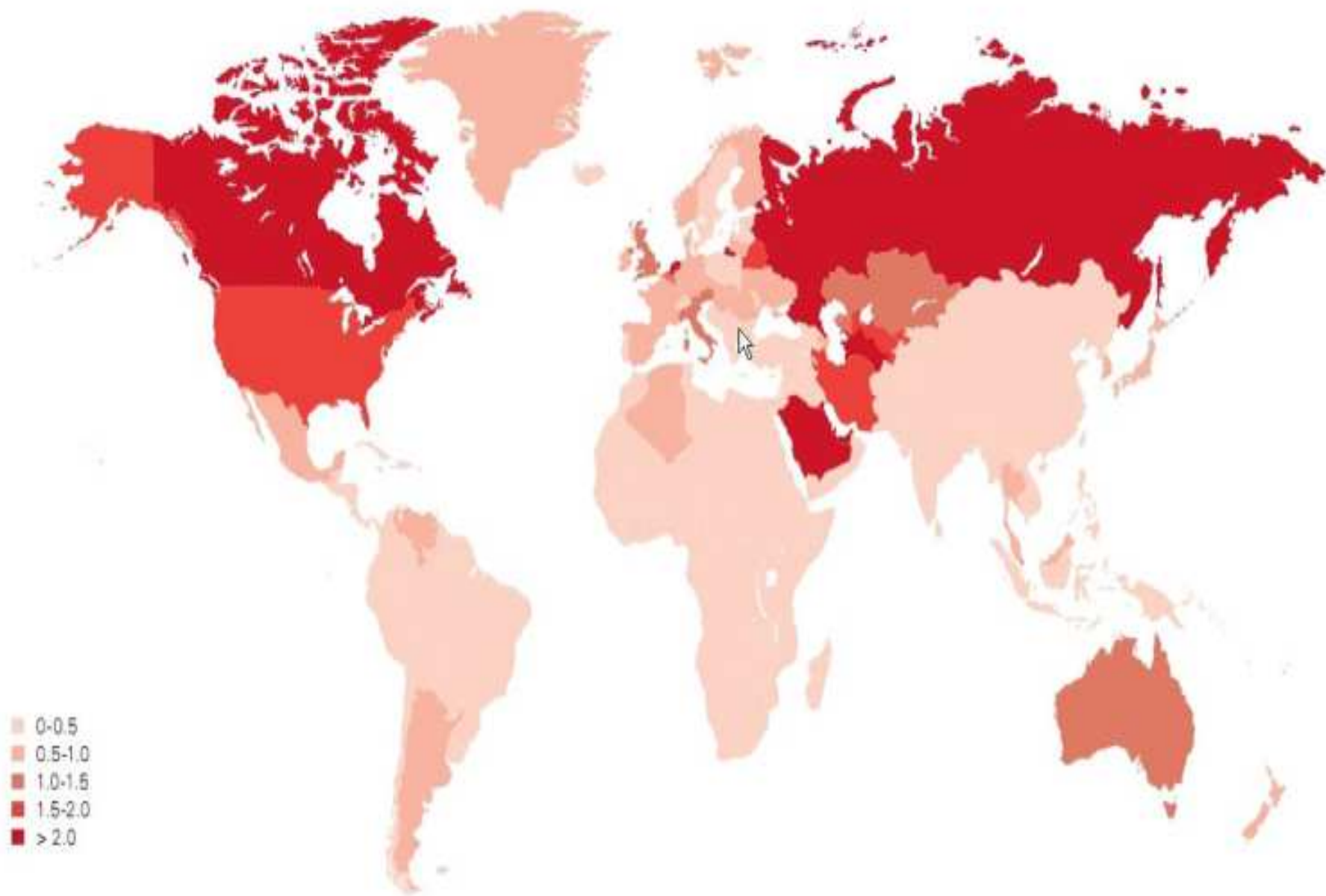


NATURAL GAS, LNG and COAL

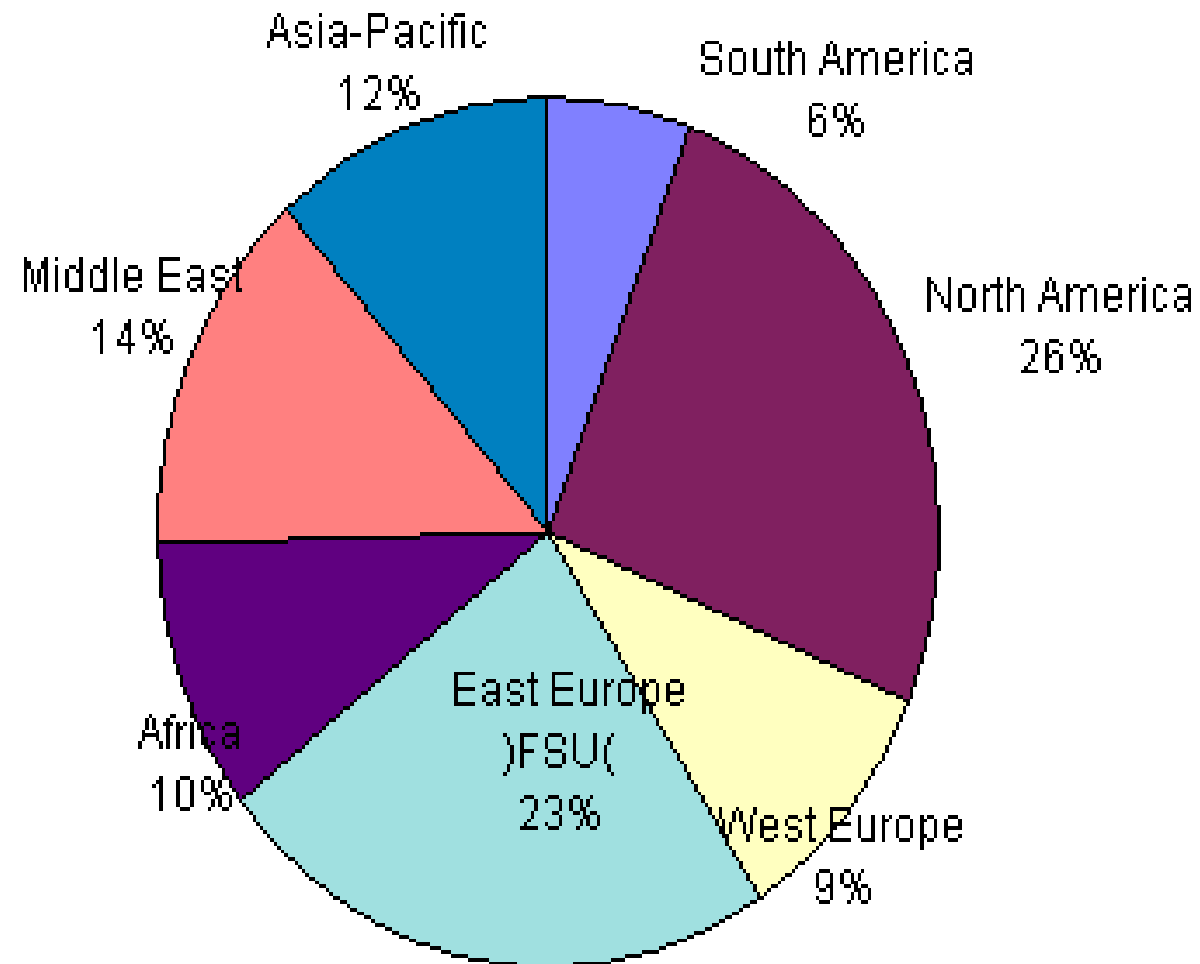
USE, RESERVES & PRICES

Consumption per capita 2009

Tonnes oil equivalent

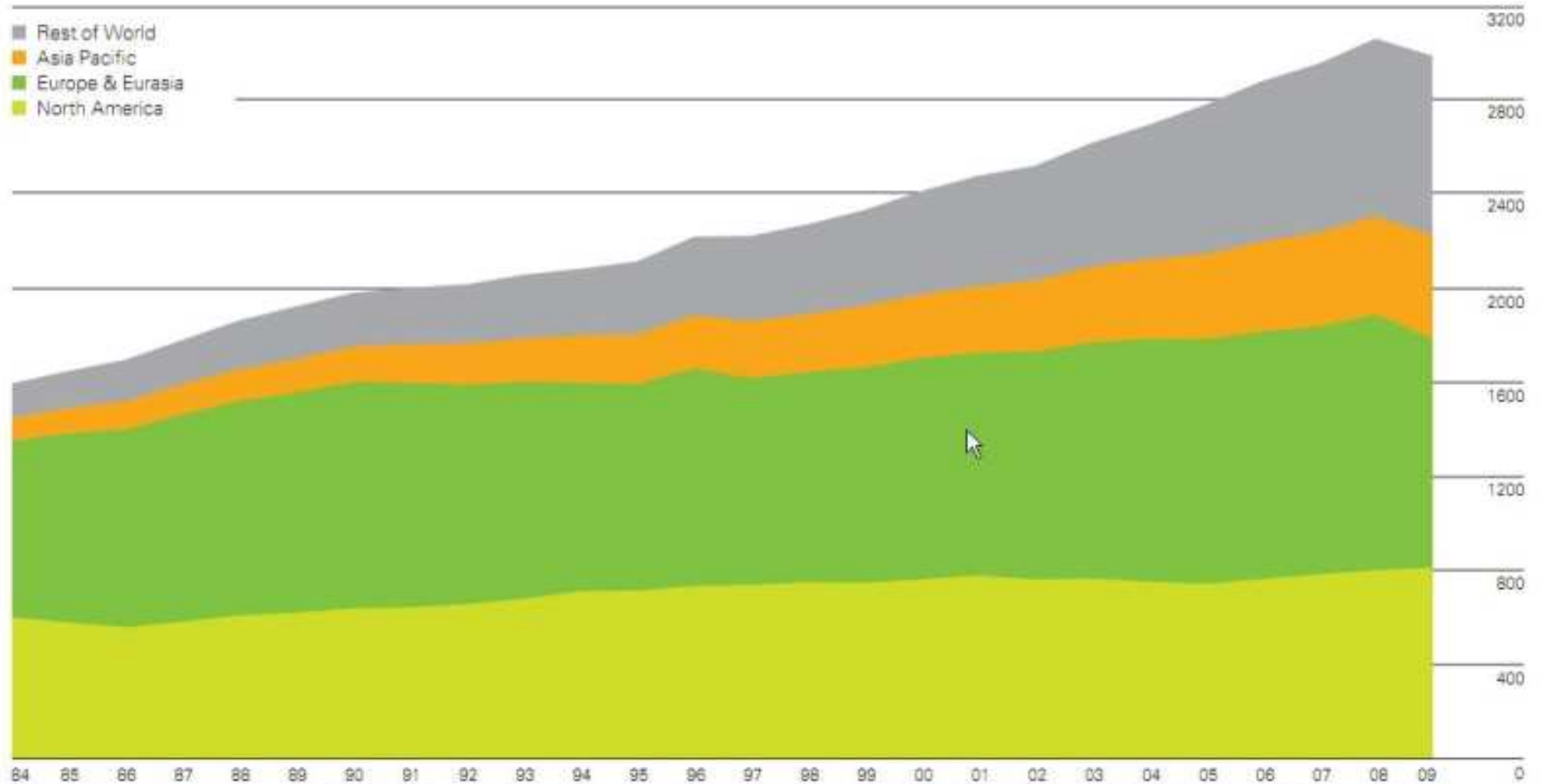


World Gas Production - 2008



Production by region

Billion cubic metres



Global natural gas production fell by 2.1% in 2009, the first decline on record. Production fell sharply in Russia (-74.2bcm) and Turkmenistan (-29.7bcm), in each case the largest decline on record. The US recorded the largest increase in the world for the third consecutive year.

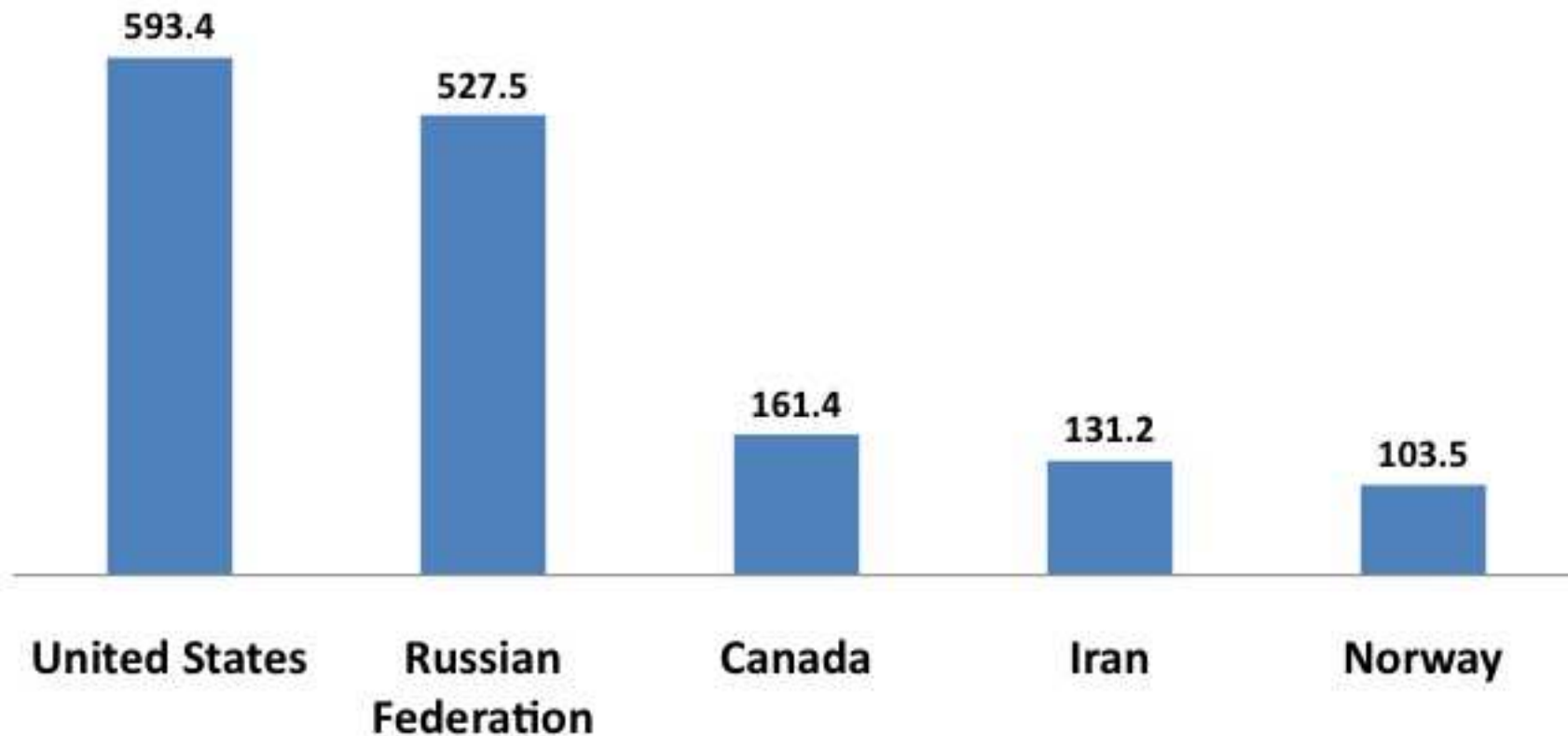
Reserves-to-production (R/P) ratios

Years

2009 by region

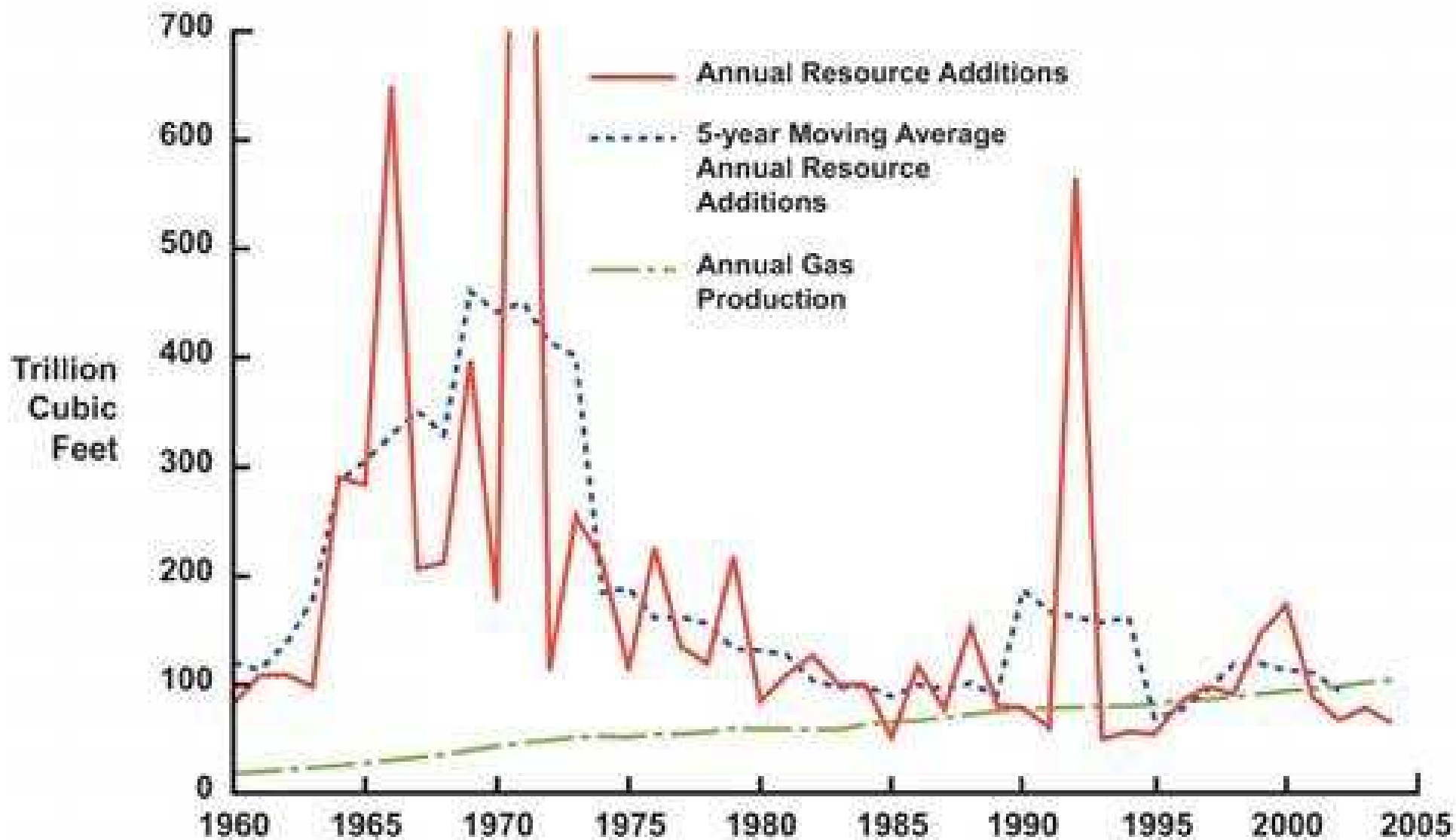
Five Largest Producers of Natural Gas, 2009

(billion cubic meters)



