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# **Global Energy, Economic Interdependence, Iraq And the Gulf**

**Anthony H. Cordesman**

**Arleigh A. Burke Chair**

**Revised: September 2007**

# Scoping the Problem

- **Not every "catastrophe" is a catastrophe. Short-term problems can lead to long-term gains. Turbulence, panics, price rises, interruptions = substitutions, new technologies, diversification, conservation and efficiency.**
- **Supply shortfall models are outdated, very uncertain, and very sharply by country.**
- **Many key security decisions are domestic: Nuclear, coal, conservation, social policy, environmental issues, efficiency, stockpiles, level of dependence on single energy sources.**
- **Not a "zero sum game" between consuming nations or consumers and suppliers: Global interdependence means energy must be shared to sustain trade, and exports. Cheaper to cooperate and rely on market forces than compete or fight.**
- **Energy costs as a percentage of total GDP, or in terms of economic dependence, leave considerable elasticity.**
- **A very unpleasant present could have serious political and economic costs, but could mean a better future.**

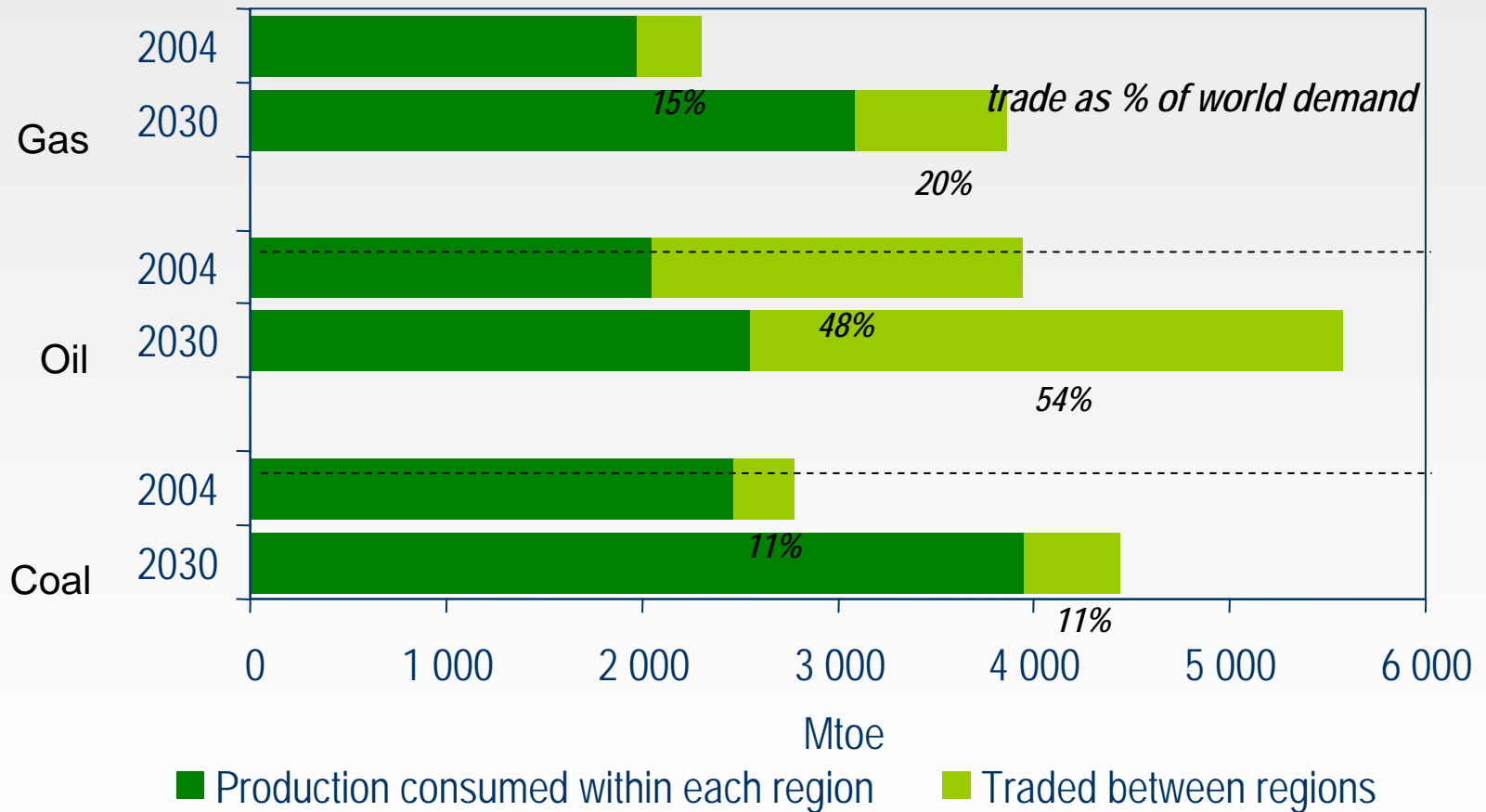
# The 19th Century Myth of Global Resource Competition

- **The world does not run out of oil and gas, it simply becomes progressively less affordable.**
- **No mechanism for global trade and globalism works better than open market prices for exports.**
- **Substitution effects work best if price driven, with limited intervention by governments.**
- **Demand-driven high prices are fair prices.**
- **The World adapts over time.**

# Reality is Global Interdependence

- **Major industrialized states and emerging economies dependent on global trade.**
- **US and Europe “import” oil through Asian manufactures.**
- **Global stability dependent on global economic growth and stability.**
- **Environment, Supply, Conservation, Efficiency evolve forward on global basis.**
- **Market forces most efficient and secure method of pricing and distribution for all major powers.**

# World Fossil Fuel Supply: The Globalism Factor



Source: IEA, World Energy Outlook, 2006

# The Challenge of ‘Elasticity

- **Elasticity in demand:** Economic growth, response to price, global economic conditions.
- **Elasticity in supply:** Quantity, price, and comparative advance of petroleum, gas, coal, nuclear and other
- **Elasticity in Conservation:** Ability to reduce demand in current uses of energy and through social change. Which are gaining influence?
- **Elasticity in Efficiency:** Ability to reduce demand for energy and achieve the same output.

# Sudden change or long slope toward rising scarcity?

- Sudden critical changes tend to breed more tension and conflict.
- Slow rises in scarcity lead to market-driven and substitution responses.
- E.g. running out of oil: Have been running out since before anyone here was born, but actual major shortfalls have been very different.
- Substitution, however, is time and cost sensitive. Can't change housing, workplace, public transportation, or vehicle fleets quickly.
  - Even more true of social behavior and values.
- National security interests create different sensitivities.
  - Some Chinese literature sees future oil crisis in these terms.
  - “Horse blinders” are also a problem. May not look in right place for alternatives or focus too narrowly on one aspect of resource.
- Technology is a predictive nightmare.
  - Always get availability, cost, effectiveness. Comparative desirability wrong.
  - By definition, cannot predict a technological breakthrough, although they do occur.

# Crisis points or substitution effects and social and economic change?

- Major global shortage of whale oil has been real. Past concerns with strategic metals, oil have not been. Neither has mattered
- Marginal value of resources changes radically in cost and use as resources become more scarce.
- Substitution effects come from scarcity but also technological change and other factors.
- Efficiency and conservation are key options, but are driven by economic realities and not ideology, social and political goals, or anticipation.
- Mid and long term elasticities are extremely difficult to predict.
- Many key shifts in resources involve complex social and economic shifts, not simply shifts in direct use of resource.
- Housing patterns and residential distance from work versus gas mileage.
- Drinking water vs. agricultural imports

# Driven by Geopolitics/Geoeconomics or Market Forces?

- Even market-driven adaptation can be very unpleasant, particularly for the most dependent and poorest nations.
  - No one ever really runs out of anything, it simply becomes progressively more unaffordable.
- Globalism does not make life fair, it simply does a better job of rewarding the successful.
- Does not really matter whether multinational, state/state company, or private entity if collectively react to market driven forces.
- Historically, conflict occurs when **perceived** scarcity leads to geopolitical or geoeconomic concepts that **can** lead to conflict.
- Greed, ambition, nationalism have historically been more of a source of conflict and tension than actual scarcity.
  - Japanese scrap Iran and oil crises of 1941.
  - Synfuels versus oil access in World War II.

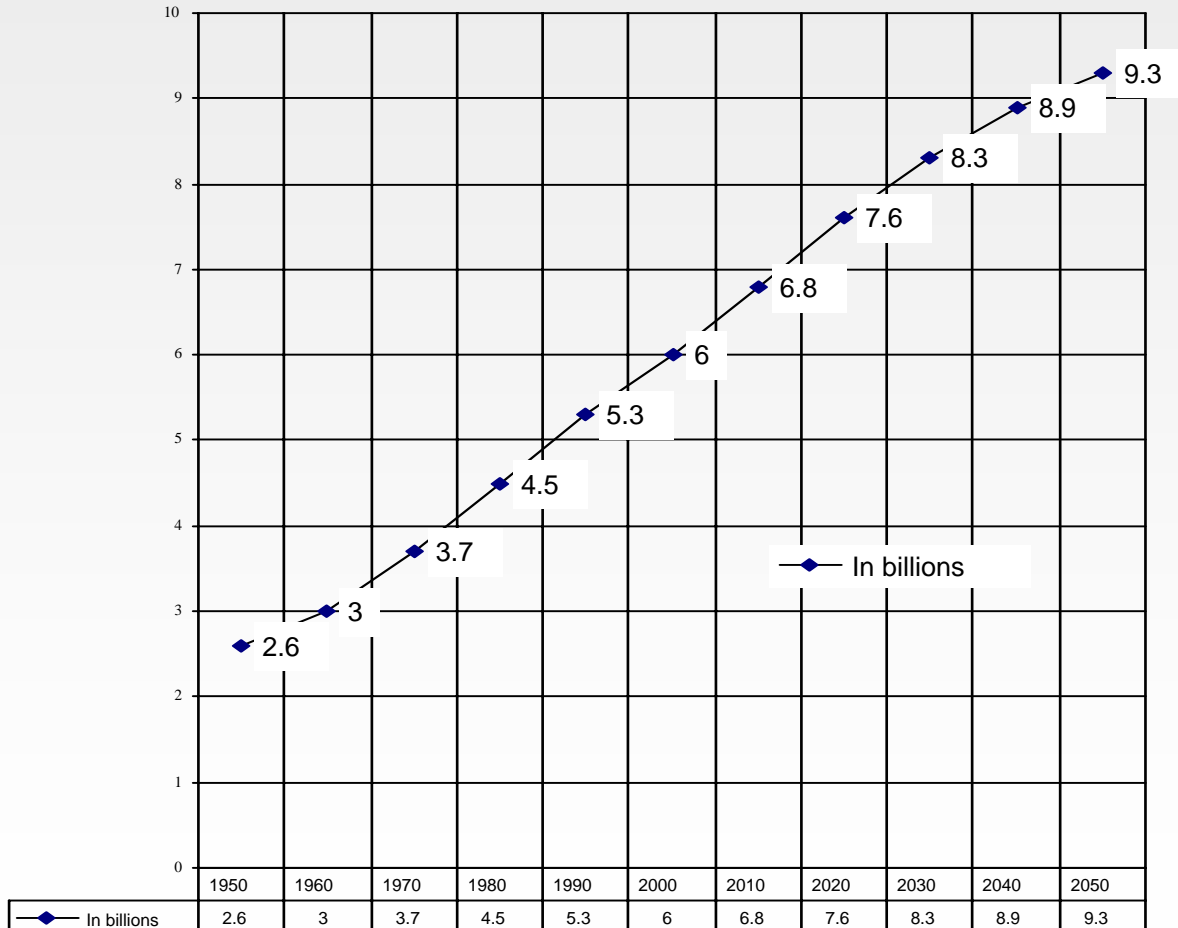
# Elasticity in Demand

# Resource Limits or Demographic Pressure?

- **Global and local/regional population growth are a key factor putting pressure on resources. Growth estimates are slowing, but still of major impact.**
- **Globalization, hyperurbanization, development, and rising living standards are equal pressures. In broad terms, resource pressure increased with national and personal income.**
- **Emerging powers and regions like China, India, SE Asia create combined pressures on resources.**
- **As the past shows, existing uses of resources are virtually never viable unless they reach a stable, long-term equilibrium, which is the exception and not the rule.**

# Demographic Pressure

(U.S. Census Bureau Estimate of World Population in Billions)

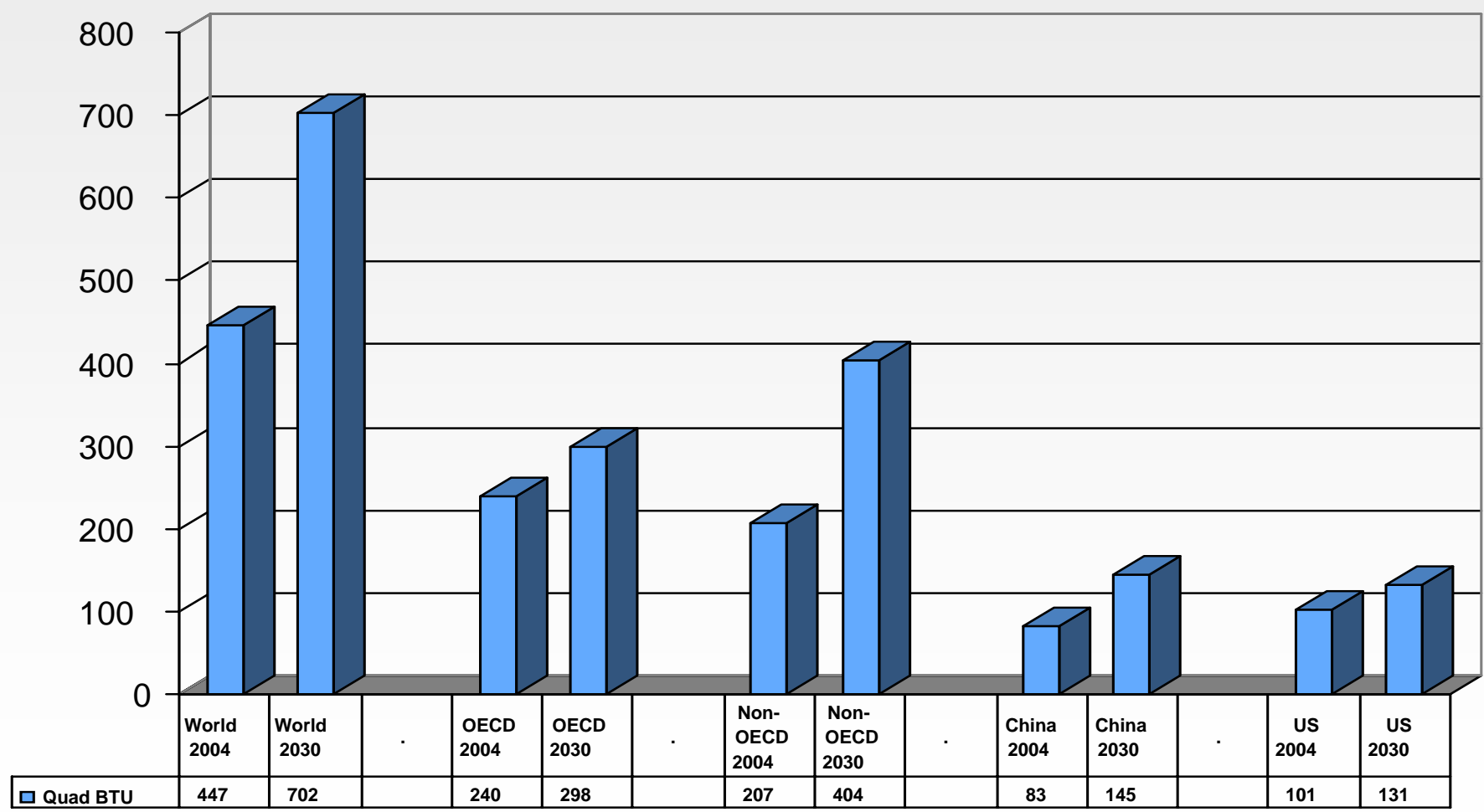


# Demographic Dynamics

- **3 billion total in 1959,**
- **6 billion total in 1999: +100% in 40 years**
- **Grow to 9 billion by 2042: +43% in 50 years**
- **Growth rate projected to drop from pace of 2% in 1960s to 1% by 2020, 0.5% by 2050. (Maybe!)**
- **Annual increment dropping from 88 million in 1990 to 78 million in 2020 to 47 million in 2050.**
- **80% of growth in 2007-2027 projected to be in poor countries.**
- **Nearly 50% of growth occurs in 8 countries, only one of which is developed.**
- **51 countries lose population by 2025, and “age.” 25% of Western Europe will be 65 or over, vs. 4% in Sub-Saharan Africa.**
- **By 2025, urbanization will reach 60% of population -- 3.9 billion.**
- **Source: US Census Bureau, World Population estimates, and CSIS, Seven Revolutions**

# Growth of Global Energy Demand

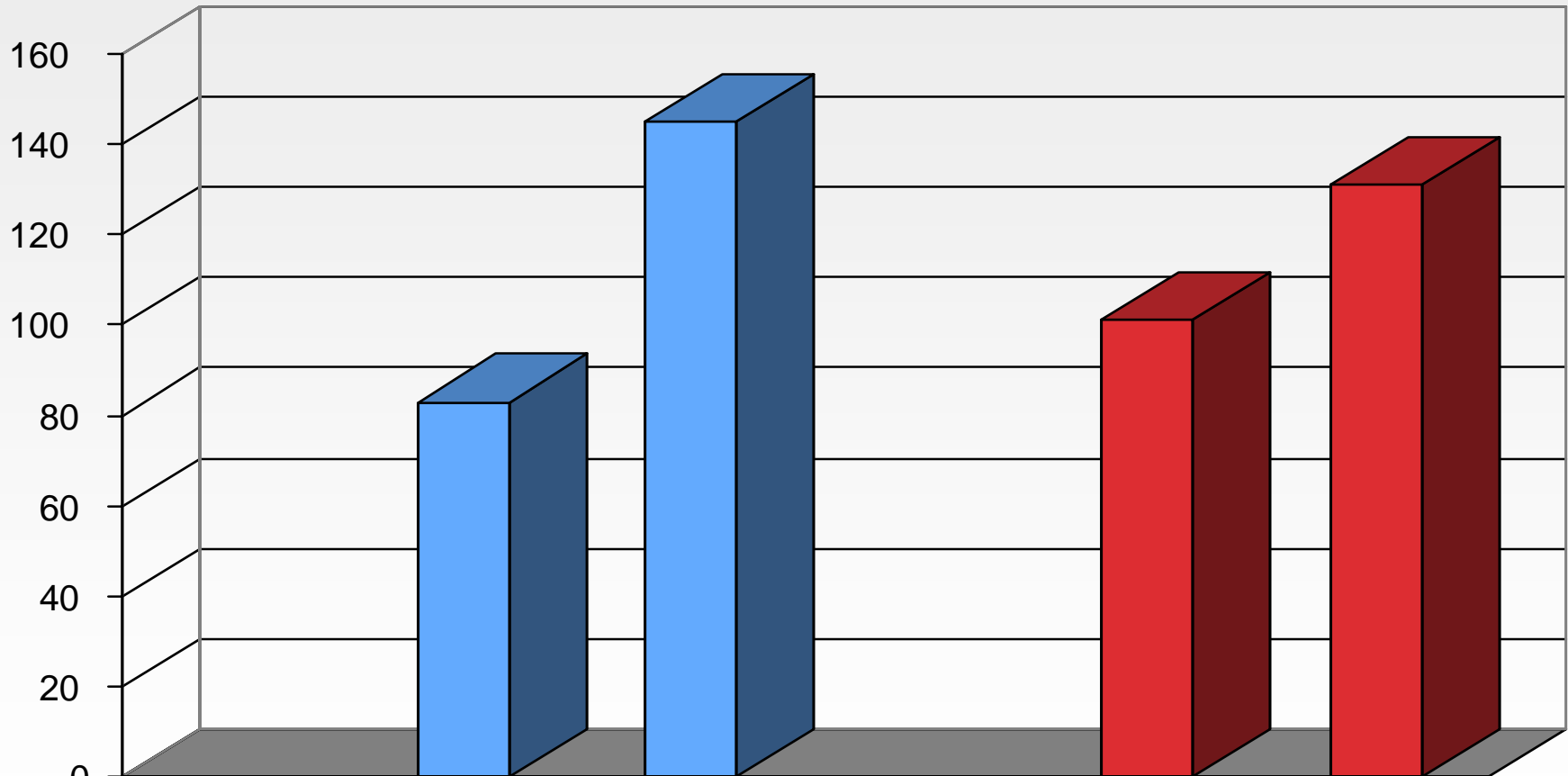
## Consumption of Energy in Quadrillion BTUs: 2004 vs. 2030



Adapted from DOE/EIA, IEO 2007, Table A1 Reference Case  
 . In Quadrillions of Btus.

