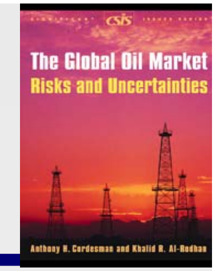


The Center for Strategic and International Studies
Arleigh A. Burke Chair in Strategy
1800 K Street, NW • Suite 400 • Washington, DC 20006
Phone: +1-202-775-3270 • Fax: +1-202-457-8746
Web: www.csis.org/burke

The Geopolitics of Energy:

Geostrategic Risks and Economic Uncertainties

Anthony H. Cordesman
Arleigh A. Burke Chair

Khalid R. Al-Rodhan
Visiting Fellow

Revised: March 20, 2006

Energy Risk and Complexity Theory

- Range of uncertainties is very high.
- Models cannot cover all key variables in one model.
- Sudden discontinuities are historical fact.
- Sustained, rapid global economic growth pushes “system” to its limits.
- Stress increases uncertainty of elasticity in both supply and demand.
- Projections go to 2025-2030; “confidence limit” (ignoring geopolitics) is 2010 to 2015.

Risks and Uncertainties

Strategic Importance: Projections

Risk Premium

Resource Availability

Geostrategic Risk

- Security of facilities
- Stability of governments
- Oil as a weapon
- Supply disruptions
- Corruption of oil deals

Nature of Resources

- Reserves estimates
- Recoverability
- Natural depletion
- New discoveries
- Technical 3-D modeling

Economic Forces

- Health of global economy
- Inflow of investment
- Demand elasticity
- Production at a given price
- Labor strikes & disputes

Production Capacity

- Sustainability
- Technological gains
- Field management systems
- Crude grade
- Refining capacity

Rational Expectation?

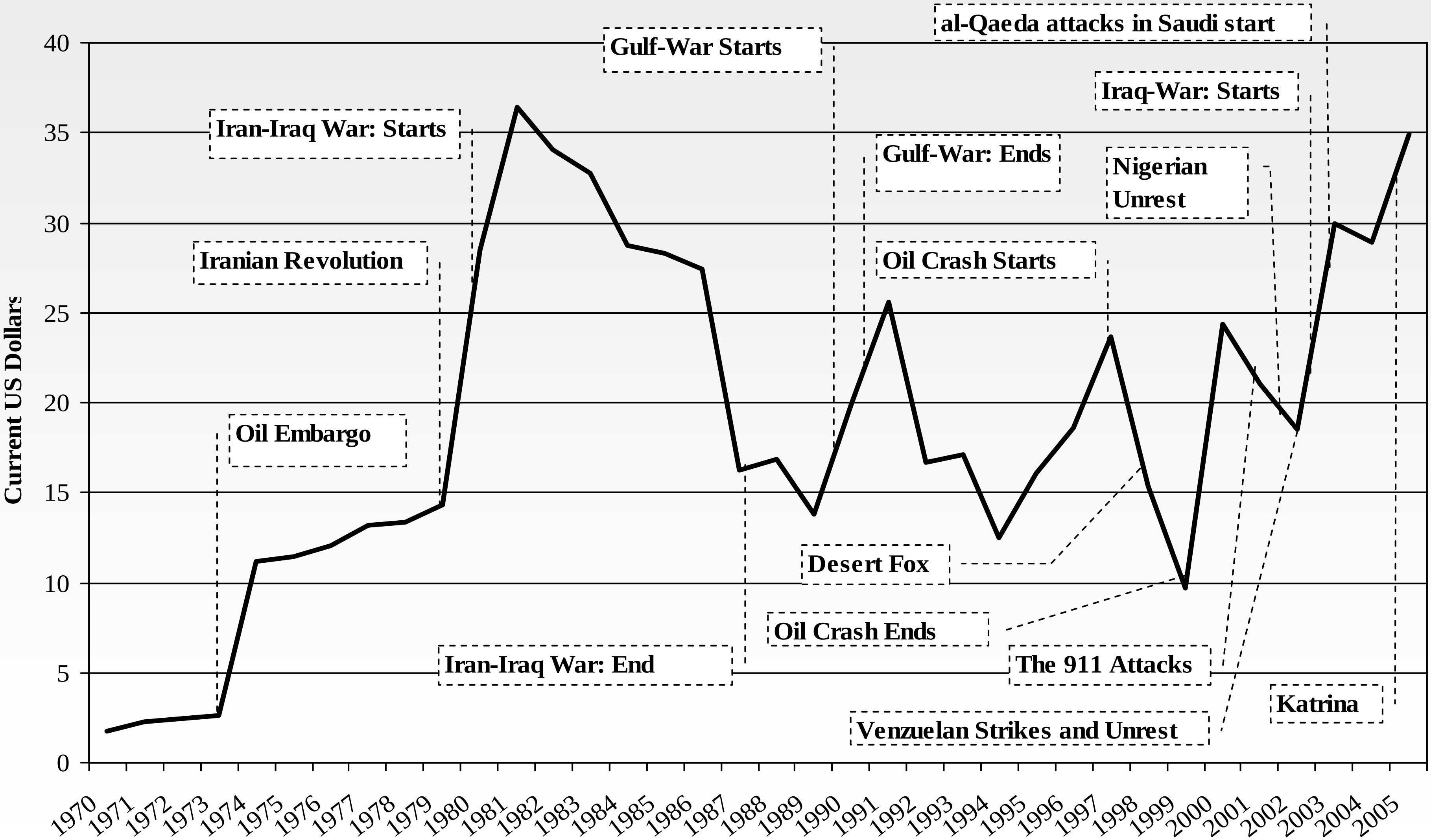
The Market is Only Part of the Story: Impact of Oil Disruptions

The following outlines key oil supply disruption incidents:

- **1956:** the Suez War caused 1.0 MMBD supply shortages for 4 months.
- **1967:** The ’67 Arab-Israeli War caused 2.0 MMBD supply shortages for 2 months.
- **1974:** The October War caused an oil embargo that cut the supply by 2.6 MMBD for 6 months. During that disruption, the world oil price tripled, from about $4 a barrel to about $12 a barrel.
- **1979**: the Iranian Revolution caused 3.5 MMBD supply shortages for 6 months.
- **1980**: the Iran-Iraq War caused 3.3 MMBD supply shortages for 3 months.
- **1990**: the Iraqi invasion of Kuwait caused the loss of 4.3 MMBD or 13% of the world export market. This led to a doubling in the world oil price from July to October 1990, from about $16.50 to about $33 a barrel.
- **2002**: strikes and unrest in Venezuela caused 2.1 MMBD supply shortages for 3 months.
- **2003**: unrest in Nigeria caused 0.3 MMBD supply shortages for 6 months
- **2003-Present**: Iraq War caused on average 1.0 MMBD supply shortages. Iraq’s oil production is still lower than pre-war levels
- **2006:** unrest in Nigeria caused 0.4 MMBD supply shortages.

History of Oil Shocks: 1970-2005

Overtimes: more incidents, more frequent volatility, higher risk of asymmetric attacks, and more geopolitical uncertainties.



Source: EIA, "Crude Prices by Selected Type 1970-2005," available at: http://www.eia.doe.gov/emeu/aer/txt/ptb1107.html.
Note: These prices are averages of several types: Saudi Light, Iranian Light, Libyan Es Sider, Nigerian Bonny Light, Indonesian Minas, Venezuelan Tia Juana light Mexico Maya, and UK Brent blend

Geopolitical Uncertainties

- **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, asymmetric attacks, sabotage**: 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 throw the market into a spiral.
- **Proliferation of WMD**: The success in stopping the AQ Khan does not mean the end of a nuclear 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.
- **Embargos and sanctions:** Another OPEC oil embargo is very unlikely. However, if oil is ever used as 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 strife:** 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 crisis are.

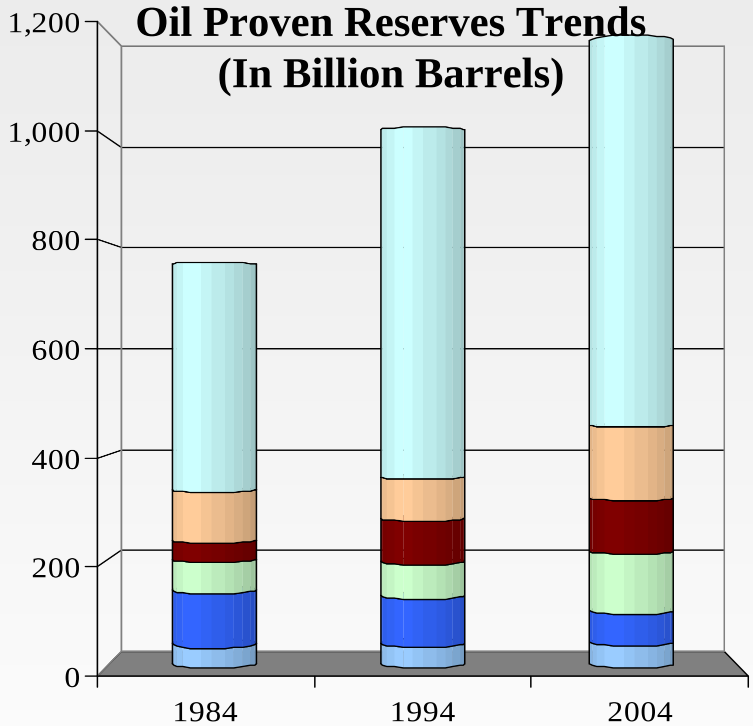
Macroeconomic Uncertainties

- **The sustainable and spare capacity of oil producing countries:** 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 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 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 to the domestic market in a timely manner can build bottlenecks that not only squeeze the average consumer but also have negative impact of demand and the pushes ups the price of crude oil futures.
- **The overall health of the global (Asian) 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 EIA, this surge from emerging countries will account for 45% of the increase in oil demand over the next 20 years.

Oil Reserve Uncertainties

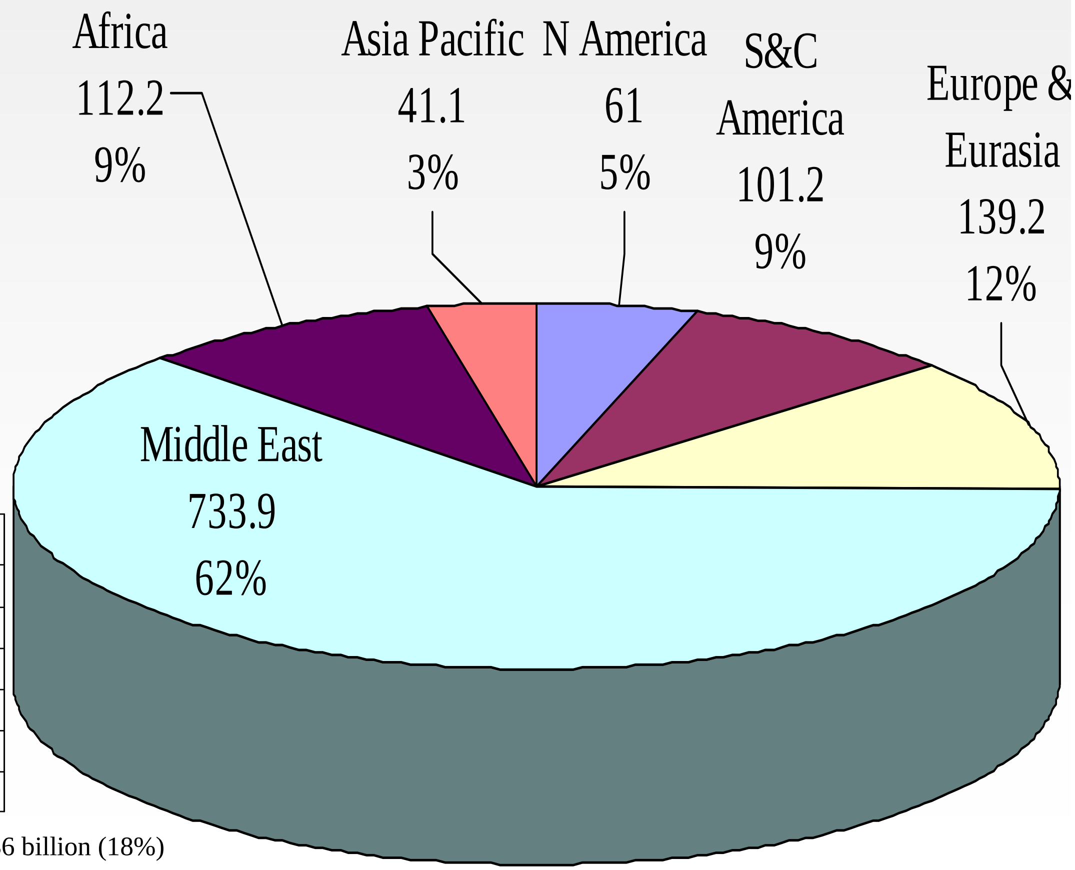
- **True nature of reserves:** There are ongoing debates on the reliability of reserves. The USGS 2000 continues to be the benchmark estimate. However, as with any estimates, forecasting uncertain. Furthermore, analysts disagree about the definition of “known” vs. “undiscovered” vs. “proven” resources.
- **Canadian tar-sands:** Canada has an estimated 175 billion barrels of tar-sands reserves. If included, they raise world proven reserves by 15%, from 1.188 trillion barrels to 1.363 trillion barrels of proven reserves.
- **Venezuelan bitumen deposits:** Venezuela is estimated to have 270 billion barrels of proven *extra-heavy and bitumen deposits.*
- **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 there 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 announcement 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 don’t replace old fashion drilling and physically measuring actual reserves.

