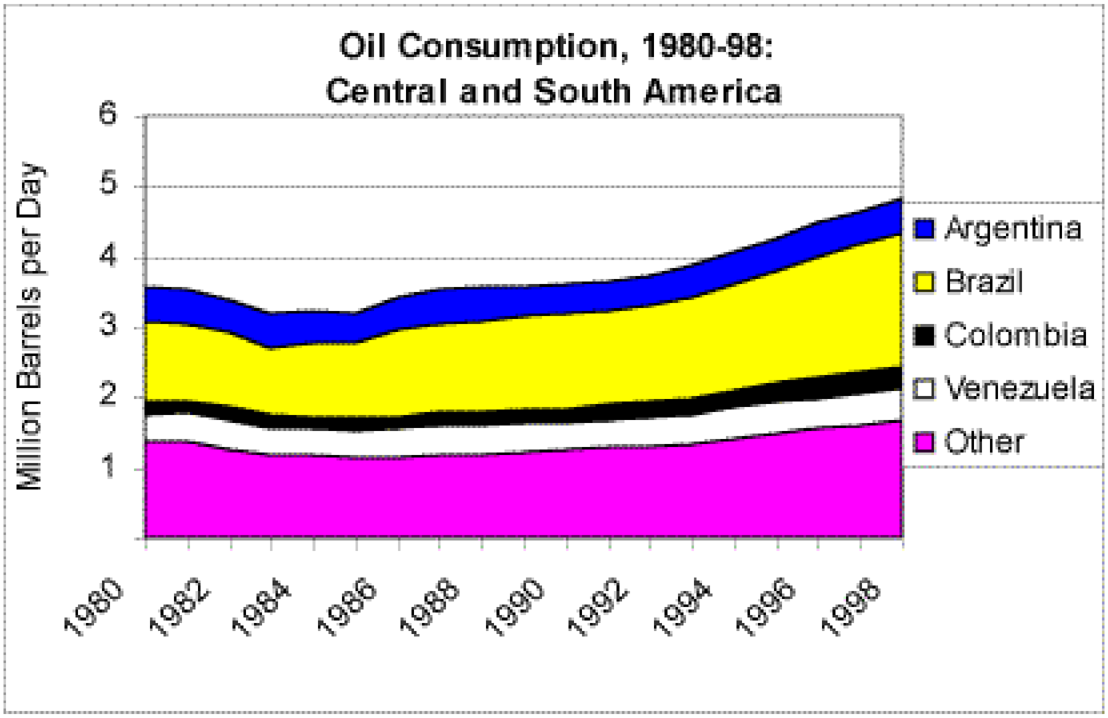
Back to World Graph To Next Graph Back to Demand chapter



Source: *International Energy Annual,* Table 1.2

Central and South America

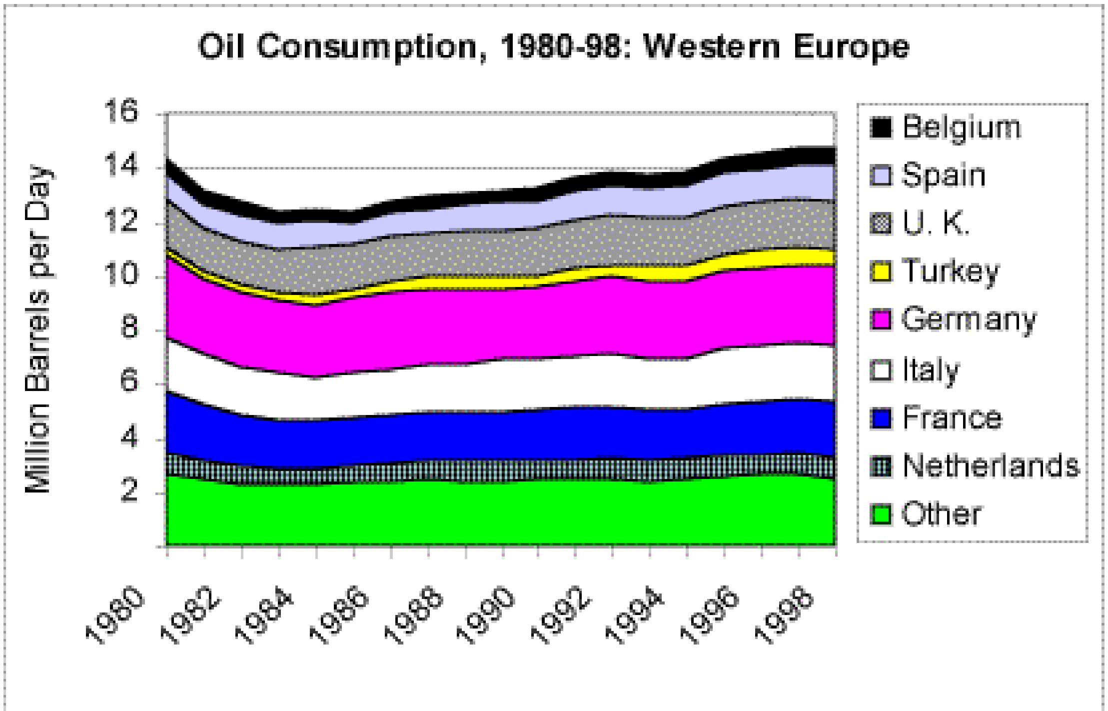
Back to World Graph   To Next Graph   Back to Demand chapter



Source: *International Energy Annual,* Table 1.2

Europe

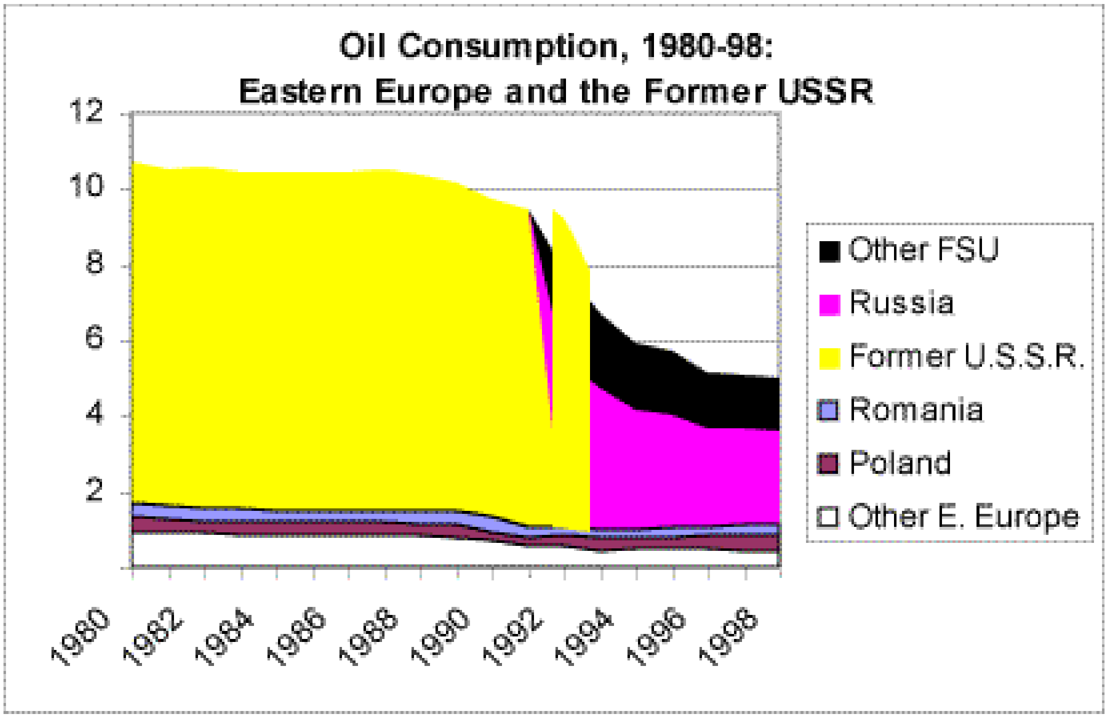
Back to World Graph   To Next Graph   Back to Demand chapter



Source: *International Energy Annual,* Table 1.2

Former Soviet Union

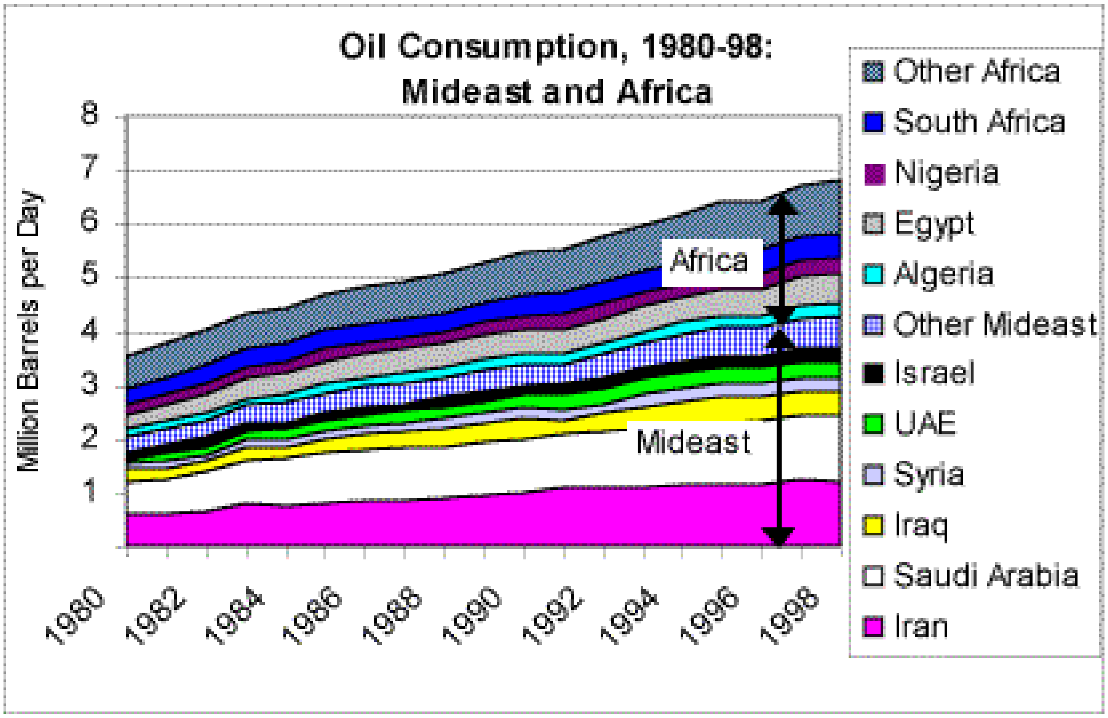
Back to World Graph   To Next Graph   Back to Demand chapter