# Growth of China and US Energy Demand

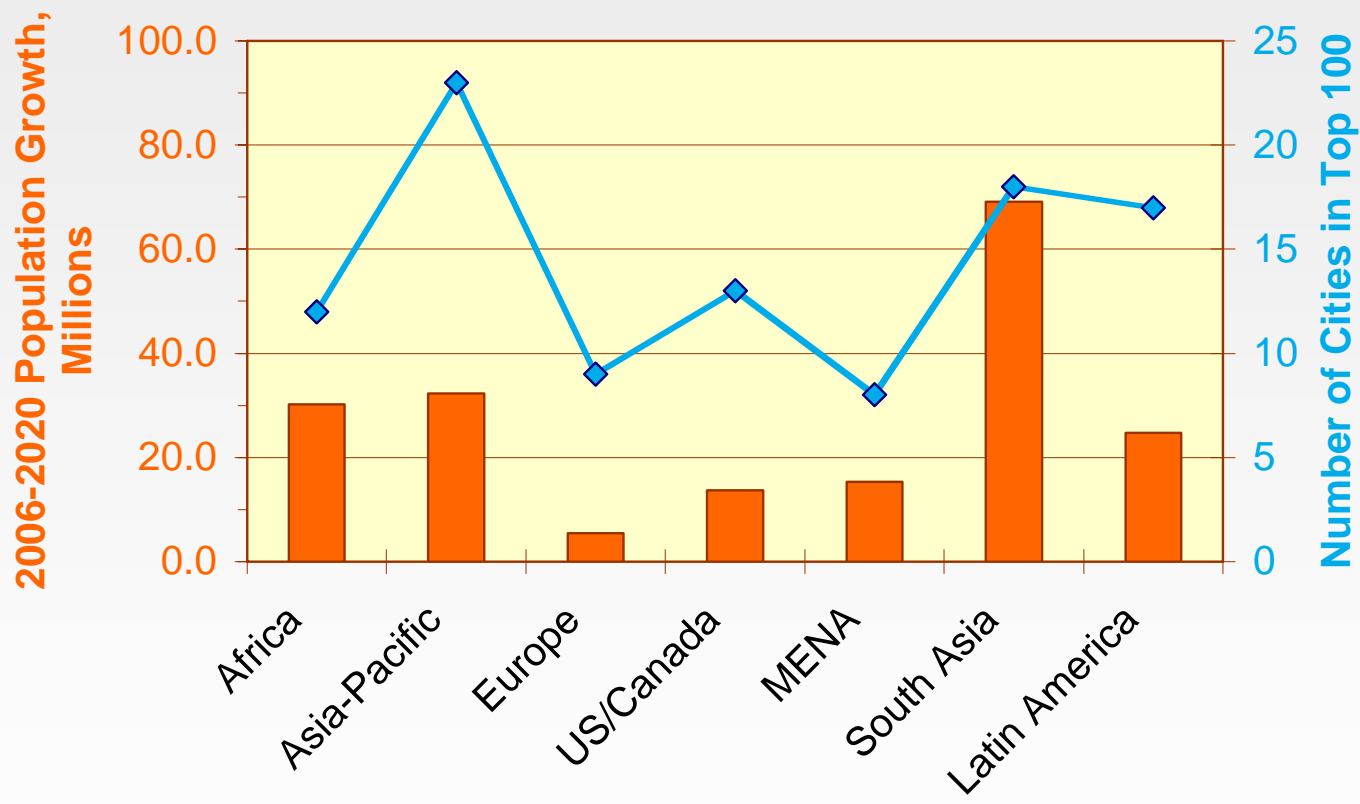
Consumption of Energy in Quadrillion BTUs: 2004 vs. 2030



3-D Column 2					
Quad BTU		83	145		

Adapted from DOE/EIA, IEO 2007, Table A1 Reference Case  
 . In Quadrillions of Btus.

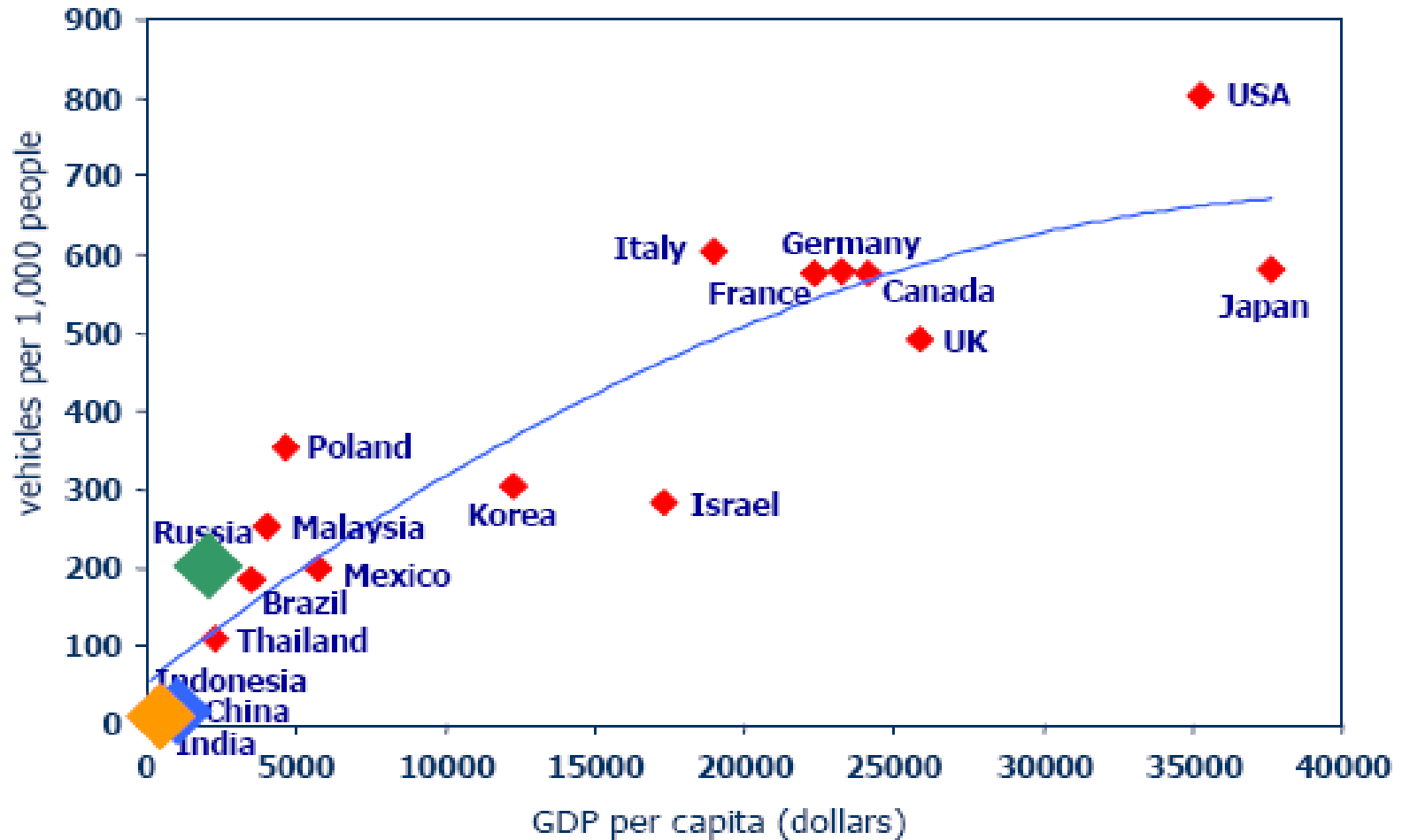
# Urban Growth Patterns will be another key: 2006-2020



- By 2020, population of world's 100 Largest Cities will grow by 191 million
- 90% of that Growth in Developing World

Source: Frank Verrastro, CSIS

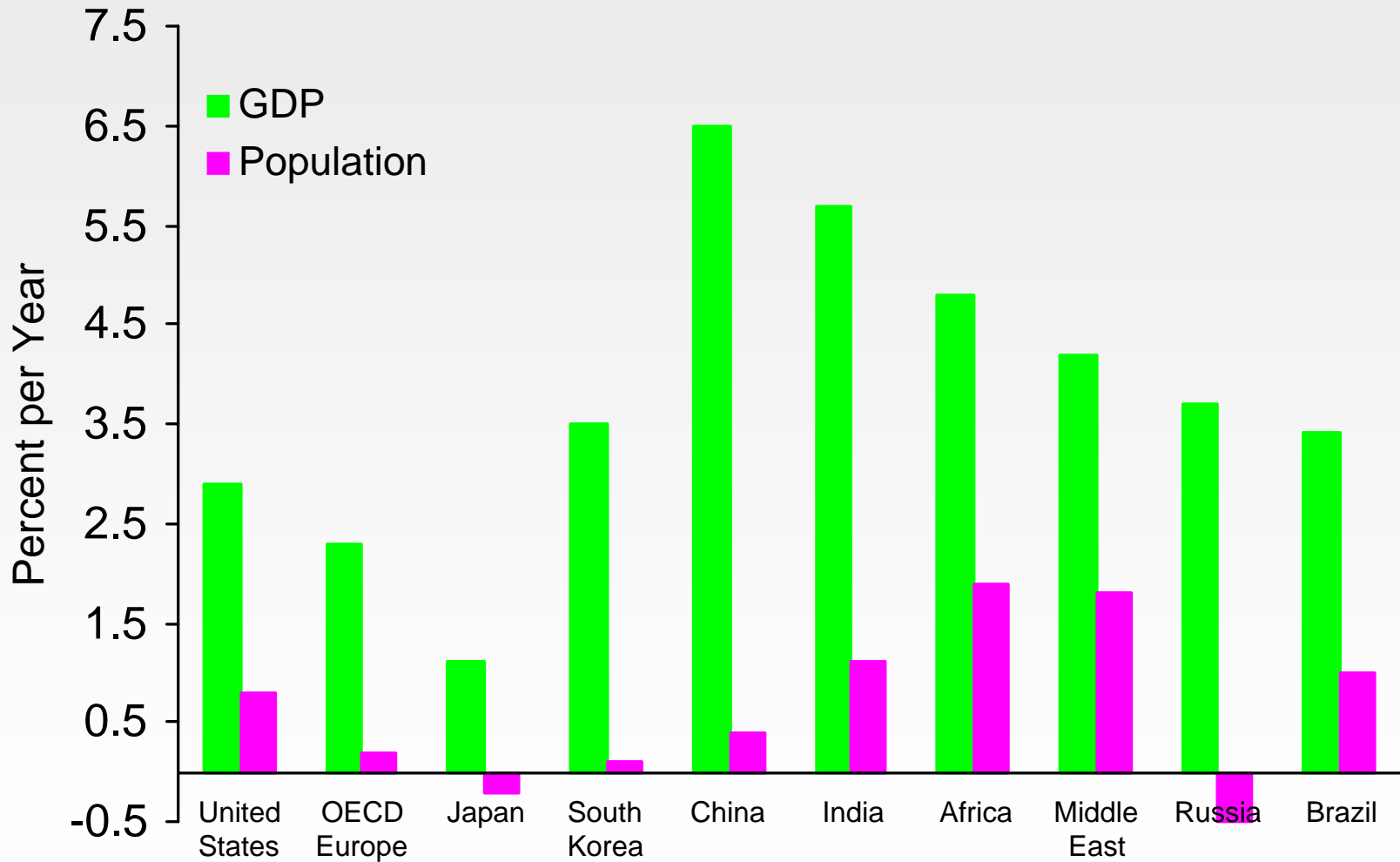
# Money Means Major Shifts in Resource Use - Car Ownership in 2004



*Potential of increased ownership in China and India, is huge*

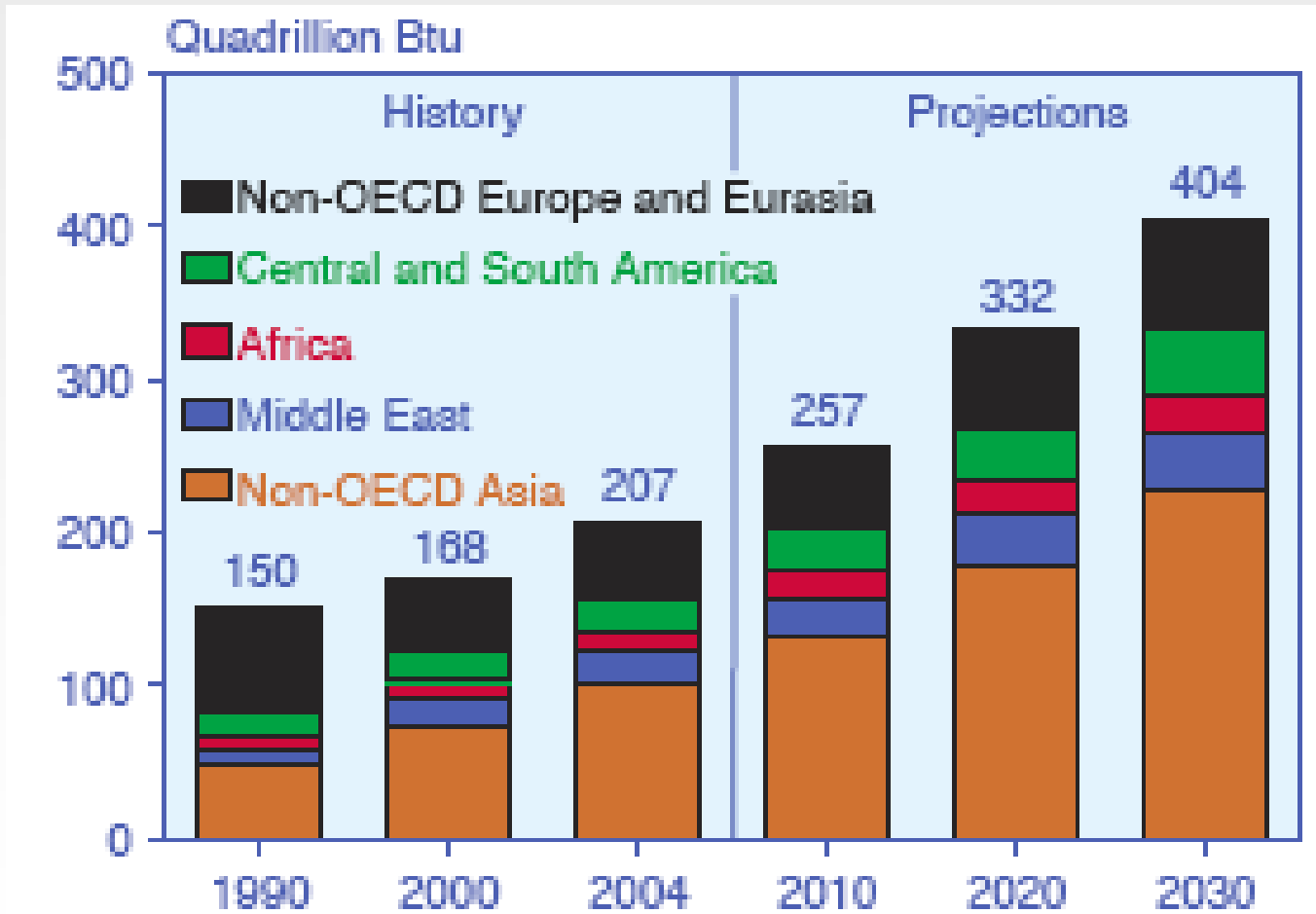
Source: OECD/IEA (2006)

## Average Annual GDP and Population Growth for Selected Regions, 2004-2030



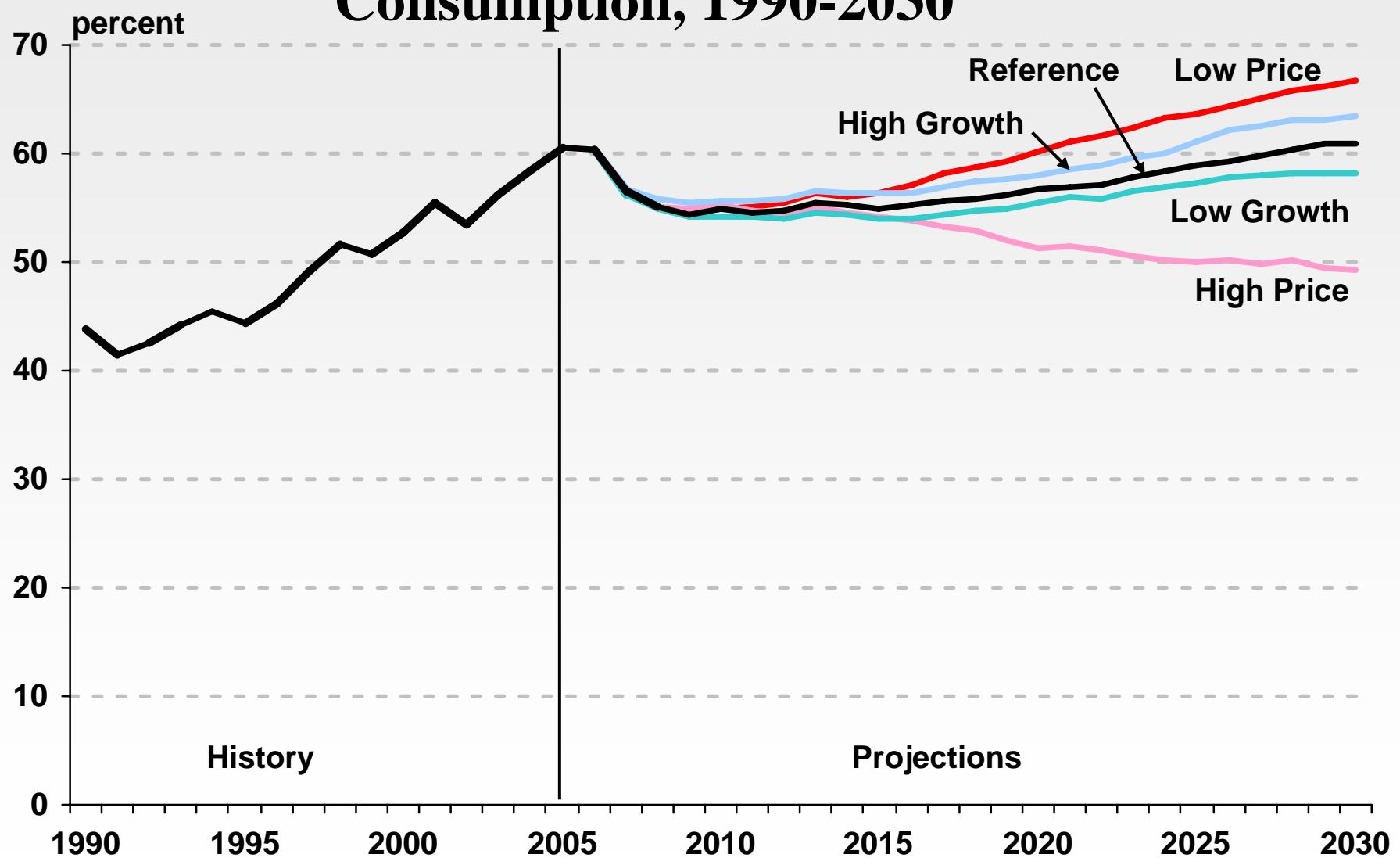
Source: EIA, IEO2007

# Non-OECD Asia Dominates the Growth in Demand



Source: DOE/EIA IEO 2007

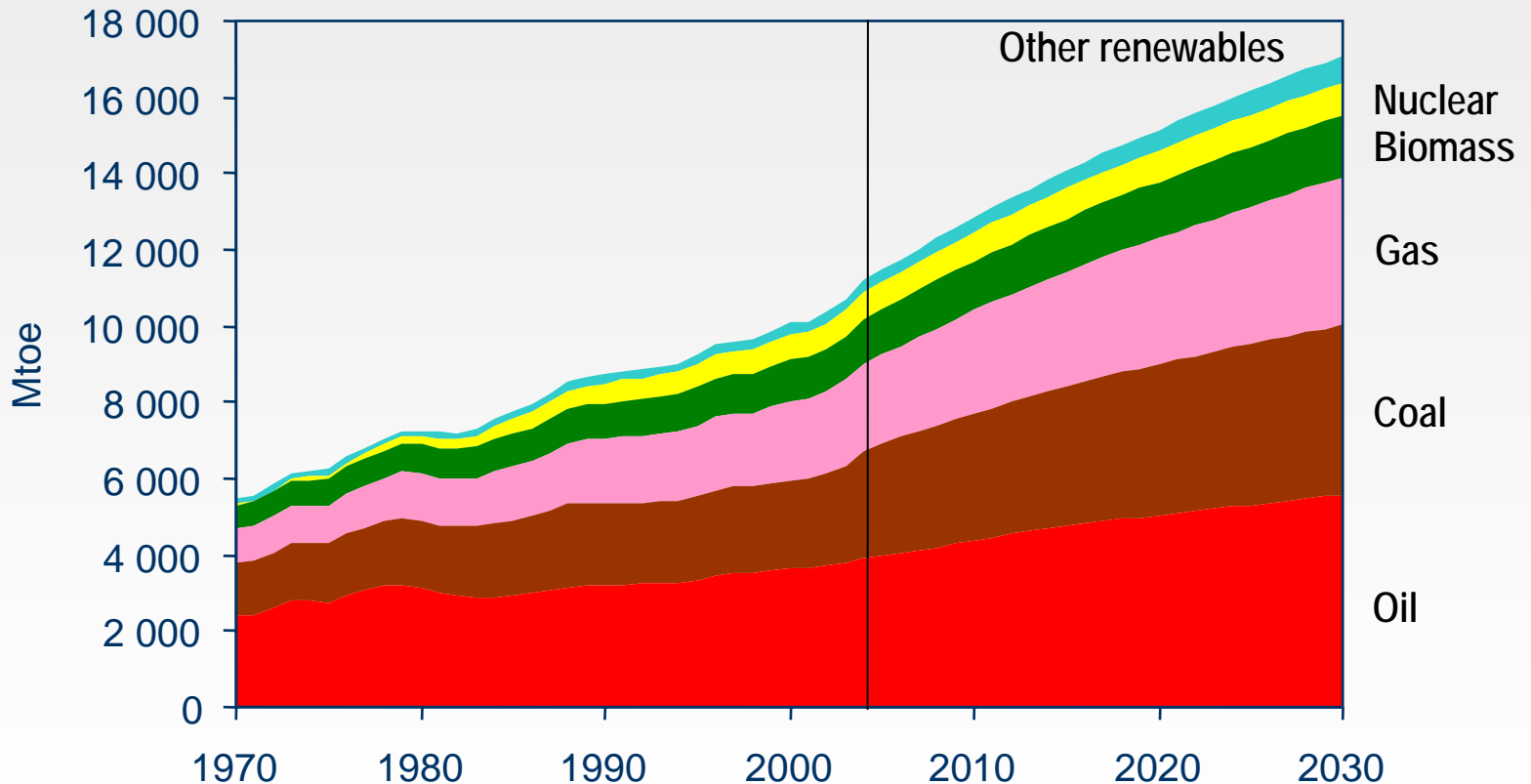
# Net Import Share of U.S. Liquid Fuels Consumption, 1990-2030