World Oil Proven Reserves



	1984	1994	2004
Middle East	430.8	661.7	733.9
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

Oil Proven Reserves 2004
(In Billion Barrels)



Note: If Canadian tar-sands are included, the North American total rises to 236 billion (18%)

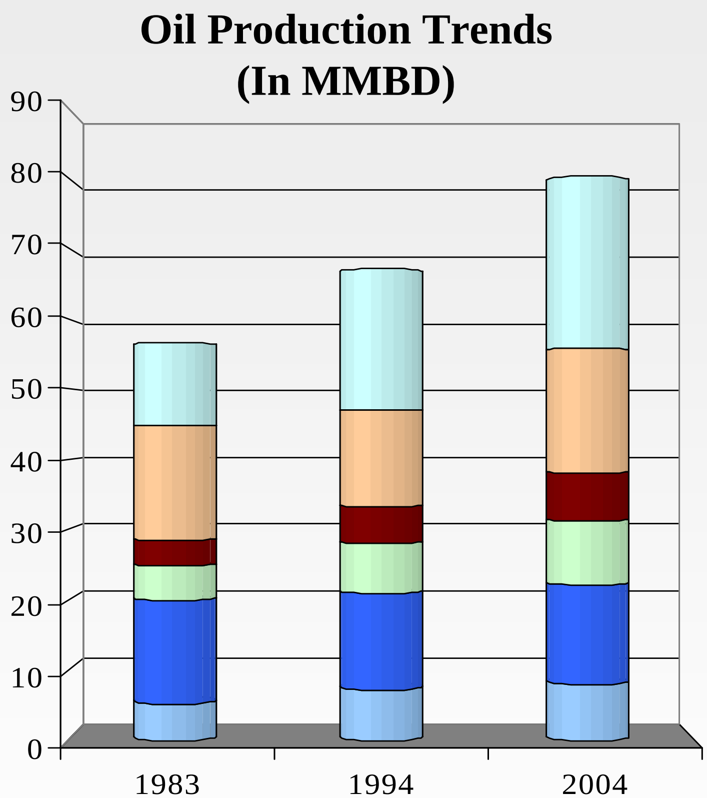
Source: BP Statistical Review

Source: BP Statistical Review

Oil Production Uncertainties

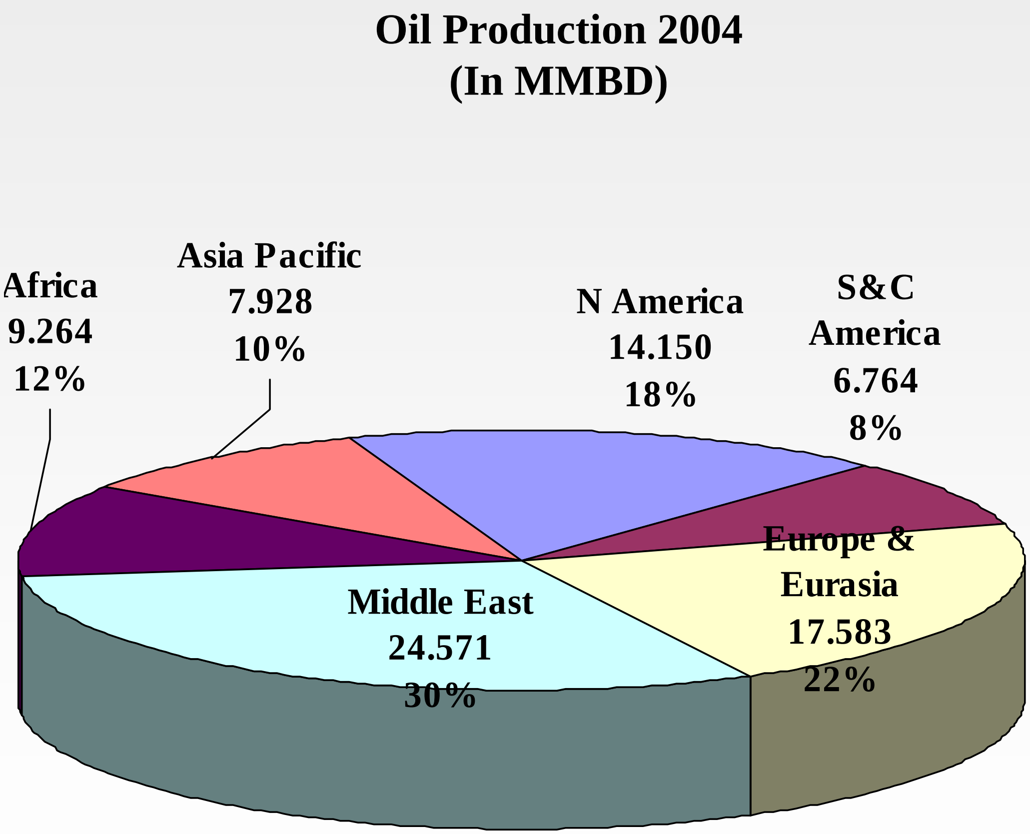
- **Little "sustainable" spare capacity:** With the exception of Saudi Arabia, in 2005, the rest of the world had no spare capacity. If there were sudden surges in demand (high economic growth) or distributions in supply of other exporters (the Iraq War in 2003, Venezuela strikes in 2004), will producers 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 don't 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 price of oil has to be high enough to cover variable, fixed, and sunk costs and investment, but not too high that it exerts too much downward pressure on demand.
- **Technological gains in the upstream industry:** Current production capacity forecasts do not and may not be able to anticipate technological gains in the upstream side of the industry. Producers strive to improve efficiency. They have invested a lot of capital. While some gains will bear fruit, it remains uncertain how successful the development of new technology will prove to be at maintaining parity with the oil production industry, in terms of supply and demand.
- **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 need of foreign investment both in terms of capital and technological sharing. The lack of security and stability, rigid foreign investment and tax laws, and transparency have prevented the inflow of FDI into these countries.

World Oil Production Trends



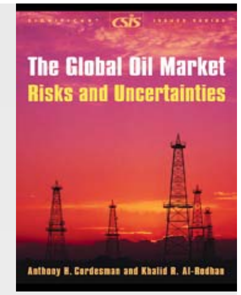
	1983	1994	2004
Middle East	11.841	20.118	24.571
Europe & Eurasia	16.343	13.657	17.583
S& C America	3.539	5.347	6.764
Africa	4.865	7.004	9.264
N. America	14.838	13.807	14.15
Asia Pacific	5.171	7.184	7.928

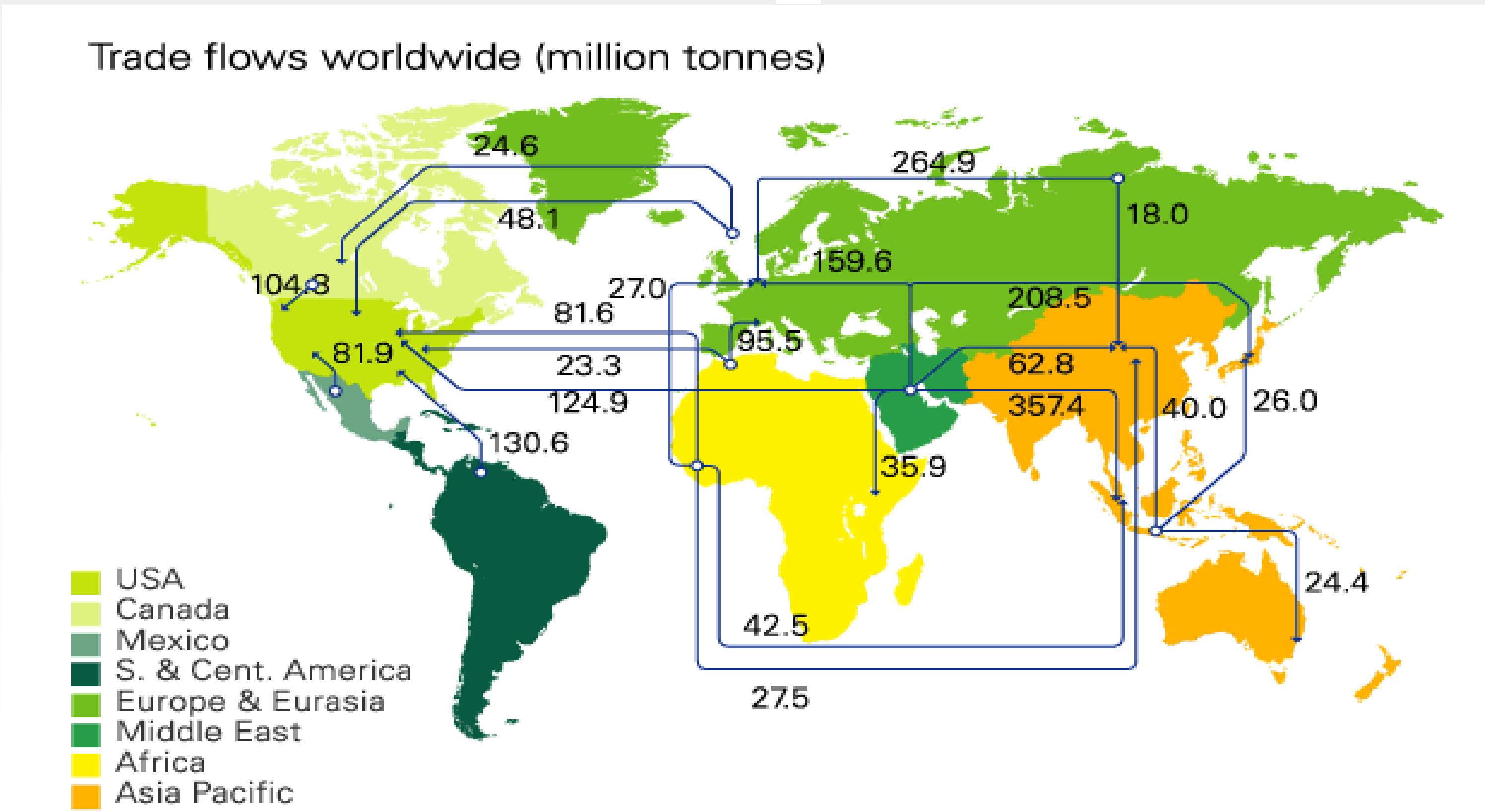
Source: BP Statistical Review



Source: BP Statistical Review

Global Dependence and Transport Risk





Note: between 2003 and 2004, total world oil trade increased by 5%; Middle East exports alone increased by 3.6%

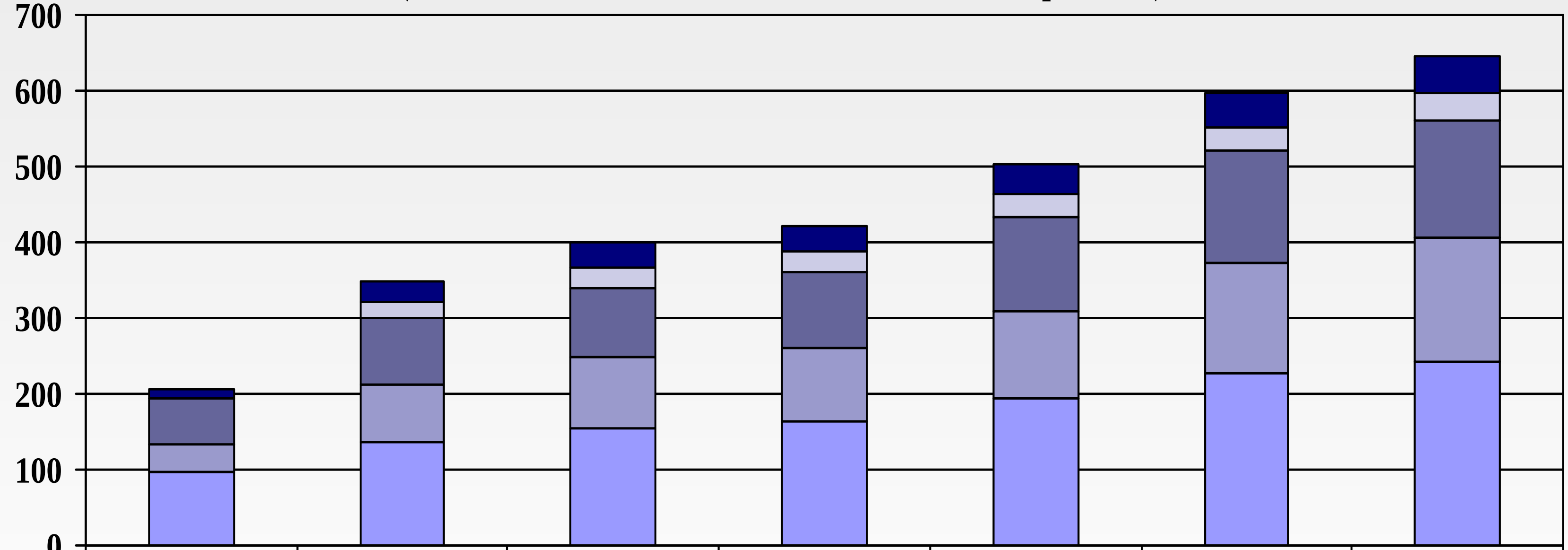
Source: BP, Statistical Review of World Energy 2005.

Shift in Global Oil Dependence

- **Geostrategic uncertainties:** Oil producing regions are unstable. Africa, the Caspian Sea, and South America are not much better than the Gulf (Pipelines sabotages in Nigeria, labor strikes in Venezuela, terrorist attacks in Saudi Arabia, corruption charges in Russia, civil unrest in Uzbekistan). Supply routes and demand competition crease growing risks as well.
- **Lack of good estimates:** There is a lack of realistic forecast models. Most demand driven models do not take into account technological gains, country plans, supply and demand interactions, or realistic oil price levels. The EIA, IEA, and OPEC use similar methodology.
- **Decay and natural decline vs. technology growth:** Natural depletion is a fact, and to sustain the same capacity countries need to replace natural declines. There are serious debates over the impact of present and future technologies. Some regions more than others have done a better job in using technology to prolong the life of some fields.
- **Alternative energy supply, efficiency, and conservation?** It takes time to adjust consumption based on conservation or alternative fuel sources. The US and other countries will continue to rely on geopolitically unstable regions for their energy.
- **The need for investment:** The uncertainties outlined above have not only influenced the supply-demand-price forces. They have delayed foreign and domestic private investment in the oil infrastructure either due to security and instability concerns, due to environmental issues such was the case in the North Sea, or due to natural disasters such was the case in the Gulf of Mexico.

Geopolitics of Energy Are Not Simply Oil

(Reference Scenario in Millions of Tons of Oil Equivalent)

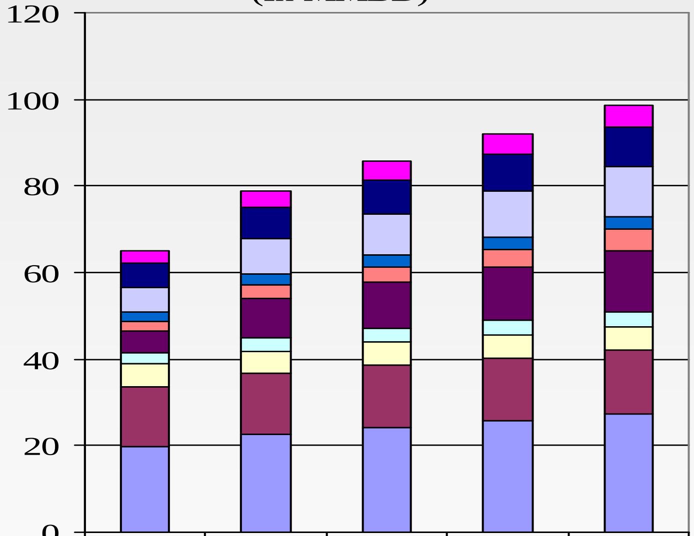


	1970	1990	2000	2003	2010	2010	2025
Other	12.2	26.4	32.8	32.9	39.8	45.2	48.9
Nuclear	0.9	20.3	25.5	26.5	30.2	32.9	34.1
Coal	59.7	90.5	93.6	100.7	125.2	146.8	156.1
Natural Gas	36.1	75	91.4	99.1	115.2	146.6	162.1
Oil	97.8	136	155.9	162.2	193.1	226.6	243.4

Source: EIA, IEO2005, reference case projection.

