Center for Strategic and International Studies
Arleigh A. Burke Chair in Strategy
1800 K Street, N.W. • Suite 400 • Washington, DC 20006
Phone: 1 (202) 775-3270 • Fax: 1 (202) 457-8746
Email: BurkeChair@csis.org

The Changing Risks in Global Oil Supply and Demand:

Crisis or Evolving Solutions?

Anthony H. Cordesman & **Khalid R. Al-Rodhan**

Arleigh A. Burke Chair in Strategy
acordesman@aol.com

Visiting Fellow
kalrodhan@csis.org

First Working Draft: October 3, 2005

Acknowledgements

The authors would like to thank many for their comments, suggestions, and corrections to an earlier version of this report. The authors would also like to thank Emily Fall for her assistance in researching and editing this report.

Authors' Notes

This paper is a working document that will be revised and updated. Please email the authors with your comments, suggestions, and corrections. Further updates of this report and other reports can be found on the CSIS website: http://www.csis.org

It relies on many sources, including reports by the EIA, the IEA, OPEC, USGS 2000, energy companies such as Aramco and BP, news articles, and the reports by energy analysts. Data and analysis for oil supply and demand was adapted from reports such as the EIA's *International Energy Outlook 2005* and the IEA's *World Energy Outlook 2005.* Reserves data were adapted from two main sources the BP's *Statistical Review of World Energy 2005* and the *US Geological Survey 2000*.

The definition of key terms may be summarized as follows: *Proven Reserves:* quantities of crude oil that geological data and engineering information indicates with reasonable certainty can be recovered in future. *Known Reserves:* discovered crude oil accumulation that are considered economically viable to produce. *Undiscovered Reserves:* quantities of crude oil that geological data and engineering information indicates exist outside known oil fields.

The report uses many acronyms and notations:

- DOE: The United Stated Department of Energy
- EIA: Energy Information Administration
- IEA: International Energy Agency
- IEO: International Energy Outlook
- IMF: International Monetary Fund
- IRAC: Importer Refiner Acquisition Cost
- MMBD: Million Barrels A Day
- MMS: US Minerals Management Services
- Mtoe: Million Tons of Oil Equivalent
- OPEC: Organization of Petroleum Exporting Countries
- TCF: Trillion Cubic Feet
- USGS: United States Geological Survey

The Arleigh A. Burke Chair in Strategy
Center for Strategic and International Studies
1800 K Street, N.W.
Washington, DC 20006
+1 (202) 887-0200
http://www.csis.org

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Executive Summary

The future of energy is of enormous importance. The global energy market is intricate and the analysis of it is uncertain. The ability of policy planners and strategists in petroleum-consuming nations is limited at best. Most of the known world reserves exist in regions and countries that are not stable. Consumers cannot control where oil reserves exist and the geostrategic risks are not likely to change in the near future.

The dynamics of the current oil market rely on four major interdependent areas of uncertainty: geostrategic risks, macroeconomic fluctuations, nature of resources risks, and the uncertainty in current and future oil production capacity.

At this point, about all that is certain is that the global energy market is unpredictable and that recent oil prices have been high and volatile. In four years, the price per barrel of oil has increased by roughly 108%. The price of crude oil averaged $25.9/barrel in 2001 and for the first eight months of 2005, the average price crude oil increased to approximately $54.1/barrel.[1]

Rigorous, transparent, and credible analysis, however, can improve our understanding of the forces at play and provide policy makers and analysts the tools necessary to forge sound energy policy based on real-world realities and risks.

Key Geopolitical Uncertainties

The six major petroleum-producing areas (Middle East, Africa, Asia-Pacific, Europe-Eurasia, North America, and Latin America) face major production and resource uncertainties. It is clear the geostrategic risks facing these regions have tangible implications on their energy sector and on the global petroleum market. The geopolitical and military implications are hard to quantify. The risk premium of these uncertainties, however, will be affected by the following key geostrategic challenges, all of which could have direct and indirect affect on the global energy market:

- **Stability of oil exporting nations:** The stability of oil producing nations is of paramount importance to the world oil market. The strikes in Venezuela, the War in Iraq, and the ongoing disruptions of Angolan and Nigeria oil were examples of what could happened if this happened in other countries such as Saudi Arabia and Iran.
- **Terrorism in the Gulf and oil facilities securities**: While the threat from Iran's conventional military may be real, the more dangerous threat is that of extremists groups' asymmetric attacks on oil facilitates. The Gulf contains over 65% of the world's "proven" reserves. There is no attack-proof security system. It may take only one asymmetric or conventional attack on a Ghawar or tankers in the Strait of Hormuz to through the market into a spiral at least for the near future.
- **Proliferations of WMD**: The success in stopping the AQ Khan does not mean the end of a nuclear black market. It remains a real threat to the entire world, especially the Gulf, of a nuclear weapon falling in "the wrong hands" such as Al-Qaeda.
- **Embargos and sanctions:** Another OPEC oil embargo is very unlikely, however, if oil is ever used a weapon to combat US or Western foreign policy or if sanctions were imposed on Iran, for example, it will have devastating effects on the global economy.
- **Ethnic conflicts and strives:** Disagreements over the control of oil revenues by ethnic groups can destabilize countries and disrupt the flow of oil. Currently, the ongoing conflict in the Niger Delta and the War in Iraq provide two examples of how devastating such crises are.

- **Natural disasters:** Natural incidents in production, export, or refining areas can be damaging to the energy market. Hurricanes in the Gulf of Mexico have caused supply and distribution disruption in the US, and have added large premiums to the price of a barrel of oil. Hurricanes Katrina and Rita, which hit the US during August and September 2005, shut down most of the refineries in the US Gulf of Mexico and forced the US to release some of their strategic petroleum reserves.

- **Security problems and accidents:** The world can absorb the problems created by most forms of local conflict and internal security problems when there is significant surplus capacity and prices start from a relatively low base. Behavior changes drastically, however, when supply is very limited and prices are already high. Even potential threats to petroleum production, exports, and distribution can radically alter prices and market behavior. Actual attacks, or major industrial accidents, can have a much more serious impact. The loss of a major supplier, or a sustained major reduction in regional exports, potentially can have unpredictable price and supply impacts that impact on the entire global economy.

Stability in petroleum exporting regions is tenuous at best. Algeria, Iran, and Iraq all present immediate security problems, but recent experience has shown that exporting countries in Africa, the Caspian Sea, and South America are no more stable than the Gulf. There has been pipeline sabotage in Nigeria, labor strikes in Venezuela, alleged corruption in Russia, and civil unrest in Uzbekistan and other FSU states.

Experts believe that, in the near future, energy supply and transportation routes may be challenged by transnational terrorism and proliferation. It is equally possible that recent surges in the demand for oil, supply disruptions by hurricanes, the US refining capacity bottleneck, and the limited spare production capacity will continue to test the energy market in the mid to long-term.[2] Natural disasters, such as hurricanes and tsunamis, may also prove to be troublesome to the instability of the energy markets by causing production, transportation, and refining disruptions.

Macroeconomic Fluctuations

Like all economic forecasts, predicting supply, demand, and prices of crude oil involves significant uncertainty. Predicting the oil market is notoriously difficult and constant updates and additions to the models are needed. The most recent EIA, IEA, and OPEC forecasts have not been adjusted to consider long-term oil prices in the $50 and above range, even in their high oil price case. Only the EIA analysis partially addresses high price cases for petroleum and it does not examine the influence these high prices would have on the demand, supply, and the long-term elasticity of global energy balances.

The following key factors influence the oil market, and each involves major uncertainties and unknowns:

- **Problems in import-dependent developing countries**: Countries with relatively free market economies that are highly developed are rich and flexible enough to adapt to high prices and supply problems far more flexible than poor countries, countries with serious foreign reserve and balance of payments problems, and importers with high levels of subsidies for oil and gas. By and large, the impact of high prices is not modeled in such terms.

- **The sustainable and spare capacity of oil producing countries:** There is a growing debate over spare capacity of OPEC nations, and their ability to "balance the market." Perceptions are as important as realities. The market's lack of confidence in the producers to meet the demand adds a risk premium to any estimates and pushes prices up.

- **The cost of sustaining and expanding petroleum production and exports, and of the necessary investments**: Most of today's estimates of the cost of future production are badly dated, and do not take into account the cost of the most advanced technology for exploration, development, and production, or the

scale of the investment needed in distribution in areas like port facilities, new tankers, refineries, etc. Cost models need a major reevaluation.

- **Country capability and practice in sustaining and expanding petroleum production and exports:** There is little effort to assess country-by-country capability to use best practices, and adopt the most advanced technology and methods. Countries like Kuwait and Iran have failed to move forward in using such practices for very different reasons. Countries like Iraq face insurgency, the risk of civil war, and a long legacy of underfunding proper development.
- **The long-term elasticity of demand:** The development of alternative sources of energy, efficiency, and conservation have long-term effect on the market, but time lags, investment costs, and delivery prices are uncertain at best in the foreseeable future.
- **The Long-term elasticity of supply:** Major debates exist over the size of proven, possible, and potential resources' rates of discovery, development and production costs, fields' life, and the impact of advanced technology.
- **The refining capacity and inventory build up of the importing nations:** The lack of ability by importing states to refine crude oil and distribute it to the domestic market in a timely manner can build bottlenecks. These bottlenecks exert upward pressure on the price of crude oil and squeeze the average consumer at the gas bump.
- **The overall health of the global economy:** While it is clear that oil prices and economic growth in developed countries are negatively correlated, it works both ways. High oil prices have negative effect on economic growth in consuming states, but low economic growth in industrialized nations causes a decrease in demand for oil and lower oil prices.
- **The rise of new economic powers:** In recent years, the oil market has experienced an unexpected increase demand of oil from countries in Asia such as China and India. According to the IMF, this surge from emerging countries could account for 40% of the increase in oil demand in 2004.
- **Lack of investment:** These pressures and uncertainties add to the economic risk premium causing oil prices to rise further. Moreover, while higher oil prices may provide incentives for private and public investment in the oil industry, the lack of geopolitical stability, and ability to predict how long high oil prices will continue, prevents many from investing in these areas.

  Providing the kind of massive surges in the demand for oil projected in recent studies, requires massive investments to build new infrastructure and finance new technologies. In 2003, the IEA projected that the world oil demand would rise by 60% by 2030, and that the world energy market would need $16 trillion of cumulative investment between 2003 and 2030 or $568 billion a year. Even this estimate is based on unrealistically low estimates of investment cost and outdated assumptions about the sophisticated exploration, development, and production technology and equipment needed in modern oil fields. Yet it still requires vast transfers of capital.

It is too soon to draw any firm conclusions about the impact of high oil prices on global oil dependence, on US and other imports, and on increases in conservation and the supply of alternative fuels, but these factors indicate that high prices are not necessarily bad for the global economy and could trigger market forces that offset their short-term negative effects. The fact, however, is that no one really knows given the complex mix of elasticities involved because meaningful modeling and analysis is only beginning.

Nature of Resource Risks

Given the strategic risks faced by oil producing nations, claims about production goals and capacity and oil reserves have long been a political tool. Some producers have inflated their "proven" reserves to project strategic importance, which has added to the uncertainty and the lack of transparency.

The fall of the Shah in 1979 and the Iran-Iraq War, for examples, led to a competition in the Gulf to announce new levels of "proven" reserves to demonstrate the strategic importance of given countries, and major increases in the claims made by Iran, Iraq, Saudi Arabia, Kuwait, and other countries.

Limited hard data are available to validate many national claims and plans. Yet, credibility in this area is of enormous importance because as we will see key modelers depend on each country's report for their demand-driven models to forecast the global supply and demand. In many cases, data are lacking, there is little validation and transparency, and current models and estimates simply assume levels of petroleum capacity that may never exist.

The global energy market faces key uncertainties in the determining the exact nature of reserves, which include:

- **True nature of reserves:** There are ongoing debates on the reliability of reserves. The USGS 2000 continues to be the benchmark estimate. However, as with any estimates, forecasting uncertain. Furthermore, analysts disagree about the definition of "known" vs. "undiscovered" vs. "proven" resources.
- **Impact of technological gain:** Some experts argue that aging oil fields have higher water cuts and that "vertical" wells cannot be used. Other energy estimates do not take into account new technological developments, which may change the estimate of "possible" & "probable" reserves.
- **Ability to substitute for current super-giant and giant fields:** Some experts have argued that new field discoveries do not support reserve estimates, and major producers such as Saudi Arabia, Iraq, Kuwait, and UAE rely on aging super-giant fields that were discovered in the 1950s and 1960s and are in decline, and that none of their kind has been found in recent years.
- **Rate of decline in fields:** The percentage of the oil reserves in the fields that have pumped out is a contentious and uncertain estimate. Analysts and investors have to rely on independent estimates and the announcements by oil companies.
- **Rate and size of new developments and discoveries:** Outside analysts have to rely on the discovering country's announcement and statement for estimate of any new discoveries. Moreover, it remains uncertain whether certain countries are "over explored" or "under-explored."
- **Inaccuracy of 3-D seismic modeling:** Some experts have argued that new technologies that use computer modeling are not enough. They provide a good estimate of possible reserves, but they do not replace old fashion drilling and physically measuring actual reserves.

In many cases, it is not clear that the Energy Information Administration (EIA), International Energy Agency (IEA), Organization of Petroleum Exporting Countries (OPEC), or United States Geological Survey (USGS) have applied sufficient rigor to a country-by-country reexamination of such estimates. (The USGS does use a different methodology because it looks at the basins on a geological potential basis, but the data available are uncertain and dated.)

Lack of Robust Modeling

Modeling urgently needs to examine supply-driven models, not just demand-driven models. Equally important, the key modelers of global energy supply and demand have not yet chosen to react to the recent rises in oil prices and examine cases that go above $50 a barrel in detail. There have been some preliminary efforts by the IMF and the EIA in its *International Energy Outlook 2005*. Projections by OPEC, the IEA, and the latest EIA's forecasts need to be revised or expanded to examine such cases, and to examine the implications of a world with a "sustained" $60/barrel, $80/barrel, or even $100/barrel oil.

The modeling of sustained high price cases is just beginning, but previous modeling efforts do provide important warnings. If oil prices drop back to the level between $31 and $35 a barrel (in 2003 dollars), as assumed in the reference case of the *International Energy Outlook 2005*, the EIA estimates that world demand for oil will increase from 78 MMBD in 2002 to 119 barrels per day in 2025. This projected increase of world oil demand would require the global oil production to increase by 42.0 MMBD over the world's 2002 capacity levels--accounting for approximately 38% of the world's energy consumption through 2025.[3] In addition, a 2004 EIA report estimates that the US and its major trading partners in developing Asia will account for 60% of the increase in world demand through this period.[4]

More generally, many laymen do not understand the wide range of problems in foundations on which forecasting methodology is based. It is all too clear that the modeling the EIA, IEA, and OPEC used in the global petroleum supply and demand forecasting has been driven by estimating global demand at comparatively low oil prices.

Reports by the EIA, IEA, and OPEC could provide a better benchmark for the global energy market if they addressed certain areas of deficiencies. The key gaps and areas of uncertainty in the *International Energy Outlook 2005*, for example, include:

- **Parametric analysis:** They lack of any parametric analysis of its oil price forecast. Furthermore, models such as the IEO treat major shifts in energy cost and different levels of economic growth largely as independent assumptions and variables.

- **Economic growth rates:** They do not provide sufficient explanation as to how the rates of economic growth interact with the price of oil and how the price-elasticity of demand changes over time given an economic growth rate.

- **Countries' plans:** They do not take into account country-by-country plans in forecasting oil production capacity. If they do, there is little explanation of how such plans have changed since their last forecast and how realistic or unrealistic those plans are.

- **Indirect imports:** The reports do not make estimates of indirect imports of oil/petroleum from other regions in terms of the energy required to produce finished goods. The US, for example, indirectly imported very significant amounts of oil in the form of manufactured goods from Asian countries dependent on Middle Eastern oil imports.

- **Technological improvements:** They do not explicitly analyze technological improvements and the role technological breakthroughs in enhancing oil recovery and exploration for new oil reservoirs, development that have significant affects on future oil supply and the oil market.

- **Relation of oil prices to demand of alternatives and conservation:** No credible explanations are given of the interactions between different oil prices and the level of oil supply and demand, or changes in the supply and demand of gas, coal, nuclear power, renewables, electricity, and conservation.

- **Supply and demand elasticities:** No effort is made to determine the very different patterns of elasticity in supply and demand for gas, coal, nuclear power, renewables, electricity, and conservation that have to emerge over time if oil prices remain so much higher than in the past, or the major uncertainties that will inevitably result from such changes.

- **Discontinuity theory**: Models and forecasts use smooth curves and largely "static" assumptions. Growth in demand and supply tends to be at constant rates or in predictable curves. Reality never produces consistent trends or allows trees to grow to the sky. There is a clear near for an assessment of what kind of sudden events or discontinuities are critical and for some form of Baseian approach to risk analysis.

As a result of these gaps, the current forecasts of EIA, IEA, and OPEC now do little more than illustrate what might happen in a world where virtually everything goes right from the importer's view, where export capacities automatically respond to need, and political and military risk have no impact.

Oil Production Uncertainties

If high-sustained demand growth actually occurs, virtually all sources indicate that it will put a growing strain on both global petroleum supply and export capacity. The BP's *Statistical Review of World Energy 2005* reported that in 2004, the average total world production was 80.26 MMBD—higher than the 2003 average by 3.206 MMBD. In 2004, OPEC produced 32.927 MMBD, which is a 7.7% increase from their 2003 production levels of 2.241 MMBD, Russia increased its production by 0.741 MMBD (+8.9%), and China by 0.089 MMBD (+2.9%).[5]

Non-OPEC supply so far has been slow to respond to the high oil prices. In fact, it increased by only 0.046 MMBD in 2004 (31.8% of which came from the FSU). According to the US DOE, the expected increase in Non-OPEC oil production for 2005 is 0.92 MMBD.[6] In the years of 2005 and 2006, more than half of this non-OPEC increase is estimated to come from the FSU and the Atlantic Basin, including Latin America and West Africa.[7]

The EIA forecasts the total world production capacity in 2025 for the low, medium, and high price cases as follows: 135.2 MMBD for the low price case, 122.2 MMBD for the reference case, and 115.5 MMBD for the high price case. In both the 2004 and 2005 cases, the projected increase in total world production capacity is still significant. By 2010, it could increase from 14.6 MMBD to as high as 21.6 MMBD. The "high price" case, however, is far easier to achieve in the real world than the "reference" or "low price" cases.

As is clear from these numbers, as the price oil decreases, production capacity increases. One notable exception is that Non-OPEC countries' production capacities have the opposite reaction to a change in the price of oil. OPEC countries largely drive this relationship between price and production capacity. From an economics point of view, a decrease in the price of oil decreases the willingness of suppliers to produce and sell oil. The *IEO2005*, however, shows the opposite effect for OPEC countries. One possible explanation is that OPEC countries control the price of oil with their quotas.

The shift toward high oil prices could, however, sharply reduce the growth in future demand for oil, and lead to major new investment in all forms of energy supply, conservation, and efficiency. In the interim, however, the following points production and resource risks now affect oil-producing nations in their efforts to expand their spare capacity:

- **Little "sustainable" spare capacity:** With the exception of Saudi Arabia, in 2005, the rest of the world had no spare capacity. If there were sudden surges in demand (high economic growth) or distributions in supply of other exporters (the Iraq War in 2003, Venezuela strikes in 2004), will producers be able to meet such shortage?

- **Elasticity in importer conservation, efficiency, and alternative supply and time/uncertainty lags:** One of the flaws of the current forecasts by the EIA, IEA, and OPEC is that they do not take into account changes in the elasticity of supply and demand. Long-term and mid-term elasticities have an impact on the demand, supply, and price, which in turns changes investment incentives and production capacity.

- **Producablilty at given prices:** Some experts have argued that the "easy oil" era is over. Oil recovery is more costly, and the price of oil has to be high enough to cover variable, fixed, and sunk costs and investment, but not too high that it exerts downward pressure on demand.

- **Technological gain in the upstream & downstream sector:** Current production capacity forecasts do not and may not be able to anticipate technological gains in the upstream side of the industry, especially demand-driven models. Producers strive to improve efficiency by investing in R&D and new technological innovations, but it remains uncertain how much, how, and when these technological gains may bear fruits in terms of real-world change in the level of recovery.
- **The "sustainable" inflow of foreign investment:** Natural depletion of current oil fields is inevitable. Expansion programs, therefore, are needed to replenish this natural decline, but developing countries are in need of foreign investment in terms of both capital and technological sharing. The lacks of security and stability, rigid foreign investment and tax laws, and limited transparency have prevented the inflow of much needed foreign investment into developing countries.

Estimates of near term spare capacity are increasingly uncertain and inevitably differ. According to the IEA, in early 2005, OPEC had 1.92-2.42 MMBD spare capacity, but according to the EIA, it had 1.1-1.6 MMBD. In both cases, practically all of the spare capacity was from Saudi Arabia. HETCO forecasted that in 2005, OPEC would increase its production by 0.70 MMBD. Again, most of the increase will depend on Saudi Arabia's ability to increase its capacity. HETCO forecasted an increase in Saudi production capacity from 10.68 to 11.15 MMBD.[8]

Solving Supply Issues Relating to Middle Eastern Oil

The potential impact of high oil prices in easy the strain on world oil supplies becomes clearer when one looks at the impact of oil prices on the need for Middle East and North Africa (MENA) conventional oil production capacity.

- The *IEO2004* called for major increases in MENA oil production capacity. It forecast that Saudi Arabia's production capacity in 2025 would be 31.5 MMBD for the low price case, 22.5 MMBD for the reference case, and 16.0 MMBD for the high price case.
- The *IEO2005* forecasts that conventional MENA production capacity in 2025 will be 51.1 MMBD for the low price case, 39.5 MMBD for the reference case, and only 28.1 MMBD for the high price case.

These contrasts are even more striking for Saudi Arabia. For many years, most of OPEC's projected increase in production capacity in both the EIA and IEA models has been driven by Saudi Arabia. In recent times, the Saudi production capacity has received a lot of attention. Some analysts have questioned the Kingdom's ability to meet sudden surges in demand because of its lack of spare production capacity, and others – like Matthew Simmons – have estimated that Saudi production may be moving towards a period of sustained decline.

In 2002, Saudi Arabia had an oil production capacity of 9.2 MMBD. This capacity was roughly 9.0-10.5 MMBD in 2004, and has so far averaged 10.5-11 MMBD in 2005. Like most of its predecessors, the *IEO* analysis for 2004 called for truly massive increases in Saudi oil. It forecast that Saudi Arabia's production capacity in 2025 would be 31.5 MMBD for the low price case, 22.5 MMBD for the reference case, and 16.0 MMBD for the high price case.

Te *IEO2005* forecasts that Saudi Arabia's production capacity in 2025 will be 20.4 MMBD for the low price case, 16.3 MMBD for the reference case, *but only 11.0 MMBD for the high price case*. *Yet, Saudi Arabia already plans to increase its production capacity to 12.5 MMBD by 2009.*

Most analysts, including current and former Saudi Aramco officials, believe that the 20.0 MMBD is an unattainable production capacity. At this point, one can argue that the Kingdom could reach this production capacity only if two things happen: there are major technological

breakthroughs that enhance recovery of existing oil fields or help find new reservoirs and there are major supply disruptions that forces Saudi Arabia to meet the shortages in supply.

General Patterns of Oil Dependence

The US and China are key "drivers" in the increasing demand for energy imports and production capacity in most models. However, current models project that African and Middle Eastern imports could double by 2025. India could emerge as a major new importer, as could other Asian states. Russia could increase domestic consumption sharply in ways that would reduce its exports. Western Europe and Japan are the only major importers not projected to make massive increases in potential demand. Once again, however, the failure to model the high prices or examine supply by supply by supplier nation in credible terms, leaves massive uncertainties.

US Import Dependence

The US has become progressively more dependent on both a growing volume of imports and steadily growing imports from troubled countries and regions. Direct US petroleum imports increased from an annual average of 6.3 MMBD in 1973, to 7.9 MMBD in 1992 to 11.3 MMBD in 2002, and 12.9 MMBD in 2004. Some 2.5 MMBD worth of US petroleum imports came directly from the Middle East in 2004.[9] Additionally, the average US petroleum imports from the Persian Gulf alone equaled 2.3 MMBD in the first 6 months of 2005, 2.4 MMBD in 2004, 2.5 MMBD in 2003, 2.2 MMBD in 2002, 2.7 MMBD in 2001, and 2.4 MMBD in 2000.[10]

If one looks at OPEC exports as a percent of US imports, these ranged from 47.8% in 1973, and 51.9% MMBD in 1992, to 39.9% MMBD in 2002, and 43.6% MMBD in 2004. If one looks at Gulf exports as a percent of US imports, these ranged from 13.6% in 1973, and 22.5% MMBD in 1992, to 19.7% MMBD in 2002, and 19.3% MMBD in 2004.

Future US gross petroleum imports will vary sharply according to price. If prices are low ($20.99/barrel), imports rise to 47.86 MMBD in 2025. If prices are moderate ($30.31/barrel), US gross petroleum imports are still 43.43 MMBD. If prices rise to $39.87/barrel, however, US imports are only 38.87 MMBD, and they would be far lower at $50, $60, $70, or more per barrel. Even the "high price" case leaves the US with nearly 60% dependence on oil imports in 2025, but the impact of this dependence on world supply is far lower than if oil prices are low or moderate. The EIA estimates of future US imports indicate that moderate oil prices will lead to major increases in US imports from the Gulf (from 2.5 MMBD in 2000 to 6.0 MMBD in 2025), the Americas (from 3.1 MMBD in 2000 to 5.0 MMBD in 2025), and "other" including North Africa (from 2.7 MMBD in 2000 to 6.2 MMBD in 2025).

The size of direct US imports of petroleum is only a partial measure of US strategic dependence on imports. The U.S. economy is dependent on energy-intensive imports from Asia and other regions, and what comes around must literally go around. While the EIA and IEA do not make estimates of indirect imports of oil from the Gulf and other regions in terms of the energy required to produce the finished goods, the US imports them from countries that are dependent on Middle Eastern exports, analysts guess that they would add at least 1.0 MMBD to total US oil imports.

The failure of the DOE and the EIA to explicitly model such indirect imports, and their steady growth, is a long-standing and critical failure in US energy analysis and policy. It seems almost certain that the that the future increase in such indirect imports will, for example, vastly exceed

any benefits in increased domestic energy supply that will result from the energy bill just passed by the US Congress in the summer of 2005.

Surge in Chinese and Indian Demand for Oil

According to China's state media reports, China imported 79.9 million tons of oil in first three quarter of 2004, which represented a 40% increase from the first eight months of 2003.[11] In 2002, China consumed 5.0 MMBD. According to EIA 2005 high price estimates, this number *could* triple by 2025 (12.50 MMBD for the low price case, 14.50 MMBD reference case, and 16.1 MMBD for the high price case).[12]

According the BP *Statistical Review of World Energy 2005*, Chinese imports totaled 3.40 MMBD in 2004. China imported 0.15 MMBD from the US, 0.038 MMBD from South and Central America, 0.052 MMBD from Europe, 0.365 MMBD from the FSU, 1.264 MMBD from the Middle East, 0.709 MMBD from Africa, 0.045 MMBD from Australasia, 0.044 MMBD from Japan, 0.824 from other Asia Pacific, and 0.010 MMBD from others.[13]

China’s domestic production could reach 3.8 MMBD in 2020, but its demand is likely to be more than three times as high.[14] During 2004, China imported 40% of its oil consumption, despite the fact that it produced 174 million tons of oil during the whole year. Some experts believe that recent high oil prices can provide the right incentives for investment into new technologies to enhance recovery and exploration and increase China’s domestic output, and reduce reliance on oil imports.[15]

There is also the “India factor.” Oil composes 30% of India’s energy consumption, but the country has only 5.4 billion barrels of oil.[16] India in 2001 consumed 2.1 MMBD, 2.2 MMBD in 2003, and according to the EIA’s reference case forecast Indian consumption will reach 2.67 MMBD in 2010 and double to as high as 4.9 MMBD in 2025.[17]

I. Introduction

The dynamics of the current oil market rely on four major interdependent areas of uncertainty: geo-strategic risks, macroeconomic fluctuations, nature of resources risks, and the uncertainty in current and future oil production capacity. At this point, about all that is certain is that the global energy market is unpredictable and that recent oil prices have been high and volatile. In four years, the price per barrel of oil has increased by roughly 108%. The price of crude oil averaged $25.9/barrel in 2001 and for the first eight months of 2005, the average price crude oil increased to approximately $54.1/barrel.[18]

The geostrategic risks are all too clear. Stability in petroleum exporting regions is tenuous at best. Algeria, Iran, and Iraq all present immediate security problems, but recent experience has shown that exporting countries in Africa, the Caspian Sea, and South America are no more stable than the Gulf. There has been pipeline sabotage in Nigeria, labor strikes in Venezuela, alleged corruption in Russia, and civil unrest in Uzbekistan and other FSU states.

Experts believe that, in the near future, energy supply and transportation routes may be challenged by transnational terrorism and proliferation. It is equally possible, however, that recent surges in the demand for oil, supply disruptions by hurricanes, the US refining capacity bottleneck, and the limited spare production capacity will continue to test the energy market in the mid to long-term.[19] Natural disasters, such as hurricanes and tsunamis, may also prove to be troublesome to the instability of the energy markets by causing production, transportation, and refining disruptions.

These pressures and uncertainties add to the economic risk premium causing oil prices to rise further. Moreover, while higher oil prices may provide incentives for private and public investment in the oil industry, the lack of geopolitical stability, and ability to predict how long high oil prices will continue, prevents many from investing in these areas.

Given the strategic risks faced by oil producing nations, claims about production goals and capacity and oil reserves have become a political tool. Some producers have inflated their "proven" reserves to project strategic importance, which has added to the uncertainty and the lack of transparency.

The fall of the Shah in 1979 and the Iran-Iraq War, for examples, led to a competition in the Gulf to announce new levels of "proven" reserves to demonstrate the strategic importance of given countries, and major increases in the claims made by Iran, Iraq, Saudi Arabia, Kuwait, and other countries.

Limited hard data are available to validate many national claims and plans. In many cases, it is not clear that the Energy Information Administration (EIA), International Energy Agency (IEA), Organization of Petroleum Exporting Countries (OPEC), or United States Geological Survey (USGS) have applied sufficient rigor to a country-by-country reexamination of such estimates. (The USGS does use a different methodology because it looks at the basins on a geological potential basis, but the data available are uncertain and dated.)

Short-Term Outlook

In the short-run, much depends on just how much pressure demand puts on limited supply, and the resulting impact on oil prices. One paradox is that over a longer period, only high prices bring demand back into balance with future level of supply. Only a cutback in global economic

growth and demand for oil can produce rapid cuts in oil prices, but only high prices stimulate rapid efforts to increase supply, find alternative sources of supply, and encourage conservation and efficiency.

The modeling of sustained high price cases is just beginning, but previous modeling efforts provide important warnings. If oil prices drop back to the level between $31 and $35 a barrel (in 2003 dollars), as assumed in the reference case of the *International Energy Outlook 2005*, the EIA estimates that world demand for oil will increase from 78 MMBD in 2002 to 119 barrels per day in 2025. This projected increase of world oil demand would require the global oil production to increase by 42 MMBD over the world's 2002 capacity levels--accounting for approximately 38% of the world's energy consumption through 2025.[20] In addition, a 2004 EIA report estimates that the US and its major trading partners in developing Asia will account for 60% of the increase in world demand through this period.[21]

If oil prices stay at $56/barrel or above, however, the EIA assumes that major reductions will take place in the rate of increase in US and other global imports. This will not reduce strategic dependence on imports in the near-term, but merely slow the rate of increase in dependence. In the long-term, the US and other importers can and must find substitutes for MENA petroleum but this will take decades. In the interim, the US and the global economy will actually become steadily more dependent on energy imports, and particularly on energy imports from the Gulf. Even after adjusting the forecast for the high-sustained oil prices, members of OPEC, dominated by Gulf state producers, are expected to supply 60% of the increased capacity required to meet future world demand.