# Elasticity in Supply

# Global Demand and Risk Involves Far More Than Oil: IEA Estimate

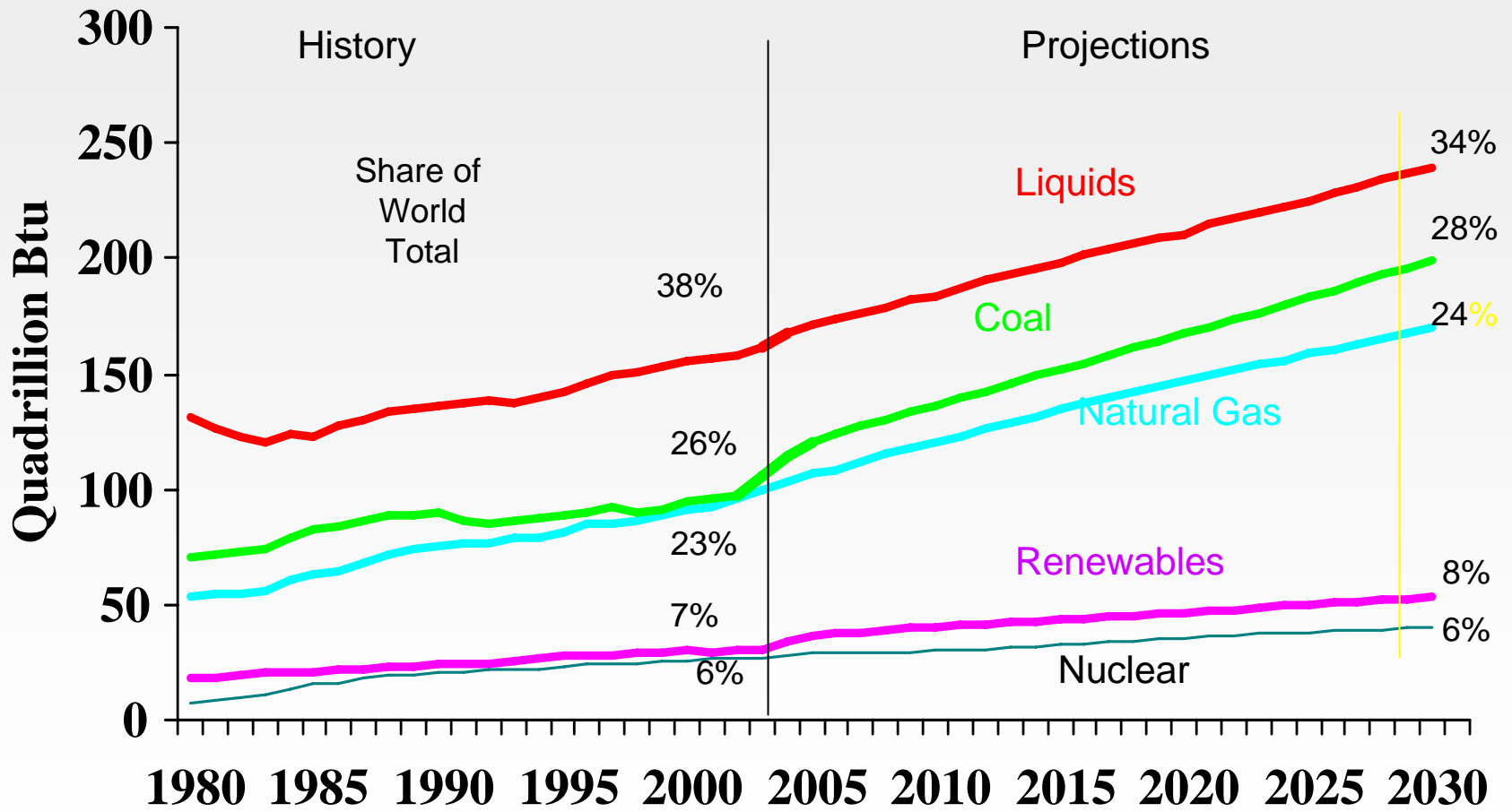
*Global demand rises 50%+ in 25 years, most in coal*



Source: IEA, World Energy Outlook, 2006

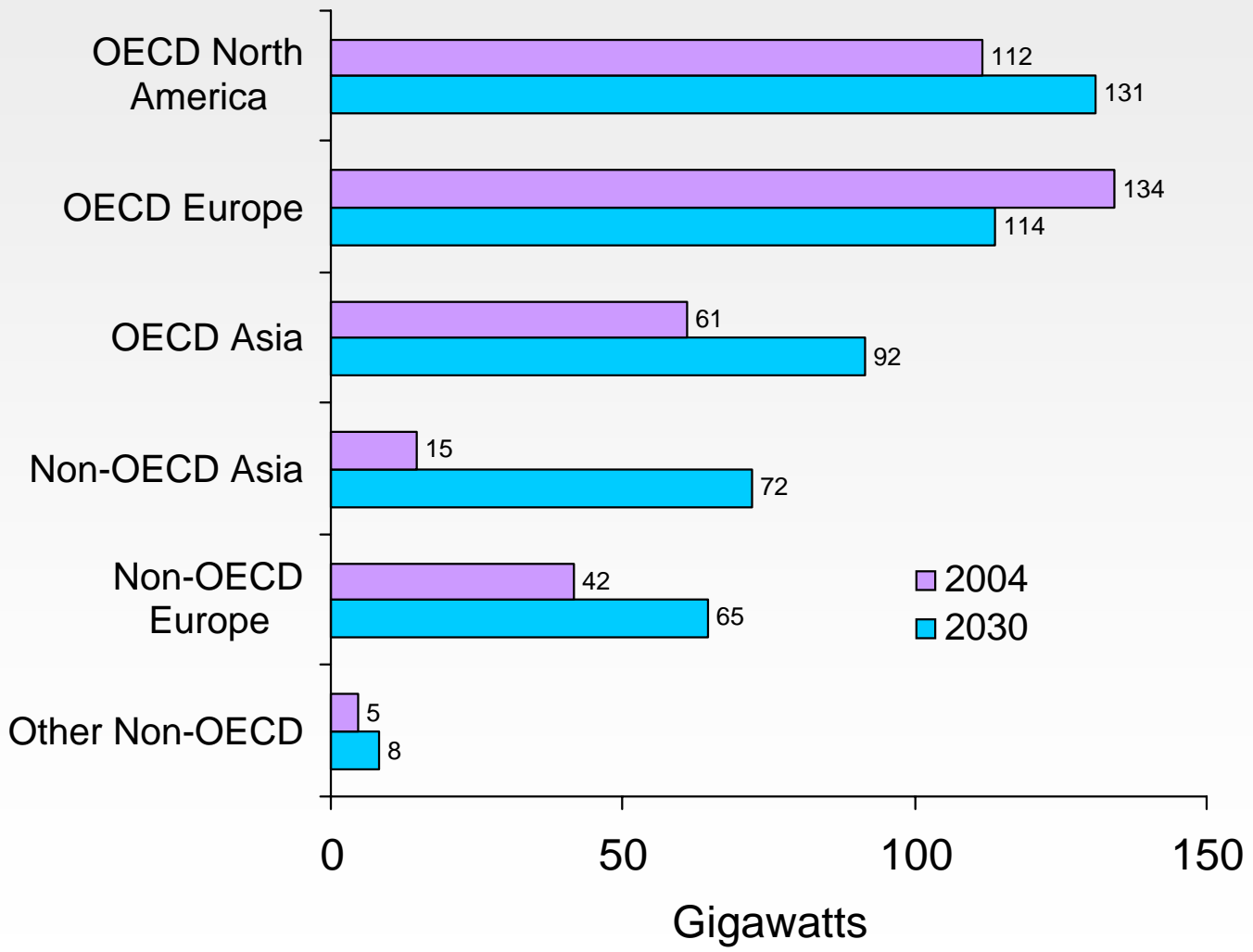
# World Marketed Energy Use by Fuel Type: 1980-2030

## The EIA Estimate



Source: EIA, IEO2007

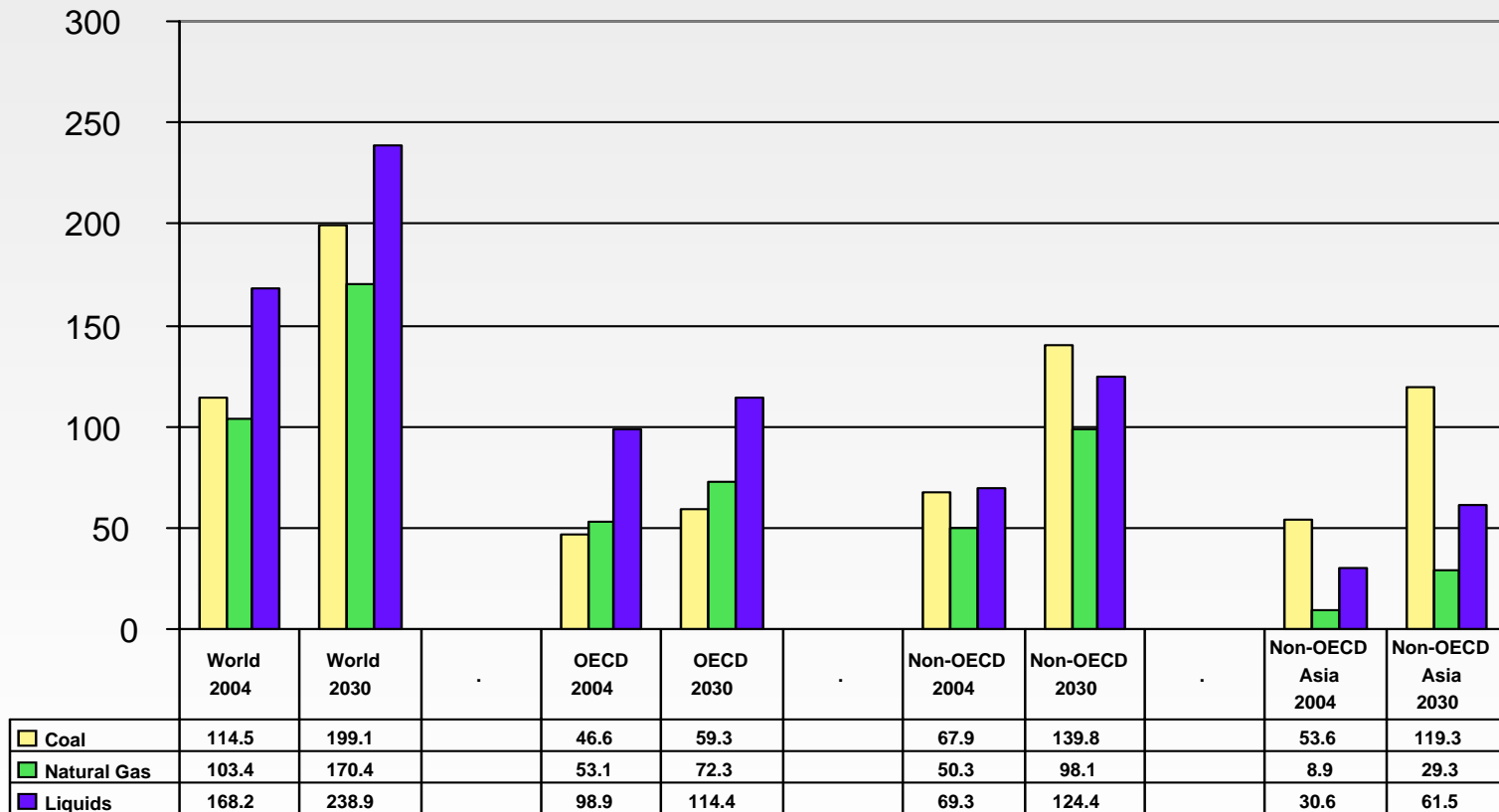
# World Nuclear Generating Capacity by Region, 2004 and 2030



Source: EIA, IEO2007

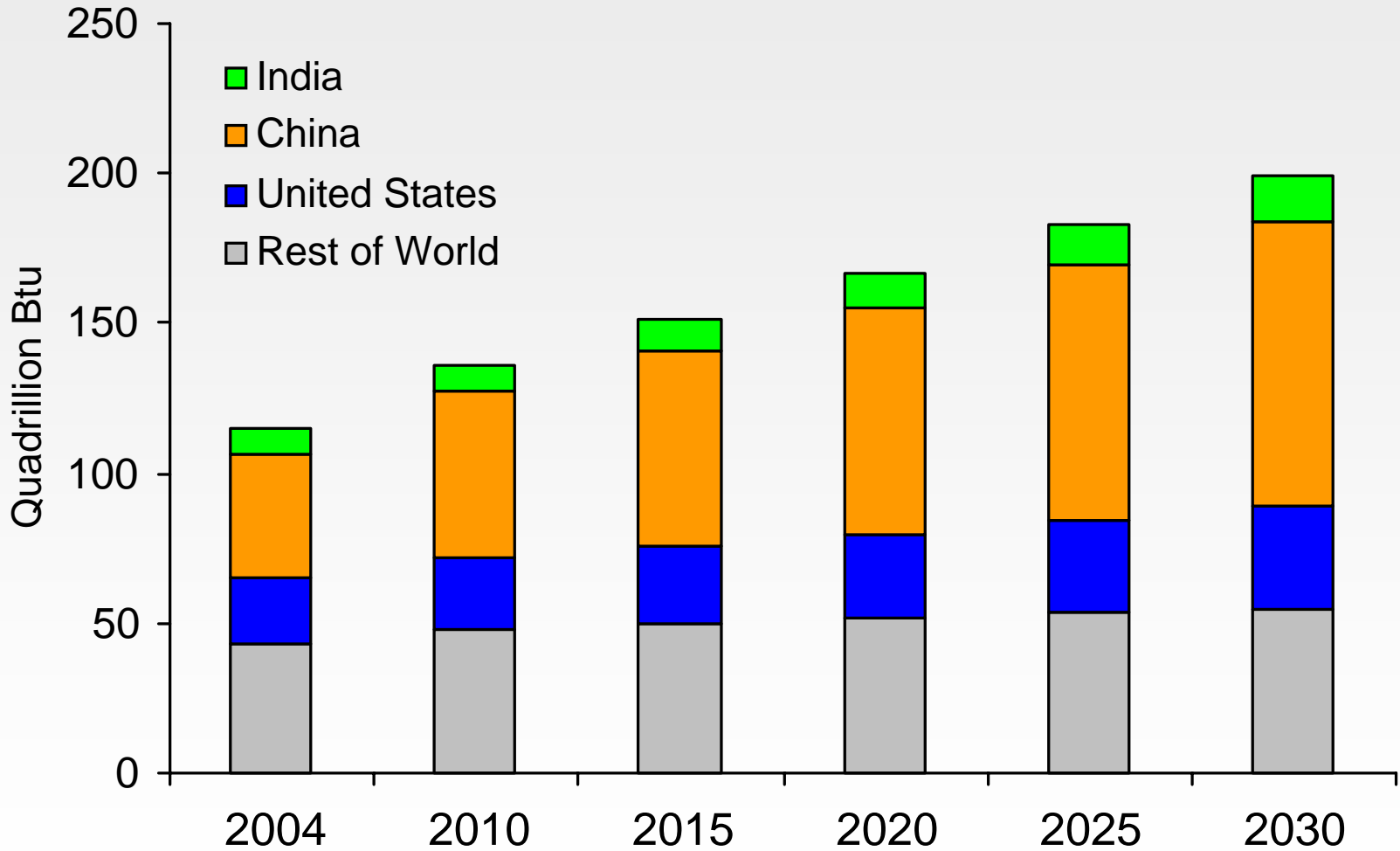
# Comparative Fossil Fuel Demand

## Consumption of Energy in Quadrillion BTUs: 2004 vs. 2030



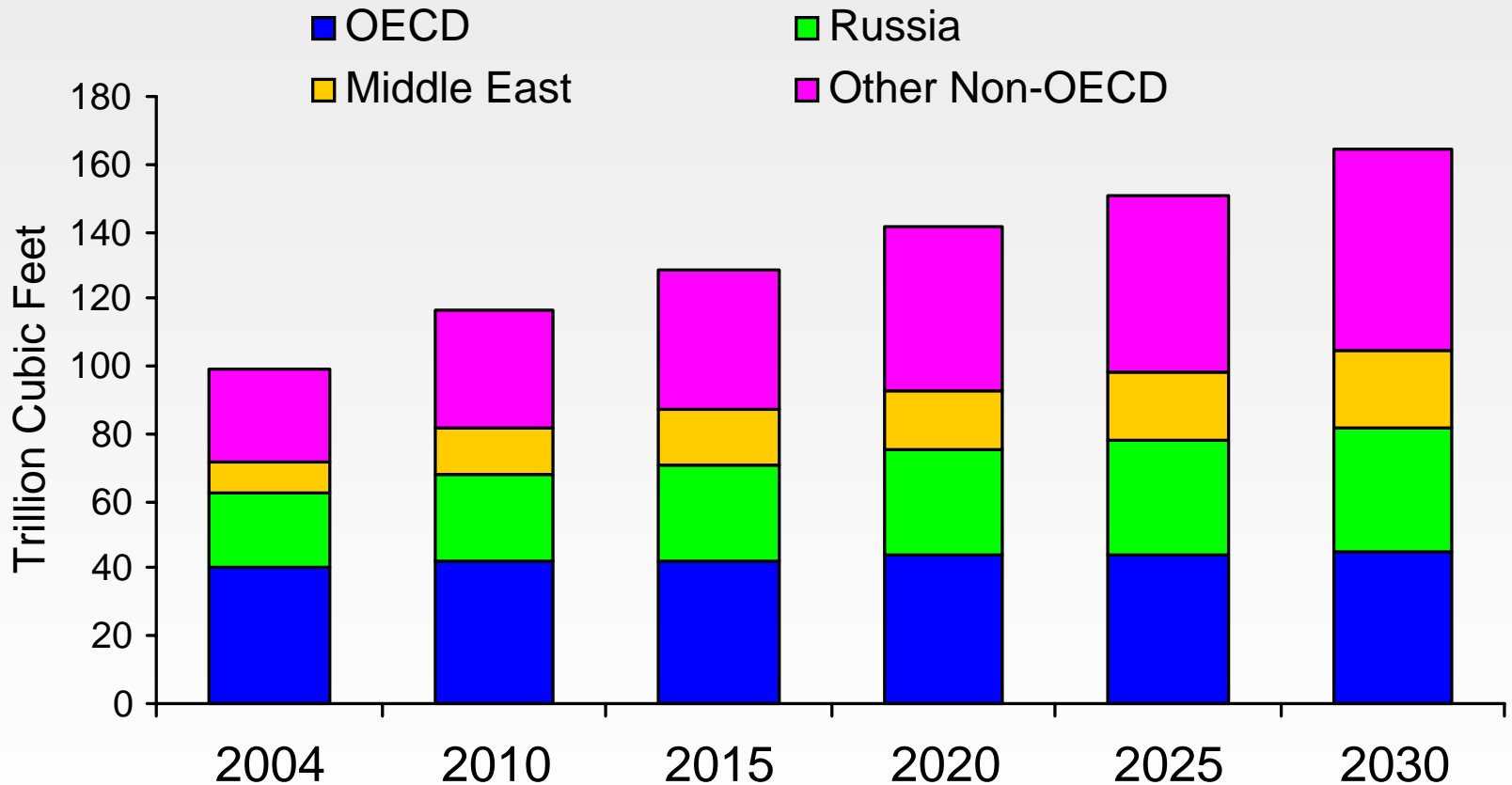
Adapted from DOE/EIA, IEO 2007, Table A2.Reference Case.  
In Quadrillions of Btus.

# World Coal Consumption, 2004-2030



Source: EIA, IEO2007

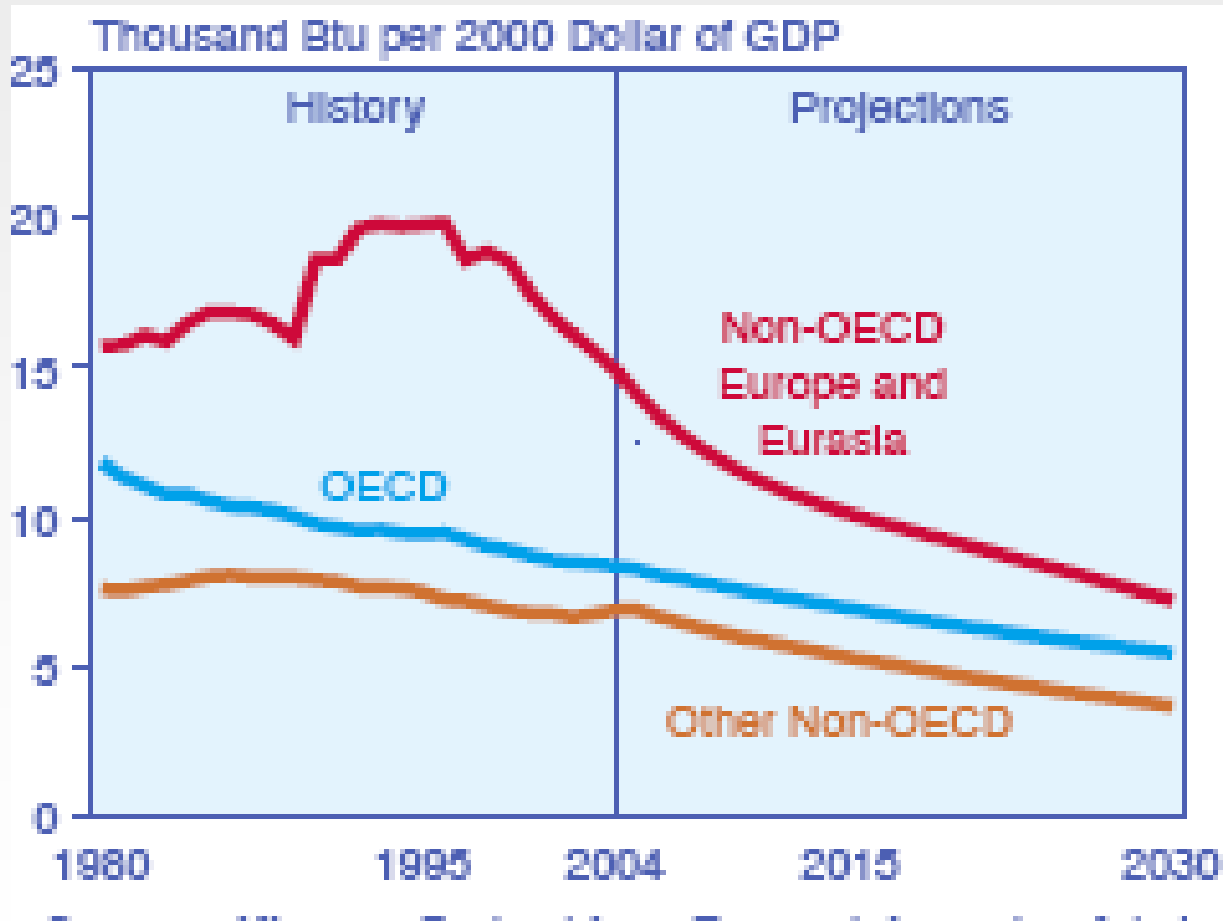
# World Natural Gas Production by Region, 2004-2030



Source: EIA, IEO2007

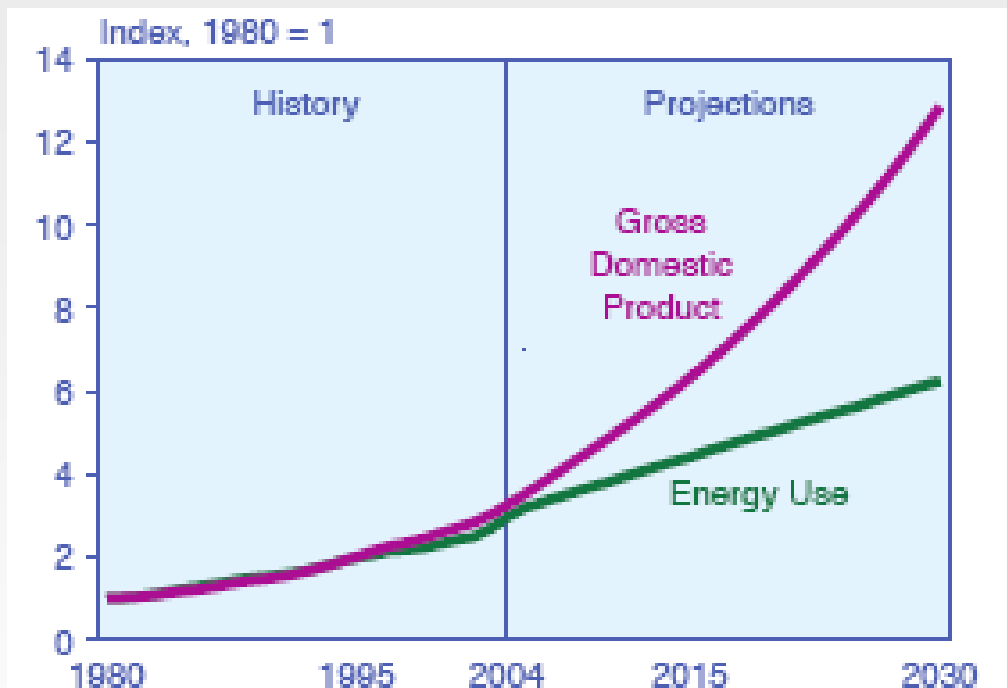
# Elasticity in Efficiency and Conservation

# Energy Intensity by Region: 1980-2030



Source: DOE/EIA IEO 2007.