Total World Oil Demand by Region

Oil Consumption by Region
(In MMBD)



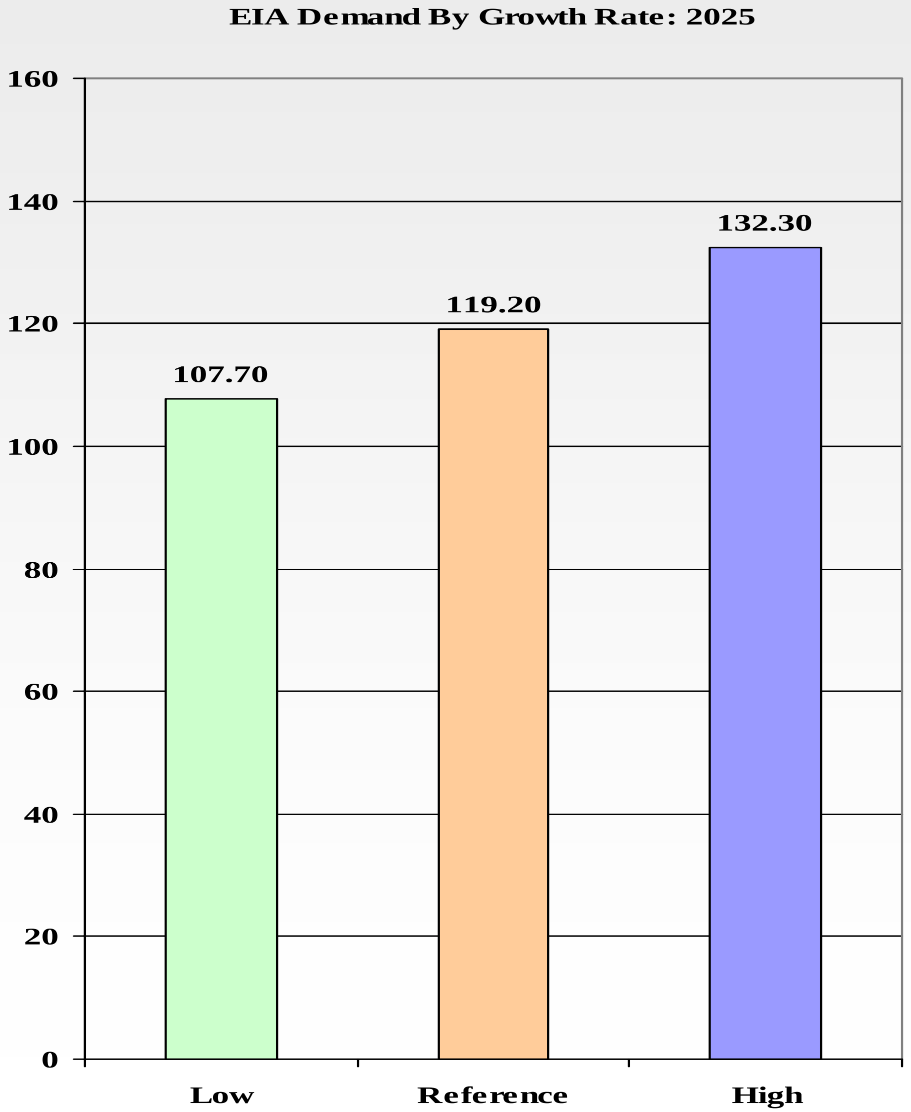
	2002	2010	2015	2020	2025
Africa	2.70	3.70	4.30	4.60	4.90
Mid East	5.70	7.30	8.00	8.60	9.20
Other Asia	5.60	7.90	9.20	10.40	11.60
S. Korea	2.20	2.60	2.80	2.90	2.90
India	2.20	3.10	3.70	4.20	4.90
China	5.20	9.20	10.70	12.30	14.20
Russia	2.60	3.00	3.10	3.30	3.40
Japan	5.30	5.30	5.40	5.40	5.30
W. Europe	13.80	14.10	14.30	14.40	14.90
USA	19.70	22.50	24.20	25.80	27.30

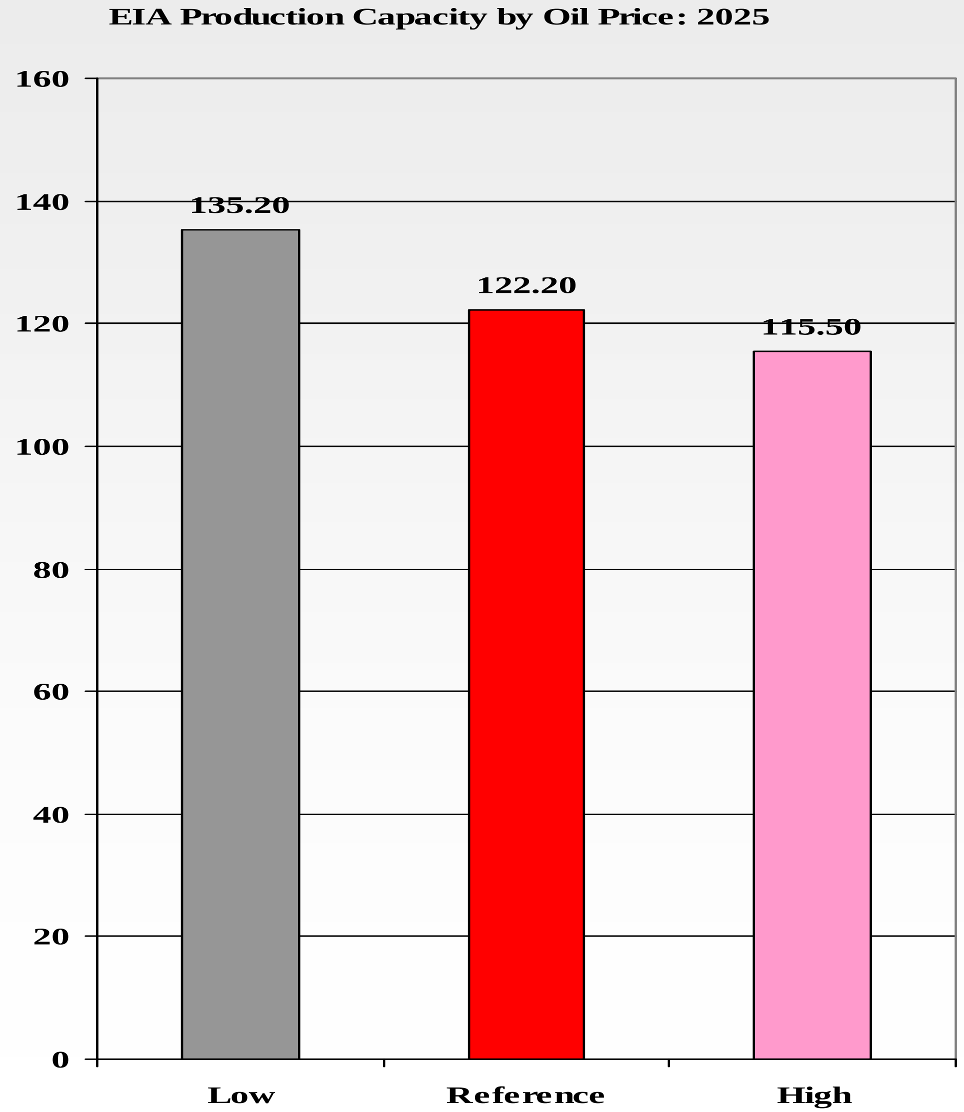
For High Growth Rates:

- China, India, & the rest of Asia will nearly triple—developing Asia growing from 13.0 MMBD to 30.7 MMBD.
- Russia, Africa, & Middle East will increase by 60%.
- US will increase by almost 40%
- Western Europe and Japan will plateau.

Source: EIA, IEO2005, reference case projection.

Future World Oil Demand vs. Supply

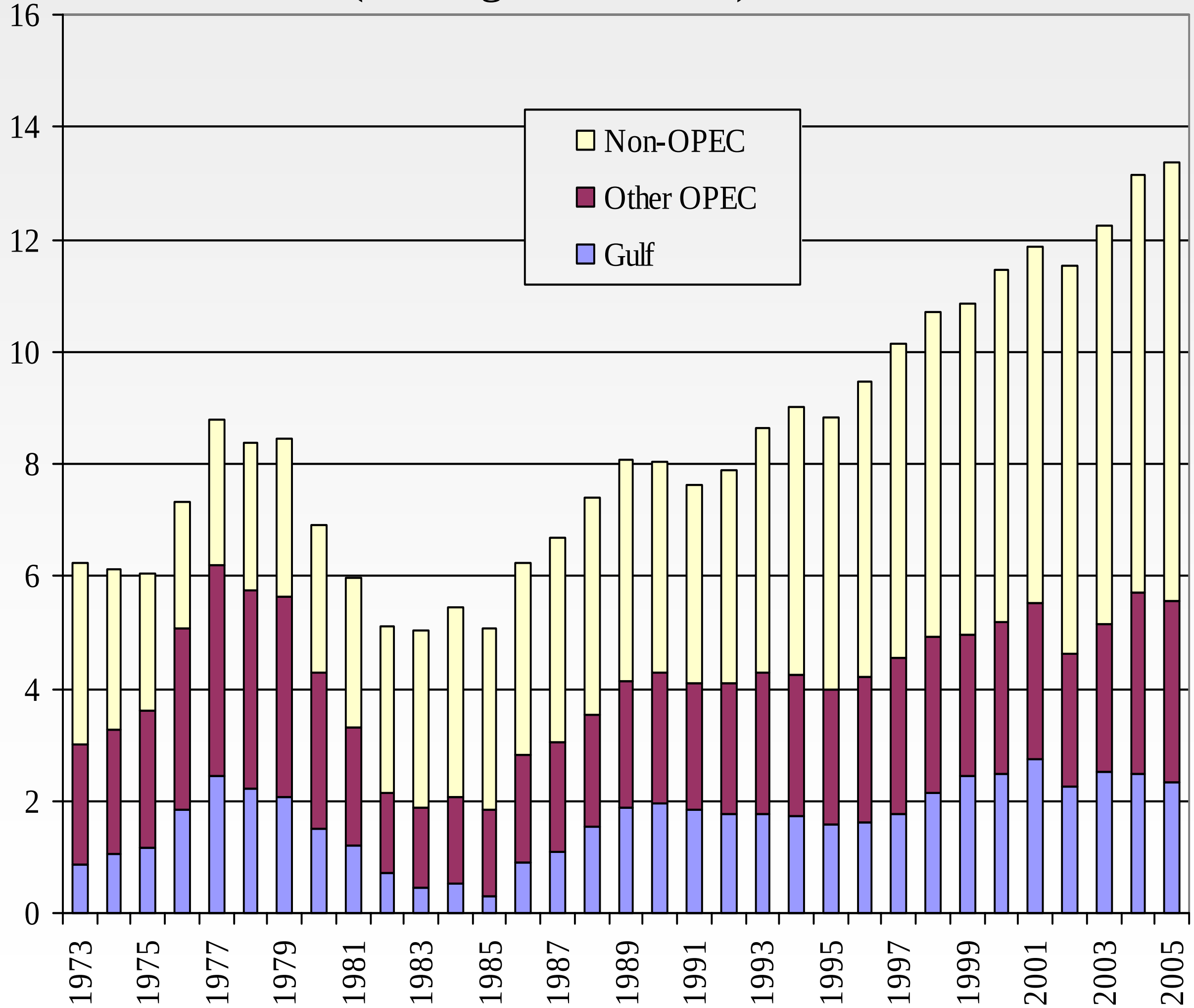




Source: EIA, IEO2005.

US Petroleum Import History

US Oil Imports: 1973-2005
(Average in MMBD)

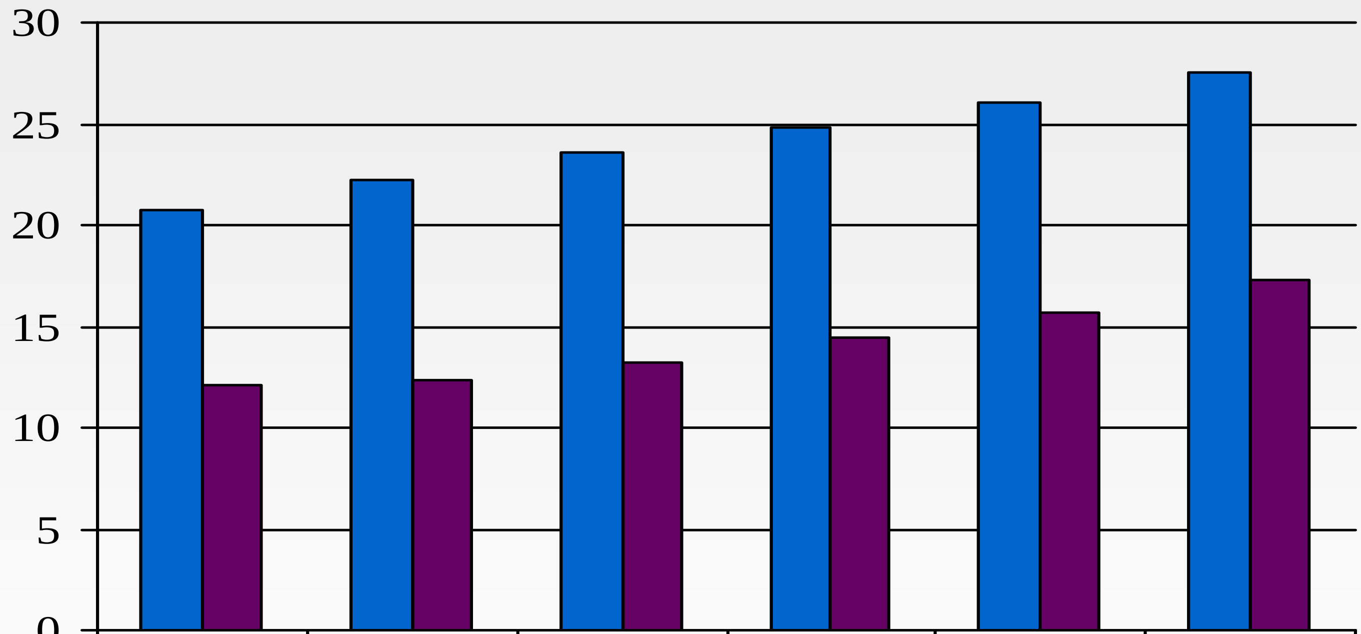


US Petroleum Imports: Top 15 Countries
(In MMBD)

Country	Imports in 2005
CANADA	2.172
MEXICO	1.646
VENEZUELA	1.506
SAUDI ARABIA	1.523
NIGERIA	1.147
ANGOLA	0.465
ALGERIA	0.477
IRAQ	0.522
ECUADOR	0.282
VIRGIN ISLANDS	0.326
KUWAIT	0.231
RUSSIA	0.398
BRAZIL	0.156
UK	0.387
NORWAY	0.230

Source: EIA.

