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energy monitor white paper



daniel bernoulli



Walking the Tightrope of Oil Supply and Demand

December 2007-January 2008

A Worldflow special report

Every quarter the Energy Monitor shines its spotlight on the oil & gas, refining & petrochemical, and power & renewables industries, looking for important events to discuss or highlight. Periodic White Paper reports provide a more in-depth look at key topics.

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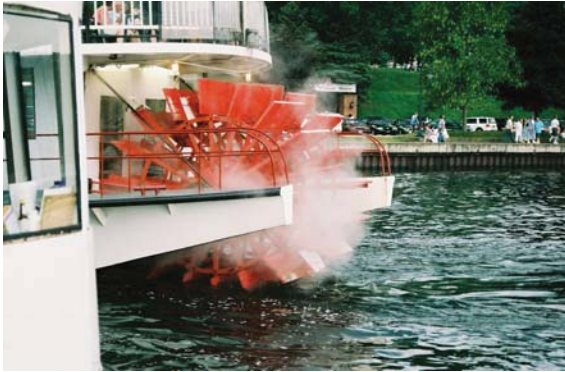
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Energy Monitor White Paper
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and Demand

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Energy Monitor White Paper: Walking the Tightrope of Oil Supply and Demand December 2007-January 2008

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A Gallon of Gasoline

*I've been waiting for years to buy a brand new Cadillac
But now that I've got one I want to send it right back
I can't afford the gas to fill my luxury limousine
But even if I had the dough no one's got no gasoline.*

*It's got power-assisted overdrive and carpets on the floor,
but it's parked out front just like a dead dinosaur.
And I'll be paying off the bank for 45 years or more.
It should go 100 miles an hour,
but it's never moved away from my door.*

*Who needs a car and a seven-forty-seven
When you can't buy a gallon of gas
Who needs a highway, an airport or a jet
When you can't get a gallon of gas
There's no more left to buy or sell
There's no more oil left in the well
A gallon of gas can't be purchased anywhere
For any amount of cash
You can't buy a gallon of gas.*

Lyrics by The Kinks

From the "Low Budget" album in 1979

Is this what the future holds? Well, that depends on how good we are at managing the resources we have available to us today. This White Paper looks at the balance between oil supply and demand, for the purpose of better understanding the forces behind oil prices. We welcome your comments.

Definitions of key terms relating to oil and gas

Term	Definition
Crude Oil	<p>A mixture of hydrocarbons that exists in liquid phase in natural underground reservoirs and remains liquid at atmospheric pressure after passing through surface separating facilities. Depending upon the characteristics of the crude stream, it may also include:</p> <p>Small amounts of hydrocarbons that exist in gaseous phase in natural underground reservoirs but are liquid at atmospheric pressure after being recovered from oil well (casinghead) gas in lease separators and are subsequently commingled with the crude stream without being separately measured. Lease condensate recovered as a liquid from natural gas wells in lease or field separation facilities and later mixed into the crude stream is also included;</p> <p>Small amounts of nonhydrocarbons produced with the oil, such as sulfur and various metals;</p> <p>Drip gases, and liquid hydrocarbons produced from tar sands, oil sands, gilsonite, and oil shale.</p> <p>Crude oil is refined to produce a wide array of petroleum products, including heating oils; gasoline, diesel and jet fuels; lubricants; asphalt; ethane, propane, and butane; and many other products used for their energy or chemical content.</p>
Dry Natural Gas	<p>Natural gas which remains after: 1) the liquefiable hydrocarbon portion has been removed from the gas stream (i.e., gas after lease, field, and/or plant separation); and, 2) any volumes of nonhydrocarbon gases have been removed where they occur in sufficient quantity to render the gas unmarketable. (Note: Dry natural gas is also known as <i>consumer-grade natural gas</i>.)</p>
Lease Condensate	<p>A mixture consisting primarily of pentanes and heavier hydrocarbons which is recovered as a liquid from natural gas in lease separation facilities. This category excludes natural gas plant liquids, such as butane and propane, which are recovered at downstream natural gas processing plants or facilities.</p>
Natural Gas Liquids	<p>Those hydrocarbons in natural gas which are separated from the gas through the processes of absorption, condensation, adsorption, or other methods in gas processing or cycling plants. Generally such liquids consist of propane and heavier hydrocarbons and are commonly referred to as condensate, natural gasoline, or liquefied petroleum gases. Where hydrocarbon components lighter than propane are recovered as liquids, these components are included with natural gas liquids.</p>
Natural Gas - Wet After Lease Separation	<p>The volume of natural gas remaining after removal of lease condensate in lease and/or field separation facilities, if any, and after exclusion of nonhydrocarbon gases where they occur in sufficient quantity to render the gas unmarketable. Natural gas liquids may be recovered from volume of natural gas, wet after lease separation, at natural gas processing plants.</p>
Production - Wet After Lease Separation	<p>The volume of natural gas withdrawn from reservoirs less (1) the volume returned to such reservoirs in cycling, repressuring of oil reservoirs, and conservation operations; less (2) shrinkage resulting from the removal of lease condensate; and less (3) nonhydrocarbon gases where they occur in sufficient quantity to render the gas unmarketable. Note: Volumes of gas withdrawn from gas storage reservoirs and native gas that has been transferred to the storage category are not considered part of production. This production concept is not the same as marketed production, which excludes vented and flared gas.</p>

Issues and Perspectives

Walking the tightrope of oil supply and demand

A Worldflow Special Report

By Jesse Yoder

The world is walking a tightrope of oil supply and demand. Today, demand for crude oil already exceeds supply. And the difference between demand and supply is small enough that a major disruption in supply can further tip the balance in favor of demand. More importantly, the trend is towards flat to declining supplies and increasing demand. Given this, the day cannot be too far off when worldwide demand exceeds the available supply by more than a razor-thin margin. At that point, the difference has to be made up by increasing supply, reducing demand, or by drawing on available reserves.

This White Paper looks at the balance between oil supply and demand. The world's oil comes from many different countries with differing political and economic structures and alliances. Major sources of oil include countries as diverse as Canada, Iran, Iraq, Mexico, Venezuela, Russia, China, and Saudi Arabia. Two of the three countries President George W. Bush identified as making up the "Axis of Evil" -- Iran and Iraq -- are major oil producers. While the need to keep oil flowing from the Middle East to the United States may not have been the primary motivation for the wars in Iraq in 1991 and in 2003, it certainly played a role in the decisions to undertake these wars. Every country has a vital need for oil, and any threat to a country's oil supply can be perceived as a threat to that country's security.

Oil production and consumption is typically measured in millions of barrels per day. The chart on the following page shows the supply and demand balance for oil on a worldwide basis in 2006 and the first two quarters of 2007. The chart views the world oil supply through the prism of OPEC countries, OECD countries, and non-OECD countries. The OECD is the Organization for Economic Cooperation and Development. It was founded in December 1960 as a group of 20 countries committed to democratic government and a market economy. Since that time, 10 more countries have joined the OECD, to make up the current total of 30 countries. Some of the more prominent members include the United States, Germany, the United Kingdom, France, Australia, and Japan.

The Organization of Petroleum Exporting Countries (OPEC), by contrast, was formed in September 1960 at the Baghdad Conference. Its founding members were **Iran, Iraq, Kuwait, Venezuela, and Saudi Arabia**. Eight other countries, including Nigeria and Algeria, joined OPEC at later times. The purpose of OPEC is to influence oil prices by controlling production, thereby keeping prices at a desirable level. In the past, OPEC had the price range of \$22 to \$28 per barrel as a target. Those days are only a fond memory at this time.