# Non-OECD Energy Intensity : 1980-2030

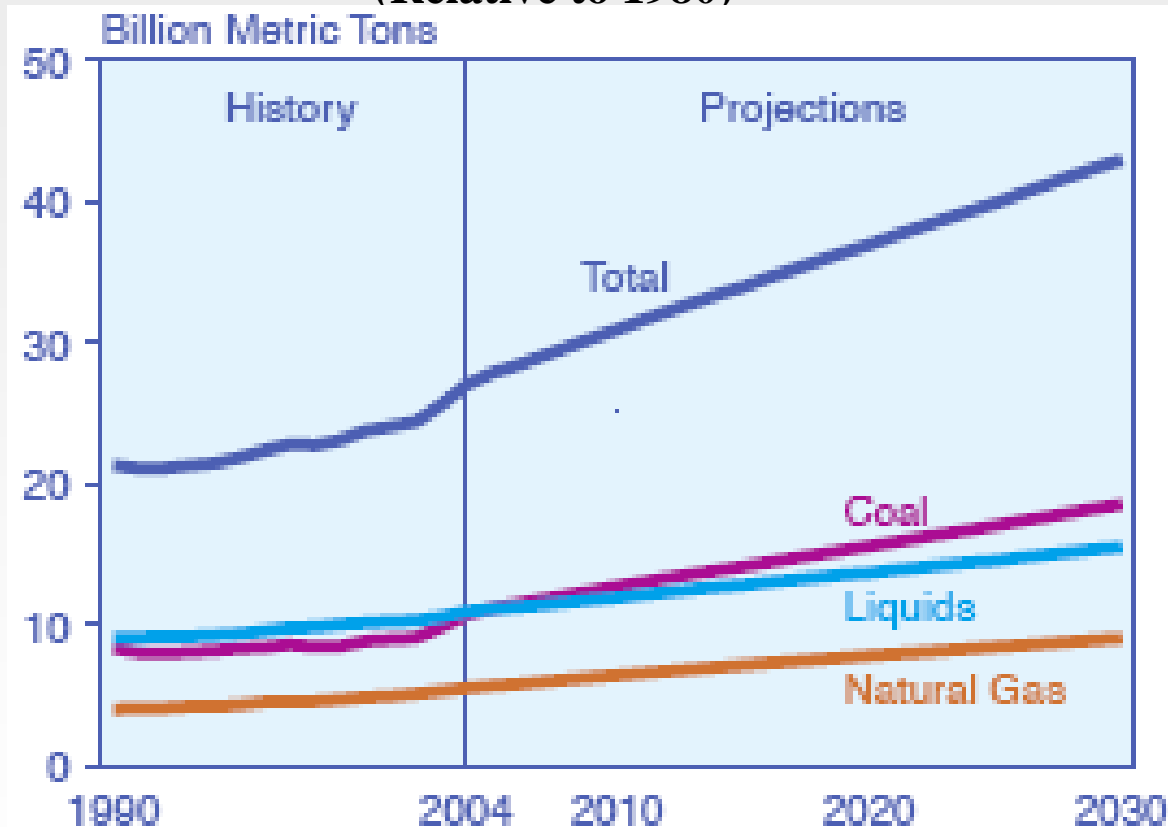


Note: Non-OECD economies in this figure exclude non-OECD Europe and Eurasia.

Sources: History: Energy Information Administration (EIA), *International Energy Annual 2004* (May-July 2006), web site [www.eia.doe.gov/iea](http://www.eia.doe.gov/iea). Projections: EIA, *System for the Analysis of Global Energy Markets* (2007).

# The “Wild Card:” Global Warming and Carbon Dioxide Emissions

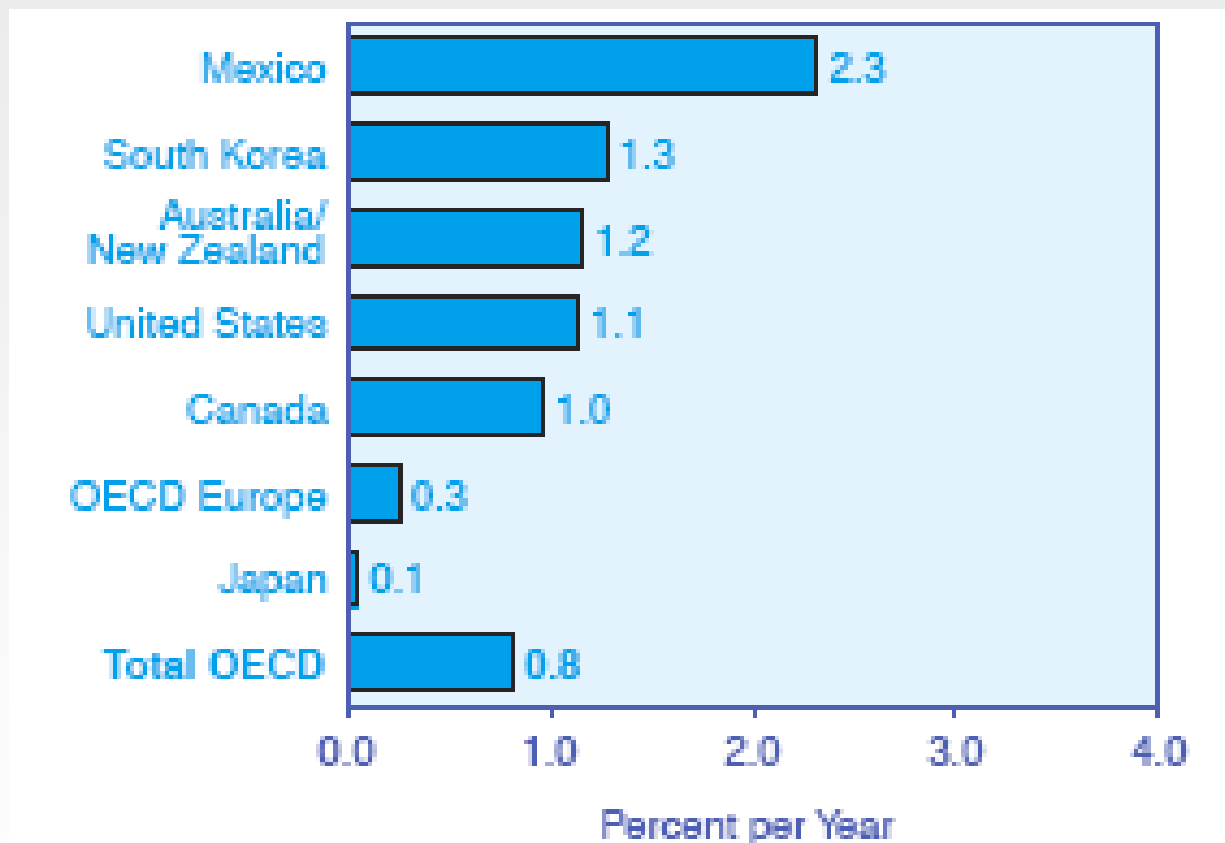
(Relative to 1980)



Sources: History: Energy Information Administration (EIA), *International Energy Annual 2004* (May-July 2006), web site [www.eia.doe.gov/iea](http://www.eia.doe.gov/iea). Projections: EIA, *System for the Analysis of Global Energy Markets* (2007).

# OECD Carbon Dioxide Emissions

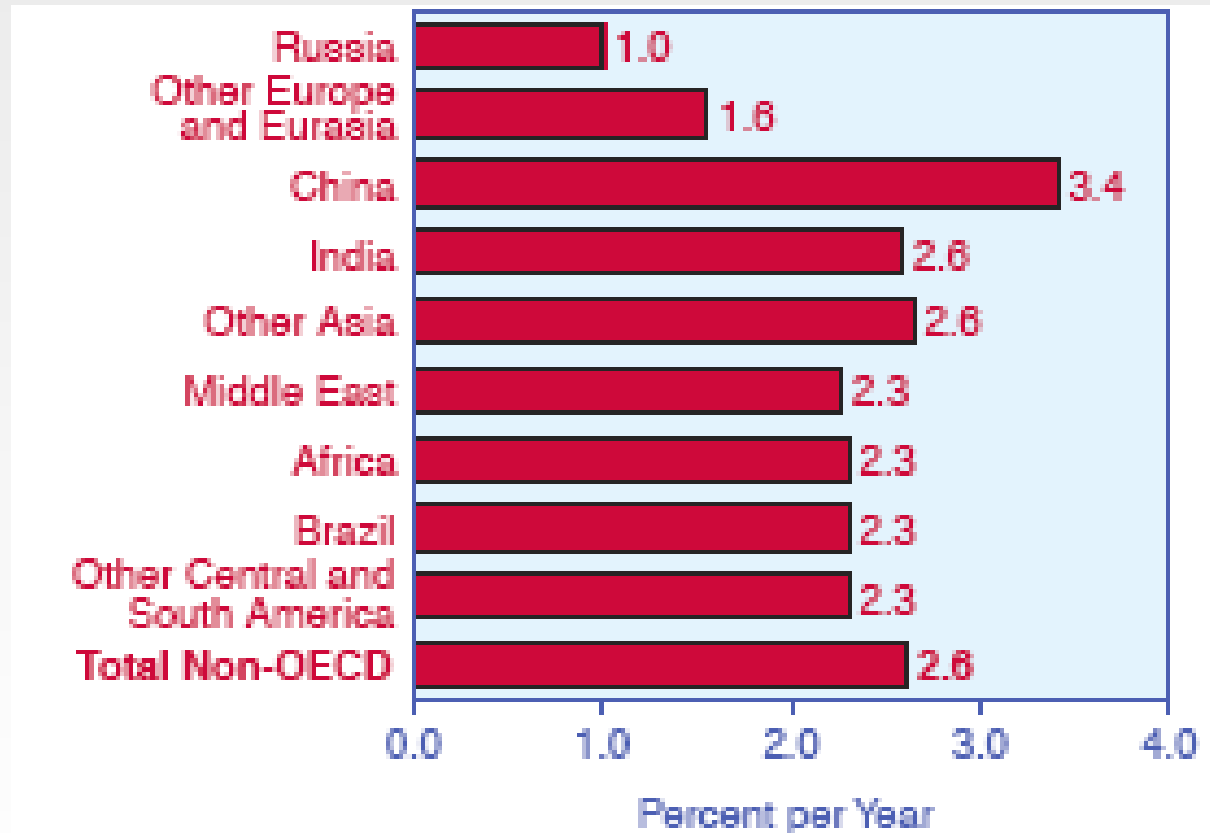
(Average Annual Growth in Percent Per Year from 2004-2030)



Sources: 2004: Energy Information Administration (EIA), *International Energy Annual 2004* (May-July 2006), web site [www.eia.doe.gov/iea](http://www.eia.doe.gov/iea). 2030: EIA, *System for the Analysis of Global Energy Markets* (2007).

# Non-OECD Carbon Dioxide Emissions:

(Average Annual Growth in Percent Per Year from 2004-2030)



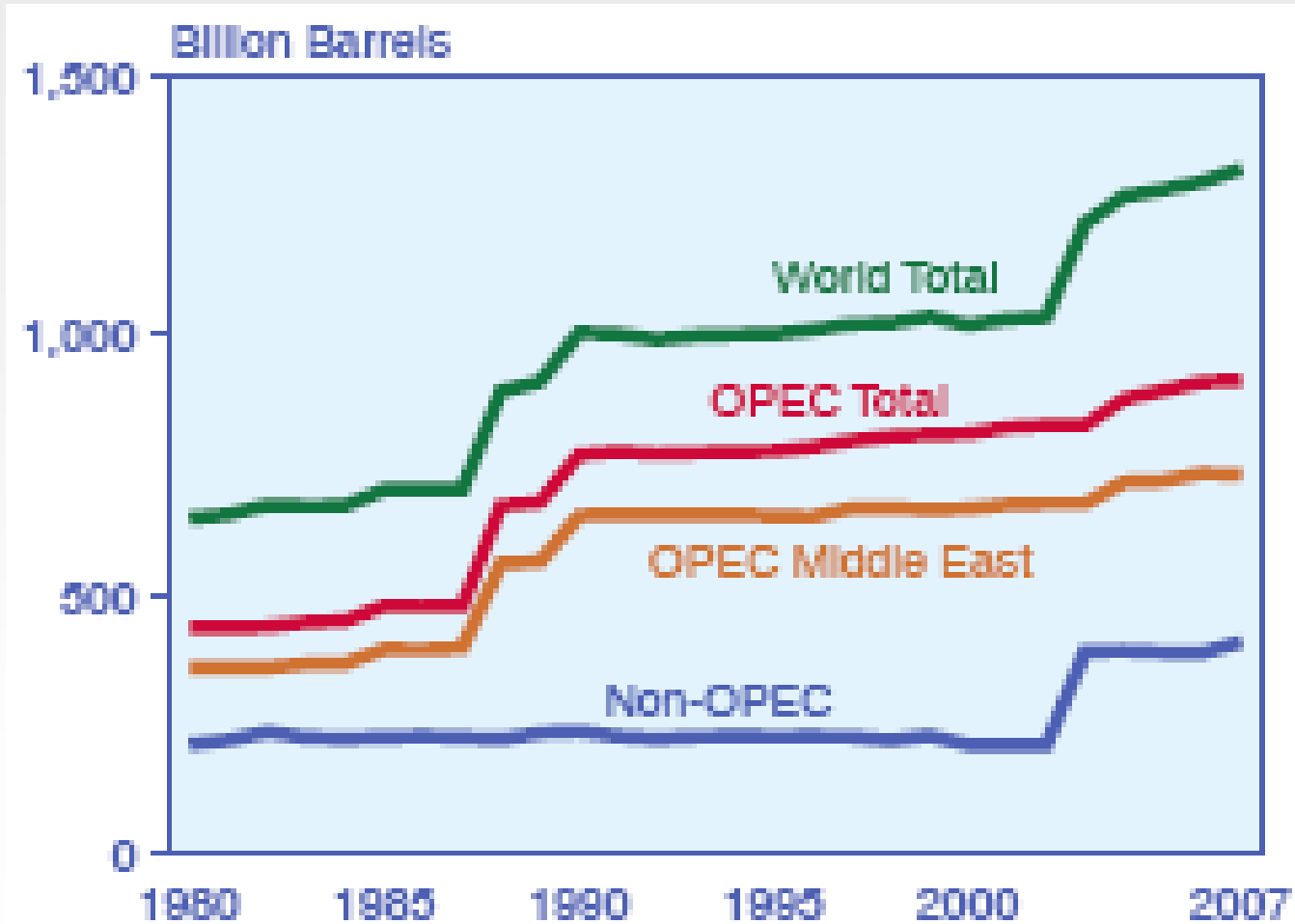
Sources: 2004: Energy Information Administration (EIA), *International Energy Annual 2004* (May-July 2006), web site [www.eia.doe.gov/iea](http://www.eia.doe.gov/iea). 2030: EIA, *System for the Analysis of Global Energy Markets* (2007).

# Global Oil Dynamics

# Oil Reserve Uncertainties

- ❑ True nature of reserves
- ❑ Canadian tar-sands
- ❑ Venezuelan bitumen deposits
- ❑ Impact of technological gain
- ❑ Ability to substitute for current super-giant and giant fields
- ❑ Rate of decline in fields
- ❑ Rate and size of new developments and discoveries
- ❑ Inaccuracy of 3-D seismic modeling

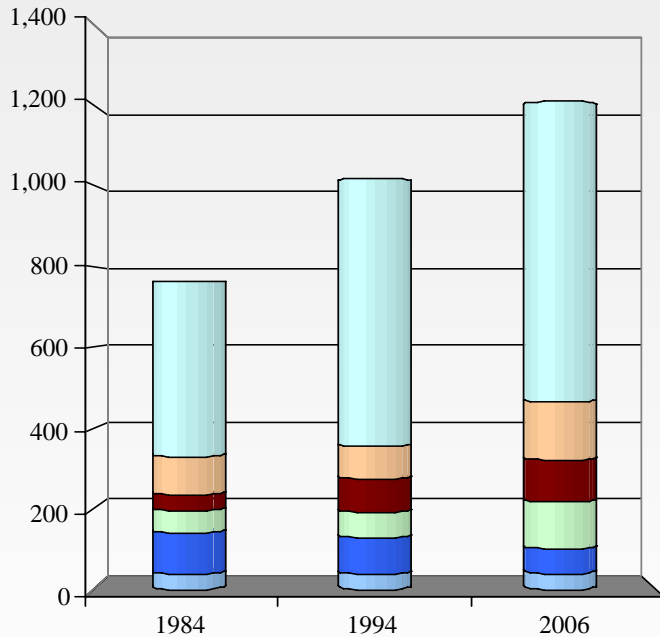
# Running Out of Oil? Trend in Reserves: 1980-2030



Source: DOE/EIA IEO 2007.