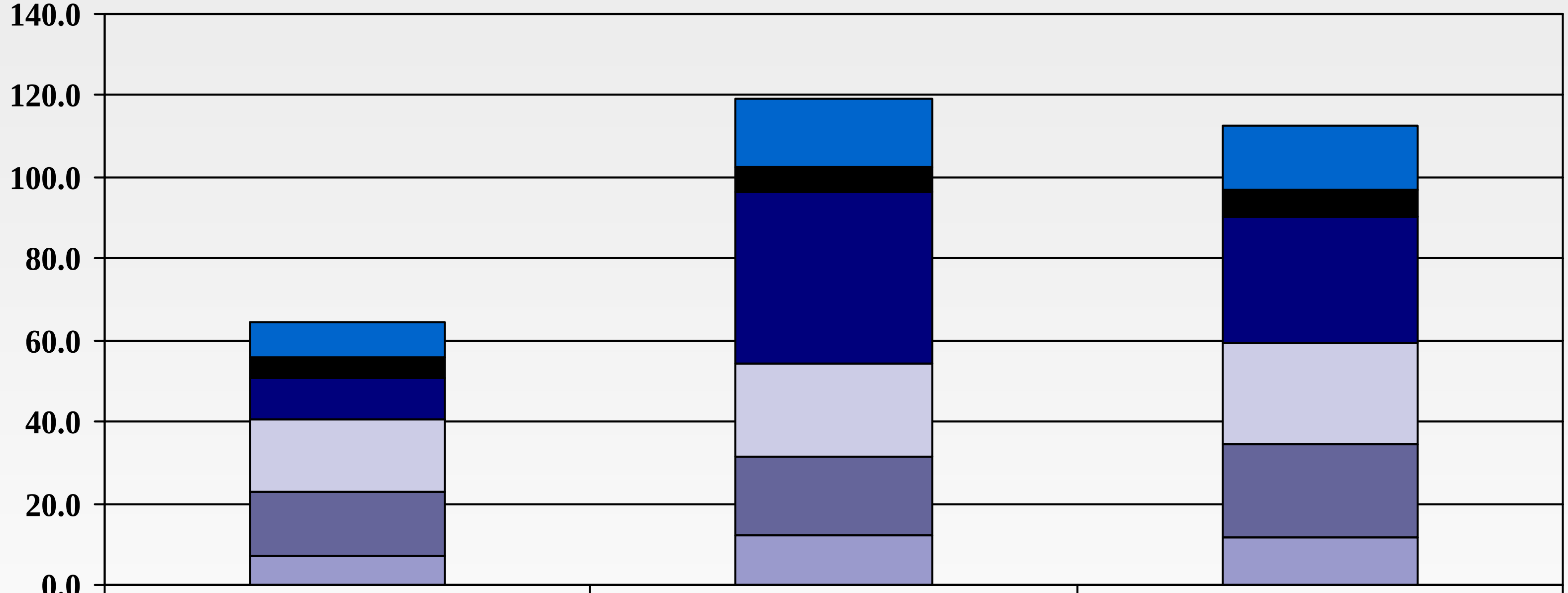
US Import Dependence: 2004-2030



	2004	2010	2015	2020	2025	2030
US Petroleum Consumption	20.76	22.17	23.53	24.81	26.05	27.57
US Net Imports	12.11	12.33	13.23	14.42	15.68	17.24
Price Per Barrel	$35.99	$43.99	$4.30	$44.99	$47.99	$49.99
US Import Dependence	58%	56%	56%	58%	60%	63%

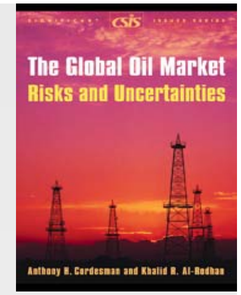
Source: EIA, Annual Energy Outlook 2006, February 2006, p. 11.

World Oil Production Capacity: 2025



	2002	2025:Ref	2025:High
Africa	8.6	16.4	15.4
Asia-Pacific	5.4	6.3	6.7
Middle East	10.1	42.1	30.8
Europe-Eurasia	17.7	22.6	25.0
N Amnerica	15.8	19.3	22.7
S&C America	7.0	12.3	11.9
Total	64.6	119.0	112.5

Source: EIA, IEO2005


The Global Oil Market
Risks and Uncertainties
Anthony H. Cordesman and Khalid R. Al-Rodhan

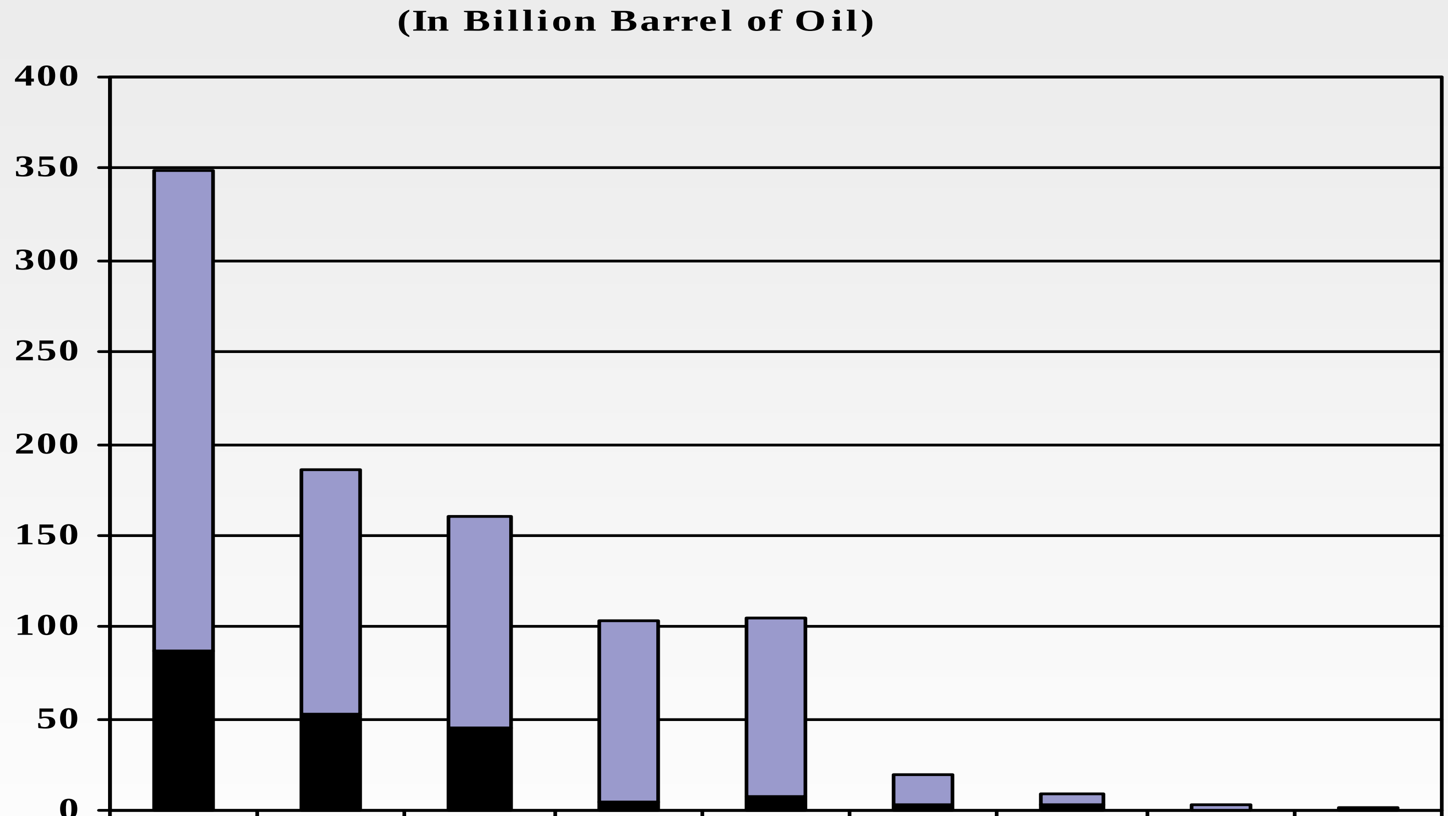
Middle East


Middle East
Turkey
Syria
Lebanon
Iraq
Iran
Tunisia
Morocco
Israel
Jordan
Kuwait
Libya
Western Sahara
Algeria
Egypt
Saudi Arabia
Bahrain
Qatar
U.A.E.
Mauritania
Oman
Sudan
Yemen

Defining the Terms

- **Reserves:**
  - **Proven:** the hydrocarbons that have been discovered and for which there is reasonable certainty that they can be extracted profitably.
  - **Undiscovered:** Quantities of crude oil that geological data and engineering information indicates exist outside known oil fields.
- **Production capacity:**
  - **Reference case:** EIA projection that is based on an oil price of $35/barrel.
  - **High price case:** EIA projection that is based on an oil price of $48/barrel.

Oil Reserves

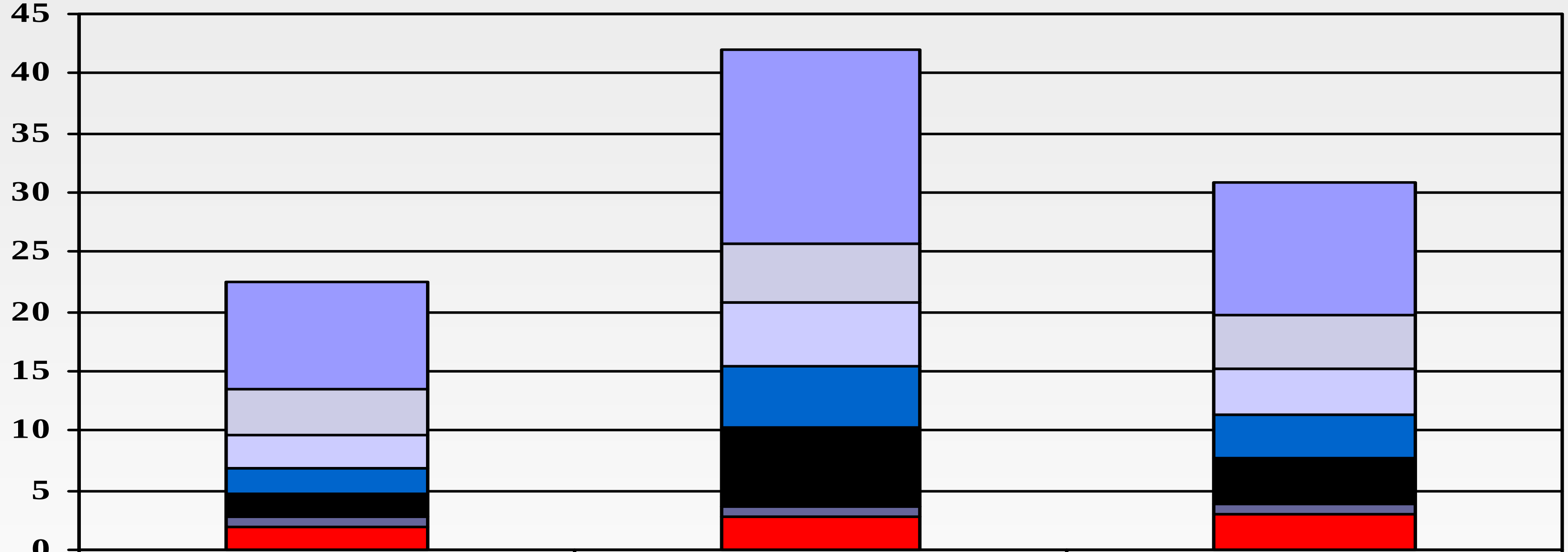


	Saudi	Iran	Iraq	Kuwait	UAE	Qatar	Oman	Neutral Zone	Bahrain
Proven	262.70	132.50	115.00	99.00	97.80	15.20	5.60	2.50	?
Undiscovered	87.09	53.11	45.10	3.84	7.70	3.62	3.45	0.00	0.90
% of World Proven	22.10%	11.10%	9.70%	8.30%	8.20%	1.30%	0.50%	0.10%	0.05%
% of World Undiscovered	11.90%	7.30%	6.20%	0.50%	1.10%	0.50%	0.50%	0.00%	0.10%

Source: BP 2005, USGS 2000, EIA 2005

Production Capacity

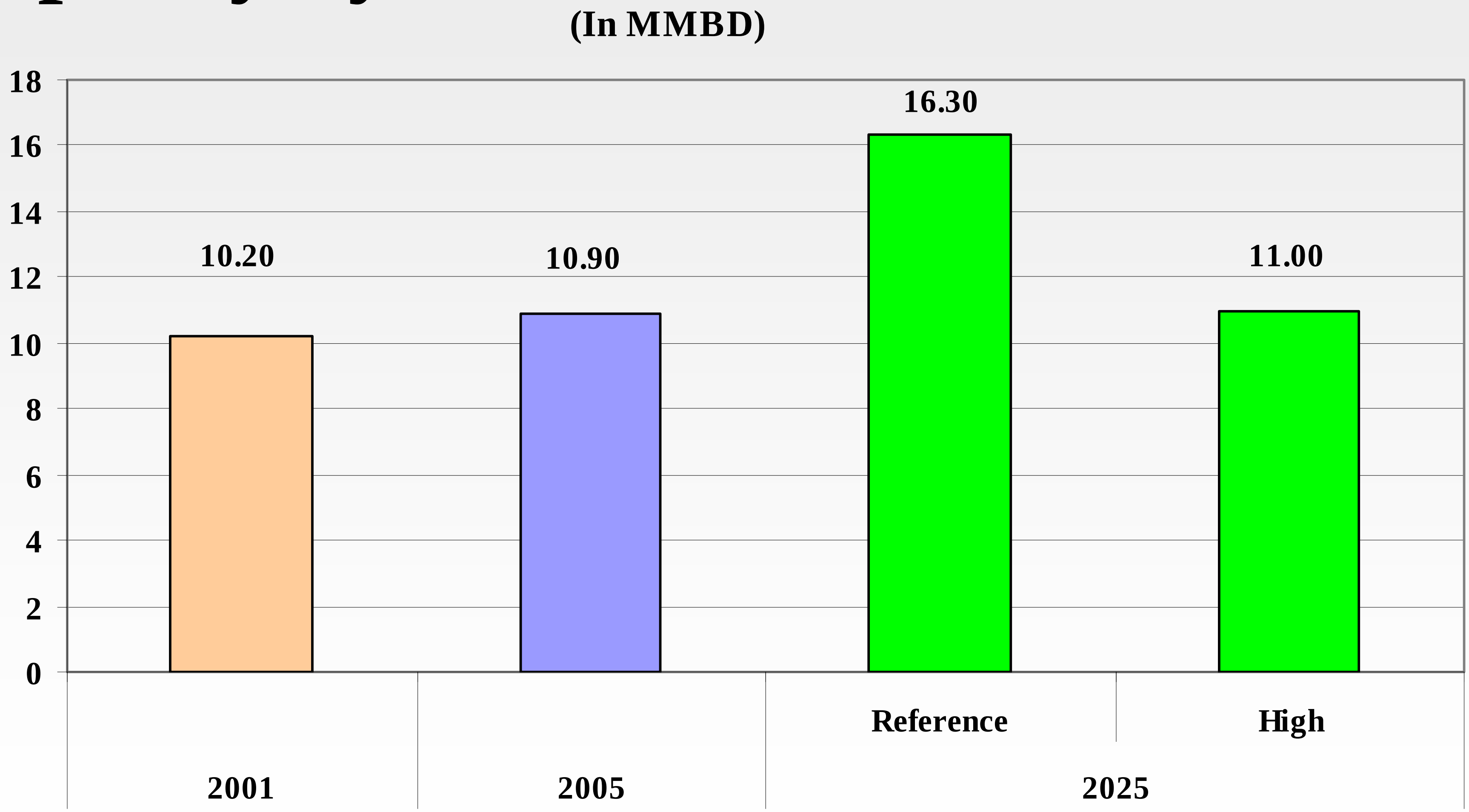
(In MMBD)



	2002	2025: Ref	2025: High
Saudi	9.2	16.3	11.0
Iran	3.7	5.0	4.5
UAE	2.9	5.4	4.0
Kuwait	2.1	5.2	3.5
Iraq	2.0	6.6	4.0
Qatar	0.8	0.8	0.8
Other	1.9	2.8	3.0
Total	22.6	42.1	30.8
% of World	28.30%	34.50%	26.70%

Source: EIA, IEO2005.