The price of oil is normally measured in terms of the price of a barrel of crude oil, which contains 42 gallons. Even this pricing figure is not exact, since different oils from different parts of the world have different prices at any given time. As a result, certain oils tend to be used as "benchmarks" for the price of oil as a whole. These include the price of West Texas

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Issues and Perspectives

Walking the tightrope of oil supply and demand

Petroleum Supply: Million Barrels per Day by Quarter							
	Q1 2006	Q2 2006	Q3 2006	Q4 2006	2006 Average	Q1 2007	Q2 2007
Total OECD	21.83	21.44	21.47	21.62	21.59	21.74	21.49
OPEC	35.36	35.19	35.66	34.97	35.30	34.51	34.58
Former USSR	11.81	12.07	12.26	12.48	12.16	12.61	12.60
Other Non-OECD	15.37	15.57	15.76	15.56	15.57	15.29	15.79
Total Non-OECD	62.54	62.83	63.67	63.01	63.02	62.41	62.98
Total World Supply	84.37	84.26	85.14	84.63	84.60	84.15	84.47
Petroleum Demand: Million Barrels per Day by Quarter							
United States	20.54	20.55	20.91	20.75	20.69	20.77	20.65
Other OECD	29.81	27.51	27.98	28.95	28.56	28.77	27.43
Total OECD	50.34	48.05	48.90	49.70	49.24	49.54	48.07
China	6.72	7.02	7.30	7.24	7.53	7.27	7.43
Former USSR	4.07	4.41	4.25	4.23	4.43	4.33	4.54
Other Non-OECD	23.20	23.56	23.83	23.88	23.98	23.81	24.07
Total Non-OECD	33.99	34.99	35.38	35.35	35.94	35.42	36.04
Total World Demand	83.65	85.33	83.43	84.25	85.63	84.66	85.58

Issues and Perspectives

Walking the tightrope of oil supply and demand

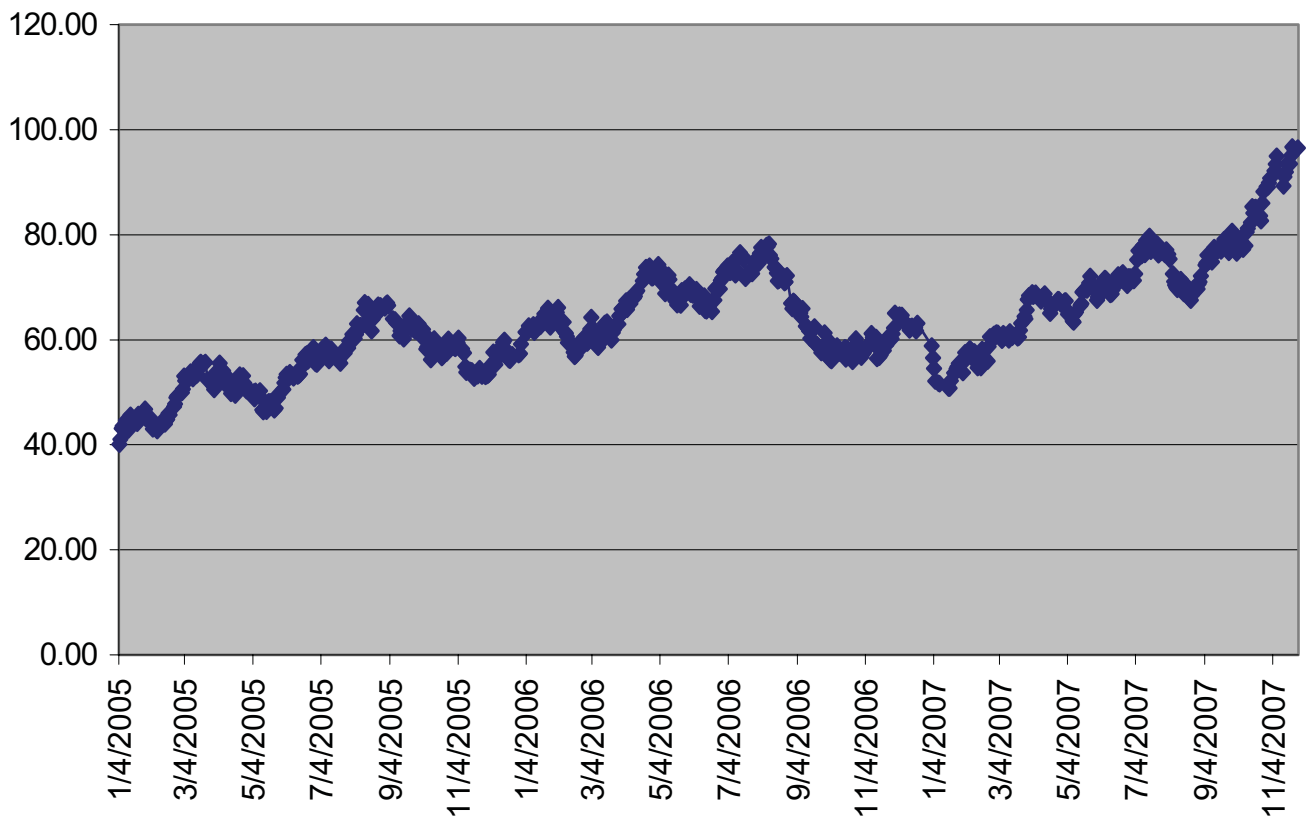
(Continued from page 9)

Intermediate (WTI_USA), Brent (Europe and Africa), and Dubai and Oman (Middle East). Of course, there is also a difference between what oil is selling for at any given time, and the futures price, which is the price of oil sold for delivery at some point in the future.

The chart below shows the pattern of oil prices over the past two years. On January 4, 2005, oil was selling for about \$40 per barrel. Since that time, the price has climbed steadily. Today, the average price of a barrel of crude oil is more than \$90 per barrel.

(Continued on page 12)

**The Spot Price of a Barrel of Brent North Sea Crude Oil, 1/4/05 to 11/26/07
(US Dollars per Barrel)**



Source: Energy Information Administration

Issues and Perspectives

Walking the tightrope of oil supply and demand

(Continued from page 11)

Factors influencing the price of oil

Many factors influence the price of oil. Some of these are:

- The Arab/Israeli conflict
- The political situation in Venezuela and Argentina
- Cutbacks in OPEC production
- Concerns with the integrity of the Trans-Alaska pipeline
- Economic growth
- Political considerations surrounding Iran

This is an unsystematic list of factors. A more systematic way to look at the factors that influence oil prices is as follows. Every drop of oil comes from somewhere on this planet. Oil supply is like a group of streams that converge into a single river, where each country represents a supply stream. Whenever anything occurs that reduces the oil supply stream from one country, this reduces the total amount of oil available worldwide. Depending on the amount of reduction, this has an impact on the price of oil. Because there are so many oil-producing countries, and so many different factors can affect oil production in these countries, there are many different factors that influence the price of oil.

The charts on pages 13-16 indicate the main oil producing countries worldwide. The numbers are in millions of barrels per day on average in 2006. Chart One gives oil production from the Organization of Petroleum Exporting Countries (OPEC). Chart Two gives oil production from selected countries, including the United Kingdom and China. Chart Three gives oil production from selected countries, including Russia, the United States, and Mexico.

The table on the following page gives the numbers that are shown in Charts One, Two, and Three.

Chart Four on page 16 shows what percent of total world oil production the top 13 countries contributed in 2006. The top five oil producing countries are Saudi Arabia, Russia, the United States, Iran, and China. Of the remaining countries listed, Mexico, Nigeria, and Venezuela have received special here attention due to political or other considerations that could threaten their oil production. The rest of this article focuses on those and other countries whose oil production is potentially or actually diminished occasionally due to political or other factors.

Issues and Perspectives

Walking the tightrope of oil supply and demand

Chart One		Chart Two		Chart Three	
OPEC Countries Average Oil Production — Millions of Barrels per Day in 2006, including lease condensate		Selected Other Countries Oil Production — Millions of Barrels per Day in 2006, including lease condensate		Selected Other Countries Oil Production, including the United States, and Total World — Millions of Barrels per Day, including lease condensate	
Algeria	1.81	Australia	.43	Gabon	.23
Angola	1.41	Colombia	.53	Syria	.41
Indonesia	1.02	Ecuador	.54	Malaysia	.61
Iran	4.03	Argentina	.70	Egypt	.64
Iraq	2.00	United Kingdom	1.49	India	.69
Kuwait	2.54	Brazil	1.72	Oman	.74
Libya	1.68	Norway	2.49	Mexico	3.26
Nigeria	2.44	Canada	2.53	United States	5.10
Qatar	0.85	China	3.69	Russia	9.25
Saudi Arabia	9.15	Total	14.12	Total	20.93
United Arab Emirates	2.64			Other Countries	6.31
Venezuela	2.51				
Total OPEC	32.08			Total World	73.54

Note: Above numbers do not include natural gas plant liquids, other liquids, or refinery gain.