It is too soon to draw any firm conclusions about the impact of high oil prices on global oil dependence, on US and other imports, and on increases in conservation and the supply of alternative fuels, but these factors indicate that high prices are not necessarily bad for the global economy and could trigger market forces that offset their short-term negative effects. The fact is, however, that no one really knows. Moreover, even if one could guess correctly about the complex mix of elasticities involved, meaningful modeling and analysis is only beginning.

Oil producing countries are only beginning to reexamine their long-term energy export capacity, investment strategies, and plans. Importing countries are equally slow to announce changes in national policy, and the private sector is only beginning to seriously react to what may or may not be significant shifts in long-term energy prices and the viability of alternative investments.

Inadequate Modeling based on Inadequate Understanding

Equally important, the key modelers of global energy supply and demand have not yet chosen to react to the recent rises in oil prices and examine cases that go above $50 a barrel in detail. There have been some preliminary efforts by the IMF and the EIA in its *International Energy Outlook 2005*. Projections by OPEC, the IEA, and the latest EIA's forecasts need to be revised or expanded to examine such cases, and to examine the implications of a world with a "sustained" $60/barrel, $80/barrel, or even $100/barrel oil.

More generally, many laymen do not understand the wide range of problems in foundations on which forecasting methodology is based. It is all too clear that the modeling the EIA, IEA, and OPEC used in the global petroleum supply and demand forecasting has been driven by estimating global demand at comparatively low oil prices.

Reports such as the *International Energy Outlook 2005* raise dramatic issues for energy policy planning, but do not provide a meaningful basis for energy analysis in today's world. It is all too clear that forecasts like the one provided by EIA are difficult due to the complicated nature of the energy market, the limited hard country-by-country data, and the "immeasurable" risks involved in forecasting.

Reports by the EIA, IEA, and OPEC could provide a better benchmark for the global energy market if they addressed certain areas of deficiencies. The key gaps and areas of uncertainty in reports such as the *International Energy Outlook 2005* include:

- **Parametric analysis:** They lack of any parametric analysis of its oil price forecast. Furthermore, models such as the IEO treat major shift in energy cost and different levels of economic growth are treated largely as independent assumptions and variables.
- **Economic growth rates:** They do not provide sufficient explanation as to how the rates of economic growth interact with the price of oil and how the price-elasticity of demand changes over time given an economic growth rate.
- **Countries' plans:** They do not take into account country-by-country plans in forecasting oil production capacity. If they do, there is little explanation of how such plans have changed their forecast from lasts and how unrealistic those plans are.
- **Indirect imports:** The reports do not make estimates of indirect imports of oil/petroleum from other regions in terms of the energy required to produce finished goods. The US, for example, indirectly important very significant amounts of oil in the form of manufactures from Asian countries dependent on Middle East oil imports.
- **Technological improvements:** They do not explicitly analyze technological improvements and the role technological breakthroughs in enhancing oil recovery and exploration for new oil reservoirs, development that have significant affects on future oil supply and the oil market.
- **Relation of oil prices to demand of alternatives and conservation:** No credible explanations of the interactions between different oil prices, and level of oil supply and demand, and changes in the supply and demand of gas, coal, nuclear power, renewables, electricity, and conservation are given.
- **Supply and demand elasticities:** No effort is made to determine the very different patterns of elasticity in supply and demand for gas, coal, nuclear power, renewables, electricity, and conservation that have to emerge over time if oil prices remain so much higher than in the past, or the major uncertainties that will inevitably result from such changes.

As a result of these gaps, the current forecasts of EIA, IEA, and OPEC now do little more than illustrate what might happen in a world where virtually everything goes right from the importer's view, where export capacities automatically respond to need, and political and military risk have no impact.

The costs of new production in the Middle East and North Africa (MENA) area are generally assumed to be extraordinarily low, and there is no explicit analysis of the capability of Saudi Arabia or any other major exporter and supplier to actually produce the amount of oil estimated in the model.

Much of the modeling effort also is based on assumptions and elasticities, which are little more than crude guesstimates. The cost factors, and investment estimates for increased production often seem to be based on cost-analysis methods and data that are 10-20 years old, and ignore the need for far more advanced production technology, exporting smaller fields, and providing modern infrastructure.

Lagging Investment

It is unclear that major exporters have ever or will ever plan to provide the production capacity called for in the low and moderate price cases used in past demand-driven models. The IEA *World Energy Outlook 2004* argued, "Fossil-fuel resources are of course, finite, but we are far from exhausting them. The world is not running out of oil just yet. Most estimates of proven oil reserves are high enough to meet the cumulative world demand we project over the next three decades. Our analyses suggest that global production of conventional oil will not peak before 2030 if the necessary investments are made."[22]

Investment in the oil market is dependent on both the health of the global economy and perceptions of future oil prices. Demand is driven by a growth in income and the availability of investment capital. Moreover, aging infrastructure and declining production capacities require funds and new technologies to revive current facilities and build new ones to meet global demand growth.

Providing the kind of massive surges in the demand for oil projected in recent studies, requires massive investments to build new infrastructure and finance new technologies. In 2003, the IEA projected that the world oil demand would rise by 60% by 2030, and that the world energy market would need $16 trillion of cumulative investment between 2003 and 2030 or $568 billion a year. Even this estimate is based on unrealistically low estimates of investment cost and outdated assumptions about the sophisticated exploration, development, and production technology and equipment needed in modern oil fields. Yet it still requires vast transfers of capital.

Actually providing such investment is most challenging in developing nations where consumption and supply are projected to increase most. The IEA argues that this is possible, but qualifies its assessment by saying that "The global financial system has the capacity to fund the required investments, but it will not do so until conditions are right."[23]

Forecasting also does not impose estimates on reality. Key suppliers like Saudi Arabia have never indicated that they will attempt to provide high levels of production capacity and exports called for in the demand-driven models used by the EIA and the IEA. The real issue is not investment per se, but this massive gap between goals set by importers and the real-world plans and goals of actual suppliers. This failure to explicitly model real-world supply by country cripples the forecasting efforts of agencies like the EIA and IEA and creates serious doubt as to their value at any level of estimated oil prices.

II. Recent Macroeconomic Developments

Price, however, is a key uncertainty that affects both global demand and the willingness of producing states to fund new capacity and boost the production of oil. Through 2004, the EIA, IEA, and OPEC still projected low price cases of $17/barrel, reference cases of $27/barrel oil, and high price cases of no more than $35/barrel.

In 2005, the EIA did adjust its prices forecast to take into account much higher oil prices, with $21/barrel for the low price case, $35/barrel for the reference case, and $48 a barrel for the high price. This price range of $21-$48/barrel is still too low, given recent developments in the global energy market. For example, the *International Energy Outlook 2005* forecasted that the price per a barrel of oil would increase by $11 in 2005. Following hurricane Katrina that hit the US Gulf coast, the price per barrel of oil reached $70.

The energy world is changing to reflect major pressure on supply—at least in the short term. In early 2005, Saudi oil Minister, Ali Al-Naimi, stated that he expected oil prices to stay between $40 and $50 a barrel for the rest of 2005. By the end of August 2005, the price of oil had actually surpassed $70 per barrel. The OPEC Secretary General stated that the price of a barrel of oil might reach $80, and Goldman Sachs stated that the price could be between $50 and $105 a barrel.

A serious recession in a key importer like the US, China, or the EU could change this situation and there are many other uncertainties. Some energy experts question whether the latest oil price hikes are due to conventional supply-demand forces or to a "bubble." Lee R. Raymond, the chairman and CEO of Exxon Mobil said, "We are in the mode where the fundamental of supply and demand really don't drive the price…Oil is a commodity and history tells us the commodity prices never stay high forever."[24] Some experts holding this view see today's prices as a supply-demand phenomenon and that high oil prices are because the market forces *believed* that OPEC was not able to clear the market in the 4th quarter of 2004.[25]

Other experts take a different stand. They believe that recent high oil prices are not due to shortages as was the case in the 1970s, but rather due to surging demand and high depletion rates of oil fields. CIBC predicts that oil prices will average $77 per barrels, and could reach as high as $100 per barrels during 2005-2010.[26]

The Uncertainties Driving Modeling and Forecasting

Like all economic forecasts, predicting supply, demand, and prices of crude oil involves significant uncertainty. Predicting the oil market is notoriously difficult and constant updates and additions to the models are needed. However, the most current EIA, IEA, and OPEC forecasts have not been adjusted to consider long-term oil prices in the $50 and above rage, even in the high oil price case, and the influence these high prices would have on the demand, supply, and the long-term elasticity of both. Moreover, real world estimate or analysis of the oil market must also consider an "expectation factor" that involves geopolitical and security risks.

The following key factors influence the oil market, and each involves major uncertainties and unknowns:

- **The geopolitics, security, and stability of oil exporting nations:** As mentioned above, the Gulf contains over 65% of the world's proven reserves. Stability in these countries, security of oil fields and routes of transportation in the region are of paramount importance to the oil market.

- **The sustainable and spare capacity of oil producing countries:** In recent years, there has been much debate about spare capacity of OPEC nations, and their ability to "balance the market." In this case, perceptions are as important as realities. The market lack of confidence in the producers to meet the demand adds a risk premium to any estimates and pushes prices up.

- **The cost of sustaining and expanding petroleum production and exports, and of the necessary investments**: Most of today's estimates of the cost of future production are badly dated, and do not take into account the cost of the most advanced technology for exploration, development, and production, or the scale of the investment needed in distribution in areas like port facilities, new tankers, refineries, etc. Cost models need a major reevaluation.

- **Country capability and practice in sustaining and expanding petroleum production and exports:** There is little effort to assess country-by-country capability to use best practices, and adopt the most advanced technology and methods. Countries like Kuwait and Iran have failed to move forward in using such practices for very different reasons. Countries like Iraq face insurgency, the risk of civil war, and a long legacy of underfunding proper development.

- **The long-term elasticity of supply and demand:** The development of alternative sources of energy or conservation could have long-term effect on the market, but the likelihood of this taking place is uncertain at best in the near future.

- **The refining capacity and inventory build-up of the importing nations:** The lack of ability by importing states to refine crude oil and distribute it to the domestic market in a timely manner can create bottlenecks that not only squeeze the average consumer, but also negatively impact demand by driving up the price of crude futures because of a product-driven market.

- **Security problems and accidents:** The world can absorb the problems created by most forms of local conflict and internal security problems when there is significant surplus capacity and prices start from a relatively low base. Behavior changes drastically, however, when supply is very limited and prices are already high. Even potential threats to petroleum production, exports, and distribution can radically alter prices and market behavior. Actual attacks, or major industrial accidents, can have a much more serious impact. The loss of a major supplier, or a sustained major reduction in regional exports, potentially can have unpredictable price and supply impacts that impact on the entire global economy.

- **Natural disasters:** Natural incidents in production, export, or refining areas can be damaging to the energy market. Hurricanes in the Gulf of Mexico have caused supply and distribution disruption in the US, and have added large premiums to the price of a barrel of oil. Hurricanes Katrina and Rita that hit the US Gulf Coast during August and September 2005, shutdown most of the refineries in the US Gulf of Mexico and forced the US to release some of their strategic petroleum reserves.

- **Security of supply**: There is little explicit data and analysis on what exporting countries are doing to help secure their production and export facilities. The size and quality of security and paramilitary forces are often unknown. The quality of repair capability, redundancy, emergency response, and recovery plans is largely unknown. Little analysis exists of the security of ports, offshore facilities, tanker routes, and other critical infrastructure. The analysis of vulnerability to terrorism and attack is limited at best.

- **The overall health of the global economy:** Economic growth rates in developed countries vary in predictable ways with the price of a barrel of oil. High world oil prices slow economic growth of consuming nations, and low economic growth in industrialized nations causes a decrease in demand for oil and eventually lowers oil prices. The elasticities and relationships involved, however, are far more uncertain in the past. It is also very difficult to model real-world behavior in most countries and regions in finding alternative sources of energy, adopting better approaches to conservation, and increasing energy efficiency. This uncertainty becomes progressively greater with time.

- **The rise of China and India:** In recent years, the oil market has experienced an unexpected increased demand of oil from countries in Asia such as China and India. In 2004, emerging economies accounted for nearly 1.9 MMBD of the 2.7 MMBD increase in world consumption. More than half of the 1.9 MMBD

increase is solely attributable to China. According to the EIA *International Energy Outlook 2005*, the demand for emerging Asia will more than double by 2025.[27]

- **The true size of import dependence:** Current estimates of import dependence only include direct petroleum imports. They do not reflect indirect imports in terms of the energy required to produce manufactured goods. In some critical cases, like the US, this grossly understates the true nature of import dependence. The US has become steadily more dependent on Asian manufactured goods, which require Asia to import petroleum, largely from the Middle East. As a result, much of China's increase in import dependence is actually to meet the demands of the US and other Western markets.

- **Problems in import-dependent developing countries**: Countries with relatively free market economies that are highly developed are rich and flexible enough to adapt to high prices and supply problems far more flexible than poor countries, countries with serious foreign reserve and balance of payments problems, and importers with high levels of subsidies for oil and gas. By and large, the impact of high prices is not modeled in such terms.

- **The cost and economic impact of energy interruptions**: A review of current estimates of the economic impact of interruptions in energy imports indicates that they are based on assumptions and models that are badly outdated, do not reflect current prices, and do not reflect cases where the market had already largely exhausted surplus oil production capacity. Such models badly need updating.

- **Problems in refining capacity and energy distribution**: Current models generally consider only total petroleum consumption, and do not analyze the problems created by limited refinery capacity and dependence on given types of crude. They do not distinguish adequately between heavy and light oil, and sweet and sour crude, consider loss of refinery capacity, or reflect the limits in the ability of existing refinery capacity in providing given types of product. Little parametric or risk analysis is made of whether or not estimated rates of refinery construction and gain are possible.

- **Discontinuity theory**: Models and forecasts use smooth curves and largely "static" assumptions. Growth in demand and supply tends to be at constant rates or in predictable curves. Reality never produces consistent trends or allows trees to grow to the sky. There is a clear near for an assessment of what kind of sudden events or discontinuities are critical and for some form of Baseian approach to risk analysis.

These are important risks and uncertainties that energy forecasters and policy planners have to take into account. Some are market forces that can correct overtime, but others are external factors that directly influence the global energy market in both the short and long-term. The ability of strategists to control political and security risks is limited, but understanding these market and geostrategic uncertainties can better inform policy planners of the underlying forces.

Key Assumptions That May Not Prove Correct

Most current short-term forecasts project a relatively high level of demand. The IEA *World Energy Outlook 2004* summarized regional macroeconomic developments in the energy market as follows:[28]

- Primary energy demand in OECD countries is projected to grow by 0.9% per year over the projection period. It will be almost a third higher in 2030 than it is today. The shares of natural gas and non-hydro renewables will increase at the expense of coal, oil and nuclear. The OECD's share of global energy use will continue to fall, from 52% in 2002 to 43% in 2030.

- Among OECD regions, North America and Oceania will experience the fastest growth in energy demand. OECD Asia demand will grow slightly less quickly, with robust growth in Korea balancing sluggish demand in Japan. OECD Europe will see the lowest rate of demand growth.

- Total primary energy demand in the developing countries as a whole is projected to rise by 2.6% per year over 2002-2030. Developing countries will account for about two-thirds of the increase in world energy demand. Their share in world energy demand will rise from 37% today to nearly half in 2030.
- China will be responsible for 21% of the increase in world energy demand to 2030. Coal will continue to be the dominant fuel in China, but the shares of oil, natural gas, and nuclear energy in the primary fuel mix will grow. By 2030, Chinese oil imports will equal the imports of the United States today. China will account for 26% of the world's incremental carbon dioxide emissions from now to 2030.
- India's primary energy demand will increase by 2.3%, reaching 1,026 Mtoe by 2030. Biomass and waste, the main fuels in the primary energy mix today, will be increasingly displaced by coal and oil. Brazil's energy demand will grow at an annual average rate of 2.5% from now to 2030. Oil and renewables are expected to remain the key fuels in its energy mix. Gas will make major inroads in power generation, particularly towards the end of the projection period.
- The amount of energy that each person consumes will continue to vary widely across regions. Even in 2030, per capita energy use in Africa and South Asia will be less than 15% of that in the OECD. The transition to modern fuels is expected to continue in developing countries, but Africa and large parts of Asia will remain heavily dependent on biomass.

As mentioned earlier, high and volatile oil prices are due to many interdependence factors. The oil market has witnessed high demand coupled with limited supply capacity. The uncertainty in the global market is compounded by the imperfect agreements between national plans and data of supply and demand provided by organizations such as the EIA and IEA.

The Forces That Could Sustain High Demand

According to the US Department of Energy (DOE), world oil demand will exceed 86.0 MMBD in the 4th quarter of 2005, which represents a 1.6-1.9 MMBD increase. Furthermore, demand is projected to increase by 1.8 to 2.1 MMBD over the entire year.[29]

The industrialized world and the US will help drive this growth in demand. In 2004, the world oil demand increased by 2.7 MMBD, and according to the head of the EIA, a third of the increase is due to increase in Chinese demand for oil.[30] In 2004, the US consumed 20.7 MMBD, China consumed 6.5 MMBD, Japan consumed 5.4 MMBD, Germany consumed 2.6 MMBD, Russia consumed 2.3 MMBD, Canada consumed 2.3 MMBD, India consumed 2.3 MMBD, and South Korea consumed 2.1 MMBD.[31]

The EIA estimated that for the 1st quarter of 2005, the US consumed 20.63, China consumed 6.83 MMBD, Japan consumed 6.05 MMBD, Germany consumed 2.52 MMBD, Canada consumed 2.35 MMBD, South Korea consumed 2.40 MMBD, and the rest of Asia consumed 8.17 MMBD.[32]

The IMF also forecasts a sharp increase in global demand for crude oil from emerging Asian countries. It projects that world oil demand growth rate will be 2.1 MMBD every year. Due to this surge, the IMF forecasts that the price per barrel of oil will be $34 in 2010 and $39-$56 in 2030. The fund concludes that the world needs to adapt to high oil prices for the next 20 years and that the global economy faces "permanent oil shock."[33]

Moreover, the *International Energy Outlook 2005* argues that emerging economies, mainly emerging economies in Asia such as India and China, account for most of the increase in global demand for oil, which the EIA projects to grow at 3.5% a year over the next 20 years. This growth in the demand for oil is directly linked to robust economic conditions in emerging economies such China and India. Transitional economies such as Eastern Europe and the FSU

will witness an oil demand growth of 1.4% a year, which translate into an increase in their oil consumption from 5.5 MMBD in 2002 to 7.6 MMBD in 2025.[34]

In 2004, China replaced Japan as the second largest consumer of petroleum. During the same year, total Chinese petroleum products consumption averaged 6.5 MMBD and the EIA projects that this can reach 14.2 MMBD in 2025. The "China factor" will continue to play a major part in global energy demand. The EIA claims that China is the source of around 40% of the global energy demand growth in 2004. Since 1983, China has been a net importer of oil and it will continue to be dependent on foreign oil, namely Middle Eastern oil, for the foreseeable future. According to the EIA's 2005 forecast, in 2025, China will import 10.98 MMBD of it total petroleum demand (77% of its total consumption needs).[35]

There is also the "India factor." Oil composes 30% of India's energy consumption, but the country has only 5.4 billion barrels of oil.[36] India in 2001 consumed 2.1 MMBD, 2.2 MMBD in 2003, and according to the EIA's reference case forecast Indian consumption will reach 2.67 MMBD in 2010 and double to as high as 4.9 MMBD in 2025.[37]

In 2004, China replaced Japan as the second largest consumer of petroleum products after the US. Japan's consumption growth rates are relatively slow. Japan consumed 5.3 MMBD in 1990, 5.4 MMBD in 2001, 5.3 MMBD in 2002, 5.5 MMBD in 2003, and 5.4 MMBD 2004. The lack of growth in the Japanese demand for oil is also apparent in the EIA forecast. The reference case forecast of the *International Energy Outlook 2005*, for example, projects that Japan's consumption in 2025 is also 5.3 MMBD.[38]

Despite this stagnation, Japanese imports of Saudi and other Middle Eastern oil have risen in the first two months of 2003. Saudi Aramco's sales to Showa Shell Sekiyu increased from 0.150 MMBD to 0.240 MMBD after the direct purchase agreement between the two companies, in which Aramco acquired 10% equity. Sales to Showa are expected to increase to 0.30 MMBD.[39]

Oil consumption of the OECD countries in 2004 was 48.777 MMBD, 5.2% higher than it was in 2003. The changes in consumptions included: the UK (+2.4%), Germany (-1.2%), Canada (+3.9), France (+0.9), US (+2.8%), Italy (-2.8%), Japan (-3.0%) and South Korea (-0.8%).[40]

China, India, and other oil thirsty nations are scarcely the only factors driving the energy market. On April 5, 2005, Alan Greenspan, the Federal Reserve Chairman, said, "Higher prices in recent months have slowed the growth of oil demand, but only modestly." Greenspan also noted that the high oil prices are due to "geopolitical uncertainties" in the oil producing states. He also argued that, "the status of world refining capacity has become worrisome," and that these factors are creating a "price frenzy."[41]

World demand for oil in 2002 was 78.20 MMBD, and for the 1st quarter of 2005 it reached 84.18 MMBD. Looking toward the future, Figure 1 shows the EIA estimates of world demand for three cases based on different economic growth rates: low, reference, and high. For the low economic growth case, the EIA estimates that total world demand will be 98.60 MMBD in 2010, 110.0 MMBD in 2015, 120.60 MMBD in 2020, and 132.30 MMBD in 2025. For the reference case, total world demand is estimated to be 93.60 MMBD in 2010, 103.20 MMBD in 2015, 111.0 MMBD in 2020, and 119.20 in 2025. For the high economic growth case, total world demand is expected to reach 91.0 MMBD in 2010, 97.20 MMBD in 2015, 102.30 MMBD in 2020, and 107.7 MMBD in 2025.

In any case, the EIA estimates that total world production capacity of oil is expected to meet the increases in the global oil demand. Because the *International Energy Outlook 2005* does not examine the impact of high oil prices on world energy balances, there is no way to guess at how much this would change if oil prices remained high. The numbers above, however, provide a good benchmark for the analysis of global oil demand and supply.

The elasticity of demand becomes steeper with time. Total world demand for oil will drop by 9.6% in 2025 compared to 2.6% in 2010 if the economic growth rate changed from reference to high, it will rise by 10.9% in 2025 compared to 5.3% in 2010 if the economic growth rate changed from reference to low, and it will increase by 23.4% in 2025 compared to 7.6% in 2010 if the economic growth changed from low to high.[42]

The Forces that Could Shape Limited Supply

If high-sustained demand growth actually occurs, virtually all sources indicate that it will put a growing strain on both global petroleum supply and export capacity. The BP's *Statistical Review of World Energy 2005* reported that in 2004, the average total world production was 80.26 MMBD—higher than the 2003 average by 3.206 MMBD. In 2004, OPEC produced 32.927 MMBD, which is a 7.7% increase from their 2003 production levels of 2.241 MMBD, Russia increased its production by 0.741 MMBD (+8.9%), and China by 0.089 MMBD (+2.9%).[43]

Non-OPEC supply so far has been slow to respond to the high oil prices. In fact, it increased by only 0.046 MMBD in 2004 (31.8% of which came from the FSU). According to the US DOE, the expected increase in Non-OPEC oil production for 2005 is 0.92 MMBD.[44] In the years of 2005 and 2006, more than half of this non-OPEC increase is estimated to come from the FSU and the Atlantic Basin, including Latin America and West Africa.[45]

Estimates of spare capacity are increasingly uncertain and inevitably differ. According to the IEA, in early 2005, OPEC had 1.92-2.42 MMBD spare capacity, but according to the EIA, it had 1.1-1.6 MMBD. In both cases, practically all of the spare capacity was from Saudi Arabia. HETCO forecasted that in 2005, OPEC would increase its production by 0.70 MMBD. Again, most of the increase will depend on Saudi Arabia's ability to increase its capacity. HETCO forecasted an increase in Saudi production capacity from 10.68 to 11.15 MMBD.[46]

As for longer-term supply and demand, the EIA forecasts that world production will steadily increase in the next two decades. Its 2005 modeling efforts estimate marks a slight decrease from the 2004 projections due to the forecasting of a longer period of sustained high oil prices.[47]

In 2002, the world oil production capacity as 80.0 MMBD. Looking toward the future, Figure 2 shows the EIA estimates of world production capacity for low price case ($21/barrel), reference case ($35/barrel), and high price case ($48/barrel). For the low price case, the EIA estimates that total world production capacity will be 101.60 MMBD in 2010, 113.30 MMBD in 2015, 123.90 MMBD in 2020, and 135.20 MMBD in 2025. For the reference case, total world production capacity is estimated to be 96.50 MMBD in 2010, 105.40 MMBD in 2015, 113.60 MMBD in 2020, and 122.20 MMBD in 2025. For the high economic growth case, total world production is expected to reach 94.60 MMBD in 2010, 101.80 MMBD in 2015, 108.50 MMBD in 2020, and 115.50 MMBD in 2025.

As is the case with the elasticity of demand, the elasticity of supply becomes greater with time. Total world oil production capacity will drop by 5.4% in 2025 compared to 1.9% in 2010 if the price changed from reference to high, it will rise by 10.6% in 2025 compared to 5.2% in 2010 if

the price changed from reference to low, and it will increase by 14.5% in 2025 compared to 6.8% in 2010 if the price changed from low to high. In any case, the forecast increases in oil capacity meet the increase in oil demand.[48]

There is, however, serious global risk and uncertainty on the supply side in both the short and long term that such forecasts only partially consider.

In the short-term, such uncertainty includes:

- Some oil firms have downgraded their reserve estimates of certain oil fields.
- The surge in oil demand has pushed many producing countries to produce at their maximum capacity, which instilled fears of the lack of spare capacity in case of further spikes in the market.
- Oman has falling production levels.
- Kuwait and the UAE have been slow to modernize production facilities and techniques.
- The world oil market is losing 1.0 MMBD from depletion every year.[49]
- Uncertainty about the flow of Iraqi oil exports in the face of the high level of internal turmoil and the lack of any infrastructure of technological upgrade in the oil infrastructure since the Gulf War.
- Continued political uncertainties in Iran and unrealistic policies towards foreign investment by the current Iranian government.
- Damage inflicted on U.S. Gulf Coast and offshore oil installations following hurricanes Charley, Frances, Ivan, Katrina, and Rita.
- Capacity constraints (upstream, downstream, and transportation).
- In addition, Venezuelan political instability, Nigerian labor strikes, and internal strife between the Russian government and oil giant, Yukos, also contributed to push crude oil and other petroleum prices higher in 2005.

In the longer-term, such uncertainty includes:

- The actual level of producible reserves in virtually all developing states at given levels of price and technology. Experts like Simmons seriously question whether current estimates seriously exaggerate such capability. The country-by-country analyses of the EIA indicate that major additional proven reserves await discovery in Saudi Arabia and virtually every MENA country.
- The real world cost of incremental production capacity. Current EIA, IEA, and OPEC estimates almost certainly use cost estimates that are too low for Saudi Arabia and other MENA countries, and that understate the full cost of infrastructure and advanced recovery techniques. What is not clear is what the real cost will be.
- Debates over the commercially recoverable oil in existing oil fields and countries, the sustainability of production with current recovery techniques, and future technology gain.
- The rate of maturity and decline in given oil fields with present and future technology.
- The future commercial potential of tar sands and heavy oil is a factor that could sharply change the distribution of the world's commercial reserves, if resources like Canadian tar sands become as cost-effective as nations like Canada hope.
- Major uncertainties over the ability to find and produce oil beyond the levels counted in proven reserves. The 2005 BP Statistical Review estimates that global proven reserves are 1,188.6 billion barrels,[50] while in

2004 the EIA projected that reserve growth will provide another 334.5 billion barrels (a growth of 26%), and there is another 538.4 billion barrels that is undiscovered (an additional growth of 43%).[51]

- Long-term substitution effects that bring alternative fuels on-line at competitive prices at whatever petroleum price levels emerge over time.

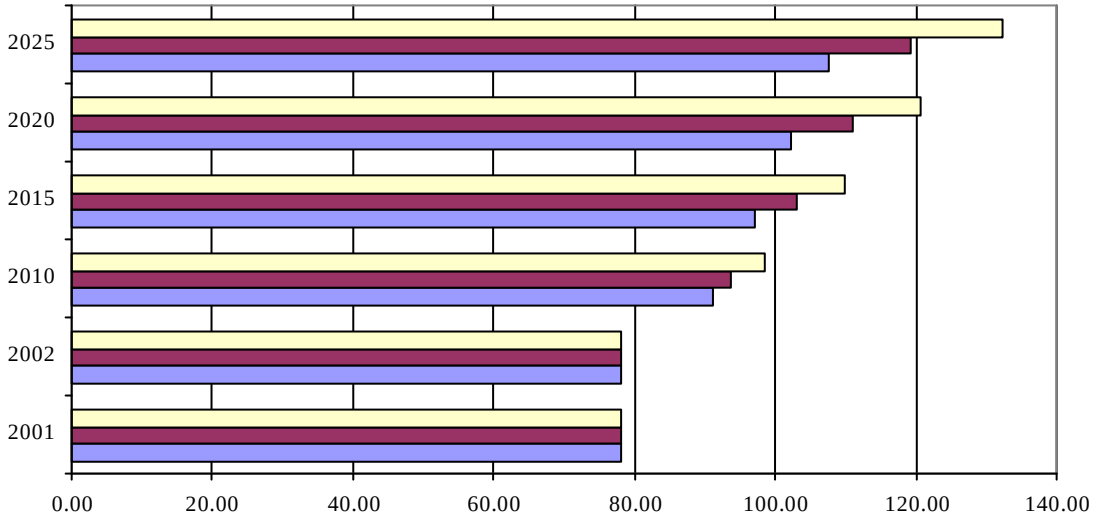
In addition, supply disruptions continue to be a constant risk, and have contributed to the high oil prices in recent years. The global energy market has experienced supply disruptions due to labor strikes, oil infrastructure sabotages, and natural disasters. On April 5, 2002, half of the workers in Venezuela's national oil company, PdVSA, went on a strike causing two out of the five Venezuelan export terminals to stop operating. Another example was the effect of Hurricanes Ivan, Katrina, and Rita. On September 14, 2004, the companies in the Gulf coast, including Shell, ExxonMobil, ChevronTexaco, and Total, to shut down their production and evacuate 3,000 of their workers from their offshore platforms. The US Mineral Management Service (MMS) estimated that Ivan caused the Gulf of Mexico's oil production declined by 61%.[52] According to MMS, Hurricane Katrina caused the Gulf of coast production to decline by 0.89 MMBD, which represent roughly 60% of the Gulf coast production.[53] It is too uncertain to make any conclusion about the medium to long-term effects of Hurricane Katrina.

Capacity constraints and the perception of limited supply have also had as much influence as actual supply disruptions. The world energy market will add only 300,000 barrels of net new on-stream supply from 2006 to 2010. This lack of growth is met by a 2.5% increase in demand. Prices would need to rise to clear the market.[54]

All of those factors confront the global economy, and energy producers, with a world in which demand-driven capacity and export forecasts are not only unreliable, but where the risk caused by such uncertainty are far more serious. Forecasts based on low prices have already proved wrong, and this may prove equally true of forecasts that point to relatively "high" oil prices that range from $40 to $105. If such high prices occur, they will eventually dampen demand for crude oil, and the magnitude of the real world drop depends on the elasticity of demand one assumes. Updated forecast models need to be built to adjust for the recent high oil prices and to modify past assumptions about the interdependence between supply forecasts, prices, and current and future demand.