Source: BP Statistical Review of World Energy, June 2010

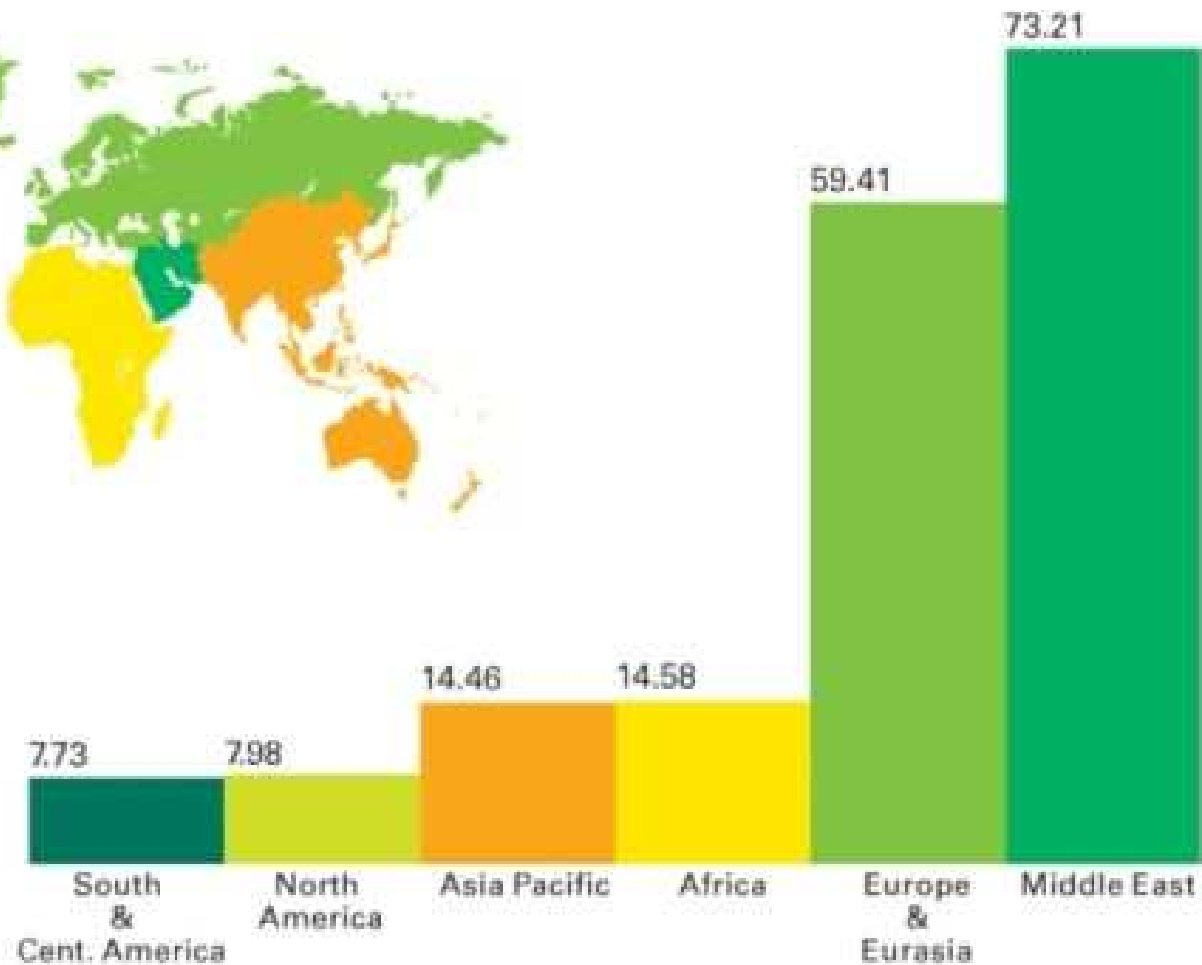
Reserves (pre-2011)



Proved natural gas reserves at end 2007

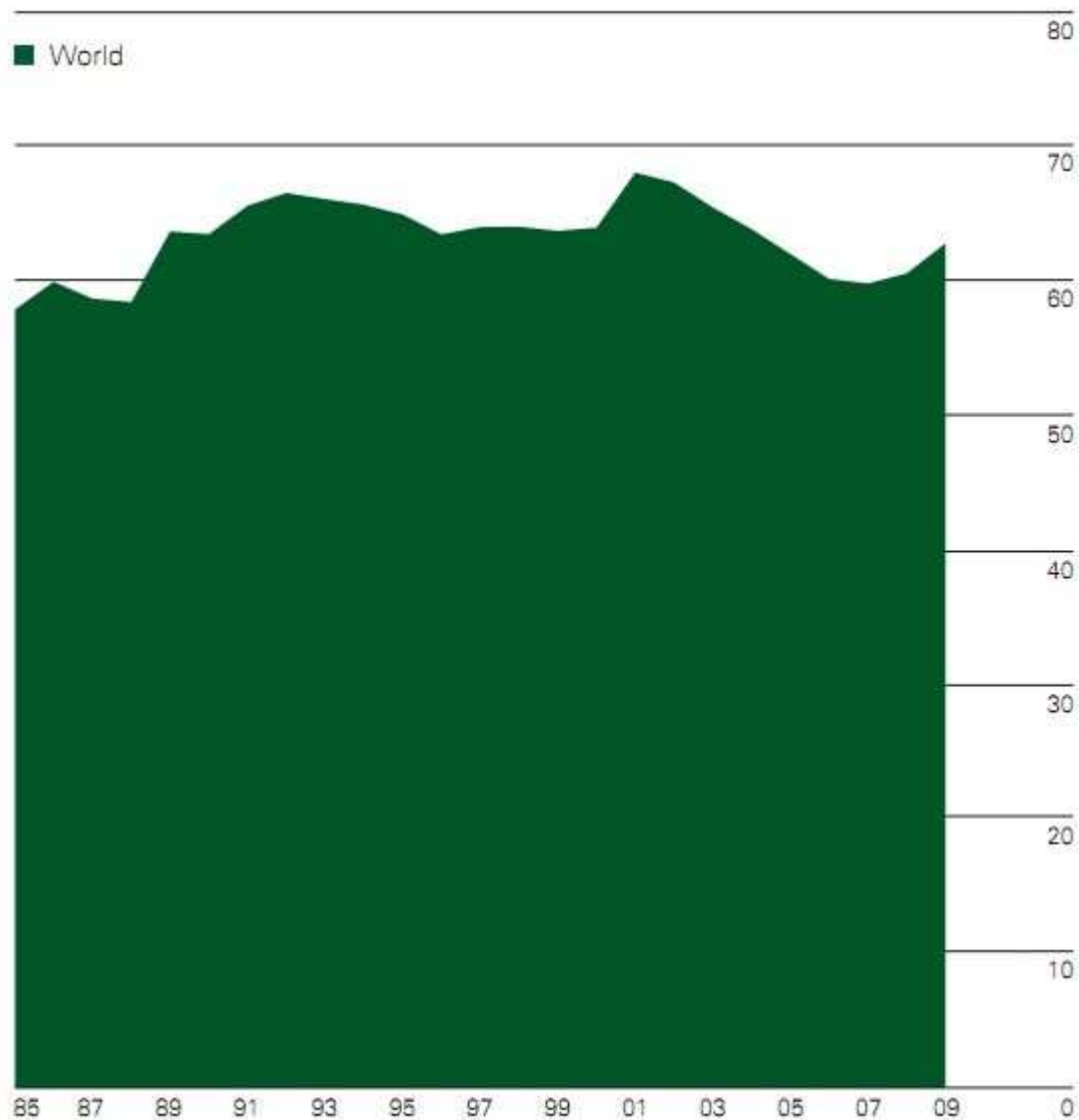


Proved reserves at end 2007
Trillion cubic metres



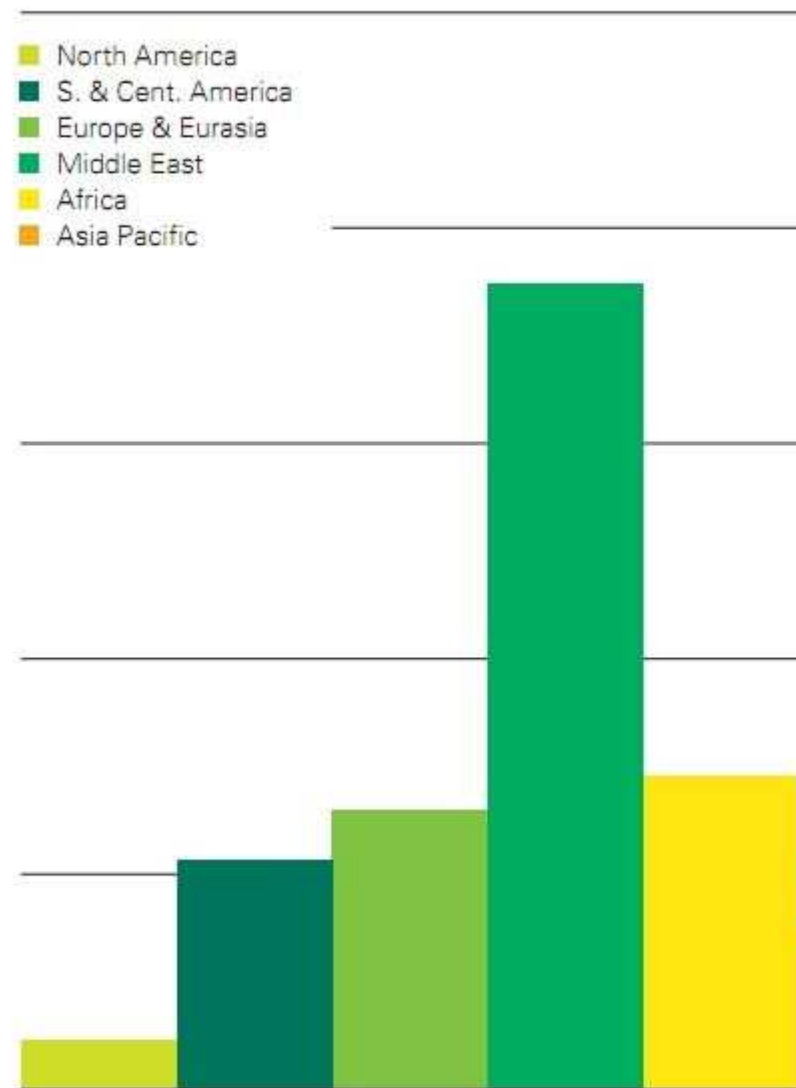
Reserves-to-production (R/P) ratios

Years



2009 by region

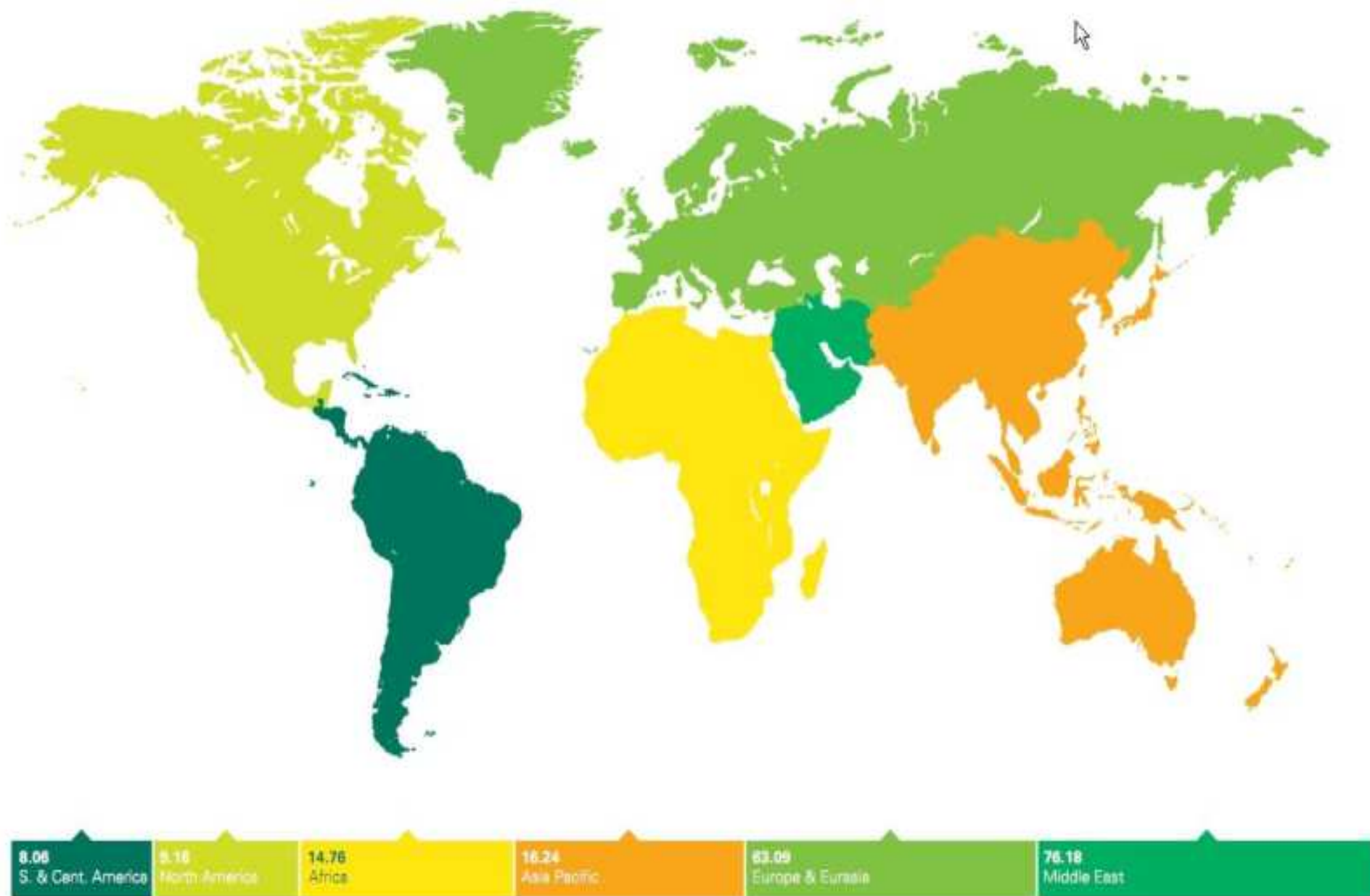
- North America
- S. & Cent. America
- Europe & Eurasia
- Middle East
- Africa
- Asia Pacific



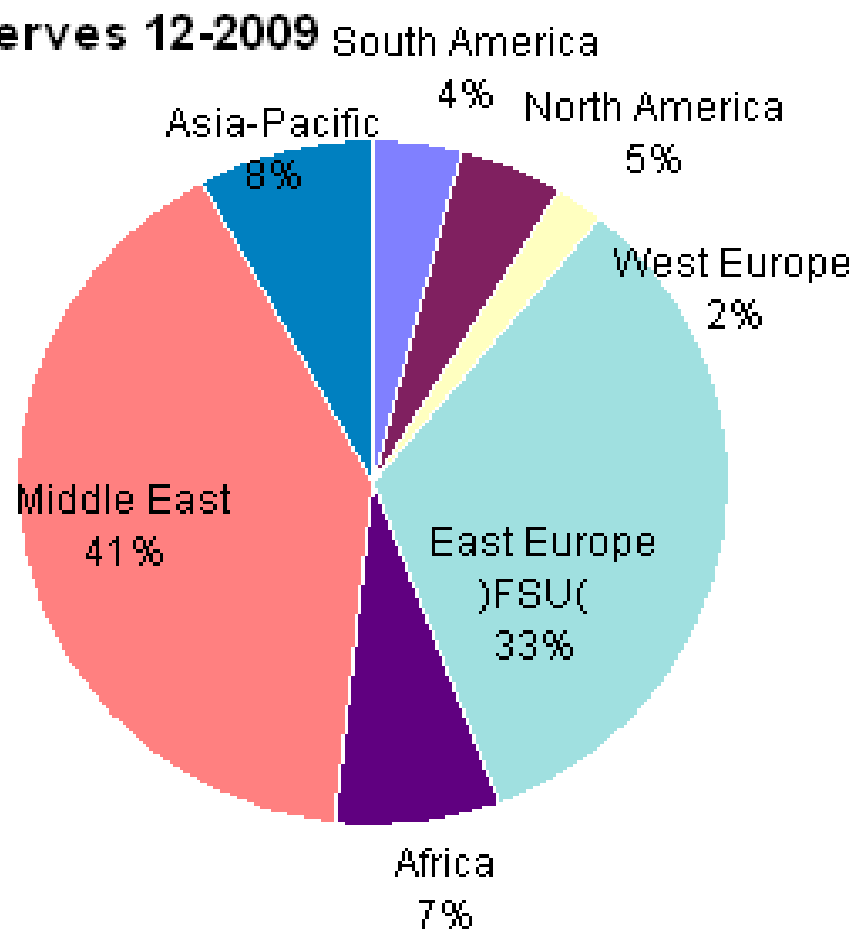
World proved reserves of natural gas grew by 2.21 trillion cubic metres in 2009, driven by increases in Russia, Venezuela and Saudi Arabia. The global R/P ratio rose to 62.8 years.