Issues and Perspectives

Walking the tightrope of oil supply and demand

World Oil Production by Country in 2006

(Millions of Barrels per Day, on Average)

Chart One—OPEC Countries

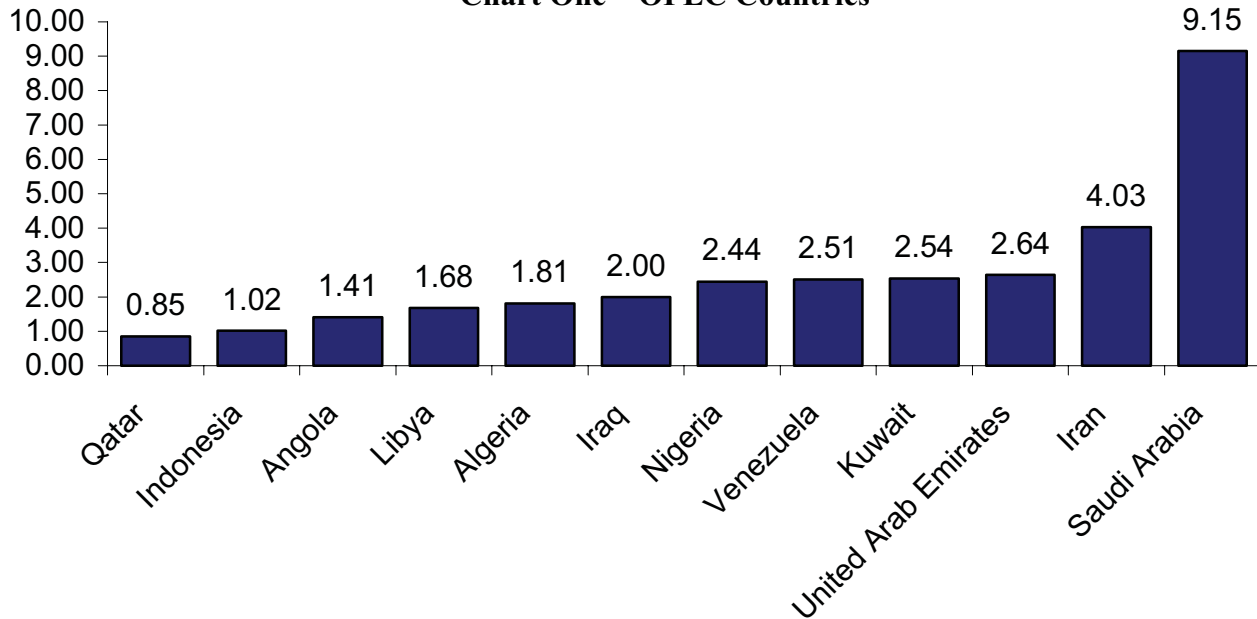
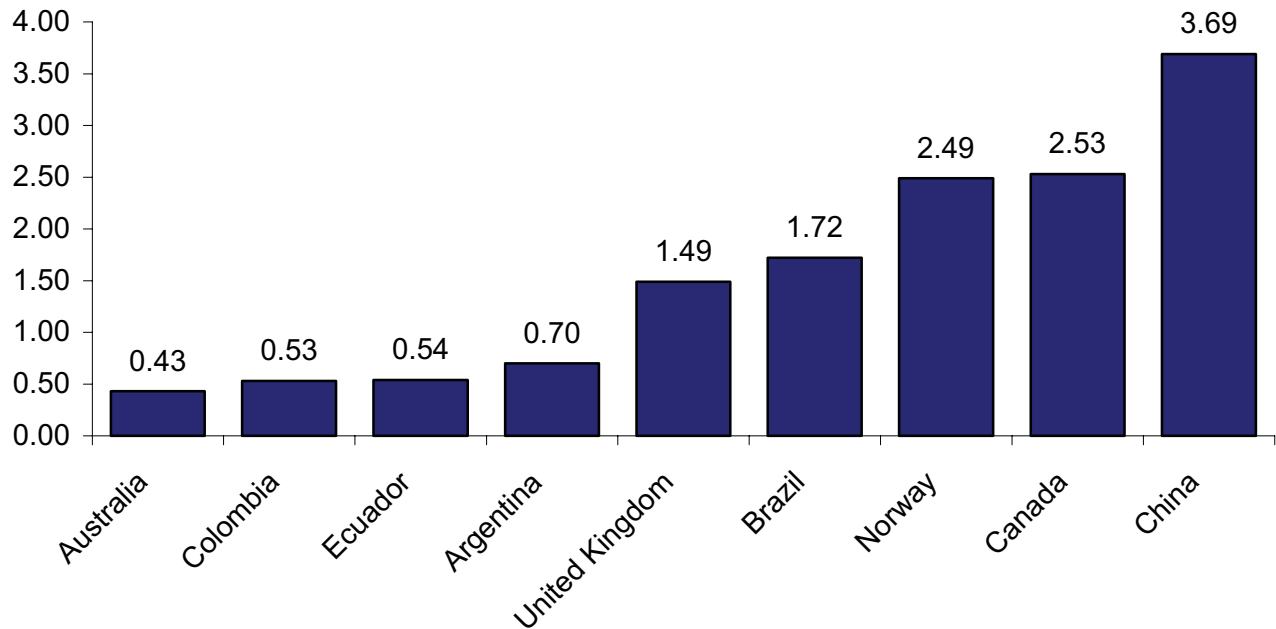


Chart Two—Selected Countries

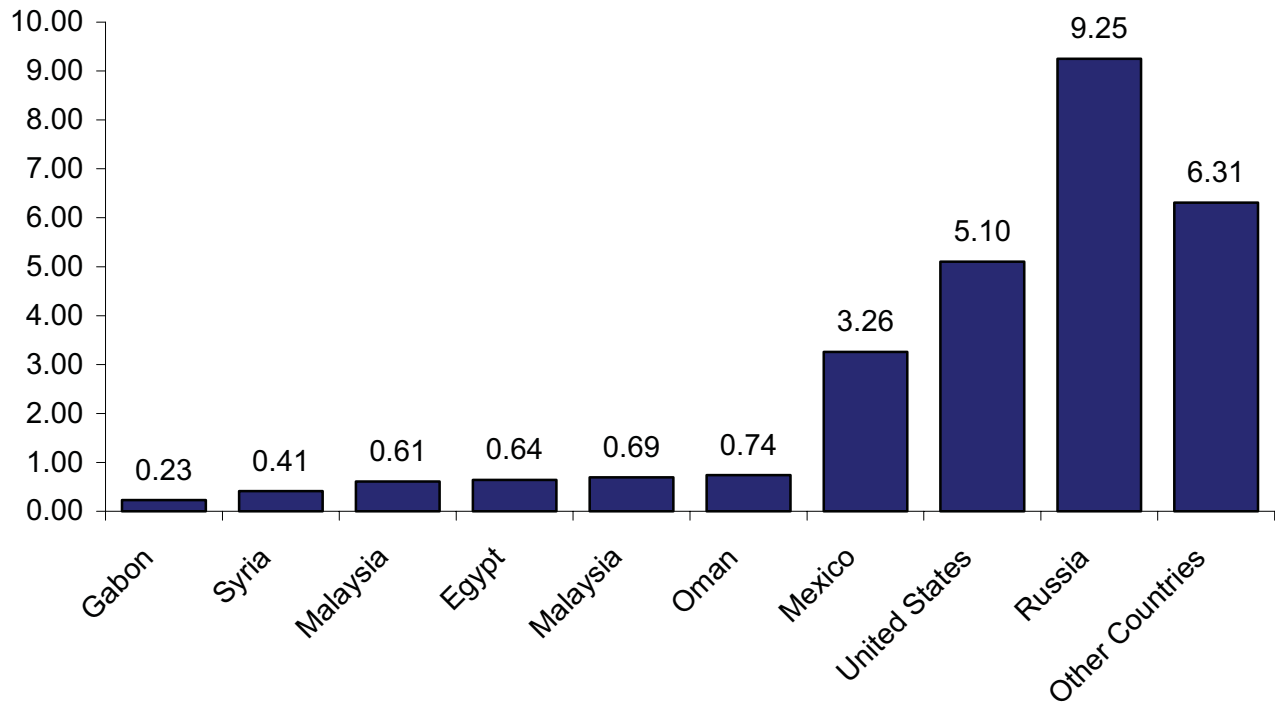


Issues and Perspectives

Walking the tightrope of oil supply and demand

World Oil Production by Country in 2006 (Millions of Barrels per Day, on Average)

Chart Three—Selected Countries



Note: The numbers on pages 13-15 refer to crude oil production. The numbers on page 10 refer to petroleum after the refining process, including crude oil (including lease condensate), natural gas plant liquids, and other liquids, and refinery processing gain (loss). This is why the world total on page 10 is higher than the world total on page 13. Source: Energy Information Administration.