Demand, however, will always be equally unpredictable. Demand may well decrease with a slowdown in Asian growth: "trees do not grow to the sky" even in China and India. If demand does rise steadily, however, producing countries such as Saudi Arabia will face growing challenges in trying to simultaneously increase production to meet demand, replace depleted fields, and recover a reserve of 2.0 MMBD--which would in any case become a steadily smaller percentage of world demand. The marginal cost of surplus capacity in a high demand market could be extremely high, particularly since the real world marginal cost of incremental production is rising all over the world because of increased technical sophistication in production and lower-yield oil fields.

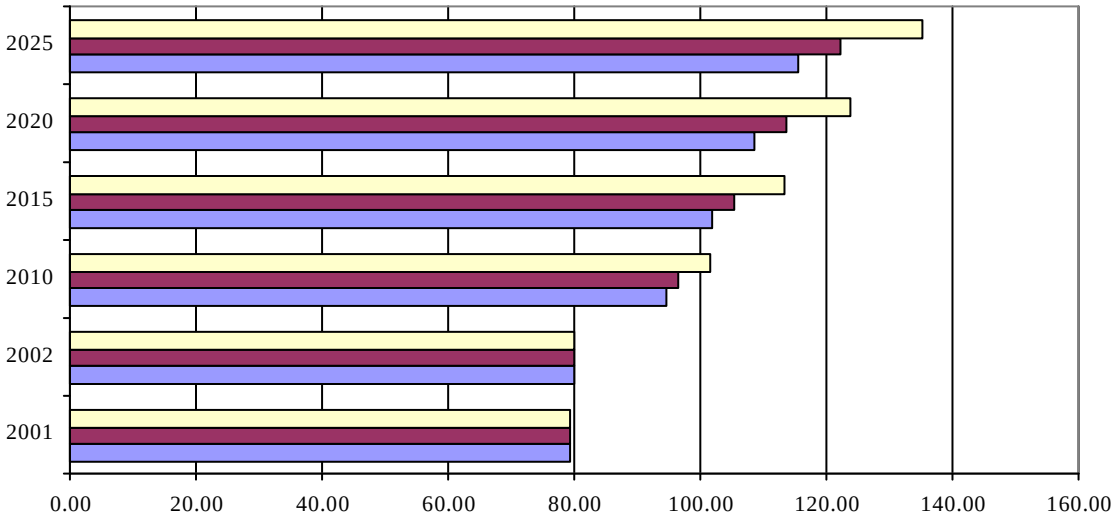
Figure 1: EIA Estimate of World Demand based on Economic Growth: 2001-2025
(In MMBD)



	2001	2002	2010	2015	2020	2025
Low Growth Case	78.00	78.20	98.60	110.00	120.60	132.30
Reference Case	78.00	78.20	93.60	103.20	111.00	119.20
High Growth Case	78.00	78.20	91.10	97.20	102.30	107.70

Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *International Energy Outlook 2005*.

Figure 2: EIA Estimate of Total World Supply Production Capacity: 2001-2025
(In MMBD)



	2001	2002	2010	2015	2020	2025
Low Price Case	79.30	80.00	101.60	113.30	123.90	135.20
Reference Case	79.30	80.00	96.50	105.40	113.60	122.20
High Price Case	79.30	80.00	94.60	101.80	108.50	115.50

Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *International Energy Outlook 2005*.
Note: Price are projected to be Low Price case ($21); Reference Case ($35); High Price Case ($48)

III. Shifts in Global Oil Dependence

As mentioned earlier, the 2005 EIA forecast indicates that world consumption will increase steadily in the next 20 years. Total crude oil demand in 2025 would be 119.20 MMBD compared to 78.20 MMBD in 2002, requiring roughly a 42.0 MMBD increase in world oil production capacity to meet the increase in demand.

Figure 3 shows the trends in regional consumption of oil based on three different cases, high, reference, and low. These cases reflect different economic growth rates by each region, and the *International Energy Outlook 2005* divides the world into three major areas based on their economic development. Mature market economies (US, Canada, Mexico, Western Europe, Japan, and Australia); transitional economies (FSU and Eastern Europe); and emerging economies (China, India, South Korea, Other Asia, Brazil, Other Central and South America, Africa, and Middle East).

China will dominate the growth of consumption for the next two decades--followed by India, Other Middle East, Africa, and the US. Japanese oil consumption, on the other hand, is estimated to plateau. These shifts will occur at a time where the US and other industrialized states are increasingly dependent on both the health of the global economy and increasing flows of oil exports to major suppliers outside the "industrialized world." With the exception of Latin America, Mexico, and Canada, all of America's major trading partners are critically dependent on Middle Eastern oil exports.

Even today, the Middle East and North Africa dominate inter-area movements of petroleum, literally "fuel" the exports of Asia to the rest of the world, and are critical sources of indirect energy exports to other regions. As Figure 4 shows, in 2004, the Middle East and North Africa supplied 5.127 MMBD of 12.538 MMBD of European imports (40.9%). MENA exporters supplied 4.202 MMBD of Japanese imports of 5.203 MMBD (80.8 %). While MENA countries supplied 1.306 MMBD out China's imports of 3.410 MMBD (38.3% and growing steadily in recent years), 0.135 MMBD of Australasia's imports of 0.694 MMBD (19.5%), and 7.33 MMBD of some 9.294 MMBD in imports by other Asian and Pacific states (78.9%).[55]

Growing Asian-Driven Demand on MENA Exports

The EIA and IEA project that the global economy will grow far more dependent on the Middle East and North Africa in the future. The EIA *International Energy Outlook 2005* projected that North America's imports of MENA oil will increase from roughly 3.3 MMBD in 2004 to 5.8 MMBD in 2025 – an increase of 91%, almost all of which will go to the US. The increase in exports to Western Europe will be from 4.7 MMBD to 7.6 MMBD, an increase of 62%.

This estimate is based on an oil price of $35/barrel, but it also assumes major increases in oil exports from the FSU and conservation will limit the scale of European imports from the Middle East. Industrialized Asia--driven by Japan--will increase its imports from 4.1 MMBD to 6.0 MMBD, or nearly 50%. China will increase its imports from 0.9 MMBD to 6.0 MMBD, or by nearly 570%; and Pacific Rim states will increase imports from 5.0 MMBD to 10.2 MMBD, or by 104%.

The IEA reported that between 1996 and 2004, China's total crude imports increased by over 440% (from 22.8 million tons in 1996 to 122.7 million tons in 2004). According to China's General Administration of Customs, China's imports of Saudi oil increased by 41.3% to reach

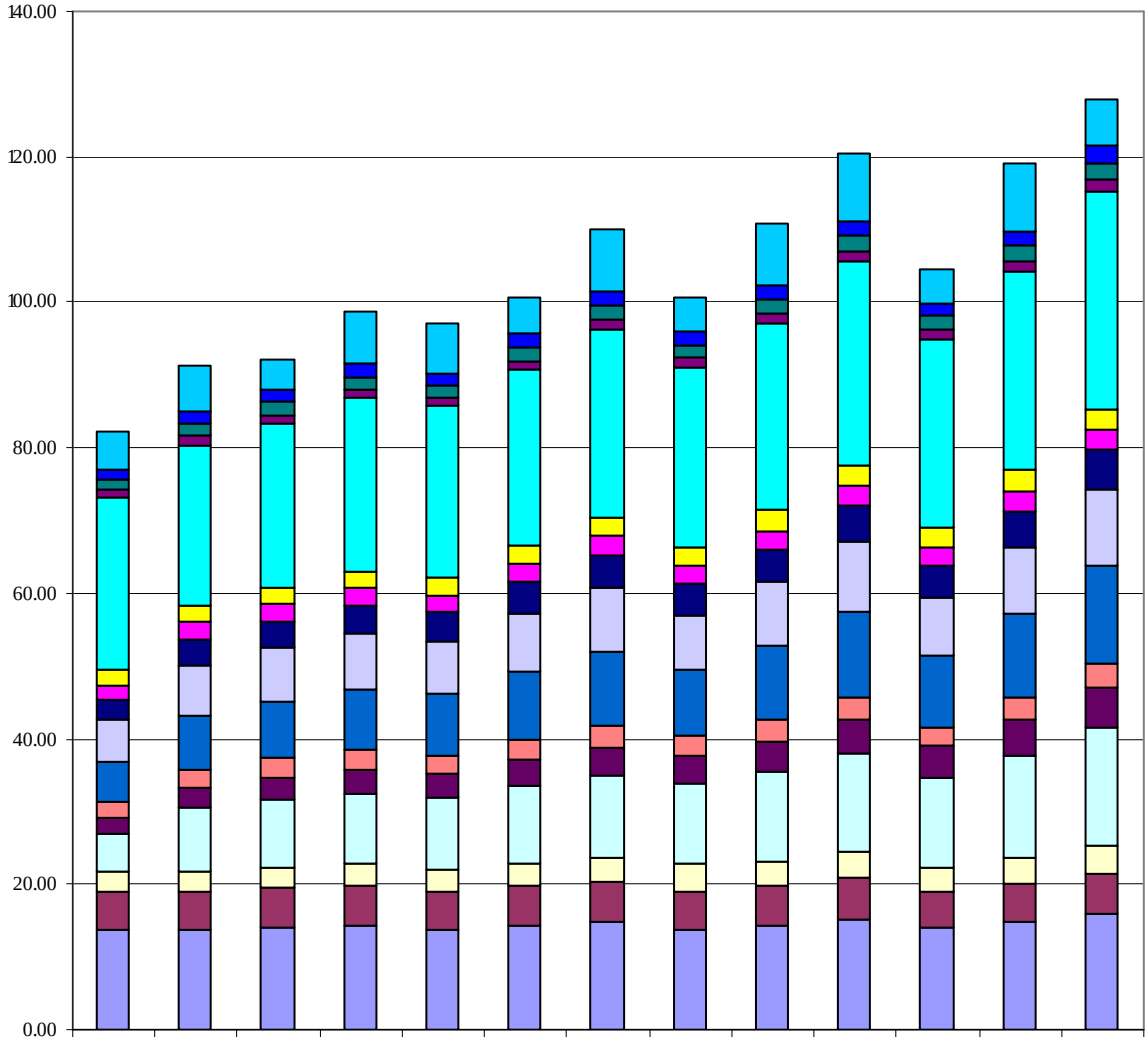
just above 3 million tons during January and February of 2005, while their imports of Iranian and Omani oil declined.[56]

By the end of 2005, such estimates indicate that China will consume 6.4 MMBD, second to US consumption of 21 MMBD. China's consumption by 2020 is projected to triple. The growth of Chinese oil demand is higher than their domestic supply. China's domestic production could reach 3.8 MMBD in 2020, but its demand is likely to be more than three times as high. In addition, dependence on Middle Eastern oil has increased from 39.79% of its imports in 1994, to 50.99% in 2002, and to over 50% in 2004.[57]

Asia is hardly the only region with thirst for oil. In 2005, the EU imported 75% of its oil and 50% of its gas demand. It is projected that by 2030 these numbers can increase to 90% and 70%, respectively. The EU is looking to expand and strengthen its bilateral relations with the GCC, as the EU energy commissioner, Andris Piebalgs, said, because the GCC is "one of the biggest long-term suppliers of hydrocarbons for the European Union." The EU and the GCC held a conference in Kuwait city in early April 2005 to discuss the EuroGulf relations. Some saw the direct negotiations between the EU and the GCC as signaling a crisis because the IEA traditionally represented oil consuming nations in such deliberations with oil producing states.

Oil experts such as John Gault, however, see the EU move as a response to aggressive Chinese efforts in the Gulf to ensure its access to energy. Gault argued that, "competition for access to oil is accelerating and that countries whose governments do not become directly involved risk being left behind." Mr. Piebalgs answered the speculations by saying that "It is a more integrated [European energy] market and that the means we should have a more integrated policy…That is why the Commission is more active on this issue. But it does not mean that we are taking responsibilities from the IEA."[58]

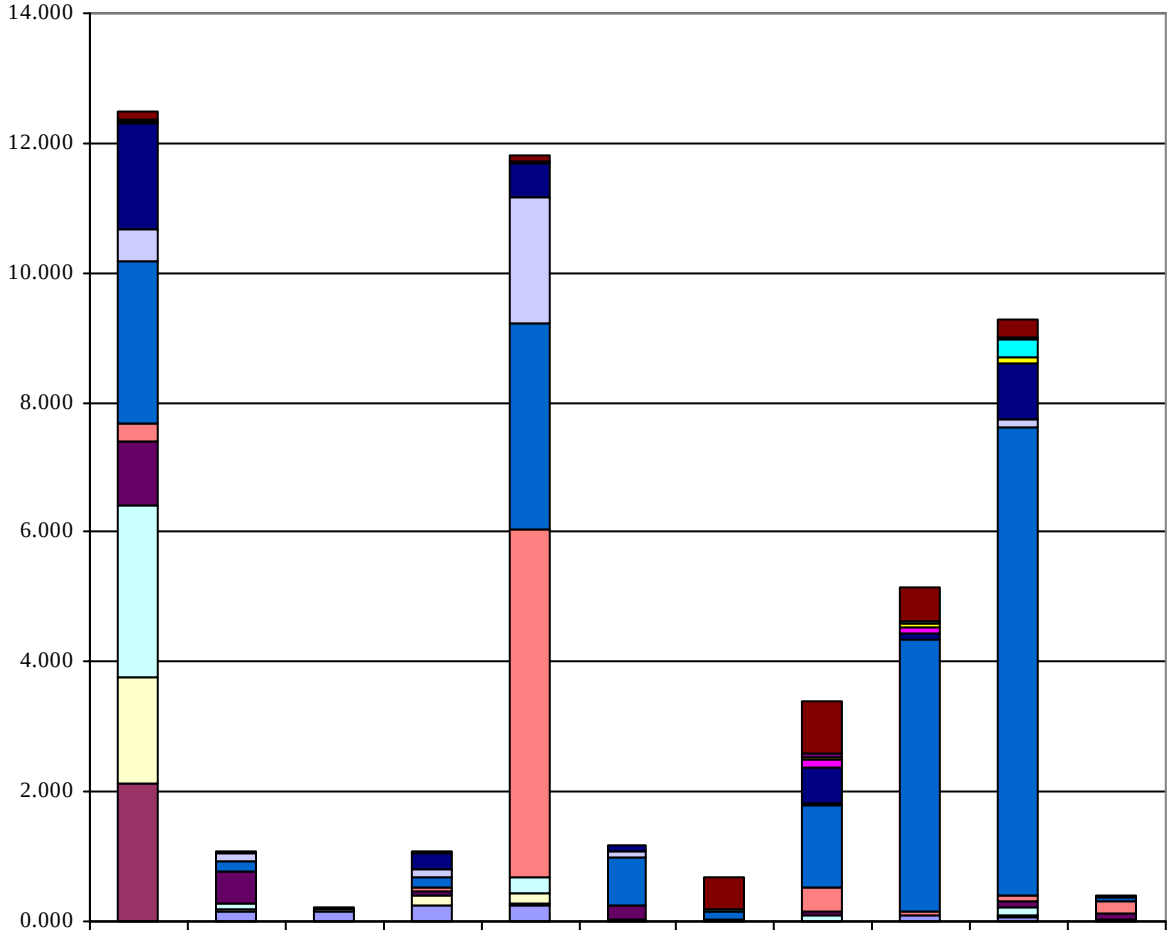
Figure 3: EIA Estimates of World Consumption by Region: 2001-2025
(MMBD)



	2002	2010 Low	2010 Ref	2010 High	2015 Low	2015 Ref	2015 High	2020 Low	2020 Ref	2020 High	2025 Low	2025 Ref	2025 High
S&C America	5.20	6.30	4.30	7.20	6.90	5.00	8.40	4.60	8.50	9.30	4.70	9.30	6.30
E. Europe	1.40	1.60	1.60	1.70	1.70	1.80	1.90	1.80	1.90	2.10	1.80	2.10	2.40
Other FSU	1.50	1.70	1.80	1.80	1.70	1.80	2.00	1.80	1.90	2.10	1.80	2.00	2.30
Australia/NZ	1.00	1.20	1.20	1.20	1.20	1.30	1.30	1.30	1.40	1.40	1.40	1.50	1.60
USA	23.80	22.20	22.50	23.80	23.50	24.20	25.80	24.80	25.80	27.90	25.90	27.30	30.00
Mexico	2.00	2.20	2.30	2.30	2.40	2.50	2.60	2.60	2.80	2.90	2.80	3.00	2.90
Canada	2.10	2.30	2.30	2.40	2.40	2.50	2.60	2.50	2.50	2.70	2.50	2.60	2.70
Africa	2.70	3.60	3.70	3.90	4.00	4.30	4.60	4.20	4.60	5.10	4.40	4.90	5.50
Middle East	5.70	6.90	7.30	7.60	7.30	8.00	8.70	7.60	8.60	9.60	7.90	9.20	10.50
Other Asia	5.60	7.40	7.90	8.40	8.30	9.20	10.10	9.10	10.40	11.70	9.80	11.60	13.40
S. Korea	2.20	2.40	2.60	2.70	2.60	2.80	3.00	2.60	2.90	3.20	2.60	2.90	3.40
India	2.20	2.90	3.10	3.20	3.40	3.70	3.90	3.90	4.20	4.60	4.30	4.90	5.40
China	5.20	8.80	9.20	9.60	9.90	10.70	11.40	11.10	12.30	13.50	12.50	14.20	16.10
Russia	2.60	2.80	3.00	3.10	2.90	3.10	3.30	3.80	3.30	3.60	3.10	3.40	3.90
Japan	5.30	5.20	5.30	5.40	5.20	5.40	5.50	5.10	5.40	5.60	5.00	5.30	5.60
W. Europe	13.80	13.70	14.10	14.40	13.80	14.30	14.80	13.80	14.40	15.20	14.10	14.90	15.90

Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *International Energy Outlook 2005*.
Note: the three cases are High Economic Growth, Low Economic Growth, and Reference Case Economic Growth.

Figure 4: BP Estimates of Inter-Area Movements: 2004
(In MMBD)



	US	Canada	Mexico	S&C America	Europe	Africa	Australasia	China	Japan	Other Asia	Rest of World
Other Asia	0.145	0.004	-	0.004	0.083	0.010	0.495	0.824	0.533	0.284	0.019
Japan	0.008	-	-	-	-	-	0.002	0.044	-	0.025	-
China	0.020	-	-	0.027	0.002	0.002	0.014	-	0.037	0.276	0.006
Australasia	0.028	-	-	-	0.004	-	-	0.045	0.053	0.093	-
E&S Africa	-	-	-	-	0.026	-	-	0.116	0.076	0.027	-
W Africa	1.637	0.016	-	0.258	0.542	0.094	0.002	0.551	0.096	0.851	-
N Africa	0.476	0.140	0.010	0.112	1.924	0.079	-	0.042	0.008	0.117	0.008
M East	2.505	0.152	0.013	0.164	3.203	0.725	0.135	1.264	4.194	7.213	0.063
FSU	0.282	-	0.002	0.070	5.343	0.020	-	0.365	0.049	0.109	0.200
Europe	0.987	0.495	0.010	0.037	-	0.217	-	0.052	0.008	0.097	0.089
S America	2.647	0.102	0.040	-	0.239	0.015	-	0.083	0.002	0.106	-
Mexico	1.642	0.032	-	0.167	0.182	-	-	-	0.006	0.036	0.004
Canada	2.119	-	-	0.004	0.015	-	-	-	0.010	-	-
US	-	0.139	0.156	0.244	0.250	0.008	0.019	0.015	0.079	0.062	0.019

Source: Adapted by A. Cordesman & K. Al-Rodhan from the BP, *Statistical Review of World Energy 2005*, Page 18.

Growing US Import Dependence In Spite of Failed Energy Bills and Policies

Two decades ago, the US used to import oil from regions with stable political systems and few security threats such as the UK, Norway, and Alaska. However, for the near future, the US and the rest of the world have to rely on unstable regions as sources and transition routes for their energy needs.[59]

The US has, however, become progressively more dependent on both a growing volume of imports and steadily growing imports from troubled countries and regions. Direct US petroleum imports increased from an annual average of 6.3 MMBD in 1973, to 7.9 MMBD in 1992 to 11.3 MMBD in 2002, and 12.9 MMBD in 2004. Some 2.5 MMBD worth of US petroleum imports came directly from the Middle East in 2004.[60] Additionally, the average US petroleum imports from the Persian Gulf alone equaled 2.3 MMBD in the first 6 months of 2005, 2.4 MMBD in 2004, 2.5 MMBD in 2003, 2.2 MMBD in 2002, 2.7 MMBD in 2001, and 2.4 MMBD in 2000.[61]

The debate on reducing the US and other oil consuming countries' dependence on foreign sources of energy has focused on the instability in the Middle East. As a result, national security and strategic planners in consuming nations have looked at different regions such as West Africa and the Caspian Sea to try to find other sources of supply, in addition to studying the feasibility of alternative energy technology. So far, such efforts have failed both to find the necessary oil reserves and a mix of nations that are more (or even "as") stable as those of the Gulf and North Africa.

As mentioned earlier, the energy market has faced many challenges not the least of which is the surge in oil demand from India and China. The recent high oil prices are hardly a demand only phenomenon, but this challenge, coupled with instability in the traditional sources of energy such as the Gulf, have forced some planners to look at countries in "long-neglected" regions such as West Africa and the Caspian in addition to investing in new offshore technologies to extract North Sea oil.[62]

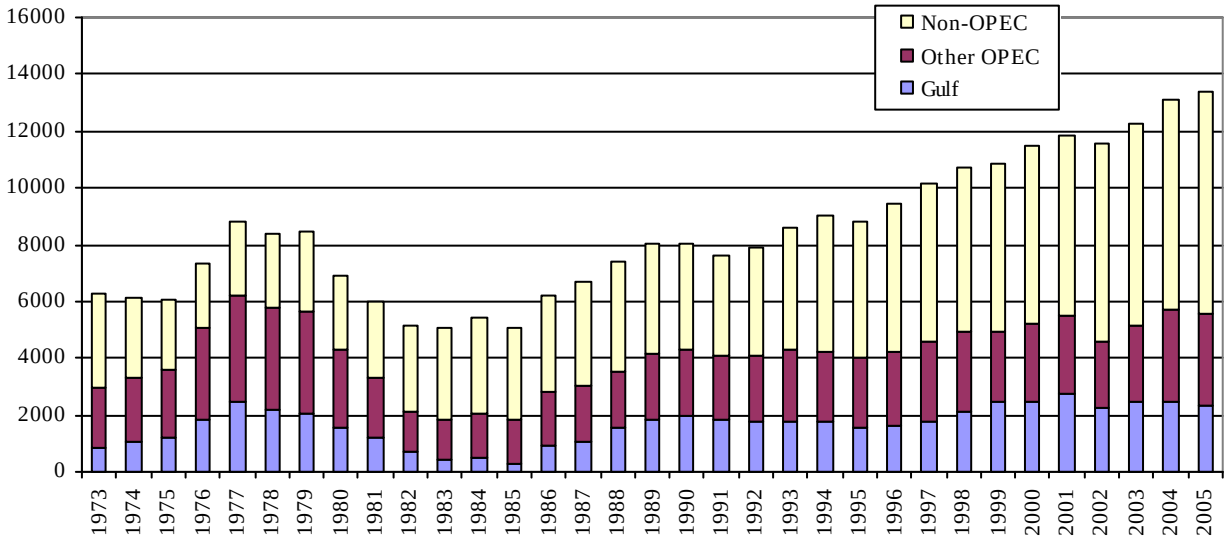
The US has clear motive for such efforts. The US military is investing time and effort in emerging oil regions. For example, the US is planning to spend $100 million to build up the Caspian Guard, a network of police and special operation forces to protect the new Baku-Tblisi-Ceyhan pipeline, from the Caspian Sea through the Caucasus. The $100 million will also be put towards protecting other energy infrastructure to limit any supply disruption from the central Asian region. The Caspian Guard also opened a radar-equipped command center in 2003 in Baku Azerbaijan to monitor the oil production and export infrastructure. Most of the Caspian Sea oil is exported to Europe, but if supply is disrupted, oil prices will likely rise and that will have direct influence on the US energy security.[63]

The economic impact of future US increases in import dependence will vary sharply with oil prices. According to March 2005 statistics from the EIA, the oil price "collapse" of late 1997 and 1998 cut U.S. net oil import costs during 1998 by around $20 billion (to $44 billion), compared to the previous two years. Increased oil prices since then have increased U.S. net oil import costs: to $60 billion in 1999; $109 billion in 2000; $94 billion in both 2001 and 2002, and $122 billion during 2003. For the first ten months of 2004, U.S. net oil import costs were running about 31% higher than during the same period in 2003. Oil currently accounts for about one-fourth of the total U.S. merchandise trade deficit.

Figure 5 shows recent trends in US import dependence on Gulf and other OPEC oil. The US is dependent on the Middle East for only part of its imports and there have been no consistent trends in the percentage of imports the US gets from OPEC and the Gulf, but it is all too clear that US oil imports are increasing.

If one looks at OPEC exports as a percent of US imports, these ranged from 47.8% in 1973, and 51.9% MMBD in 1992, to 39.9% MMBD in 2002, and 43.6% MMBD in 2004. If one looks at Gulf exports as a percent of US imports, they ranged from 13.6% in 1973, and 22.5% MMBD in 1992, to 19.7% MMBD in 2002, and 19.3% MMBD in 2004.

Figure 5: US Oil Imports and Dependence on OPEC and the Gulf: 1973-2005
(Average in Thousands Barrels a Day)



Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *Monthly Energy Outlook*, available at: http://www.eia.doe.gov/emeu/mer/overview.html

US Dependence on Global Oil Markets Makes the Source of US Imports of Limited Importance

Under most conditions, the areas and countries the US imports from, and the normal day-to-day destination of oil exports, is strategically irrelevant. Oil is a global commodity, which is distributed to meet the needs of a global market based on a bidding process by importers acting in global competition.

With the exception of differences in price because of crude type and transportation costs, buyers and importers compete equally for the global supply of available exports, and the direction and flow of exports changes according to marginal price relative to demand. As a result, the percentage of oil that flows from the MENA region to the United States under normal market conditions has little strategic or economic importance.

If a crisis occurs, or drastic changes take place in prices, and the U.S. will have to pay the same globally determined price as any other nation, then the source of US imports will change accordingly. Moreover, the U.S. is required to share all imports with other OECD countries in a crisis under the monitoring of the International Energy Agency.

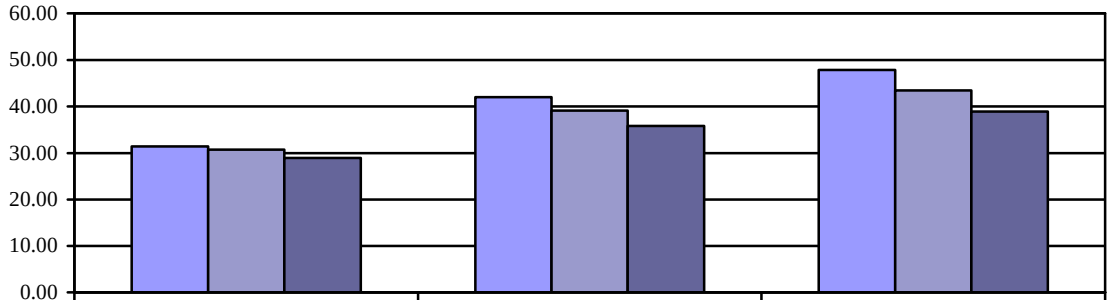
Estimates of the Potential Growth of US Imports

Looking toward the future, the EIA forecast in the *Annual Energy Outlook 2005* that total US petroleum imports would reach 20.0 MMBD by 2025, as Figure 6 shows. This projection is based on somewhat more realistic oil prices (low price case, $20.99; reference case, $30.31; high price case, $39.24) than those used in the EIA's 2004 estimates which have been the basis for the previous discussion of global trends.

The EIA outlined its 2005 reference case forecast for US imports as follows:

> Total U.S. gross petroleum imports are projected to increase in the reference case from 12.3 million barrels per day in 2003 to 20.2 million in 2025 [Table 1]. Crude oil accounts for most of the increase in imports, because distillation capacity at U.S. refineries is expected to be more than 5.5 million barrels per day higher in 2025 than it was in 2003. Gross imports of refined petroleum, including refined products, unfinished oils, and blending components, are expected to increase by almost 60 percent from 2003 to 2025.
>
> Crude oil imports from the North Sea are projected to decline gradually as North Sea production ebbs. Significant imports of petroleum from Canada and Mexico are expected to continue, with much of the Canadian contribution coming from the development of its enormous oil sands resource base. West Coast refiners are expected to import small volumes of crude oil from the Far East to replace the declining production of Alaskan crude oil. The Persian Gulf share of total gross petroleum imports, 20.4 percent in 2003, is expected to increase to almost 30 percent in 2025; and the OPEC share of total gross imports, which was 42.1 percent in 2003, is expected to be above 60 percent in 2025.
>
> Most of the increase in refined product imports is projected to come from refiners in the Caribbean Basin, North Africa, and the Middle East, where refining capacity is expected to expand significantly. Vigorous growth in demand for lighter petroleum products in developing countries means that U.S. refiners are likely to import smaller volumes of light, low-sulfur crude oils.[64]

Figure 6: Core Petroleum US Import Elasticity-Forecast for 2025
(In MMBD)



	2010	2020	2025
Low: $20.99	31.41	42.01	47.86
Reference: $30.31	30.75	39.12	43.43
High: $39.24	28.91	35.83	38.87

Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *Annual Energy Outlook 2005*, Page 177.

If one looks at Table 1, this estimate indicate that moderate oil prices will lead to major increases in US imports from the Gulf (2.5 to 6.0 MMBD), the Americas (3.1 to 5.0 MMBD), and "other" including North Africa (2.7 to 6.2 MMBD). Figure 6 shows, however, that future imports vary sharply according to price. If prices are low ($20.99/barrel), imports rise to 47.86 MMBD in

2025. If prices are moderate ($30.31/barrel), imports are still 43.43 MMBD. If prices rise to $39.87/barrel, however, US imports are only 38.87 MMBD, and they would be far lower at $50, $60, $70, or more per barrel. Even the "high price" case leaves the US with nearly 60% dependence on oil imports in 2025, but the impact of this dependence on world supply is far lower than if oil prices are low or moderate.

Table 1: U.S. Gross Petroleum Imports by Source, 2000-2025
(In MMBD)

	Gulf	Other OPEC	N. America	Europe	Caribbean	Far East	Other
2000	2.49	2.74	3.11	0.96	0.37	0.69	1.10
2005	2.70	3.25	3.35	1.08	0.41	1.17	0.97
2010	3.18	3.70	3.53	1.01	0.49	1.28	1.19
2015	4.28	4.19	4.03	0.93	0.51	1.38	1.12
2020	5.52	4.77	4.25	0.92	0.50	1.24	0.97
2025	5.99	6.16	5.01	1.05	0.54	1.18	0.99

Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *Annual Energy Outlook 2005*, Figure 41, Page 74.

In any case, the size of direct US imports of petroleum is only a partial measure of US strategic dependence on imports. The U.S. economy is dependent on energy-intensive imports from Asia and other regions, and what comes around must literally go around. While the EIA and IEA do not make estimates of indirect imports of oil from the Gulf and other regions in terms of the energy required to produce the finished goods, the US imports them from countries that are dependent on Middle Eastern exports, analysts guess that they would add at least 1.0 MMBD to total US oil imports.

The failure of the DOE and the EIA to explicitly model such indirect imports, and their steady growth, is a long-standing and critical failure in US energy analysis and policy. It seems almost certain that the that the future increase in such indirect imports will, for example, vastly exceed any benefits in increased domestic energy supply that will result from the energy bill just passed by the US Congress in the summer of 2005.