Importance of Saudi Production Capacity by Future Oil Price

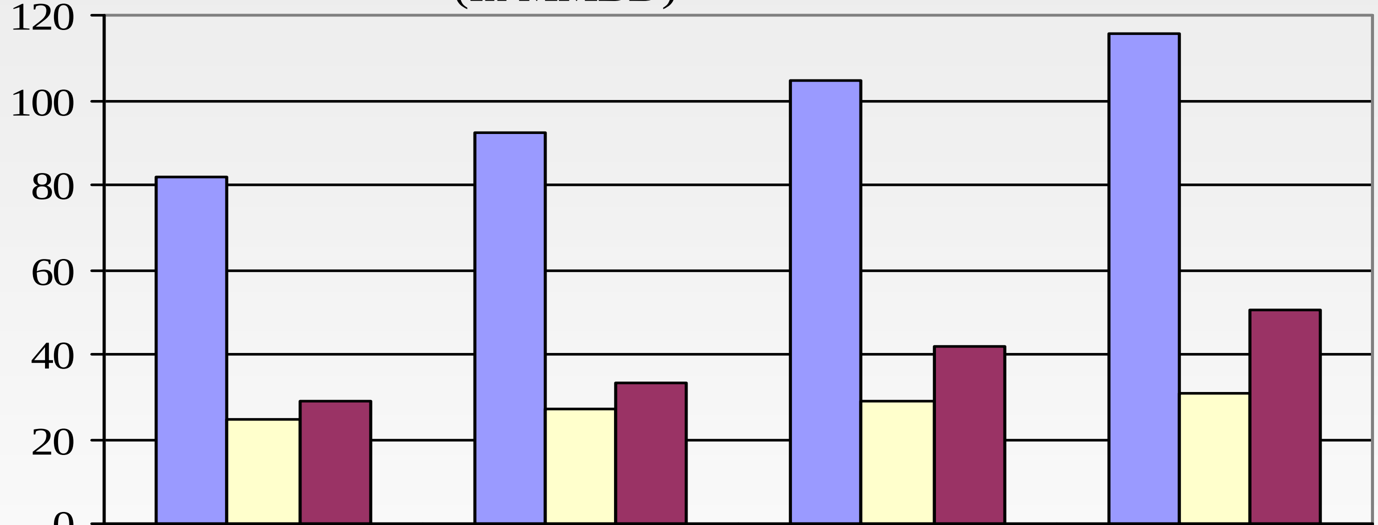


% of World Total: 13% 13% 14% 10%

Source: EIA, IEO2005.

World Dependence on MENA Oil Production: 2004-2030

(In MMBD)



	2004	2010	2020	2030
World Demand	82.1	92.5	104.9	115.4
North American Demand	24.9	26.9	29.1	30.6
MENA Production	29.0	33.0	41.8	50.5
Price Per Barrel	$36.0	$35.0	$37.0	$39.0
MENA as % of World	35%	36%	40%	44%
MENA as % of N America	116%	123%	144%	165%

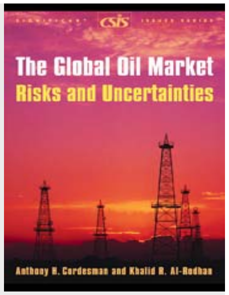
Source: IEA, World Energy Outlook 2005.

Strategic Challenges

- **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. The question, however, remains can the other southern Gulf states withstand such attacks.
- **Asymmetric threats to the strait of Hormuz and oil facilities:** The security challenges to the Gulf countries are to prevent attacks against oil infrastructure before they take place and reduce the damages when they occur.
- **Instability in Iraq:** The uncertainty in the 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.
- **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.
- **High unemployment rates:** Unemployed young men are a recruitment pool for extremist causes. The southern Gulf countries continue to heavily rely on foreign labor, this can be a real long term security threat.
- **The demographic "time bomb:"** In most of the Middle East, over 50% of the population is under the age of 30. This presents a real mid and long-term crisis in the economic, social, and security realms.
- **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 WMDS, 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 Developments

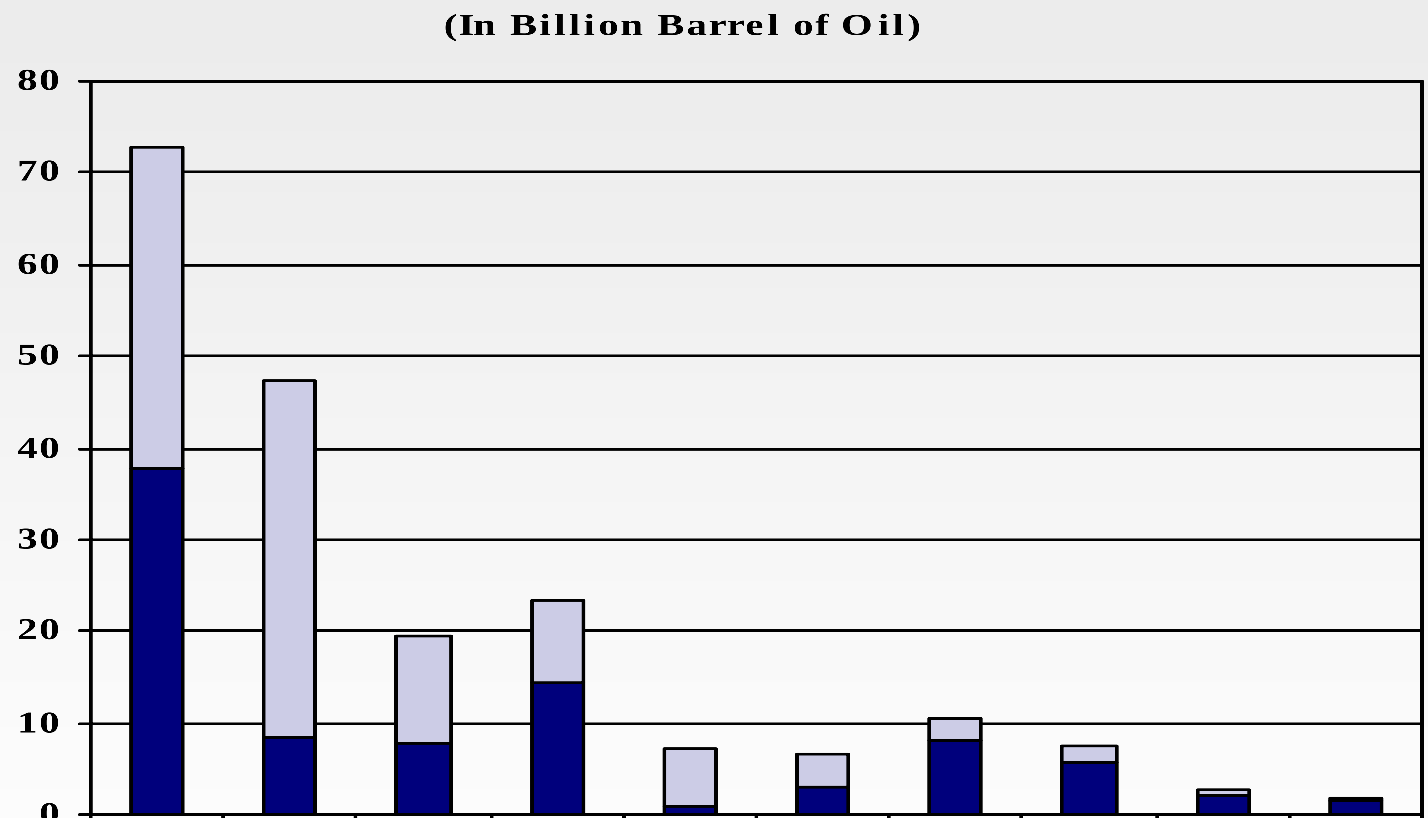
- **Natural depletion rates:** Some analysts argue that the depletion rates of major oil fields are higher than reported. The implications are that current reserve estimates production capacity may not also be what is being reported, and that fields with high depletion rates have a higher change of collapsing making extracting oil impossible.
- **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 specifically has a dozen giant and super-giant fields. Some of these fields are old and may have peaked. Are there other fields to large enough to replace these giant 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.
- **Limited spare production capacity:** With the exception of Saudi Arabia, in 2005, the other Gulf and Middle East countries have 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.


The Global Oil Market
Risks and Uncertainties
Anthony H. Cordesman and Khalid R. Al-Rodhan

Africa


Morocco
Tunisia
Western Sahara
Algeria
Libya
Egypt
Mauritania
Mali
Niger
Chad
Sudan
Eritrea
Sengal
Gambia
Guinea-Bissau
Guinea
Burkina Faso
Benin
Djibouti
Sierra Leone
Liberia
Ghana
Nigeria
Central African Republic
Ethiopia
Côte d'Ivoire
Togo
Cameroon
Somalia
Equatorial Guinea
Republic of the Congo
Uganda
Kenya
Gabon
Democratic Republic of the Congo
Rwanda
Burundi
Tanzania
Angola
Malawi
Zambia
Mozambique
Namibia
Zimbabwe
Africa
Madagascar
Botswana
Swaziland
Lesotho
South Africa

Oil Reserves



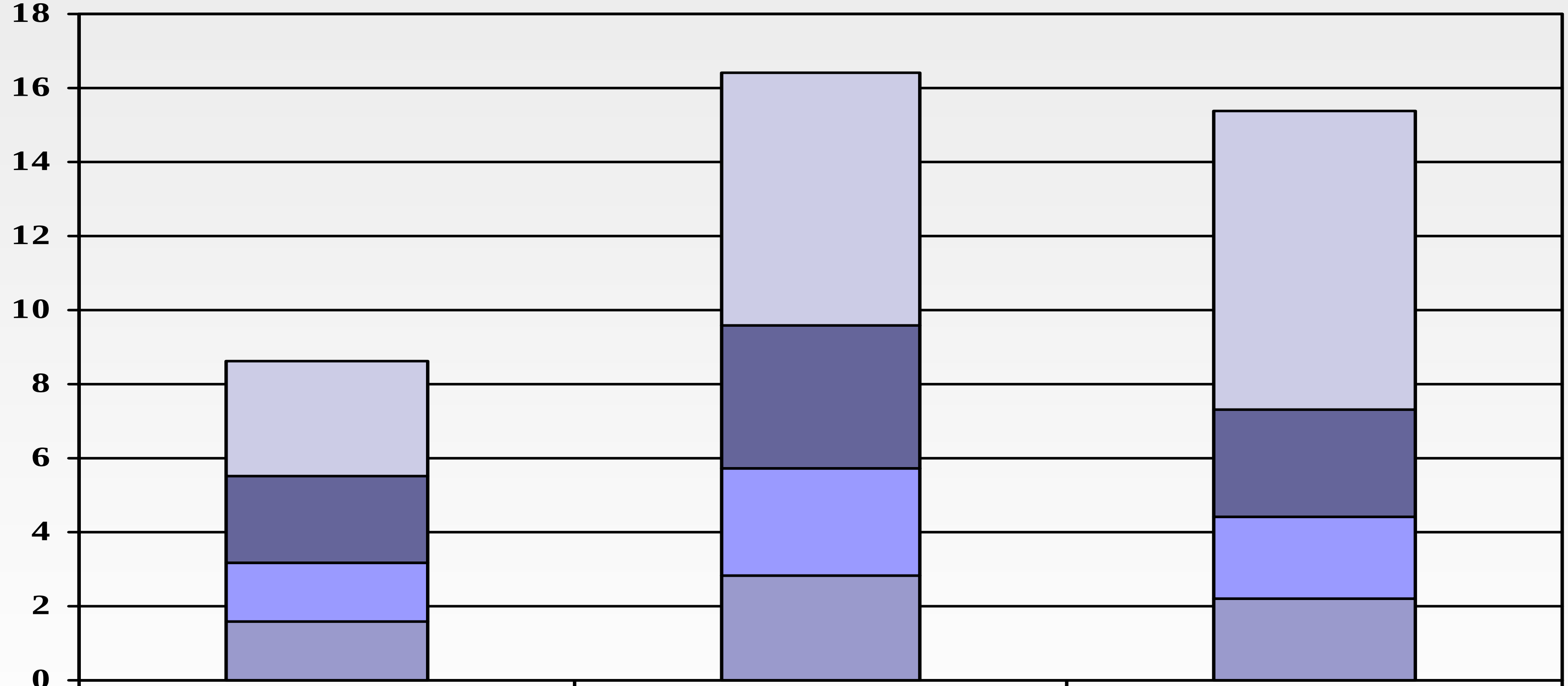
	Nigeria	Libya	Algeria	Angola	Sudan	Egypt	Gabon	Rep of Cong	Tunisia	Cameroon
Proven	35.30	39.10	11.80	8.80	6.30	3.60	2.30	1.80	0.60	0.20
Undiscovered	37.62	8.27	7.73	14.52	0.77	3.12	8.18	5.80	2.18	1.53
% of World Proven	3.0%	3.3%	1.0%	0.7%	0.5%	0.3%	0.2%	0.2%	0.1%	0.0%
% of World Undiscovered	5.1%	1.1%	1.1%	2.0%	0.1%	0.4%	1.1%	0.8%	0.3%	0.2%

Source: BP 2005 & USGS 2000

Africa

Production Capacity

(In MMBD)



	2002	2025: Ref	2025: High
Other	3.1	6.8	8.1
Nigeria	2.3	3.9	2.9
Libya	1.6	2.9	2.2
Algeria	1.6	2.8	2.2
Total	8.6	16.4	15.4
% of World	10.8%	13.4%	13.3%

Source: EIA, IEO2005.