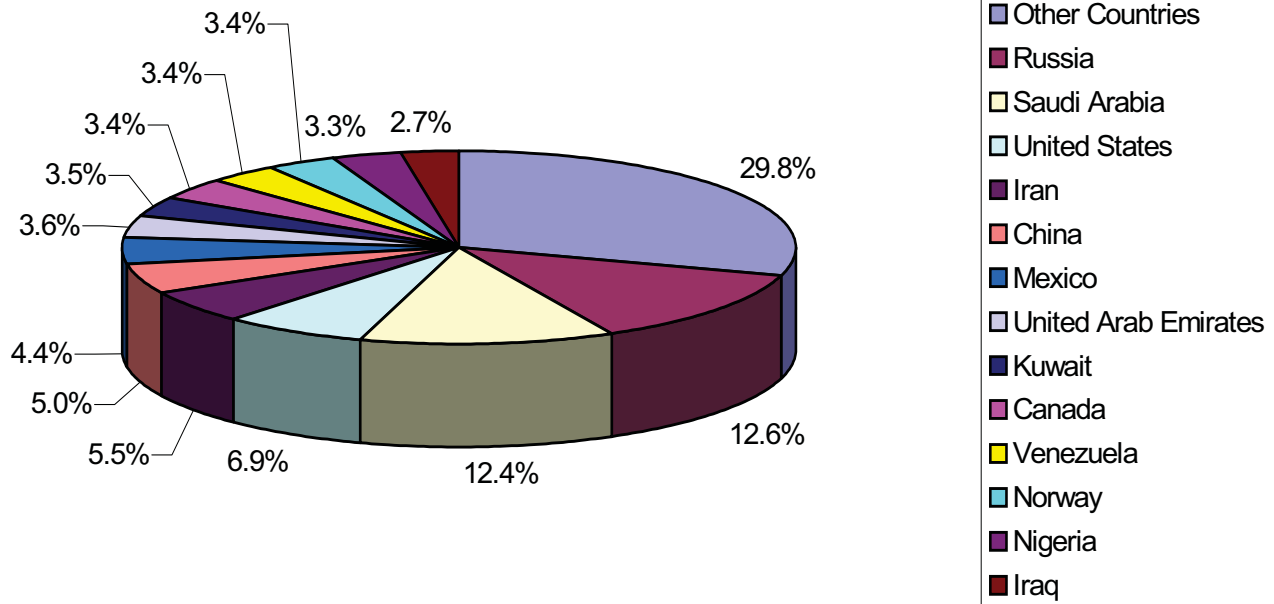
Issues and Perspectives

Walking the tightrope of oil supply and demand

Chart Four

Worldwide Crude Oil Production by Percent by Country in 2006

World Total = 73.5 million barrels/day, on average



Source: Energy Information Administration

Issues and Perspectives

Walking the tightrope of oil supply and demand

An “Orifice Plate” on Oil Production

In order for differential pressure (DP) flow measurement to take place, a restriction of some kind must be placed on the flowstream. This restriction forces the flow through a narrower flow diameter, speeding up the flow and causing a pressure drop. An orifice plate is one kind of restriction used in DP flow. Factors that cause a reduction in oil production in a country act somewhat like an orifice plate on a flowing stream. They place a restriction on total oil production from the country, and reduce the total amount of oil available worldwide. With the supply/demand balance so tight, any sudden actual or perceived drop in oil production anywhere in the world can have an immediate effect on the price of oil. In most cases, the price of oil increases as a result of the “orifice plate” restriction.

The strongest reason for the high price of crude oil today is the balance between supply and demand. Demand exceeded supply by less than one million barrels per day in 2006. However, many of the upward fluctuations in price are due to actual or perceived threats to the oil supply from the major oil producing countries. **When the oil supply is threatened from any major oil producing country, prices typically rise on fears of reduced supply.** The rest of this article looks at the main oil-producing countries, and actual or potential threats to their oil production that have an impact on worldwide oil prices.

Note: Some of the information on particular countries on pages 18 to 27, including the maps, was derived from the Energy Information Administration (EIA).



A Christmas tree at an oil well in Bay City, Michigan (Photo by Flow Research)



A pumping unit at an oil well in Hale, Michigan (Photo by Flow Research)

Issues and Perspectives

Walking the tightrope of oil supply and demand: Saudi Arabia



With one-fourth of the world's proven oil reserves and some of the lowest production costs, Saudi Arabia is likely to remain the world's largest net oil exporter for the foreseeable future. In 2006, Saudi Arabia supplied the United States with 1.42 million barrels per day of crude oil, or 14% of U.S. crude oil imports during that period.

According to Saudi Aramco, the state-owned national energy firm, Saudi Arabia contains 259.9 billion barrels of proven oil reserves (including 2.5 billion barrels in the Saudi-Kuwaiti Divided, aka "Neutral" Zone), around one-fourth of proven, conventional world oil reserves. Around two-thirds of Saudi reserves are considered "light" or "extra light" grades of oil, with the rest either "medium" or "heavy." Although Saudi Arabia has around 80

oil and gas fields (and over 1,000 wells), more than half of its oil reserves are contained in only eight fields, including Ghawar (the world's largest oil field, with estimated remaining reserves of 65-70 billion barrels) and Safaniya (the world's largest offshore oilfield, with estimated reserves of 19 billion barrels). Ghawar alone accounts for about half of Saudi Arabia's total oil production capacity.

Saudi Arabia produces a range of crude oils, from heavy to super light. Of Saudi Arabia's total oil production capacity, about 65 -70 percent is considered light gravity, with the rest either medium or heavy; the country is moving to reduce the share of the latter two grades. Lighter grades generally are produced onshore, while medium and heavy grades come mainly from offshore fields.

Potential "orifice plate" restrictions on Saudi oil production:

1. *Potential terrorist attacks on Saudi production or processing facilities, such as the unsuccessful attack on Feb. 24, 2006 on a Saudi oil processing facility by Al Qaeda.*
2. *Unexpected production cuts.*
3. *Reduced supply — no one knows how much oil Saudi Arabia really has.*

Saudi Arabia is a key oil supplier to the United States and Europe. Asia (e.g., China, Japan, South Korea, India) now takes around 60 percent of Saudi Arabia's crude oil exports, as well as the majority of its refined petroleum product exports. During the first eight months of 2007, Saudi Arabia exported an average of 1.42 million bbl/d of crude oil to the United States. For this time period, Saudi Arabia ranked fourth (after Canada, Mexico, and Venezuela) as a source of total (crude plus refined products) U.S. oil imports, and third for crude only. While Saudi Arabia crude oil exports have steadily declined over the last six years, from 1.61 bbl/d in 2001 to today's 1.4 bbl/d, the country remains an important supplier to the U.S. and a firm ally for a variety of closely aligned economic and security reasons.

Issues and Perspectives

Walking the tightrope of oil supply and demand: Russia

Major Russian oil basins



Source: IEA

In 2006, Russia's real gross domestic product (GDP) grew by approximately 6.7 percent, surpassing average growth rates in all other G8 countries, and marking the country's seventh consecutive year of economic expansion. Russia's economic growth over the past five years has been fueled primarily by energy exports, given the increase in Russian oil production and relatively high world oil prices during the period.

In the 1980s, the Western Siberia region, also known as the

"Russian Core," made the Soviet Union a major world oil producer, allowing for peak production of 12.5 million barrels per day in 1988. Following the collapse of the Soviet Union in 1991, Russia's oil production fell precipitously, reaching a low of roughly 6 million bbl/d, or around one-half of the Soviet-era peak. Several other factors are thought to have caused the decline, including the depletion of the country's largest fields due to state-mandated production surges and the collapse of the Soviet central planning system.