Chinese Import Dependence

According to China's state media reports, China imported 79.9 million tons of oil in first three quarter of 2004, which represented a 40% increase from the first eight months of 2003.[65] In 2002, China consumed 5.0 MMBD. According to EIA 2005 high price estimates, this number *could* triple by 2025 (12.50 MMBD for the low price case, 14.50 MMBD reference case, and 16.1 MMBD for the high price case).[66]

According the BP *Statistical Review of World Energy 2005*, Chinese imports totaled 3.40 MMBD in 2004. China imported 0.15 MMBD from the US, 0.038 MMBD from South and Central America, 0.052 MMBD from Europe, 0.365 MMBD from the FSU, 1.264 MMBD from the Middle East, 0.709 MMBD from Africa, 0.045 MMBD from Australasia, 0.044 MMBD from Japan, 0.824 from other Asia Pacific, and 0.010 MMBD from others.[67]

As mentioned earlier, China's domestic production could reach 3.8 MMBD in 2020, but its demand is likely to be more than three times as high.[68] During 2004, China imported 40 % of its oil consumption, despite the fact that it produced 174 million tons of oil during the whole year. Some experts believe that recent high oil prices can provide the right incentives for investment

into new technologies to enhance recovery and exploration and increase China's domestic output, and reduce reliance on oil imports.[69]

China is aware of its impending total dependence on foreign exporters for oil and petroleum products. In the late 1990's, the Chinese government has restructured its oil industry to deal with its high dependence on oil imports. The EIA summarized this reorganization as follows:

> China's petroleum industry has undergone major changes over the last decade. In 1998, the Chinese government reorganized most state owned oil and gas assets into two vertically integrated firms -- the China National Petroleum Corporation (CNPC) and the China Petrochemical Corporation (Sinopec). Before the restructuring, CNPC had been engaged mainly in oil and gas exploration and production, while Sinopec had been engaged in refining and distribution. This reorganization created two regionally focused firms -- CNPC in the north and west -- and Sinopec in the south, though CNPC is still tilted toward crude oil production and Sinopec toward refining. The other major state sector firm in China is the China National Offshore Oil Corporation (CNOOC), which handles offshore exploration and production and accounts for more than 10% of China's domestic crude oil production. Regulatory oversight of the industry now is the responsibility of the State Energy Administration (SEA), which was created in early 2003.[70]

The major Chinese state oil companies--CNPC, Sinopec, and CNOOC--have aggressively pursued contracts with foreign firms for production and exploration. CNPC has acquired a variety of holdings in Azerbaijan, Canada, Indonesia, Iraq, Iran, Kazakhstan, Venezuela, and Sudan. In November 2004, Sinopec purchased rights for the development of the Yadavaran oil field in Iran, which is slated to produce 0.300 MMBD at full capacity. Sinopec also hopes to import additional petroleum products through its May 2005 acquisition of a 40% share holding of Canada's Northern Lights oil sands project that is scheduled to be up and running by 2010. CNOOC, the Chinese offshore oil production company, acquired a stake in the small Malacca Strait oilfield and made an unsuccessful bid for Unocal, a US-based firm that opted for a contract with Chevron after pressure from the US Congress not to sell to China.[71]

China has also made notable inroads in the FSU and the far eastern region of Russia. In May 2004, the governments of China and Kazakhstan signed an agreement for a $700 million oil pipeline to run from Atasu in central Kazakhstan to Alashankou in the western Chinese province of Xinjiang, which will have the capacity to supply three Chinese refineries with 0.200 MMBD of crude oil. China's CNPC also agreed to provide 20 years of development aid to Kazakh oil firm Aktobemunaigaz after purchasing a 60% share in the company in 1997.[72]

The biggest Chinese oil acquisition yet may come from Canadian oil firm PetroKazakhstan, which has large reserves in Kazakhstan and trades in New York. CNPC has offered $4.18 billion for the company, including $55 cash per share and $76 million toward the creation of an offshoot company led by current PetroKazakhstan chief executive Bernard Isautier. Although the proposed plan has not yet been voted upon by stockholders of the Canadian firm, a binding clause prevents PetroKazakhstan from backing out by threatening a $125 million penalty for accepting a higher offer.[73]

The Overall Patterns in Energy Imports

The US and China are the "drivers" in increasing energy imports in most models – and it should be noted that such models generally do not consider a major recession or depression in such driver economies or on a global basis through 2025. (Trees effectively grow to the sky,) If one looks in detail at the estimates in Figure 3, however, they are clearly only part of the story even if one only considers increases in demand.

African and Middle Eastern imports could double by 2025. India could emerge as a major new importer, as could other Asian states. Russia could increase domestic consumption sharply in ways that would reduce its exports. Western Europe and Japan are the only major importers not projected to make massive increases in potential demand. Once again, however, the failure to model the high prices or examine supply by supply by supplier nation in credible terms, leaves massive uncertainties.

IV. Regional Strategic and Production Risks

Turning back to global trends in supply, Figures 7 and 8 show recent trends in estimates of oil reserves and oil production by region. The geopolitical risks in every region can take many forms. The security of oil facilities is most obvious, but stability of sovereign governments is also central to preventing supply disruptions and insuring the safely of trade routes.

In 2005, the IEA summarized its apprehensions about energy security as follows:

> [S]erious concerns about energy security emerge from the market trends… The world's vulnerability to supply disruptions will increase as international trade expands. Climate destabilizing carbon-dioxide emissions will continue to rise, calling into question the sustainability of the current energy system. Huge amounts of new energy infrastructure will need to be financed. And many of the world's poorest people will still be deprived of modern energy services. These challenges call for urgent and decisive action by governments around the world.[74]

Moreover, given the interdependence of the global market, perceptions of instability are as important as realities. To reassure markets, producers have to build confidence not only in their capability to prevent attacks, but also in their ability to contain the damage of unexpected violence through building redundancy in production and export systems.

Since the start of terrorist attacks in the Kingdom in May 2003, Saudi Arabia has increased security and redundancy of its oil infrastructure including its oil reservoirs, export terminals, and refineries on the Red Sea and the Gulf. The attempted attacks in the Saudi cities of Yanbu and Al-Khubar in the summer of 2004 sent ripples through out the global energy market. The redundancy of the Saudi export and production systems in addition to the swiftness in which the Saudi forces suppressed the attacks reassured the global markets.[75]

Attempts against Saudi oil, however, continue to worry the global energy market and the Saudi leadership. Following a siege and a raid by the Saudi security forces against extremists in Dammam, the Saudi security forces discovered more than 60 hand grenades and pipe bombs, pistols, machine guns, RPGs, two barrels full of explosives, and video equipment. The Saudi Minister of Interior, Prince Nayef al-Saud, was quoted saying that the al-Qaeda cell had planned to attack Saudi oil and gas infrastructure, but Prince Nayef added, "There isn't a place that they could reach that they didn't think about," and insisted that al-Qaeda's ultimate goal has been to cripple the global economy.[76]

Oil fields are large area targets with many redundant facilities. While fires can be set in many areas of a working field, including at oil wells, fires do not produce critical or lasting damage. Unless wells are attacked with explosives deep enough in the wellhead to result in permanent damage to the well, most facilities can be rapidly repaired.

There are, however, larger items of equipment and central facilities whose damage would do far more to interrupt production, and many of which require months of manufacturing time to replace. Such facilities include central pumping facilities, gas-oil separators (GOSPs), related power plants, water injection facilities, and desalination plants. Vulnerability also increases sharply if key targets in a field are attacked as a system, rather than as individual elements, and if expert assistance is available to saboteurs or attackers.

It is impossible to eliminate the threat against energy infrastructure from conventional military attacks, asymmetric warfare by extremists, or proliferation. However, given the recent security

efforts by the Saudi government, for example, the overlapping and redundant layers of defense around key installations, and the extensive disaster planning and drills that have taken place has significantly lessened the probability of any major attacks being carried out successfully.

Short of a spectacular strike on the scale of 9/11, or some form of systematic sabotage, or other key energy industries, most foreseeable assaults are likely to be quickly confined and any resulting damage is likely to be repaired relatively quickly. Energy security, however, will be a continuing problem particularly if global energy demand does actually rise by more than 50% by 2025. The security of energy exports will play a steadily more vital role in the world's economy.

The Middle East makes a good case in point. In the last two decades, the Middle East and Africa experienced the largest increase in oil production of any other region. As is shown in Figure 8, in 1983, Africa produced 4.865 MMBD and the Middle East produced 11.841 MMBD, but by 2004, these numbers reached 9.264 MMBD and 24.571 MMBD, respectively. Production levels of other regions remained at approximately the same level they were in the 1980s.

Most of the growth in reserves in the last two decades came from the Middle East, namely the Gulf. In 1983, the Middle East proven reserves were 396.9 billion barrels of oil and in 2004, that number nearly doubled to 733.9 billion. Other regions, however, saw substantial growth in their reserves. Latin America's proven oil reserves increased from 33.7 billion barrels in 1983 to 101.20 billion barrels in 2004. Only North America had its proven oil reserves decline during the same period, but Asia-Pacific region has seen little growth in its proven reserves.

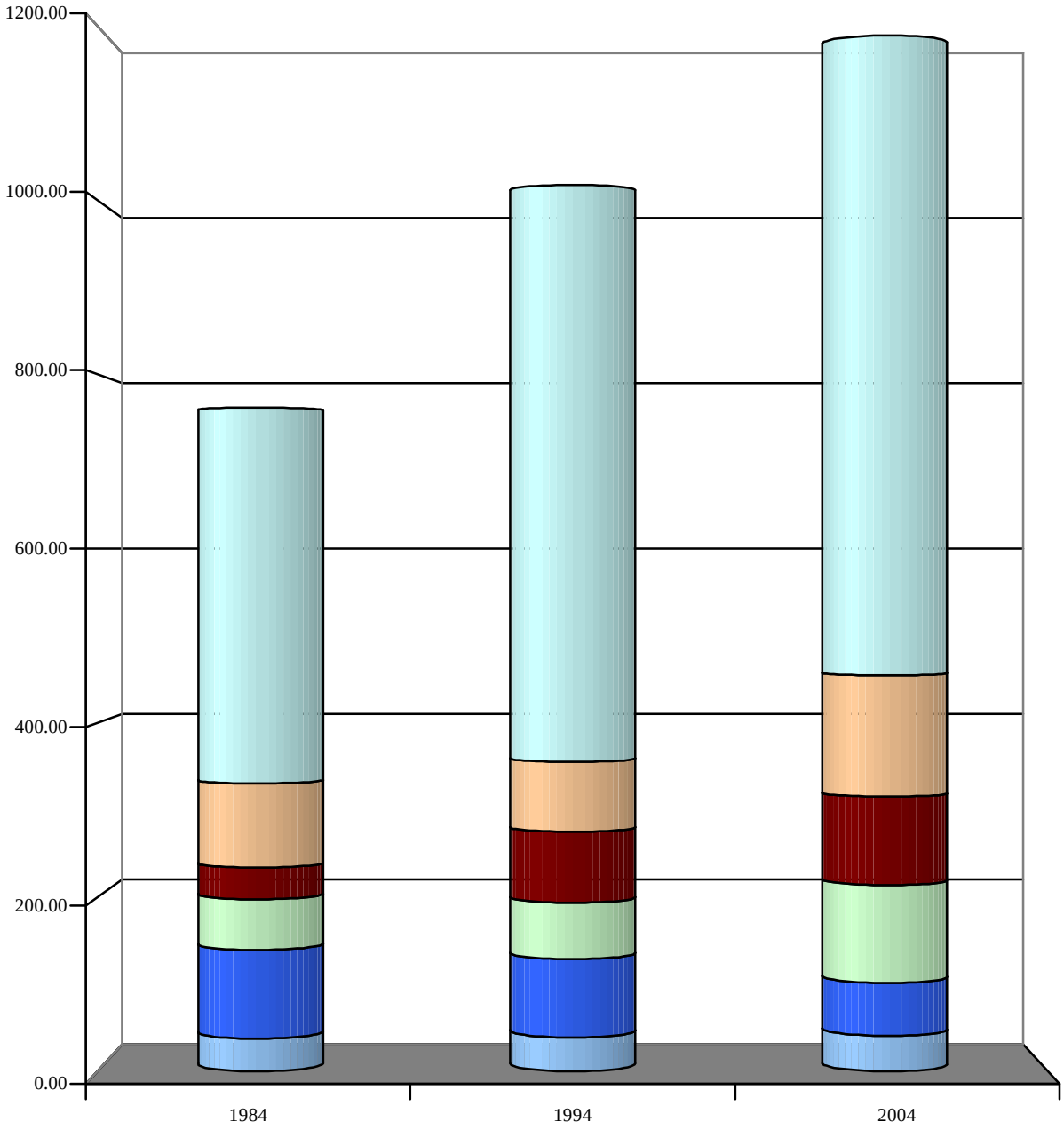
While a nation like Iran can pose a conventional and asymmetric military threat to oil facilities in the Gulf, the more dangerous threat is that of asymmetric attacks by extremists groups on oil facilities in the Gulf, where 65% of the world's "proven" reserves exist. There is no attack-proof security system. It may take only one attack on Ghawar or a tanker in the Strait of Hormuz to throw the global oil market into a spiral.

In addition to current asymmetric capabilities of rouge states and terrorist organizations, there is a growing risk that such states and groups may acquire the capability to use WMDs to blackmail oil-producing states for economic or political reasons. Recent success in stopping the AQ Khan does not mean the end of the WMD black market. Russian loose nukes and disenfranchised former FSU scientists, however, continue to be a source of expertise for extremists and rogue states who are trying to acquire the technology.

Regional stability is multilayered. Social and political stability is as important as effective security. Labor strikes in Venezuela, hurricanes in the Gulf of Mexico, the Iraq War, and the ongoing disruptions of Angolan and Nigeria oil compounded by surge in oil demands were examples of what could hike the price to $70 a barrel.

Supply and demand pressures play a major role in determining the price of oil, but they cannot explain the energy market. Regional geopolitical and production challenges exert pressure on oil prices, but it is hard to quantify these risks. The following sections will attempt to outline mid and long-term strategic challenges to oil producing regions as well as production developments and risks associated with the nature of resources, technological developments, and management issues including field maintenance and the cost of production.

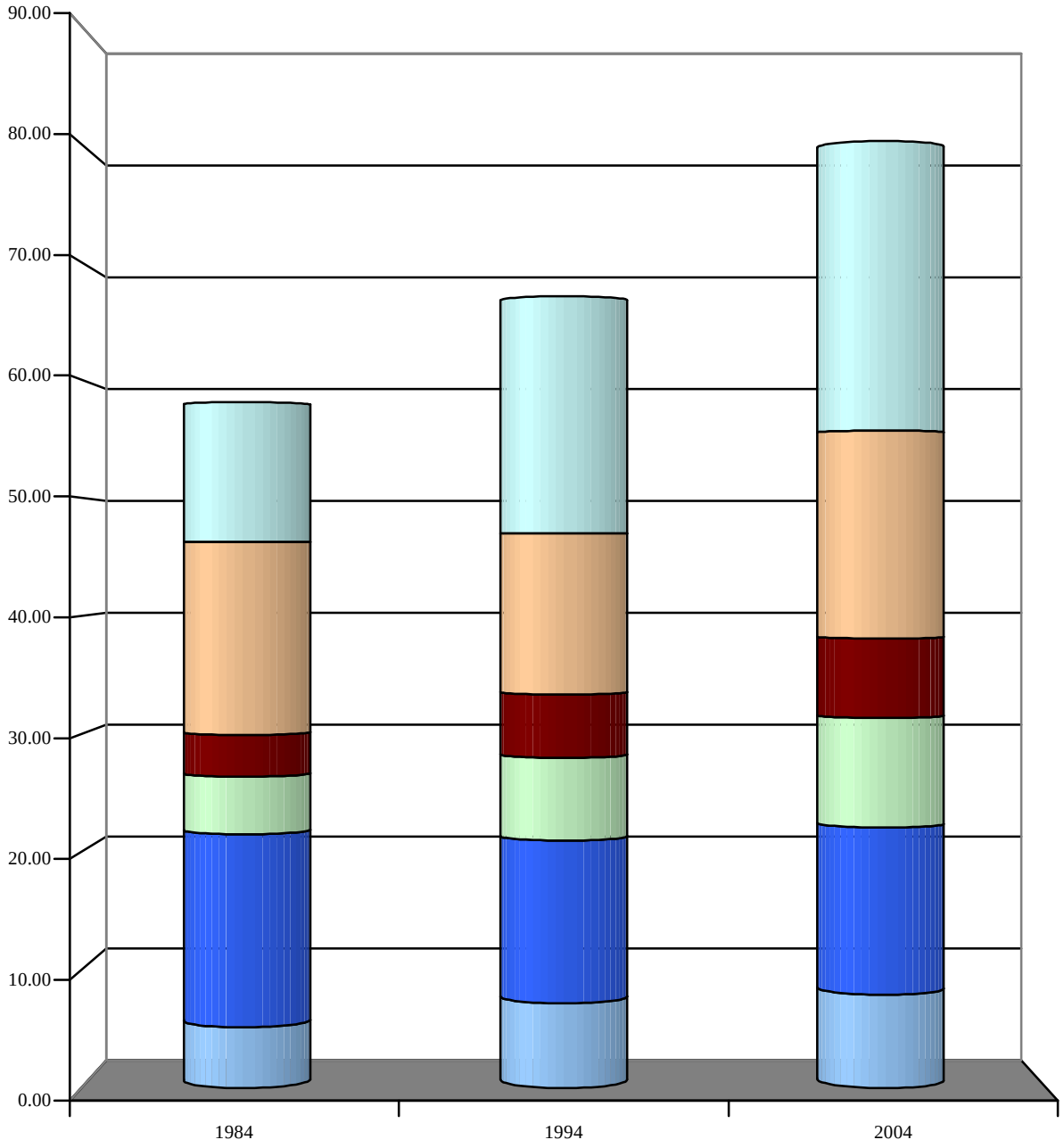
Figure 7: World Proven Oil Reserves Trends: 1984-2004
(In Billion Barrels)



	1984	1994	2004
Middle East	430.80	661.70	733.90
Europe & Eurasia	96.70	80.30	139.20
S&C America	36.30	81.50	101.20
Africa	57.80	65.00	112.20
N. America	101.90	89.80	61.00
Asia Pacific	38.10	39.20	41.10

Source: Adapted by A. Cordesman & K. Al-Rodhan from the BP, *Statistical Review of World Energy 2005*.

Figure 8: World Oil Production Trends: 1984-2004
(In MMBD)



	1984	1994	2004
Middle East	11.84	20.12	24.57
Europe & Eurasia	16.34	13.66	17.58
S&C America	3.54	5.35	6.76
Africa	4.87	7.00	9.26
N. America	16.34	13.81	14.15
Asia Pacific	5.17	7.18	7.93

Source: Adapted by A. Cordesman & K. Al-Rodhan from the BP, *Statistical Review of World Energy 2005*.

The Middle East

The previous figures have shown that the Middle East was estimated to have 62% of the world's conventional oil reserves in 2005 (733.90 billion barrels) and had produced 23% of total world production (24.57 MMBD). The Middle East still has roughly 53% of the world's reserves if Canadian tar sands are included (some estimate the tar sands to contain 175 billion barrels of oil). The Middle East also has 40.6% (2,570.8 TCF) of the world total gas reserves (6,337.4 TCF).

Figures 7 and 8 show that the Middle has dominated not only the level of production and reserves, but has also seen the largest growth in both. In Figure 9, the Middle East has 672.6 billion barrels of "known" reserves, 204.8 billion barrels of undiscovered, and 728.7 billion barrels of "proven." The definition of each of these terms may be summarized as follows:

- **Proven Reserves:** Quantities of crude oil that geological data and engineering information indicates with reasonable certainty can be recovered in future.
- **Known Reserves:** Discovered crude oil accumulation that are considered economically viable to produce.
- **Undiscovered Reserves:** Quantities of crude oil that geological data and engineering information indicates exist outside known oil fields.

Some 40% of all world oil exports, and roughly one quarter of world supply now pass daily through the Strait of Hormuz. Both EIA and IEA projections indicate this total will increase to around 60% between 2025 and 2030 at low oil prices. An examination of the EIA estimates further indicates that this figure will still be around 50% in the high price case.[77]

Current IEA projections indicate that Middle Eastern exports could total some 46 MMBD by 2030, and represent more that two-thirds of the world total exports although it must be stressed that such projections are based on relatively low prices. This means that the daily traffic in oil tankers will increase from 15 MMBD and 44% of global interregional trade in 2002, to 43 MMBD and 66% of global interregional trade in 2030. It also means that the daily traffic in LNG carriers will increase from 28 BCM and 18% of global interregional trade in 2002, to 230 carriers and 34% of global interregional trade in 2030.[78] The IEA does, however, estimate that these increases would be some 11% lower if oil prices remained consistently high in constant dollars.

A combination of massive reserves and comparatively low incremental production costs seem likely to ensure that the region will continue to dominate increases in the world's oil production capacity regardless of probable variations in oil prices -- at least through 2015 and quite possibly through 2025. Much does, however, depend on the long-term trend in world oil prices.

As has been discussed earlier, the IEA projected that world oil demand will increase by 60% between 2004 and 2030, and the EIA forecasts that total world oil demand will increase by roughly 40% during the same period.

Most analysts do believe that world dependence on Middle Eastern oil will increase and that OPEC members in the Middle East will meet most of the increase in demand. In the real world, however, many factors drive the behavior of countries in the Middle East in determining their production capacity.

It is far too soon to make long-term predictions about what MENA states will do if prices and revenues remain high. It is clear from EIA country surveys, however, that high prices, high demand, and high revenues have prompted most Middle Eastern countries to either increase production capacity or develop new plans to do so. The exceptions are those counties with major political or internal security problems.

Figure 10 shows the EIA production capacity forecast for selected countries in the Middle East. In 2025, for the reference case, the Middle East will have a production capacity of 42.6.6 MMBD, compared to 30.6 MMBD, for the high price case, which represent a 91% or 34% increase from its production capacity in 2002, respectively. As mentioned previously, these projections are based on oil prices that are almost certainly unrealistically low (the high price case used a $48/barrel, while the reference case used $35/barrel).

According to the EIA *Monthly Energy Review*, the OPEC Gulf countries produced 22.65 MMBD in 2002. The EIA, however, projects that the Gulf will produce 39.3 MMBD in 2025 for its reference case forecast, 27.8 MMBD for its high price forecast, and 50.0 MMBD for its low price case. Similarly, the IEA projected that production from the Gulf will double by 2030, but this was based on relatively low oil prices. The IEA *World Energy Outlook 2004* concluded, "A disruption in supply at any of these points could have a severe impact on oil markets. Maintaining the security of international sea-lanes and pipelines will take on added urgency."[79]

National Developments

It is important to note that the real-world export capacity of the Middle East region will probably be supply-limited regardless of future oil prices. The demand-driven modeling of the IEA and the EIA has a fantasy like character in assuming purely market-driven increases in Middle Eastern country export capacity regardless of real world political, economic, and oil field development constraints. It also seems to be based on unrealistically low development and future export costs.

At the same time, the strategic vulnerabilities of both Middle Eastern exporters, and outside importers, do not alter significantly if the Middle East cannot expand exports and production capacity to the projected level. If anything, vulnerability increases in terms of its economic and strategic impact in prices become very high, and supply remains under constant stress because of high levels of demand.

Bahrain

Bahrain has proven oil reserves of only 125 million barrels and production levels have been steadily declining since the 1970s. In addition, Bahrain produces only refined petroleum products, so it must import crude oil to meet its domestic demand. However, the Bahrain Petroleum Company (Bapco) recently finished a $900 million project that increased production capacity, allowing Sitra to produce a wider range of petroleum products.

Bahrain has long-standing political tensions between its Sunni elite and Shiite majority, which could explode into open civil conflict, lead to Iranian covert or overt intervention, and/or bring down its royal family. Sectarian tensions are compounded by structural economic problems resulting from the depletion of oil reserves, the growing population, and an over-dependence on foreign labor.

Iraq

Although the US and Iraqi governments have given a high priority to restoring Iraqi oil production and exports, an increasingly violent and destabilizing low intensity conflict in the reconstruction in the reconstruction period has caused oil and gas production to fall. In the first 6 months of 2005, oil production averaged only 1.9 MMBD.[80]

Funds that have been appropriated by the U.S. to the Iraqi oil sector have been diverted to security efforts, as the violence has increased and the need for basic infrastructure outside the oil sector has proved to be more expensive than originally estimated.[81] More damage has been inflicted on vital infrastructure by looting than fighting during the conflict. The Institute for the Analysis of Global Security estimates that there have been 267 attacks on Iraqi oil infrastructure and personnel between June 2003 and September 2005. [82]

While security issues have constantly affected the development of the northern fields, the southern fields have remained unscathed in this regard. However, the lack of adequate U.S. investment in repairs to these fields have contributed to the low production levels, which have actually declined in the past year and are much lower than target levels. Some estimate that if repairs were completed on schedule, Iraq would currently be producing an additional 0.5 MMBD, which translates into an addition $8 billion in annual revenue.[83]

There are no current plans from major oil companies to develop the Iraqi oil industry and fix these problems in the near future, which suggests that it will be several years at least before Iraq can achieve the 5.5 MMBD that is predicted to be possible by its extensive reserves. Issam al-Chalabi, Iraqi oil minister in the 1980s, told a London conference, “There is no plan to develop the Iraqi oil industry.” In addition, he notes that article 109 and 112 of the newly drafted Iraqi Constitution are contradictory in terms of who is in charge of the oil industry—the federal authority or the separate provinces. Thamir Abbas Ghadbhan, current member of the Iraqi oil industry, notes that 24 million liters are needed per day, compared to only 10 million liters of current production, requiring Iraq to import additional oil to meet its domestic demand.[84]

Three key projects in Iraqi oil reconstruction are not going as planned, which will likely add to the total price needed for restoration of the Iraqi economy and stymie growth beyond expected levels. In addition, fighting between the Sunnis, Shiites, and Kurds during the drafting of the Iraqi Constitution was largely over the way in which oil and gas revenues will be divided in the future. Sunnis have threatened to block the ratification process by stalling the referendum, which would likely further postpone Iraqi national development and increase the instability of the region, as well as retard the growth of the Iraqi economy, cripple the political structure, and lower social welfare. It is expected that Iraq’s economic and social problems will continue well beyond 2010, even under the best of circumstances

More broadly, Iraq’s growing sectarian and ethnic tensions, ongoing insurgency, and risk of an escalating civil war make Iraq at least a moderate mid-term risk in terms of maintaining both current export levels, and providing a stable climate for major future investment and development.

Iran

Although Iran remains the second largest oil producer and holds the world fourth-largest pool of proven oil reserves (132.50 Billion barrels of oil), its production has dropped by more than a

third to its 2005 levels of 4.1 MMBD.[85] The EIA projects that Iran production capacity in 2025 will be 4.5 MMBD or 5.0 MMBD for high price case and reference case, respectively.

Iran also contains the world's second largest gas reserves, totaling an estimated 940 trillion cubic feet (Tcf). Dramatic recent increases in energy prices and net oil exports have the potential to significantly improve the economy of Iran, but the country retains a massive budget deficit that is exacerbated by the refusal of the Majlis to raise consumer prices. In January 2005, the Majlis froze domestic prices for oil and other fuels at 2003 levels, maintaining prices lower than 40 cents per gallon of gasoline.[86]

Ambitious production goals by Tehran will not be possible without tens of billions of dollars in investment; however, the laws prohibit the granting of petroleum rights to any private company on a concessionary basis or direct equity stake. In addition, the situation with Iran's nuclear program remains uncertain. If the case is referred to the UN Security Council and sanctions are imposed, it may make it harder for Iran to attract any meaningful foreign investment in its energy sector.

Both last year's election for the Majlis and this year's Presidential election have strengthened the hand of Iran's hard-liners and those who oppose a major foreign role in Iran's oil and gas development.

Kuwait

Kuwait contains an estimated 99.9 billion barrels of proven oil reserves, or approximately 8.3% of the world total. Its gas reserves are among the world's top 20 (1.57 trillion cubic meters, or 0.9% of the world's reserves. Its oil sector showed promise at the official end to combat of the Iraq War, due to Kuwaiti involvement in Iraqi development contracts and the possibility of collaboration on energy projects, but security issues have dampened prior optimism. In addition, two border incidents in July of 2005 have forced a renewed dispute over land and the Ratqa-Rumaila oil fields into the public arena.[87]

Kuwait's oil wealth should be enough to support the needs of its population with only limited economic reform and diversification, and the government already maintains a "Future Generations Fund" to which it deposits 10% of all oil revenues, to be tapped into when the oil supply runs out. The government has also proposed Project Kuwait, a $7.0 billion, 25-year plan to increase the nation's oil production with help from international firms; however, final approval must come from the Kuwaiti Parliament, whose nationalist and Islamist MPs have stood firm in their opposition to foreign involvement in the Kuwaiti energy sector.[88]

Kuwait instead has been attempting to expand its state-owned investments in petrochemicals, export facilities, and MENA regional pipeline networks. There is broad agreement in the world oil industry, however, that the end result has been to provide inadequate investment in development and next technology, and possibly to reduce Kuwait's ultimate recovery from the fields it is currently exploiting.

Kuwait seems to have moderate internal stability. The regime has weak top leadership, and the strength of Islamist movements is growing, fueled in part by the backlash to the Iraq War.

While Kuwait has some Islamic extremists, it does not seem to face significant internal security threats. Kuwait seem to be in a "cultural dilemma," where it enjoys the US security blanket, it has to balance that with the social forces that are increasingly of an Islamist nature. Furthermore, experts note that younger generations of Kuwaitis did not have to suffer Saddam Hussein's

invasion of their country and do not appreciate the role the United States played in liberating their country.

With exploding birth rates, the young people are increasingly anti-American for both the war in Iraq and the US' perceived unconditional support of Israel. It has been reported that among the insurgents in Iraq are Kuwaiti nationals. Furthermore, radicals in Kuwait have attacked US convoys on their way to Iraq, and there were investigations on a possible plot to assassinate the interim Iraqi Prime Minister, Iyad Allawi, who were visiting Kuwait on the 14th anniversary of the Iraqi invasion.[89]

Oman

Figure 9 shows that Oman has 7.28 billion barrel of known reserves, 3.45 billion of undiscovered reserves, and 5.60 billion barrel of proven oil reserves. Oman has made a substantive effort to diversify its economy by exploiting other available natural resources, developing a domestic manufacturing base, and through "Omanization," a program intended to employ more Omani citizens in the private sector. Currently only 10% of workers in private firms are Omani nationals. Despite Omani efforts to diversify its economy, Oman continues to be heavily dependent on oil revenues. For example, in 2004, oil revenues accounted for 75% of its export earnings and roughly 40% of its GDP.[90]

Oman's oil fields are generally smaller, more widely scattered, less productive, and more costly to produce than in other Gulf countries, due to their extensive use of EOR technologies to maximize production.

Oman has been successful in attracting foreign investment to its energy sector as part of its continuing effort to diversify the economy and to develop domestic value-added industries. It is planning to seek additional foreign investment in petrochemical production, and is involved with the promising Dolphin Project. Oman began supplying gas to DEL in late 2003, although plans call for the pipeline flow to eventually reverse, supplying Oman with gas from Qatar to be used in petrochemical and fertilizer plants. However, Oman has been left with more bureaucratic restrictions than in neighboring Dubai, its labor productivity remains low, and political reforms have been minimal.

Oman is having limited problems with Islamist extremists. In addition, the political succession process in Oman is uncertain. There are no obvious successors to Sultan Qaboos and it remains unclear if the Omani political system has evolved enough to deal with a lack of leadership on the top.