Proved reserves at end 2009

Trillion cubic metres



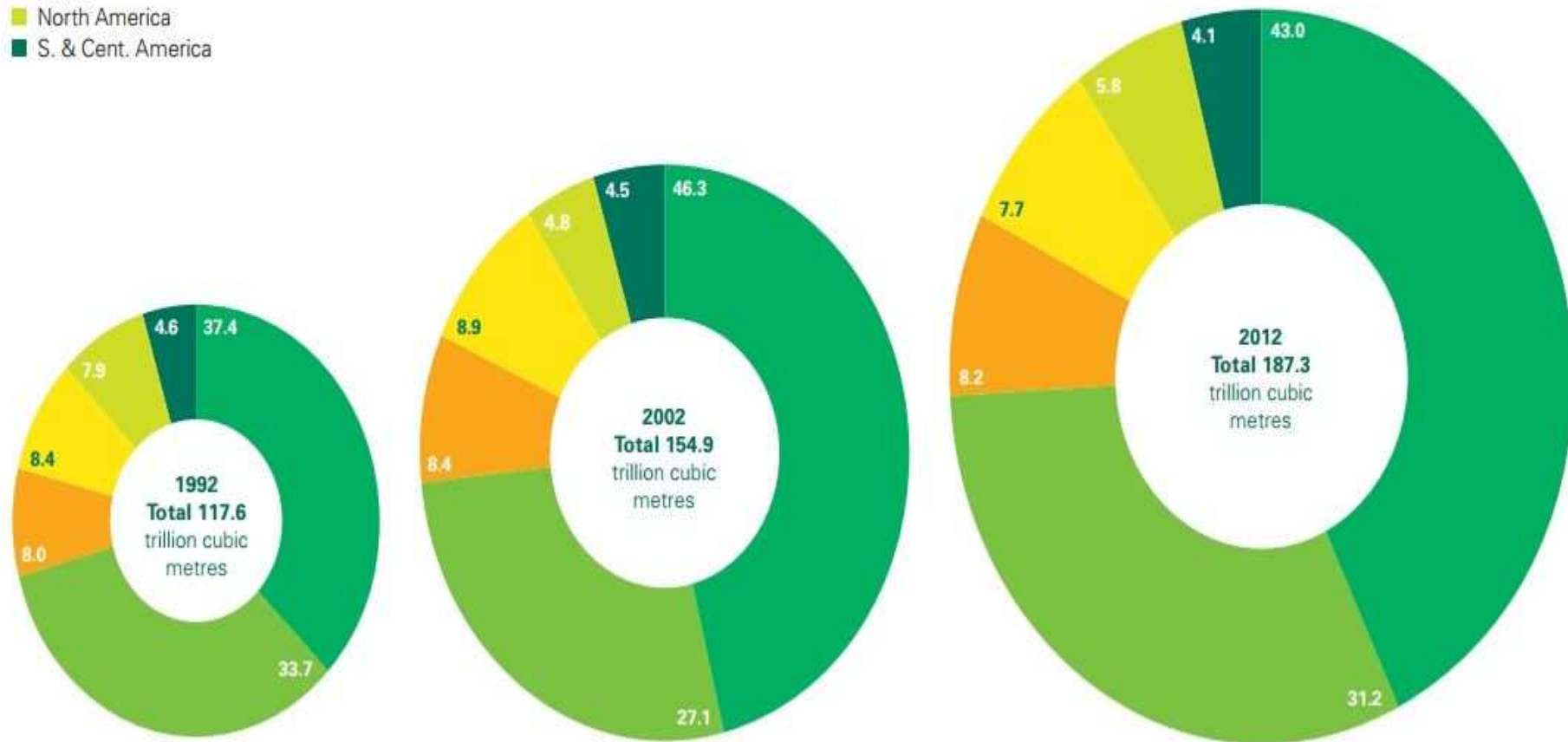
World Gas Reserves 12-2009



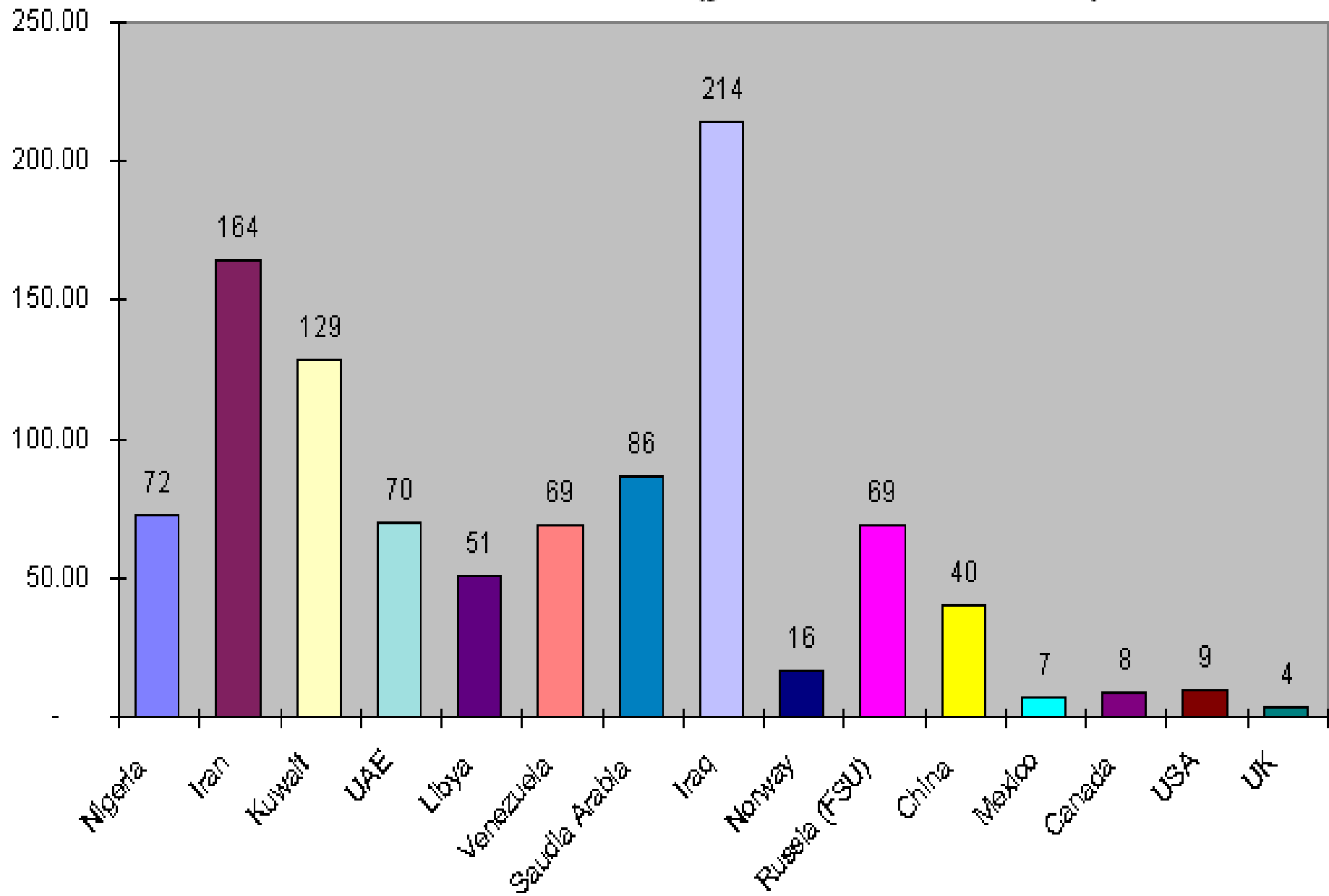
Distribution of proved reserves in 1992, 2002 and 2012

Percentage

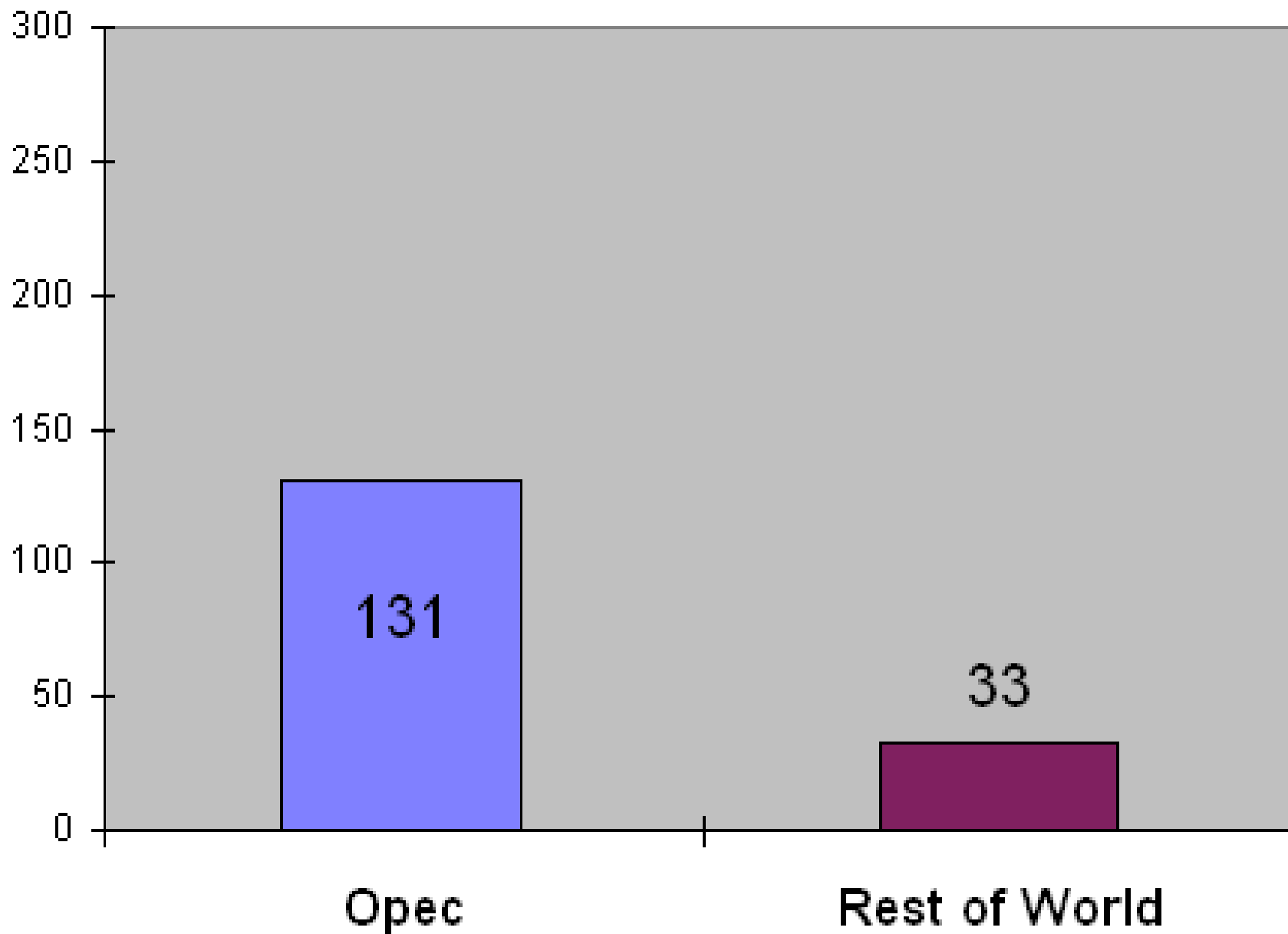
- Middle East
- Europe & Eurasia
- Asia Pacific
- Africa
- North America
- S. & Cent. America



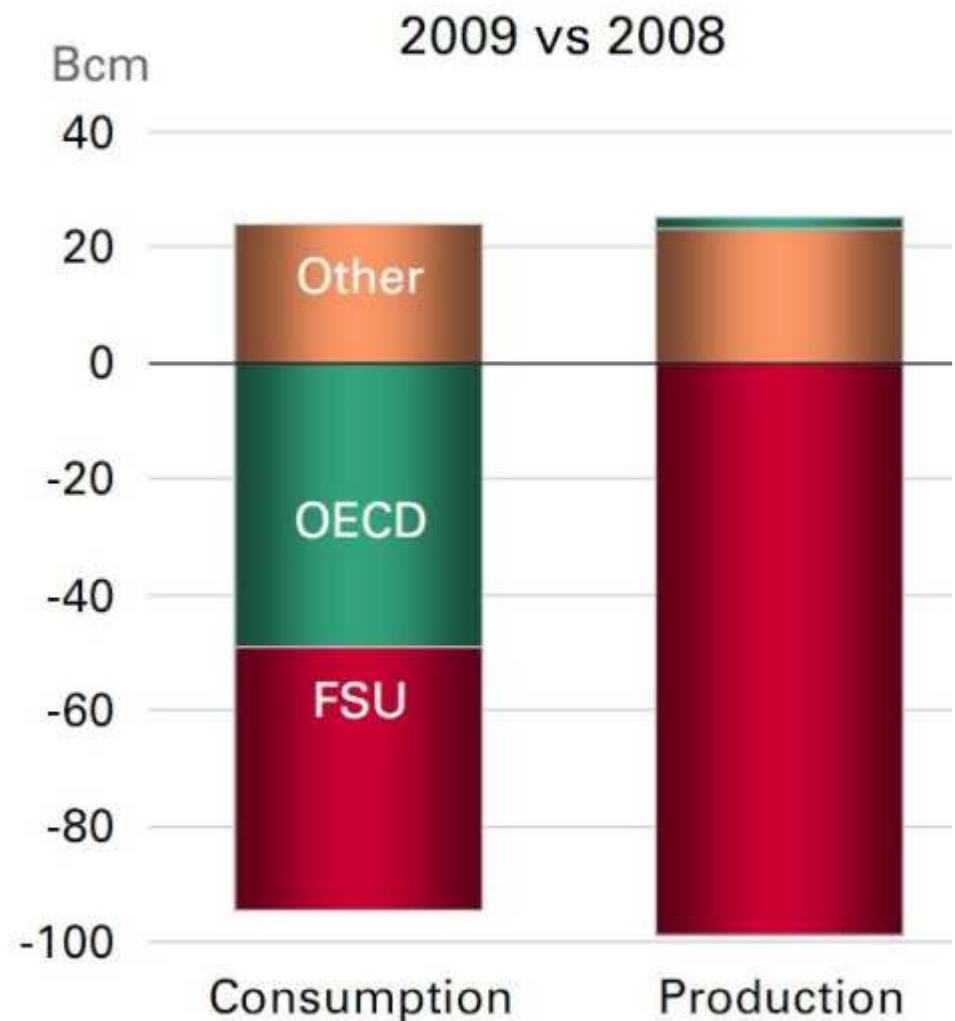
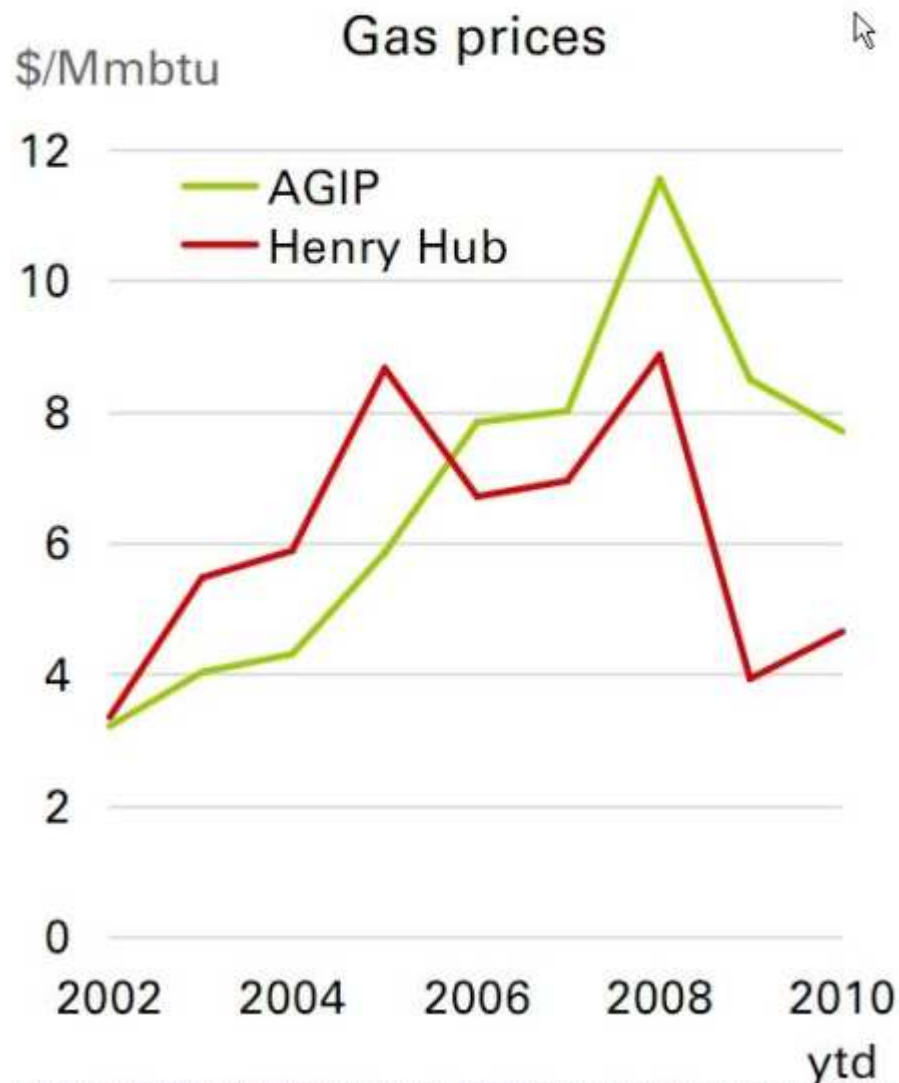
Gas Reserve Life Index - (years at current rate)

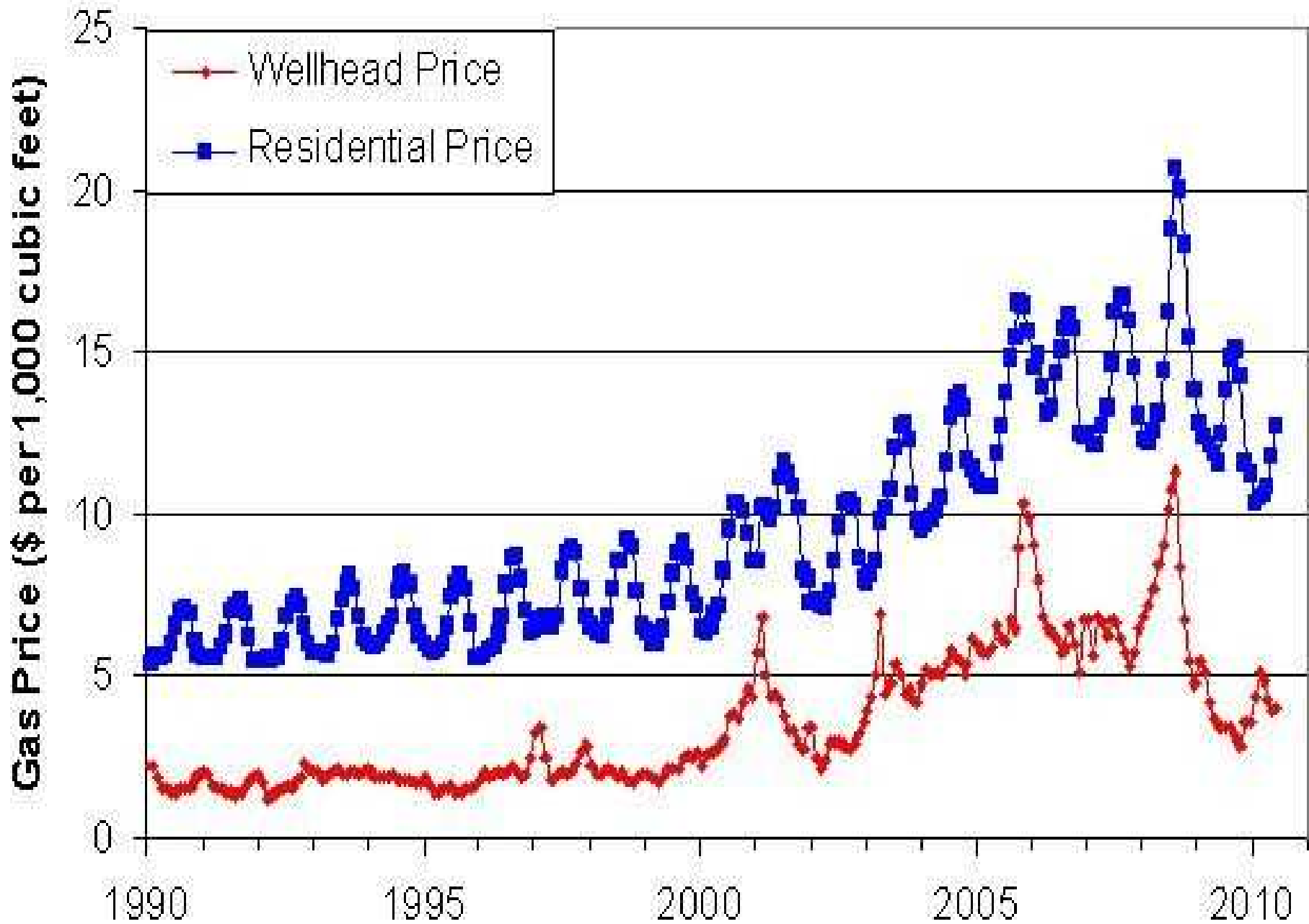


Gas Life Index - years left at current rate



Natural Gas Market

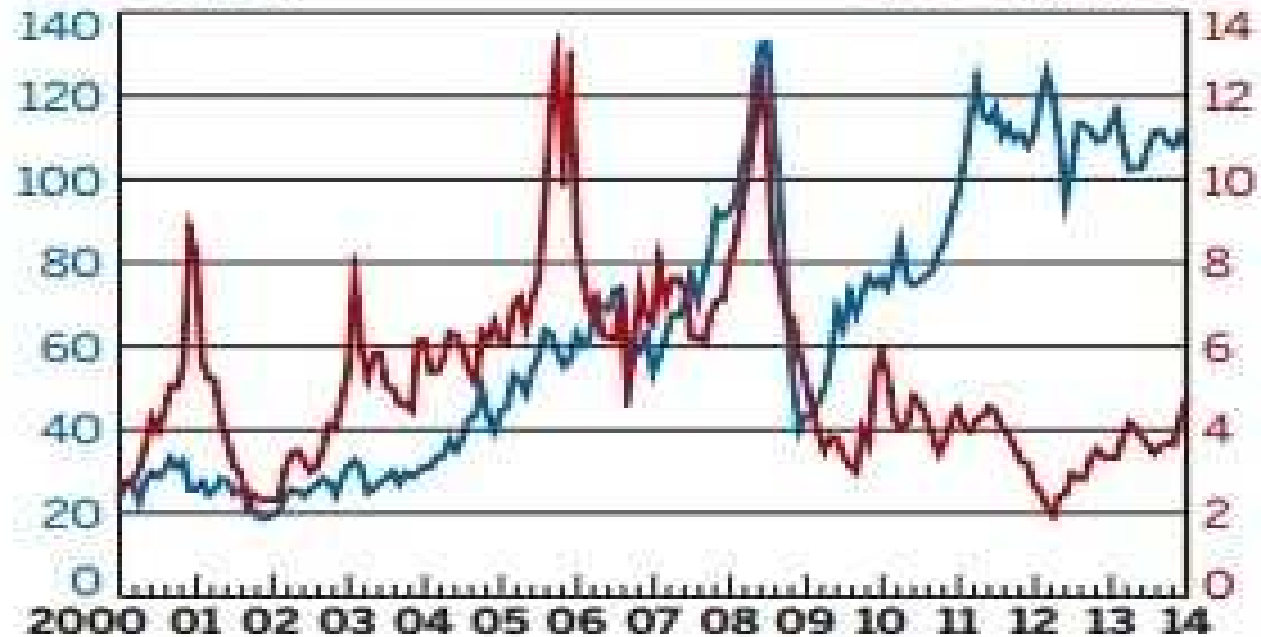




WIDE GULF The price of natural gas—the feedstock of choice in the U.S.—has plummeted relative to that of oil.