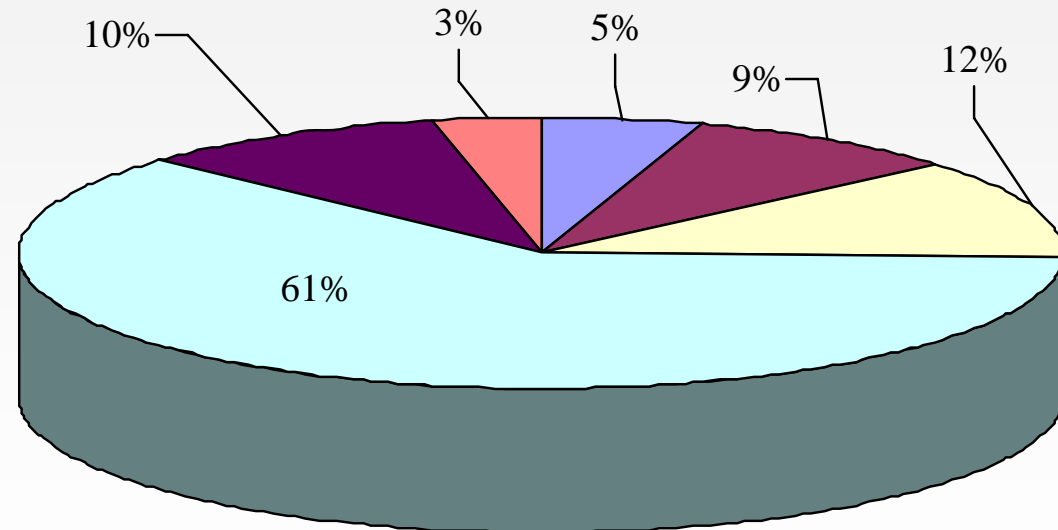
# World Oil Proven Reserves

**Oil Proven Reserves Trends  
(In Billion Barrels)**



	1984	1994	2006
□ Middle East	430.8	661.7	742.7
□ Europe & Eurasia	96.70	80.30	144.40
■ S&C America	36.30	81.50	103.50
□ Africa	57.80	65.00	117.20
■ N. America	101.90	89.80	59.90
□ Asia Pacific	38.10	39.20	40.50

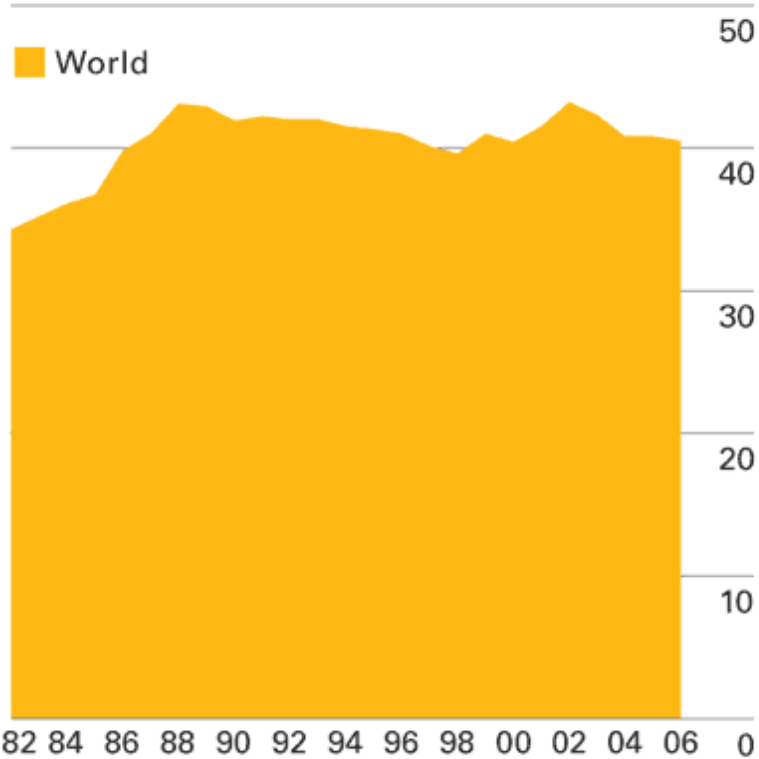
**Oil Proven Reserves 2006  
(In % of Total)**



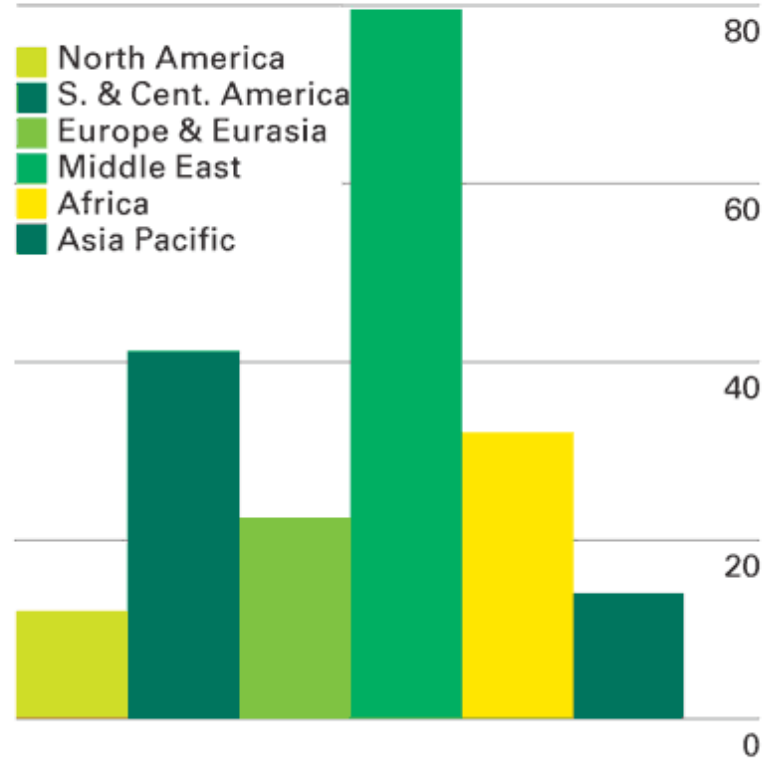
Note: If Canadian tar-sands are included, the North American total rises to 236 billion (18%)

# Oil Reserves-to-Production Ratios

Reserves-to-production (R/P) ratios  
Years



2006 by area



The world's oil R/P ratio edged lower in 2006, reaching 40.5 years, compared with 41 years in 1996 and 39.8 years in 1986. The level of reserves fell by 1 billion barrels, or 0.1%. Declines in Norway and Mexico were partially offset by increases in Russia and Brazil.

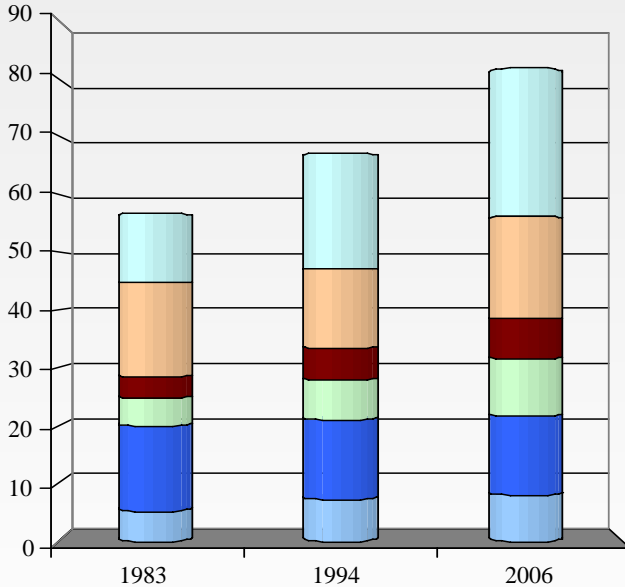
Source: BP Amoco Statistical Review of Energy 2007

# Oil Production Uncertainties

- ❑ **“Sustainable” spare capacity**
- ❑ **Elasticity in importer conservation, efficiency, and alternative supply and time/uncertainty lags**
- ❑ **Feasibility of production at given prices**
- ❑ **Technological gains in the upstream industry**
- ❑ **“Sustainable” inflow of foreign investment**

# World Oil Production Trends

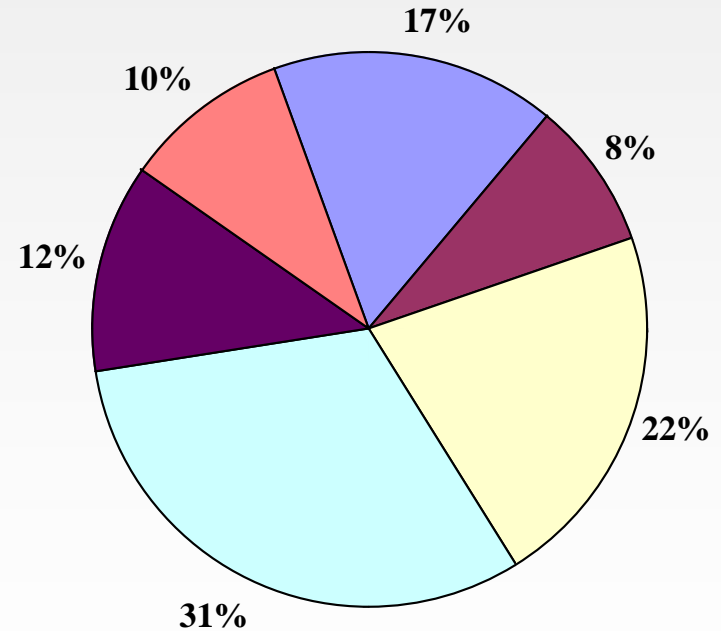
**Oil Production Trends  
(In MMBD)**



	1983	1994	2006
□ Middle East	11.841	20.118	25.599
■ Europe & Eurasia	16.343	13.657	17.563
■ S & C America	3.539	5.347	6.881
■ Africa	4.865	7.004	9.991
■ N. America	14.838	13.807	13.699
■ Asia Pacific	5.171	7.184	7.941

Source: BP Statistical Review 2007

**Oil Production 2006  
(In Percent)**

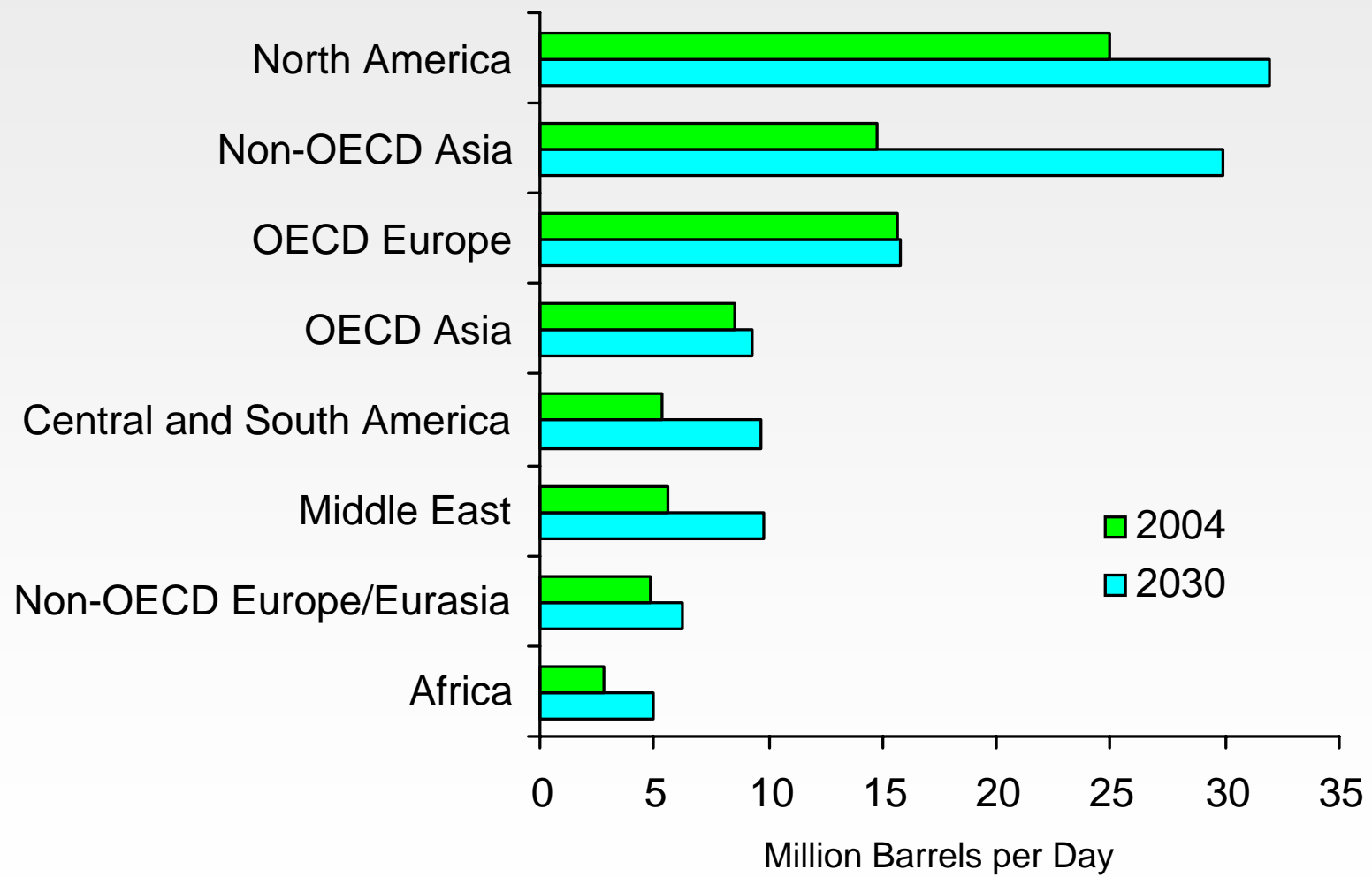


Source: BP Statistical Review

# Shift in Global Oil Dependence

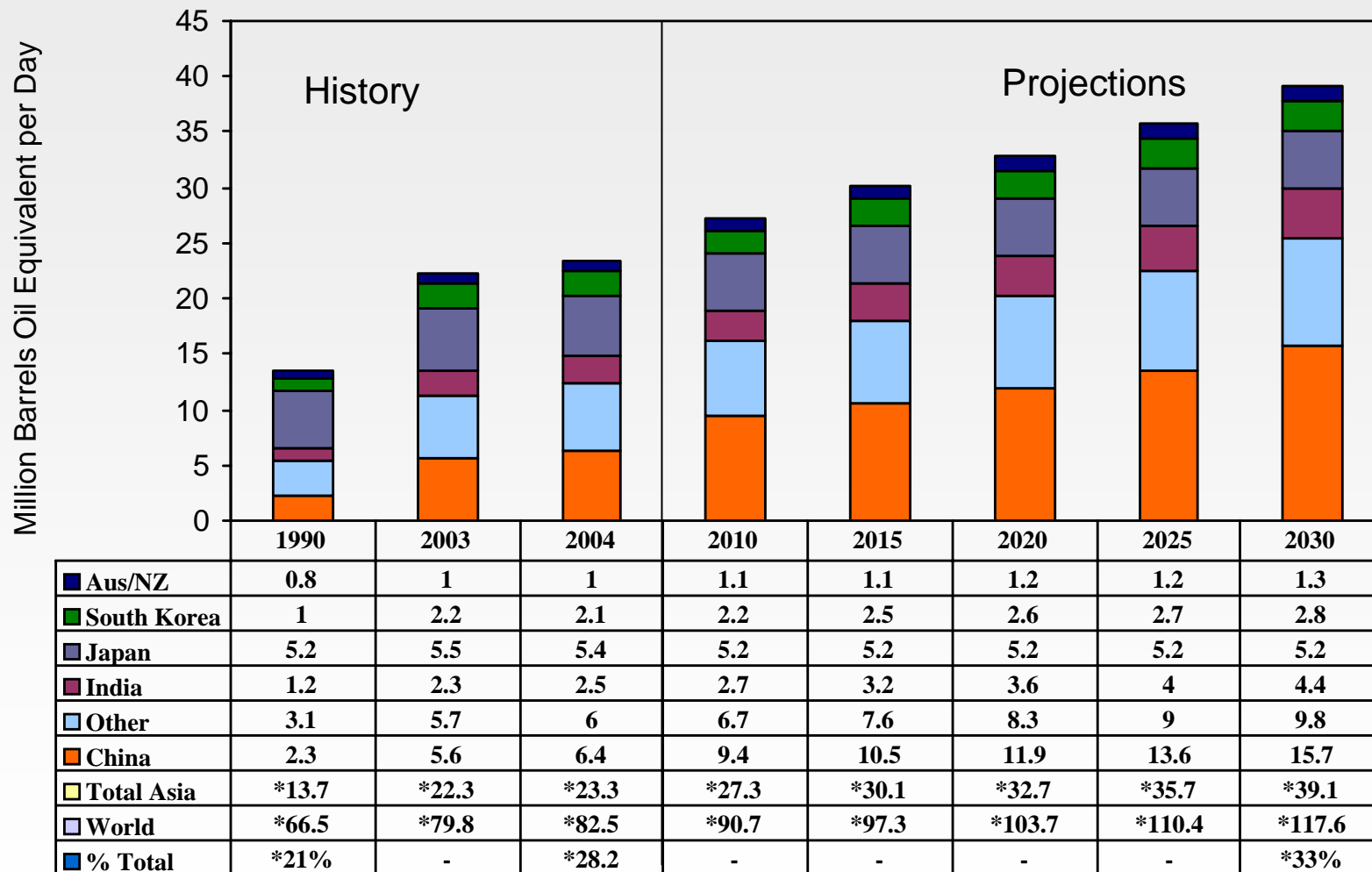
- ❑ **Geostrategic uncertainties**
- ❑ **Lack of good estimates**
- ❑ **Decay and natural decline vs. technology growth**
- ❑ **Alternative energy supply, efficiency, and conservation?**
- ❑ **The need for investment.**