Source: *International Energy Annual,* Table 1.2

Mideast and Africa

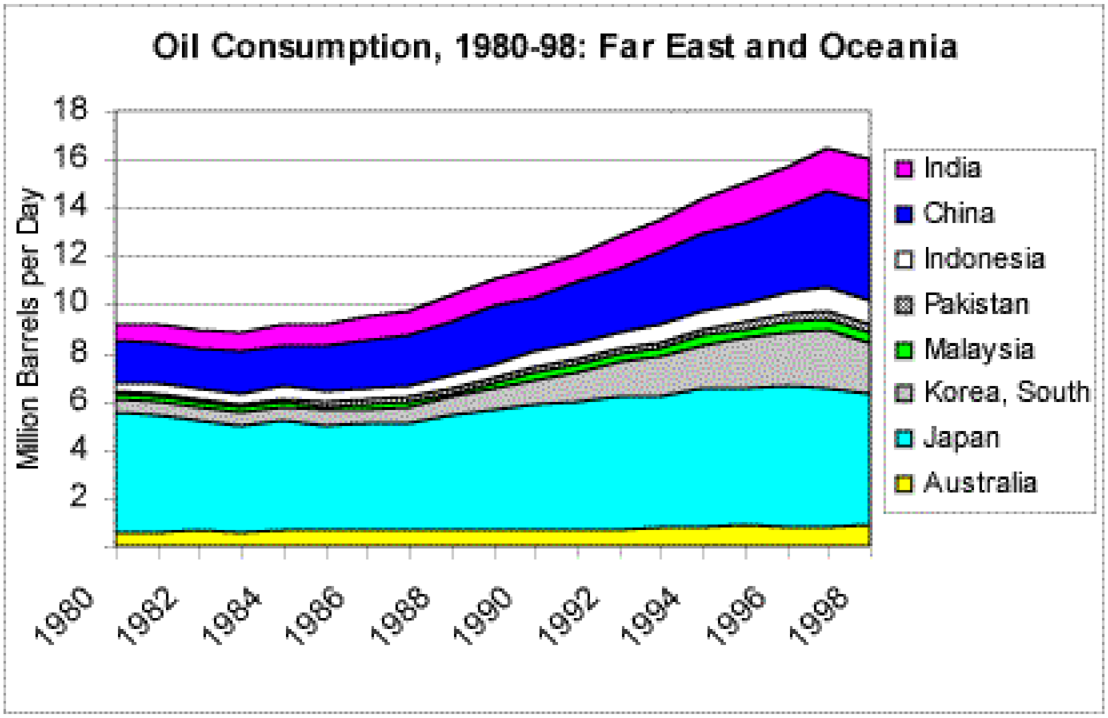
Back to World Graph   To Next Graph   Back to Demand chapter



Source: *International Energy Annual,* Table 1.2

Far East

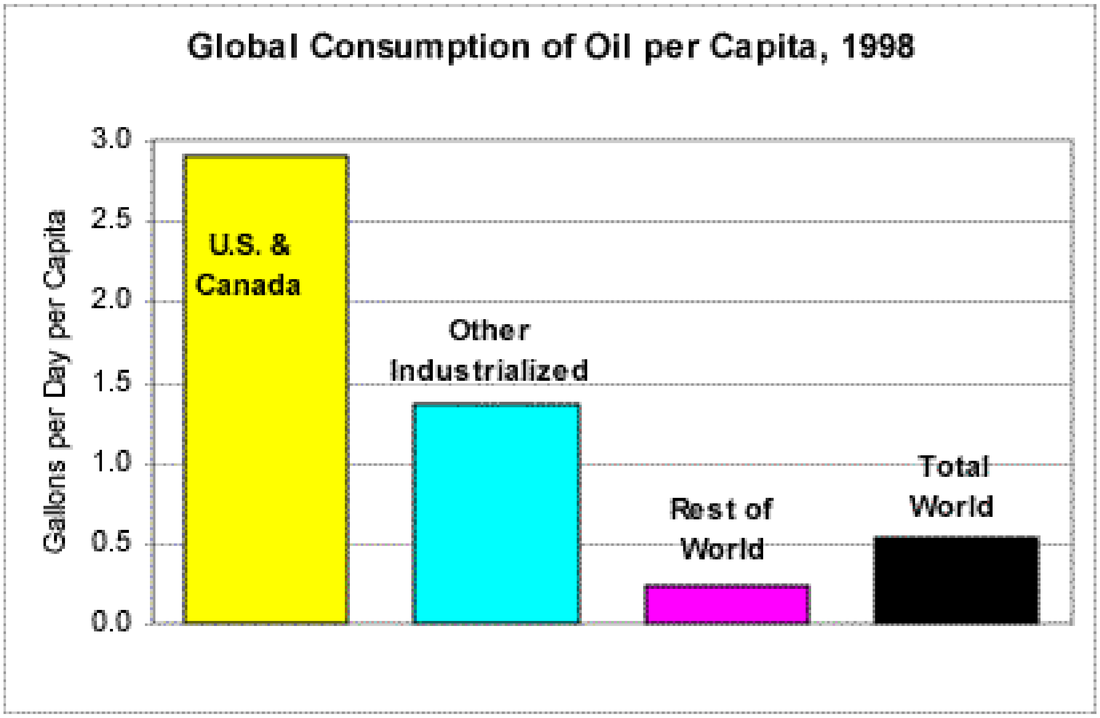
[Back to World Graph](#) [Back to Demand chapter](#)