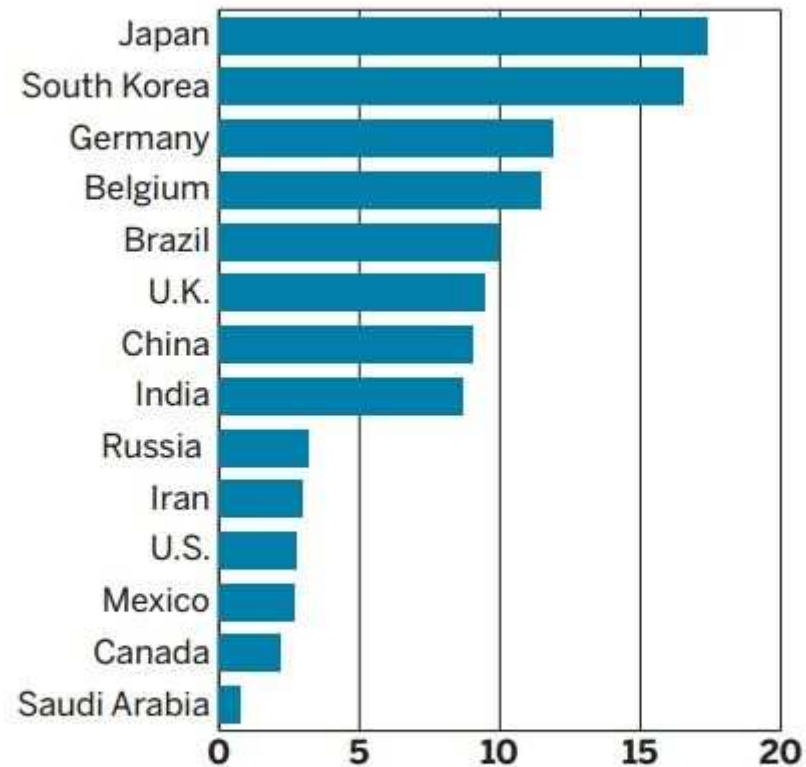
Crude oil (Brent),
\$ per barrel

Natural gas (Henry Hub),
\$ per million BTU



SOURCE: U.S. Energy Information Administration

COMPETITION PROBLEM Europe sees some of the highest prices for natural gas.

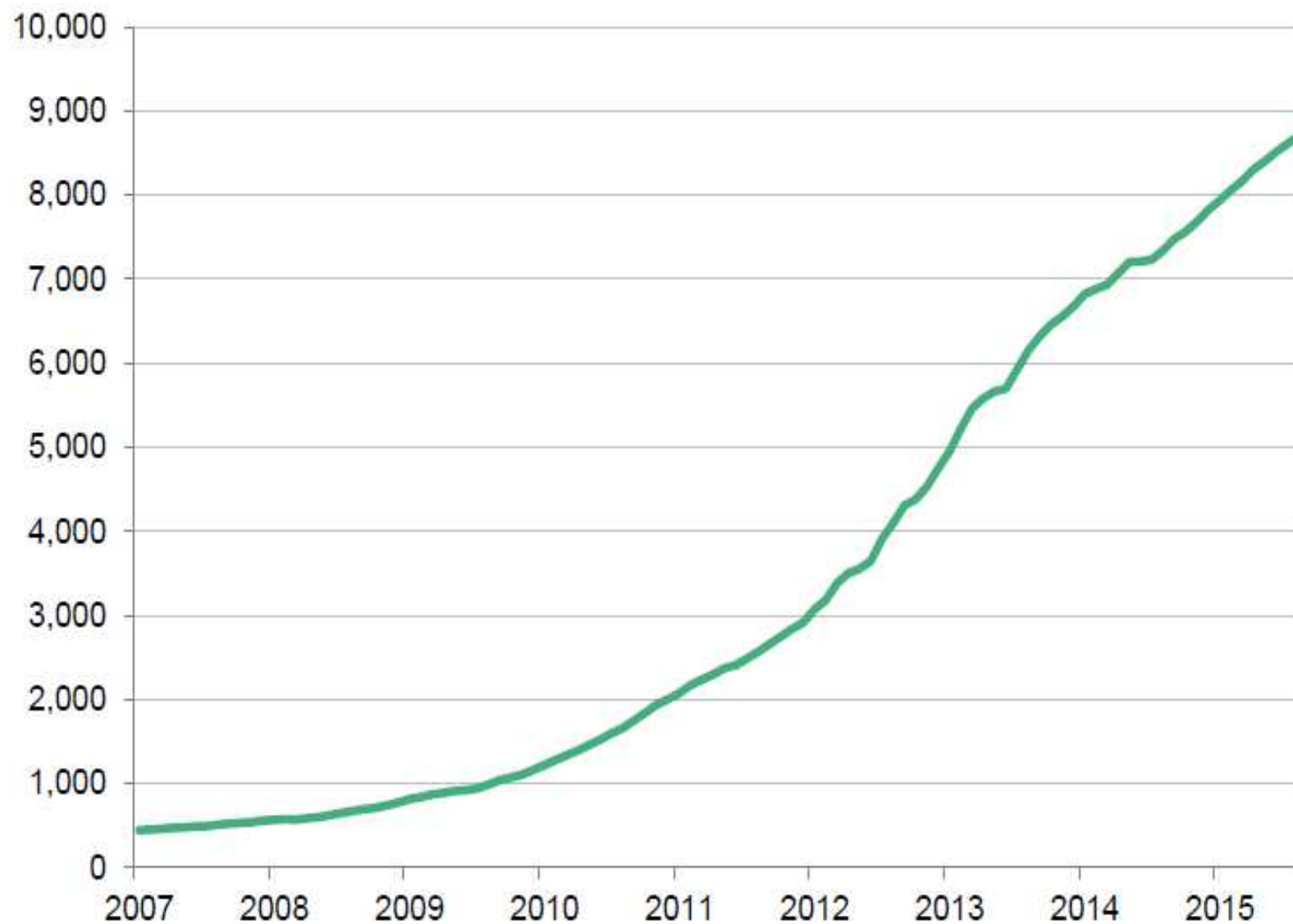


Natural gas price in 2012, \$ per million Btu

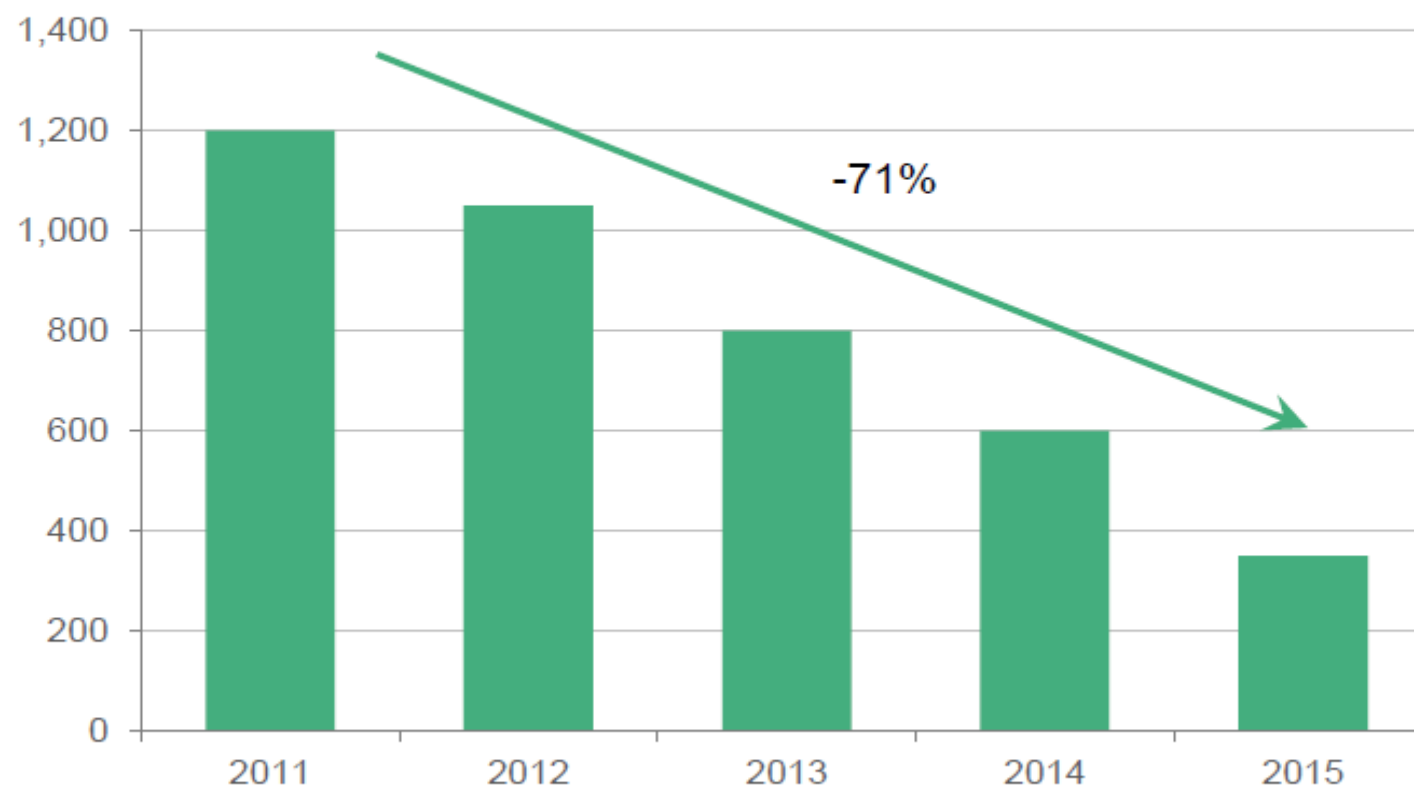
NOTE: Prices generally reflect domestic wellhead/hub prices or prices for gas imported via pipeline. Some nations, such as Japan and South Korea, have higher prices because they import liquefied natural gas.

SOURCE: American Chemistry Council

NORTHEAST GAS PRODUCTION PER RIG (MCFD)

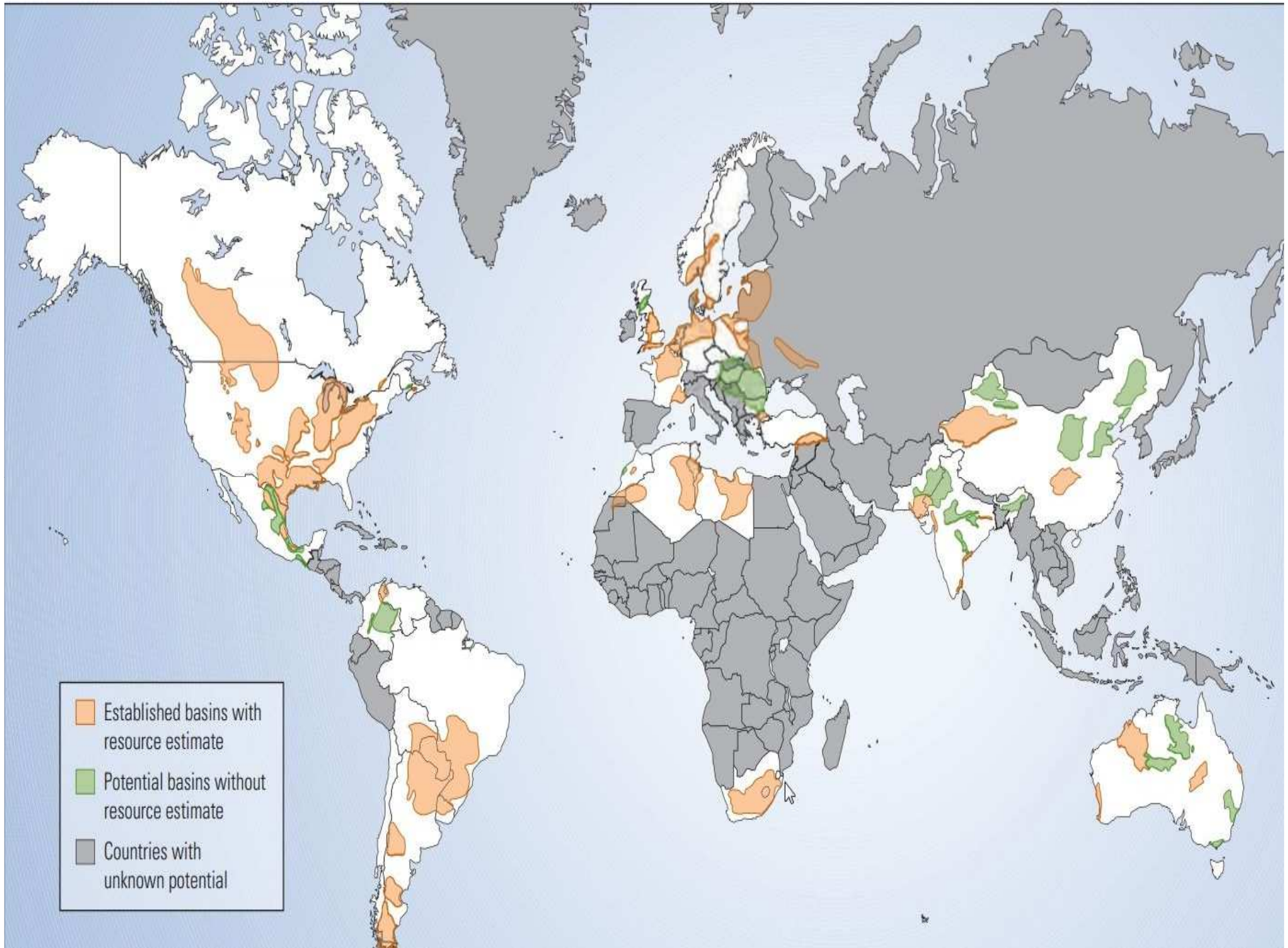


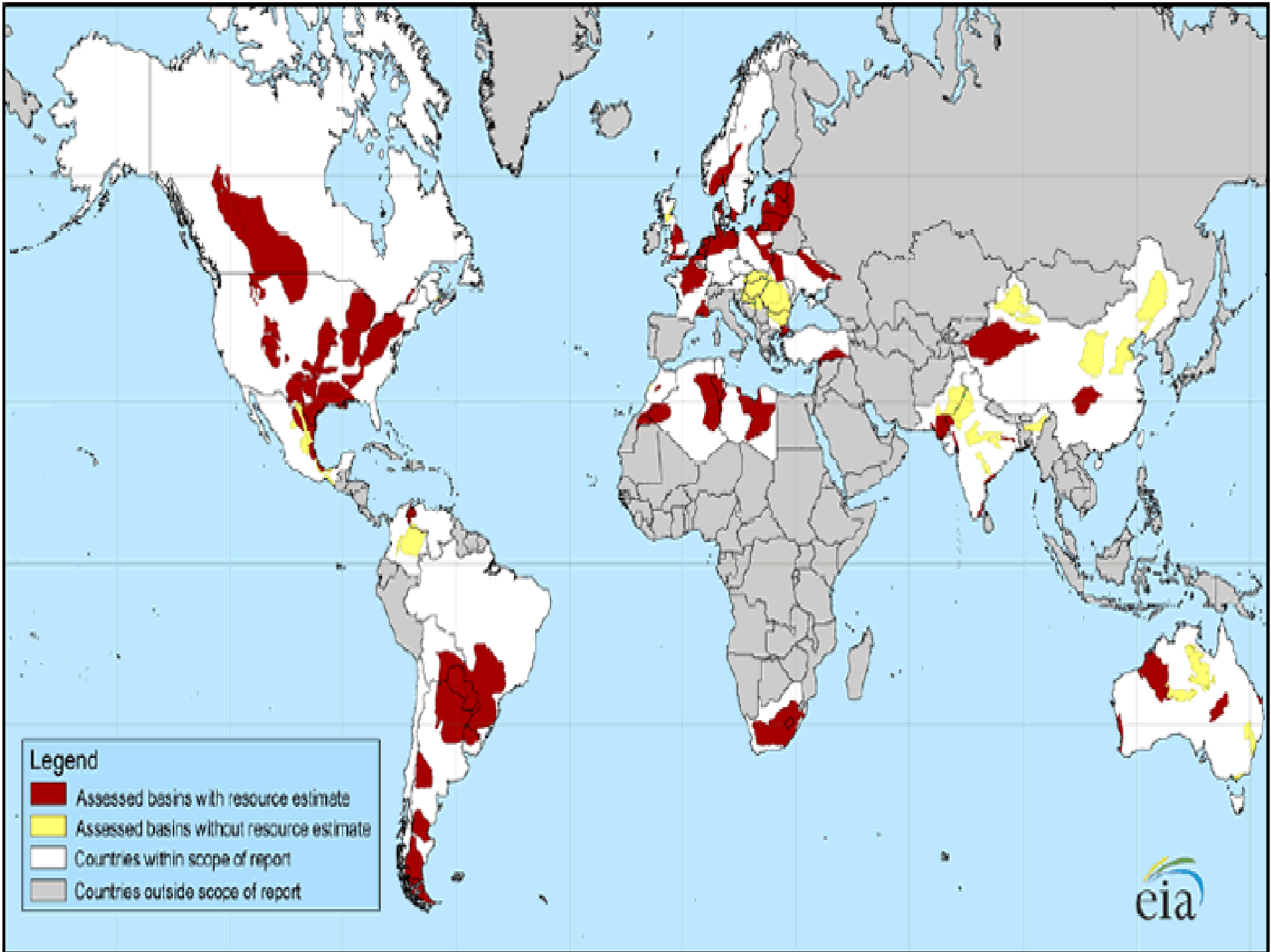
DRILLING COST/LATERAL LENGTH (INCLUDES VERTICAL) (\$/FOOT)