# World Liquids Consumption by Region, 2004 vs. 2030



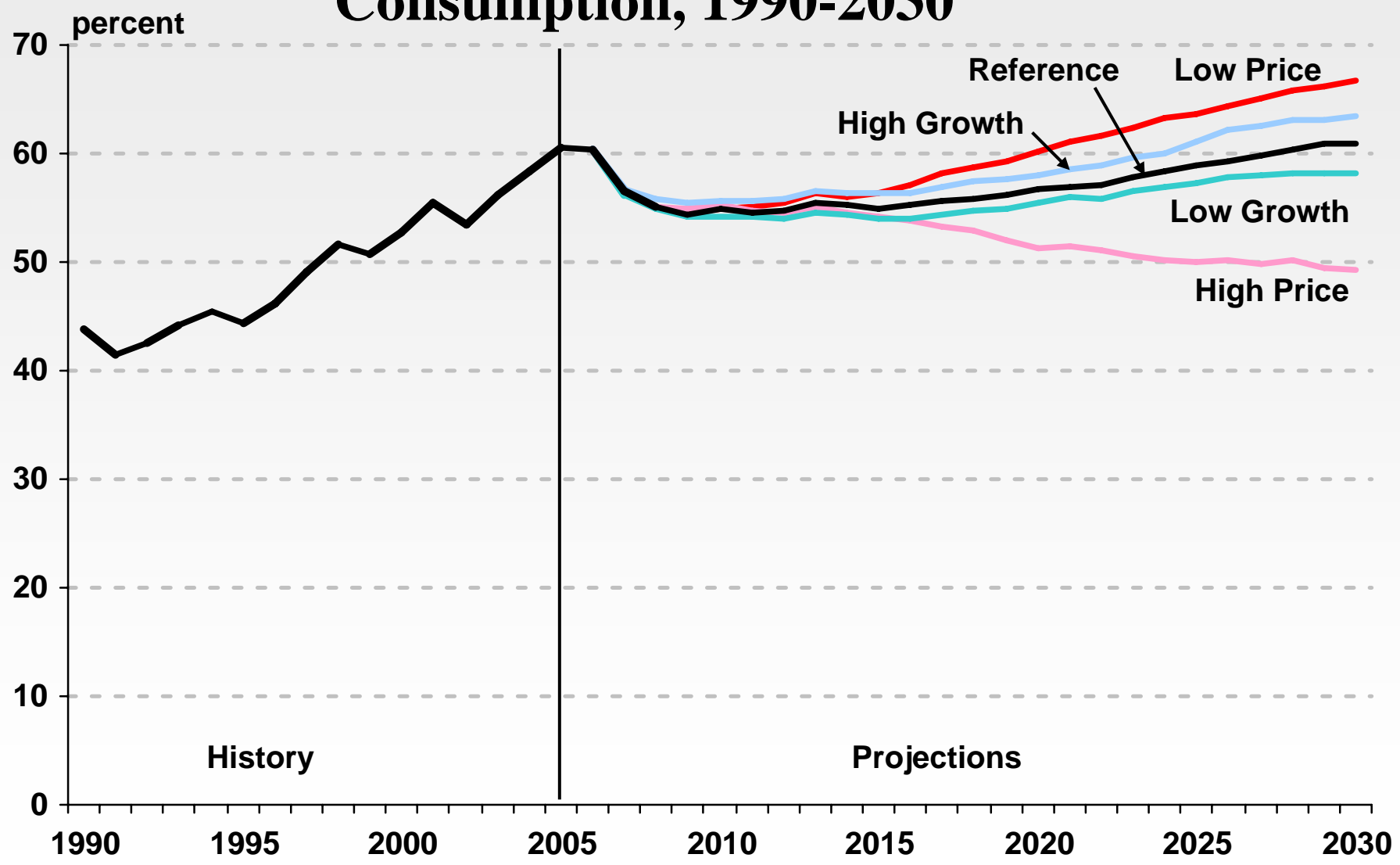
Source: EIA, IEO2007

# Asian Liquids Consumption in the EIA Reference Case, 1990-2030

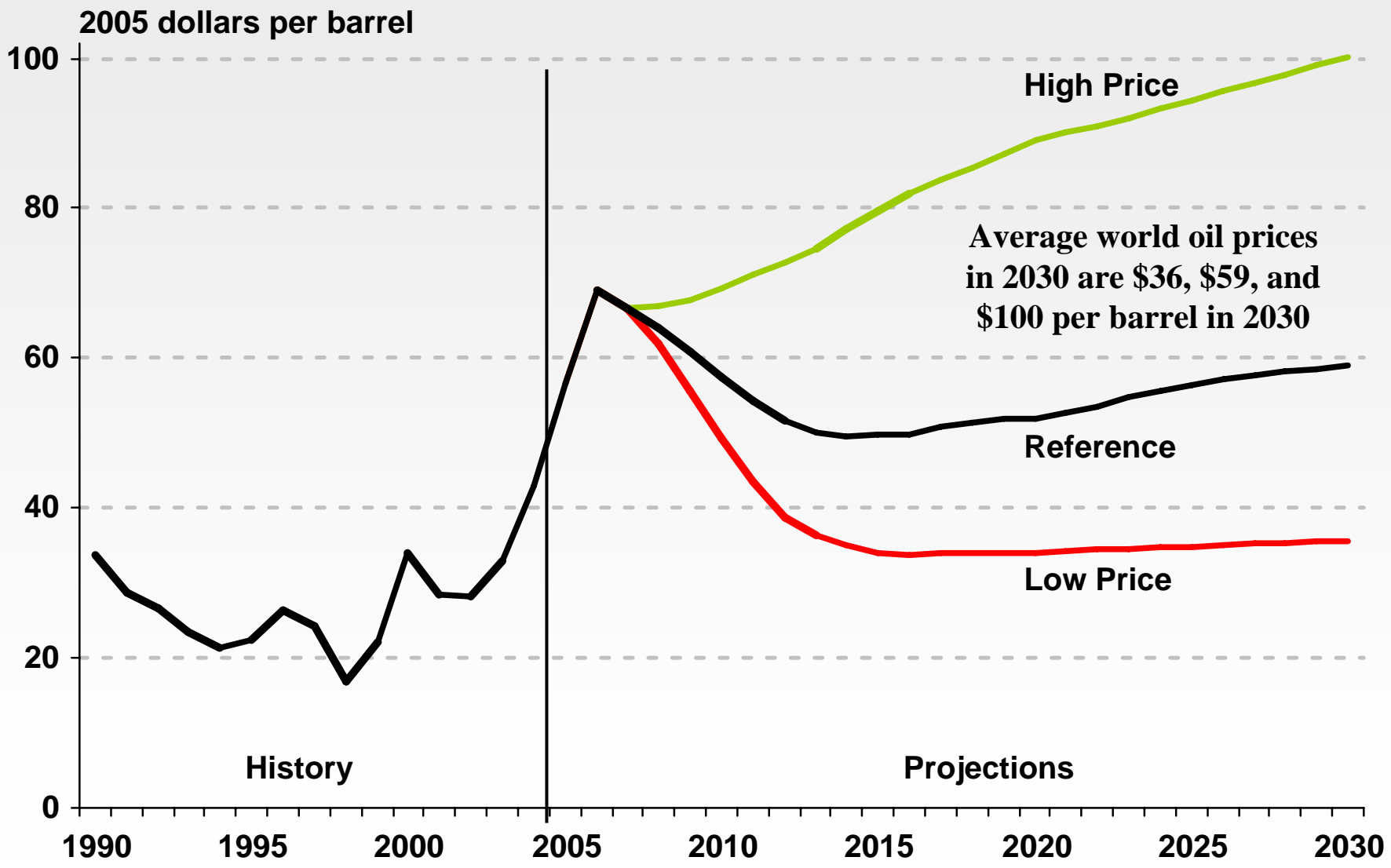


Source: EIA, IEO2007, Appendix A, p. 88

# Net Import Share of U.S. Liquid Fuels Consumption, 1990-2030



# World Oil Prices in Three Cases, 1990-2030



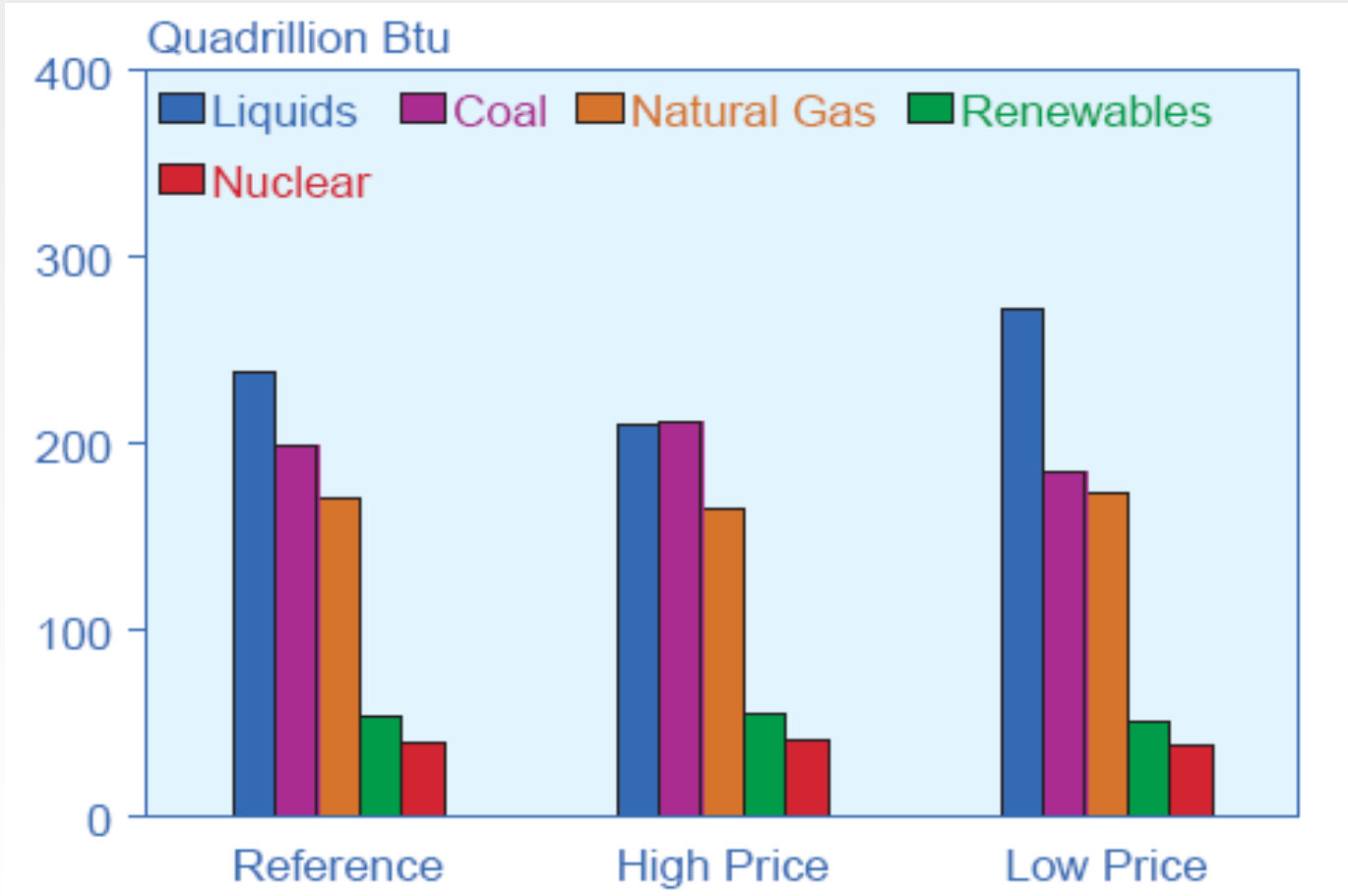
# Oil Price Sharply Affects Global Demand for All Liquids

(Millions of Barrels Per Day - Source: EIA, International Energy Outlook, 2007,



**Average world oil prices in 2030 are \$36, \$59, and \$100 per barrel in 2030**

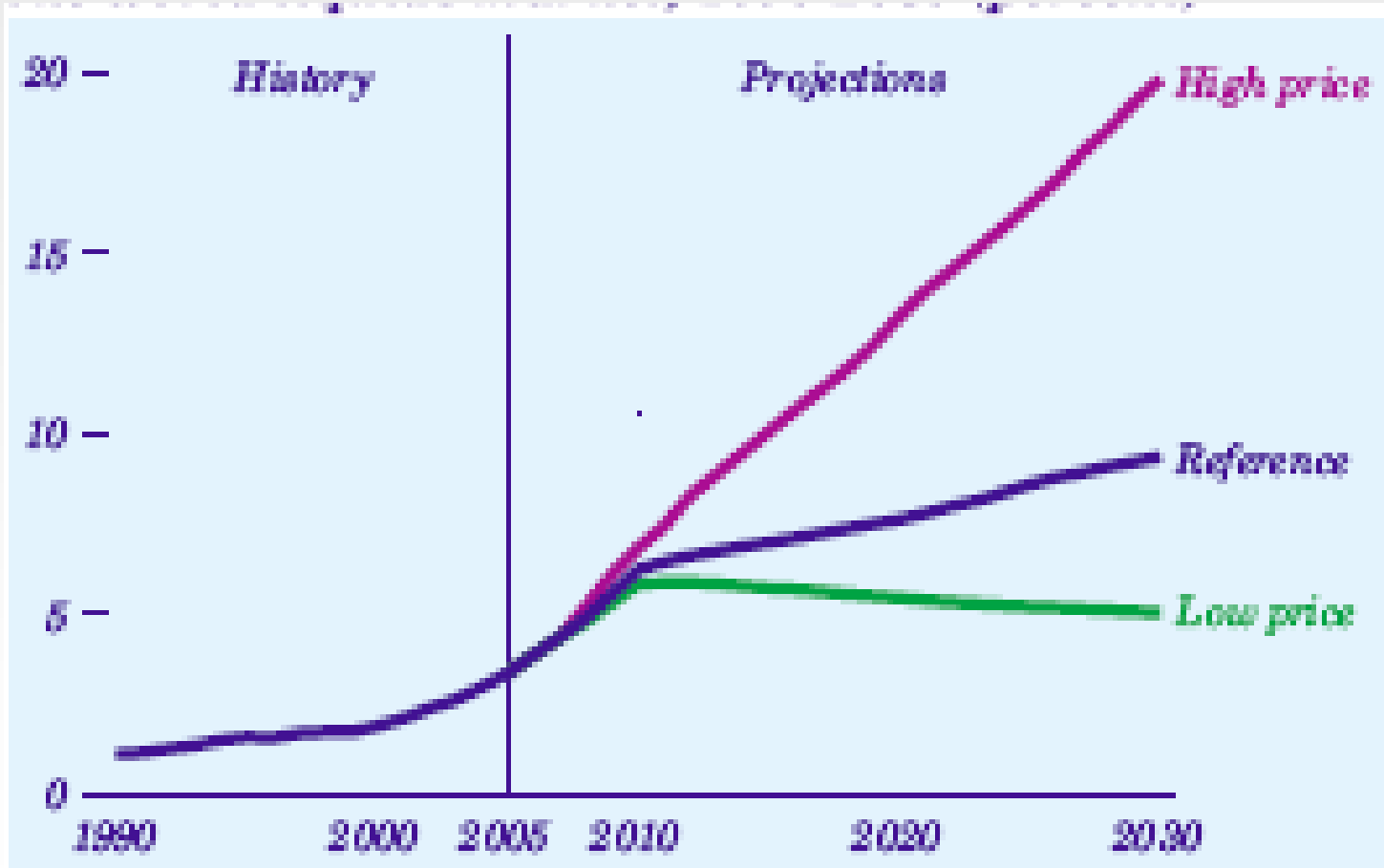
# How Oil Price Could Affect Energy Demand by Type in 2030



**Average world oil prices in 2030 are \$36, \$59, and \$100 per barrel in 2030**

Source: EIA, IEO 2007pg. 13.

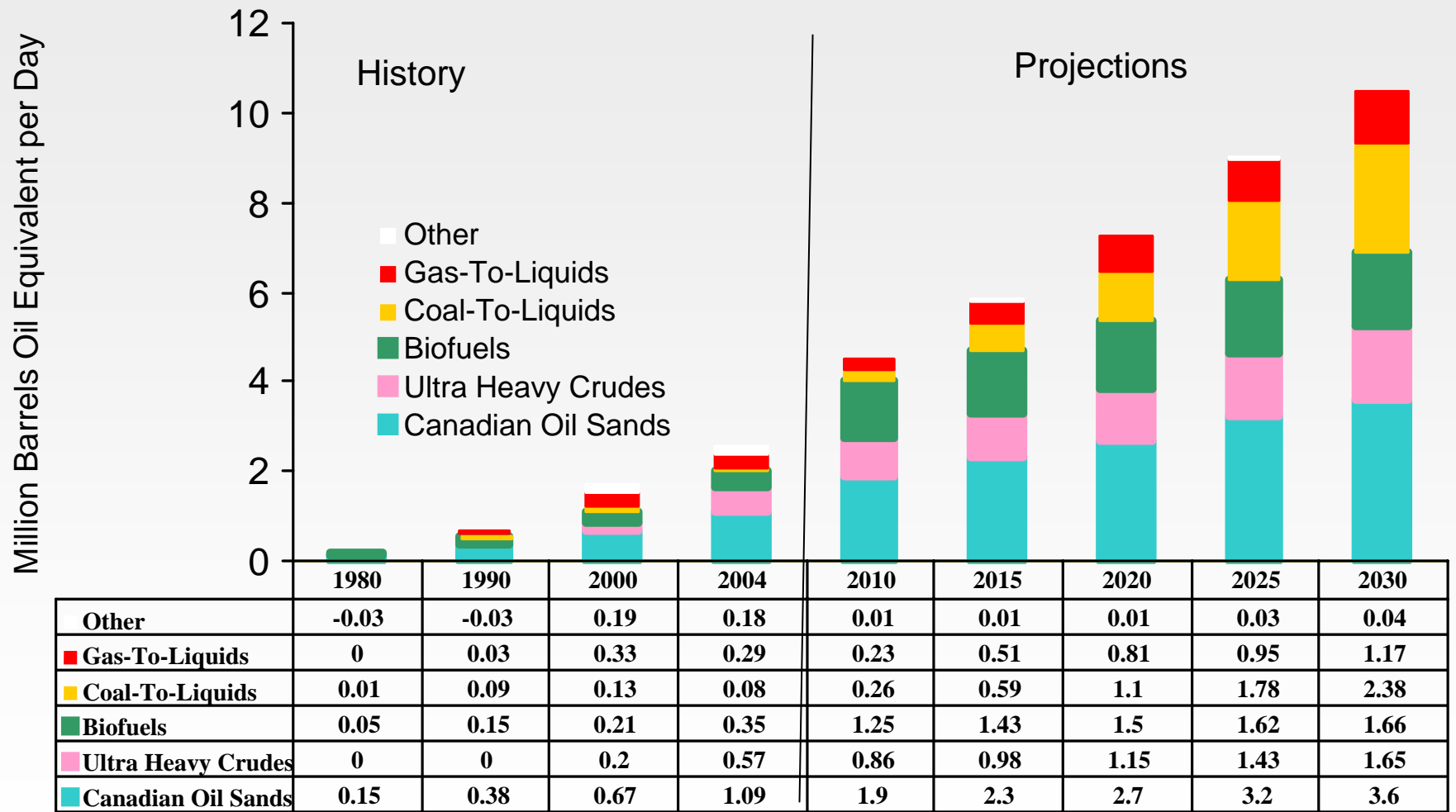
# World Unconventional Liquids Production as Percent of Total: 2005-2030



**Average world oil prices in 2030 are \$36, \$59, and \$100 per barrel in 2030**

Source: DOE/EIA AEO 2007.

# World Unconventional Liquids Production in the Reference Case, 1980-2030



Note: "Other" includes shale oils and other unidentified sources of unconventional liquid fuels. Source: EIA, IEO2007

# Oil Production Risks

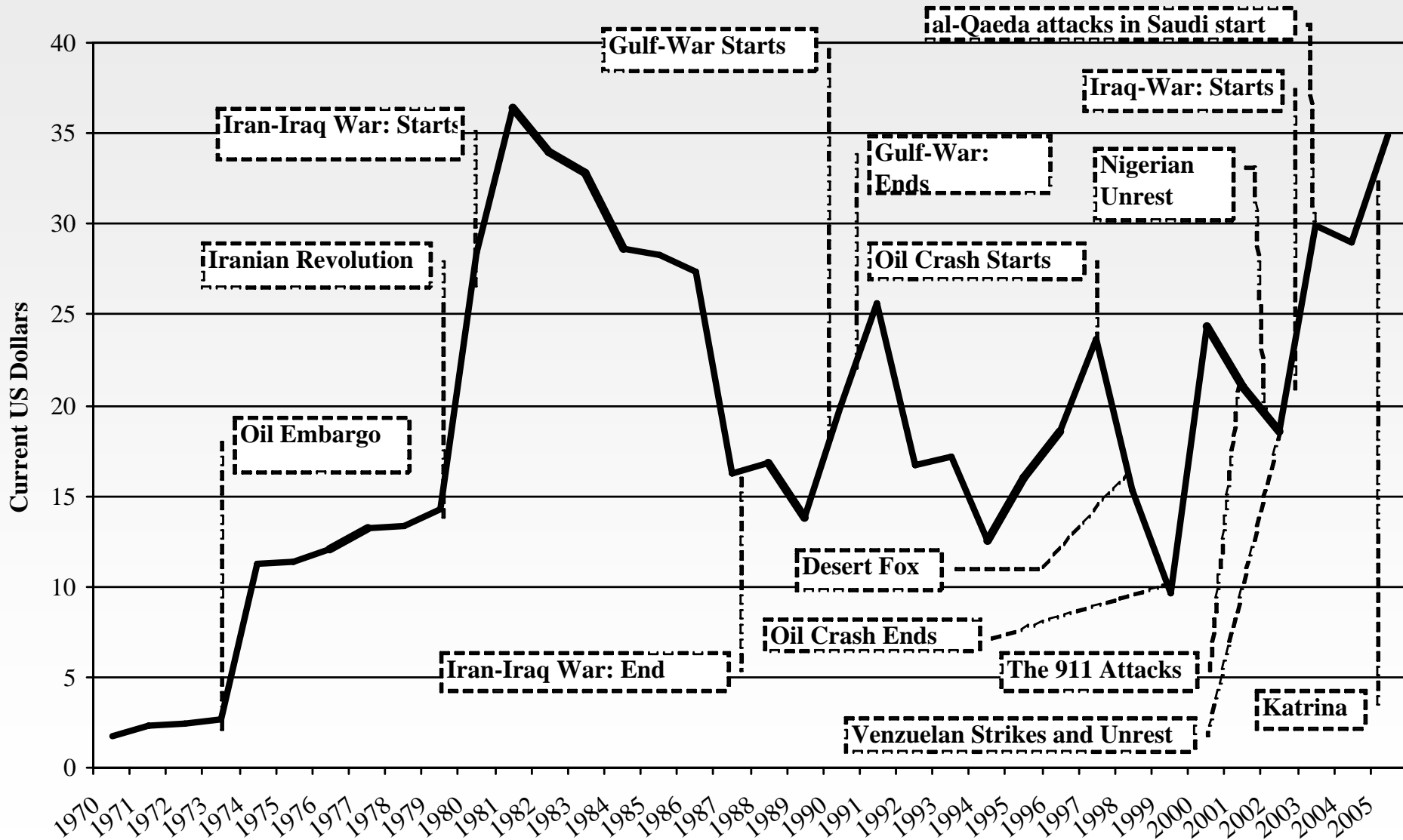
# Market is Only Part of the Story: Impact of Oil Disruptions

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

# Current DOE/EIA Oil and Gas “Hotspots”

<u>Country/Region</u>	<u>Thousands of BB/D</u>	
	<u>in 2004</u>	<u>in 2010</u>
Algeria (Gas and Oil)	1,900	2,000
Bolivia (24 Tcf)	40	45
Caspian Sea (Gas & Oil)	1,800	2,400-5,000
Caucasus Region (Gas & Oil)	( pipeline transit)	
Columbia	351	450
Ecuador	535	850
Indonesia (Oil shifting to Gas)	900	1,500
Iran (Gas and Oil)	4,100	4,000
Iraq	2,025	3,700
Libya Gas and Oil)	1,600	2,000

# Current DOE/EIA Oil and Gas “Hotspots” II

<u>Country/Region</u>	<u>Thousands of BB/D</u>	
	<u>in 2004</u>	<u>in 2010</u>
Nigeria	2,500	2,600
Russia (Gas & Oil)	9,300	11,100
Saudi Arabia (gas & Oil)	10,400	13,200
Sudan	344	530
Venezuela	2,900	3,700
<b>Total “at Risk”</b>	<b>38,895</b>	<b>45.475</b>

Adapted from DOE/EIA, “World Energy Hostpots,”

[http://www.eia.doe.gov/emeu/cabs/World\\_Energy\\_Hotspots/Overview.html](http://www.eia.doe.gov/emeu/cabs/World_Energy_Hotspots/Overview.html)

# Global Chokepoints 1

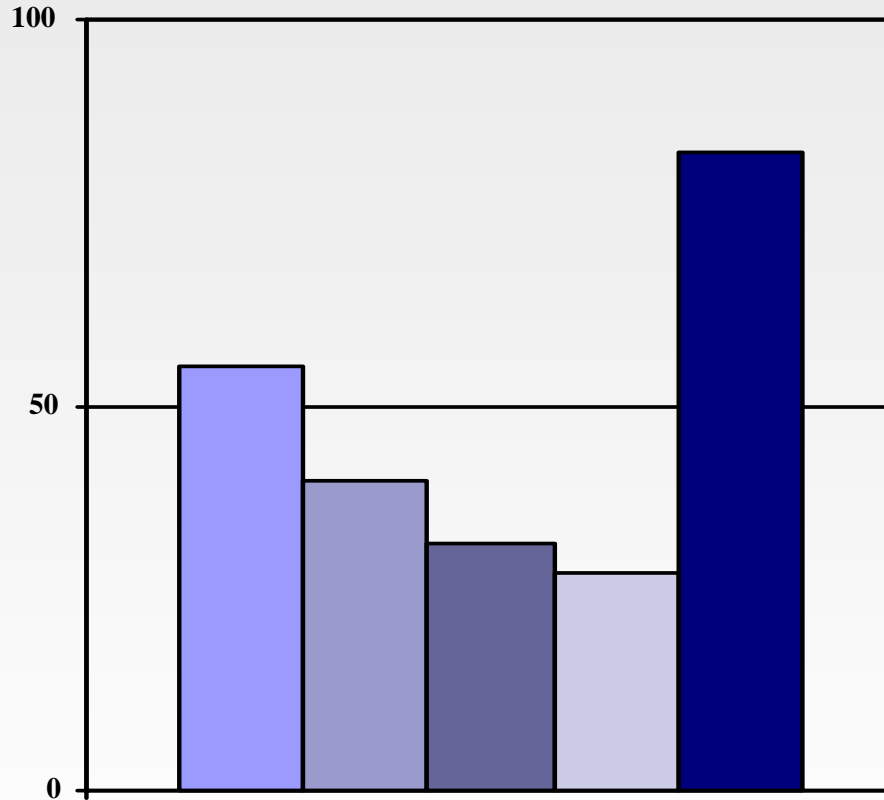
- Bab el-Mandab Closure could keep tankers from Gulf from reaching the Suez Canal/Sumed pipeline complex, diverting them around the southern tip of Africa
  - Oil Flows: 3 million bbl/d
  - Destination of Oil Exports: Europe, United States, Asia
  
- Bosphorus Export routes for production from the Caspian Sea region pass westwards through the Black Sea and the Turkish Straits en route to the Mediterranean Sea and world markets.
  - Oil Flows: 3.1 million bbl/d
  - Destination of Oil Exports: Western and Southern Europe
  
- Strait of Hormuz The Strait of Hormuz is by far the world's most important chokepoint: Oman/Iran; connects Persian Gulf with the Gulf of Oman and the Arabian Sea
  - Oil Flows: 17.0 million bbl/d
  - Destination of Oil Exports: Japan, United States, Western Europe

# Global Chokepoints: 2

- **Malacca:** Connects the Indian Ocean with the South China Sea and the Pacific Ocean.
  - Oil Flows: 11.7 million bbl/d
  - Destination of Oil Exports: Japan, South Korea, China, other Pacific Rim countries
  
- **Panama Canal:** United States is not heavily reliant on the Panama Canal for its petroleum imports.
  - Location: Panama; connects the Pacific Ocean with the Caribbean Sea and Atlantic Ocean
  - Oil Flows): 0.5 million bbl/d; Trans-Panama pipeline 0.1 million bbl/d
  
- **Suez/Sumed:** Closure of the Suez Canal and/or Sumed Pipeline would divert tankers around the southern tip of Africa , adding greatly to transit time.
  - Oil Flow): 3.8 million bbl/d northbound, and 0.4 million bbl/d southbound.
  - Destination of Sumed Oil Exports: Predominantly Europe; also United States.
  