Source: *International Energy Annual,* Table 1.2

World Oil Demand per Capita by Region, 1998

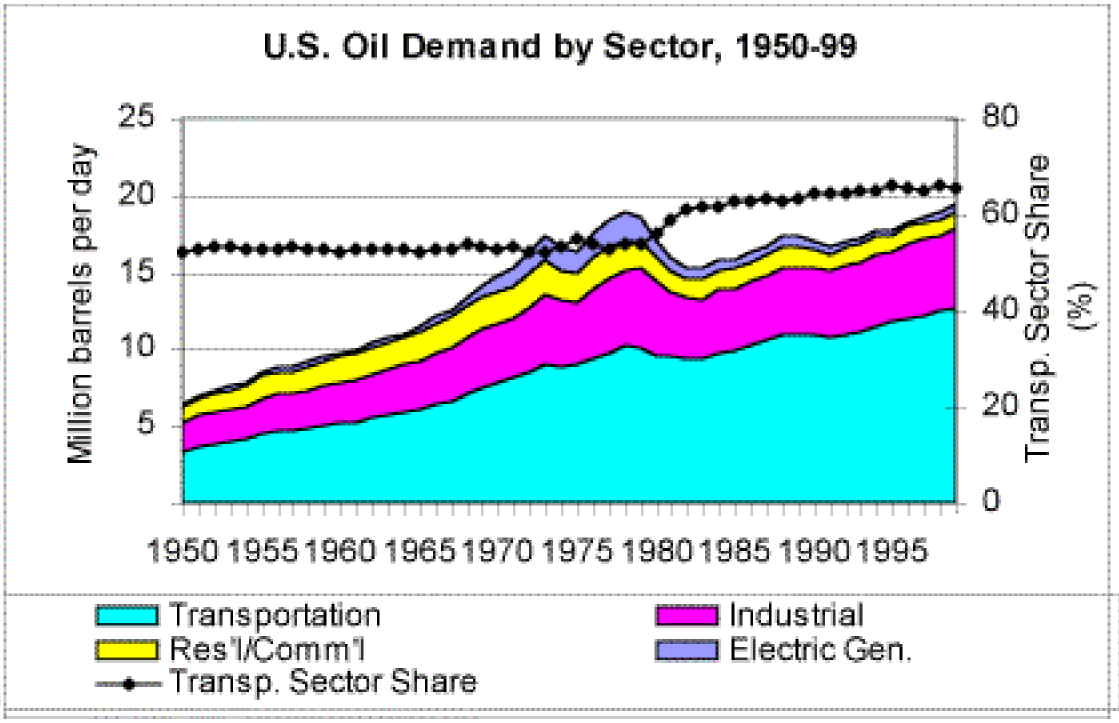
To Demand Chapter   To Demand Charts



Source: Tables 1.2 and B1, International Energy Annual

U.S. Oil Demand by End-Use Sector, 1950-1999

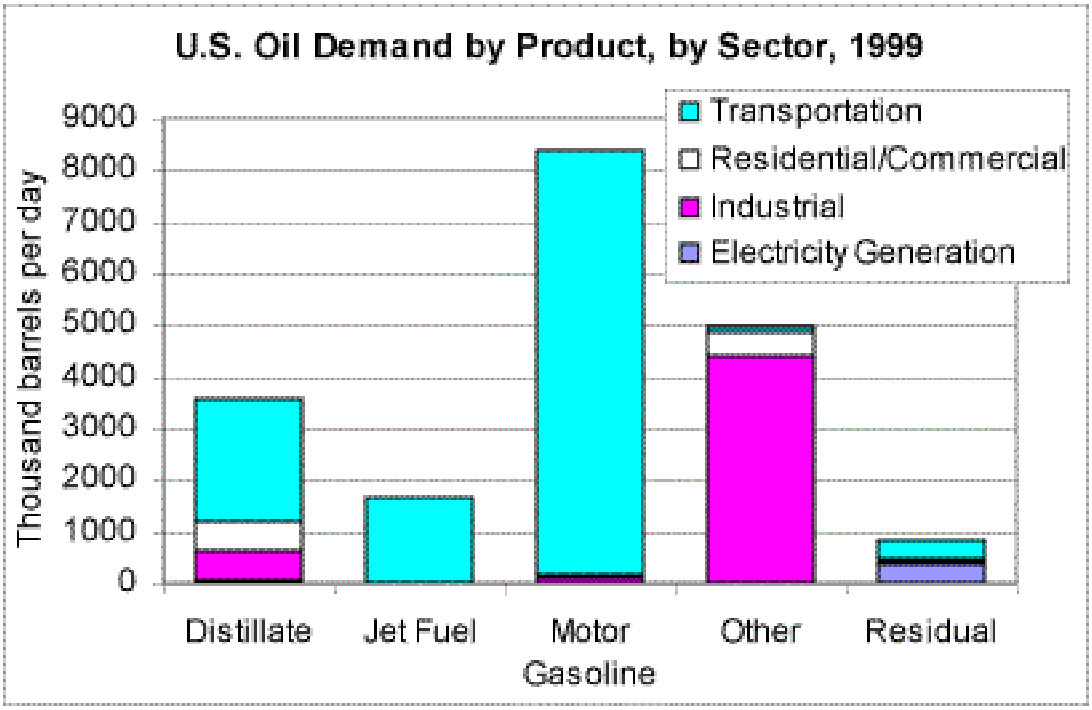
To Demand Chapter   To Demand Charts



Source: *Annual Energy Review*, Tables 512a and 512b

U.S. Oil Demand by Product, 1999

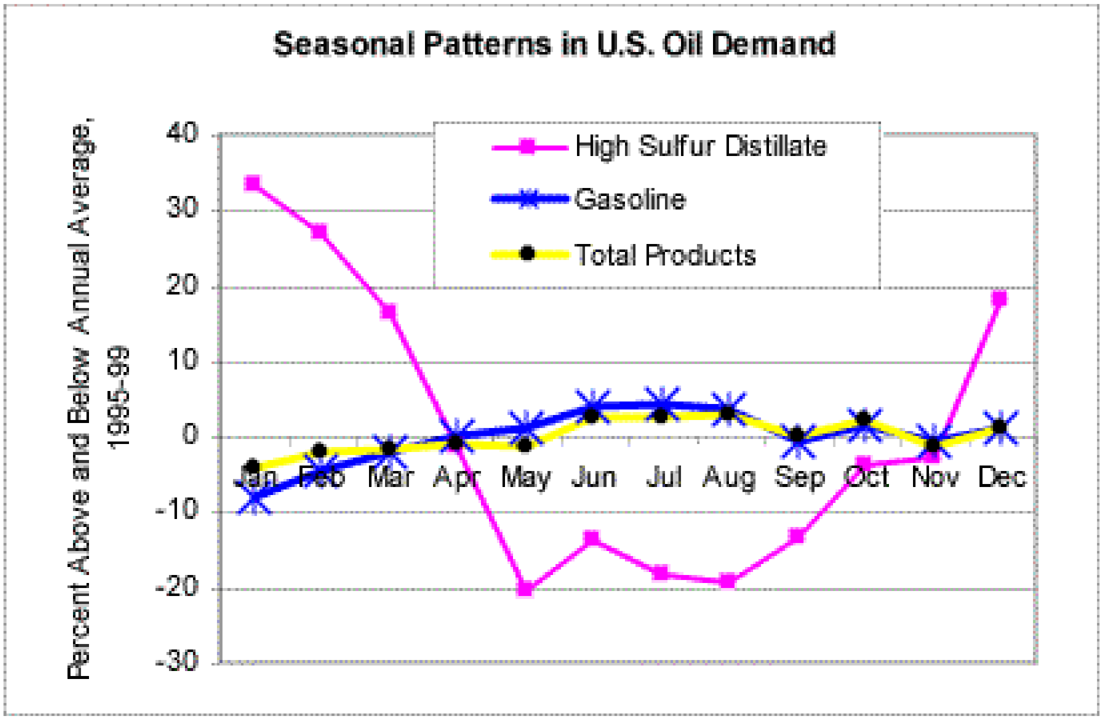
To Demand Chapter   To Demand Charts



Source: *Annual Energy Review*, Tables 5.12a and 5.12b

U.S. Petroleum Product Demand by Month, 1995-1999

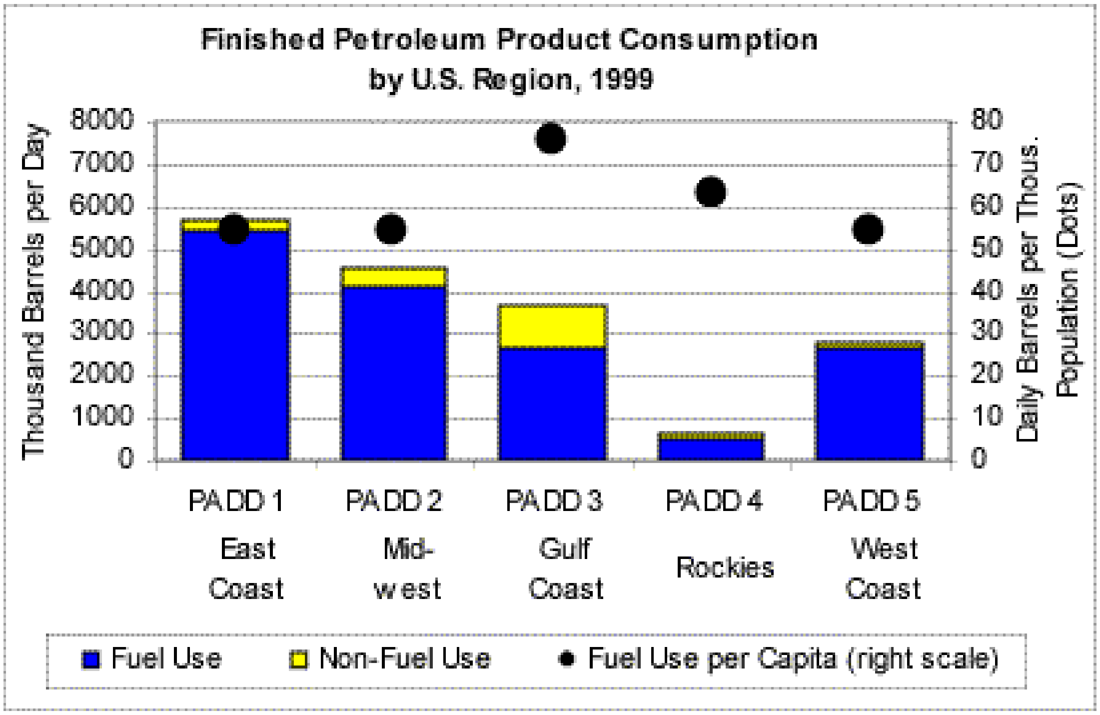
To Demand Chapter   To Demand Charts



Source: *Petroleum Supply Monthly*

U.S. Oil Demand by Region, 1999

To Demand Chapter   To World Consumption Graph   To Demand Charts
To Map of PAD Districts



Source: *Petroleum Supply Annual,* "Non-Fuel" use: products not burned for energy, such as asphalt, lubricants, petrochemical feedstocks

Demand Links

Some sources listed below link to non-EIA sites and data. These links are provided solely as a service to our customers, and therefore should not be construed as advocating or reflecting any position of the Energy Information Administration. In addition, EIA does not guarantee the content or accuracy of any information presented in linked sites.

U.S. Demand Data (current) **To Demand Chapter**

Weekly U.S. Product Supplied estimates from EIA's *Weekly Petroleum Status Report*
Includes 5-week and year-to-date estimates (Tables S1 (*.pdf) and Table 10)
Monthly U.S. Product Supplied data from EIA's *Petroleum Supply Monthly*
Includes Annual (1973-current) and Monthly (last two years): Table S2
Current Month (U.S.): Table 2; Year-to-Date (U.S.): Table 3
Current Month (for each PAD District): Table 6 [see also Tables 8, 10, 12, 14, 16, 18, 20, 22, and 24]
Year-to-Date (for each PAD District): Table 7 [see also Tables 9, 11, 13, 15, 17, 19, 21, 23, and 25]
Monthly U.S. Product Supplied estimates from EIA's Monthly Energy Review
Annual (final) U.S. Product Supplied data from EIA's *Petroleum Supply Annual* (annual summary) (monthly detail)
Monthly "*Prime Supplier Report*"

U.S. Demand Data (historical) **To Demand Chapter**

Annual estimates of Product Supplied, 1949-on from EIA's *Annual Energy Review*
Includes estimates by product (Table 5.11) and estimates by end-use sector (Tables 5.12A and 5.12B)
Annual estimates of Sales of Fuel Oil and Kerosene (by end-use sector, by state, by region) from EIA
Annual estimates of consumption by state, by end-use sector, by product from EIA's State Energy Data System (*.pdf)

International Demand Data **To Demand Chapter**

Monthly OECD Consumption from EIA's *Monthly Energy Review*
Estimates from EIA's *Annual Energy Review*
Includes Quarterly and Monthly Consumption and Annual Consumption
Annual World Consumption from British Petroleum
Country Analysis Briefs from EIA(for example see Japan)

Demand Forecasts **To Demand Chapter**

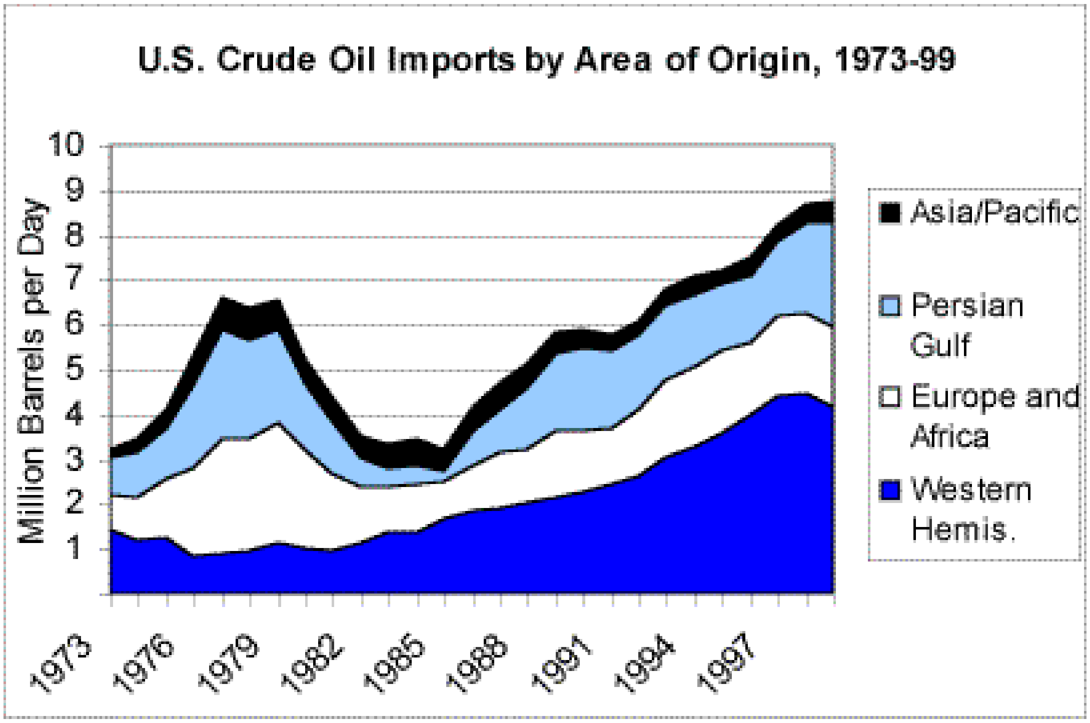
U.S. Supply and Demand by quarter for eight quarters from EIA's *Short-Term Energy Outlook*
U.S. Supply and Demand by Year to 2020 from EIA's *Annual Energy Outlook*
International Supply and Demand to 2020 from EIA's *International Energy Outlook*
Impacts of the Kyoto Protocol on U.S. Energy Markets & Economic Activity
Service Report: The Impacts of Increased Diesel Penetration in the Transportation Sector
Demand and Price Outlook for Phase 2 Reformulated Gasoline, 2000

Back to Demand Chapter

- To Demand Graphs
- To Next Chapter (Trade)
- To Appendices:
  - A - Map of Petroleum Administration for Defense Districts
  - B - Links to Environmental Sources
- Return to Table of Contents