The revolution in Gas production

FRACKING AND SHALE GAS





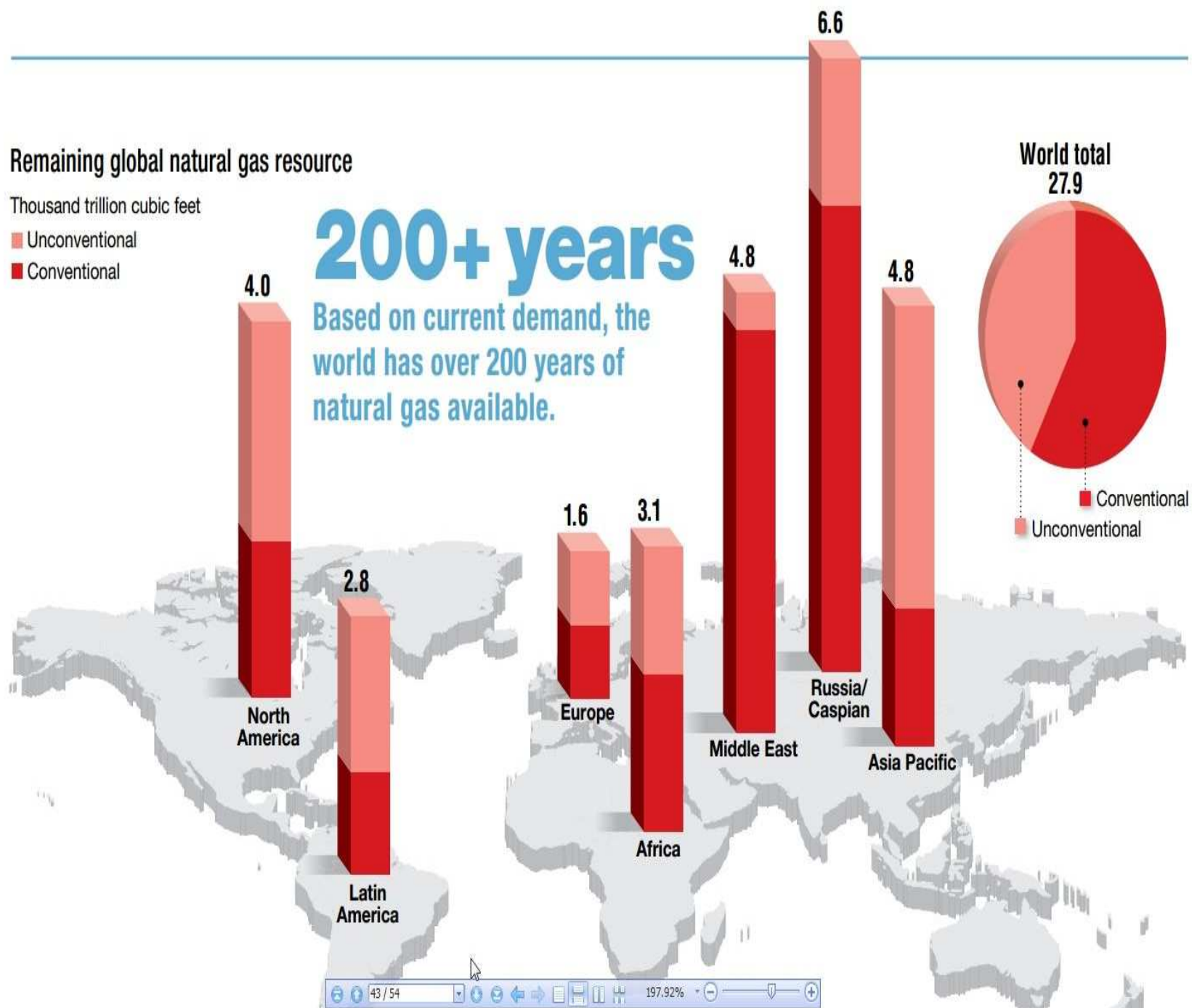
Remaining global natural gas resource

Thousand trillion cubic feet

- Unconventional
- Conventional

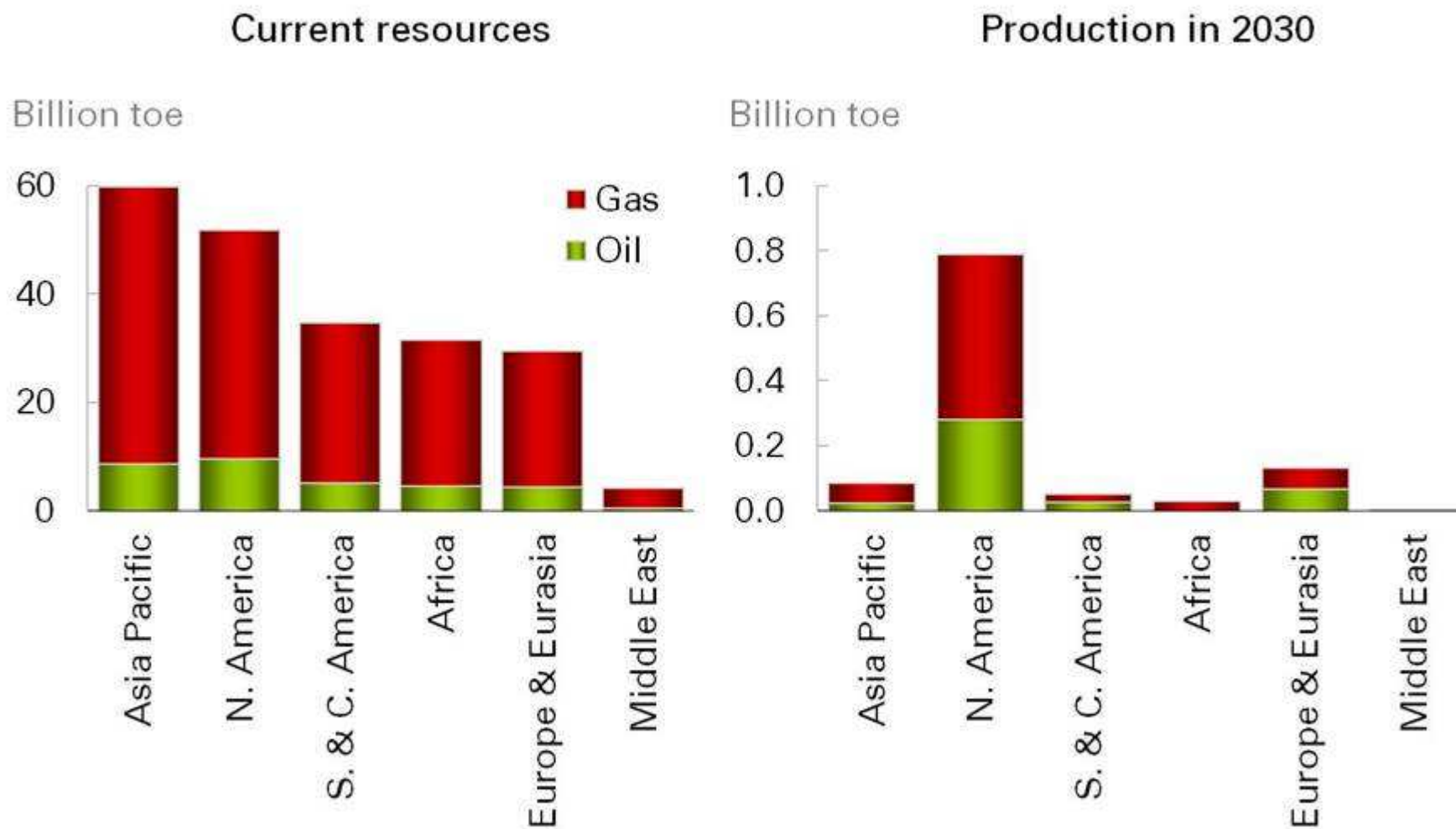
200+ years

Based on current demand, the world has over 200 years of natural gas available.





Shale gas and tight oil resources and production...

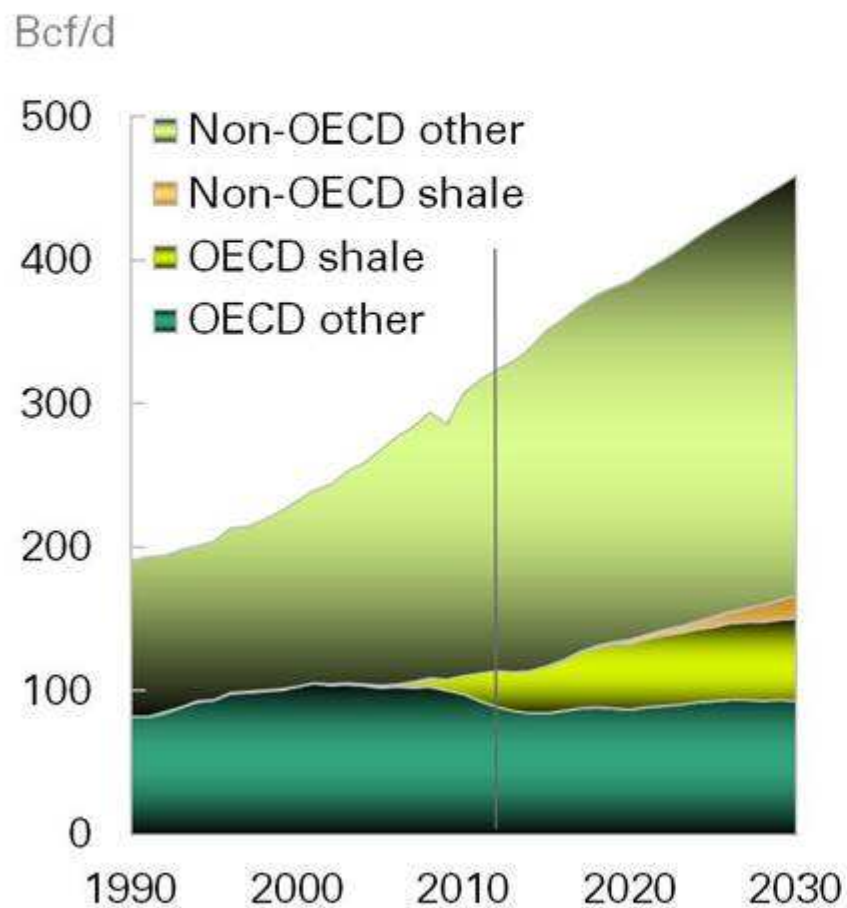


Resources data © OECD/IEA 2012

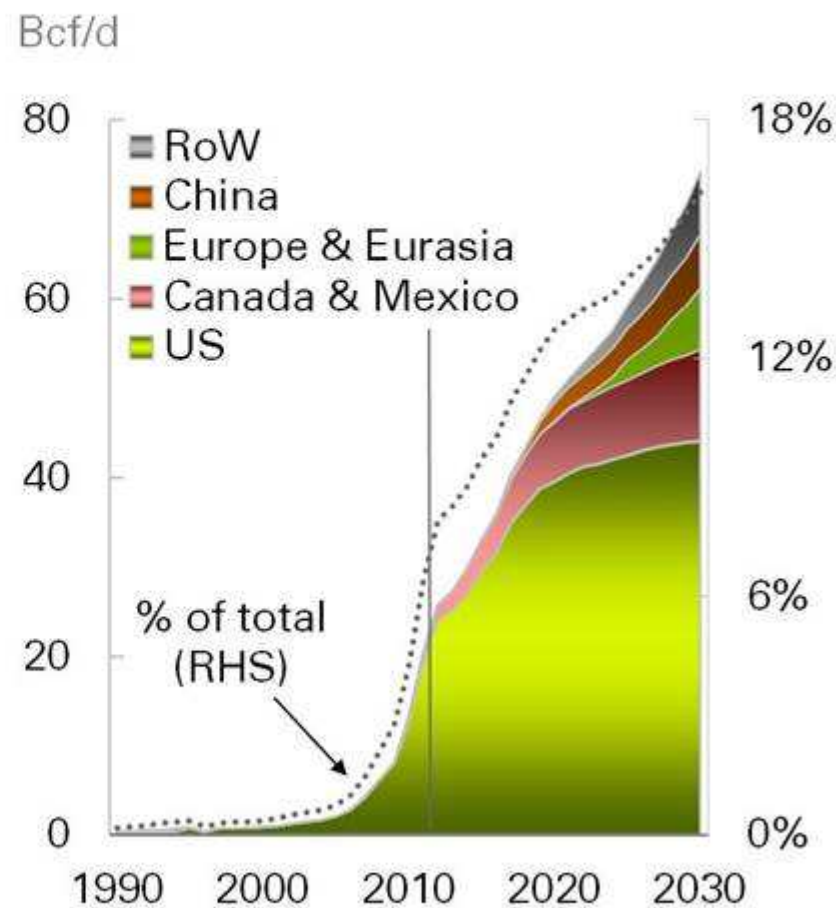


Shale gas growth will gradually spread beyond the US...

Gas production by type and region



Shale gas production



Fracking - gas from shale

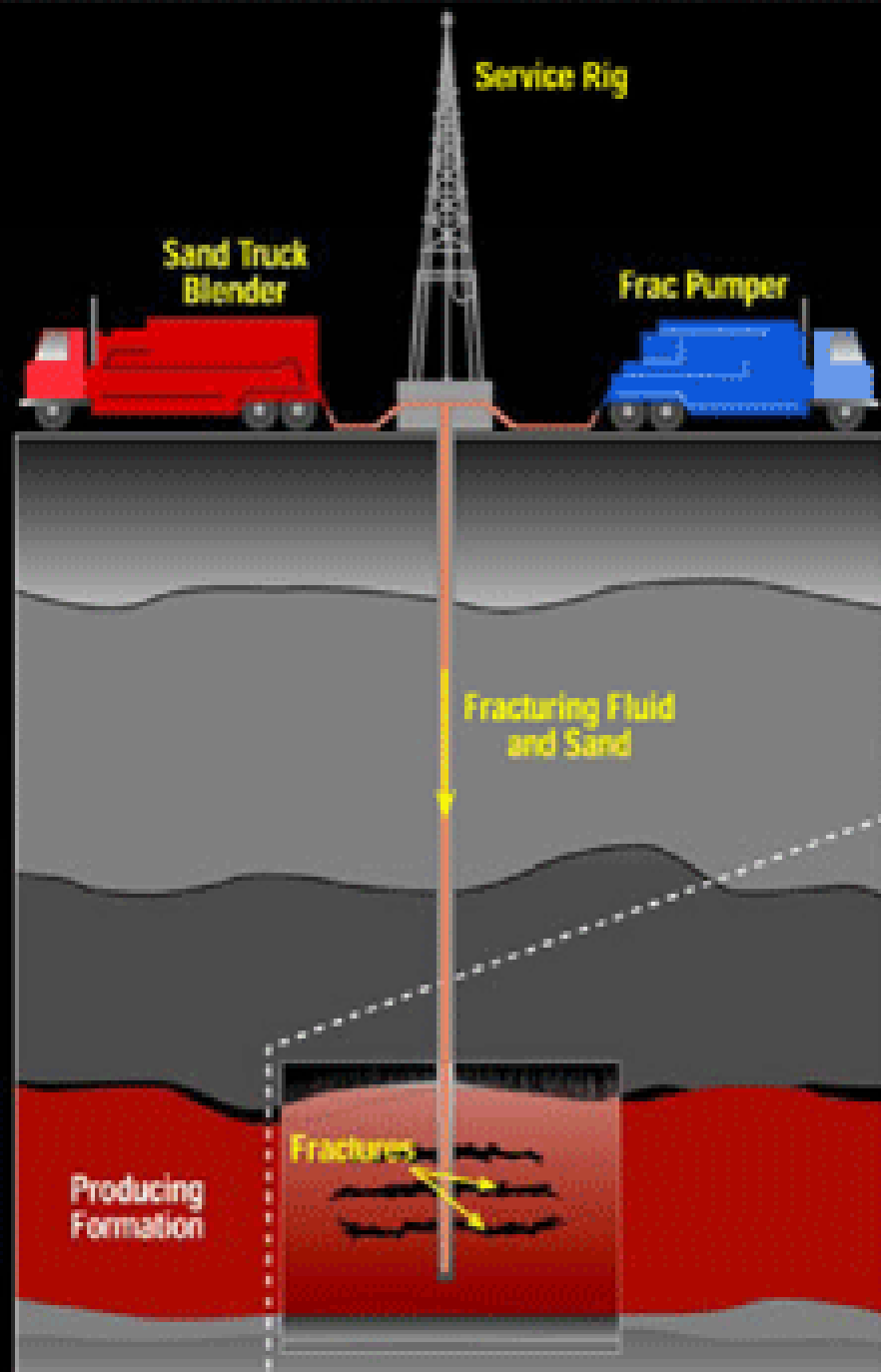




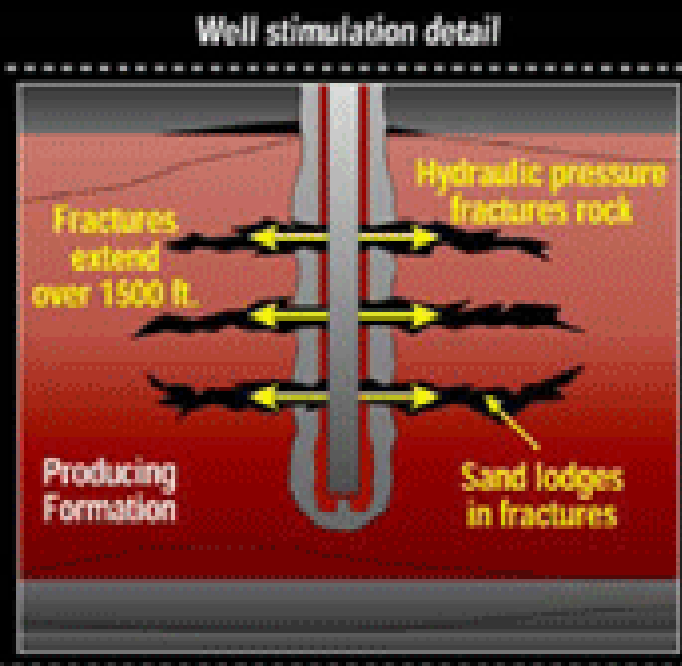


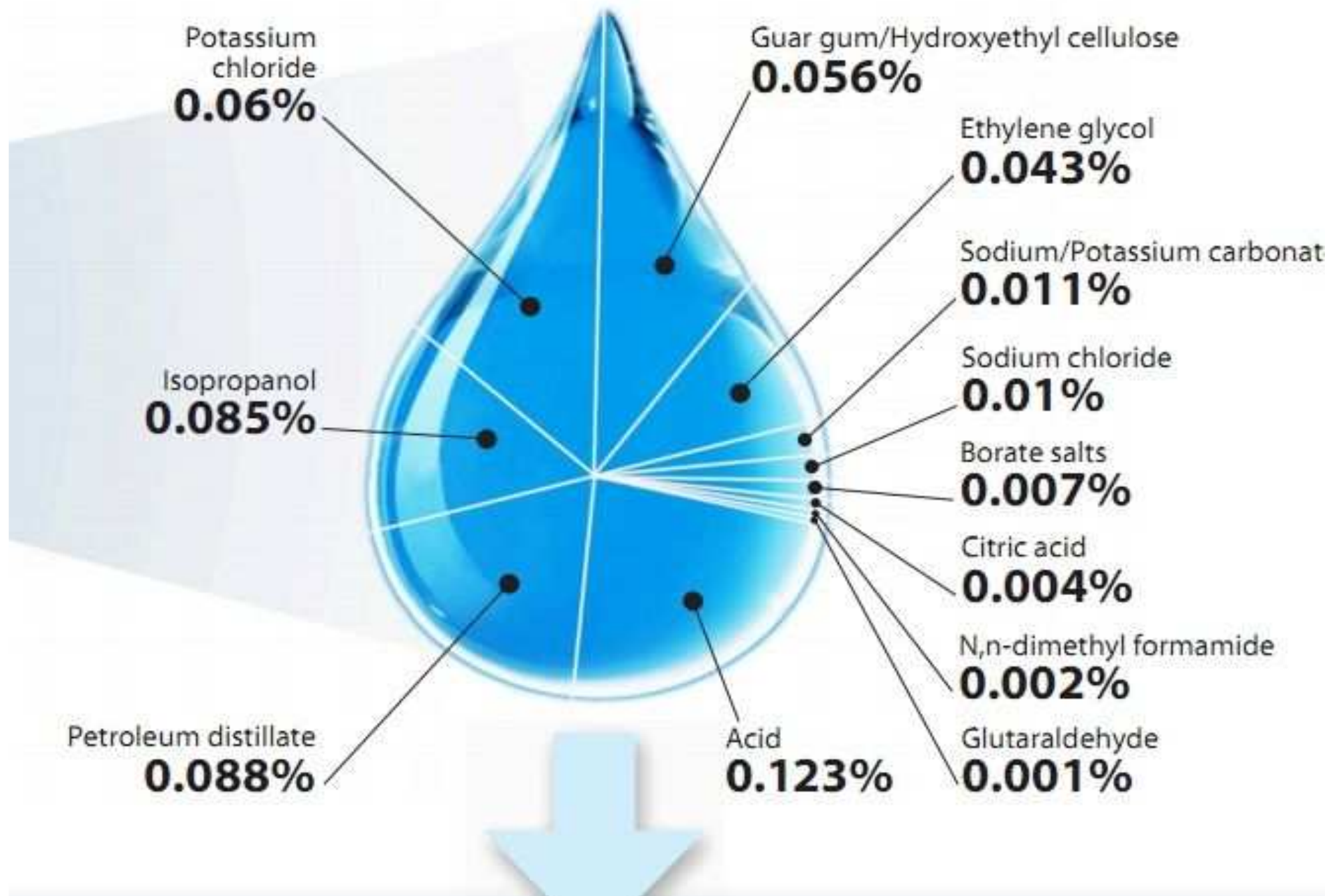
© June 2008, WVSORO
www.wvsoro.org





Light sand fracture technology has reduced development costs and increased the amount of reserves which can be recovered.