Potential "orifice plate" restrictions to oil production in Russia:

1. *Bottlenecks in the Transneft system of pipelines; only about 4 million barrels per day can be transported by pipeline; the remaining 3 million barrels per day are sent by rail and river, which is more expensive.*
2. *Political problems are another potential restriction on oil from Russia. In January 2006, Russia had a dispute with the Ukraine over natural gas prices that had it shutting off supplies to the Ukraine until the dispute was resolved in a compromise.*

A turnaround in Russian oil output began in 1999. Many analysts have attributed the rebound in production to the eventual privatization of the industry following the collapse of the Soviet Union. The privatization clarified incentives and increased less expensive production. Higher world oil prices, the use of technology that was standard practice in the West, and the rejuvenation of old oil fields also helped raise production levels. Others partially attribute the increase to after-effects of the 1998 financial crisis and the subsequent devaluation of the ruble.

In 2006 Russian total liquids production averaged almost 9.7 million bbl/d, including 9.2 million bbl/d of crude oil, a 220,000 bbl/d increase over 2005. This growth rate was down from annual growth of roughly 700,000 bbl/d between 2002-2004.

Issues and Perspectives

Walking the tightrope of oil supply and demand: Iran



Iran, or more formally, the Islamic Republic of Iran, is a country of strategic significance within several different dimensions. Located in the volatile Middle East, Iran shares its border with the politically important nations of Pakistan, Afghanistan, Iraq, and Turkey among others. Iran also has direct access to the Caspian Sea, the Persian Gulf, the Gulf of Oman, and the Strait of Hormuz, a vital maritime pathway for crude oil transport from the region.

Iran was known as Persia until 1935, when its government at the time formally requested others to use its native Persian language word for the country. After several successive governments, including one or more which were the objects of serious foreign interference, Iran became an Islamic republic in 1979 following the

overthrow of the shah. Iran's territory extends over an area of more than 631,000 sq miles, about the size of Alaska, and has an estimated 2007 population of just over 65 million people.

The country's most abundant natural resources are petroleum and natural gas, and these resources are also the source of much of Iran's worldwide influence. A charter member of the Organization of Oil Exporting Countries (OPEC) in 1960, Iran has exerted power in the energy markets for years due to its rich reservoirs of crude oil and natural gas, and its willingness to leverage its supplier strength to influence both oil price levels and political and other agendas.

Potential "orifice plate" restrictions on oil production:

1. Iran has been in the news recently due to the Middle East conflict. If Iran becomes more involved in this way, its oil production could be affected.

2. Iran's nuclear program is another source of uncertainty, and Iran has threatened to cut oil exports if the United Nations imposes sanctions on the country.

Iran is currently ranked third in the world in terms of proven crude oil reserves with 136 billion barrels, trailing only Saudi Arabia and Canada. In terms of natural gas production, Iran ranks fourth in the world at 3.7 trillion cubic feet, behind only Russia, the United States, and Canada. Clearly, Iran is a significant component of the global energy supplier portfolio, as the two charts on the next page clearly demonstrate.

In the Q2/2006 issue of *Energy Monitor*, we observed and illustrated the point that demand and supply volumes for petroleum products were in near equilibrium, creating an environment of price instability. Furthermore, we provided country case examples where disruptions in supply were likely to occur and suggested what

would be their likely causes.

In the case of Iran, our assertion was that the continuing conflicts in the Middle East region and negative international reaction to its nuclear program would be the two most likely causes of disruption to Iran's ability to supply petroleum product. To these actions we can also add domestic infrastructure investment policy, as the government continues to divert capital away from much-needed production requirements.

Issues and Perspectives

Walking the tightrope of oil supply and demand: Iran

Proven Crude Oil Reserves

2007 Rank	Country	Billions of Barrels
1	Saudi Arabia	262.3
2	Canada	179.2
3	Iran	136.3
4	Iraq	115.0
5	Kuwait	101.5

Source: Energy Information Administration (EIA)

There has not yet been a measurable decline in Iran's production, but there has been increased concern that the lack of investment in their oil field exploration programs and production infrastructure has definitely led to a slowing of their production capacity. Any oil field will eventually decline in production over time as primary recovery methods become less effective, and it is at this point that decisions are customarily made to pursue secondary recovery techniques or to increase exploratory drilling programs to maintain or increase overall

production (whether at a company or a national level).

Iran's crude oil production has definitely flattened. The 2006 production average of 4.1 million barrels per day is essentially identical to 2004 production levels. This compares unfavorably to other regional suppliers such as Kuwait, Saudi Arabia, and United Arab Emirates, for example, all of whom have increased production during the same timeframe from 1.7% (Saudi Arabia) to 6.4% (Kuwait and UAE). Iran's natural gas production, in contrast, has increased more than 25% in the same period.

Natural Gas Production

2006 Rank	Country	Trillions of Feet ³
1	Russia	23.2
2	United States	18.5
3	Canada	6.5
4	Iran	3.7
5	Algeria	3.1

Source: Energy Information Administration (EIA)

Part of the government's response to perceived citizenry unrest with the Iranian economy and certain hot-button issues has been to continue its generous policies of subsidized energy consumption (e.g. imported gasoline is priced well below its to-market cost). Such programs are squandering oil revenues that could otherwise be reinvested into exploration and production.

The net result of the above is that it is unlikely that Iran can be depended upon to reliably expand its role as an important supplier into the global crude oil markets, while it is quickly becoming a vital supplier of natural gas. Its proven reserves here, at 974 trillion cubic³, are ranked #2 in the world behind only Russia. Demand for natural gas remains strong worldwide, and Iran has the inventory to grow its position in the natural gas market. Look for Iran to do so.

Issues and Perspectives

Walking the tightrope of oil supply and demand: Mexico



Mexico's economy continued to experience strong growth in 2006, with gross domestic product (GDP) increasing by 4.8 percent in 2006, after growing by 3.0 percent in 2004. This growth is a sharp contrast to the earlier part of the decade, when Mexico's GDP growth was very small or negative. A combination of high global oil prices and economic recovery in the United States has driven

the economic recovery in Mexico.

According to the Oil and Gas Journal (OGJ), Mexico had 12.3 billion barrels of proven oil reserves as of January 1, 2007, the third-largest amount of conventional crude oil reserves in the Western Hemisphere. Most reserves consist of heavy crude oil varieties, with a specific gravity of less than 25° API. The largest concentration of remaining reserves occurs offshore in the southern part of the country, especially in the Campeche Basin.

Mexico is the sixth-largest producer of oil in the world. The country produced an average of 3.74 million barrels per day (bbl/d) of total oil liquids during 2006, a 1.2 percent decline from 2005 and a 2.5 percent decline from 2004. Of Mexico's oil production, about 88 percent was crude oil and condensate, the rest consisting of natural gas liquids (NGL) and refinery gain. Many analysts believe that Mexican oil production has peaked, and that the country's production will continue to decline in the coming years. EIA forecasts that Mexico will produce 3.6 million bbl/d of oil in 2007, down from 3.8 million bbl/d in 2005 and 3.7 million bbl/d in 2006, mainly driven by declining production at its super-giant Cantarell field

Potential "orifice plate" restrictions for oil production in Mexico:

- 1. Encroaching water and gas is threatening production at the Cantarell oil field, Mexico's largest. Experts believe this field is in irreversible decline, and the rate of decline could soon be 15% per year.*
- 2. Tropical storms and hurricanes. In July 2005, Hurricane Emily forced the evacuation of thousands from the Campeche state region.*

The Mexican constitution provides that the Mexican nation owns all hydrocarbon resources of the country. In 1938, Mexico nationalized its oil sector, creating Petroleos Mexicanos (Pemex) as the sole oil operator in the country. In 1992, Pemex divided into four operating subsidiaries: Exploration and Production, Gas and Basic Petrochemicals, Petrochemicals, and Refining. Pemex is the largest company in Mexico and one of the largest oil and natural gas companies in the world.