U.S. Oil Imports by Area of Origin, 1973-1999

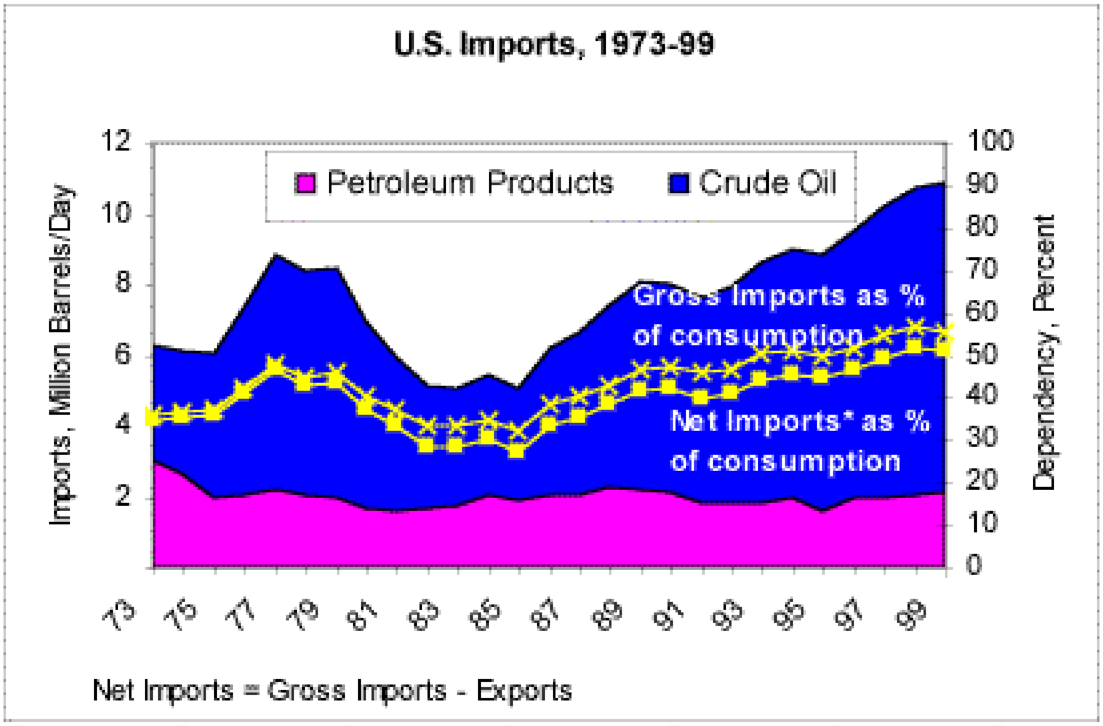
To Trade Chapter   To Trade Graphs



Source: *Monthly Energy Review,* Table 3.3

U.S. Imports of Crude Oil and Petroleum Products, 1973-1999

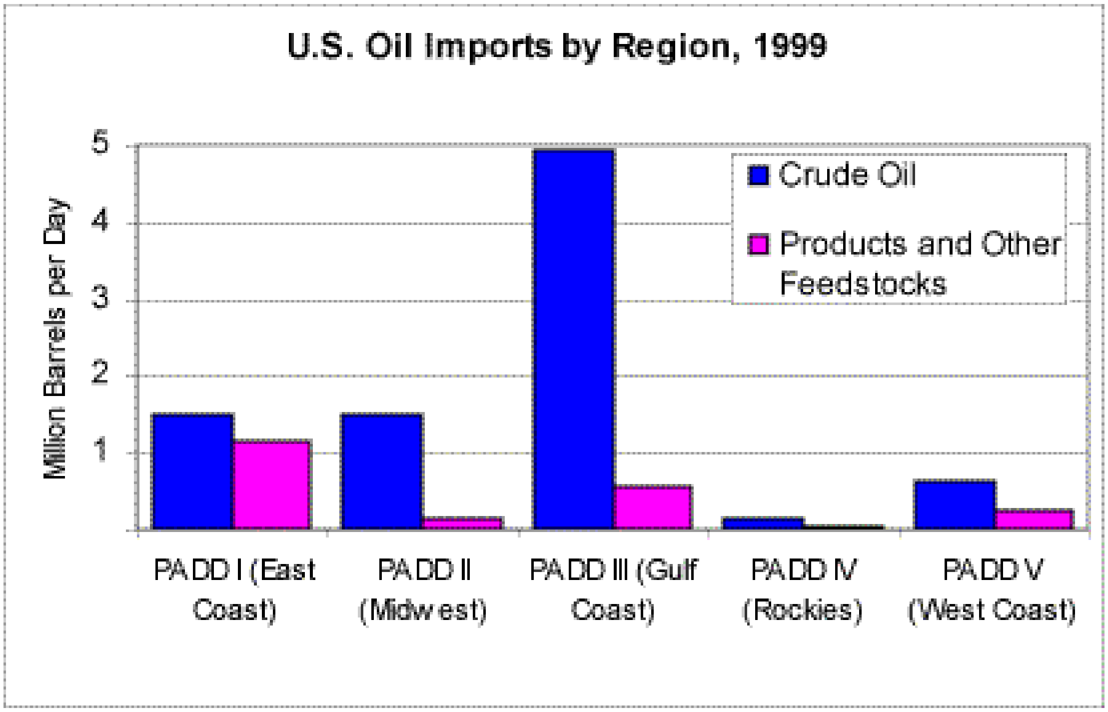
[To Trade Chapter](#)   [To Trade Graphs](#)



Source: *Monthly Energy Review,* Table 3.1

U.S. Oil Imports by Region, 1999

[To Trade Chapter] [To Trade Graphs]
[To Map of PAD Districts]

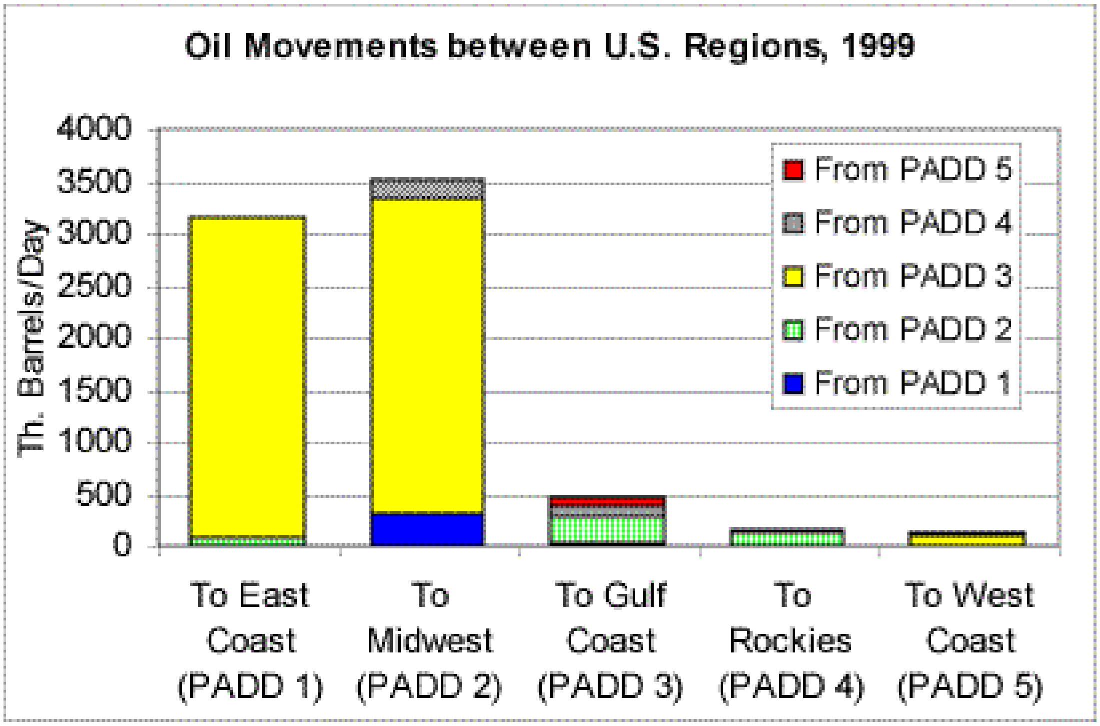


Source: *Petroleum Supply Annual,* Table 20

To Map of PAD Districts

Movements of Petroleum Products between U.S. Regions,1999

To Trade Chapter To List of Graphs
To Map of PAD Districts



Source: *Petroleum Supply Annual,* Table 32

Trade Links

Some sources listed below link to non-EIA sites and data. These links are provided solely as a service to our customers, and therefore should not be construed as advocating or reflecting any position of the Energy Information Administration. In addition, EIA does not guarantee the content or accuracy of any information presented in linked sites.

EIA Info at a Glance: U.S. Petroleum Imports and Exports
EIA Info at a Glance: U.S. Petroleum Movements

U.S. Import and Trade Data **To Trade Chapter**

History of Crude Oil and Petroleum Products Imports and Exports from EIA's *Petroleum Supply Monthly (PSM)*, and *Monthly Energy Review (MER)*, including annual (1973 – present) and monthly (1996 - present):
- Petroleum Trade Overview -- *MER, Table 1.8*
- Crude Oil and Petroleum Products Overview -- *PSM, Table S1*
- Crude Oil Supply and Disposition -- *PSM, Table S2*
- Crude Oil and Petroleum Product Imports by County of Origin -- *PSM, Table S3*

Imports and Exports by Petroleum Product:
- Finished Motor Gasoline -- *PSM, Table S4*,
- Distillate Fuel Oil -- *PSM, Table S5*,
- Residual Fuel Oil -- *PSM, Table S6*,
- Jet Fuel -- *PSM, Table S7*,
- Propane/Propylene -- *PSM, Table S8*,
- Liquefied Petroleum Gases -- *PSM, Table S9*,
- Other Petroleum Products -- *PSM, Table S10*.

Petroleum Balance:
- Current Month and Year-to Date -- *Petroleum Supply Monthly, Table 1*
- Latest Year, Month-by-Month -- *Petroleum Supply Annual, Vol.2, Table 1*
- Latest Year -- *Petroleum Supply Annual, Vol.1, Table 1*

Crude Oil and Petroleum Products Supply and Disposition:
- Current Month -- *Petroleum Supply Monthly, Table 4*
- Year-to-date -- *Petroleum Supply Monthly, Table 5*
- Latest Year, Month-by-Month -- *Petroleum Supply Annual, Vol.2, Table 3*
- Latest Year -- *Petroleum Supply Annual, Vol.1, Table 3*

Imports of Crude Oil and Petroleum Products by County of Origin and by Product:
- Current Month -- *Petroleum Supply Monthly, Table 35*
- Year-to-date -- *Petroleum Supply Monthly, Table 40*
- Latest Year, Month-by-Month -- *Petroleum Supply Annual, Vol.2, Table 21*
- Latest Year -- *Petroleum Supply Annual, Vol.1, Table 21*

Movements of Crude Oil and Petroleum Products between PAD Districts, Current Month:
- by Pipeline, Tanker and Barge -- *Petroleum Supply Monthly, Table 53*
- by Pipeline -- *Petroleum Supply Monthly, Table 54*
- by Tanker and Barge -- *Petroleum Supply Monthly, Table 55*
- Net Movements -- *Petroleum Supply Monthly, Table 56*

Imports of Residual Fuel Oil by Sulfur Content
Current Month -- *Petroleum Supply Monthly, Table 32*
Latest Year, Month-by-Month -- *Petroleum Supply Annual, Vol.2, Table 26*
Latest Year -- *Petroleum Supply Annual, Vol.1, Table 26*

Monthly Import Data at Company Level from *EIA, Company Level Imports, including history and current month*

Exports of Crude Oil and Petroleum Products by Destination and by Product:
Current Month -- *Petroleum Supply Monthly, Table 47*
Year-to-date -- *Petroleum Supply Monthly, Table 48*
Latest Year, Month-by-Month --*Petroleum Supply Annual, Vol.2, Table 28*
Latest Year -- *Petroleum Supply Annual, Vol.1, Table 28*

Net Imports of Crude Oil and Petroleum Products by County and by Product:
Current Month -- *Petroleum Supply Monthly, Table 49*
Year-to-date -- *Petroleum Supply Monthly, Table 50*
Latest Year, Month-by-Month --*Petroleum Supply Annual, Vol.2, Table 29*
Latest Year -- *Petroleum Supply Annual, Vol.1, Table 29*

Petroleum and Other Energy Trade Value: *Monthly Energy Review, Table 1.6*

International Trade Data **To Trade Chapter**

Oil Trade, Imports and Exports from International Petroleum Annual
Oil Trade, Imports and Exports, and Interarea Movements from BP Statistical Review of World Energy

U.S. Import and Trade Feature Articles **To Trade Chapter**

Measures of Oil Import Dependence from EIA, 1998 Forecasting Issues
EIA's Articles on Imports and Exports (Scroll down to "Analysis")
Oil Disruptions and Dependency from EIA
World Oil Transit Chokepoints from EIA, Country Analysis Briefs