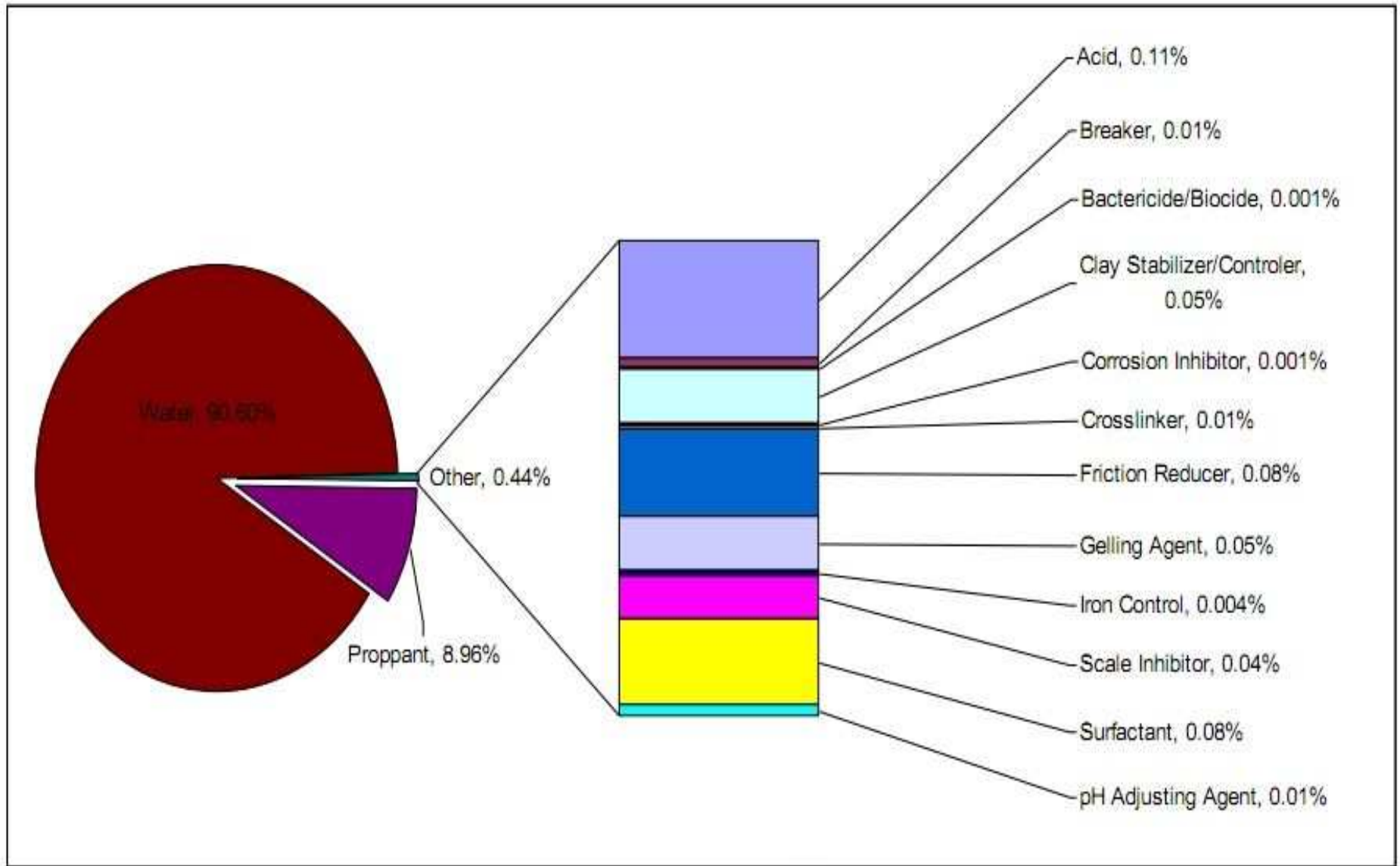
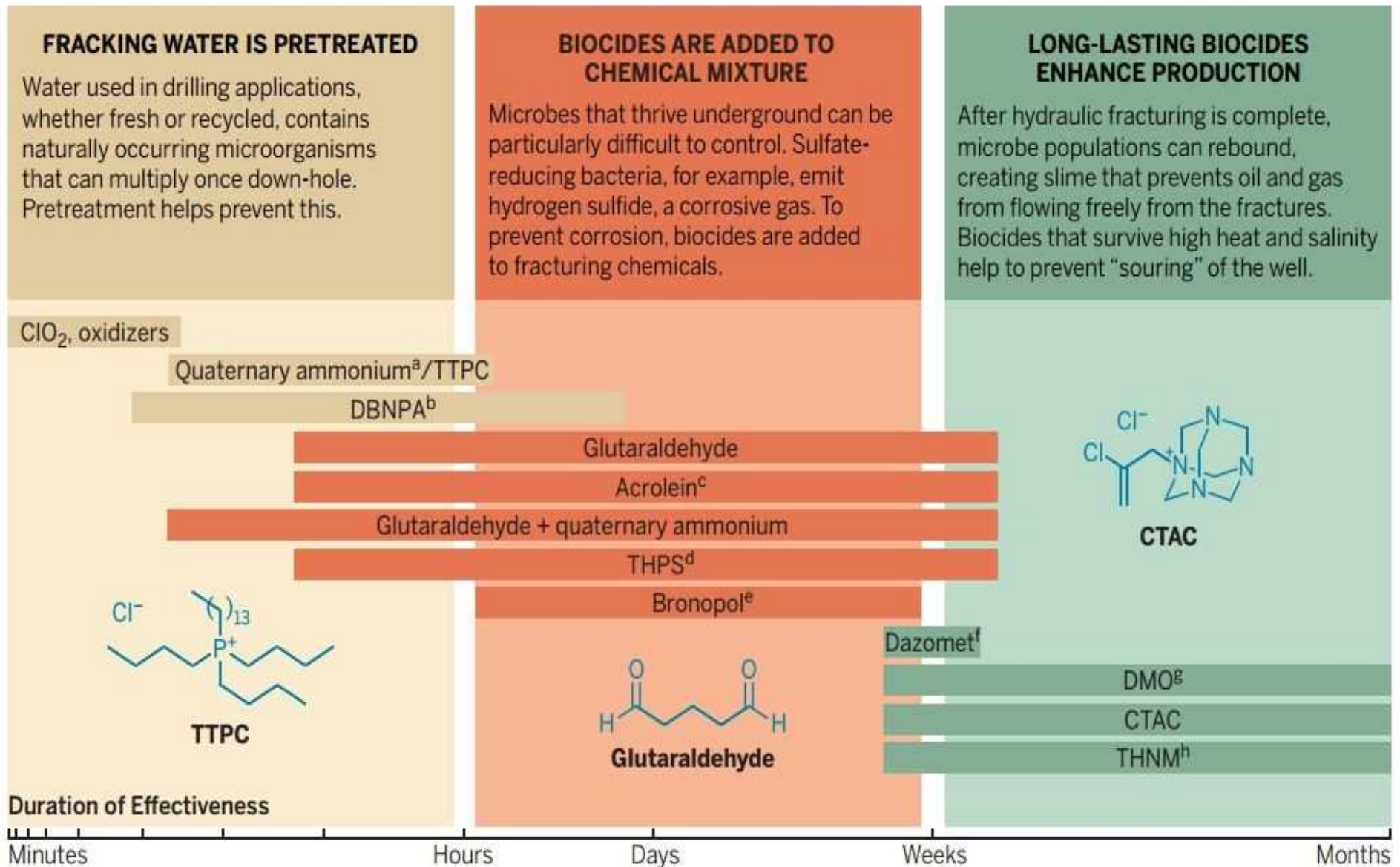


Figure 5-3 - Sample Fracture Fluid Composition by Weight

BIOCIDE BLAST Sophisticated microbial control is required at all stages of the oil- and gas-drilling process.



a For example, didecyl dimethyl ammonium chloride. **b** 2,2-Dibromo-3-nitrilopropionamide. **c** Prop-2-enal. **d** Tetrakis(hydroxymethyl)phosphonium sulfate. **e** 2-Bromo-2-nitropropane-1,3-diol. **f** 3,5-Dimethyl-1,3,5-thiadiazine-2-thione. **g** 5,5-Dimethyl-2,4-oxazolidinedione. **h** 2-Hydroxymethyl-2-nitro-1,3-propanediol.

SOURCES: Dow Chemical, C&EN

COLORADO FRACKING SPILLS BY THE NUMBERS



Number of active wells in the state as of March 2015:

53,288

Number of spills from fracking operations reported in 2013^a:

600



Amount of produced water generated from fracking in 2013:

388 million bbl

Amount of produced water spilled in 2013:

14,241 bbl

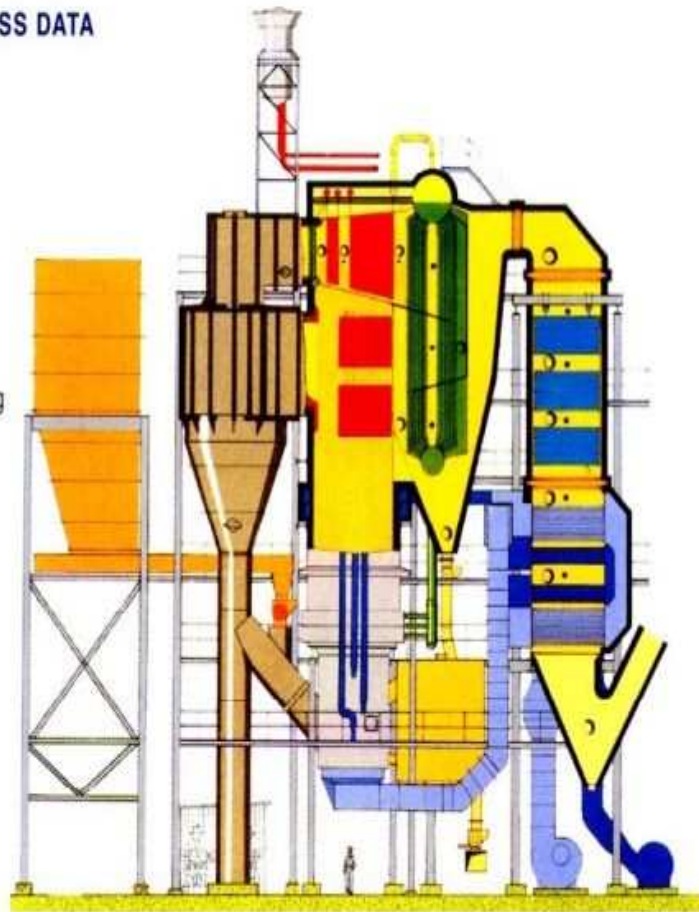
^a Most recent full-year statistics. **SOURCES:** Colorado Oil & Gas Conservation Commission

Import-Export
Bulletin Board
www.import-export.com

The Mishor Rotem Oil Shale FBC power plant

DEMONSTRATION BOILER - PROCESS DATA

Steam data	
Total Heat Output	41 MW th
Steam Flow	13.9 kg/s
Steam Pressure	43 bar
Steam Temperature	480° C
Fuel Data	
Oil Shale	Oil Shale
Organic Matter	13.6 - 16%
Sulphur	1.1 - 1.7%
Moisture	16 - 22%
Ash	44 - 50%
Lower Heating Value	3.155 MJ/kg
Design Performance	
Furnace Temperature	800° C
Flue Gas Exit Temperature	155° C
Feed Water Temperature	105° C
Boiler Efficiency (DIN)	83.7%



Cross-section of the Demonstration Boiler

The power station, designed and built by PAMA uses oil shale rock to produce energy (electricity and steam), about 13 MW.

Active since 1989.

Profitable - on operational basis.

Annual energy production is equals to 31,000 tons of oil (2004).

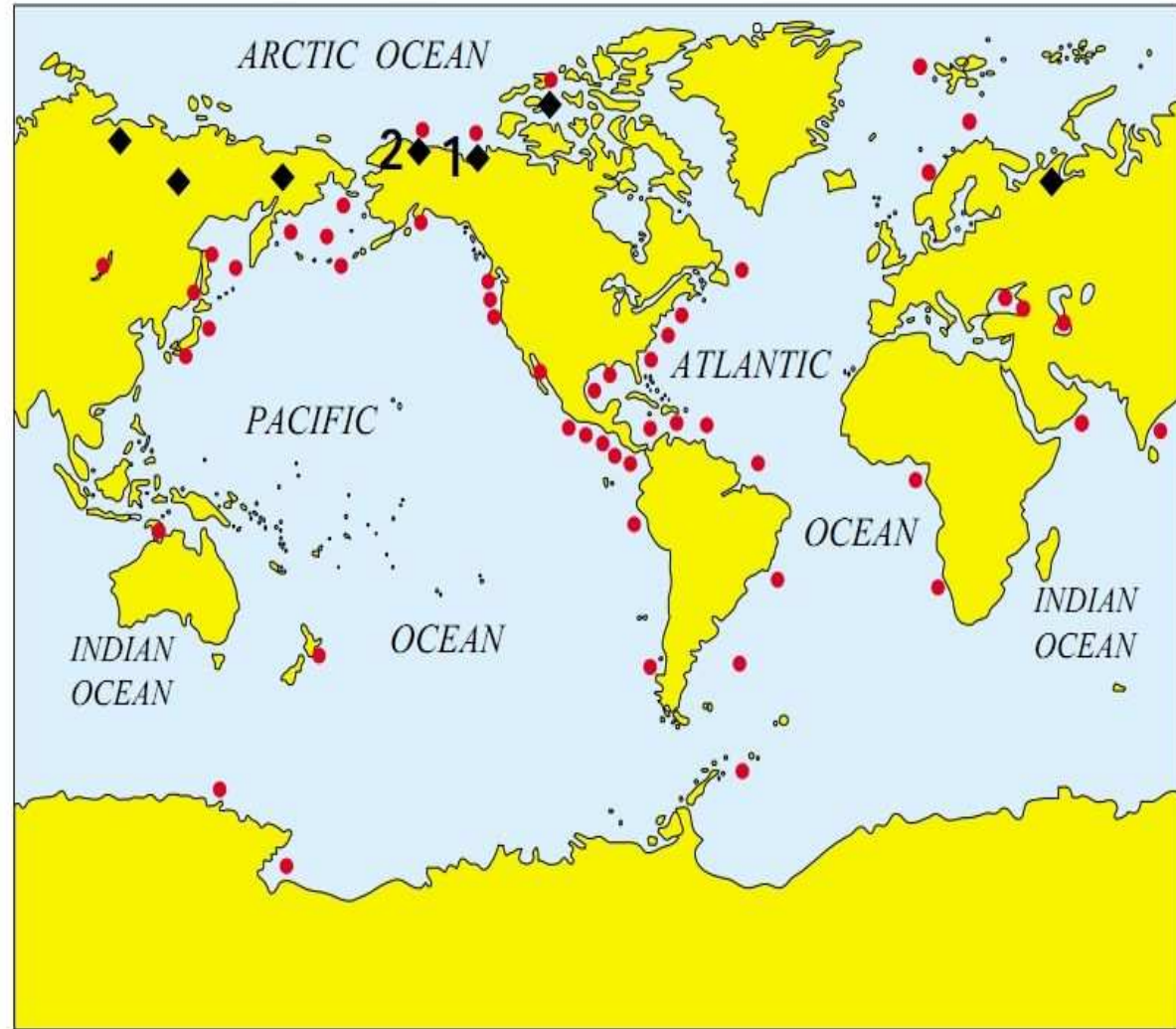
Annual mining rate - ~450,000 tons of raw oil shale.

Natural Gas Hydrates—Vast Resource, Uncertain Future

Introduction

Gas hydrates are naturally occurring icelike solids in which water molecules trap gas molecules in a cagelike structure known as a clathrate. Although many gases form hydrates in nature, methane hydrate is by far the most common; methane is the most abundant natural gas. The volume of carbon contained in methane hydrates worldwide is estimated to be twice the amount contained in all fossil fuels on Earth, including coal.