Most of Mexico's oil production occurs in the Gulf of Campeche, located off the southeastern coast of the country in the Gulf of Mexico. During the first nine months of 2005, this area accounted for 83 percent of Mexico's total crude oil production. There are other important production centers in onshore basins in the northern and southern parts of the country. Source: EIA

Issues and Perspectives

Walking the tightrope of oil supply and demand: Venezuela



Venezuela, or, more formally, República Bolivariana de Venezuela, is located on the northern coast of South America on the Caribbean Sea. A Spanish explorer provided the country's common name, which translates to "Little Venice". More than 340,000 square miles in size, it is a little larger than the state of Texas, and has an estimated 2006 population of nearly 26 million. The government is a federal republic and led, since 1999, by President Hugo Chavez.

When it comes to energy production and use, what is of greatest interest is Venezuela's oil story. The story begins with the fact that Venezuela is the eighth largest net exporter in the world, and the largest in the Western Hemisphere. The story continues with estimates that Venezuela's proven oil reserves — some 80 billion barrels — are nearly

four times that of the United States, and among the largest in the world. At this early juncture, the oil story here now becomes a bit murky.

The size and international rank of Venezuela's oil reserves depends very much on one's definition of "oil reserve." Estimates are usually based on a conventional definition of what an oil reserve may contain. However, if Venezuela's massive amounts of heavy oil and bitumen are included, then the country's proven reserves would balloon to more than 316 billion barrels. This accounting would make Venezuela the most oil-rich nation on earth.

Under ordinary circumstances, the presence of a huge identified source of petroleum reserves outside of the volatile Middle East would be considered a good thing. In this case, there are issues that are very complex and cannot escape being intertwined with Venezuelan politics.

Potential "orifice plate" restrictions for oil production in Venezuela:

- 1. Labor unrest: From December 2002 to February 2003, a workers strike at the state-run oil company, Petroleos de Venezuela (PDVSA) nearly brought production to a standstill.*
- 2. Political retaliation: President Hugo Chavez has threatened to "cut off oil" to the United States if the US "crosses the line" in its efforts to undermine his revolution.*

Of immediate import are the intentions of President Chavez. He nationalized the oil industry on May 1, 2007. Among the companies that ceded control to the Venezuelan government include BP, ExxonMobil, ChevronTexaco, StatOil, and Total SA.

This situation will certainly impede future foreign investment into Venezuela, a country acting with little support from its neighbors.

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Issues and Perspectives

Walking the tightrope of oil supply and demand: Venezuela

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The stakes are high for all involved in this oil drama.

Venezuela's Oil Reserves

According to Oil and Gas Journal (OGJ), Venezuela had 80.0 billion barrels of proven oil reserves in 2007, the largest amount in South America. Venezuela is a major supplier of crude oil to the world market: in 2006, the country had net oil exports of 2.2 million barrels per day (bbl/d), sixth-largest in the world and the largest in the Western Hemisphere. In recent years, crude oil production in the country has fallen, mostly due to natural decline at existing oil fields.

Venezuela nationalized its oil industry in 1975-1976, creating Petroleos de Venezuela S.A. (PdVSA), the country's state-run oil and natural gas company. Along with being Venezuela's largest employer, PdVSA accounts for about one-third of the country's GDP, 50 percent of the government's revenue and 80 percent of Venezuela's exports earnings. In recent years, the Venezuelan government has reduced PdVSA's previous autonomy and amended the rules regulating the country's hydrocarbons sector. An example of this trend is the November 2004 appointment of Rafael Rodriguez, the energy minister, as chairman of PdVSA.

Industry analysts estimate that PdVSA must spend some \$3 billion each year just to maintain production levels at existing fields, as many of these fields suffer annual decline rates of at least 25 percent. Affecting PdVSA's ability to meet its investment goals are the increasing demands placed upon its finances by the Venezuelan government. In 2004, the Venezuelan government established a special development fund to finance infrastructure projects throughout the country; PdVSA will supply billions of dollars per year directly to this fund. The company also funds additional social programs directly from its budget. These new priorities divert billions of dollars per year away from oil-related activities. Along with these directly administered programs, PdVSA pays billions of dollars each year to the Venezuelan government in the form of income taxes and royalties.

Venezuela's actual level of oil production is difficult to determine, with the country and independent industry analysts offering differing estimates. Most industry analysts and the EIA estimate that the country produced around 2.8 million bbl/d of oil in 2006. These estimates conclude that the country has not fully recovered from the strikes of 2002-2003. Another factor that complicates comparisons of Venezuelan oil production estimates are methodological and classification issues. For example, the EIA estimates that, of Venezuela's 2.8 million bbl/d of oil production, 2.5 million bbl/d was crude oil and 300,000 bbl/d was condensate, natural gas liquids (NGL), and Orimulsion. On the other hand, it is unclear what "other liquids" are included in official estimates of oil production. Another methodological issue is the measuring of crude oil production by the four extra-heavy strategic associations. Some analysts count the extra-heavy oil produced by the associations as part of Venezuela's crude oil production. Others (including EIA) count the upgraded syncrude produced by the four as part of Venezuela's crude oil production, which is about 10 percent lower than the volume of the original extra-heavy feedstock.

Source: Energy Information Administration

Issues and Perspectives

Walking the tightrope of oil supply and demand: Nigeria



Nigeria is located on the west central coast of Africa, and is the most populous nation on the continent. Nigeria is about twice the size of California. Politically, the country was under British influence through the 19th century, and did not achieve independence until 1960. Since then, Nigeria survived a basically military rule and was able to adopt a new constitution in 1999. The country experienced its first successful civilian-to-civilian transfer of power this past April, 2007 when President Umaru Musa Yar'adua was voted in as the new president, succeeding Olusegun Obasanjo.

The new government has inherited a political situation which has been unstable, economically damaged, and rife with corruption. The nation had once been considered the breadbasket of Africa, but now is an importer of basic food commodities. Anti-government forces have been the frequent maker of headline stories where kidnapping — most notably of oil field workers — and subsequent ransom demands for political reforms have been demanded.

On the financial front, the government has not been able to steer a course away from oil-dependency. Fully 95% of foreign exchange earnings and nearly 20% of GDP is directly attributable to the oil sector. Over the last several years, Nigeria has been on an adventure with international credit institutions, culminating in an agreement to finally initiate corrective economic reforms which should stabilize the country's finances.

Nigeria's Oil Industry

The first discovery of oil was made by Shell D'Arcy in 1956, after a period of nearly 50 years of exploration by a succession of companies. Export of oil began in 1958, and today Nigeria is ranked eighth among all the countries of the world in crude oil export volume. Nigeria has a special energy relationship with the United States, as approximately 42% of its annual 2.15 million bbl/day of oil exports reach the shores of the USA. To the United States, Nigeria is the fifth most important source of foreign crude oil, behind Canada, Saudi Arabia, Mexico, and Venezuela, and in that order. Europe receives another 19% of Nigerian crude oil exports.

Nigeria's petroleum infrastructure includes more than 3,100 miles of pipeline network, 21 storage depots, and nine LPG depots. These are in addition to the four existing refineries which together have a total installed capacity of 445,000 bbl/day. Three petrochemical plants are also a part of downstream operations, as are six export terminals.

All of the country's petroleum infrastructure falls under the aegis of the Nigerian National Petroleum Corporation (NNPC), a government agency vested with the exclusive responsibility of

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Issues and Perspectives

Walking the tightrope of oil supply and demand: Nigeria

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both upstream and downstream development. Problems due to political instability, sabotage, fire, poor management, and a lack of proper maintenance have all combined to the point where refinery output is less than half of refinery potential. Despite this statistic, there are plans to construct a new refinery in Lagos by an existing Nigerian marketing firm. This would be a real boost for the country's economy, as Nigeria cannot currently refine enough crude oil to satisfy domestic requirements.

In addition, using figures through May of this year, it appears that 2007 crude oil production will end the year well below 2006 levels. Peak crude oil production was realized in 2005 and has been falling ever since.

Primarily to comply with stipulations associated with international financial agreements, and partly due to the new environment being created by the change in government, Nigeria is very interested in moving their petroleum industry to a market-driven, privatized model. The petroleum infrastructure is now for sale. There has been little interest by independent oil companies in acquiring any of the facilities, but there has been recent interest expressed by Libyan, Indian, and Chinese investor interests.