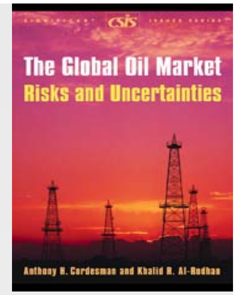
Strategic Challenges

- **The HIV/AIDS epidemic:** The continent of Africa continues to be threatened by the AIDS virus. Between 1981 to 2003, HIV/AIDS killed 20 million people. Almost 1600 children die of aids world wide, and at least 90% of them are African. This represents a 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. Outside powers must help local governments deal with phenomenon through training programs, sharing of intelligence, and assistance in patrolling their shores.
- **Lack of 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.
- **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.

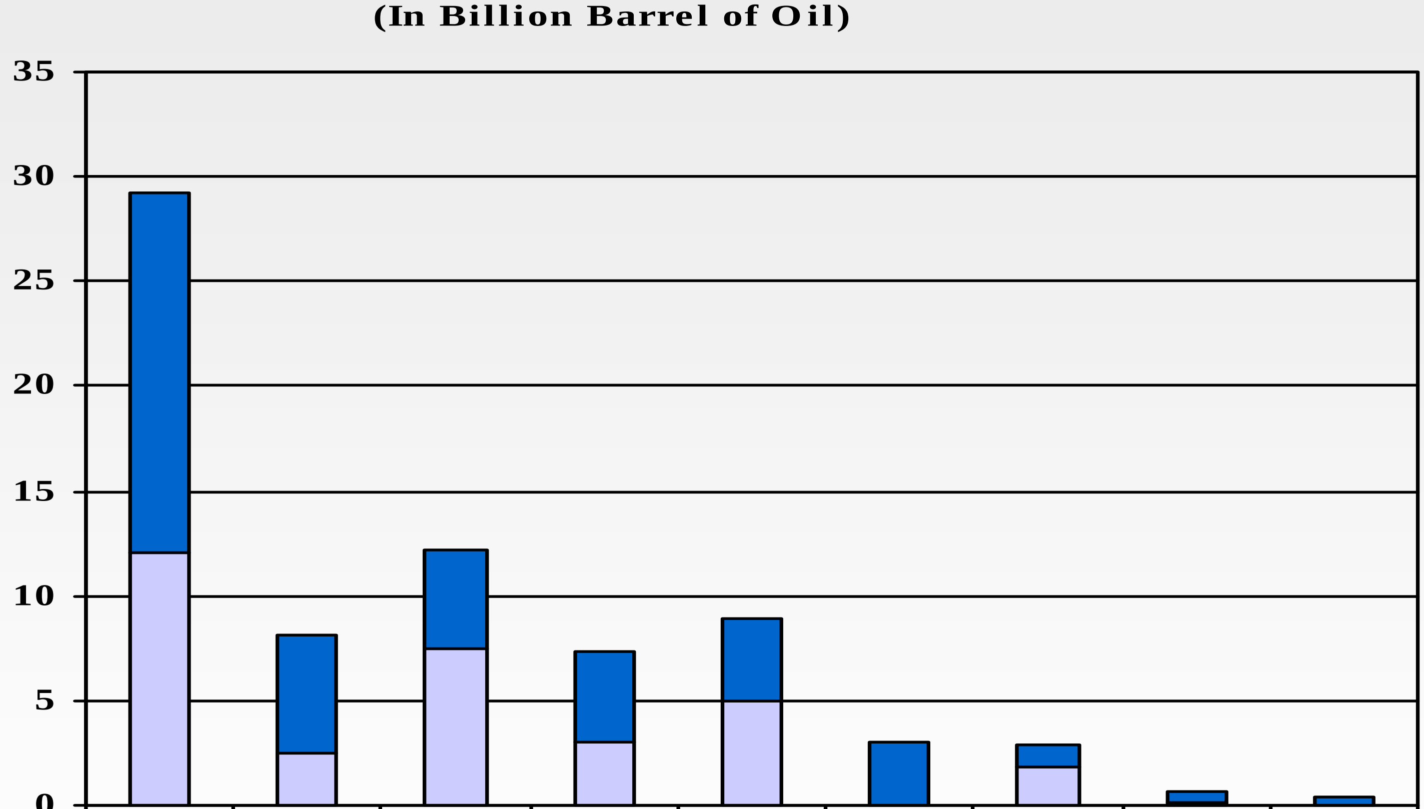
Production Developments

- **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, and the majority of the growth will come from Nigeria and Angola.
- **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.
- **Deep offshore facilities:** Most of the new discoveries are deep sea ones, and are mostly away from any social conflict, but pipelines and onshore oil facilities continue to vulnerable to rebel attacks.
- **Ethnic strife:** 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 environment and natural habitat. This problem, however, is often ignored.
- **Strikes and labor disputes, poor income distribution:** 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.

Asia & Pacific



Oil Reserves

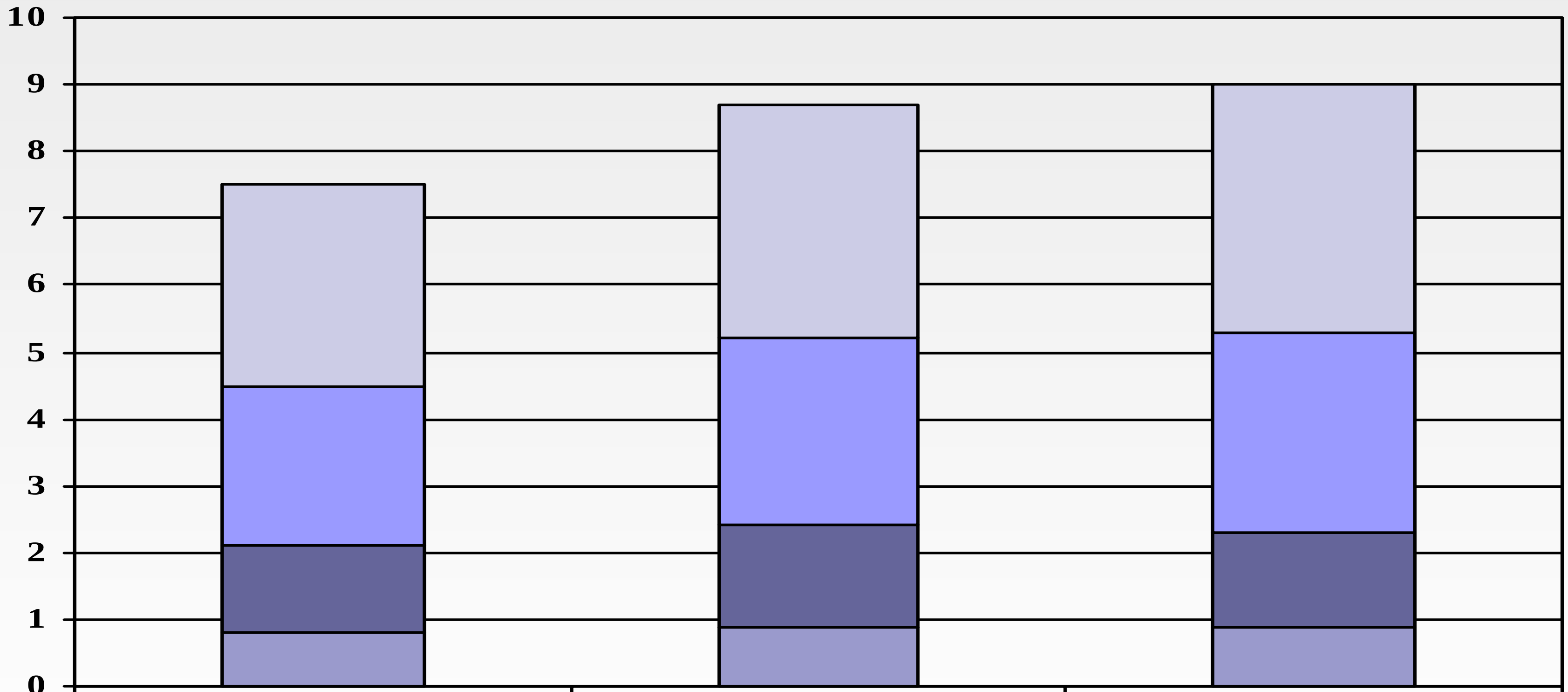


	China	India	Indonesia	Malaysia	Australia	Vietnam	Brunei	Thailand	Papua New Guine
Proven	17.10	5.60	4.70	4.30	4.00	3.00	1.10	0.50	0.40
Undiscovered	12.12	2.56	7.44	3.04	4.98	0.04	1.80	0.10	?
% of World Proven	1.4%	0.5%	0.4%	0.4%	0.3%	0.2%	0.1%	0.5%	0.5%
% of World Undiscovered	1.7%	0.3%	1.0%	0.4%	0.7%	0.0%	0.2%	0.0%	?

Source: BP 2005 & USGS 2000

Production Capacity

(In MMBD)



	2002	2025: Ref	2025: High
China	3.0	3.5	3.7
Other	2.4	2.8	3.0
Indonesia	1.3	1.5	1.4
Australia	0.8	0.9	0.9
Total	7.5	8.7	9.0
% of World	9.4%	7.1%	7.8%

Source: EIA, IEO2005.

The "China Syndrome"

	Total Consumption in 2002 (In MMBD)	Total Consumption in 2025			Increase 2002-2025		
		Low	Reference (In MMBD)	High	Low	Reference (In MMBD)	High
China	5.20	12.50	14.20	16.10	7.30	9.00	10.90
India	2.20	4.30	4.90	5.40	2.10	2.70	3.20
Other Asia	5.60	9.80	11.60	13.40	4.20	6.00	7.80
Sub-Total	13.00	26.60	30.70	34.90	13.60	17.70	21.90
Japan	5.30	5.00	5.30	5.60	-0.30	0.00	0.30
Australia/NZ	1.00	1.40	1.50	1.60	0.40	0.50	0.60
South Korea	2.20	2.60	2.90	3.40	0.40	0.70	1.20
Sub-Total	8.50	9.00	9.70	10.60	0.50	1.20	2.10
Total	21.50	35.60	40.40	45.50	14.10	18.90	24.00

Source: EIA, IEO2005.

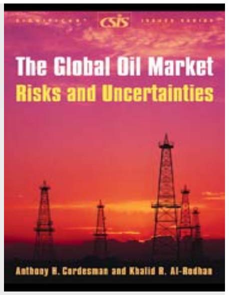
Strategic Challenges

- **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's 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 intricate US-China relations, it's unclear what the American response towards any Chinese aggression toward Taiwan.
- **India and Pakistan's nuclear stand off:** 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, terrorists 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 has gotten much attention. Moreover, India has been on the receiving end of much of the outsourcing. Poverty, HIV/AIDS, and ethnic clashes, however, continue to plague the subcontinent.

Production Developments

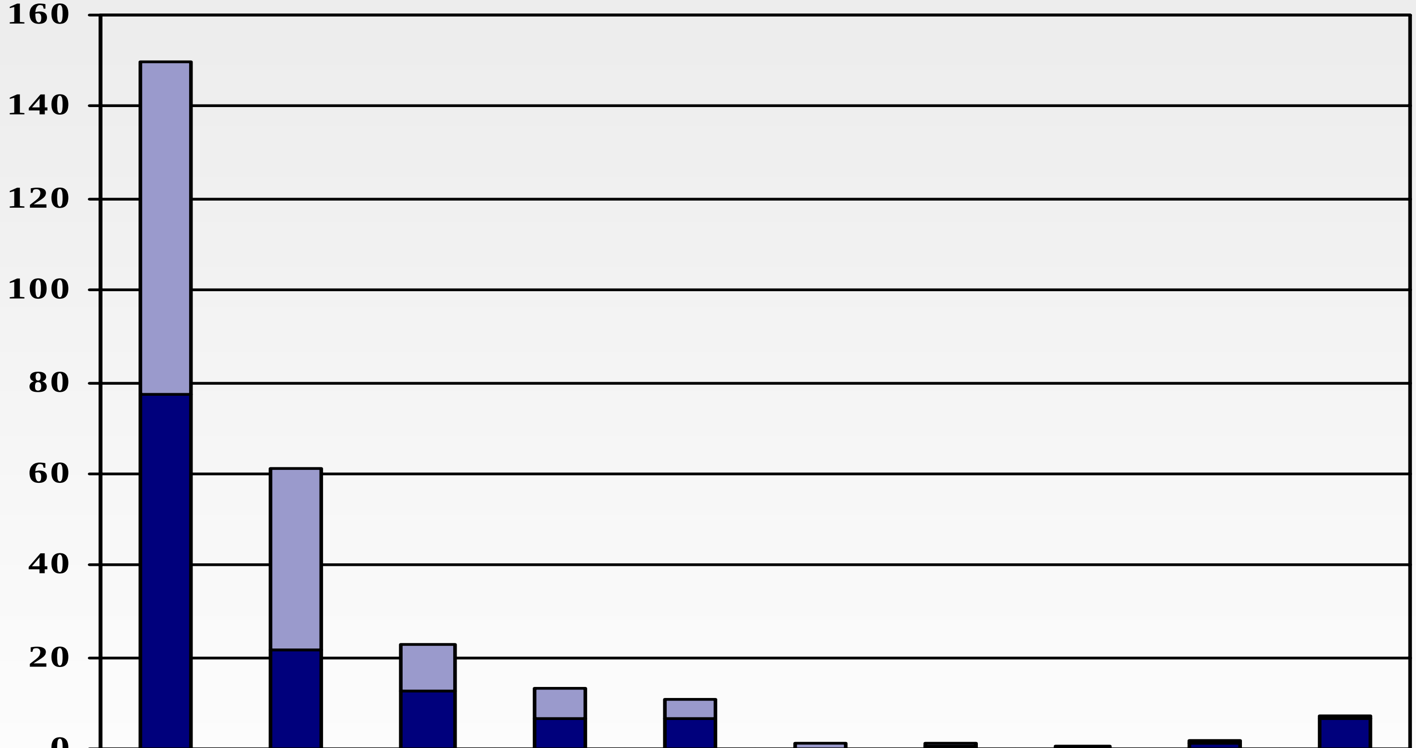
- **Territorial disputes:** China, the Philippines, Malaysia, Vietnam, Indonesia, Thailand, and Brunei continue to contest the ownership of off shore natural resources in the South China sea. These disputes limit development and have added to the uncertainty of the nature of resources.
- **Rugged Terrain:** 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.
- **Natural depletion:** Efforts have been made to prolong the life of existing fields in South East 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).
- **Chinese exploration:** 9% Chinese oil production capacity 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. Having begun production 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 0.24 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 0.08 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.