Estimates of the global resources of natural gas hydrate range from 100,000 to almost 300,000,000 trillion cubic feet (TCF)—to put these quantities in context, estimates of the remaining global reserves and undiscovered resources of conventional natural gas total about 13,000 TCF. Interest in natural gas hydrates will increase as finite conventional natural gas

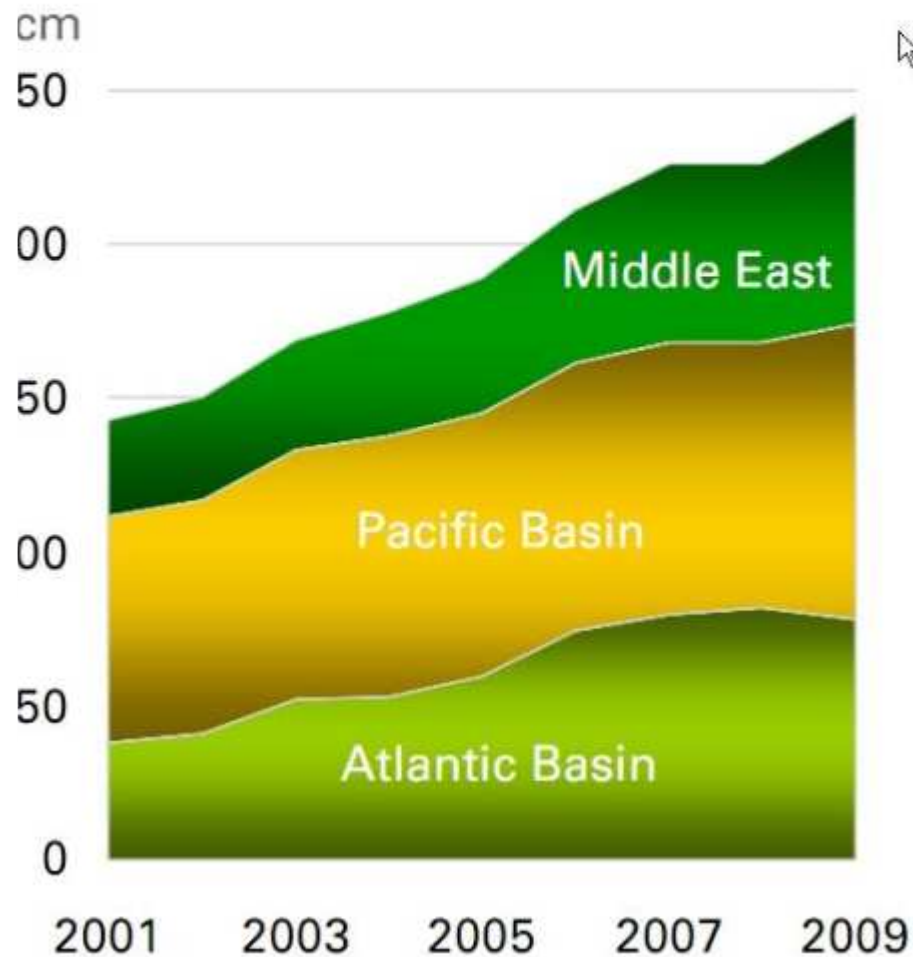


LNG – Liquefied Natural Gas

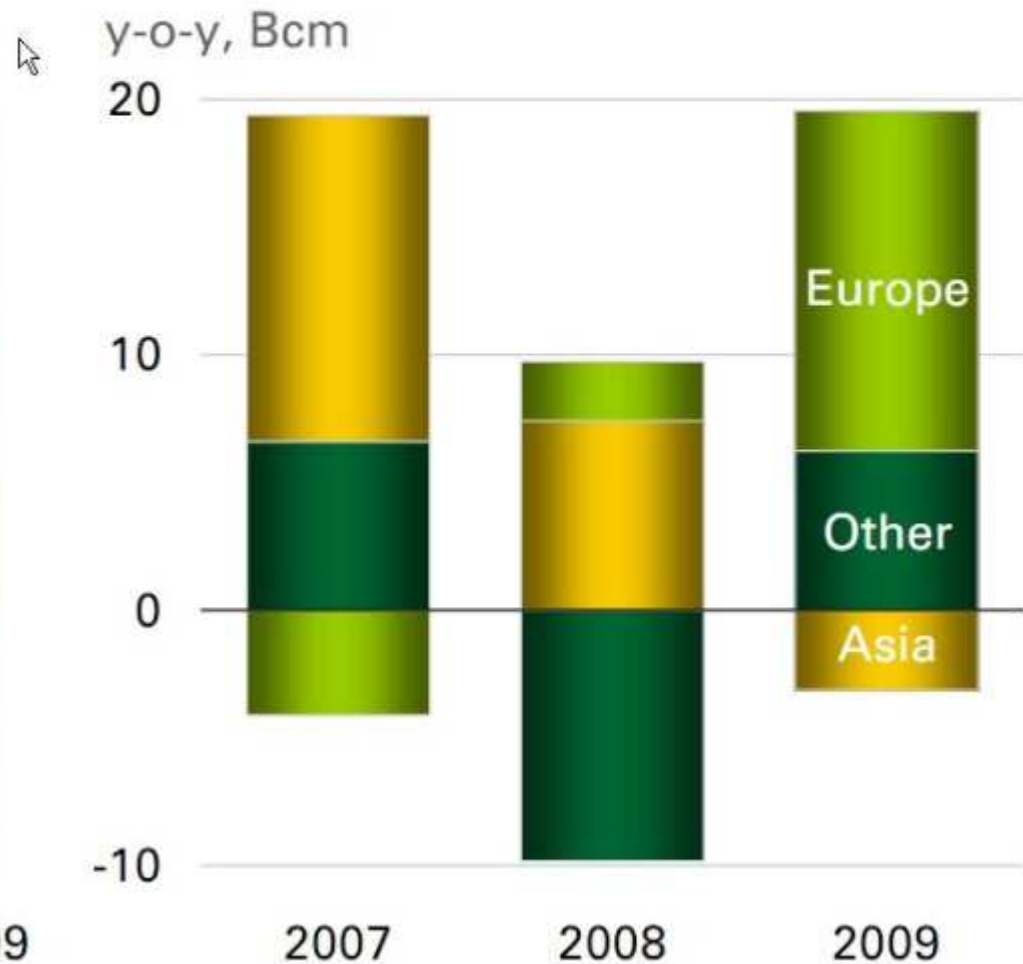
Liquefied Natural Gas

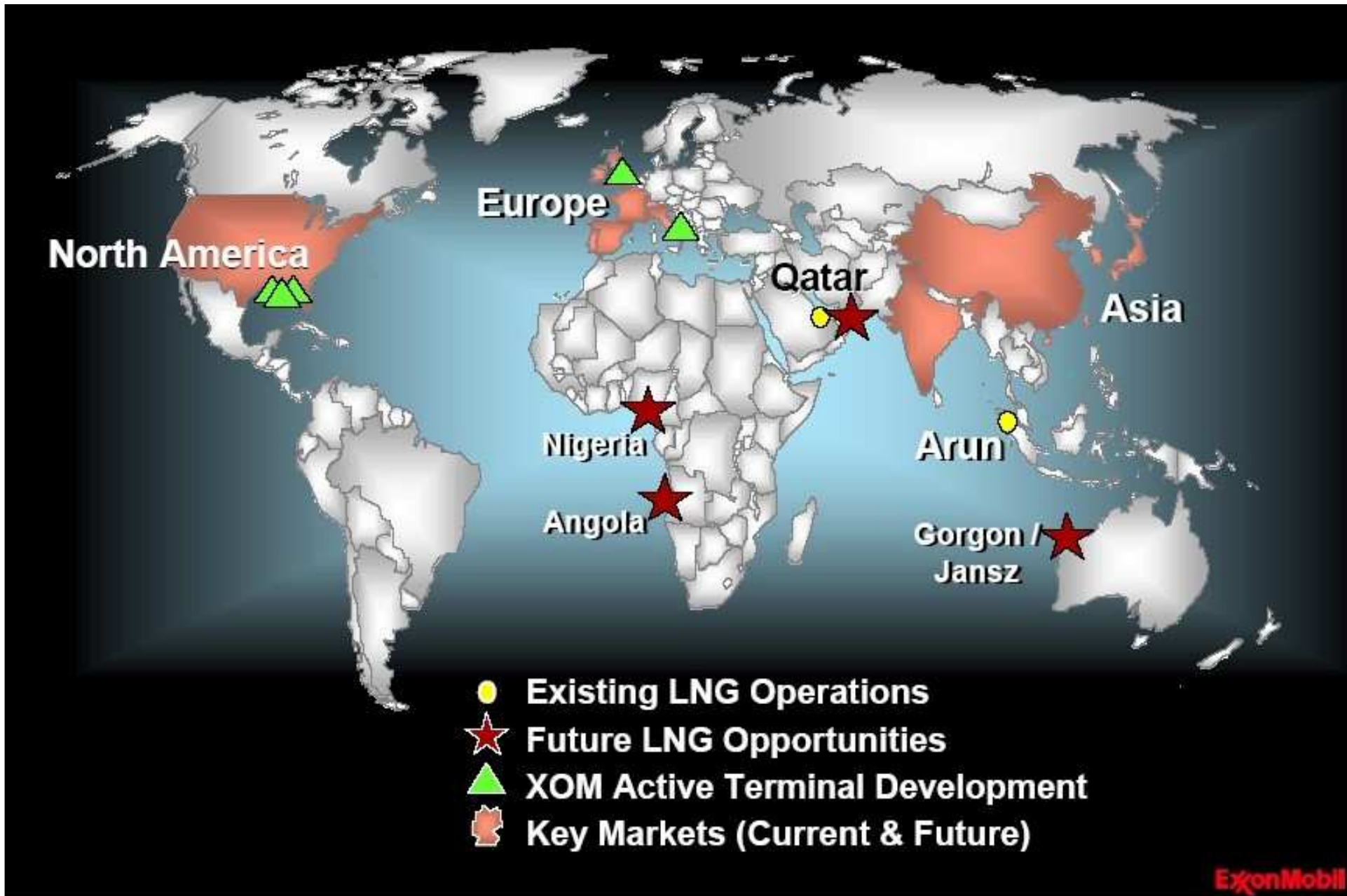


LNG exports by basin



LNG import growth by region





Major trade movements

Trade flows worldwide (billion cubic metres)

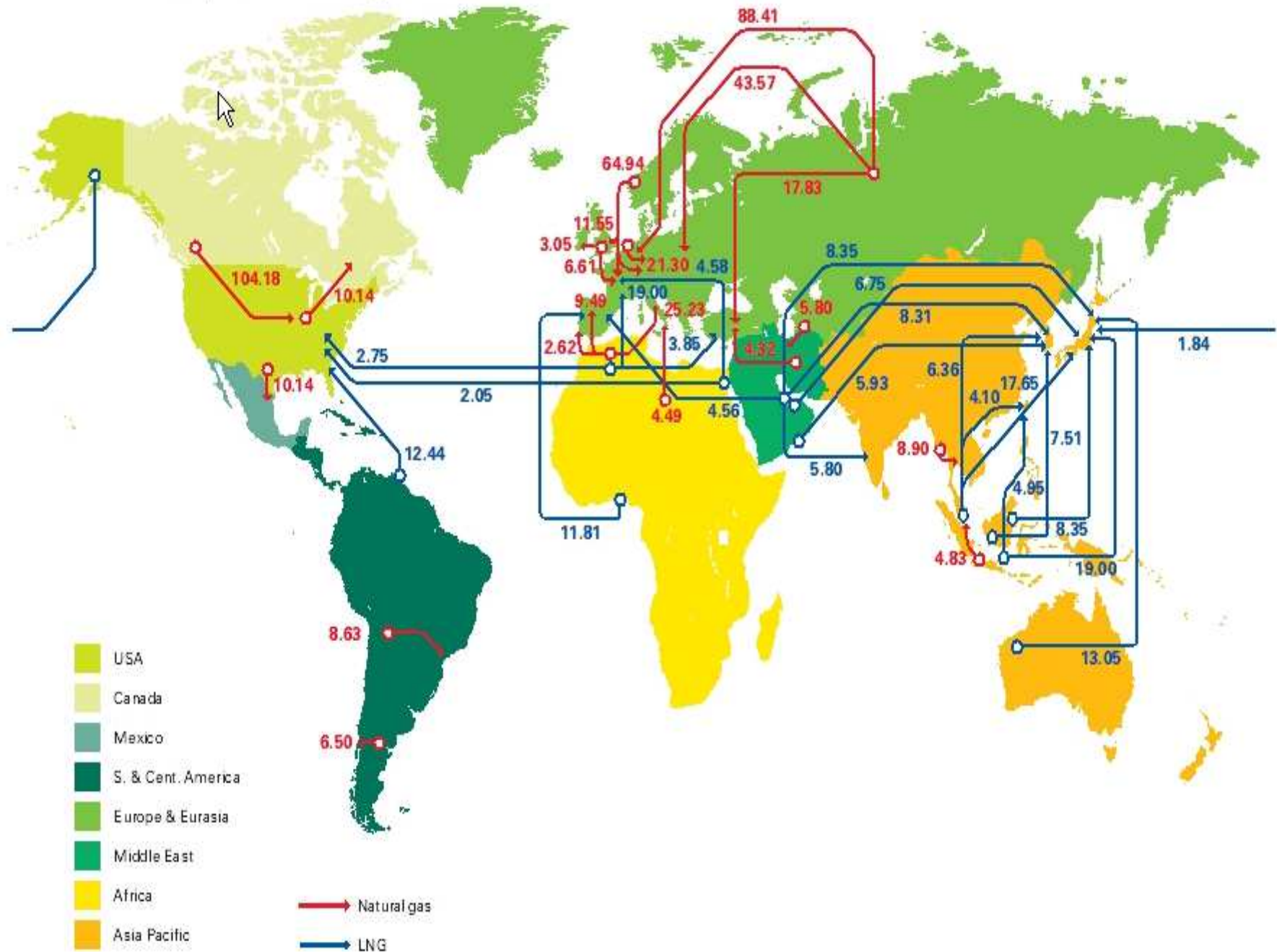
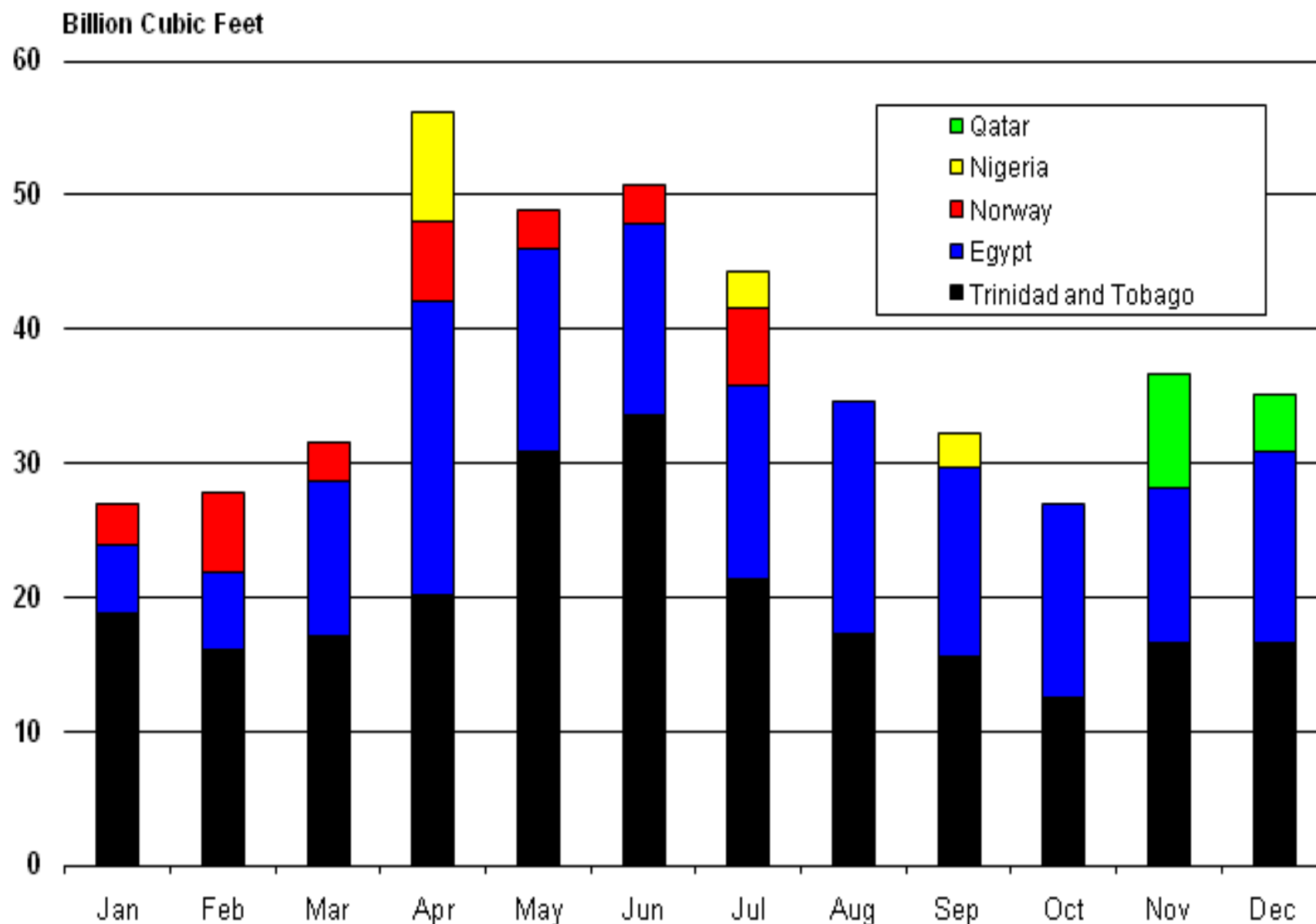


Figure 9. Trinidad and Tobago Accounted for the Largest Amount of LNG Imports in 2009