- Back to Trade Chapter
- To Trade Graphs and Charts
- To Next Chapter (Refining)
- **To Appendices:**
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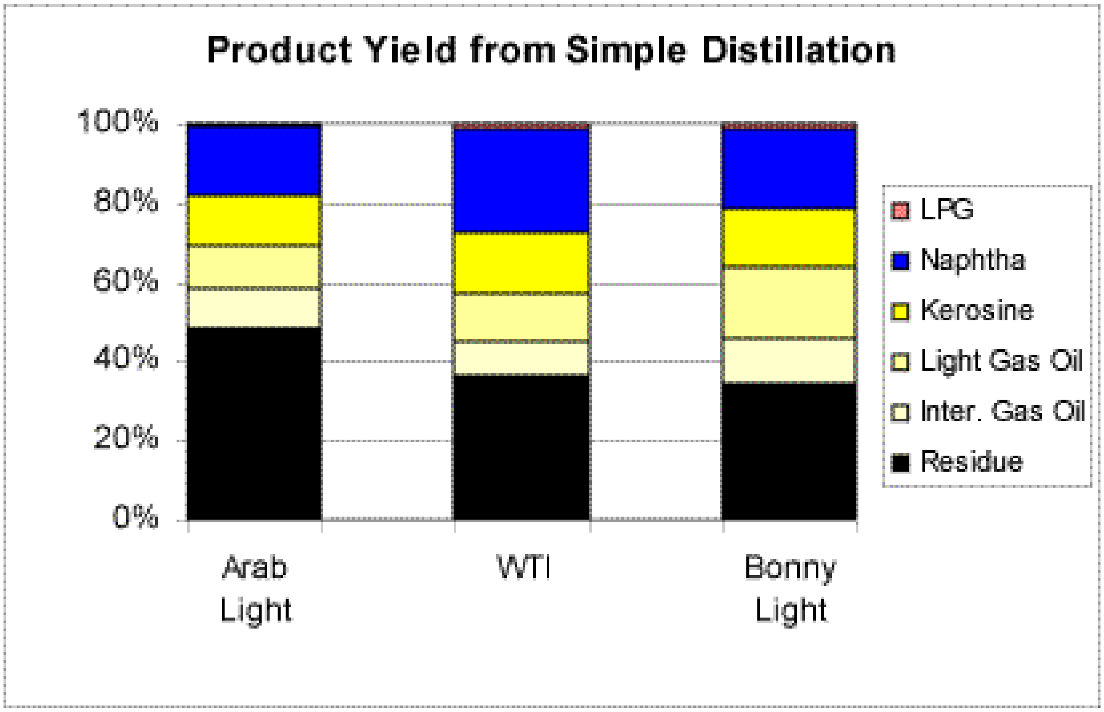
  - B - Links to Environmental Sources
- Return to Table of Contents

Typical Product Yield from Simple Distillation

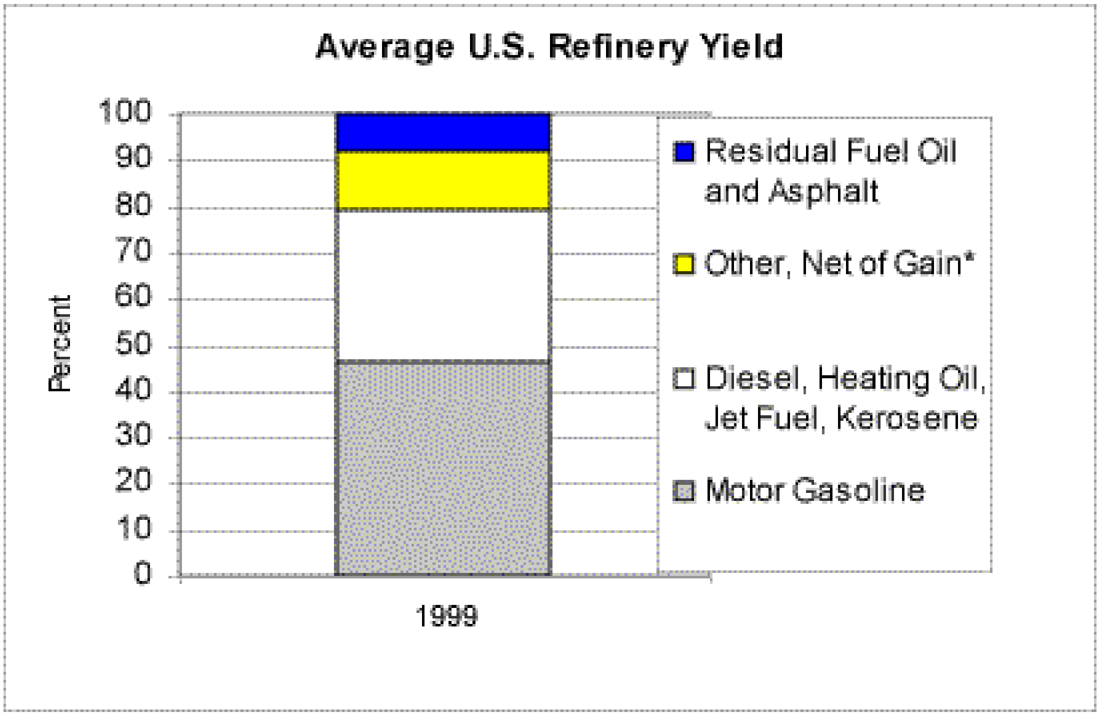
To Refining Chapter   To Refining Charts



Source: Energy Intelligence Group, *Int'l Crude Oil Market Handbook*

Average U.S. Refinery Yield

To Refining Chapter   To Refining Charts

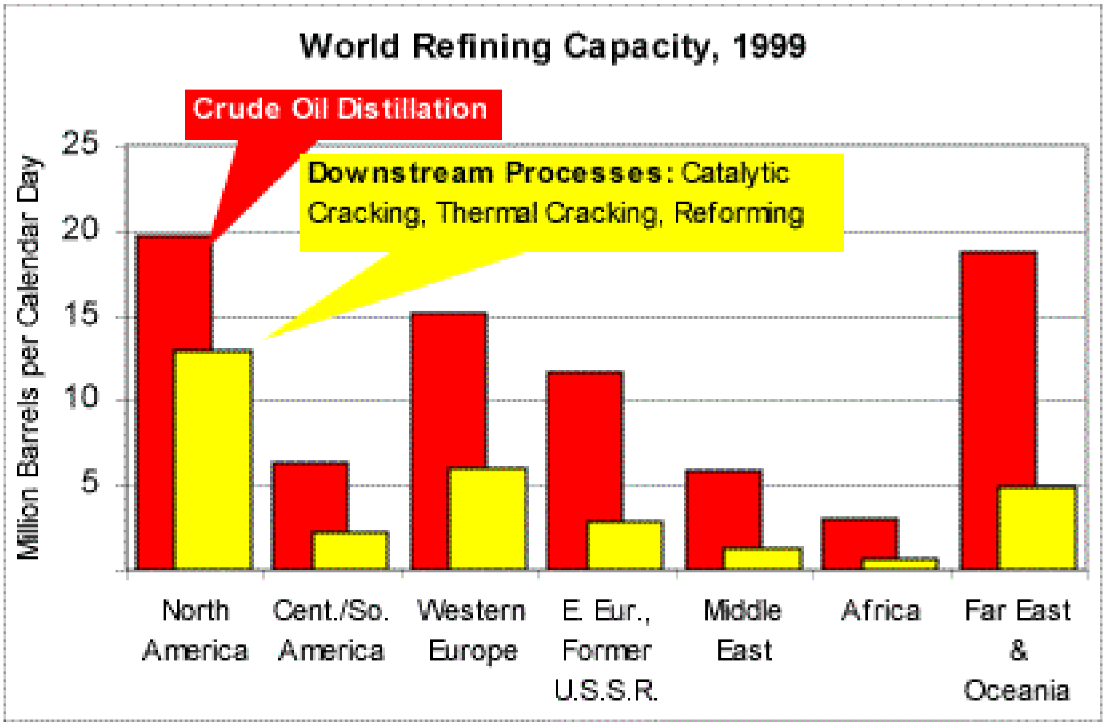


Source: *Petroleum Supply Anuual,* Table 19

*Note: Processing gain is the volume increase that results as denser molecules (e.g., residual fuel oil) are split into less dense ones (e.g. gasoline). The processing gain in U.S. refineries is equal to about 6%.