Europe & Eurasia



Oil Reserves

(In Billion Barrel of Oil)

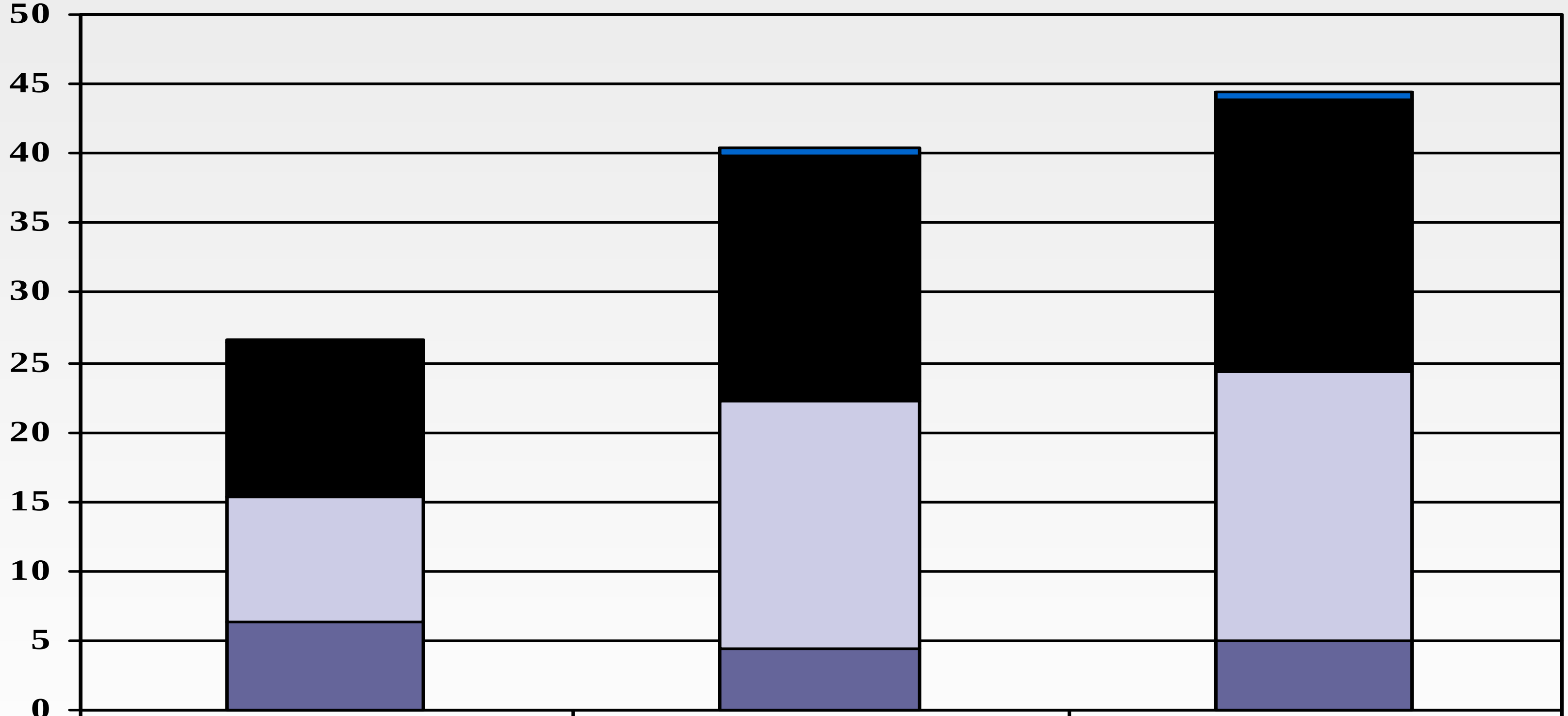


	Russia	Kazakhstan	Norway	Azerbaijan	UK	Denmark	Italy	Uzbekistan	Romania	Turkmenistan
Proven	72.30	39.60	9.70	7.00	4.50	1.30	0.70	0.60	0.50	0.50
Undiscovered	77.38	21.33	12.88	6.31	6.33	0.10	0.37	0.14	1.07	6.84
% of World Proven	6.1%	3.3%	0.8%	0.6%	0.4%	0.1%	0.1%	0.1%	0.1%	0.1%
% of World Undiscovered	10.6%	2.9%	1.8%	0.9%	0.9%	0.0%	0.1%	0.0%	0.1%	0.9%

Source: BP 2005 & USGS 2000

Production Capacity

(In MMBD)



	2002	2025: Ref	2025: High
Eastern Europe	0.2	0.5	0.5
FSU	11.2	17.6	19.6
Caspian Sea	9	17.8	19.4
North Sea	6.3	4.5	4.9
Total	26.7	40.4	44.4
% of World	33.4%	33.1%	38.4%

Source: EIA, IEO2005.,

Strategic Challenges

- **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 scientist due to poverty and lack of job opportunity could be allured to help rogue states or terror organizations acquire nuclear weapons.
- **Political instabilities:** 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's 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:** Investigation of the 9/11 attacks and the Madrid bombing has shown that the existence of 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's a lack of assimilation of immigrants with the general population.

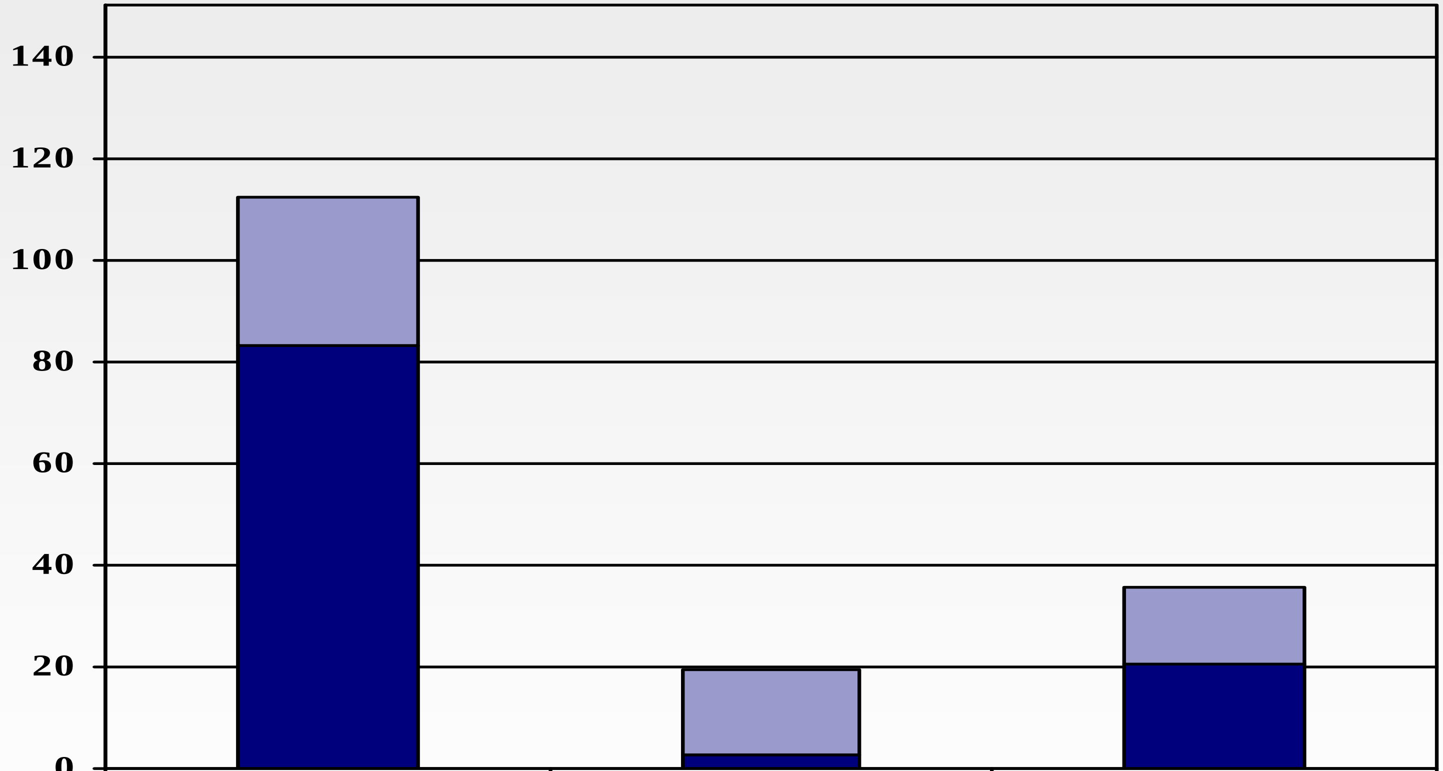
Production Developments

- **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 0.64 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.
- **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.
- **Barents Sea exploration resumption:** There has 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.
- **The UK's maturing oil fields:** 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 variable."

North America

Oil Reserves

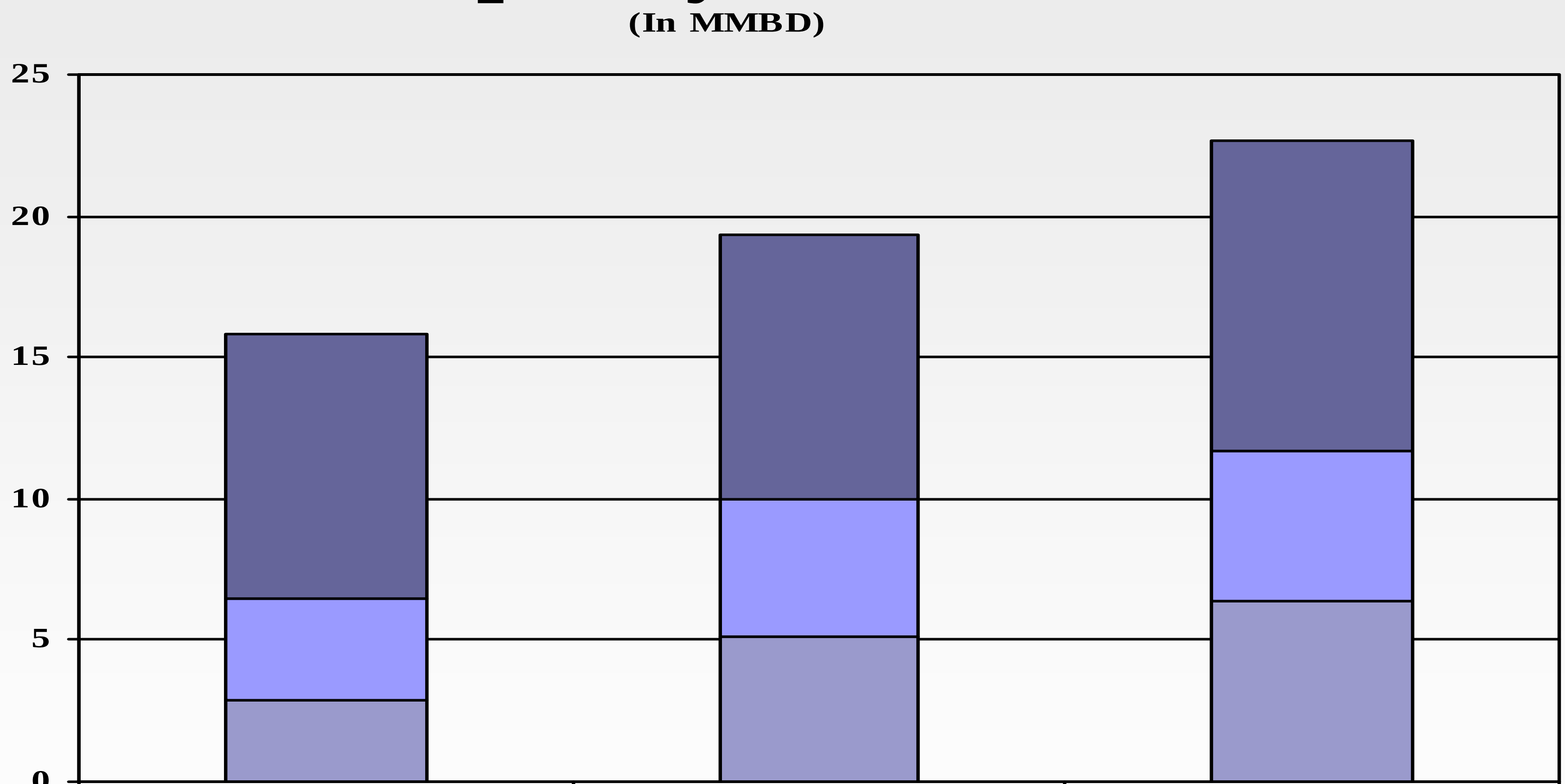
(In Billion Barrel of Oil)



	USA	Canada	Mexico
Proven	29.4	16.8	14.8
Undiscovered	83.0	2.8	20.6
Tar-Sands/Shale	1,600	175	?
% of World Proven	2.5%	1.4%	1.2%
% of World Undiscovered	4.0%	2.3%	2.0%

Source: BP 2005 & USGS 2000

Production Capacity



	2002	2025: Ref	2025: High
US	9.3	9.3	11.0
Mexico	3.6	4.9	5.3
Canada	2.9	5.1	6.4
Total	15.8	19.3	22.7
% of World	19.8%	15.8%	19.7%

Source: IEO 2005, EIA

Strategic Challenges

- **Homeland Security:** Following the 9/11 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.
- **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 deals with not only enforcing the laws but dealing 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 the 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 run. 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.

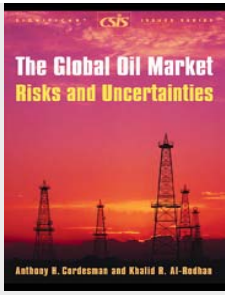
Production Developments

- **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, Cantarell, with an estimated 35 billion barrels of oil witnessed a decline in the 1990s. Premex 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 had predicted that Cantarell's decline would 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, which mean 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, in 2004, hurricane Ivan caused disruptions in production.
- **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 lie within the Ugnu, West Sak and Schrader Bluff formations. Largest source of potential oil is the heavy oil formations near main producing zones at Prudhoe and Kuparuk.