Nigeria's Oil Future

Assuming that buyers of these petroleum assets can be found, the future of the oil industry in Nigeria should brighten considerably. The country's most significant deficits have been a lack of political stability due to the insurgent movement, and the ultimate strain on financial resources due to the government's lack of purpose in pursuing a diverse economy relatively unhindered by continued accusations of corruption.

The new government's economic reforms, while mostly due to external applications of pressure, appear to be genuine attempts to cure past ills. This should serve to pre-empt the demands of the rebellious elements and create a more stable environment for industry and commerce alike.

Potential "orifice plate" restrictions for oil production in Nigeria:

- 1. Labor unrest: In 2004, Total shut down oil and gas production due to fears of a labor strike.*
- 2. Pipeline vandalism: Attacks from October 2005 through February 2006 reduced oil production and threatened refining capacity.*
- 3. Kidnappings of oil workers: Early in 2006, workers from Shell oil were kidnapped and held for ransom.*

While this is certainly an optimistic view, and the necessary political and economic changes are in their early days, it is also true that the global energy market will remain a strong inducement to set things right, when there is so much to gain by doing so. The powers in Nigeria are sure to turn toward the fundamental concept of winning through cooperation, if not friendship.

Oil Supply

This section looks at the supply side of the oil supply and demand equation. It looks at the role of the Organization of Petroleum Exporting Countries (OPEC) and the Organization of Economic Cooperation and Development (OECD) in relation to oil production. It also discusses the topic of oil prices, and the drivers behind the price of oil.

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Issues and Perspectives: Oil Supply

Crude oil sets record; tops \$90 a barrel

A Worldflow Flash Report

By Jesse Yoder and Norm Weeks

The price of a barrel of crude oil plunged through the psychologically important \$90 price barrel on October 25, 2007. On October 25, the price of a barrel of West Texas Intermediate Crude closed at \$92.97. Analysts have been talking about \$90 crude oil for a number of months, but this is the first time it had actually reached this benchmark number.

In a special report on the price of crude oil in the Q2 2006 Energy Monitor, we published an article called “Walking the tightrope of oil supply and demand.” According to this article, “The strongest reason for the high price of crude oil today is the balance between supply and demand.” The article then went on to state that “When the oil supply is threatened from any major oil producing country, prices typically rise on fears of reduced supply.” Supply disruptions were likened to an orifice plate that places a restriction on the flow. The article looked at six oil producing countries that are susceptible to supply disruptions: Saudi Arabia, Russia, Iran, Mexico, Venezuela, and Nigeria.

What is especially important about the recent run-up in oil prices is that it is not primarily a result of “orifice plate” restrictions on supply. Instead, the price reflects the tightrope of supply and demand. According to the Energy Information Agency (EIA), world demand for oil in Q1 2007 was 85.36 million barrels per day (bpd). During the same quarter, the world oil supply was 84.15 million bpd. So worldwide demand is already beginning to outstrip the available supply.

What is most impressive about the run-up in oil prices is that it occurred without a lot of supply disruptions, either from the major oil-producing countries or from the weather. Even at the current high prices, the price of oil could go higher if “orifice plate” supply disruptions occur. While these effects are often short-term, they could temporarily boost the price of crude oil by several dollars a barrel.

What it means. The long-term trend for oil is for demand to increase while supply remains tight. The emerging markets of China and India, as well as the markets of other developing countries, are continuing to ramp up the demand for oil. This trend is not likely to be reversed, given the rapid growth rates of these countries, especially China. While a truly long-term solution will incorporate other sources of energy, such as renewables, demand for oil in the near-term is likely to increase.

As the price of oil increases, along with the price of natural gas, companies will be willing to pay more to measure it. The worldwide flowmeter market is currently on an upswing that began towards the end of 2003 and the beginning of 2004. During this time, the pressure transmitter market has also shown dramatic growth. Companies that focus on the energy industries, especially oil & gas production, exploration, and transportation, stand to gain from the rally in

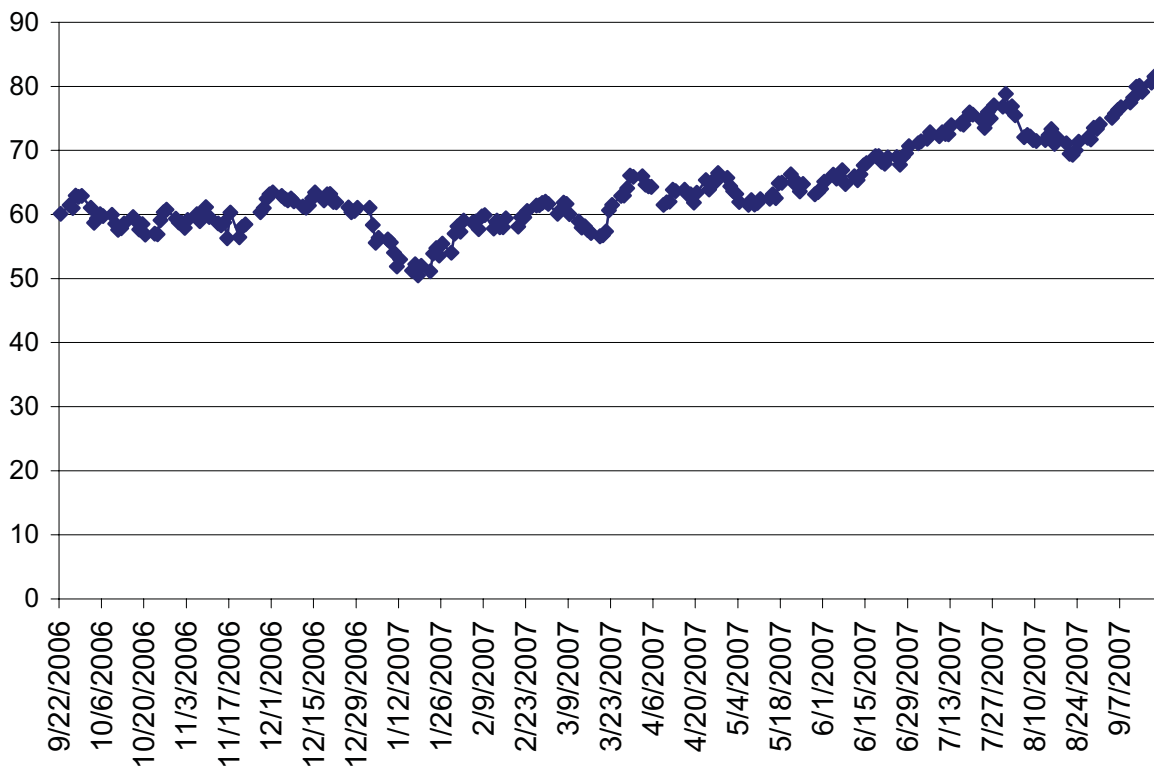
Issues and Perspectives: Oil Supply

Crude oil sets record; tops \$90 a barrel

energy prices. Custody transfer and billing applications are especially significant in these markets.

The chart below shows the price of one barrel of West Texas Intermediate (WTI) crude oil over the past year.

The Price of One Barrel of WTI Crude Oil in US Dollars
from Sept. 22, 2006 through Sept. 18, 2007



Issues and Perspectives: Oil Supply

Worldwide oil supply and demand

A Worldflow Special Report

By Jesse Yoder

A look at supply and demand worldwide shows that supply is remaining steady while demand is increasing. The following discussion from the Energy Information Agency (EIA) provides an analysis of both worldwide supply and demand for oil in 2007. The charts on the following two pages show worldwide supply and demand in 2006 and early 2007.

Oil Consumption. World oil consumption rose by 1.2 million barrels per day (bbl/d) in the second quarter of 2007 compared with year-earlier levels. China, the Middle East, the United States, and India accounted for most of the increase in oil consumption. EIA projects that world oil consumption will increase at a year-over-year rate of 1.8 million bbl/d during the second half of 2007. Recent volatility in financial markets contributes to uncertainty in the consumption projections, suggesting possible future downward revisions if the situation leads to slower economic growth than currently expected.