World Refining Capacity by Region, 1999

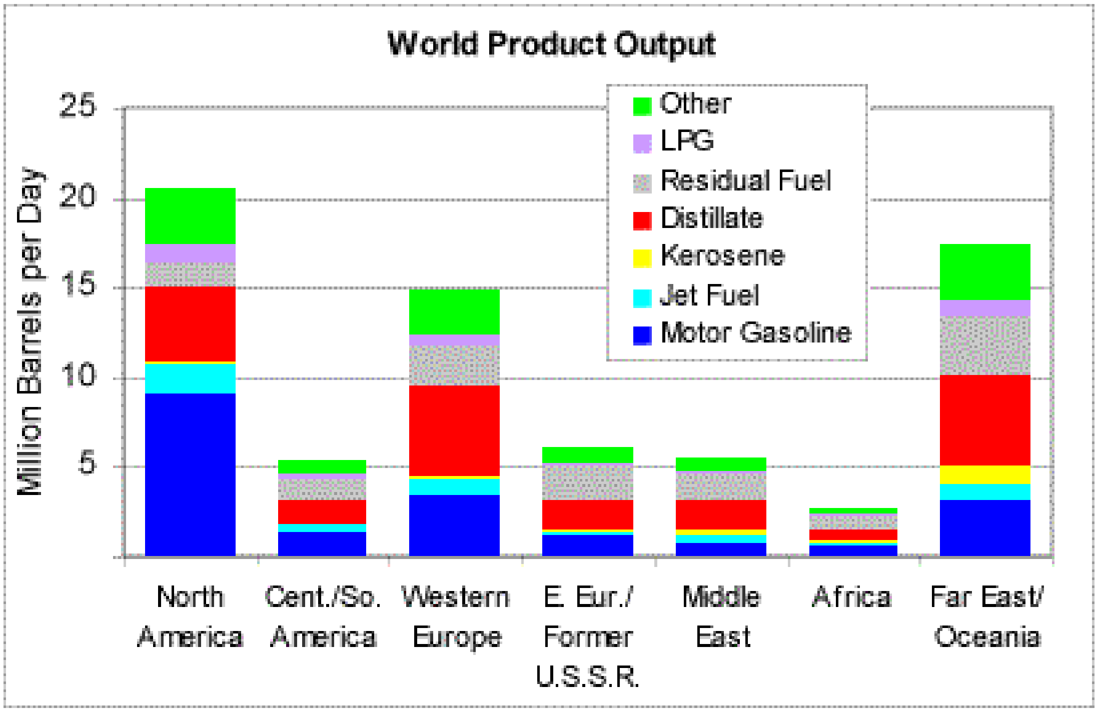
To Refining Chapter To Refining Charts



Source: *International Energy Annual,* Table 3.6

World Petroleum Product Output by Region, 1997

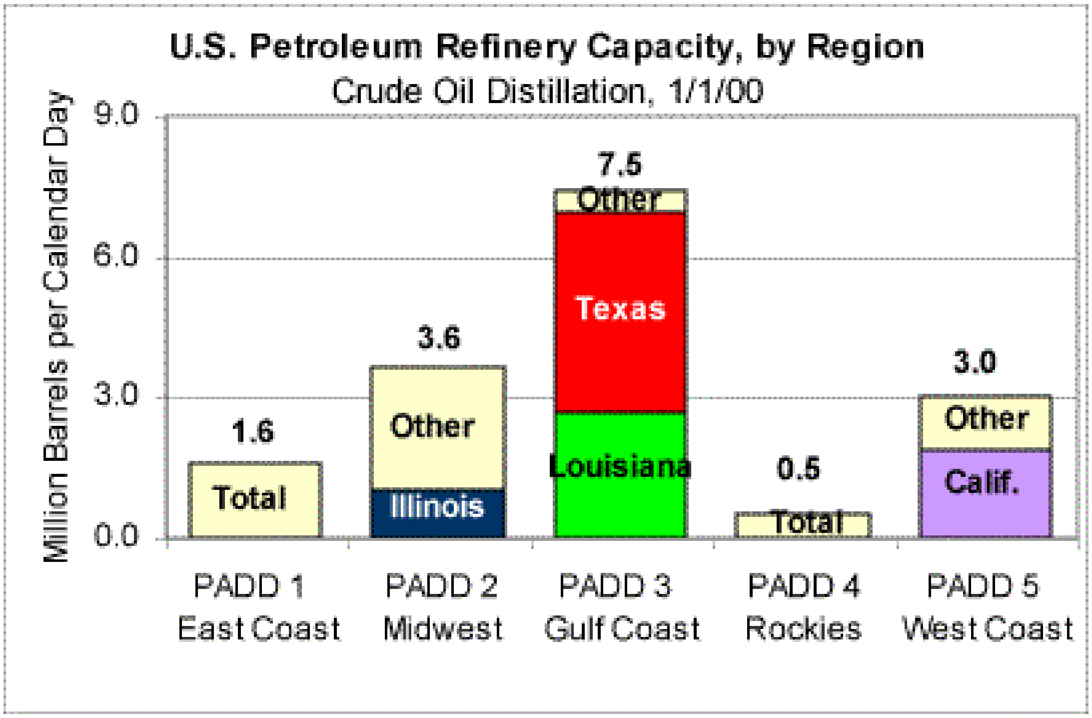
To Refining Chapter To Refining Charts



Source: *International Energy Annual,* Table 3.2

U.S. Refining Capacity by Region, January 1, 2000

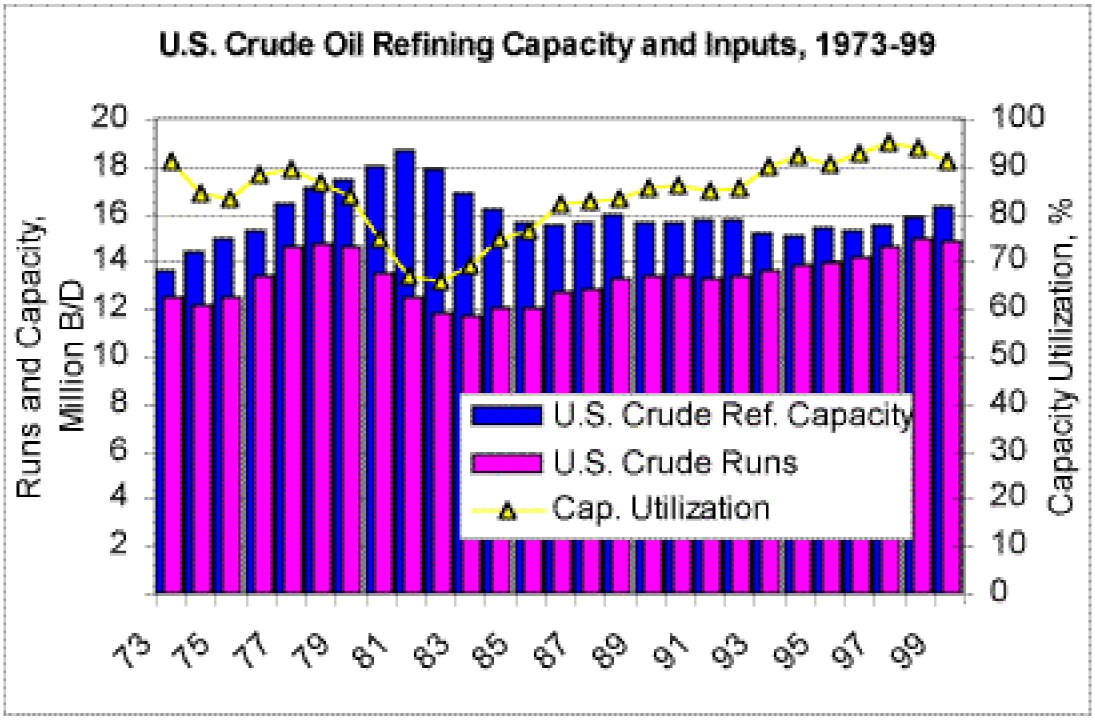
To Refining Chapter To Refining Charts To Map of PAD Districts



Source: *Petroleum Supply Annual,* Table 36, Biennial Refinery Report

U.S. Refining Capacity, Crude Runs, and Utilization Rate, 1973-1999

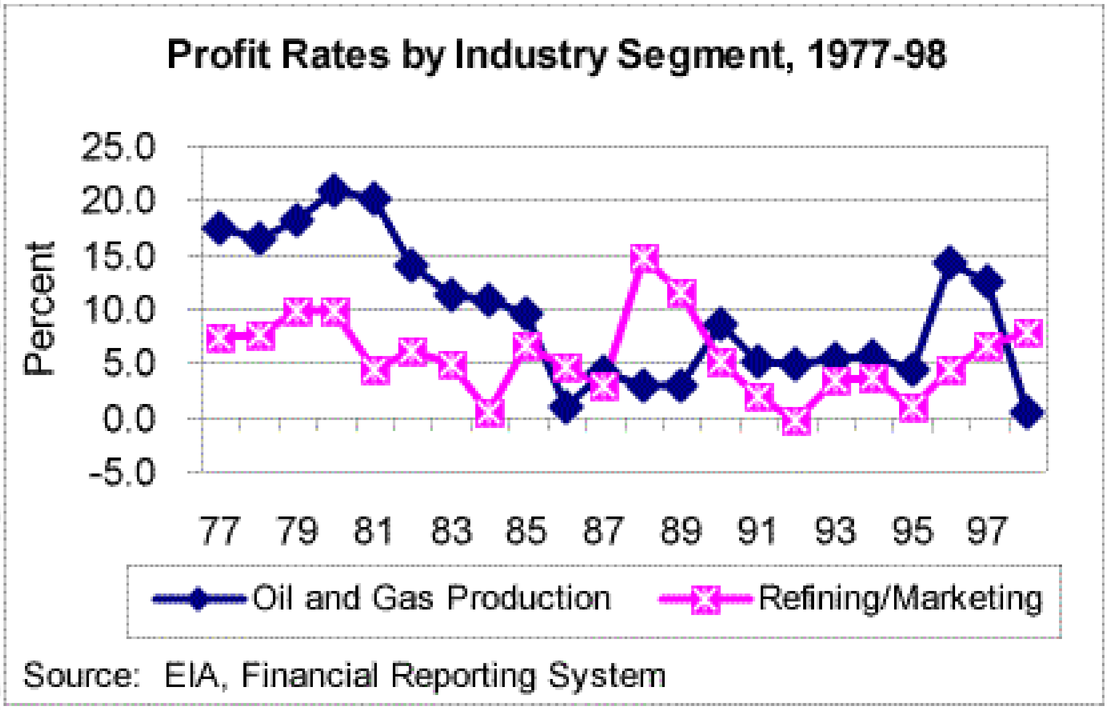
To Refining Chapter To Refining Charts



Source: *International Energy Annual,* Table 3.6, and Petroleum Supply Annual

Profit Rates by Oil Industry Segment, 1977-1998

To Refining Chapter   To Refining Charts



Refinery Links

Some sources listed below link to non-EIA sites and data. These links are provided solely as a service to our customers, and therefore should not be construed as advocating or reflecting any position of the Energy Information Administration. In addition, EIA does not guarantee the content or accuracy of any information presented in linked sites.

EIA Info at a Glance: U.S. Petroleum Refining Operations

U.S. Refinery Capacity Data **To Refining Chapter**

Operable Refinery Capacity as of January 1, 2000 from EIA's Petroleum Supply Annual, Vol.1 (*.pdf): Number & Capacity of Operable Refineries by PAD and State -- Table 36 (*.pdf)
Capacity of Operable Refineries by State by Refinery -- Table 38 (*.pdf)
Production Capacity of Operable Refineries by PAD and State -- Table 37 (*.pdf)
Production Capacity of Operable Refineries by State by Refinery -- Table 39 (*.pdf)
Refiners' Operable Atmospheric Crude Oil Distillation Capacity -- Table 40 (*.pdf)
January 1981 – Current Operable Crude Oil and Downstream Charge Capacity of Petroleum Refineries -- Table 41 (*.pdf)
January 1981 – Current Production Capacity of Operable Refineries -- Table 42 (*.pdf)
Shutdown and Deactivated Refineries During Previous Year -- Table 48 (*.pdf)
Refinery Sales During Previous Year -- Table 49 (*.pdf)

U.S. Refinery Input, Output and Yield Data **To Refining Chapter**

Refinery Input of Crude Oil and Petroleum by PAD and Refining Districts:
Weekly data for Most Recent Period -- Weekly Petroleum Status Report
Current Month -- Petroleum Supply Monthly, Table 28
1997 by Month -- Petroleum Supply Annual, Vol.2, Table 16
1997 --Petroleum Supply Annual Vol.1, Table 16

Refinery Net Output of Finished Petroleum Products by PAD and Refining Districts:
Weekly data for Most Recent Period -- Weekly Petroleum Status Report
Current Month -- Petroleum Supply Monthly, Table 29
1997 by Month -- Petroleum Supply Annual, Vol.2, Table 17
1997 -- Petroleum Supply Annual Vol.1, Table 17

Refinery Yield of Petroleum Products by PAD and Refining Districts:
Current Month -- Petroleum Supply Monthly, Table 31
1997 by Month -- Petroleum Supply Annual, Vol.2, Table 19
1997 -- Petroleum Supply Annual Vol.1, Table 19

Refinery Fuel Use and Losses by PAD District, 1997 -- Petroleum Supply Annual Vol.1, Table 37

International Refining and Refinery Data **To Refining Chapter**

Refinery Capacity, Output and related international data from *International Petroleum Annual*
Refinery Capacity and Throughputs from *BP Statistical Review of World Energy*

Articles and Reports on U.S. Refinery Activity **To Refining Chapter**

EIA's Articles on Refinery Operations (scroll down to "Analysis")
National Petroleum Council: Reports on Refining
U.S. Refining Cash Margin Trends, in *Petroleum Issues and Trends*, Sep. 1997
Refining and Marketing Chapter in EIA's *Performance Profiles of Major Energy Producers*