Qatar

Figure 9 shows that Qatar has 9.20 billion barrel of known reserves, 3.62 billion of undiscovered reserves, and 15.20 billion barrel of proven oil reserves. Due to high oil revenues coupled with a small population, Qataris have 80% of the wealth per capita of the European average, and the economy grew at the high rate of 7.0% in 2004 with a 6.7% growth level predicted for 2005. However, Qatar has a high foreign debt ($17 billion in 2004) and an increasing rate of inflation that is projected to reach 4.1% in 2005, largely due to significant investments in infrastructure to increase production capacity of oil and gas. Nevertheless, it has maintained a net surplus in revenues in recent years, allowing government allocations for infrastructure and development to total 22% of Qatar's overall budget for 2004-2005. All of the additional capacity will go toward

exports, as oil makes up less than 15% of domestic energy consumption, a number that is already low due to the small population.[91]

The sharp rise in oil income has allowed Qatar to allocate much more money toward development of oil fields, and the pace and scope of projects has significantly improved. Qatar is also pressing ahead with several high priority gas projects, including the construction of new liquefaction facilities, the Dolphin Project, and an expansion of exports to the Asian market, adding India to its client list of the world's two largest LNG importers, Japan and South Korea.[92]

Qatar had several clashes with Saudi Arabia before the two countries finally agreed on a border settlement, and Qatar accused several of its Southern Gulf neighbors of supporting a coup attempt by the present Emir's deposed father. The Qatar-Saudi relations, however, continue to be tenuous at best due to Qatar's support of al-Jazeerah network and Qatar's desire to sign a Free Trade Agreement with the US. In addition, many experts believe that the Qatar's Foreign Minister, Sheikh Hamad Bin Jassim al-Thani, has made comments that that may undermine the Saudi Peace Initiative, which promised normalization of Arab-Israeli relations if Israel withdrew to the 1967 border. On September 15, 2005, the foreign minister suggested that it is possible for Qatar to establish full diplomatic relations with Israel even before a full withdrawal.[93]

In contrast, Qatar has so far been able to maintain good relations with Iran in developing the giant gas field the two countries share in the Gulf. While Iran is the primary potential threat, there have never been serious recent tensions between the two countries. The future is, however, uncertain.

Saudi Arabia

Figure 9 shows that Saudi Arabia has 283.51 billion barrel of known reserves, 87.09 billion of undiscovered reserves, and 262.70 billion barrel of proven oil reserves. Saudi Aramco recently announced that it has plans to reach production capacity levels of 12.05 MMBD by 2009, followed by an additional increase to 15.0 MMBD "if the market situation justifies it."[94] The EIA forecasts that in 2025, Saudi production capacity will reach 16.30 MMBD in its reference case forecast, and 11.0 MMBD in its high reference forecast.

The Kingdom's current capacity is estimated to be between 10.5 and 11.0 MMBD, which include the increase from Abu Safah and Qatif. An estimated 2.3-2.4 MMBD of new capacity will come on stream between 2005 and 2009, but an estimated 0.8 MMBD of that will go into replenishing the natural decline curve. The end result is a net addition of roughly 1.6 MMBD to the current sustainable capacity of 11.0 MMBD. This addition increases the sustainable capacity to 12.5 MMBD of by 2009. According to Aramco's Senior Vice President for Exploration and Production, Abdullah Al-Saif, the capacity expansion program has been put on a fast track, and the fields may come on stream before 2009.[95]

The investment cost for the Saudi capacity expansion plan is estimated to be around $15 billion. It was also reported that, during the same period, the Kingdom's total investment in the petroleum sector was estimated to total $50 billion.[96] Experts believe that the latter number represent Saudi Arabia's total energy investment, while the $15 billion represent the cost of the projects outlined earlier.

Whatever the debates over Saudi capacity may be today, these projects and dates now provide clear benchmarks for measuring Saudi capacity and credibility. Success will greatly enhance all aspects of Saudi credibility. Failure will be an important strategic warning.

Saudi Aramco has a proven record of success in consistent oil exploration and construction. There is a need, however, to make massive further increases in gas exploration and development, which comes at the same time that the Kingdom must fund oil development, restructure the rest of its economy and meet rapidly growing civil demands from its rising population.[97]

There have been major internal debates over privatization and opening the energy industry to foreign investment. Additionally, there is a heightened security risk since al-Qaeda's terrorist attacks in May 2003, which has required the Saudi government to spend additional funds on protection of oil installations. Attacks on the Abqaiq oil processing facilities have the potential to cut the current oil output of 9.6 MMBD by 4.0 MMBD, a scenario that could sustain itself for 2 months or more.[98]

While details of the Saudi security budget are classified, it is estimated to total more than $8.0 billion in 2004. Between 2002 and 2004, the Saudi government allocated approximately $1.2 billion to increase security at all of its energy facilities. At any one time, it is estimated that there are between 25,000 and 30,000 troops protecting the Kingdom's oil infrastructure. "For years, Saudi Arabia has recognized the importance of protecting its vital facilities, long before the recent terrorist actions. So we've always maintained a high level of security," says Abdullatif Othman, Executive Director of Saudi Aramco affairs.[99]

United Arab Emirates

Figure 9 shows that UAE has 72.93 billion barrel of known reserves, 7.70 billion of undiscovered reserves, and 97.80 billion barrel of proven oil reserves. The UAE holds 97.8 billion barrels of proven reserves, accounting for almost 8% of the world total.[100] It is currently in the process of expanding production capacity in several of its fields (its immediate goal being to raise overall production capacity to 3.5 MMBD in one year), but it is in great need of foreign investment in these expansion projects, not for asset management or cost cutting measures, but for expertise, management tactics, and EOR technologies.[101]

The UAE is particularly motivated to develop the infrastructure needed for an increased oil production capacity due to the allure of the rapidly expanding Asian market and the abundance of opportunities for UAE investors to make huge profits by securing their export share of the increasingly high demand in the Pacific Rim. The UAE is also looking to expand its portfolio by buying into utility and gas companies overseas, as well as to partner with a foreign firm and buy into the LPG market.[102]

Sheik Zayed of Abu Dhabi died on November 2, 2004. While the transition to this son, Khalifah, has been smooth, it is still unclear if Khalifah has the ability to keep Al-Nahayan family together while maintaining the support to the other six families ruling the emirates. Zayed left behind 19 sons from many wives, and the competition for power between them might threaten the stability of largest emirate, Abu Dhabi, and eventually the union. Some experts have argued that Khalifah lacks the leadership skills of his father, and that he will be overshadowed by his younger half brother, Mohammad, whom his father named as deputy crown prince in 2003.[103] Mohammad bin Zayed is also the Chief of Staff of the UAE Armed Forces and is competing with the crown prince of Dubai, Mohammad bin Rashed Al-Maktoom, who is also the Defense Minister. While the friction has been kept civil during Zayed life, it remains uncertain how the two Mohammads relationship develops following the passing of Zayed.

The competition within and between the families was apparent in June 2003 when the ruler of Ras Al-Khaimah replaced crown prince Khalid, who apposed the US led war in Iraq with another son. Crown prince Khalid and his supporters refused apposed the decision and the situation almost got violence, which led the government in Abu Dhabi to send APC to protect the ruler of Ras Al-Khaimah and break up the protest.[104]

Yemen

The Yemeni government actively courts foreign oil companies, especially since most of the major international firms pulled out of Yemen in the mid- to late-1990s due to a violent civil war, unattractive exploration and production contractual conditions, and the low success rate of new hydrocarbon discoveries. In 2001, improvements to the terms of foreign investment were passed that allowed for more flexibility in contracts and the ability to negotiate on a case-by-case basis in terms of contract extensions and the amendment of restrictive legislation. However, the government has been inconsistent in the reform process, as exemplified by its 2001 cancellation of the Aden refinery rebuilding process, which was initially scheduled for privatization, but now is subject only to a vague plan of intention to sell partial stakes to private firms in the future.

Yemen seeks to become an LNG producer, but its future in the industry has looked bleak since a massive pullout in 2002 by several companies scheduled to build up LNG infrastructure. Another obstacle to Yemen becoming a major LNG producer is competition from regional powers Iran and Oman, both of whom have more advanced pipeline infrastructure and more investment contracts and offers to expand their existing networks. Industry inconsistencies coupled with a resurgence of rioting in August 2005 over a doubling of national fuel prices makes Yemen's future appear much bleaker than its regional counterparts do.

Yemen is the wild card in the southern Gulf. In strict terms, it is not a southern Gulf power. It has coasts and islands on the Indian Ocean and Red Sea, and occupies a strategic position at the Bab el Mandab – the narrow strait that controls the entrance to the Red Sea and which every ship passing through the Suez Canal must traverse. It does, however, share borders with Oman. While Yemen has resolved its border disputes with Oman and Saudi Arabia, there has been a long history of tension between Yemen and its neighbors. Yemen sponsored a violent Marxist insurgent movement and provided it with military support and sanctuary during the Oman's Dhofar rebellion.

In addition, the Saudi-Yemeni border has a long history of clashes, and smuggling from Yemen to Saudi Arabia – including the supply of arms and explosives for Islamic terrorists – is a continuing problem.

Although Yemen is making progress towards stability, it has a long history of civil war and violence. It also has a large and rapidly growing population of over 20 million, which its economy cannot support. Only remittances from workers oversea and foreign aid allow the nation to function. This economic and demographic instability, coupled with a long history of tolerating the presence of extremist and terrorist movements when they do not directly threaten the regime, makes Yemen a potential threat to both Oman and Saudi Arabia.

The Levant: Egypt, Israel, Jordan, Lebanon, and Syria

Despite recent declines, Egypt is hoping that exploration activity funded by current high fuel prices will discover sufficient oil in coming years to return crude oil production to a level maintainable level near 0.80 MMBD. So far, exploration and production-boosting projects,

especially near the Gulf of Suez and Western Desert, have proved fruitful. A revamping of the Suez Canal intended to cut down transit times may also prove lucrative.

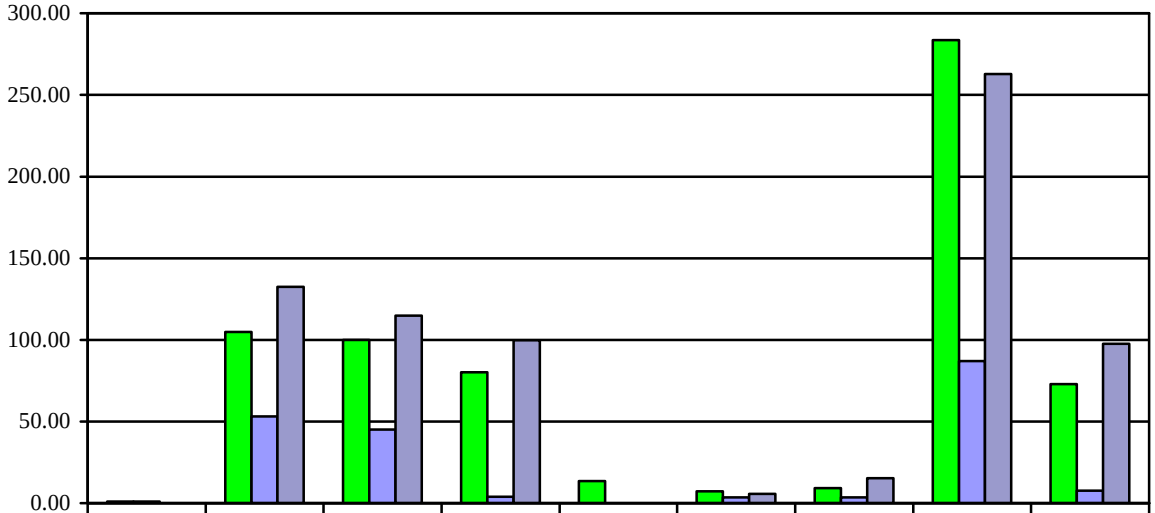
Due to drastic changes in Jordan's oil supply and the loss of cheap, subsidized oil from Iraq, Jordan has pushed forward with plans for exploration and development of its own oil potential, which is largely unknown as of yet. To help attract foreign investment for this new and expensive endeavor, the Jordanian government has plans to privatize its oil sector and to possibly burn shale for electricity.

While Israel has historically relied on Egypt, the North Sea, West Africa, and Mexico to supply its energy needs, it now reportedly imports a majority of its oil from former Soviet countries, such as Russia and the Caspian nations. Its most notable gas purchase comes from Egypt, which in 2005 agreed to provide Israel with 60 billion cubic feet per year for 15 years, marking a large step toward political progress as well.[105] Israel's Petroleum Commission estimates that the country could contain up to 5 billion barrels of oil located under gas reserves, however only 20 million barrels are believed to be extractable.

Syrian oil production dropped sharply in 2003 when illegal imports from Iraq were cut off. In addition, its oil development has been politicized and inefficient, and its economic reforms, including those related to oil, have either failed or moved too slowly in virtually every respect. Without significant new discoveries in the next few years, oil officials predict that the country could become a net oil importer by the end of 2005. Syria is attempting to make reforms in its energy sector such as using intensified oil exploration and production efforts, and switching to natural gas-fired electric power plants to maximize revenue from oil exports. However, Syria's relationship with Iraq and the US is on the decline, and it has failed to take its security situation seriously or make a genuine effort at long-term political and economic reform.

Figure 9: Middle East Proven, Known, Undiscovered Oil Reserves

(In Billion Barrels)

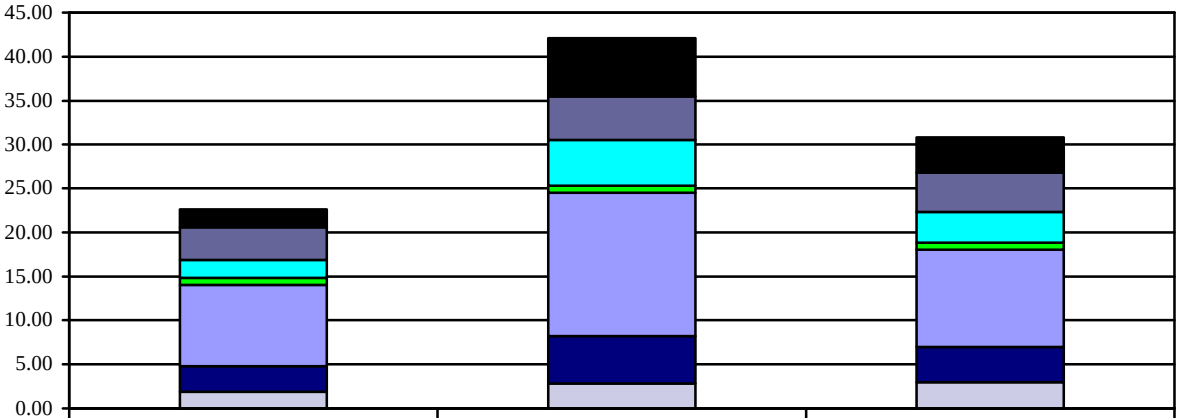


	Bahrain	Iran	Iraq	Kuwait	Neutral Zone	Oman	Qatar	Saudi	UAE
Known	1.05	104.98	100.07	80.10	13.51	7.28	9.20	283.51	72.93
Undiscovered	0.90	53.11	45.10	3.84	0.00	3.45	3.62	87.09	7.70
Proven	?	132.50	115.00	99.90	?	5.60	15.20	262.70	97.80

Source: Adapted by A. Cordesman & K. Al-Rodhan from the BP, *Statistical Review of World Energy 2005* and the *US Geological Survey 2000*.

Figure 10: EIA Estimates of Middle East Oil Production Capacity

(In MMBD)



	2002	2025: Ref	2025: High
Iraq	2.00	6.60	4.00
Iran	3.70	5.00	4.50
Kuwait	2.10	5.20	3.50
Qatar	0.80	0.80	0.80
Saudi	9.20	16.30	11.00
UAE	2.90	5.40	4.00
Other ME	1.90	2.80	3.00

Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *International Energy Outlook 2005*.

Key Strategic Challenges

Countries in the Middle East face long-term strategic challenges as well as short to mid-term uncertainty. The risk premium of these uncertainties is hard to quantify, but the following are the key strategic challenges that the Gulf and the greater Middle East face, which have direct and indirect effects on the energy market:

- **Internal threats from extremists:** Saudi Arabia has experienced attacks since the May 2003 bombing; the Kingdom's forces have proven their ability to deal with this threat. However, the question remains: can the other southern Gulf states withstand such attacks?

- **Asymmetric threats toward the Strait of Hormuz and oil facilities:** The security challenges to the Gulf countries are to prevent attacks against oil infrastructure and reduce the damage when they occur.

- **Instability in Iraq:** The uncertain outcome in Iraq and the possible spillover of insurgency into the neighboring states remain a real threat to stability in the rest of the region. Cross border infiltrations by fighters have been reported, but currently only crossing into Iraq. Will these fighters go back to their countries? Do governments of these countries have a plan to deal with them? Or will they become like the "Afghan Arabs"?

- **"Glitter factor" in terms of regional status:** Rivalries and past tensions between the southern Gulf states prevented serious efforts at developing joint capabilities and interoperability. At the same time, a number of states limited their military efforts because of the fear of coups. The end result was that the southern Gulf states largely preferred de facto dependence on US and British power projection forces over effective regional and national military efforts.

- **Lack of economic diversification:** The Gulf economies continue to be highly dependent on oil. With no exception, the Gulf countries lack a vibrant private sector. This adds to the economic uncertainty due to the volatility of the oil market and the high dependence of state budget on oil revenues.

- **Fiscal and debt crunches:** Many countries in the region, despite high oil wealth, have faced budget derelicts, large sovereign debts, slow privatization campaigns, and lagging financial sectors. Such stagnations tend to crowd out valuable foreign and domestic private investment, which is much needed to create jobs and build a vibrant private sector.

- **High unemployment rates:** Estimates for unemployment are unreliable, but most countries in the Middle East face large number of unemployed. Moreover, the southern Gulf States continue to rely heavily on foreign labor. Saudization, Bahrainization, Emaritization, etc. have shown little success in the last decade.

- **Reforming educational systems:** Part of solving the unemployment problem is reforming the educational system to better prepare students for a competitive job market. Young people without jobs tend of blame it on the regime and become a recruitment target for extremist causes.

- **The demographic "time bomb:"** In most of the Middle East, over 50% of the population is under the age of 30. This has many implications. First, it deepens the unemployment problem. Most countries are adding more people to the job market than the market can employ. Second, it adds fiscal constraints on government programs and social entitlements including health care and public education, which further complicates the fiscal situation of their economies. Third, the population distribution is such that most of the population is young, unemployed, and perfect target for extremist recruitment.

- **Iran's WMD program:** The southern Gulf States will have to find a way to deal with a nuclear Iran through building a missile defense shield, acquiring their own WMD, or relying on the US's power projection in the Gulf.

- **Ongoing Israeli-Palestinian conflict:** The Gulf oil policy and the Palestinian issue have been kept separate by both the US and the Gulf countries. The leadership in the Gulf, however, is facing pressure from its population to use its oil political capital to help the Palestinian cause.

Production Risks and Developments

A combination of past low oil prices and geopolitical uncertainties has limited recent investment in the energy sector in the Middle East. The region's oil infrastructure is aging, and countries in the Gulf have spent a lot of money on internal security, social, and economic programs and in certain cases, have spent less money on upgrading their aging energy infrastructure.

The shift toward high oil prices could provide the necessary incentives for new investments. The following points, however, are key production and resource risks in the Middle East even if the region's political and military risks can be minimized and investment capital becomes available:

- **Natural depletion rates:** Some analysts argue that the depletion rates of major oil fields are higher than reported. The implications are that current reserve estimates production capacity may not also be what is being reported.
- **Iran's oil fields are depleting:** Iran's oil fields are estimated to have a natural depletion of 0.20-0.25 MMBD. These fields need to be upgraded, and it is estimated that the country's oil infrastructure needs as much as $1 billion of foreign investment to reach 5.0 MMBD by 2009.
- **Iran's large subsidies:** It is estimated that the Iranian government pays large subsidies totaling more than $3 billion a year resulting in large wastes and inefficiencies.
- **Intense water management systems:** Oil companies in the Middle East, and for that matter in most places, have used intense water injection to postpone natural depletions. Water management, however, can cause damage to the oil fields, and may cause the fields to collapse.
- **Major oil fields may have "peaked":** The Gulf has a dozen giant and super-giant fields. While the published data regarding depletion and reserve are uncertain, some of these fields are old and their upstream infrastructure has aged. Are there other fields large enough to replace these giant fields?
- **Dependence on giant and super-giant fields:** Oil officials in the region claim that these fields are huge, and even if they have aged, they are larger than any other fields we have seen and will take along time before they are out of oil. While it is true that these fields are huge and may have a long way to go before they run out of oil, producing nations are dependent on the health of these oil fields.
- **Vertical wells are not enough:** When oil fields mature, vertical wells are not enough to extract oil, and therefore it may require horizontal wells or MRC (maximum recovery contact) to produce oil.
- **Politicization of reserves and capacity:** Oil reserves are seen as signaling strategic importance. Some experts have argued that countries inflate their oil reserves as a political tool against their neighbors and outside powers.
- **Little spare production capacity:** With the exception of Saudi Arabia, in 2005, the other Gulf and Middle Eastern countries had no spare capacity. This requires large foreign and private domestic investment in technology and in capacity expansion programs—given that the current surge in demand is not expected to cool off anytime soon.
- **Loss of valuable Iraqi reservoir data:** Following the invasion of Iraq, experts believe, that many valuable data were looted from the Iraqi oil fields and ministry of oil regional buildings.
- **Iraq's labor force:** Workers in the Iraqi oil sector lack the training to develop and modernize the energy industry due to sanctions and the instability of post-conflict.

Africa

Figure 11 shows current estimates of African oil reserves. Africa's "proven" reserves were estimated to be 112.2 billion barrels in 2004 (9.4% of the world total proven reserves). This is nearly double what the continent was estimated to have in 1994 -- roughly 65 billion barrels of proven reserves. In 2003, the energy task force, headed by Vice President Dick Cheney, projected that Africa's oil sector will be the fastest growing in the world.[106] During the last few years, this projection has been proven correct; Africa has been the fastest growing region in terms of discoveries and production.

West Africa's share of world's total, including unproven reserves, can reach 7%. The Gulf of Guinea has 33.8 billion barrels of proven reserves, which is relatively small compared to those of the Middle East, which has 733.9 billion barrels of proven reserves. In addition, production costs in the Ecowas region are higher because the majority of the oil reserves are offshore.[107]

National Developments

Nigeria, a member of OPEC, has the largest reserves (known, undiscovered, and proven) in the continent. Nigeria has approximately 35.3 billion barrels of proven reserves. In addition, according to the *US Geological Survey 2000*, Nigeria has about 37.62 billion barrels of undiscovered oil. It is the largest West African producer, and the fifth largest exporter to the United States. Fully half of its exports of 2.5 MMBD flow to the U.S. The Gulf of Guinea as a whole currently supplies 15 percent of U.S. oil and according to the U.S. National Intelligence Council, this number could rise to 25 percent by 2015. In the next 5 years, 1 in 5 new barrels of oil on the global market will come from the region.[108]

Some experts argue that the hopes those West African oil and gas reserves can be exploited and should not be overestimated. Geo-strategic risks including revolutions, violence, and corruption have limited the potential of African oil reserves. Border disputes have slowed the process of developing offshore oil fields in West Africa.

Interethnic strife and violence in the Niger Delta including kidnapping, sabotage, and attacks of oil facilities have caused production and supply disruptions. For example,

> In March 2003, Chevron-Texaco and Shell moved some of their staff off location and suspended their production in the Niger Delta, which caused Nigerian production to drop by 13% or 0.266 MMBD.[109]
>
> In June 2005, the U.S. consulate at Lagos was closed for several days due to an internet terror threat supposedly posted by Osama bin Laden marking the country for "liberation."[110]
>
> On September 23, 2005, the Nigeria radical separatist groups, People's Volunteer Force, issued a statement in which they threatened, "We will kill every iota of oil operations in the Niger Delta. We will destroy anything and everything. We will challenge our enemies in our territory and we shall feed them to the vultures." The threat came after the Nigerian authorities arrested Dokubo-Asari on allegations of treasons. The government of Nigeria announced that it deployed 900 extra police officers. Following the statement, Chevron Corp. and Royal Dutch Shell PLC shut their oil facilities in the Niger Delta. The two Chevron stations that were shut down produced 0.027 MMBD.[111]

As mentioned earlier, the problem with oil from West Africa is the high volatility of its production due to instability and production risks. Nigerian exports to the US provide a perfect example of this. During 2002, oil exports to the US from Nigeria decreased by 6.27%. Regional and energy experts have argued that increasing US reliance on West African oil means increasing the US vulnerability to the instability of the region.[112]

Some humanitarian organizations have also argued that this growth in national energy sectors has hampered balanced economic and social development in Africa. The Catholic Relief Services, for example, has reported that African countries where oil was discovered a few decades ago, such as Gabon, Angola and Nigeria had lower economic development, growth, and poverty reduction that those without oil.[113] Part of this stagnation can be attributed to oil related corruption and lack of transparency. In addition, governments in such countries have relied on oil revenues to support their state budgets and have done little to liberalize and diversify their economies away from the oil sector.[114]

Angola has the second largest undiscovered reserves in Africa, roughly 14.52 billion barrels of oil in addition to 8.8 billion barrels of "proven" reserves. In 2003, the IMF found that $1 billion of the Angolan government's $5 billion budget goes missing every year. Moreover, Global Witness, a human rights organization based in the UK, made the claim that the money from oil contracts--paid to Angolan government officials--including President José Eduardo dos Santos, helped extend Angola's civil war.[115]

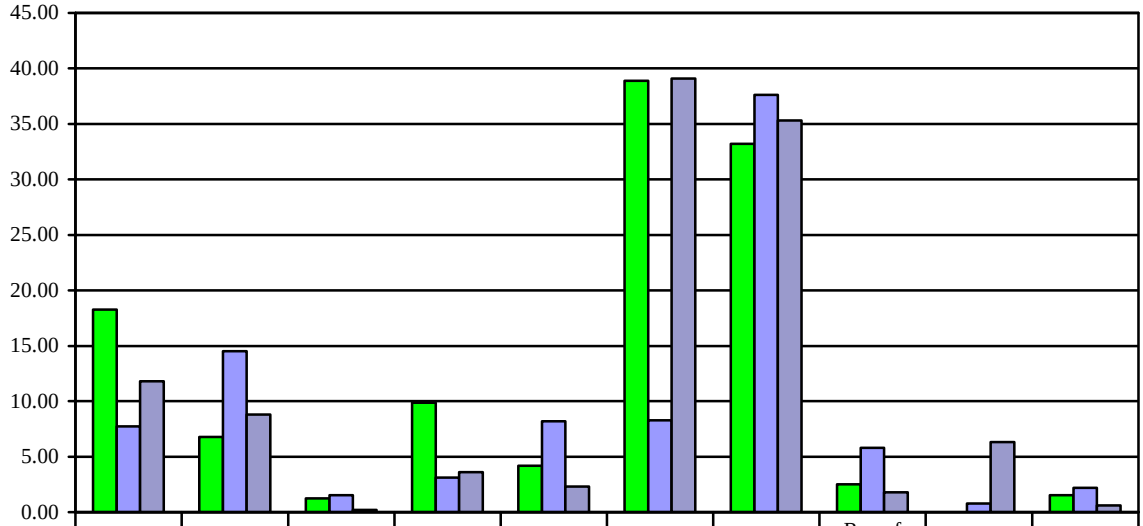
There have been US efforts to improve stability in the region. It was reported that the US European Command was talking to leaders in West Africa to increase cooperation in protecting the oil facilities in Nigeria, Angola, Cameroon, Guinea, and Ghana. The US held a meeting in October 2004 to discuss energy security with regional leaders. Western Africa supplies roughly 14% of the US' imports, which is early double what it was 20 years ago, and some experts predict that if the same rate of offshore discovery continues, the fraction of US imports from Africa can rise to 20% in the next decade.[116]

Given the importance of the West African region, the US is also trying to curb corruption. Col Mike Anderson, Chief policy planner for the European Command, said that the US is working with West African leaders to put in place anti-corruption measures, but he said of these efforts, "It's a tough nut to crack there." [117]

As for current and future production and exports, Algeria and Nigeria have dominated past oil production in Africa, but Figure 12 shows that the EIA forecasts that other African countries, presumably in West Africa, will increase their production capacity from 3.10 MMBD in 2002 to 6.80-8.10 MMBD depending on oil prices. Nigeria, Algeria, and Libya's production capacity will see some increase in their capacity. Figure 12 shows that the EIA estimated that their production capacity would increase from 5.5 MMBD in 2002 to 9.6 MMBD in the reference case and 7.3 MMBD in the high price case in 2025.

The problem with such estimates is that the EIA's demand-driven modeling again ignores actual country plans and regional political instability. In the real world, actual output could be much lower for political investment, and management reasons, or much higher as poor nations seek to maximize oil imports by any means possible.

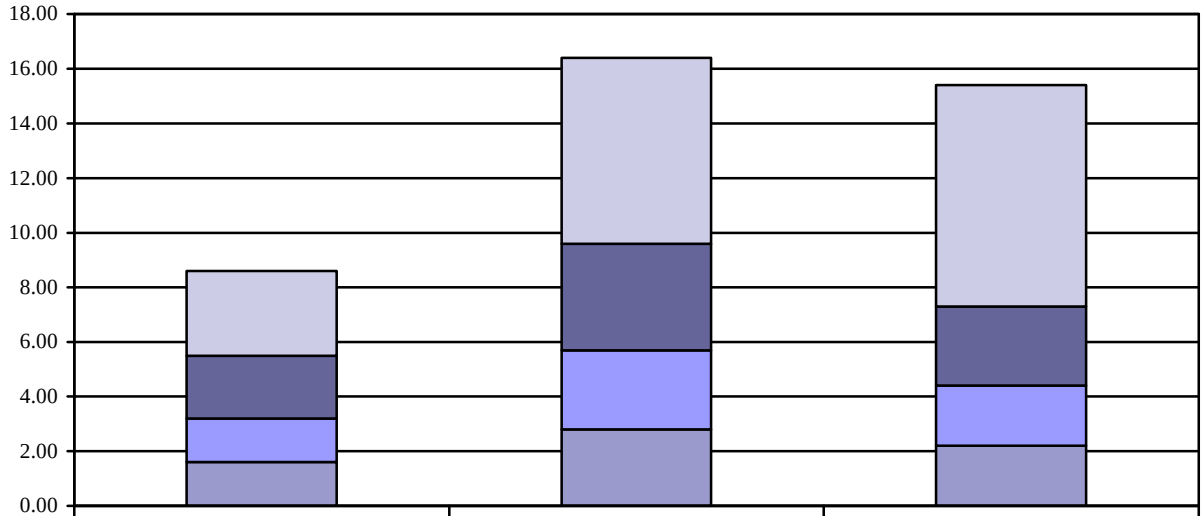
Figure 11: Africa Proven, Known, Undiscovered Oil Reserves
(In Billion Barrels)



	Algeria	Angola	Cameroon	Egypt	Gabon	Libya	Nigeria	Rep of Congo	Sudan	Tunisia
Known	18.28	6.78	1.24	9.87	4.17	38.90	33.20	2.50	0.00	1.52
Undiscovered	7.73	14.52	1.53	3.12	8.18	8.27	37.62	5.80	0.77	2.18
Proven	11.80	8.80	0.20	3.60	2.30	39.10	35.30	1.80	6.30	0.60

Source: Adapted by A. Cordesman & K. Al-Rodhan from the BP, *Statistical Review of World Energy 2005* and the *US Geological Survey 2000.*

Figure 12: EIA Estimates of Africa Oil Production Capacity
(In MMBD)



	2002	2025: Ref	2025: High
Other	3.10	6.80	8.10
Nigeria	2.30	3.90	2.90
Libya	1.60	2.90	2.20
Algeria	1.60	2.80	2.20

Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *International Energy Outlook 2005.*

Key Strategic Challenges

The geopolitical risks in Africa are as complex—if not more so than—in the Middle East. Ethnic tensions, government corruption, and border disputes compound the uncertainty of the energy sector in Africa and the global oil market. As is the case with the other producing regions, quantifying geopolitical risks is impossible, but the followings are the major strategic challenges the oil producing nations in the continent face:

- **The HIV/AIDS epidemic:** The continent of Africa continues to be threatened by the AIDS virus. Between 1981 and 2003, HIV/AIDS killed 20 million people. Almost 1,600 children die of AIDS worldwide, and at least 90% of them are African. This represents social, economic, health, and humanitarian crises.