Canadian Energy Resources

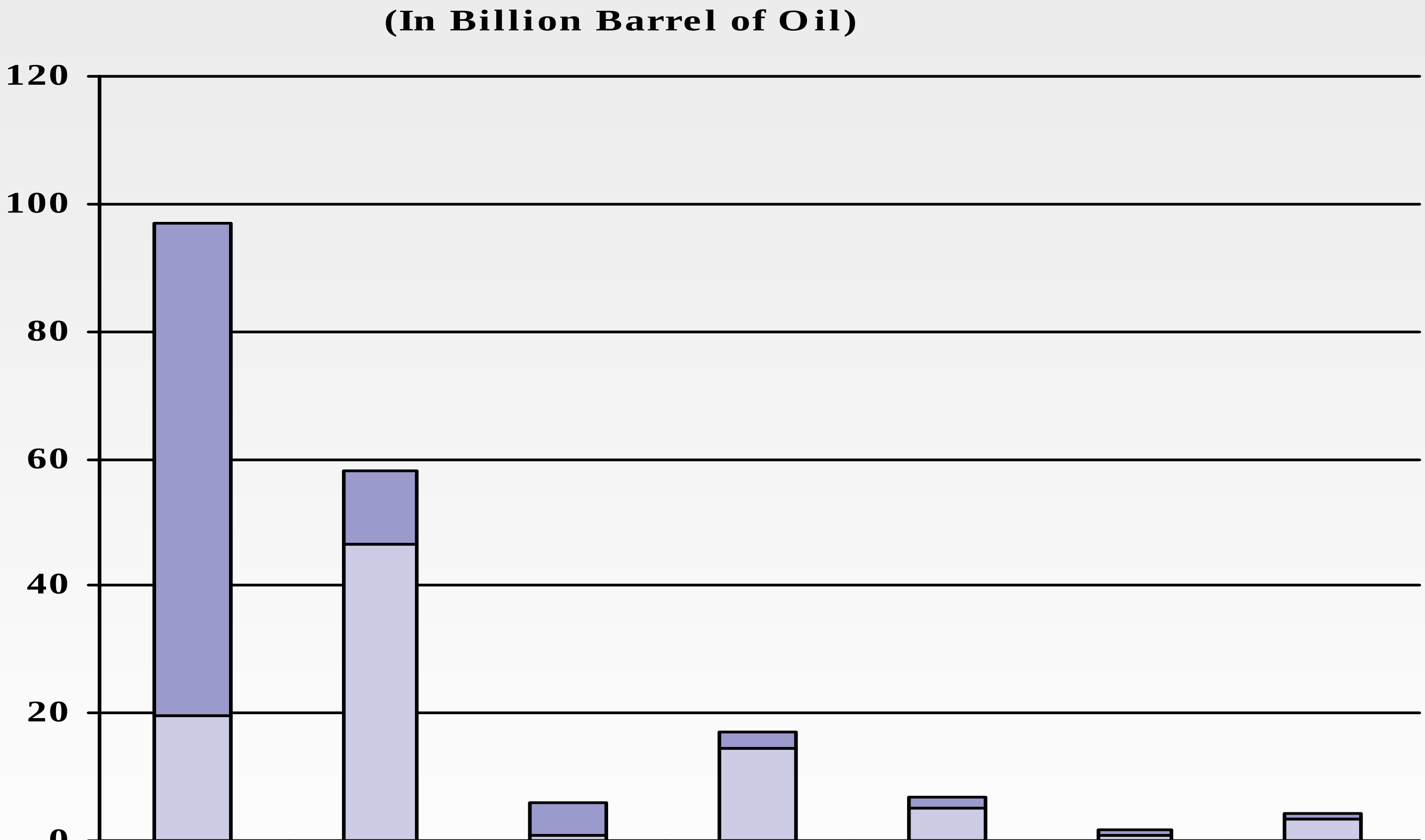
- "New" sources of liquid fuels include coal liquifaction, gas liquifaction, biomass, natural generation, oil shale and tar sands.
- Canada claims 179 billion barrels in tar sands, second only to Saudi Arabia
- Largely certified by National Energy Board and Alberta government (175 billion barrels).
- Already have invested $US 28 billion during 1996, and producing more than 1.0 MMBD.
- Expect $US 36 billion more invested during 2005-2010, and production to rise to 2.7 MMBD.
- Current production costs are $8-13 bbl for Bituman; $18-23 bbl for synthetic light oil.
- Extraction from mining and upgrading produces 20% recovery.
- Steam assisted gravity drainage (SAGD) and solvents expected to produce 80% ultimate recovery.
- **EIA forecast of Canadian energy production:**
  - The "High B" Case examines $43-$48 bbl oil.
  - This case reduces the growth in US import dependence substantially. Is now 56%. Reference price case raises to 68% in 2025; "High B" case keeps at 58%.
  - EIA largely accepts 175-179 billion barrels of Canadian tar sands reserves; issue is cost of production and upgrading.
  - Role of Canadian tar-sands is critical. Total production is estimated to rise from around 1.0 MMBD today to 3.5 MMBD in 2025 in *Reference Case*, and 4.7 MMBD in *High B Case*.
  - Rise in production matched by conversion from largely bitumen to largely synthetic liquids.

S&C America


The Global Oil Market
Risks and Uncertainties
Anthony H. Cordesman and Khalid R. Al-Rodhan


Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Brazil
Peru
Bolivia
Chile
Paraguay
Uruguay
Argentina
South America
Falkland Islands

Oil Reserves

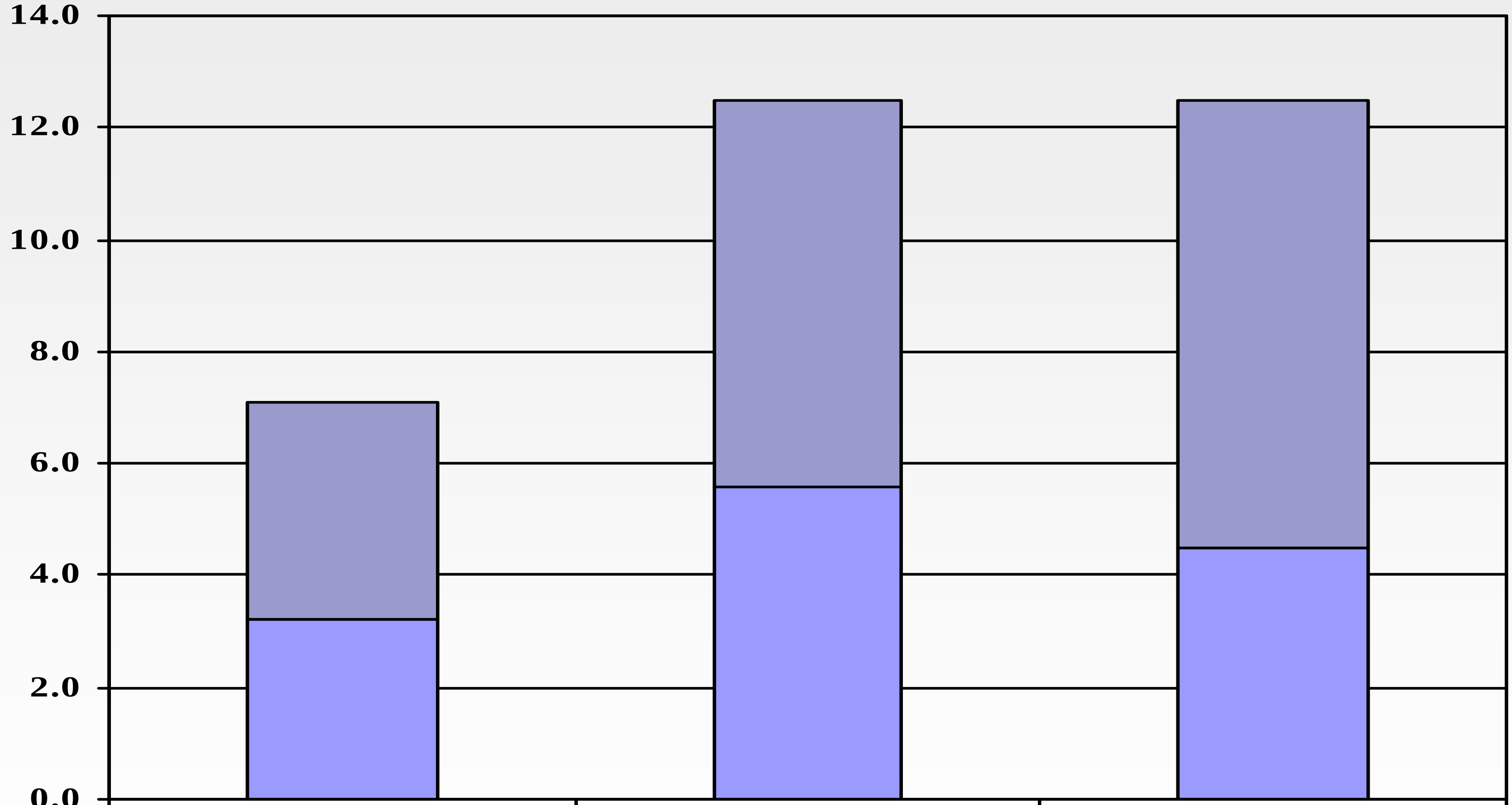


	Venezela	Brazil	Ecuador	Argentina	Colombia	Trinidad	Peru
Proven	77.20	11.20	5.10	2.70	1.50	1.00	0.90
Undiscovered	19.66	46.75	0.97	14.52	5.12	0.76	3.32
% of World Proven	6.5%	0.9%	0.4%	0.2%	0.1%	0.1%	0.1%
% of World Undiscovered	2.7%	6.4%	0.1%	2.0%	0.7%	0.1%	0.5%

Source: BP 2005 & USGS 2000

Production Capacity

(In MMBD)



	2002	2025: Ref	2025: High
Other S America	3.9	6.9	8
Venezuela	3.2	5.6	4.5
Total	7.1	12.5	12.5
% of World	8.9%	10.2%	10.8%

Source: IEO 2005, EIA

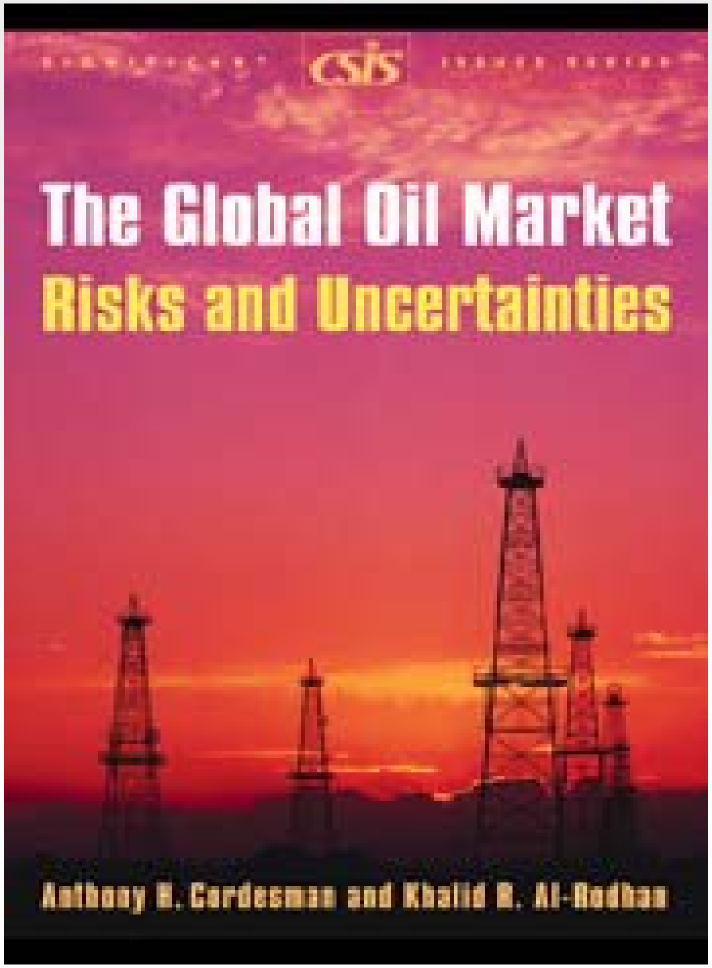
Strategic Challenges

- **Narcotic trafficking:** Illegal drugs continue to plague the continents. Rebel groups have been a destabilizing force to the region. The lack of security and uncertainty have 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 foreseeable future.
- **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. Many experts believe that the problem is not with political instability per say, but rather with the Chavez's government relationship with the US. Those experts argue that in the short-term, the Chavez government is politically stable. It remains uncertain how recent high oil prices and oil revenues can influence the domestic political systems, and vice versa.
- **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 haven in Latin American due to its proximity to the US and the ability to use illicit drug trafficking to finance their operations.
- **Weak domestic institutions and laws:** Countries such as Colombia and Peru suffer from weak judicial institutions. This has added to the uncertain nature of doing business in South America.
- **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 by weak political institutions.

Production Developments

- **Venezuela heavy oil reserves:** Venezuela has 77.2 billion barrels of proven conventional oil reserves, the largest amount in the Western Hemisphere. This estimate, however, does not include substantial extra-heavy and bitumen deposits, which could be as high as 270 billion barrels.
- **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.
- **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 demand and imposing pressure on limited domestic supply.
- **Colombia's declining oil production:** Colombia's oil production has decreased in early 2004 by 6%. 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 Colombia. These two developments in addition to the lack of any new discoveries may, according to the president of Colombia, force Colombia to become an oil importer.
- **Exploration in Brazil:** There has 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.
- **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 1.0%-16.6% and granted PdVSDA at least 51% stake in any project regarding exploration, production, transportation and initial storage of oil.

Conclusions



Lack of Robust Modeling

- **Parametric analysis:** The lack of a full range parametric analysis in energy models and forecasts. 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:** Models do not reflect sufficient explorations of 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.
- **Country plans:** Models normally do not take into account country-by-country plans in forecasting oil production capacity. When 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:** Models and reports on oil and gas exports 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:** Models do not explicitly analyze the impact of technological improvements in national oil and gas production and export capacity.
- **Supply and demand elasticities:** Little effort is made to explain, justify, and parametrically model 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.

Crisis of Evolving Solutions?

- **Energy infrastructure Security:** There is no bullet-proof security system. Ethnic strife in Nigeria, insurgency in Iraq, and ongoing threat of asymmetric attack in the Gulf will continue to threaten energy facilities.
- **Health of global economy:** The US and other industrialized countries are increasingly dependent on the health of the global economy, and the health of the global economy is increasingly dependent on energy prices.
- **Mid and long-term regional instability:** The rest of the oil producing regions are not more stable than the Gulf.
- **Increasing dependence:** There is no meaningful near and mid-term options that will allow the world to reduce dependence on the MENA region's energy exports in any meaningful strategic sense.
- **Higher demand:** The surge in oil demand will continue: China, India, & the rest of Asia will at least double—developing Asia will grow from 13.0 MMBD to 30.7 MMBD; Russia, Africa and Middle East will increase by 60%; US demand will increase by 40%, and Western Europe and Japan will plateau.
- **Sustainable capacity:** The oil market is out of any spare capacity with the exception of Saudi Arabia's 1.0-1.8 MMBD. The market needs to build more cushion to meet future surges in demand or cuts in supply.
- **Investment:** Oil infrastructure in most developing countries is aging and needs to be upgraded. The public sector in these countries, however, cannot afford large capital investment. The flow of foreign and domestic private investments is essential to insuring reliable supplies of energy.
- **Price volatility:** The global energy market is all too aware of geopolitical risks and economic uncertainties, which is reflected in recent price fluctuations.