- Back to Refining Chapter
- To Refining Graphs
- To Next Chapter (Stocks)
- **To Appendices:**
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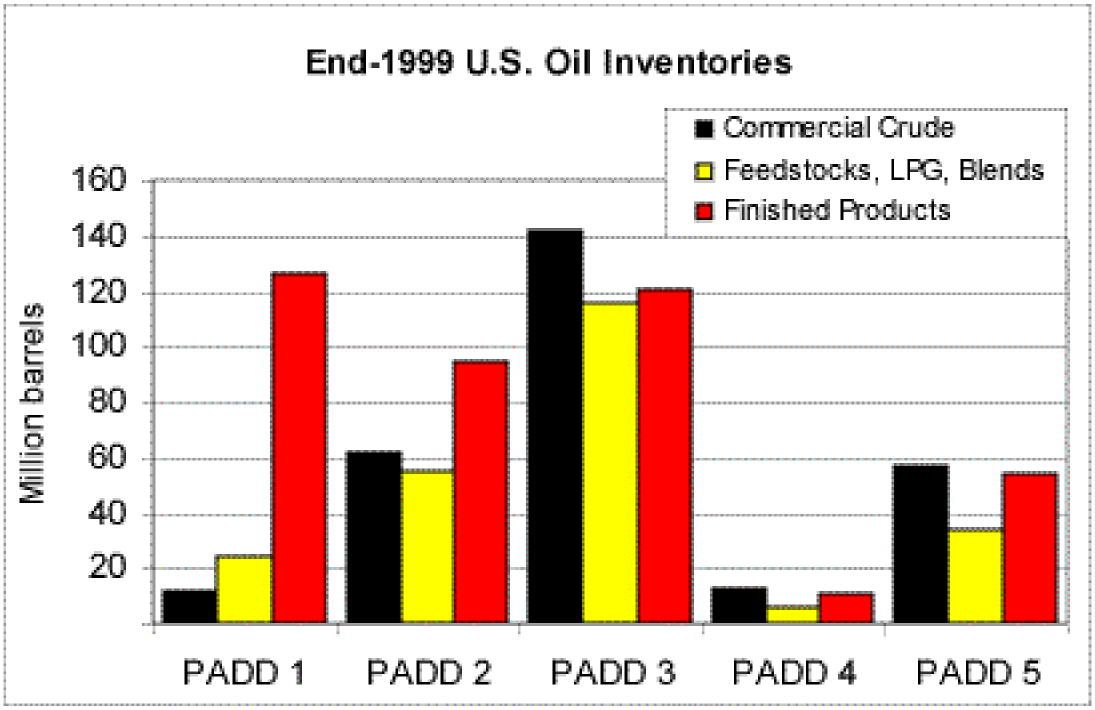
  - B - Links to Environmental Sources
- Return to Table of Contents

U.S. Oil Inventories by Region, December 31, 1999

To Stocks Chapter To List of Graphs To Map of PAD Districts



Source: *Petroleum Supply Annual,* Table 30

Types of Transactions

Oil is sold under a variety of **contract arrangements** and in **spot transactions**. Oil is also traded in **futures markets**, a mechanism designed to distribute risk among participants on different sides (or with different expectations) of the market, but not generally to supply physical volumes of oil. Both spot markets and futures markets provide critical price information for contract markets, and so they are discussed first.

A **spot transaction** is an agreement to sell or buy one shipment of oil under a price agreed-upon at the time of the arrangement. In a sense, a consumer's purchase of gasoline is a kind of spot transaction -- the consumer needed supply, found the price acceptable, and made no promise to make additional purchases. More traditionally, however, the oil industry uses the spot market to balance supply and demand. When a company temporarily has too much supply for its own needs, it will offer some for sale in the spot market. Likewise, if it needs additional volumes to meet a demand spike, or because supply is unexpectedly curtailed, it will purchase oil on a cargo-by-cargo, shipment-by-shipment basis. In recent years, the growth of "merchant refiners" has depended on viable spot markets. These independent refiners manufacture products not to fill their own marketing networks, but to sell the oil in third-party transactions to the highest bidder.

Prices in spot markets send a clear signal about the supply/demand balance. Rising prices indicate that more supply is needed, and falling prices indicate that there is too much supply for the prevailing demand level. There are "spot markets" for different commodities and qualities (crude oil, for instance, as distinct from gasoline or heating oil, and low sulfur crude oil as distinct from high sulfur crude oil), and for different regions (Rotterdam/Northwest Europe, New York Harbor/U.S. Northeast, Chicago/U.S. Midwest, Singapore/South East Asia, and the U.S. Gulf Coast, for instance). [For further information on crude oil quality, refer to the section on Oil Refining.] The evolution of a regional market into a pricing center has its foundation in logistics. These markets have a ready supply, transportation choices, storage facilities, and many buyers and sellers. [For further information about regional markets, refer to the section on Trade.]

Spot prices are reported for transactions in these different markets and prices in spot markets are relatively "transparent" -- they are reported by a number of sources and widely available in a variety of media. While some of the most active spot markets offer deals on supplies that will be available in the future (a "forward" physical market), most focus on "prompt" delivery of readily available volumes.

The prices paid on futures markets further enhance the availability of price information to all aspects of the oil market. While spot markets involve the trade of physical barrels of oil, **futures markets** are designed as a financial mechanism. While everyone in the market wishes to buy at a low price and sell at a high price, buyers and sellers are on opposite sides of the transaction and their risks are inherently different. Different market participants may also have varying appetite for risk, and speculators may wish to gamble that the price will move one way or another. The futures market, a zero-sum game where there is a buyer for every seller, distributes the risk among market participants according to their positions and appetites.

A futures contract is a promise to deliver a given quantity of a standardized commodity at a specified place, price and time in the future. In practice, oil is seldom actually delivered under a futures contract. At futures exchanges such as the New York Mercantile Exchange or International Petroleum Exchange in London, oil is traded literally by open outcry. Offers to buy and sell are given vocally, and by hand signals; in this "recognition trading," the buyer and the seller each acknowledge the completion of the transaction by recognizing the other party across the physical trading area. The exchange records the pairings of buyers and sellers, and reports the transaction prices. Electronic services then report these prices with minimal lag. Furthermore, prices are available throughout the day from the exchanges via the Internet, are published in specialty trade publications and daily newspapers throughout the country, and are reported on a weekly basis by the Energy Information Administration. The ready availability of the reported prices has enhanced "price transparency" -- the ability of any market participant to assess the prevailing price level.

Existence of the futures market also allows any participant to "lock in" the prevailing price for future deliveries, such as heating oil prices for the winter heating season. Such a strategy, called a hedge, involves a series of transactions, offsetting profits or losses on a futures transaction against losses or profits on the physical purchase or sale of oil. By limiting the uncertainty over future costs, the hedge allows companies or consumers to make other choices. A marketer, for instance, can offer fixed price arrangements to customers, or a consumer (primarily a bulk consumer) can budget with confidence.

As described in the chapter on Stocks, the fact that futures contracts are traded for each month for 18 months in the future provides a forward price curve -- a picture of expected prices in the future. (It is important to note that trade volumes are extremely low for more distant months.) Thus, the futures market also allows a mechanism for companies to profit from changes in market prices by holding nearly risk-free inventories in a rising market. Furthermore, options and other well-developed over-the-counter financial mechanisms allow participants to limit their risk without eliminating their benefit in the event of higher or lower than expected prices. The mechanisms together have allowed companies to offer "price cap" and/or fixed price deals to their customers.

Contract arrangements in the oil market in fact cover most oil that changes hands. In earlier decades, contracts covered almost all oil, with terms that were infrequently readjusted. Even the pricing term of the contract was only seldom re-examined. Prices at all levels of the oil market were relatively stable. Pricing power was more dominantly in the hands of the seller, because oil availability was the paramount issue for purchasers. After the very high prices of the early 1980's, demand declined and supply increased, leading to significant price declines. At the same time, additional players (both countries and companies) entered the oil market. Worries over supply faded. It became apparent that the old constant price called for in most contracts was too high -- higher than the purchaser would pay in the abundantly-supplied open market. Purchasers rebelled, with many abandoning contracts and relying instead on the spot market. To coax them back, suppliers granted pricing terms tied to a market indicator -- the spot market, for instance, or the futures market. Thus while most oil flows under contract, its price varies with spot markets. Contract arrangements for different products are discussed below.

Most of the **crude oil** that flows in international trade is priced by formula: a base price, usually based on a market indicator, plus or minus a quality adjustment. A common pricing term sets a base of a spot price published by a particular source or publication. For crude oil sold into the U.S. Gulf Coast, for instance, the base would commonly be the price of West Texas Intermediate crude oil. This high quality crude oil indigenous to the U.S. Southwest is an informal benchmark for the region. Analogously, crude oil sold into Northwest Europe is often tied to the spot price for the North Sea's Brent Blend, and crude sold into Singapore or other South East Asian locations is often tied to Dubai. The base price is then adjusted for quality. (As explained in the section on Oil Refining, the value of a crude oil is based on the ease with which it can be refined into high value products. Thus, denser crude oils with higher sulfur content are worth less than lighter, low sulfur ones.) Finally, the credit terms affect the realized price.

Other pricing terms have also been common in the past. One, briefly in use in the mid-1980's, based the price of a crude explicitly on the spot prices of the refined products it could produce ("netback"). The netback proved ultimately unresponsive to markets. For instance, high refinery runs would create a relative over-supply of products, thus reducing the market price of refined product and hence also the back-calculated price of the crude oil. The price signal to the refiner -- that he was overproducing -- was thus muted at best

In the United States, some domestically-produced crude oil is sold at a posted price. Named for the sheet that was literally posted in a producing field, posted prices are established by the buyers, usually refiners, but sometimes firms that aggregate supply, "gatherers." Posted prices generally apply to a crude oil "stream" -- a crude oil or blend of oils of standardized quality (West Texas Intermediate, Louisiana Light Sweet), with quality adjustments where the oil varies from the standard. In decades past, posted prices remained relatively stable even while spot prices fluctuated. Today, they more commonly reflect market conditions quickly. Companies may also add a temporary premium to a posted price ("Posting Plus") to account for transient market conditions.

Contracts for products between suppliers and resellers and/or bulk consumers are often priced in a similar way to international crude oil: a base price tied to a market indicator, then adjusted for other factors such as volume, delivery terms, etc. Bulk consumers may also be able to convince their suppliers to provide fixed prices, or may be able to enter into the types of offsetting financial transactions that will have the same effect.

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Taxes

Taxes on crude oil production

Most States impose a **severance tax** when oil (or gas or another natural resource) is produced from property within their territory. It is generally a percentage of the sale price and thus varies with markets. In 1996, States collected a total of about $3.3 billion in severance taxes on oil and gas production. For Alaska, the State by far the most dependent on oil production activity, severance taxes account for about half of all State tax revenue. In other large producing States, severance tax revenue is important but is less than 10 percent of total tax revenue.

Royalties are not taxes but fees paid to landowners, whether private or public. (As noted earlier, private ownership of mineral rights is unique to the United States.) Payment of royalties is universal, part of a standard contract to produce oil or gas from a given property. The amount of the royalty percentage is part of the negotiation process and thus varies with boom and bust cycles in the industry. Generally, oil royalties are about 1/7 (some 14 percent) of the sale price. Royalty agreements with the Federal government have generally required a higher royalty payment. In 1996, the Federal government collected approximately $3 billion in royalties on oil and gas production from Federal property, including Federal offshore areas.

Excise and Other Taxes

U.S. **import** tariffs on oil are generally modest, except on gasoline. They are a fixed level per unit and thus become more important at low overall market prices. Depending on the density of the oil, crude oil and fuel oils pay 5.25 cents per barrel (for heavier quality) and 10.5 cents for lighter oils. Transportation fuels, such as gasoline and jet fuel, pay 52.5 cents per barrel, or 1.25 cents per gallon.

Excise taxes are an important source of revenue to the taxing authority, whether the authority is the Federal, State, or local government. Among oil products, highway fuels are by far the most heavily taxed. Federal excise taxes on gasoline are 18.3 cents per gallon and on diesel fuel are 24.3 cents. In addition, the Federal government collects a fee of 0.1 cents per gallon to finance the Leaking Underground Storage Tank Trust Fund. Furthermore, State taxes on gasoline vary from less than 10 cents per gallon to about 40 cents, averaging about 22.6 cents per gallon in early 1998. Taxes on diesel used as a highway fuel show a similar range and also average 22.6 cents per gallon. These data for State taxes include "excise" taxes as well as other taxes, such as sales taxes that some States impose on gasoline and diesel. State excise taxes alone, as of early 1998, average about 18 cents per gallon.