- **Ethnic and tribal conflicts:** The ongoing conflict in Darfur, the low intensity civil war in Algeria, the ethnic division in Zimbabwe, and the fragile peace in Rwanda have contributed to the ongoing uncertainly and instability in Africa. A long-term realistic strategy must be put in place to deal with them.

- **Transit and training ground for terrorism:** Some extremist movements have found a safe haven in east Africa due to failure of local governments to control their borders and due to its proximity to the Gulf and Saudi Arabia. Outside powers must help local governments deal with this phenomenon through training programs, intelligence sharing, and assistance in patrolling their shores.

- **Illicit small arms smuggling:** Countries such as Democratic Republic of Congo, Sierra Leone, Angola, parts of Nigeria and Liberia have also experienced internal conflicts in recent years. Small arms in the hands of warlords have caused a lot of damage to human life and infrastructure. Since the start of the "Global War on Terrorism," security services have turned their attention to transnational terrorist organizations in West Africa and their relation to illegal diamonds and arms smuggling.

- **Transparent and accountable governments:** the African continent continues to lack good governance and is plagued by corruption such as the case in Zimbabwe and Liberia.

- **Coups and military takeovers:** Countries in Africa are plagued with insurgency and coups. On August 3, 2005, the Mauritanian army ousted President Maaouya Ould Sid'Ahmed Taya, and the military rulers appointed a new civilian government and declared that it will hold elections within two years.

- **Effective regional security forces:** the African Union lacks any well-trained, deployable, and effective regional security forces. Such forces are needed to stop ethnic strife such was the case in Rwanda or to calm political unrest such was the case in Liberia.

Production Risks and Developments

African production capacity of Africa was 8.6 MMBD in 2002. According to the EIA forecast issued in 2005 and shown in Figure 12, its production capacity will nearly double by 2025 (15.4 MMBD for high case, 16.4 MMBD for reference case).

In addition to the geo-strategic risks, Africa faces other petroleum development problems. African oil reserves are often offshore and costly to extract. At the same time, recent discoveries and production developments are changing the face of African oil. Key recent developments and production challenges in the oil sector face are:

- **Highest rate of discovery in the world:** During the last five years, West Africa saw the highest rate of discovery in the world, mostly in the Gulf of Guinea. The majority of the growth will come from Nigeria and Angola.

- **Angola's production level:** According to the EIA, by 2008, Angola's oil production is estimated to reach 2.8 MMBD. The country, however, is still recovering from 27 years civil war and its oil industry continues to suffer from lack of transparency, corruption, and misuse of its oil revenues by government officials.

- **Lack of economic development:** This growth, however, has come at the cost of necessarily economic development and poverty reduction programs. As mentioned earlier, countries with the higher oil discoveries have had the lowest economic liberalization and poverty reduction rates.

- **Lack of foreign investment**: There has been an inflow of foreign investment; however, it has gone mostly to West African countries. Central and North African countries have seen limited investment, especially in the area of upgrading current infrastructure and exploration to replenish natural depletion in existing oil fields.

- **Lack of transparency:** NGOs have reported cases of corruption by oil officials. For example, the World Bank reported that 80% of the oil revenue in Nigeria went to 1% of the population, despite the fact that 70% of the population in Nigeria is in Poverty.

- **Libya's energy infrastructure is dated:** Due to the sanctions and mismanagement, Libyan oil infrastructures is aging and have not been upgraded since 1970s. Lack of technological capabilities and sound transportation systems have prevented Libya from increasing its production capacity.

- **Deep offshore reserves and facilities:** Most of the new discoveries in West Africa are offshore and are deep sea. While these reserves and facilities are removed from any social conflict, pipelines and onshore oil facilities continue to be vulnerable to rebel attacks. Moreover, offshore reserves have higher production costs, require highly advanced technologies, and need higher level of foreign investment.

- **Rebel attacks:** Violent clashes between ethnic groups in the Niger Delta region have caused enough insecurity for some oil companies to evacuate their operations from Nigeria. Rebel groups have attacked and sabotaged oil installations. Algeria is another example where the Algerian military estimates that 400 militants or terrorists are currently residing in Algeria. In 2001, approximately 1,100 people were killed in clashes with insurgents.

- **Environmental damage of oil exploration and production:** According to the EIA, there has been "chronic release of oil" into the shipping ports, which has significant effects on the environment. This problem, however, is often ignored.

- **Strikes and labor disputes:** Labor disputes have caused disruption to oil production in Nigeria. Strikes, tax laws, and corruption continue to limit much needed foreign and private investment into the oil sector in central and West Africa.

- **Lagging Sudan's oil industry:** In 2005, Sudan's oil production level was roughly 0.50 MMBD and it is estimated to have a potential to reach 0.75 MMBD by 2006. The tenuous peace agreement in the south and the unrest in Darfur continue to plague the country and have prevented the inflow of foreign investment into Sudan's oil industry.

Asia-Pacific

As Figure 13 shows, the Asia-Pacific region has the lowest reserves of any other region. In 2004, BP reported that the region had 41.1 billion barrels of proven reserves. It also has limited undiscovered reserves. According to the USGS 2000, Asia contains roughly 32.064 billion barrels of undiscovered oil reserves. Figure 14 shows the region also has low levels of production, which are only estimated to increase from 7.5 MMBD in 2002 to 8.7-9.0 MMBD in 2025.

National Developments

China has the largest oil reserves in the region with 48.5 billion barrels of "known" reserves. China's production capacity in 2005 was 3.6 MMBD. Chinese production capacity has seen very little growth. The EIA projects that by 2020; Chinese production capacity could reach 3.8 MMBD in the high oil price case, or remain at 3.6 MMBD in the reference case. All of China's production is sold domestically in addition to the 3-4 MMBD of oil it imports.

Indonesia is the only Asian country that is a member of OPEC. It has 22.4 billion barrels of known reserves, 4.7 billion barrels of proven reserves, and 7.4 billion barrels of undiscovered oil reserves. While these numbers are small, Indonesia has played a major role in OPEC in the past. Indonesia's production declined in 2003 and 2004, however, due to natural depletion and aging oilfields. Its oil industry is in need of investment and further exploration to replace this decline.

The EIA forecasts that Indonesia's oil production capacity will stay at the same level in 2025 as it was in 2001, 1.5 MMBD. In August 2005, the Indonesian government announced that the country has been an oil net importer for the second quarter of 2005. During the same period, the country's imports averaged 0.080 MMBD. Indonesia's OPEC quota is 1.45 MMBD, but Indonesia produced only 0.94 MMBD in June 2005.[118]

According the EIA, the new Indonesian oil field, Cepu, which is estimated to hold at least 600 million barrels of oil reserves, is being developed by Exxon Mobil in partnership with Pertamina, but they cannot agree on profit sharing or extending Exxon Mobil's technical assistance beyond 2020. Despite the 2001 legislation that attempted to limit the company's monopoly power in the upstream business, corruption charges against Petramina continue surface.[119]

With the exception of India, the rest of Asia consumes a growing amount of energy with little petroleum production. India's oil consumption has grown rapidly in the last decade. In 2003, its average production was 0.819 MMBD leaving India with a net 1.4 MMBD imports. It is trying to decrease its dependence on foreign sources of energy, so it is expanding exploration, has ended price control, and as has planned to build strategic petroleum storage.

Japan lacks large domestic petroleum reserves. According to the EIA, Japan contains only 59 million barrels of proven reserves. Its domestic production is minimal, but it is the third largest consumer of energy after the US and China. In 2004, Japan consumed 5.288 MMBD.

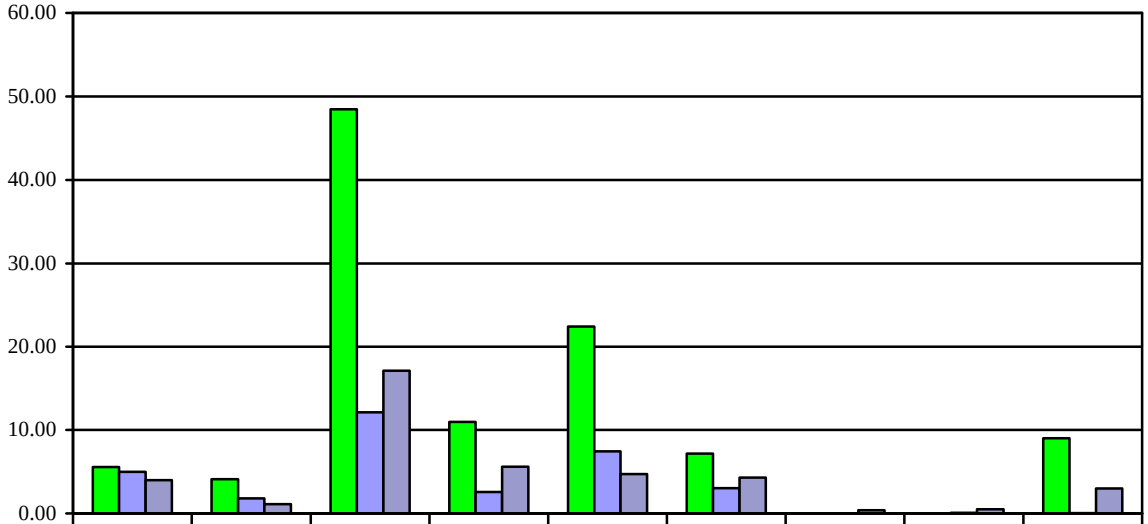
To compensate for this deficit, Japanese companies have been active overseas including in Indonesia, the Gulf, and Russia. The loss of drilling rights in the Saudi portion of Saudi-Kuwaiti Neutral zone was a major disappointment. The concession, which ended in February 2000, was producing 0.82 MMBD for Japan's Arab Oil Company (AOC). The loss of the Saudi-Neutral zone deal meant the loss of nearly 1/5 of Japan's oil consumption.[120]

The Russian Far East is another potential source of energy for Japan, and the Japanese have proposed a pipeline, the Nakhodka pipeline, which extends from Siberia to the Pacific coast, with direct access to Japan. In mid 2004, Japan offered to finance up to $10 billion of the pipeline cost.[121]

Japan is competing with China as the main guarantor of the Siberian oil, and the two nations have been engaged in a bidding war for several years over the route of the pipeline, the amount government subsidies available to promote their respective offers to Russia, and the feasibility of drilling in the Siberian region. Differing opinions exist as to the actual amount of proven reserves in Siberia and extreme temperatures in the winter make it difficult to drill in the frozen ground to complete exploration, drilling, and pipeline construction.[122]

Two possible routes have been discussed which would transport 1.0 MMBD from Siberia to the rapidly growing East Asian oil market. China's CNPC and Russia's Yukos Oil have agreed to transport 1.0 MMBD of crude oil from Anagarsk, Siberia to join the existing pipeline network Daqing, which would enable virtually all of the oil to flow into the Chinese market. Japan's $10 billion offer came after an alternative plan backed by Russia's Transneft was proposed which would create a spur leading to the Pacific port of Nakhodka. Transneft will begin construction of the first phase of the pipeline to Skovordino, approximately 50 miles from the Chinese border, as early as the end of 2005, despite the lack of an agreement on the final destination of the pipeline.[123] Russia may likely continue to entertain the price war between China and Japan, and can ultimately sign an agreement with the highest bidder.

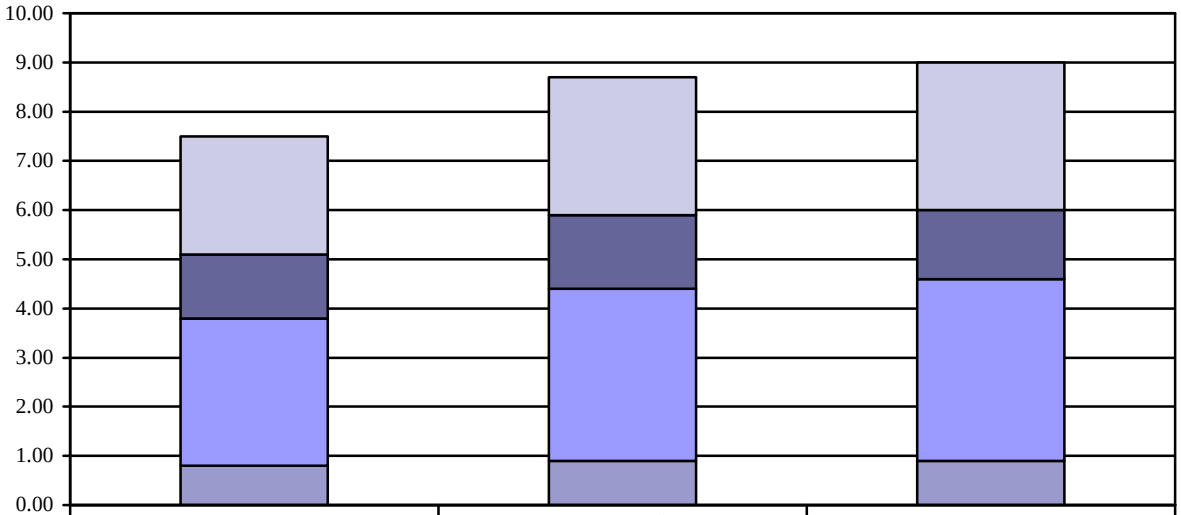
Figure 13: Asia-Pacific Proven, Known, Undiscovered Oil Reserves
(In Billion Barrels)



	Australia	Brunei	China	India	Indonesia	Malaysia	Papua New Guinea	Thailand	Vietnam
Known	5.56	4.09	48.46	10.98	22.42	7.18	?	0.00	9.00
Undiscovered	4.98	1.80	12.12	2.56	7.44	3.04	?	0.10	0.04
Proven	4.00	1.10	17.10	5.60	4.70	4.30	0.40	0.50	3.00

Source: Adapted by A. Cordesman & K. Al-Rodhan from the BP, *Statistical Review of World Energy 2005* and the *US Geological Survey 2000*.

Figure 14: EIA Estimates of Asia-Pacific Oil Production Capacity
(In MMBD)



	2002	2025: Ref	2025: High
Other	2.40	2.80	3.00
Indonesia	1.30	1.50	1.40
China	3.00	3.50	3.70
Australia	0.80	0.90	0.90

Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *International Energy Outlook 2005*.

Key Strategic Challenges

Given the volume of exports by Asian countries such as China, India, and Taiwan, a disruption of petroleum supply to these countries would have a major indirect influence on the economies dependent on their exports.

China, India, and Pakistan, which are all nuclear powers, have ongoing strategic disputes and tensions. North Korea continues to pose a threat to its neighbor and may have nuclear weapons. The most populated countries in the world, China and India, are rising economic and military powers with uncertain future ambitions and growing need for petroleum imports.

Aside from the risk of another Asian economic crisis, most of the other long-term strategic risks are sub-regional. As mentioned above, the Asia-Pacific region it is a net importer of oil, but it is an important oil-consuming region.

The following risks may have a major future influence on the stability of the region and the global oil market:

- **North Korea's nuclear program:** It is likely that the North Korean regime has at least one nuclear weapon. A confrontation with North Korea could destabilize the region, and force Japan to acquire its own nuclear weapons.
- **China and Taiwan:** China's ambitions toward Taiwan are clear and unlikely to change anytime soon. With China's rising military and economic powers, the recent expressed US unhappiness with Taiwan's quest for independence, and the complexity of the US-China relations, it is unclear what the American response towards Chinese aggression against Taiwan would be.
- **India and Pakistan's nuclear standoff:** Two nuclear rivals have been at confrontation for over 50 years. The situation is complicated by any instability in the region and the possible transfer of nuclear weapons into the hands of transnational terrorist organizations.
- **Terrorism and counter-terrorism:** Counter-terrorism efforts in Afghanistan, Pakistan, Indonesia, the Philippines, and other South East Asian countries have proved effective. However, terrorist organizations may have well-established cells and the war against such organizations is far from over.
- **China's rise:** Experts argue that the rise of China will be the biggest strategic challenge to the US in the Asia-Pacific region. However, it is becoming a key economic partner, a major economic power, and its economy is a key factor in world oil demand.
- **India's rise:** India's economic progress in the past decade has been miraculous. Most recently, India's energy demand has surged. Moreover, India has been on the receiving end of much of the outsourcing, but poverty, HIV/AIDS, and ethnic clashes continue to be long-term challenges for India.

Production Risks and Developments

In terms of production developments, Asian oil production suffers from natural depletion and lack of investment in the exploration and production sector. The lack of new discoveries is largely due to limited reserves but is also affected by lack of investment, the ruggedness of the terrain, and strict environmental laws.

The security of oil facilities and ethnic disputes are currently only limited problems in Asia, largely affecting Indonesia. Territorial disputes and large-scale wars could, however, significantly affect future energy supply. The following production developments in the Asia-Pacific region affect its energy supply and security:

- **Territorial disputes:** China, the Philippines, Malaysia, Vietnam, Indonesia, Thailand, and Brunei continue to contest the ownership of offshore natural resources in the South China Sea. These disputes have limited economic development and have added to the uncertainty of the nature of energy resources in the region.

- **Rugged Terrain:** According to the EIA, pre-tertiary basins in eastern Indonesia contain large but unproven oil reserves. The ruggedness of the terrain, however, has limited exploration and it is uncertain if these reserves exist or if they can be produced. Terrain is similarly a problem for Russia's Siberian region, which may contain large quantities of oil reserves, but is located in a far-reaching area with little existing infrastructure, and where construction and drilling is difficult during the winter months.

- **Natural depletion:** Efforts have been made to prolong the life of existing fields in Southeast Asia through the use of steam injection, but success has been limited, the EIA reported. Following the project at the Duri field on Sumatra, for example, production has actually dropped by roughly 0.071 MMBD in 2003 (Half of the drop is attributed to natural depletion).

- **Indonesia's declining production:** The production level and capacity of Indonesia is on the decline due to natural depletion. The country's oil infrastructure lacks necessary investment in its exploration and downstream sector. The EIA estimates that Indonesia's production capacity in 2001 and 2025 will be the same, 1.5 MMBD. There are, however, some sings of improvements in terms of investment. The new oil field, Cepu, estimated to hold reserves of at least 600 million barrels of oil, is being developed by ExxonMobil in partnership with Pertamina. Alleged corruption charges against Petramina and continues disagreements over profit sharing and technical assistance beyond 2020 continue to stint the development of Cepu.

- **Chinese explorations:** Most Chinese oil production capacity, close to 90%, is located onshore. One field alone, Daqing in northeastern China, accounts for about 1.0 MMBD of China's production, out of a total crude oil production of around 3.4 MMBD. Daqing, however, is a mature field. Production began in 1963. Its production fell by 3.5% in 2003. At China's second-largest producing field, Liaohe in northeastern China, CNPC has contracted with several foreign firms for work to enhance oil recovery and extend the life of the field.

- **Chinese refining bottlenecks:** In late 1990s, as many as 110 small refineries were shut down. Now key Chinese oil companies are trying to upgrade existing refineries. These upgrades include: 1) CNOOC has a 0.240 MMBD refinery project in the city of Huizhou in Guangdong province--it is expected to become operational in early 2008. 2) ExxonMobil and Saudi Aramco signed a contract to expand the refining capacity of the Quongang refinery in Fujian from 0.080 MMBD to 0.24 MMBD. 3) CNPC is planning a major expansion of the Dushanzi refinery in Xinjiang, which will be partially supplied by the new pipeline from Kazakhstan.

- **Lagging energy sector in Australia:** Australia's oil fields have matured, and need to be upgraded with new technologies in addition to expanding the exploration program, but the government has made cuts to exploration costs. Australian tax laws have been seen as obstacles to large foreign investment. In addition to declining production and discovery rates, Australia has eight refineries, and all of them have had declining gross margins for several years, mainly due to competition from foreign refineries benefiting from economies of scale.

Europe-Eurasia

The Europe-Eurasia region covers all of Western Europe including the North Sea, Eastern Europe, FSU states, and the Caspian Sea region. As Figure 15 shows, the two sub-regions that are rich in petroleum resources are the Caspian Sea area and the North Sea. In 2004, Europe and Eurasia had a total of 139.2 billion barrels of proven reserves. Since 1993, there has been a growth of 20 billion barrels of oil.

National Developments

The country with the largest oil reserves is Russia, which has 225.95 billion barrels of known reserves, but only 72.3 billion barrels of it is "proven." In addition, according to the USGS 2000, it has the second largest "undiscovered" oil reserves after Saudi Arabia, 77.38 billion barrels. The EIA does not report Russia's production capacity, but Figure 16 shows that the total FSU oil production capacity in 2002 was 11.2 MMBD and is projected to reach 17.6 MMBD for the reference case in 2025.

The Kremlin continues to advance the state's influence in the energy sector. Moreover, Russian oil companies, such as Yukos, have been accused of corruption and tax evasion. Due to the uncertainty and instability, the inflow of investment in the Russian oil sector has slowed down. In late September 2005, the Moscow City Court upheld the conviction of Mikhail Khodorkovsky, former head of Yukos, who is accused of tax evasion. Mr. Khodorkovsky has been in jail since October 2003, and he accuses the Putin government for arresting him to break up Yukos Oil and increase its control over the Russian oil industry.[124]

On September 27, 2005, Gazprom, the state-controlled Russian energy company, announced that it would acquire 72.66% of Sibneft's shares for $13.01 billion. This sale will be financed by $12 billion from a consortium of Western banks. Alexei Miller, chief executive of Gasprom, was quoted as saying that "The businesses of Gasprom and Sibneft have a defined synergy. This will make Gazprom more effective both in Russia and the world oil and gas market." Many experts disagree. They see this as another attempt by the Kremlin to tighten its grip over the Russian oil sector, especially given the fact that Gazprom is buying the shares held by Roman Abramovich, a Russian billionaire with close ties to the Kremlin, who would gain $13 billion from this sale. In addition, they argue that the sale price is too low because the $13 billion works out to be $3.30 per barrel of reserves, which is lower than other recent oil deals.[125]

Russian does not allow foreigners to buy shares of Gazprom that are traded on the Russian market. It has announced, however, that it may relax some of these restrictions in the near future. Recently, Gazprom extracted about 545 billion cubic meters of gas per year and 1.17 MMBD of crude oil.[126] It remains, however, uncertain how the new purchase or future policy may influence it level of production.

Other FSU states such as Kazakhstan have seen significant foreign investment in their oil industry, but political instability and corruption continue to plague their energy sector. Kazakhstan has the second largest reserves in the FSU after Russia. It has 18.327 billion of known reserves, and 39.6 billion barrels of proven reserves. According to the USGS 2000, Kazakhstan has 21.327 billion barrels of undiscovered oil reserves, roughly more than twice its proven reserves.

Figure 16 shows that the Caspian Sea region has the potential to become a major oil and natural gas exporter over the next decade. The region is thought to hold the world's second largest oil

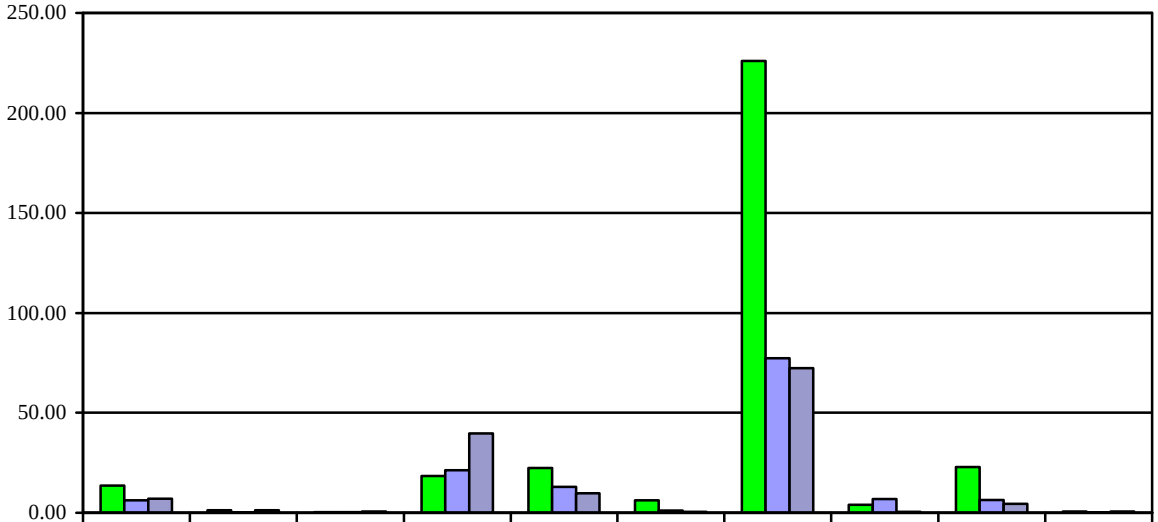
and natural gas reserves behind the Middle East. However, according to the EIA, several factors threaten to complicate the region's potential, including a lack of adequate export infrastructure, disagreement over new export routes, and border disputes between the littoral states.

The North Sea has the second largest reserves in the region. Figure 15 shows the oil reserves in the region. Norway and the United Kingdom hold the majority of the North Sea's reserves with 9.7 billion barrels and 4.50 billion barrels of proven reserves, respectively. Denmark, the Netherlands, and Germany have smaller North Sea oil and natural gas resources.

According to the EIA, the region is a relatively high cost producer because of the cold weather and the fact that it required sophisticated offshore technology, but its political stability and proximity to major European consumer markets have allowed it to play a major role in world oil and natural gas markets. The North Sea oil is used as a "benchmark." Brent oil is traded on the International Petroleum Exchange and market forces reflect in the price of Brent.[127]

Most of the North Sea countries have experienced a slow in oil production growth in the last few years. The growth of the UK and Norway's crude oil production has essentially come to a halt, however, and Figure 16 shows that their production rates are projected to begin their long-term decline. In 2002, their production capacity was 6.3 MMBD and it is projected to drop to 4.3-4.9 MMBD in 2025. In fact, only Germany has seen a year-to-year growth of its production. The fact that the output of Brent oil is too small has moved some analysts to question if Brent oil should continue to be used as the benchmark. The new system Platts, therefore, has widened its definition of Brent oil to include other North Sea oil in calculating the price.[128]

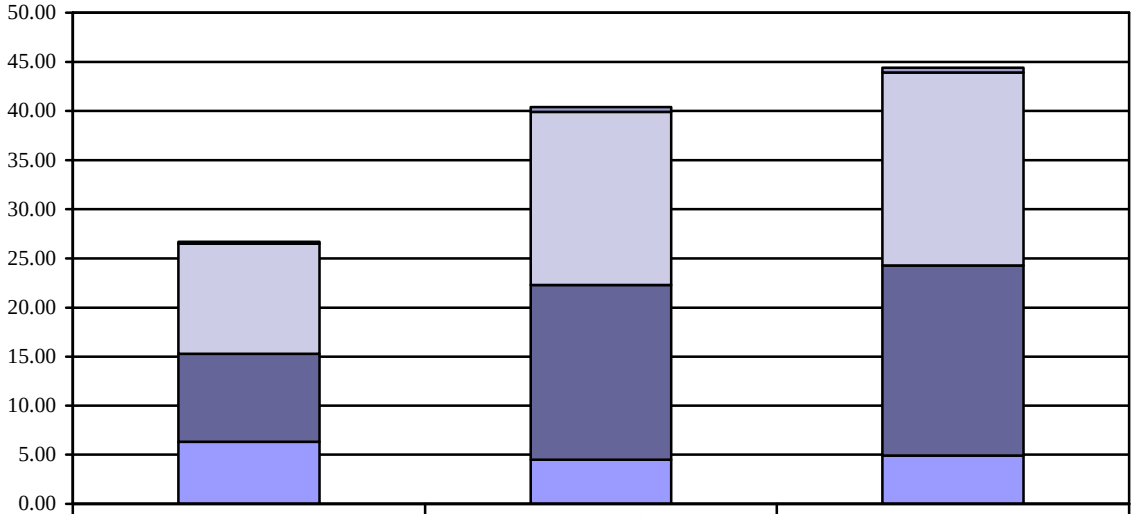
Figure 15: Europe-Eurasia Proven, Known, Undiscovered Oil Reserves
(In Billion Barrels)



	Azerbaijan	Denmark	Italy	Kazakhstan	Norway	Romania	Russia	Turkmenistan	UK	Uzbekistan
Known	13.62	1.29	0.37	18.33	22.32	6.26	225.96	4.00	22.93	0.62
Undiscovered	6.31	0.10	0.37	21.33	12.88	1.07	77.38	6.84	6.33	0.14
Proven	7.00	1.30	0.70	39.60	9.70	0.50	72.30	0.50	4.50	0.60

Source: Adapted by A. Cordesman & K. Al-Rodhan from the BP, *Statistical Review of World Energy 2005* and the *US Geological Survey 2000*.

Figure 16: EIA Estimates of Europe-Eurasia Oil Production Capacity
(In MMBD)



	2002	2025: Ref	2025: High
Eastern Europe	0.20	0.50	0.50
FSU	11.20	17.60	19.60
Caspian Sea	9.00	17.80	19.40
North Sea	6.30	4.50	4.90

Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *International Energy Outlook 2005*.

Key Strategic Challenges

Russia and the other FSU states present different challenges from Western European states. Russia faces long-term problems of lack transparency, vulnerability of its oil facilities, and higher water cut rates. The Caspian states lack the level of investment needed to upgrade their oil infrastructure and increase their recovery and discovery rates. On the other hand, the North Sea faces the problems of aging fields that may have started their long-term decline.

The key security and socioeconomic challenges faced by the countries in Europe and Eurasia include:

- **Loose nukes:** Before its collapse in 1991, the Soviet Union had about 27,000 nuclear weapons. Experts argue that these nukes are dispersed around the FSU countries and are poorly guarded. Moreover, former nuclear scientists, due to poverty and lack of job opportunity, could be allured to help rogue states or terror organizations acquire nuclear weapons.

- **Political instabilities in the FSU:** In recent years, "revolutions" took place in FSU states such as Georgia, Ukraine, and Uzbekistan. While most of these movements were peaceful forces for change, it was not the case in Uzbekistan. These instabilities add to the uncertainty and prolong economic development.

- **Russia's reemergence:** Under Vladimir Putin, Russia has tried to expand its influence over former satellite states in Eastern Europe and central Asia. While it is harder to know Russia's intentions, it is clear that recent Russian involvement in internal affairs of FSU countries have been destabilizing force. Moreover, Chechnya's quest for independence continues to preoccupy Russia due to bombing against soft and military targets in Russia.

- **Sleeper cells in Western Europe:** Investigation of the 9/11 attacks and the Madrid bombing has shown that the existence off significant Al-Qaeda cells. Law enforcements in the UK, Germany, and Spain have succeeded in breaking up some of the cells. Experts, however, believe that major cells still exist in many Western European countries.

- **Immigration:** Recent events in the Netherlands have shown the tensions that exist between immigrants and many Europeans. Due to aging population, many European economies need cheap labor. The tension is unlikely to go away as long as there is a lack of assimilation of immigrants with the general population.

Production Risks and Developments

The Caspian Sea's production has increased by roughly 70% since independence from the Soviet Union. Most of the increase came from the northern Caspian countries Kazakhstan and Azerbaijan. Other countries in the region have seen less substantial progress toward developing their energy industry since 1992. Large multinational oil companies have tried to win oil projects in Azerbaijan and Kazakhstan, Turkmenistan and Uzbekistan, but have not been able to land any major deals from the governments.[129]

According to the EIA, North Sea oil production, both on- and offshore, totaled 5.9 MMBD in 2005, falling from approximately 5.6 MMBD in 1999. In 2005, Norway's production accounted for 57% and the UK accounted for 30% of the North Sea total output, making them the largest producers in the North Sea. Norway and the UK, however, continue to experience a year-to-year decline in their production.[130]

The Caspian and North Seas regions must deal with the following developments and challenges:

- **Caspian Sea projects:** The Caspian Sea has seen an increase in their production and "proven" reserves. In 2004, projects like Tengiz and Karachaganak (in Kazakhstan), and Azerbaijan's Azeri, Chirag, and

deepwater Gunashli (ACG) field have produced roughly 0.644 MMBD—these projects are expected to increase production to 1.7 MMBD by 2010.