- [http://www.eia.doe.gov/cabs/World\\_Oil\\_Transit\\_Chokepoints/Full.html](http://www.eia.doe.gov/cabs/World_Oil_Transit_Chokepoints/Full.html)

# Gulf Oil Dynamics

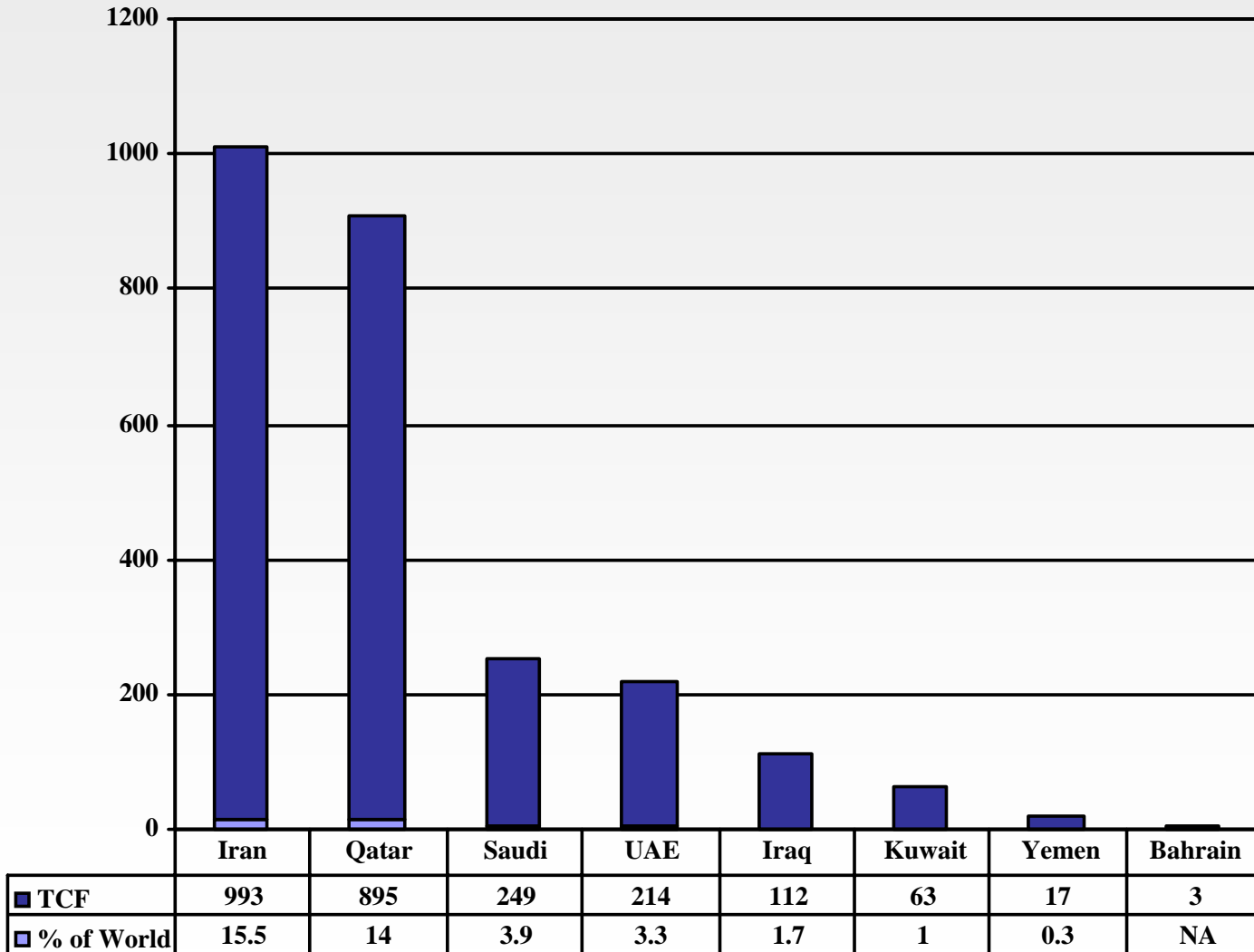
# Gulf Energy as Percent of World



■ Crude Oil Reserves	55
■ Natural Gas Reserves	40
■ Oil Production Capacity	32
■ Oil Production	28
■ Excess Oil Production Capacity	83

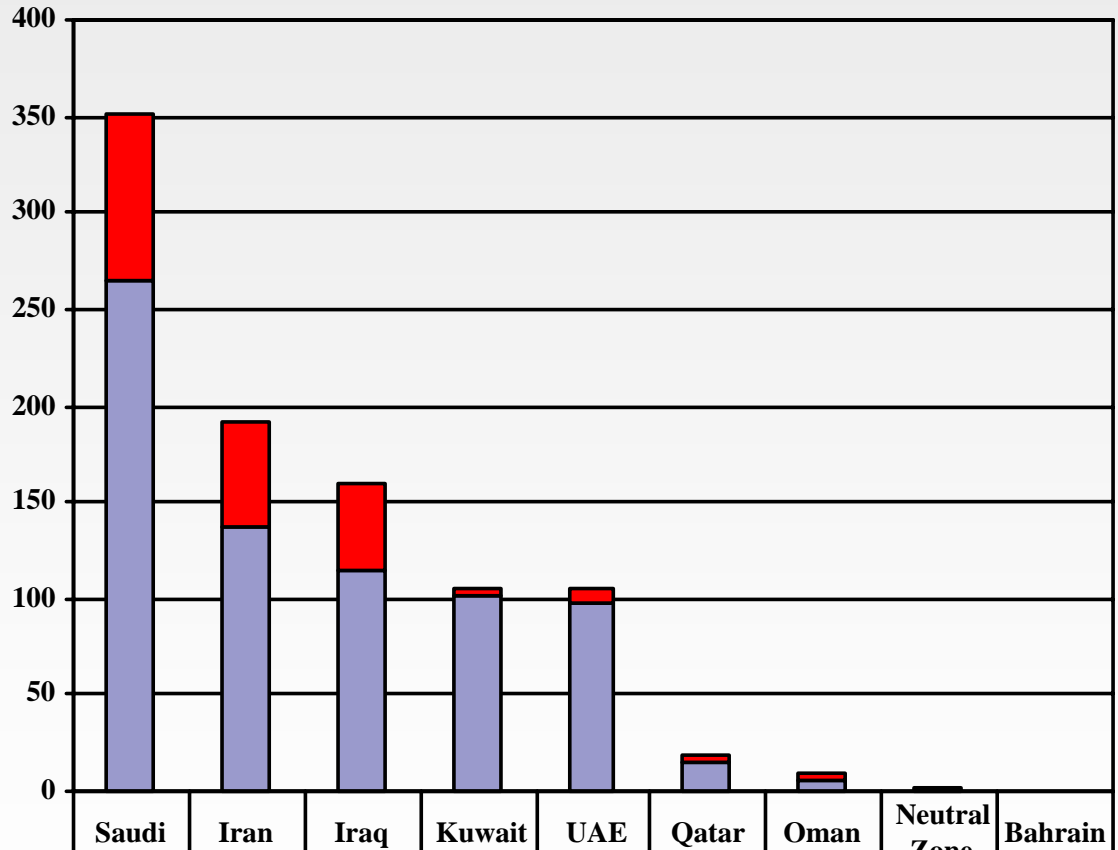
# Gulf Proven Natural Gas Reserves

(In Trillions of Cubic Feet)



# Gulf Proven & Undiscovered Conventional Oil Reserves

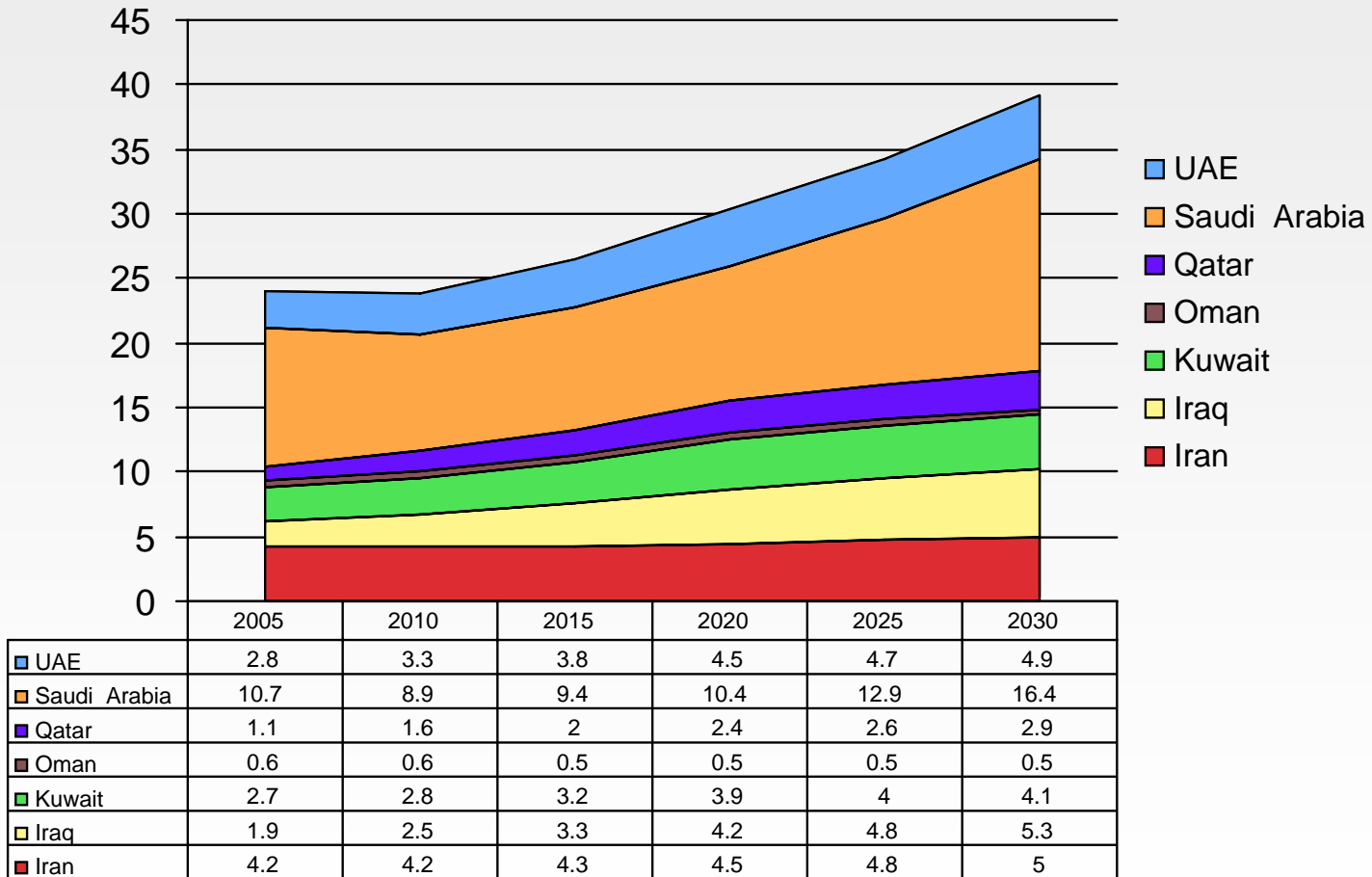
(In Billion Barrel of Oil)



■ % 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%
■ Undiscovered	87.09	53.11	45.10	3.84	7.70	3.62	3.45	0.00	0.90
■ Proven	264.30	137.50	115.00	101.50	97.80	15.20	5.60	2.50	?

# Gulf Oil Production: 2005-2030

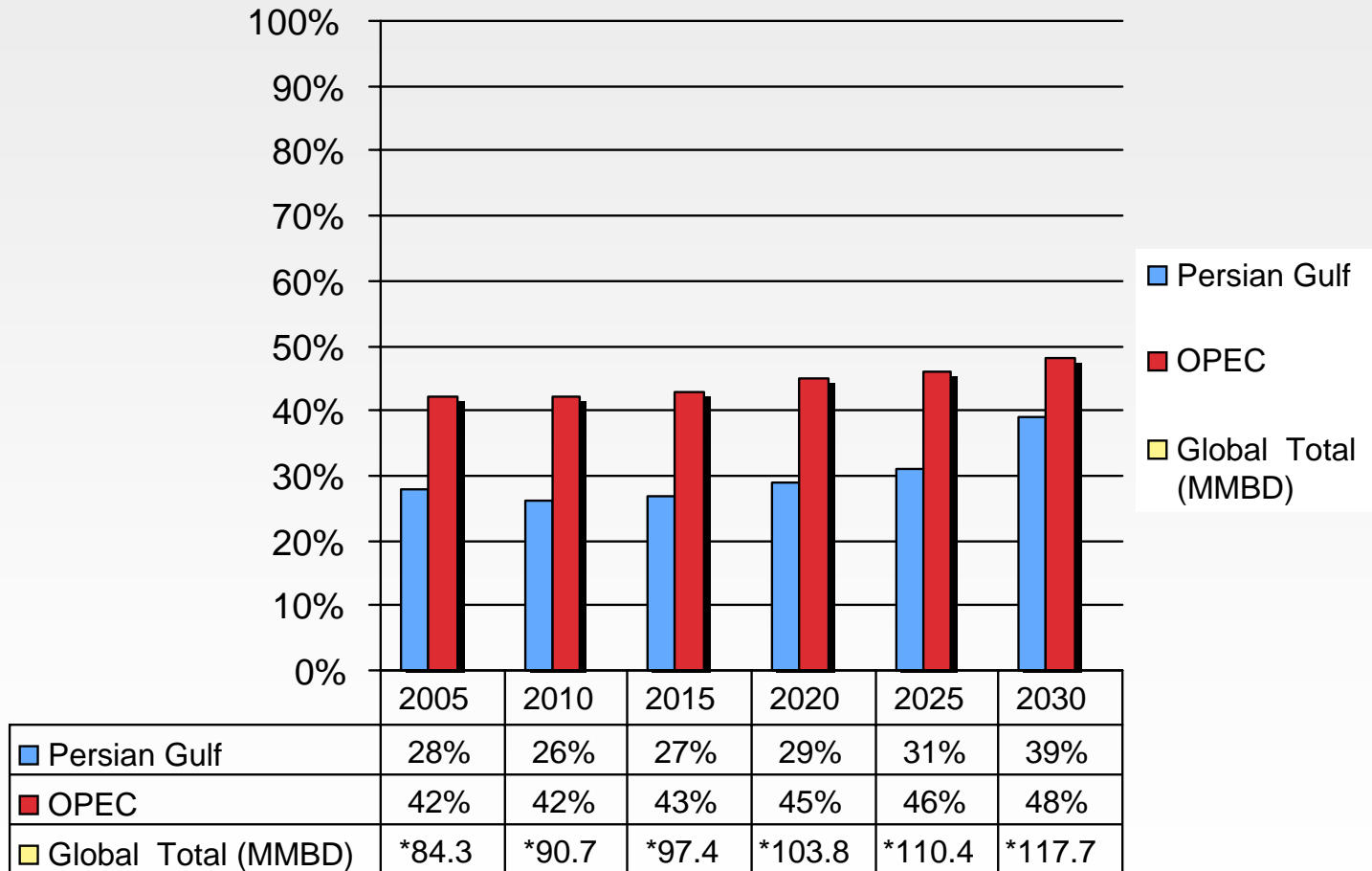
(In MMBBD in EIA/DOE Reference Case in IE0 2007)



**Average world oil prices in 2030 are \$36, \$59, and \$100 per barrel in 2030**

# Gulf Share of Global Oil Production: 2005-2030

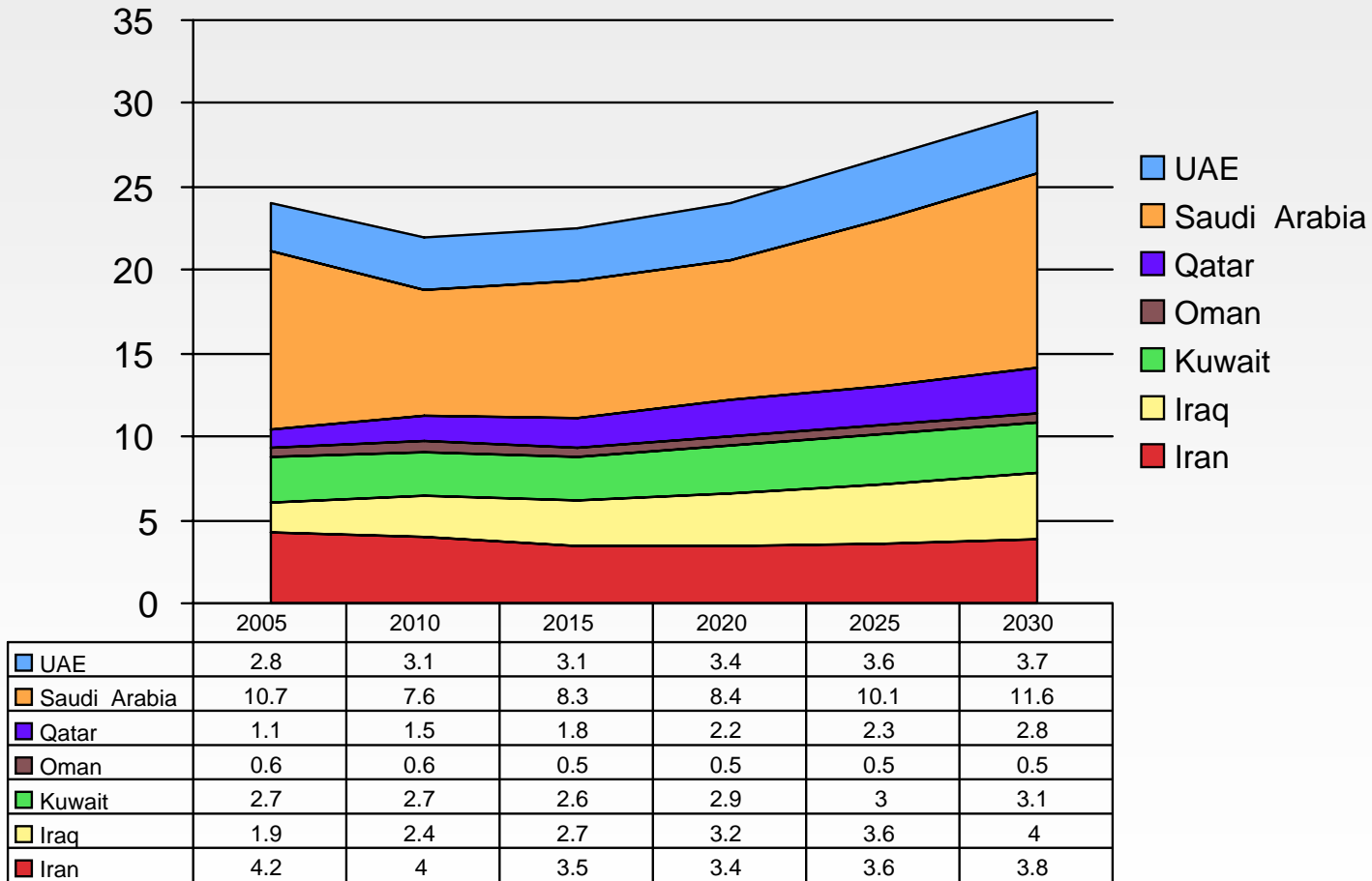
(In Percent in EIA/DOE reference case in IE0 2007)



**Average world oil prices in 2030 are \$36, \$59, and \$100 per barrel in 2030**

# Gulf Oil Production: 2005-2030

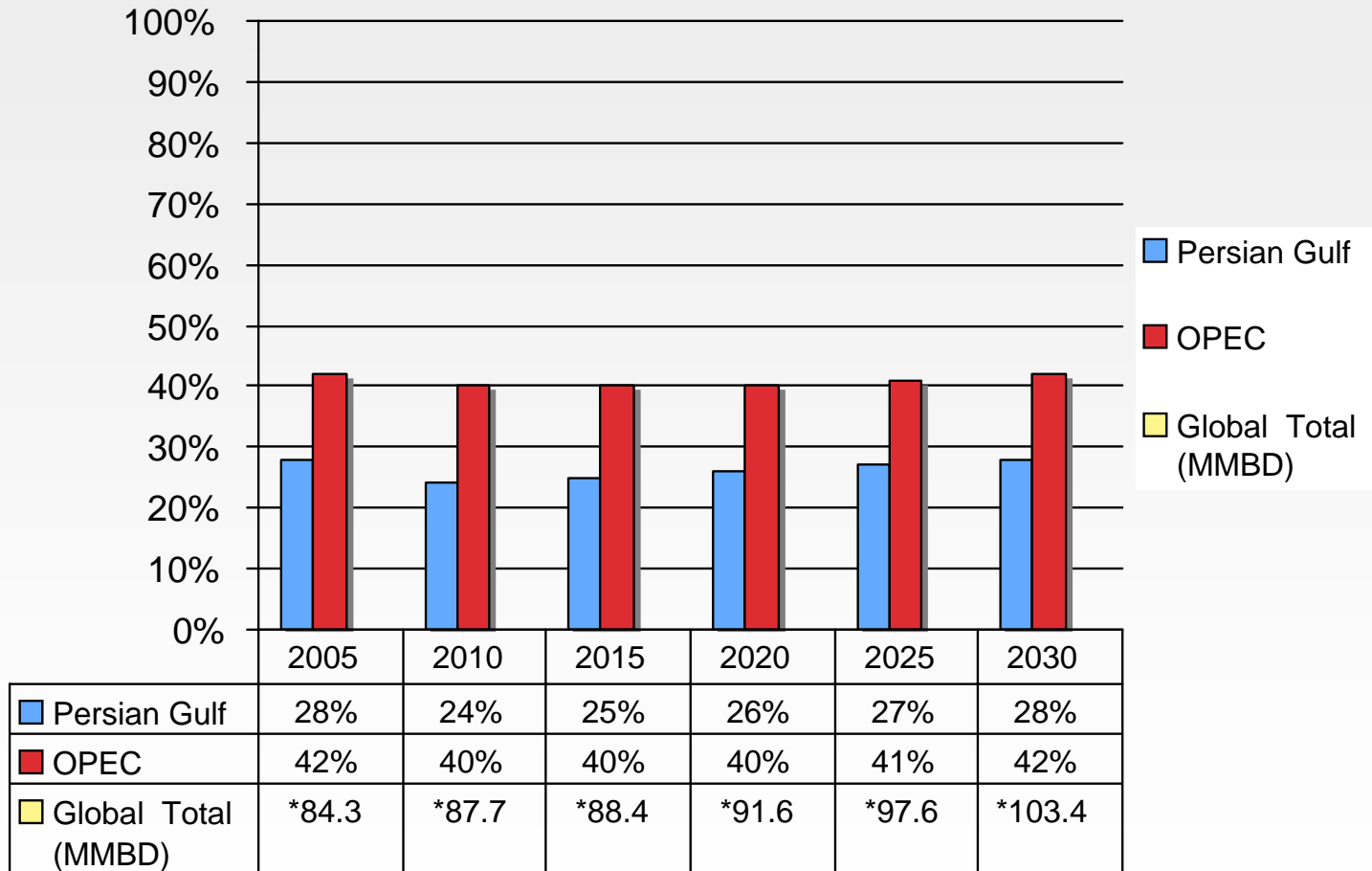
(In MMBBD in EIA/DOE high price case in IE0 2007)