Non-OPEC Supply. Non-OPEC oil production is projected to grow by about 600,000 bbl/d during 2007 compared with year-earlier levels, a reduction of roughly 100,000 bbl/d from last month's Outlook. A downward revision of 51,000 bbl/d in Mexico's 2007 oil production is a principal cause of this change. In 2008, EIA estimates that non-OPEC petroleum production will grow by about 1 million bbl/d. The 2008 forecast is about 100,000 bbl/d lower than the last assessment due to a downward revision in projected U.S. ethanol and conventional oil output.

OPEC Supply. Announced maintenance at fields in the United Arab Emirates has lowered EIA's projection for OPEC crude oil production in the fourth quarter by 100,000 bbl/d from last month's Outlook to 30.9 million bbl/d. In 2008 EIA expects that OPEC will increase production slowly, to an average of 31.4 million bbl/d, in order to manage inventories and maintain prices. The economic uncertainty and risks to oil demand brought on by the turmoil in financial markets will likely reinforce OPEC's cautious approach to production-target decision-making.

Despite expected increases in production capacity by several OPEC members, the expected gains in demand for OPEC oil will likely keep surplus capacity in the 2-3 million bbl/d range through 2008. Most of the surplus will remain concentrated in Saudi Arabia, leaving Riyadh with the flexibility to play a key role in influencing oil market developments. The modest level of worldwide surplus capacity makes the market vulnerable to unexpected supply disruptions.

Inventories. At the end of June 2007, Organization for Economic Cooperation and Development (OECD) inventories stood at 2.66 billion barrels, near the high end of the 5-year range. EIA's projections of world oil supply and demand indicate that OECD inventories may register a counter-seasonal stock draw in the third quarter. Inventories are expected to decline at a faster-than-average rate in the fourth quarter, leaving inventories at the low end of the last 5-year range through the rest of the forecast period.

Issues and Perspectives: Oil Supply

Worldwide oil supply and demand

OECD and OPEC

The EIA reports world oil supply and demand through the prism of the Organization of Economic Cooperation and Development (OECD) and the Organization of Petroleum Exporting Countries (OPEC). The charts of supply and demand on page 10 on page 10 of this White Paper report crude oil supply and consumption in terms of those two organizations. For this reason, it is worth looking more closely at both organizations.

OECD

The roots of the OECD go back to the Organization for European Economic Cooperation (OEEC). The OEEC was formed in 1947 to administer American and Canadian aid after World War II for the reconstruction of Europe according to the Marshall Plan. Its headquarters were established in Paris in 1949. In 1961, the OECD took over from the OEEC.

What is common to members of the OECD is that they are committed to democracy and a market economy. The member countries are shown in the following table.

Member Countries of the OECD					
Europe				Asia	Americas
Austria	Germany	Luxembourg	Spain	Australia	Canada
Belgium	Greece	Netherlands	Sweden	Japan	Mexico
Czech Republic	Hungary	Norway	Switzerland	New Zealand	United States
Denmark	Iceland	Poland	Turkey	South Korea	
Finland	Ireland	Portugal	United Kingdom		
France	Italy	Slovakia			

Issues and Perspectives: Oil Supply

OPEC and the price of oil from 1970 to today

The Organization of Petroleum Exporting Countries (OPEC) was founded at the Baghdad Conference held on September 10-14, 1960. The founding members of the organization were Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. The chart below shows the membership of OPEC today, including when the additional countries joined. OPEC's headquarters were in Geneva, Switzerland initially, but these were moved to Vienna, Austria on September 1, 1965.

OPEC began wielding its influence over oil prices in the 1970s, with two oil pricing crises. The first was the Arab Oil Embargo in 1973. In 1972, oil was selling for as little as \$3 per barrel, while by the end of 1974, it had increased to \$12 per barrel. This was the period of the Yom Kippur War between Israel, Egypt, and Syria.

Prices remained fairly steady from 1974 to 1978. The second oil crisis began in 1979, with the Iranian revolution. This was followed in September 1980 by the Iran-Iraq war. Oil prices increased from \$14 a barrel in 1978 to \$35 a barrel in 1981. After 1981, oil prices began to decline, and bottomed out at less than \$10 per barrel in 1986. After the 1986 crisis, oil prices rebounded, although they did not reach the high levels of the early 1980s.

In the early 1990s, oil prices spiked again to more than \$30 per barrel with the advent of the Gulf War. OPEC members played a role in bringing

prices back down by increasing output. Following the Gulf War, oil prices declined until 1994, when they began increasing again. Price increases came to an end in 1997, with the Asian economic crisis. Early in 1999, oil prices briefly dropped below \$10 a barrel. Prices then began recovering until early in 2001, when they exceeded \$28 per barrel. OPEC had three production quota increases in 2000, in an effort to keep prices down. Prices began declining after the events of 9/11/2001 in the US. In December 2001, prices declined to the range of \$18 a barrel.

Country	Region	Joined OPEC
Algeria	Africa	1969
Angola	Africa	2007
Indonesia	Asia	1962
Iran*	Middle East	1960
Iraq*	Middle East	1960
Kuwait*	Middle East	1960
Libya	Africa	1962
Nigeria	Africa	1971
Qatar	Middle East	1961
Saudi Arabia*	Middle East	1960
United Arab Emirates	Middle East	1967
Venezuela*	South America	1960
* Founding Member		

Issues and Perspectives: Oil Supply

OPEC and the price of oil from 1970 to today (cont.)

OPEC responded to the lower oil prices by deferring production cuts. However, in January 2002 OPEC reduced its quota by 1.5 million barrels per day. Russia also added its own production cuts. These actions had the desired effect, and the price of crude oil was up to \$25 per barrel by March 2002.

OPEC Meetings. OPEC typically meets twice a year, in March and September, although it can meet at other times as events require. The Oil and Energy Ministers of the member countries meet. OPEC operates on the principle of unanimity, and each country has one vote. OPEC has traditionally attempted to control prices by limiting production. This idea goes back to the founding conference in 1960. Two of the representatives to the original OPEC meeting had studied the way the Texas Railroad Commission had controlled prices by limiting production.

OPEC's Price Band Mechanism. In its March 2000 meeting, OPEC set up a price band mechanism to respond to the changes in world oil prices. This band was based on the price of a "basket" of crude oils that was created in January 1987. An average oil price was computed by taking an arithmetic average of seven crude oil streams. These oil streams include crude oil from Saudi Arabia, Dubai, Indonesia, Nigeria, Algeria, Venezuela, and Mexico. According to the price band set up in March 2000, OPEC basket prices above \$28 per barrel for 20 consecutive trading days or below \$22 per barrel for 10 consecutive trading days would result in production adjustments. As long as this target band remained in effect, OPEC had a controlling mechanism to help keep oil prices between \$22 and \$28 per barrel. It remained in effect until early in 2005, when OPEC abandoned it as unrealistic.

Price Fluctuations. Prices remained below \$30 per barrel until the end of 2002. In 2003, oil prices were between \$25 and \$35 per barrel for most of the year. In 2004, prices fluctuated in the high 30s at first, then hit the high of \$40 per barrel in May 2004. By October 2004, oil prices exceeded \$50 per barrel for the first time. In 2005, prices varied between \$45 and \$55 per barrel in the first half of the year. Then in July 2005, oil prices exceeded \$60 per barrel for the first time. Prices remained above \$60 for much of the rest of the year, although they did dip below \$60 per barrel to the high \$50s in November and December 2005.

In 2006, prices began the year in the \$63 range, then exceeded \$70 per barrel in April 2006. From April to September 2006, oil prices mostly varied from the high \$60s to the lower \$70s. The chart on page 29 begins in September 2006, and shows that prices in the past year have mostly been between \$60 per barrel and \$80 per barrel, even though they dipped briefly below \$50 a barrel.

There are a number of drivers of oil prices. However, the price of oil is fundamentally a result of supply and demand. Worldwide supply and demand is currently in the 84 to 85 million barrels per day range. What is happening now is that supply is remaining relatively constant while demand is increasing. In particular, demand for oil is increasing from Asian countries, especially from China. This is why oil prices continue to increase. The charts on the next two pages tell the supply and demand story. In Q1 2007, worldwide supply was 84.15 million barrels per day, while worldwide demand was 85.36 million barrels per day. Demand exceeds supply.

Oil Demand

This section looks at the demand side of the oil supply and demand equation. It looks at oil demand by geographic region, and lists the top 15 oil consuming countries. It also looks at the driving forces behind oil demand.

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