- **Russian oil turmoil:** Analysts blame the turmoil in the Russian oil industry to the privatization of the industry and the following corruption by oil tycoons. However, the privatization drive is also seen as a reason to improve incentives and increase the use of new technologies to upgrade matured oil infrastructure, which in turn will increase production at lower costs. Overall, Russia's production has increased.

  Siberian oil fields were increasing at 14% a year since the early 1990s. However, since the "nationalization" of the main production branch of Yukos oil company, Yuganskneftegas, in December 2004, the flow of oil from the richest Siberian oil fields stopped. In 2005, it is projected to produce the same amount of oil that it produced in 2004, 385 million barrels.[131]

- **Kremlin control over energy sector:** Many analysts believe that the drop in the Siberian oil fields' production is due to Russia's mismanagement of the nationalization process. The state controlled company Rosneft took over from Yuganskneftegas after it was nationalized. The takeover of the company was part of payment of $28 billion tax claim against Yukos. In addition, the Kremlin is also seen as attempting to buy out Russian fifth largest oil company, Sibneft, which produced 0.900 MMBD. If this deal goes through, the Kremlin will increase its holdings to one quarter of all Russian production.[132]

- **Kazakhstan instability:** Kazakhstan has seen a lot of inflow of foreign capital into its oil industry. Its oil production capacity has increased in recent years, but the growth rate could have been higher. The lack of political and economic stability has prevented these investments producing the results they otherwise would have, given the potential of the oil industry. Other experts, however, attribute the decrease in the growth rates to restrictive government policies.

- **Barents Sea exploration resumption:** There have been two discoveries in the Norwegian part of the North Sea. According to the EIA, Statoil discovered oil at its Linerle prospect and delimited its Alve discovery well. In addition, it was reported that oil companies planned start drilling for oil in the Barents Sea marking the end of the suspension that started in 2001 in order to study environmental impact of explorations.

- **Britain oil fields are maturing:** The EIA reported that the UK's oil industry has shifted its focus from exploration to improving productivity and prolonging hydrocarbon extraction from its large matured oil fields and developing smaller fields through the use of new technologies. High oil prices have provided the incentives for companies to invest in oil fields that were not considered "commercially viable."

- **Norway's maturing oil fields:** Although the North Sea will continue to be an important oil producer, its oil production from both the UK and Norway is on the decline. With new EOR technologies and large inflow of investment in their oil infrastructure, the life of their oil fields may be prolonged. There has been little in the area of new discoveries, but Norway has attempted to focus on increasing recovery rates of existing oil fields.

North America

North America's oil reserves are shown in Figure 17, and have been in decline since the 1980s. According to the BP *Statistical Review of World Energy 2005*, North America had 101.9 billion barrels of proven reserves in 1984. In 2004, its proven reserves decreased to 61.0 billion barrels. North American oil production has also declined during the same period. It produced 14.150 MMBD in 2004 compared to 13.807 MMBD in 1994[133] and 14.838 MMBD in 1983.[134]

National Developments

The US production capacity was 9.3 MMBD in 2002. The EIA forecasts show that the US' oil production capacity will increase marginally or even plateau. In 2025, the US will have a production capacity of 9.3 MMBD for the reference case and 11.0 MMBD for the high price case, as shown in Figure 18. The *Oil and Gas Journal* reported that the United States had 21.9 billion barrels of proved oil reserves as of January 1, 2005.[135]

The US has over 500,000 producing oil wells, but according to the Department of Energy, most of them are classified as "marginal" or "stripper" wells. This means that those wells have marginal production. For 2003, the major oil producing areas included the Gulf of Mexico (1.6 MMBD), Texas onshore (1.1 MMBD), Alaska's North Slope (0.949 MMBD), California (0.683 MMBD), Louisiana onshore (0.244 MMBD), Oklahoma (0.178 MMBD), and Wyoming (0.143 MMBD).[136]

There has been much debate about the size of reserves in Alaska, and the expected production. Current technology and simulation models cannot predict exact reserves, cost of production, or the grade of oil in the Arctic National Wildlife Refuge (ANWR). At this point, all that is certain is that production in ANWR also depends on the price of crude oil. The EIA has summarized its views on oil in ANWR as follows:

> Alaskan crude oil production originates mainly from the North Slope, which includes the National Petroleum Reserve-Alaska (NPR-A) and the State lands surrounding Prudhoe Bay. Because oil and gas producers are prohibited from building permanent roads in NPR-A, exploration and production are expected to be about 30 percent more expensive than is typical for the North Slope of Alaska. Because drilling is currently prohibited in the Arctic National Wildlife Refuge (ANWR), AEO2005 does not project any production from ANWR; however, an EIA analysis [142] projects that if drilling were allowed, production would start 10 years later and reach 900,000 barrels per day in 2025 if the area contains the mean level of resources (10.4 billion barrels) estimated by the U.S. Geological Survey.
>
> In the reference case, crude oil production from Alaska is expected to decline to about 810,000 barrels per day in 2010. After 2010, increased production from NPR-A raises Alaska's total production to about 890,000 barrels per day in 2014. Depletion of the oil resource base in the North Slope, NPR-A, and southern Alaska oil fields is expected to lead to a decline in the State's total production to about 610,000 barrels per day in 2025.
>
> As in the lower 48 States, oil production in Alaska is marginally sensitive to projected changes in oil prices. Higher prices make more of the reservoir oil in-place profitable. In 2025, Alaska's production is projected to be about 100,000 barrels per day above the reference case level in the high A oil price case and 60,000 barrels per day below the reference case level in the low oil price case.[137]

There are no meaningful near and mid-term options that will allow the US to reduce its dependence on foreign petroleum exports in any significant strategic sense. The US must shape its security policies accordingly, regardless of what happens in Iraq.

Canada, on the other hand, does claim that it has tapped into "new" sources of liquid fuels include coal liquifaction, gas liquifaction, biomass, natural generation, oil shale, and tar sands. Moreover, it claims 179 billion barrels in tar sands, second only to Saudi Arabia.[138] In addition, in 2005, *Oil and Gas Journal* reported that Canadian oil reserves were 178.8 billion barrels, but over 95% of the reserves are oil sands deposits in Alberta.[139]

Analysts predict that oil sands production will increase significantly in coming years and offset the decline in Canada's conventional crude oil production. While the Canadian tar sands sound promising, extracting oil from them is costly and requires new technologies. Current production costs are $8-$13 a barrel for Bituman and $18-$23 a barrel for synthetic light oil. Currently, extraction from mining and upgrading produces 20% recovery, and Steam assisted gravity drainage (SAGD) and solvents expected to produce 80% ultimate recovery.[140]

Canada has invested $US28 billion since 1996, and is now producing more than 1.0 MMBD. It is expected to invest another $US 36 billion during 2005-2010. During the same period, production is expected to rise to 2.7 MMBD.[141] Figure 18 shows that the EIA projects Canada's production capacity can reach 5.1 MMBD in 2025 for the reference case, and 6.4 MMBD for the high price case.

Mexico has the third largest proven reserves in North America. In 2004, it has 14.8 billion barrels of proven reserves. Figure 17 shows that according to the USGS 2000, Mexico had 44.41 billion barrels of known oil reserves and 20.570 billion barrels of undiscovered oil reserves.

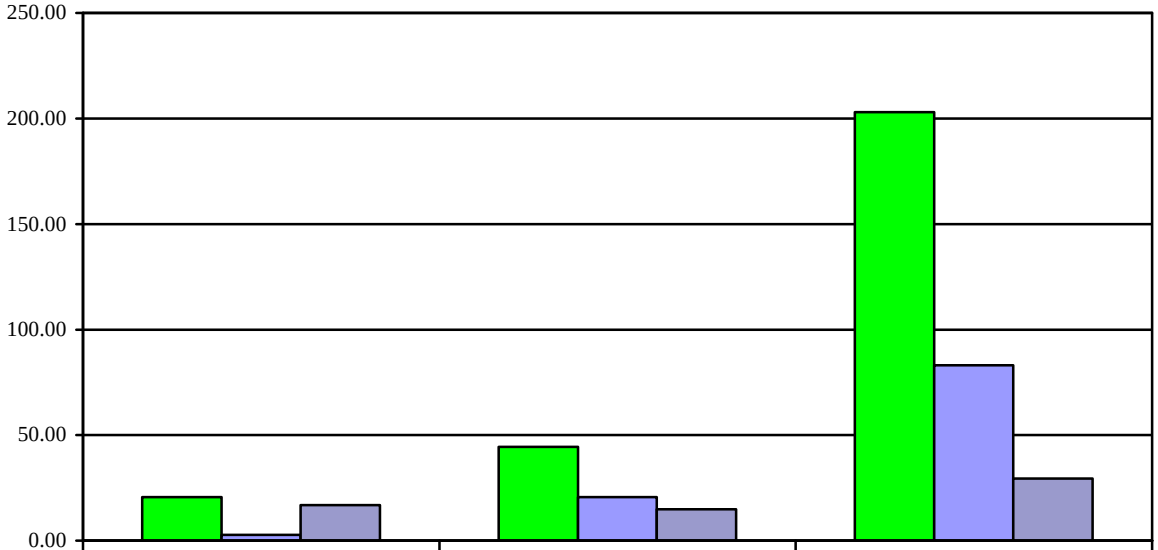
There is a debate about the nature of Mexican oil reserves. In September 2002, Pemex, the national oil company, claimed that it estimates of proven crude declined by 53%, to 12.6 billion barrels. Later they raised their oil proven reserves estimates to 15.7 billion barrels. In June 2004, Fernando Elizondo, Mexico Energy Secretary, announced that Mexico had 18.9 billion barrels of proven reserves, which he claimed could run out in 11 years.[142]

Mexico's government budget heavily relies on oil revenues by Pemex. In 2003, oil revenues represented 33% of its budget. Pemex pays roughly 2/3 of its oil revenues to the government, and 8% to cover pension liabilities. These obligations, according to the EIA, along with the fact that Pemex relies on the Congress for its budget are making it more difficult to invest in expanding their production capacity and explore for new discoveries.[143]

In 2002, Figure 18 shows that Mexico's oil production capacity was 3.6 MMBD. The EIA forecasts that Mexico production capacity can reach up to 5.3 MMBD in 2025 for the high price case and 4.9 MMBD for the reference case. This forecast, however, was based on lower prices and before the latest speculations by Mexico's Secretary of Energy that the country's oil reserves can run out in 11 years.

Figure 17: North America Proven, Known, Undiscovered Oil Reserves

(In Billion Barrels)

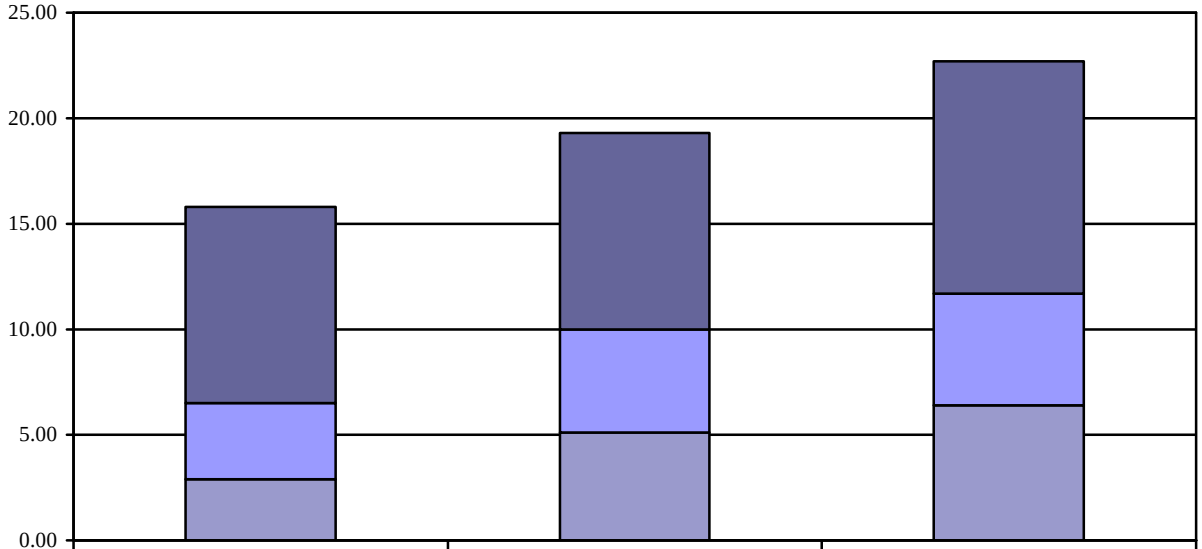


	Canada	Mexico	USA
Known	20.56	44.41	203.00
Undiscovered	2.77	20.57	83.00
Proven	16.80	14.80	29.40

Source: Adapted by A. Cordesman & K. Al-Rodhan from the BP, *Statistical Review of World Energy 2005* and the *US Geological Survey 2000*.

Figure 18: EIA Estimates of North America Oil Production Capacity

(In MMBD)



	2002	2025: Ref	2025: High
US	9.30	9.30	11.00
Mexico	3.60	4.90	5.30
Canada	2.90	5.10	6.40

Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *International Energy Outlook 2005*.

Key Strategic Challenges

Unlike other regions, countries in North America have not experienced sabotage in their oil facilities or rebel demanding higher share of oil revenues. There is little chance of a large-scale war in North America, although key facilities, population center, and food supplies remain venerable to attacks by terrorists.

The following list summarizes the major long-term uncertainties that affect petroleum developments in the countries of North America:

- **Homeland Security:** Following the 911 attacks, the US administration created the Department of Homeland Security. The US homeland, however, continues to be vulnerable to attack. The US borders with Mexico and Canada are not protected, and terrorist organizations may use them to infiltrate into the country.
- **Immigration:** In light of the terrorist attacks, immigration is of national security importance to the US. There are nearly 20 million illegal aliens. A realistic and effective immigration policy that enforces current US laws and deals with the economic needs of Mexico and other Central American countries. Canadian immigration and asylum laws have also been under scrutiny following the 9/11 attacks.
- **Poverty and instability in Mexico:** One cause of high immigration into the US from Mexico is the lack of economic opportunities in Mexico. While the political system in Mexico has improved stability wise, corruption or at least he perception of it continue to plague the system.
- **Twin deficits:** The massive trade imbalance with China and the skyrocketing federal budget deficit are still sustainable, but they may exert pressure on future generations through higher taxes and weaker dollar.
- **Aging populations and the entitlement programs:** The aging population in the US and Canada will have economic and cultural implications in the long-term. Programs such as Medicare and social security need more workers per retirees, but the demographic forces are limiting the ability of these programs to survive and support themselves. They are becoming too expensive for the taxpayers.

Production Risks and Developments

Oil fields in the US and Mexico are maturing. Some analysts have argued that they have started their long-term decline and claim that current reserves estimates are debatable.

As mentioned earlier, one estimate predicts that Mexico's reserves could run out in 11 years. Other experts claim that due to the lack of investment, Mexico's replacement rate is too low. They argue that with right amount of capital investment in the oil industry including enhanced recovery technology and intensive exploration, Mexico can improve its replacement rate and prolong the life of its current oil fields.

After years of debate, the US Congress narrowly passed a bill to allow drilling on the coastal plain of the Arctic National Wildlife Refuge in Alaska by inserting a provision for such drilling in the budget resolution for fiscal year 2006; however, the bill has not yet been signed into law.

It is uncertain how much oil reserve the refuge actually contains. The USGS 1998 estimates that the mean estimate of recoverable oil and natural gas liquids in coastal ANWR is 10.3 billion barrels (with a 95% chance that at 5.7 billion barrels of oil are recoverable and 5% chance that 16 billion barrels of oil are recoverable).[144] This could increase domestic oil production by a mean of 876,000 barrels per day at its peak in 2024, but access to ANWR oil would only lessen U.S. dependence on foreign oil by approximately 4% in the reference case, according to the EIA.[145]

There is far more reason for optimism with regards Canada's oil reserves. Most analysts believe that Canada has the potential to increase its production capacity. Canada faces slightly different problem. While estimates differ, most agree that the Canadian tar sand contain 170-185 billion barrels of oil reserves. The issue is not whether those reserves exist, but in fact the cost of extracting them and the availability of the right extraction technology.

The following major production uncertainties affect petroleum development in the US, Canada, and Mexico:

- **Mexico's oil fields are maturing:** Some experts believe that Pemex, the state owned company, to be unable to lead to any new discoveries and modernize existing infrastructure. The Fox administration has proposed opening the industry up to foreign investment in exploring for offshore oil in the Gulf of Mexico.

- **Cantarell upgrade**: Production from the largest oilfield in Mexico, Cantraell, with an estimated 35 billion barrels of oil witnessed a decline in the 1990s. Pemex inaugurated a project to use nitrogen injection to increase pressure and prolong the depletion, and the project was completed in 2001. By 2002, it showed remarkable recovery in that it doubled its 1995 production level. However, some have argued that Cantraell's decline could come as soon as mid-2005.

- **Canadian oil sands:** The main issue with the tar sand is the fact that most of the deposits contain heavy or "viscous oil," which is harder to extract and costly to refine. According to the EIA, the problem is that the bitumen oil is too deep below the surface to use open pit mining. A method that is used is what is called *in situ* (in place) and it uses steam to separate bitumen from the sands and pushes it to collection pools near the surface.

- **US Gulf of Mexico production:** Recently, the US production from the Gulf of Mexico has increased due to more efficient deepwater wells, which account for about two-thirds of total U.S. Gulf output. However, hurricanes Ivan, Katrina, and Rita caused disruptions in production and refining, which sent the oil prices to reach $70/barrel.

- **US North Slope:** The Alaskan sloes contain the largest oil field in North America, Prudhoe Bay. In addition, according to the US DOE, as much as 36 billion barrels of original-oil-in-place lay within the Ugnu, West Sak, and Schrader Bluff formations. The largest source of potential oil is the heavy oil formations near main producing zones at Prudhoe and Kuparuk.

South and Central America

Figure 19 shows current estimates of Latin American oil reserves and Figure 20 shows current estimates of production capacity. South and Central American production totaled 5.17 MMBD in 1983, and increased to 6.764 MMBD in 2004. Most of the production is led by Venezuela, the fourth largest oil exporter to the US (behind Mexico, Saudi Arabia, and Canada). Venezuela exported 1.315 MMBD of oil to the US in March 2005. However, President Hugo Chavez has recently threatened to cut all oil exports to the U.S., claiming that the U.S. market is not vital to their export market.[146]

National Developments

In 2002, Venezuela had a production capacity of 3.1 MMBD. According the EIA reference case forecast, it will reach 5.6 MMBD in 2025 as is shown in Figure 20. The rest of the region had a production capacity of 3.9 MMBD. By 2025, its output could surpass Venezuela's. The EIA projects that other South and Central American countries' production capacity can reach 6.9 MMBD for the reference case and 8.0 MMBD for the high price case.

Despite limited production, the South American continent has the third highest proven oil reserves in the world after the Middle East and Eurasia. Figure 19 shows that South and Central America had 101.2 billion barrels in 2004. Venezuela contains most of these reserves with 77.2 billion barrels, the largest oil reserves outside the Middle East, followed by Brazil with 11.2 billion barrels of proven reserves.

Figure 19 shows that according to the USGS 2000, Brazil also contains 46.746 billion barrels of undiscovered oil reserves. This total is followed by Venezuela with 19.664 billion barrels and Argentina with 14.516 billion barrels.

This discrepancy between oil reserves and production is due to region's failure to take advantage of technological gains, the ongoing political and security instabilities, and rigid laws that limit investment in the energy industry.

Brazil has the highest "undiscovered" oil reserves in the region and the fifth largest in the world. At the same time, it is the 10th largest oil consumer in the world and the third largest in the Western hemisphere, after the US and Canada. According the EIA, Brazil has made great strides in increasing its total oil production.[147] By 2004, Brazil's domestic production nearly met domestic demand. It produced an average of 1.542 MMBD. Brazil goal hopes that by 2010, its production capacity can reach 2.3 MMBD. To achieve this goal, Brazil has started a reform process of its oil industry.

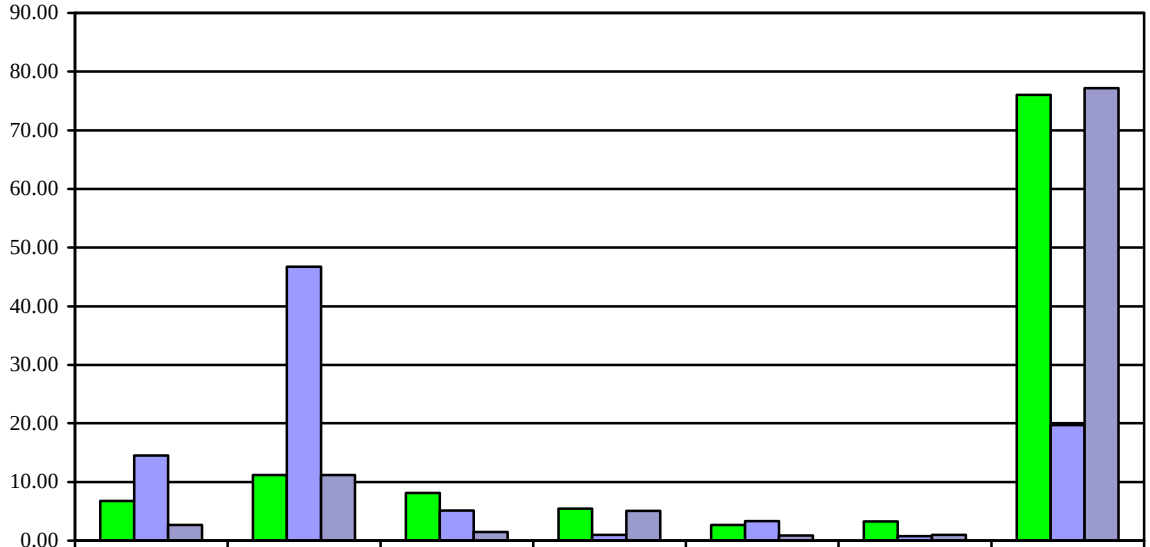
Brazil is also trying to partially privatize its energy sector and allow foreign companies to participate in developing its infrastructure. The EIA has reported, however, that:

> Despite these encouraging developments, Brazil's energy sector is still hampered by problems. Energy privatization has stalled, and Petrobras' presence in the oil and natural gas sectors remains pervasive, possibly slowing the development of competitive markets and the attraction of foreign investment. In addition, Brazil is still recovering from the 2001 energy crisis, which forced the government to implement a power-rationing program. The crisis highlighted Brazil's dependence on hydropower and its need to diversify the country's fuel mix. Since then, the da Silva administration has introduced new legislation for electricity and natural gas that would help avert a future energy crisis, but it remains unclear whether the new regulations will guarantee supply. Analysts are also skeptical about Brazil's attempt to become oil self-sufficient, questioning how long the country would be able to maintain this status once reached, particularly with a burgeoning

> population and a recovering economy. With oil consumption likely to increase significantly in coming years, the question remains whether increased domestic oil output will simply offset domestic demand.[148]

Argentina is another major oil producer in Latin America. The EIA reports that it has 2.9 billion barrels of proven oil reserves, while BP claimed that Argentina contains 2.7 billion barrels of proven oil reserves.[149] The EIA does not report current production capacity for Argentina, but it has reported that its production peaked in 1998 at 0.916 MMBD, and that its production has been declining since. In 2004, however, Argentina's production averaged 0.756 MMBD compared to its 0.393 MMBD of oil consumption, which made it a net exporter of 0.363 MMBD.[150]

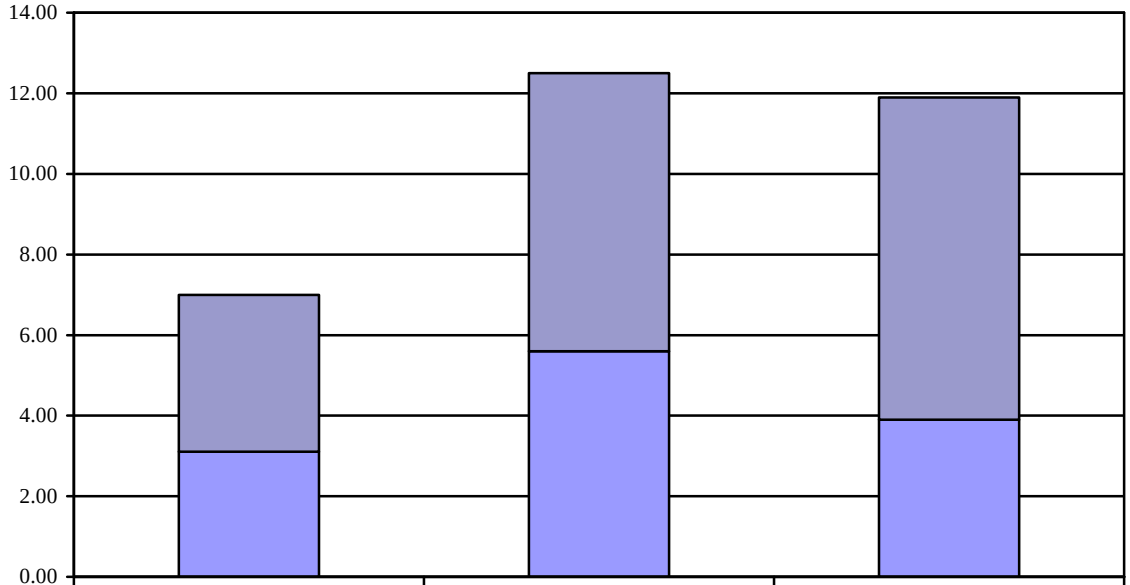
Figure 19: South and Central America Proven, Known, Undiscovered Oil Reserves
(In Billion Barrels)



	Argentina	Brazil	Colombia	Ecuador	Peru	Trinidad	Venezela
Known	6.78	11.16	8.13	5.45	2.66	3.29	76.04
Undiscovered	14.52	46.75	5.12	0.97	3.32	0.76	19.66
Proven	2.70	11.20	1.50	5.10	0.90	1.00	77.20

Source: Adapted by A. Cordesman & K. Al-Rodhan from the BP, *Statistical Review of World Energy 2005* and the *US Geological Survey 2000*.

Figure 20: EIA Estimates of South America Oil Production Capacity
(In MMBD)



	2002	2025: Ref	2025: High
Othe S America	3.90	6.90	8.00
Venezuela	3.10	5.60	3.90

Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *International Energy Outlook 2005*.

Key Strategic Challenges

Latin America is important to the oil market for two key reasons. First, proximity to the US, the largest oil consumer in the world, and high US dependence on foreign source of energy makes Latin America an attractive source. Second, the region is rich with natural resources, and supply disruptions from the region can have devastating influence on the world oil market and the overall health of the global economy.

According to the EIA, Venezuela has the largest oil reserves outside the Middle East. Regional and energy experts believe that recent events in the Latin American country have shown the importance of the region to the world economy. They have attributed some of the surge in oil prices to the supply disruption due to the labor strikes and the political instabilities in Venezuela.

Latin American countries do, however, face three types of instabilities: political, economic, and security. As mentioned earlier, the uncertainty has had a major impact on the production capacity of the three major countries Argentina, Brazil, and Venezuela. Countries face following uncertainties and risks:

- **Narcotic trafficking:** Illegal drugs continue to plague the continents. Rebel groups have been a destabilizing force to the region. The uncertainly accompanied by the lack of security has caused a decline in foreign investment in the energy industry.
- **Economic instabilities:** Argentina is recovering from the 2002 financial crises, but large sovereign debt, tenuous at best fiscal situation, and lack of transparency continue to be real problems from the region in the near future.
- **Political instability in Venezuela:** The 2002 labor strikes, the violent unrests in the streets, and the referendum on Chavez presidency have caused massive uncertainty regarding the future stability of the South American country. Chavez's apparent relations with Fidel Castro continue to worry the US and may prevent any real inflow of foreign investment to upgrade the aging oil infrastructure. This is exacerbated by Chavez's threats to terminate oil exports to the US as a rebuke for US "aggressive" behavior towards the Chavez regime.
- **Political and economic uncertainty in other Andean states:** Venezuela is not the only country facing such uncertainties. Peru, Bolivia, and Ecuador continue to be clouded with such political struggles. Trust in the political systems and current governments are at all time low. Experts argue that economic and political fluctuations have become the norm in the Andean states, and this has contributed to the lacking inflow of foreign investment and the slow rates of modernizing their energy infrastructure.
- **Insurgency and terrorism:** Rebel groups are a security threat to the weaker states in south and Central America. While terrorist attacks in the region have been mainly directed toward internal political struggles, transnational terrorist organizations could find safe heavens in Latin American due to its proximity to the US and the ability to use illicit drug trafficking to finance their operations.

Production Risks and Developments

In addition to the strategic challenges outlined above, Latin-American countries have had production set backs. Some countries like Brazil have made strides in overcoming these challenges, but other countries such as Venezuela continue to suffer from these problems.

The region suffers from a lack of capital investment in its upstream, downstream, and exploration industries. This is due to many reasons including the security and political instability in the region, but it is not limited to that. Latin America continues to suffer from rigid foreign

investment and tax laws, powerful but inefficient national oil companies, and official government corruption.

The following key developments affect the oil industries of the Latin American countries:

- **Strikes in Venezuela:** In 2002, half of PdVSA's workers went on a strike and caused over 2.0 MMBD drop in its production. PdVSA claims that its production is back to its pre-strike level while others, including former PdVSA workers, claim that its production level is considerably lower than it was in 2002. While it has been reported that the company has major strides in restoring its production and refining capacity, it is too uncertain to know PdVSA's oil production level.

- **Lack of foreign investment:** Strikes, economic stagnation, oil concession laws, and political risks in the South America have discouraged foreign investment in their upstream and downstream oil sector. This lack of investment has limited the ability of countries to expand their production capacity, take advantage of new technological improvements, improve exploration and recovery rates, and adapt new training techniques.

- **Rigid regulations in the energy industry:** The Chavez administration changed the Hydrocarbon Law such that to increase royalties paid by private companies to 20%-30% from previous 1%-16.66% and granted PdVSDA at least 51% stake in any project regarding exploration, production, transportation and initial storage of oil.

- **State imposed price controls:** Due to the high oil prices in 2004, countries in South America, namely Argentina, imposed a price ceiling causing a surge in a surge in demand and imposing pressure on limited domestic supply.

- **Argentina's production capacity:** Argentinean oil production is still recovering from the energy crisis of 2004, and as mentioned earlier, this was compounded by government imposed price controls. Argentina's oil production peaked in 1998 at 0.916 MMBD and by 2004; its production level reached 0.692 MMBD. Despite this, Argentina remains the third largest oil producer in Latin America, exporting 0.295 MMBD in 2004.

- **Offshore exploration in Argentina:** According to the EIA, "two onshore basins produce 82% of Argentina's oil: Neuquen, in western-central Argentina; and Golfo San Jorge, in the southeast. In 2004, Petrobras Energia acquiring a license to explore the CAA-1 and CAA-8 blocks located off the country's central-east coast. Nearly every oil company active in Argentina has plans to develop offshore fields, both in the central-east and Tierra del Fuego regions. These areas should also be a major center of exploration for the new, state-owned energy company, Enarsa, which will have control over all offshore concessions not already licensed to private companies."[151]

- **Columbia's declining oil production** Columbia's oil production decreased by 5% from 2003 to 2004, and between 2004 to 2005 its proven reserves declined by 13%. This translates into a 58% reduction in imports to the United States.[152] This decline is mostly attributed to natural depletion of the Cusiana, Cupiagua, and Caño Limon oil fields (the largest of the three). Guerrilla groups have sabotaged pipelines and oil facilities in Columbia. These two developments in addition to the lack of any new discoveries, according to the president of Columbia, may force Columbia to become an oil importer.