Gasohol, a blend of 10 percent ethanol and 90 percent gasoline, may also be subject to a different excise tax rate. The Federal tax on gasohol is 13 cents per gallon, or 5.3 less than the rate of tax on gasoline. Nine States also provide preferential excise or sales tax treatment for gasohol, ranging from 1 cent per gallon (Connecticut, Iowa) to 15 cents per gallon (Ohio.)

Excise taxes account for almost all of the difference between prices for gasoline in the United States and prices in our foreign trading partners, such as Europe and Japan. When the price of gasoline in the United States is $1.10 per gallon, for instance, excise taxes account for about 40 cents, or 36 percent of the total; the pre-tax price is about 70 cents. At the same time, the price in Germany, for instance, might be $3.00 per gallon, with taxes accounting for some $2.30, or some 77 percent of the total; the pre-tax price is about the same as that in the United States: 70 cents per gallon. Similar examples can be constructed from other International Energy Agency data.

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Gasoline Classes of Trade

The gasoline distribution system in the United States is massive. Moving gasoline to approximately 200,000 retail outlets throughout the United States has required the development of a complex distribution infrastructure. The complexity of the market structure is reflected in the multiple pricing levels ("classes of trade") for gasoline. Thus, before it reaches the consumer, gasoline may be sold in one or more of the following wholesale transactions:

- By refiners as it leaves the refinery: so-called "refinery gate" prices.
- By refiners or by resellers as it leaves a distribution terminal: so-called "rack" prices, named after the super-structure of pipes, hoses, and manifolds that delivers the product into a tank truck or tank wagon.
- By refiners or resellers to retailers at the gasoline service station: so-called "dealer tank wagon" prices.

Both refinery gate prices and rack prices are influenced primarily by spot and/or futures prices. At a minimum, rack prices will conceptually exceed refinery gate prices by the transportation cost to move the gasoline from the refinery to the terminal, usually by pipeline or by barge.

Dealer tank wagon prices represent the cost of the product to the gasoline retailer. In addition to reflecting overall market conditions, dealer tank wagon prices include payments for additional services that a supplier may provide to a retailer, especially a "branded" retailer -- a gasoline station that sells gasoline under the name of a large oil company. These services may include trademark, credit cards, and advertising, as well as security of supply. Gasoline retail marketing follows a variety of structures and contractual arrangements. Some gasoline stations, for instance, are owned by a refiner, but most are leased by the refining company to an independent dealer. The cost structure also varies, as may the companies' marketing stance and, hence, its margin. Various EIA publications review the structure of the gasoline market and its pricing. See, for instance, *Motor Gasoline Assessment, Spring 1997*.

Pre-tax gasoline retail prices are set by retailers. (The price on the pump reflects this price plus taxes). Pre-tax prices reflect both the retailer's purchase cost for the product and the other costs of operating the retail outlet. They also reflect local market conditions and factors such as the desirability of the location and the marketing stance of the owner.

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Price Links

Publication and Table Guide to Price Data from EIA's Petroleum Division.
Also see EIA's Price Information at a Glance and More Sources.

Data Frequency/ Geographic Coverage			Petroleum Marketing Monthly	Petroleum "Watches"	Winter Fuels Report	Weekly Petroleum Status Report
Crude Oil	Spot			Crude Oil Watch		13f, 13u ("comma delimited")
	Contract (International)			Crude Oil Watch		12f, 12u ("comma delimited"), 12u (database)
	Futures					15f, 15u ("comma delimited")
	Refiner Acquisition Cost		1 (PDF), 1 (TXT)			19f, 19u ("comma delimited")
	Imported		1 (PDF), 1 (TXT), 24 (PDF), 24 (TXT), 25 (PDF), 25 (TXT), 26 (PDF), 26 (TXT), 27 (PDF), 27 (TXT), 29 (PDF), 29 (TXT), 30 (PDF), 30 (TXT)			
	First Purchase (U.S.)		21 (PDF), 21 (TXT), 22 (PDF), 22 (TXT), 23 (PDF), 23 (TXT)			
Refined Products	Motor Gasoline	Spot		Gasoline Watch		13f, 13u ("comma delimited")
		Futures				15f, 15u ("comma delimited")
		Wholesale (Rack)	31 (PDF), 31 (TXT), 32 (PDF), 32 (TXT) , 33 (PDF), 33 (TXT), 34 (PDF), 34 (TXT)	Gasoline Watch		
		Wholesale (Dealer Tank Wagon)	31 (PDF), 31 (TXT), 32 (PDF), 32 (TXT), 33 (PDF), 33 (TXT), 34 (PDF), 34 (TXT)			
		Retail	31 (PDF), 31 (TXT), 32 (PDF), 32 (TXT), 33 (PDF), 33 (TXT), 34 (PDF), 34 (TXT)	Gasoline Watch		16f, 16u, 17f, 17u
	Distillate/ Diesel	Spot		Distillate Watch		13f, 13u ("comma delimited") 14f, 14u ("comma delimited")
		Futures				15f, 15u ("comma delimited")
		Wholesale	15 (PDF), 15 (TXT), 16 (PDF), 16 (TXT), 17 (PDF), 17 (TXT), 39 (PDF), 39 (TXT), 40 (PDF), 40 (TXT), 41 (PDF), 41 (TXT)	Distillate Watch	TXT, PDF	

		Retail	15 (PDF), 15 (TXT), 16 (PDF), 16 (TXT) , 17 (PDF), 17 (TXT), 18 (PDF), 18 (TXT), 39 (PDF), 39 (TXT), 40 (PDF), 40 (TXT), 41 (PDF), 41 (TXT)	Distillate Watch	TXT, PDF	16f, 16u, 18f, 18u
	Propane	Spot		Propane Watch		14f, 14u ("comma delimited")
		Futures				15f, 15u ("comma delimited")
		Wholesale	14 (PDF), 14 TXT, 38 (PDF), 38 (TXT)	Propane Watch	TXT, PDF	
		Retail	14 (PDF), 14 TXT, 38 (PDF), 38 (TXT)	Propane Watch	TXT, PDF	
	Other Products	Spot				14f, 14u ("comma delimited")
		Wholesale	19 (PDF), 19 (TXT), 42 (PDF), 42 (TXT)			19f, 19u ("comma delimited")
		Retail	42 (PDF), 42 (TXT)			

Other Price Data

Some sources listed below link to non-EIA sites and data. These links are provided solely as a service to our customers, and therefore should not be construed as advocating or reflecting any position of the Energy Information Administration. In addition, EIA does not guarantee the content or accuracy of any information presented in linked sites.

Spot Prices To Prices Chapter

Weekly, Weekly Petroleum Status Report. Includes:
Weekly, Spot Prices of Crude Oil, Gasoline and Heating Oil (also available in "comma-delimited" format, table13u.txt)
Weekly, Spot Prices of Low-Sulfur Diesel, Kerosene-type Jet Fuel, Residual Fuels and Propane (also available in "comma-delimited" format, table14u.txt)
Weekly, Crude Oil Watch
Weekly, Distillate Watch
Weekly, Gasoline Watch

Futures Prices and Futures Markets To Prices Chapter

Weekly, NYMEX Prices
Daily, NYMEX Prices

Crude Oil Contract Prices To Prices Chapter

Weekly, World Crude Oil Prices (detailed list; other formats available)
Weekly, Crude Oil Watch (summary only)

Crude Oil Contract Formulas To Prices Chapter

International Crude Oil Market Handbook, a publication of Energy Intelligence Group, January 1997.
Petroleum Intelligence Weekly, a publication of Energy Intelligence Group.

Wholesale Prices **To Prices Chapter**

Weekly, Crude Oil & Petroleum Product Prices
Weekly, Distillate Watch
Weekly, Gasoline Watch
Weekly, Winter Fuels Report

Retail Prices **To Prices Chapter**

Monthly, *Monthly Energy Review* (includes inflation-adjusted and "as-paid")
Weekly, Distillate Watch
Weekly, Gasoline Watch
Weekly, Winter Fuels Report
Weekly, Retail Motor Gasoline and On-Highway Diesel Prices
Weekly, Retail Motor Gasoline Prices by PADD
Weekly, Retail On-Highway Diesel Prices by PADD
Weekly, Crude & Petroleum Product Prices

Prices in the Year 2000 **To Prices Chapter**

EIA's Senate Testimony About Rising Crude Oil and Gasoline Prices
A Year of Volatility: Oil Markets and Gasoline
On-going Updates of Gasoline and Diesel Prices
Primer on Gasoline Prices
Additional EIA Articles and Presentations on Price (Scroll down to "Analysis")

Other Price and Profitability Analyses **To Prices Chapter**

Monthly, *Petroleum Marketing Monthly*, *Monthly Highlights*
Motor Gasoline Assessment, Spring 1997 (*.pdf)
Contrast between Distillate Fuel Oil Markets in Autumn 1996 and 1997 (*.pdf)
Propane Market Assessment for Winter 1997-1998 (*.pdf)
An Analysis of U.S. Propane Markets, Winter 1996-97 (*.pdf)
"Noncommercial Trading in the Energy Futures Market" (*.pdf)
"1995 Reformulated Gasoline Market Affected Refiners Differently" (*.pdf)
"Price Changes in the Gasoline Market" (*.pdf)

Taxes **To Prices Chapter**

State Excise Taxes (*.pdf, p. 8)
State Excise and Other Taxes (*.pdf)
State Severance Taxes (from Independent Petroleum Association of America)
State Severance Taxes (from EIA)
International Excise Taxes (*.pdf; p.11)
Taxes Paid by Large Energy Producers

Price Forecasts **To Prices Chapter**

Short-Term Energy Outlook(*.pdf) (from EIA)

Annual Energy Outlook (*.pdf) (from EIA)

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Stocks Links

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EIA Info at a Glance: U.S. Petroleum Stocks

U.S. Oil Stocks and Inventory Data **To Stocks Chapter**

History of Crude Oil and Petroleum Products Stocks from EIA's *Petroleum Supply Monthly (PSM)*, and *Monthly Energy Review (MER)*, including annual (1973 – present) and monthly (1996 - present):
Crude Oil Supply and Disposition -- *PSM, Table S2*

Historical End-Month Stocks by Petroleum Product:
Finished Motor Gasoline -- *PSM, Table S4*,
Distillate Fuel Oil -- *PSM, Table S5*,
Residual Fuel Oil -- *PSM, Table S6*,
Jet Fuel, Propane, LPG and Other Petroleum Products -- *PSM, Tables S7-S10*
Latest year, Month-by-Month -- *Petroleum Supply Annual, Vol.2, Table 3*
End-year -- *Petroleum Supply Annual, Vol.1, Table 3*

Stocks of Crude Oil and Petroleum Products by PAD District:
Weekly data for Most Recent Period -- *Weekly Petroleum Status Report*
Current Month -- *Petroleum Supply Monthly, Table 51*
Latest year, Month-by-Month -- *Petroleum Supply Annual, Vol.2, Table 20*
End-year -- *Petroleum Supply Annual, Vol.1, Table 20*
Refinery, Bulk Terminal and Natural Gas Plant Stocks of Selected Petroleum Products by PAD District and State:
Current Month -- *Petroleum Supply Monthly, Table 52*
Latest year, Month-by-Month -- *Petroleum Supply Annual, Vol.2, Table 21*
End-year -- *Petroleum Supply Annual, Vol.1, Table 21*

International Stock Data **To Stocks Chapter**

Oil Stocks in the OECD from *International Energy Annual*

U.S. Stocks Feature Articles **To Stocks Chapter**

EIA's Articles on Stocks (Scroll down to "Analysis")

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