**Average world oil prices in 2030 are \$36, \$59, and \$100 per barrel in 2030**

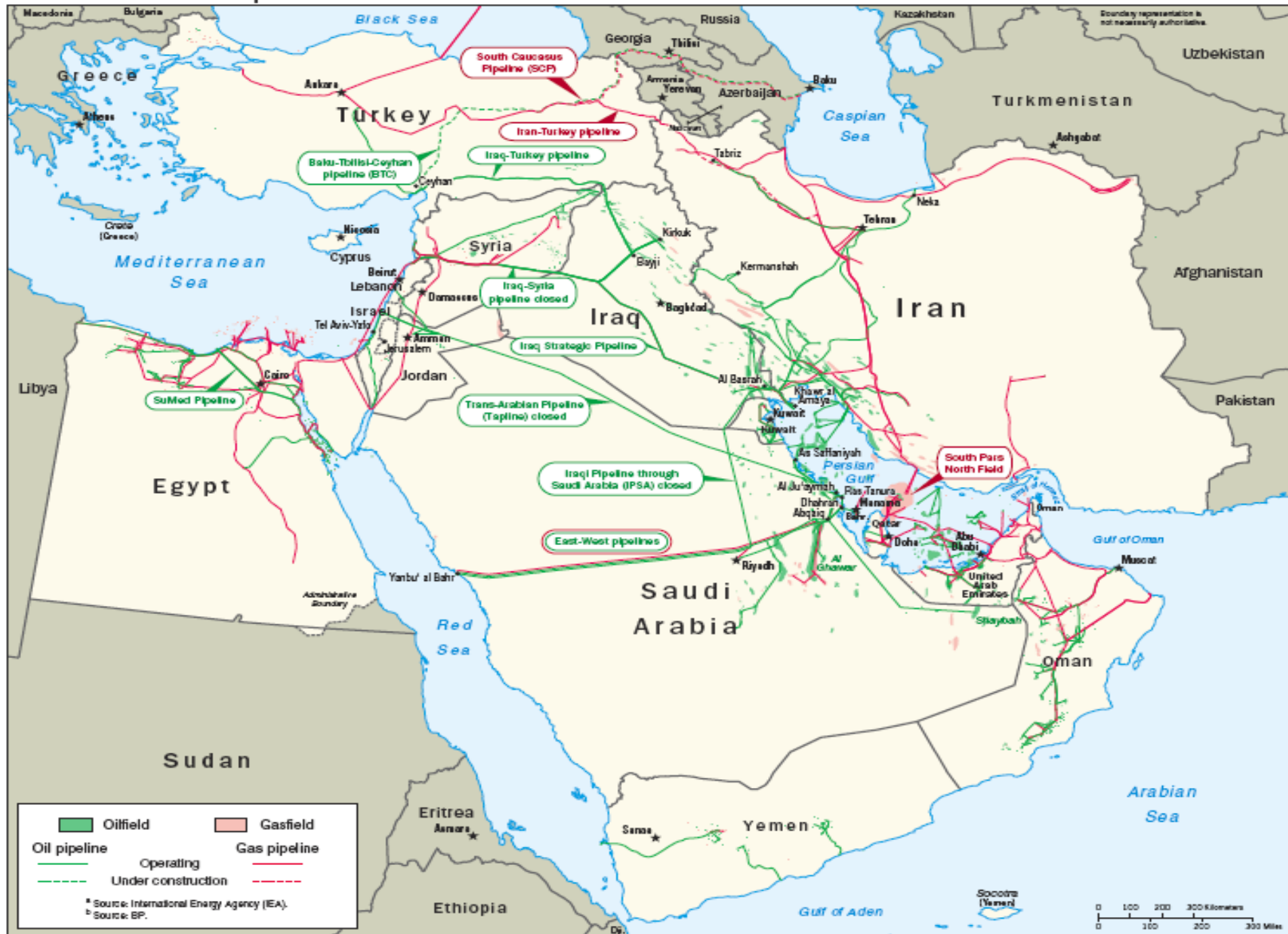
# Gulf Share of Global Oil Production: 2005-2030

(In Percent in EIA/DOE high price case in IE0 2007)



**Average world oil prices in 2030 are \$36, \$59, and \$100 per barrel in 2030**

# Selected Oil and Gas Pipeline Infrastructure in the Middle East



# Gulf Chokepoints 1

- **Strait of Hormuz:** Entrance to Gulf from Indian Ocean: The Strait of Hormuz is by far the world's most important chokepoint: Oman/Iran; connects Persian Gulf with the Gulf of Oman and the Arabian Sea
  - Oil Flows: 17.0 million bbl/d
- **Bab el-Mandab:** Entrance to Red Sea From Indian Ocean: Closure could keep tankers from Gulf from reaching the Suez Canal/Sumed pipeline complex, diverting them around the southern tip of Africa
  - Oil Flows: 3 million bbl/d
- **East-West Pipeline:** Abqaiq to Yanbu on Red Sea:
  - Oil Flows: 5 million bbl/d.
- **Abqaiq-Yanbu NGL:** Abqaiq to Yanbu on Red Sea:
  - Oil Flows: 0.55 million bbl/d.
- **Trans-Arabian:** Saudi Arabia to Jordan:
  - Oil Flows: 0.05 million bbl/d.

# Gulf Chokepoints 2

- **IPSA:** Iraq to Saudi Arabia: Link from Southern Iraq closed. Saudi Arabia used it to carry gas to Yanbu.
  - Oil Flows: Conversion possible to 1.65 million bbl/d
- **Iraqi Strategic Pipeline:** North-South Pipeline in Iraq. Two parallel lines from Rumalia to Kirkuk to Turkey. Only one complete.
  - Oil Flows: Not functioning. 700,000 bbl/d with growth to 1.5 million bbl/d.
- **Iraq-Turkey Pipeline:** Kirkuk in Iraq to Ceyan in Turkey on the Mediterranean. Sporadic use.
  - Oil Flows: Two parallel lines with 1.5 million bb/d design capacity and 300,000 near term with repairs.
- **Iraq-Syria-Lebanon Pipeline:** Connects Kirkuk oil area to Banias in Syria. Use halted after 2003 invasion. Two pipelines with combined capacity of 700,000 bbl/d. Once carried 450,000-600,000 bbl/d/
  - Oil Flows: 200,000 bbl/d before 2003
- **Gulf Strategic Pipeline:** Plan to build lines to ports in Oman on Red Sea.
  - Oil Flows: 1.5 million bbl/d plus.

# Asymmetric Warfare: Iran as a Case Study

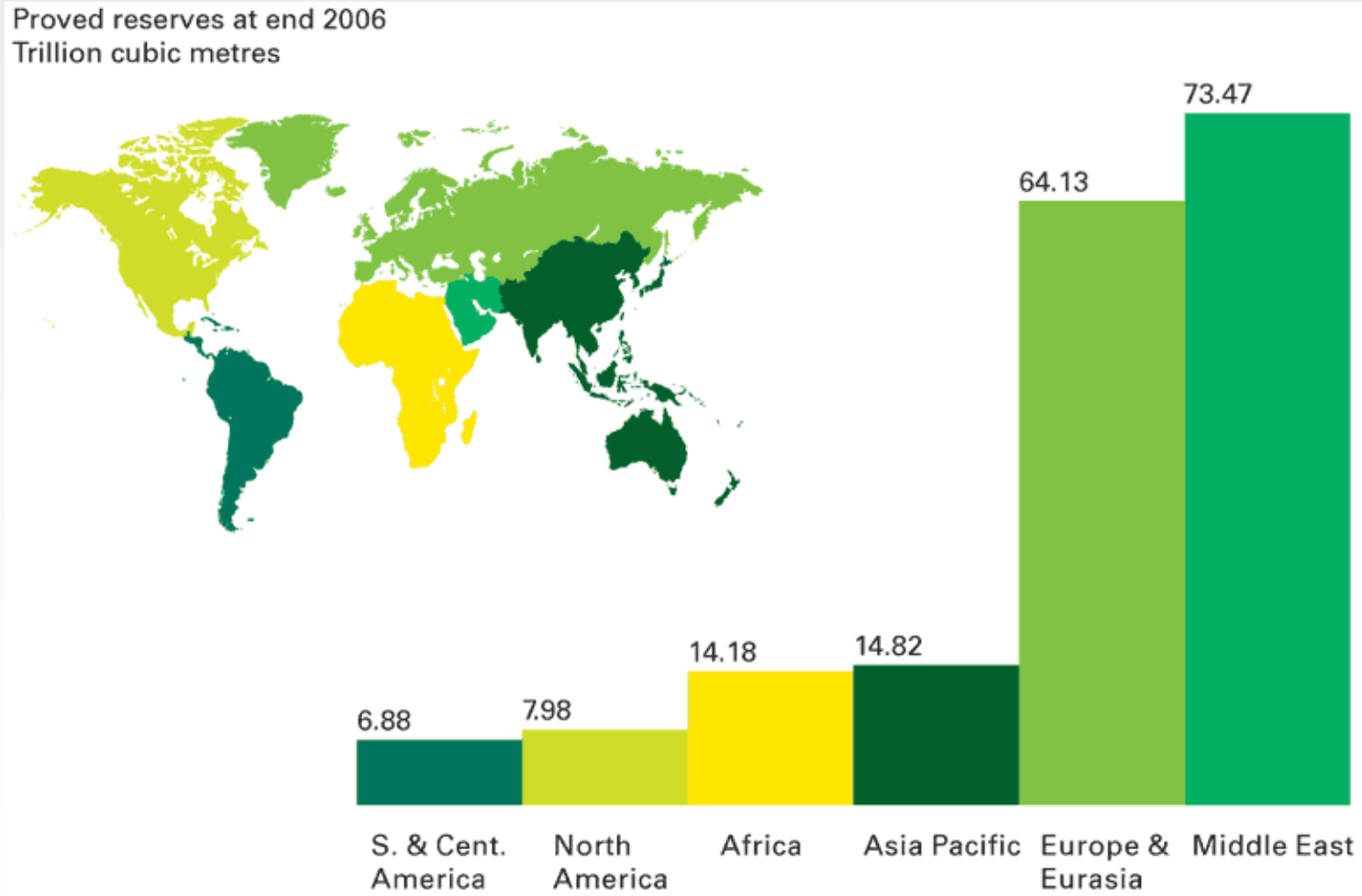
- **Three “Kilo” submarines with long-range wire-guided and homing torpedoes, bottom mines (?), anti-ship missiles**
- **Smart mines, bottom mines, influence mines.**
- **Ship, land, air anti-ship missiles.**
- **Small, “stealth” missile patrol boats**
- **20,000 men in Naval Guards Branch.**
- **Small craft armed with ATGMs, recoilless rifles, RPGs.**
- **Any ship is a mine layer.**
- **Floating mines.**
- **“Single round” attacks by infiltrator, sea, or air.**

# Global Gas Dynamics

# Gas Modeling and Vulnerability Still Limited

- Costs of expansion of capacity very uncertain on global level as is technology gain.
- Expect to become major source of global exports-imports.
- Many pipeline and LNG project have very uncertain timing, cost and viability.
- Competitiveness with other energy sources and oil exports very uncertain

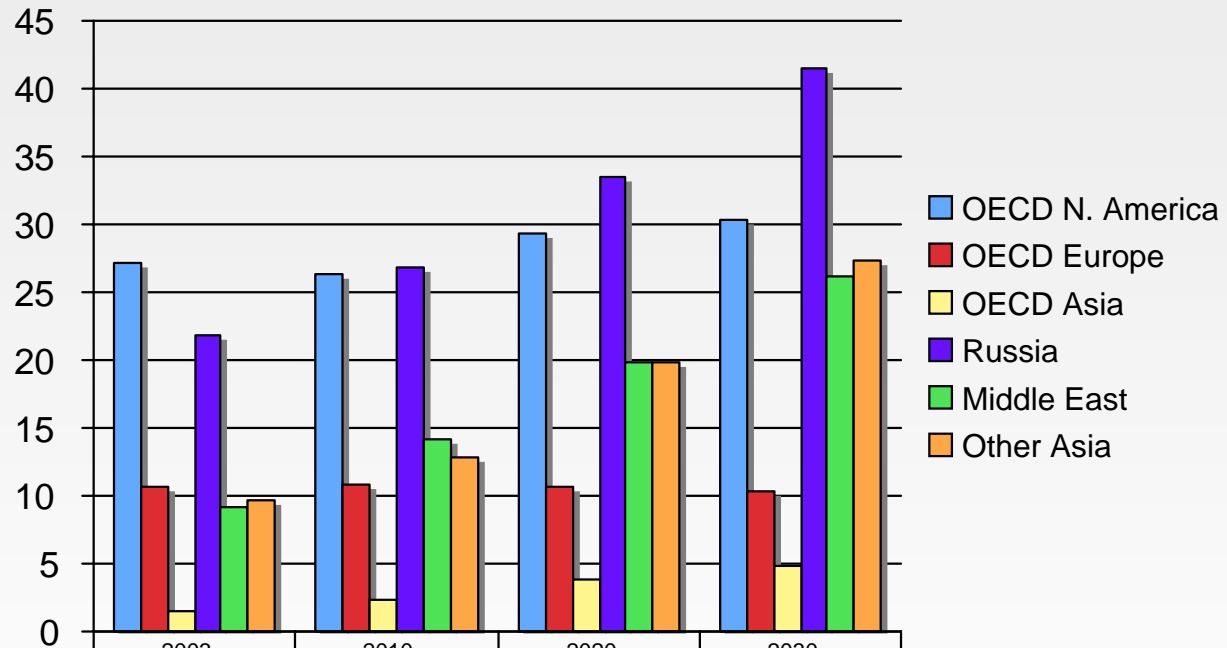
# Proved Natural Gas Reserves at End 2006



Source: BP Amoco Statistical Review of Energy 2007

# Key Gas Producers: 2003-2030

(In TCF in EIA/DOE reference case in IE0 2006)



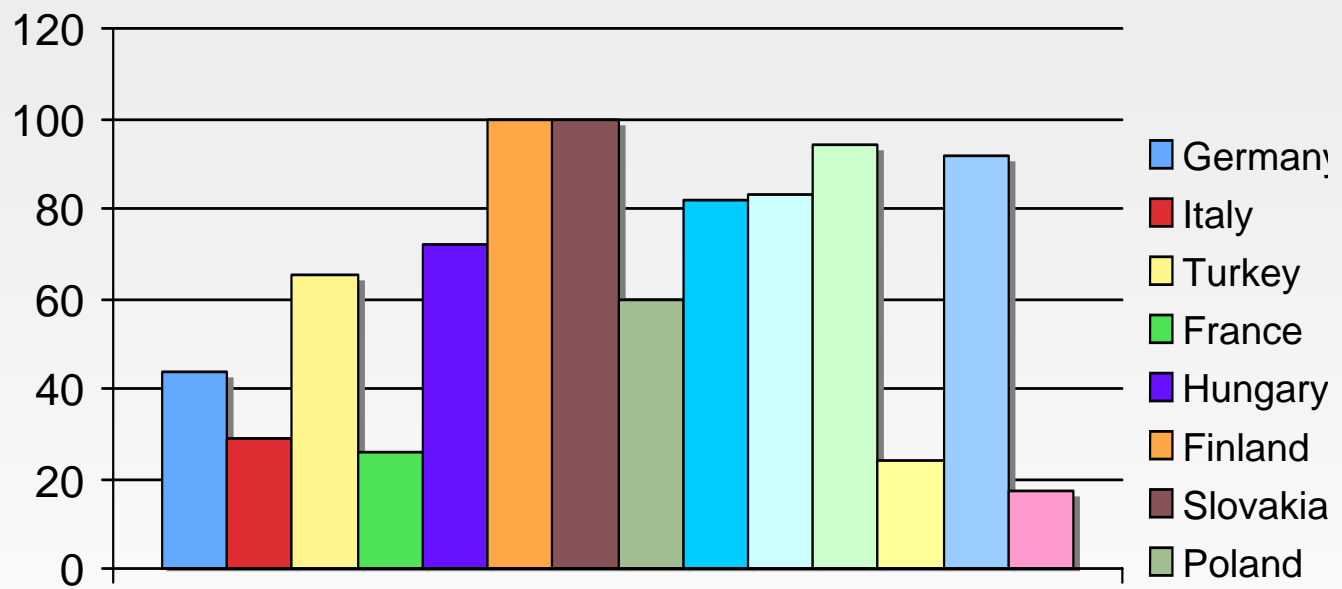
	2003	2010	2020	2030
OECD N. America	27.1	26.4	29.3	30.4
OECD Europe	10.7	10.9	10.7	10.3
OECD Asia	1.5	2.4	3.9	4.8
Russia	21.8	26.8	33.5	41.5
Middle East	9.1	14.2	19.8	26.2
Other Asia	9.7	12.9	19.9	27.4

# The Russian Gas and Energy Issue

- **Critical European Dependence**
  - Gas reserves of 1.680 TcF, Prod 22.4 Tcf, Exp 7.1 TcF.
  - Oil reserves of 60 billion proved+67 billion prob/poss.
- **Uncertain ability to reach projected production.**
  - Gas rises from 21.8 TCF in 2003 to 41.5 in 2030.
  - Oil from 8/5 MMBD to 11.6 MMBD.
- **Cost of investment to reach these levels unknown.**
- **Major pipeline issues to Europe. China, and control of Caspian and Central Asia.**
- **Bypass Eastern Europe?**

# European Dependence on Russia

Percentage of total natural gas consumption in order of total volume imported. EIA, IEO 2006



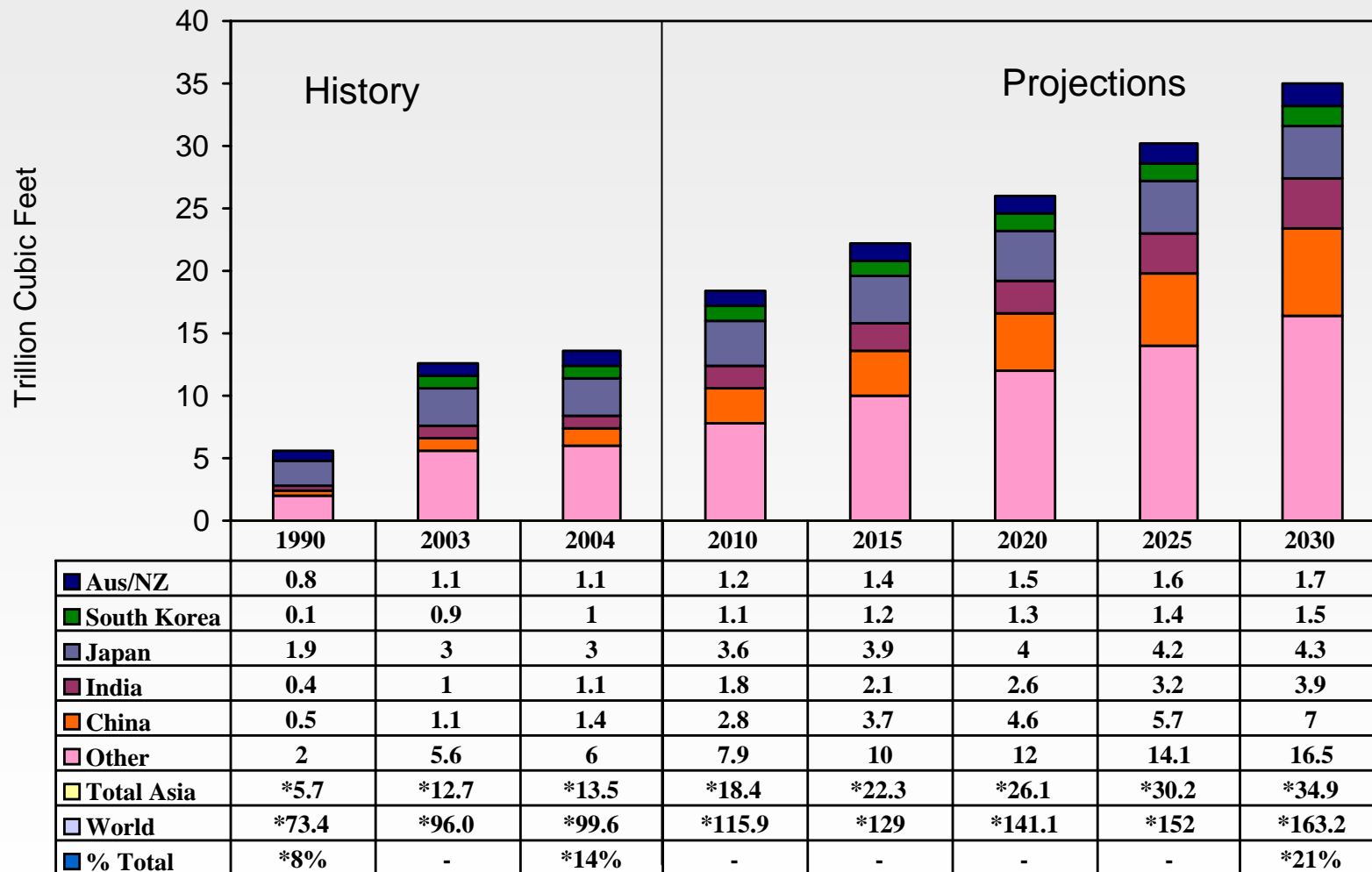
Germany	44
Italy	29
Turkey	65
France	26
Hungary	72
Finland	100
Slovakia	100
Poland	60
Czech	82
Austria	83
Bulgaria	94
Romania	25
Greece	92
Swiss	18

# Asian Gas Dependence

- Non-OECD Asia accounts for much of the growth in natural gas demand projected for the non-OECD region.
- Led by demand in China and India, natural gas consumption in non-OECD Asia expands by 5.1 percent per year on average from 2003 to 2030.
- In both China and India, natural gas is currently a minor fuel in the overall energy mix, representing only 3 percent and 7 percent, respectively, of total primary energy consumption in 2003;
- Both countries are rapidly expanding infrastructure to facilitate natural gas consumption, as well as natural gas imports. In the reference case, natural gas consumption grows at an average annual rate of 6.8 percent in China and 5.9 percent in India.

Source: DOE/EIA, IEO 2006, "Natural Gas"

# Asian Natural Gas Consumption in the EIA Reference Case, 1990-2030



Source: EIA, IEO2007, Appendix A, p. 89