- **Exploration in Brazil:** There have been some discoveries in Brazil, but according to the IEA, many of the discoveries are "viscous oil." In addition, most of these discoveries have been offshore and in deep water. These "geological disappointments" make production in Brazil an expensive undertaking and making foreign investment less attractive, which can further complicate Brazil's oil sector.

V. Oil Production and Recovery Technologies

Given finite resources, the natural depletion of oil fields is inevitable. To sustain the same level of production capacity producers need to replenish the natural decline curve either through new discoveries or by enhancing recovery. Declining production from giant and super giants oil fields has become increasing hard to replace with new discoveries. However, technological gains have improved discovery and recovery rates.

Oil fields have three stages of development, which depend on the level of pressure in the oil field or reservoir that help the flow of crude to the surface.[153]

- **Primary Recovery:** During the first stage of extraction, production depends on the natural pressure of the reservoir. Sometime wells are injected with fluids to improve or stimulate the natural pressure in the field.
- **Second Recovery:** During the second stage of extraction, water or gas injections are used to increase the pressure of the field and to push materials up to the surface of the well.
- **Tertiary Recovery:** During the third stage of extraction, gases such as carbon dioxide, and heat such steam or hot water.

Historically, the average recovery rate of an oil field has averaged around 30%. Some analysts, however, argue that current recovery rates of some oil fields can be as high as 50% through increasing recovery efficiency.

Techniques have been developed to enhance oil recovery (EOR) methods that have been applies to matured oil fields. EOR techniques refers to any recovery method other than primary and the conventional secondary recovery methods through "flooding" (water or fire) or through injecting steam or gas such as nitrogen or carbon dioxide. “All tertiary recovery methods are enhanced, but not all enhanced methods are tertiary.”[154]

In addition, diagnostic technologies such as 3-D seismic have improved discovery rates as well as recovery efficiency through providing reservoir data to help in controlled directional drilling. There has been much debate about the nature of these technologies and the level of capital that has been invested in them. It is, however, important to note that the nature of technology is as important as is how this technology is used.

Key Technological Developments

The recent surge in demand has put a strain on production capacity, and at this point, the world has little sustainable spare capacity. If producers are to ease the strain imposed by the lack of spare production capacity, they must improve their production rates by investing in finding new discoveries or improving recovery rates from existing fields.

During the past three decades, there have several areas of technological breakthroughs that have improved production and recovery rates. Oil companies around the world are developing these techniques or financing the R&D in this area. One area of focus is “integration” or reservoir technology, which analysts claim give experts more data capabilities and improve their overall understanding of the fields.

Recent technological developments and techniques include:

- **Parallel Oil Water & Gas Reservoir Simulator (POWERS):** This is part of the reservoir simulation process in the appraisal stage of the field management process. Because this is early in the process, oil

companies have not historical data to make any meaningful prediction. It utilizes Massive Parallel Processing (MPP) technology to provide simulated data using such data involve considerable uncertainty.

- **Maximum Reservoir Contact:** MRC is a type of a well that has long reservoir contact through a single or multilateral wellbore completion. Aramco claimed that initial assessments indicated that MRC wells could have 30% reduction in cost.

- **C2O Enhanced Oil Recovery:** This has been increasingly used in the US because of the large resources of CO2. The way CO2 EOR works is that it injects CO2 underground, and it "closes the carbon loop," which would have been lost in the atmosphere. The US DOE has been investing in the C2O R&D since the 1970s, and is has been used in some projects in Kansas.[155]

- **Bio-Competitive Exclusion Process:** This method replaces traditional method of recovering tertiary oil. The benefits to this are: it significantly increases oil production with less cost than the traditional methods, it eliminates poisonous hydrogen sulfide in the production system, improves secondary and tertiary recovery, and enables producer to recover large residual oil reserves.[156]

- **Real Time Geosteering:** This technology enables asset teams to steer the direction of drilling a wellbore a mile or more underground. Satellite technology sends drilling and LWD (logging while drilling) data directly from the drill bit to visualization centers, where experts analyze the data and navigate the wellbore trajectory through the reservoir.

- **Intelligent Wells:** It enables experts to monitor a reservoir in real time to analyze the data and remotely initiate intervention if needed. Recent experience has increased the technology's reliability. At this point, the technology is expensive, but the technology offers accelerated production, improved recovery, and lower operational expense.

- **Horizontal wells:** It is debated how effective these wells are, but some have claimed that their productivity is several times that of offset vertical wells. The level of increase in productivity, however, depends on the characteristics of the reservoir. This gain is not without problems, logging such wells is challenging because when a drill pipe has to go through the horizontal pat of the well, which consumes times and is costly. However, effective use of these wells requires strong understanding of fracture type, fracture orientation, and facies distribution.[157]

- **Intelligent Downhole Network (IDN):** IDN is a new generation of pressure and temperature gauges, an advanced multi-purpose Downhole Interface Module, and a subsea/topside Downhole Network. It offers communication, power, and interface for completion projects.[158]

- **Steam-Assisted Gravity Drainage (SAGD):** SAGD is an in situ method, and is the most promising thermal recovery technology for Canadian bitumen resources. SAGD employs horizontal wells are drilled near the bottom of the reservoir where the top horizontal well is used to inject steam and the bottom one collects the produced liquids. The injected steam from the upper well increases the formation and forms a large chamber of steam on top of the well. This steam then condenses and heats the oil, which allows it to drain to the production well. This drainage process leads to high oil rates and a high recovery of the original oil in place (OOIP).[159]

Key Exporting nations are reacting to the need to increase the use of advanced technology. Canada, for example, has announced that it is investing in developing new technologies to facilitate the production and recovery of the Canadian tar sands. Saudi Arabia is also putting more money into R&D. The Saudi oil Minister said on April 27, 2004, "Eventually, technological advances will usher in a new energy resource to replace oil. Oil will not cede its position as the pre-eminent fuel because the world runs dry, but because technology has rendered it less desirable. We in Saudi Arabia believe that there are sufficient quantities of oil left to make the transition to the next great energy source a smooth one."[160]

VI. Conclusion

For all practical purposes, the world known oil reserves exist in region and countries that suffer from political, economic, social, and security instabilities. In the short-term, there is little that world can do to change these uncertainties. Energy policies and planning, however, have to be geared more toward risks management than averting risks and toward improving understanding of forces shaping the global energy market.

Reports by the EIA and the IEA are considered by many in government, business, journalism, and academia as a key reference for energy reporting and analysis. They are also the most reliable picture of how governments see the future of world energy supply and demand. The annual *International Energy Outlook* of the EIA and the *World Energy Outlook* of the IEA have long been considered the best of these reports and key tools in analyzing energy policy.

The EIA published its annual *International Energy Outlook 2005* on July 29, 2005. This report has been issued at a time when oil prices are at all time high due to geopolitical and security risks, surges in the demand for oil, the US refining capacity bottleneck, and the limited spare production capacity in some oil producing nations.

The EIA's report does focus on a wide range of energy related issues. It attempts to analyze world energy supply and demand in addition to outlining major developments in the world market for oil, natural gas, coal, and electricity. It also forecasts major indicators in the energy market such as crude oil production capacity and world energy consumption by fuel.

However, it fails to fully come to grips with the most important single development in world energy supply. Last year's report by the EIA, the *IEO2004*, was criticized by experts for not adjusting its forecasts high oil prices, and was considered out of date before it came out in April 2004.

This year, the EIA did adjust its price forecast to take into account much higher oil prices, with a price range of $21 to $48 a barrel, and the introduction of the *IEO2005* even indicates that the "high price" case may be the most likely case. Unfortunately, however, *IEO2005* states that such high prices could radically reduce future oil consumption, and then makes almost no meaningful analysis of the broader implications of such drastic shifts in the oil market and global energy balances. Its focus is almost solely on a reference case of $35 a barrel and different levels of global economic growth.

Why High Prices Can Be So Important

The price of oil is a major uncertainty that affects every aspect of global energy demand, production capacity, investment, and the elasticity of demand and supply. As mentioned earlier, the *IEO2004* used unrealistically low prices. Analysts hoped that the *IEO2005* would shed some light on the current energy market taking into account high oil prices and realistic long-term effects of conservation and alternative on the elasticity of demand. The *IEO2004* projected that oil price in 2025 will be $17/barrel for the low price case, $27/barrel for the reference case, and $35/barrel for the high price case.

According to the *IEO2005*, during 2004, oil prices rose by more than $9. The *IEO2005* forecasts is based on three cases for 2025: $21/barrel for the low price case, $35/barrel for the reference case, and $48/barrel for the high price case. The report forecasts that oil prices will continue to rise in 2005, adding around $11/barrel in 2005.

The report summarized the reasons for high oil prices:

> First, world petroleum demand grew at a robust 3.4 percent (2.7 million barrels per day) in 2004, reflecting dramatic increases in China's demand for oil-generated power and oil-based transportation fuels, as well as a rebound in U.S. oil demand. Second, oil prices typically are sensitive to any incremental tightening of supply during periods of high economic growth. On the supply side, there was very little spare upstream capacity, and the spare downstream capacity was not always properly configured to produce the required slate of products. World oil inventories, in terms of "days of supply," were unusually low. Next, geopolitical tensions in major oil-producing countries—including the continuing the war in Iraq and uncertain prospects for a return to normalcy in Iraq's oil sector—and potential unrest in Nigeria and Venezuela contributed to the volatility in world oil markets.[161]

The three scenarios presented in the *IEO2005* forecasts do use far more realistic price ranges than those used in the *IEO2004*. As has been touched upon earlier, however, the "reference case" used in the EIA forecasts assumes the price per barrel of oil will start declining, and reach $31 in 2010 and $35 in 2025. It never really addresses a "high price" future, and the rational for the steep decline in the future price of oil in the "reference case" is not clear.

Such a case is always possible, but is anything but certain as a "reference." It is all too clear that the *IEO2005* should have used a parametric range of oil prices in a climate of much uncertainty. Economic forecasting always involves significant uncertainty, and history has shown predicting oil price is even more uncertain due to the many variables that can affect the oil market. In fact, even the introduction to the *IEO2005* questions where its "reference case" is the most probable case.

Using both the high price case and the reference case seem to be the proper basis for more realistic forecasts than the low price case. The low price scenario can happen if a practical alternative to oil is reached, massive oil reserves are discovered, the world stop using oil, or oil-producing nations have no control over short-term market.

Moreover, the definition of "world oil price" is misleading. The *IEO2005* defines oil prices as "average refiner acquisition cost" of importer oil to the US, or IRAC. According to the *IEO2005*, on average IRAC tends to be less than the higher quality WTI. IRAC, however, provides a good benchmark as to what refiners are paying for crude oil and how much suppliers are getting. It also gives us a better idea of how the bottleneck in the US refining capacity may have a direct influence on the "world price of oil."

Oil Production and Production Capacity Forecasts

These may seem like technical issues and analytic quibbles, but they have truly massive policy implications. As Table 2 shows, the high price case of $48 in the *IEO2005* analysis radically reduces the need for new oil production capacity and actual production, and radically increases unconventional oil production from sources like Canadian tar sands and Venezuelan heavy crude -- production that was not even analyzed in *IEO2004*.

There are problems in the EIA modeling approach that make it extremely difficult to estimate the credibility of such projections. The fact is that any assumptions about the impact of sustained high oil prices on petroleum supply, unconventional oil, the production of competing sources of energy like nuclear and coal, and conservation and efficiency is highly speculative. Moreover, few analysts and oil experts outside the EIA and IEA have ever believed that world oil production and production capacity could or would every reach the levels projected in the low

price case for either *IEO2004* or *IEO2005*, and many have doubted the credibility of the levels called for in the reference case.

Nevertheless, no one can disregard the potential importance of the *IEO2005* high price projections. They indicate that market forces would solve many supply problems if oil did reach the prices called for in this case, and that price rises produce a much steeper drop in demand that most analysts have previously thought.

This illustrates a policy gap that was a critical problem in the *IEO2004* projections, which only used comparatively low prices, and which largely assumed oil production capacity could rise to meet demand regardless of current country plans. As a result, it called for unrealistically high oil demand and production capacity, very high levels of oil imports, and created the impression of a potential global crisis in supply.

This is clear from a brief comparison of the key conclusions in the 2004 and 2005 editions of the IEO. Actual total world production capacity in 2002 was 80.0 MMBD. The *IEO2004* forecast that total world production capacity for 2025 would be 137.0 MMBD for the low price case, 126.1 MMBD for the reference case, and 117.3 MMBD for the high price case.

In contrast, the *IEO2005* forecasts the total world production capacity in 2025 for the low, medium, and high price cases as follows: 135.2 MMBD for the low price case, 122.2 MMBD for the reference case, and 115.5 MMBD for the high price case. In both the 2004 and 2005 cases, the projected increase in total world production capacity is still significant. By 2010, it could increase from 14.6 MMBD to as high as 21.6 MMBD. The “high price” case, however, is far easier to achieve in the real world than the “reference” or “low price” cases.

As is clear from these numbers, as the price oil decreases, production capacity increases. One notable exception is that Non-OPEC countries’ production capacities have the opposite reaction to a change in the price of oil. OPEC countries largely drive this relationship between price and production capacity. From an economics point of view, a decrease in the price of oil decreases the willingness of suppliers to produce and sell oil. The *IEO2005*, however, shows the opposite effect for OPEC countries. One possible explanation is that OPEC countries control the price of oil with their quotas.

OPEC actual production capacity in 2002 was 20.6 MMBD. As Table 2 shows, the IEO2004 forecast that OPEC production capacity in 2025 as 75.7 MMBD for the low price case, 61.5 MMBD for the reference case, and 46.8 MMBD for the high price case. In contrast, the *IEO2005* forecasts OPEC production capacity in 2025 as follows: 72.80 MMBD for the low price case, 56.00 MMBD for the reference case, and 40.40 MMBD for the high price case.

Price sensitivity in the current projection is indicated by the fact the high price level of production capacity for 2005 is 75.1% of the low price estimate and 87.7% of the reference case estimate. If the high price level is compared to the 2004 case, the high price level of production capacity for 2005 is only 53.4% of the low price estimate and 65.7% of the reference case estimate. This indicates that sustaining an average oil price of around $45 dollars per barrel would have an incredible impact in reducing past estimate of petroleum demand and supply.

Table 2: World Oil Production and Production Capacity in 2025: *IEO2004* vs. IEO *2005*
(In Million Barrels Per Day)

Region	2002 Actual	IEO2004 Low Price	IEO2004 Reference	IEO2004 High Price	IEO2005* Low Price	IEO2005* Reference	IEO2005* High Price
Price: $/Barrel	$23.78	$17.00	$27.00	$35.00	$21.00	$35.00	$48.00
Production Capacity							
Persian Gulf	18.70	56.80	45.00	32.90	50.00	39.30	27.80
Algeria	1.30	3.00	2.70	2.20	3.70	2.80	2.20
Libya	1.50	3.10	2.90	2.40	3.90	2.90	2.20
Other Middle East	1.40	2.60	2.80	3.10	2.70	2.80	3.00
OPEC	27.20	75.70	61.50	46.80	72.80	56.00	40.40
World Total	69.40	137.00	126.10	117.30	135.20	122.20	115.50
Persian Gulf as % of Total	26.95%	41.46%	35.69%	28.05%	36.98%	32.16%	24.07%
Production							
Middle East	19.00	29.90	42.10	54.00	48.40	36.90	25.70
OPEC	28.70	40.10	54.90	7.30	67.60	52.70	35.00
Unconventional Oil	0.00	6.50	4.70	3.90	4.30	5.70	10.50
Canada	0.00	3.90	3.30	2.80	2.90	3.50	4.70
Latin America	0.00	2.60	1.40	1.10	1.20	1.50	3.00
World Total	78.10	112.70	12.60	132.50	130.90	118.90	112.90
Persian Gulf as % of Total	24.30%	26.50%	34.80%	40.70%	37.00%	31.00%	18.40%

Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *International Energy Outlook 2004*, and *International Energy Outlook 2005*
*IEO Totals include conventional and nonconventional oil. Nonconventional oil production is dominated by Canadian Tar Sands and Venezuelan heavy crude, which were not broken out as separate categories in the IEO2004 analysis. Total unconventional production is assumed to reach 5.7 MMBD in the reference case by 2025. The figure is 10.5 MMBD for the high price case and 4.3 MMBD for the low price case. Total Middle Eastern unconventional oil production is only 0.1 MMBD in the reference case, 0.6 MMBD in the high price case, and 0.0 MMBD in the low price case.

Solving the Supply Issues Relating to Middle Eastern Oil

The potential impact of high oil prices in easy the strain on world oil supplies becomes even clearer when one looks at the impact of oil prices on the need for Middle East and North Africa (MENA) conventional oil production capacity.

- The IEO analysis for 2004 called for major increases in MENA oil production capacity. It forecast that Saudi Arabia's production capacity in 2025 would be 31.5 MMBD for the low price case, 22.5 MMBD for the reference case, and 16.0 MMBD for the high price case.
- The *IEO2005* forecasts that conventional MENA production capacity in 2025 will be 51.1 MMBD for the low price case, 39.5 MMBD for the reference case, and only 28.1 MMBD for the high price case.

These contrasts are even more striking for Saudi Arabia. For many years, most of OPEC's projected increase in production capacity in both the EIA and IEA models has been driven by Saudi Arabia. In recent times, the Saudi production capacity has received a lot of attention. Some analysts have questions the Kingdom's ability to meet sudden surges in demand because of its lack of spare production capacity, and others – like Matthew Simmons – have estimated that Saudi production may be moving towards a period of sustained decline.

In 2002, Saudi Arabia had an oil production capacity of 9.2 MMBD. This capacity was roughly 9.0-10.5 MMBD in 2004, and has so far averaged 10.5-11 MMBD in 2005. Like most of its predecessors, the IEO analysis for 2004 called for truly massive increases in Saudi oil. It forecast that Saudi Arabia's production capacity in 2025 would be 31.5 MMBD for the low price case, 22.5 MMBD for the reference case, and 16.0 MMBD for the high price case.

As Table 3 shows, the *IEO2005* forecasts that Saudi Arabia's production capacity in 2025 will be 20.4 MMBD for the low price case, 16.3 MMBD for the reference case, *but only 11.0 MMBD for the high price case. Yet, Saudi Arabia already plans to increase its production capacity to 12.5 MMBD.*

Most analysts, including current and former Saudi Aramco officials, believe that the 20.0 MMBD is an unattainable production capacity. At this point, one can argue that the Kingdom could reach this production capacity only if two things happen: there are major technological breakthroughs that enhance recovery of existing oil fields or help find new reservoirs and there are major supply disruptions that forces Saudi Arabia to meet the shortages in supply.

Uncertain Transparency and Uncertain Credibility

Table 3 shows similar, if less dramatic trends for most of OPEC, and the trends apply to most of the non-OPEC states not shown on this table. Non-OPEC production capacity is also expected to show large increases in the mid-term. These increases will come mainly from deepwater exploration in the North Sea, the Caspian Sea, the Gulf of Guinea, and the Gulf of Mexico. With advanced exploration and recovery technology, experts believe that offshore production can have significant influence on the world energy market in the mid to long-term.

High prices defer not only many of the issues relating to future oil supply, *but also most of the issues relating to any geopolitical competition for oil imports*. The projected increases in production capacity at the high price case for IEO2005 are far more achievable and sustainable in terms of the flow of global imports than any past EIA and IEA projections.

They would effectively eliminate the kind of struggle postulated in scenarios showing Chinese and Western competition for imports. The only problem is that the EIA does not explicitly address any of these issues, or provide the kind of data on overall energy balances and assumptions about supply and demand elasticities in other sectors of energy that would give such data meaning and credibility.

Table 3: OPEC Oil Production Capacity 2005-20025
(In Million Barrels Per Day)

	2005	2010			2025		
	August	**Low Price**	**Reference**	**High Price**	**Low Price**	**Reference**	**High Price**
Algeria	1.380	2.200	2.000	1.800	3.700	2.800	2.200
Indonesia	0.945	1.200	1.500	1.400	1.500	1.500	1.400
Iran	4.000	4.800	4.000	4.000	6.600	5.000	4.500
Iraq	1.900	4.000	3.500	3.100	8.600	6.600	4.000
Kuwait	2.500	3.600	2.900	2.900	6.200	5.200	3.500
Libya	1.635	2.200	2.000	1.800	3.900	2.900	2.200
Nigeria	2.450	3.300	2.600	2.400	6.400	3.900	2.900
Qatar	0.800	0.800	0.600	0.600	0.900	0.800	0.800
Saudi	10.50-11.00	15.600	14.000	10.400	20.400	16.300	11.000
UAE	2.400	4.000	3.300	3.400	7.000	5.400	4.000
Venezuela	2.500	4.600	3.500	3.200	7.300	5.600	3.900
Total	**31.005-31.505**	46.300	39.900	35.000	72.500	56.000	40.400

Source: Adapted by A. Cordesman & K. Al-Rodhan from the EIA, *International Energy Outlook 2005*

World Economic Growth and Consumption

The *IEO2005* forecasts that total energy consumption will increase by 57% from 2002 to 2025. Much of this growth will be fueled by high economic growth in emerging markets in Asia. In fact, the *IEO2005* claims that increases in energy consumption in the transitional economies and the mature market economies will be "modest." It forecasts emerging economies to grow by 5.1%, mature economies growth rate will be 2.5%, and transitional economies will add 4.3% as measured in the growth of GDP in purchasing power terms.

World oil consumption in 2002 was 78.2 MMBD, for the reference case; total world oil consumption is expected to rise to 103.2 MMBD, to 111.0 MMBD in 2020, and to 119.2 MMBD in 2025. During the 2002-2025 period, China's consumption is forecasted to rise from 5.2 MMBD in 2002, 9.2 MMBD in 2010, 10.7 MMBD in 2015, 12.3 MMBD in 2020, and 14.2 MMBD in 2025. Between 2002 and 2010, China's oil consumption will increase by 7.5%, but the growth rate will gradually decline.

The *IEO2005* demand forecast adjusts for the higher prices (*IEO2004* forecast that in 2025 total world oil consumption would be 121.0 MMBD compared 119.2 MMBD). The projection, however, does not address the effect of conservation and alternative sources of energy. Moreover, the report does not enough data for analysis of the demand-price elasticity.

One key example is renewables. The EIA forecasts in *IEO2005* show they will have little future impact on mid to long-term world oil demand as measured in quadrillions of BTUs (Quads). If one excludes oil, natural gas, coal, and nuclear, all other sources of energy only increase by an average of 1.9% in the reference case. As a result, their total contribution to world energy supply drops from 7.8% in 2002 to 7.6% in 2025 -- in spite of all of the political focus on increasing such sources.

Because the *IEO2005* does not examine the impact of high oil prices on world energy balances, there is no way to guess at how much this would change if oil prices remained high, The two excursions the EIA does examine do not even hint at such impacts. All other energy supplies drop to 7.3% of world supply in the "high economic growth" case, and 7.5% in the "low economic growth" case.

Demand-Driven Models

Some argue that the energy market is demand-driven, and that supply is largely exogenous. That is that overtime oil-producers supply petroleum based on the level of demand in the global energy market. This level of demand depends, amongst other things, on the level of economic growth, the price of oil, the existence of close substitute or alternatives, and preferences of consumers.

The models used by the EIA in its *International Energy Outlook 2005*, for example, are demand-driven where first they forecast demand and then project the production capacity to meet this projected demand. The country's share of world's reserves is used to determine the country's share of the increase in production capacity, but demand-driven models do not take into account country-by-country plans. It is based on the assumption that petroleum is produced to be consumed in terms of goods and services.

The first problem with this approach is that production capacity is entirely determined by assumptions about economic growth and the range of oil prices the market will pay. If this range

is unrealistic, then the whole model has limited ability to predict. Demand-driven models do not lend themselves to parametric analysis of possible ranges of supply constraints. They have limited flexibility for sensitivity analysis, especially in terms of changing prices, technological changes in the industry, and potential changes in energy and foreign policy.

Demand driven forecasts also tend to overestimate the influence of the price changes. Adjustments to demand and supply elasticities, however, are slow. In addition, these models do not seem to take into account "habit formation." If these models are demand-driven, they must take into account persistence in changing habits that have formed over years. When the price of a barrel of oil jumped by 108% during 2001-2005, some analysts, for example, were surprised to see that demand did not adjust immediately.

Supply-Driven Models

Supply-driven models have the potential advantage of providing parametric and sensitivity analysis for demand, production, and production costs based on estimates of reserves and projected increased in production from technological improvements. They are also better built to take into account production and geopolitical risks and the impact of geostrategic risks on future flow of petroleum. Supply-driven models can be of enormous importance to analysts and policy makers and EIA, IEA, and the USGS have to combine their efforts with the national energy agency to issue reports that are credible, transparent, and robust from a technical point of view.

This does not mean that demand-driven models do not have great values, but to fully understand the global petroleum market, energy experts must make a balancing effort to forecast supply and then determine what the demand will be. This approach, as mentioned earlier, is more robust, but requires the accesses to credible data from suppliers or it needs to estimate many inputs including production and transportation costs, the influence of new technological innovations on the recovery and exploration rates, actual and possible reserves in the ground, and supply and demand elasticities.

Today, estimates of production capacity are largely based on guesstimates and "trusting" of government claims. Estimating actual reserves in the abstract is difficult. Agencies such as the USGS, which look at reserves from geological potential basis, have to update their estimates. Otherwise, the IEA and other organizations have to rely on the credibility and goodwill of the suppler countries to provide data, often without independent verifications.

Current supply-driven models also suffer from the lack of price sensitivity analysis and the influence of technological improvements. Most energy models are not parametric or even semi-parametric and hence limit the ability of testing future changes in supply, demand, and prices. In addition, the same lack of elasticity computation and the impact of efficiency, conservation, and alternatives.

It has been reported that the IEA is updating its estimates in its annual *World Energy Outlook* in November 2005. It is too soon to judge their report, but history has shown that the IEA lack credibility due to its lack of transparency. It is expected of any international body with many competing members, different reporting systems, and lack of consensus on the importance of transparency.

Major Areas of Uncertainty in Energy Modeling

In short, reports such as the *IEO2005* raise dramatic issues for energy policy planning, but do not provide a meaningful basis for energy analysis in today's world. Adjusting the energy models to address all of the implications of the high oil price is a vital and necessary first step. So is making all of the assumptions and uncertainties involved in such analysis transparent.

There are, however, several other major areas that also need improvements. It is all too clear that forecasts like the one provided by *IEO* are difficult due to the complicated nature of the energy market, the limited hard country-by-country data, and the "immeasurable" risks involved in forecasting. There areas where reports like the *IEO* could provide a better benchmark for the global energy market if they addressed the gaps and uncertainties left by the *IEO2005*.

The key gaps and areas of uncertainty in the *IEO2005*:

- It does not provide any parametric analysis of its oil price forecast. With the exception of the introduction, the other sections are putting the appendices in words.
- The report does not provide sufficient explanation as to how the rates of economic growth interact with the price of oil and how the price-elasticity of demand changes over time given an economic growth rate.
- It states that it has taken into account country-by-country plans in forecasting oil production capacity, but there is little explanation of how such plans have changed their forecast from lasts and how unrealistic those plans are.
- The report does not make estimates of indirect imports of oil from the Gulf and other regions in terms of the energy required to produce finished goods. The US, for example, indirectly important very significant amounts of oil in the form of manufactures from Asian countries dependent on Middle East oil imports.
- It does not provide a breakdown of the FSU, the Caspian Sea, the North Sea, Africa, and other South and Central American countries production forecasts. These areas are considered to have the greatest potential for enhancing production and new discoveries. These areas should be broken down by country, e.g. Russia should not be lumped in with smaller FSU states.
- The report does not explicitly analyze technological improvements and their role in improving oil recovery and exploration for new oil reservoirs, development that have significant effects on future oil supply and the oil market.
- The report does not credibly explain the interactions between different oil prices, and level of oil supply and demand, and changes in the supply and demand of gas, coal, nuclear power, renewables, electricity, and conservation.
- No effort is made to determine the very different patterns of elasticity in supply and demand for gas, coal, nuclear power, renewables, electricity, and conservation that have to emerge over time if oil prices remain so much higher than in the past, or the major uncertainties that will inevitably result from such changes.
- The impact of growing Asian demand, especially China, is subject to only limited sensitivity analysis. A Chinese recession/depression case is one such example.
- Major shift in energy cost and different levels of economic growth are treated largely as independent assumptions and variables.
- The report does not address the impact of key options the US energy policy or of the energy bill that was recently passed by Congress, especially options relating alternative energy sources and possible "strategies" to decrease dependence on foreign sources of energy.
- It does not analyze the effect of alternative source of energy or conservation, and provides little data for any elasticity based analysis.

- It does not analyze the impact of a persistently high oil price on consumption of oil, production capacity, or conservation. Moreover, the report provides the three estimates (low, reference, and high), but provides no analysis of what they mean to the global energy market and how they relate to the world energy demand.
- It had limited historical or current data to enable us to make conclusions about the effect of conservation or alternative sources of energy on countries production capacities.

One key aspect of these problems is the lack of any correlation between the EIA projections and either the Bush Administration's energy policies and the energy legislation passed by Congress. The is important in the case of the Bush Administration because the potential impact of its various energy policies have never been explicitly analyzed in the forecasts of either the IEO reports or the EIA's annual report on US energy.

It is important in the case of the recent energy bill passed by Congress because if the *IEO2005* projection is correct, a sustained increase in oil prices would have far more impact on US energy needs than the measures in the bill. It also would have far more impact on US energy imports, although any realistic projection of the impact of the Bush Administration's policies, the energy bill, and/or high oil prices would still not change the level of US strategic dependence on oil imports.

In all three cases, the US will be critically dependent on direct and indirect oil imports through 2025. In the case of the Bush Administration policies and energy bill, the potential impact not only will be limited, but the basic policy is fatally flawed. It assumes that America's problems can be solved by focusing on American imports. The reality is that the US is steadily more dependent on the global economy and on the global flow of energy imports. Playing with marginal reductions in US oil imports is of virtually no strategic importance at all.

Still the Best Game in Town

It should be stressed that the EIA is so far the only major agency to even begin to address the prospect of sustained high oil prices, and react to real world trends. Furthermore, the structural problems in the EIA projections are no different from the demand-driven modeling of the IEA and OPEC—and that used in virtually all government reports. In fact, the EIA's modeling and analysis is far more transparent than that of the IEA—which generally sets very low standards in this area.

The future of energy, however, is of enormous importance, and reports can provide significant insight in the energy market. The *IEO2005* has attempted to fill the gaps that existed in the *IEO2004*. Unfortunately, it highlights the critical impact that oil prices may have on world oil demand and supply and then does not analyze these effects on any other aspect of energy supply and demand or energy balances.

Moreover, the IEO does not cover many important areas such as the role of technological improvement and the effect of alternative sources of energy on production capacity and world energy demand respectively. As such, the EIA's failure is even more critical because the IEA and OPEC have so far done nothing meaningful to update their analyses to deal with the possibility of long-term "high price" cases.

Endnotes

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According to the Energy Information Administration's *International Energy Outlook 2005's* reference case forecast, Persian Gulf oil production increased from 18.7 MMBD in 1990 to 22.4 MMBD in 2001 to 20.7 MMBD. It is expected to reach about 28.3 MMBD by 2010, and 35.2 MMBD by 2020, and 39.3 MMBD in 2025.

The estimate, however, does change in the high oil price case: it is expected to reach about 24.4 MMBD by 2010, and 26.2 MMBD by 2020, and 27.8 MMBD in 2025.
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Closure of the Strait of Hormuz would require use of longer alternate routes (if available) at increased transportation costs. Such routes include the 5 million-bbl/d capacity Petroline (East-West Pipeline) and the 290,000-bbl/d Abqaiq-Yanbu natural gas liquids line across Saudi Arabia to the Red Sea. Theoretically, the 1.65-MMBD Iraqi Pipeline across Saudi Arabia (IPSA) also could be utilized, more oil could be pumped north to Ceyhan (Turkey), and the 0.5 million-bbl/d Tapline to Lebanon could be reactivated.

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