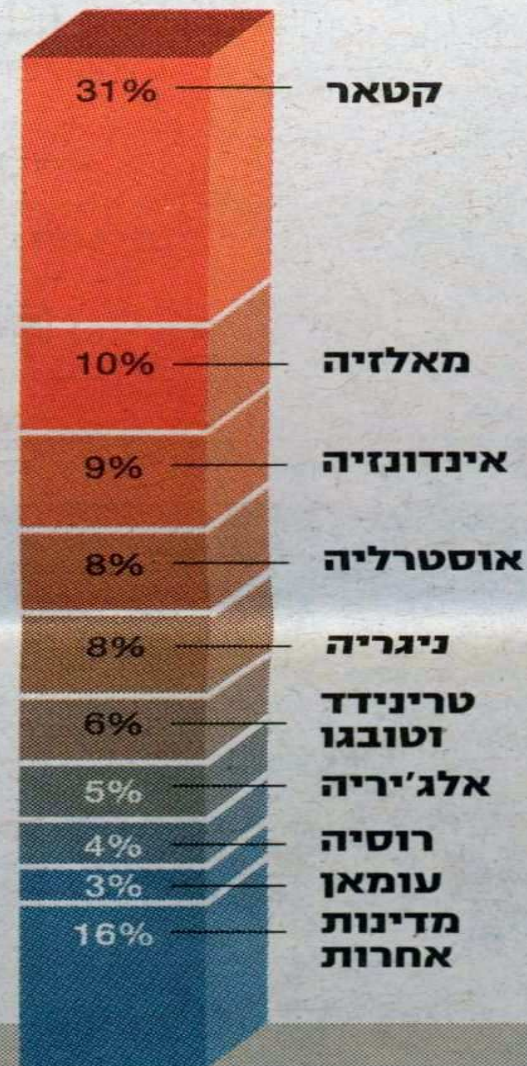
יצואניות ויבואניות גז טבעי נוזלי בעולם

סך כל היקף הסחר ב-2011: BCM 330.8

היבואניות הגדולות



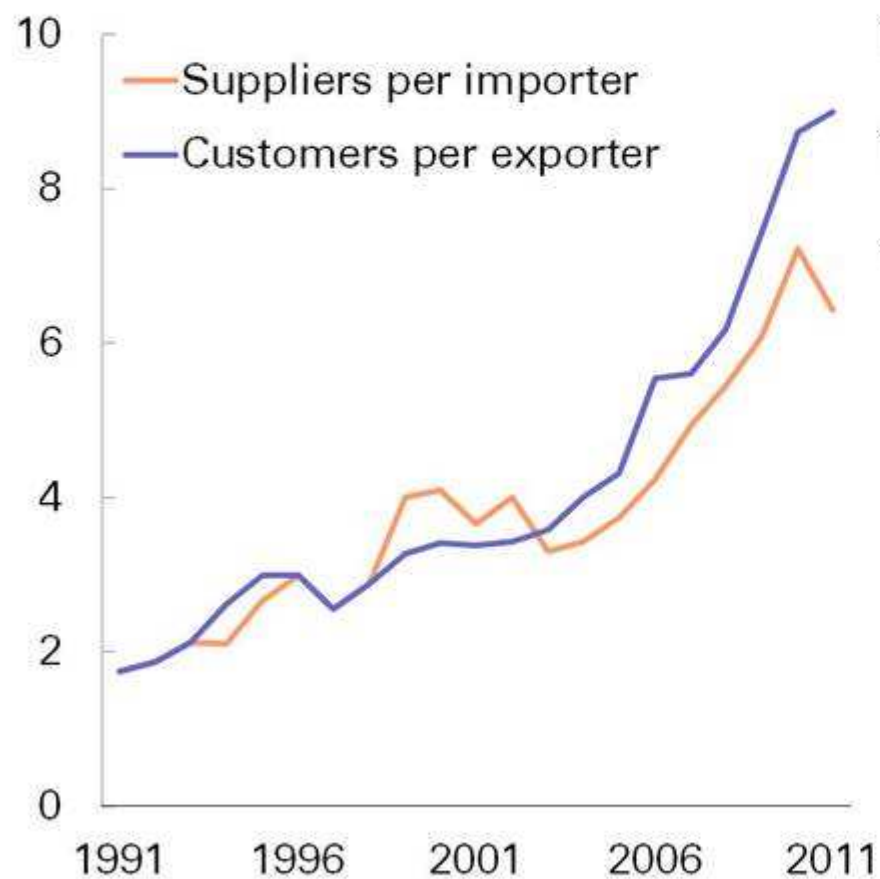
היצואניות הגדולות



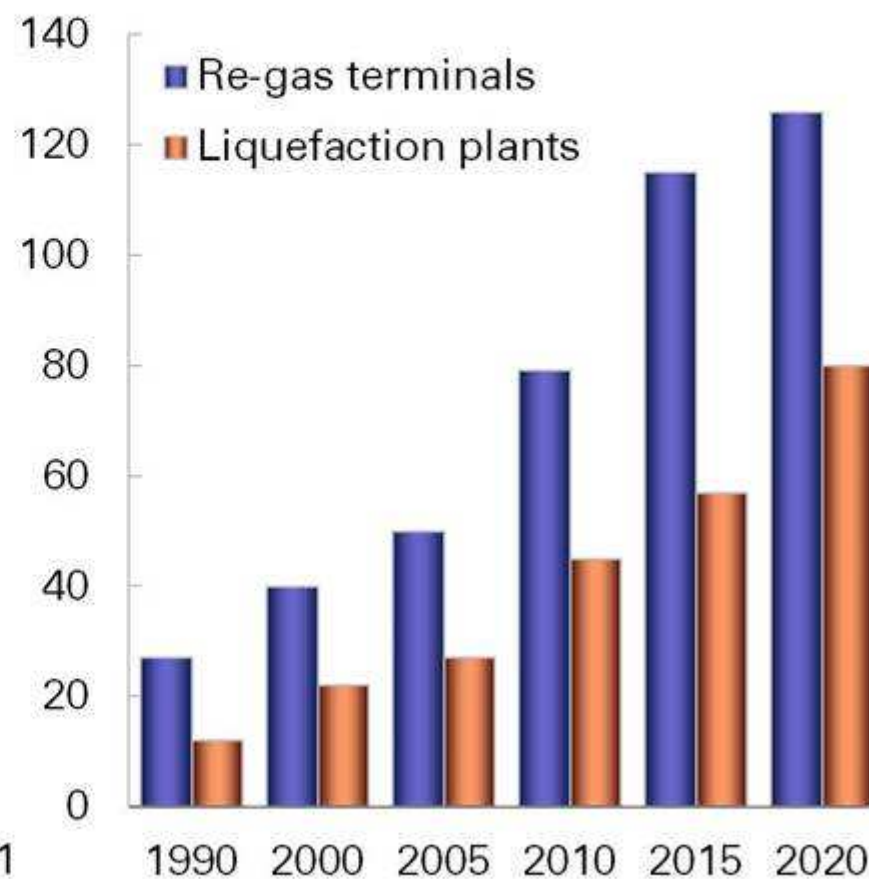


LNG trade is accompanied by deeper market integration...

LNG diversification

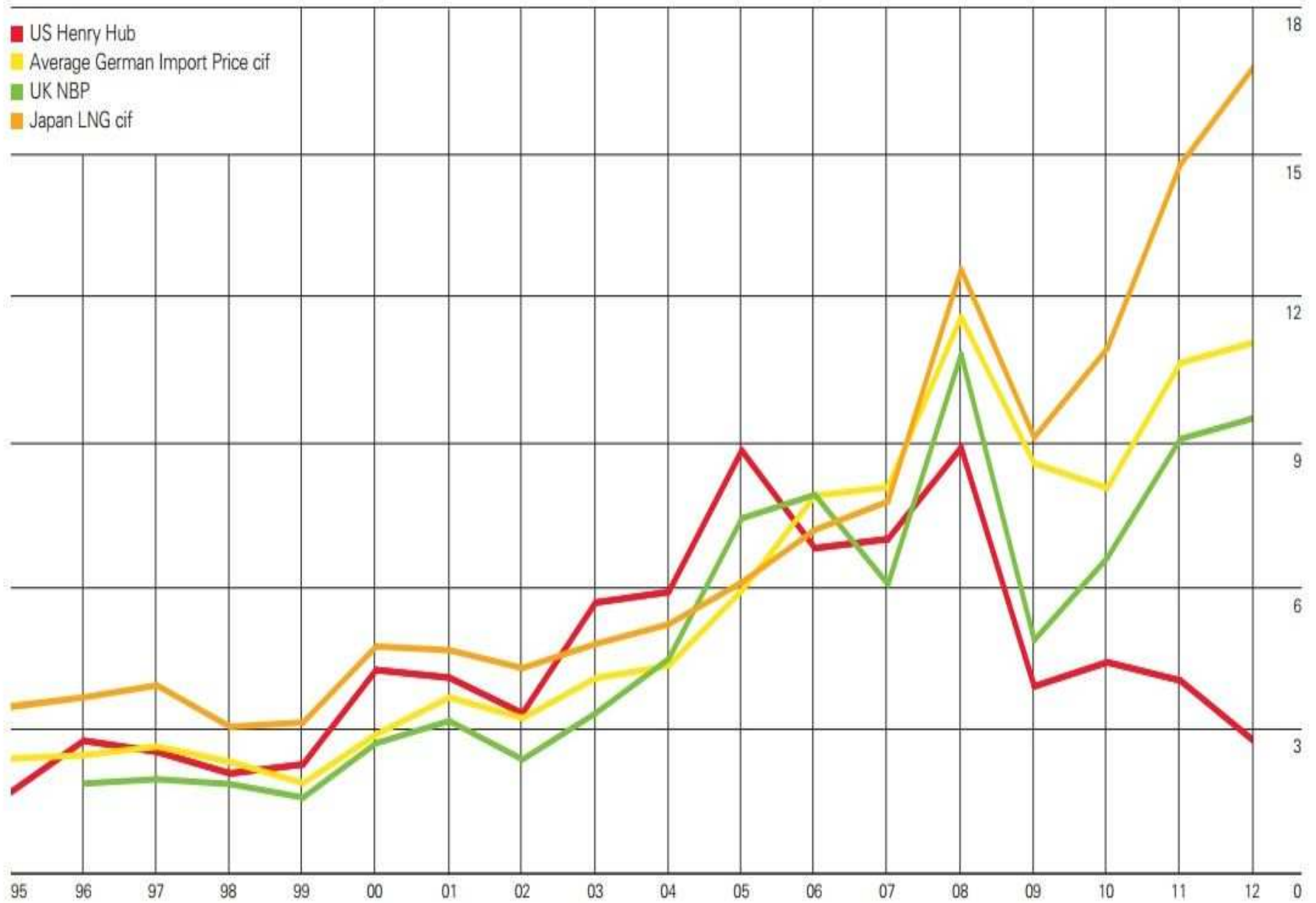


LNG infrastructure



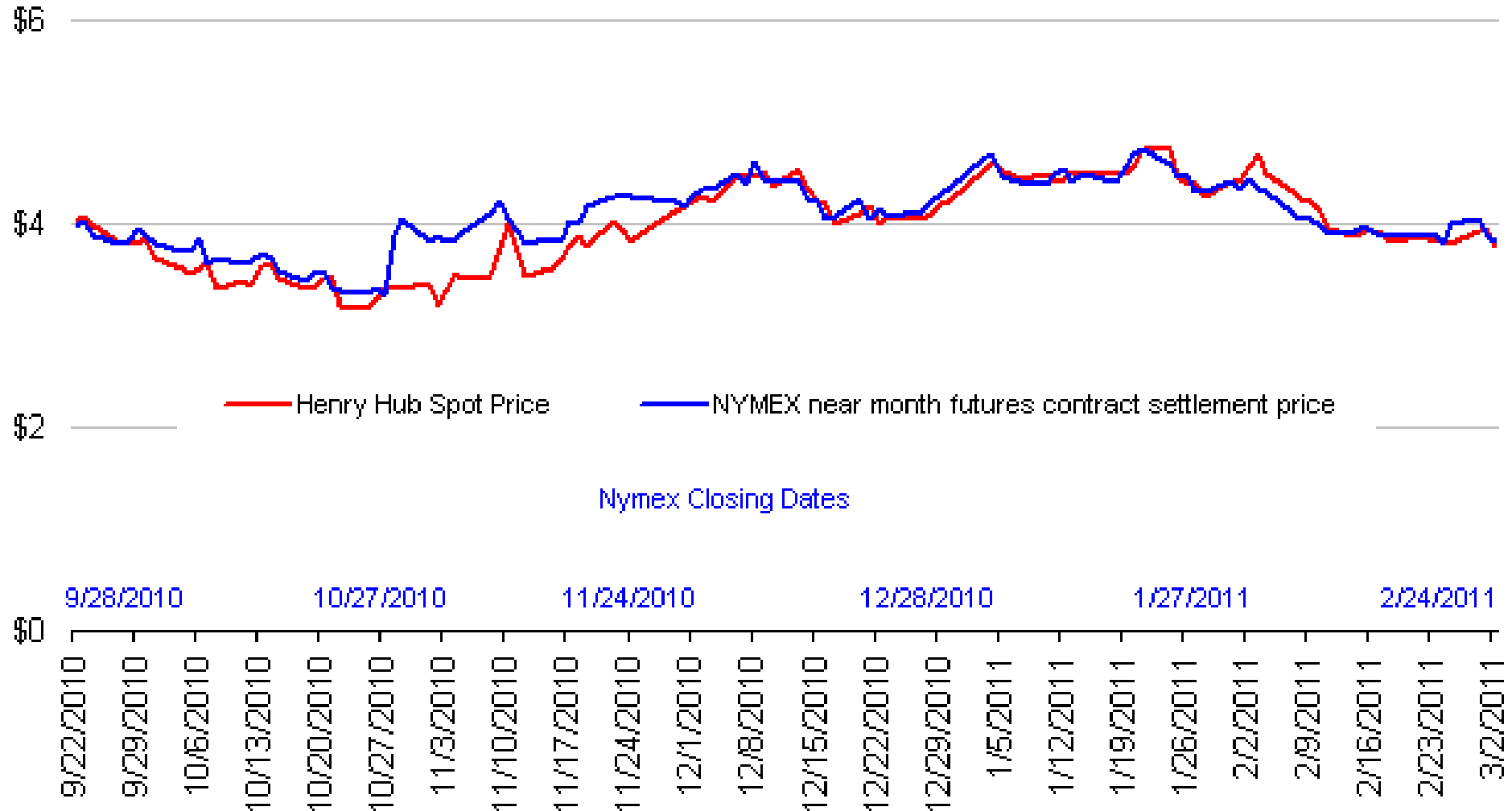
Prices

\$/Mmbtu



NYMEX Natural Gas Futures Near-Month Contract Settlement Price, West Texas Intermediate Crude Oil Spot Price, and Henry Hub Natural Gas Spot Price

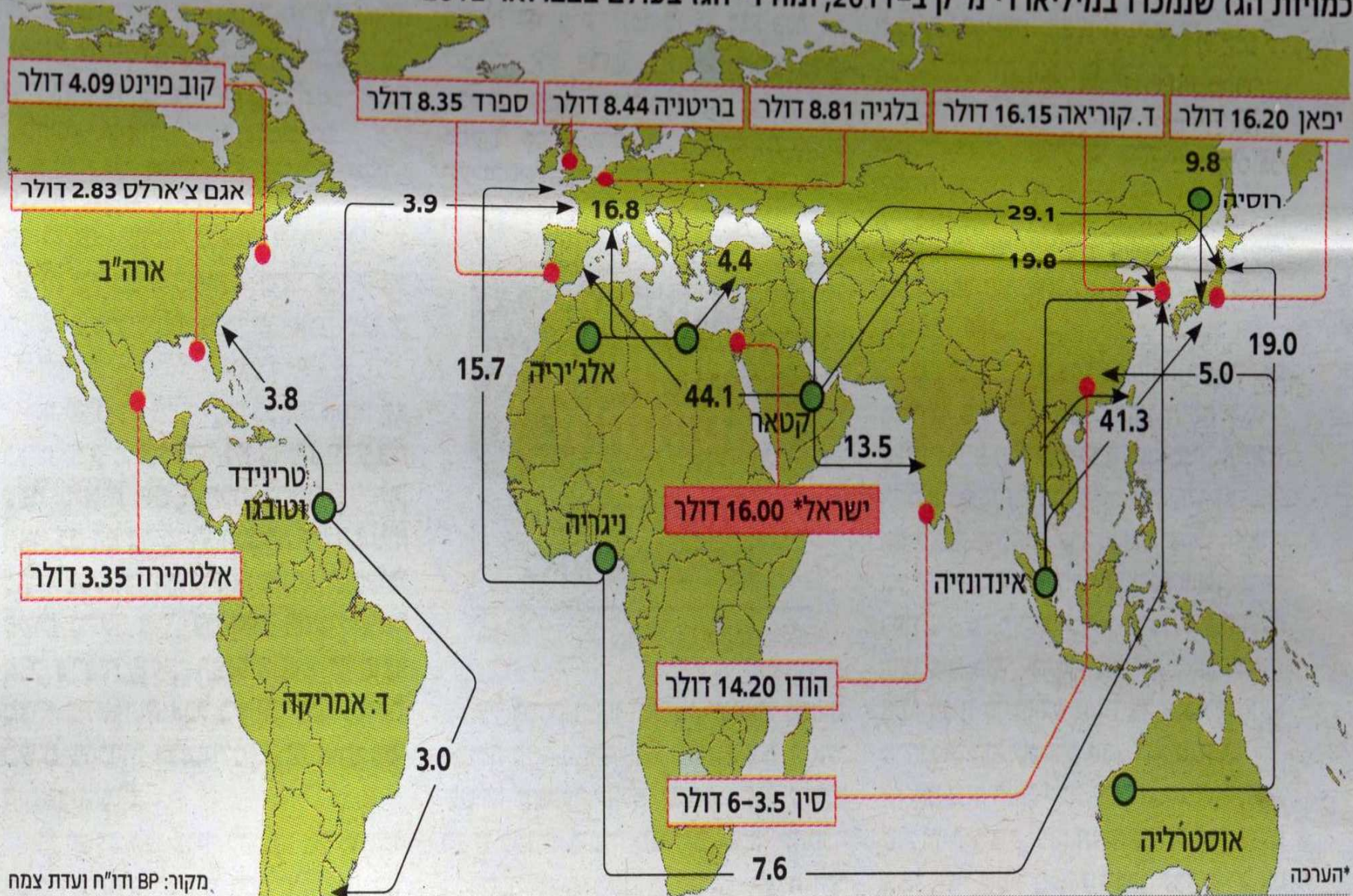
dollars per Million Btu



Note: The West Texas Intermediate (WTI) crude oil price, in dollars per barrel, is converted to \$/MMBtu using a conversion factor of 5.80 MMBtu per barrel. The dates marked by vertical lines are the NYMEX near-month contract settlement dates.
 Source: Natural gas prices, *NGI's Daily Gas Price Index* (<http://intelligencepress.com>); WTI price, Reuters News Service (<http://www.reuters.com>).

הסחר העולמי בגז טבעי נוזלי (LNG)

כמויות הגז שנמכרו במיליארדי מ"ק ב-2011, ומחירי הגז בעולם בפברואר 2012



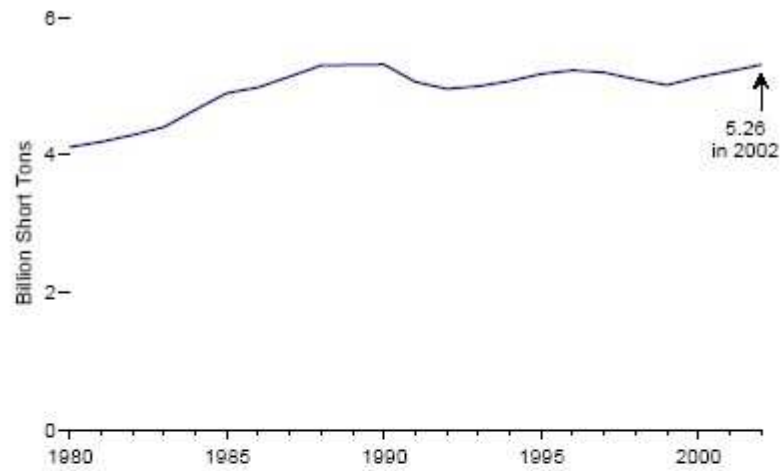
מקור: BP ודו"ח ועדת צמח

*הערכה

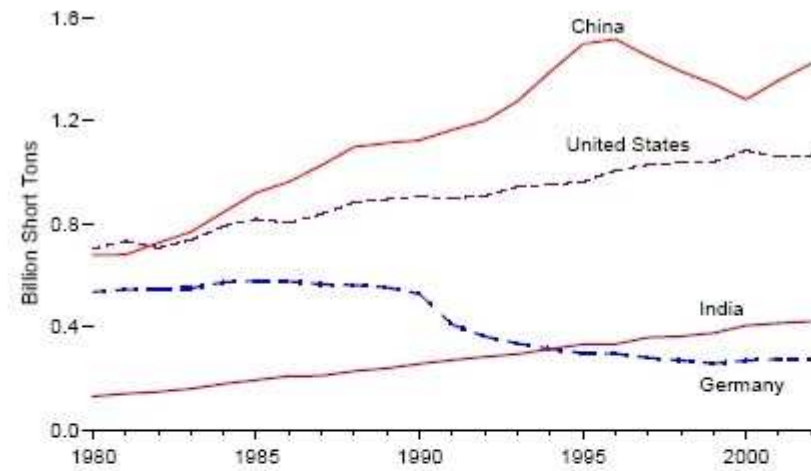
COAL

Production, Reserves & Prices

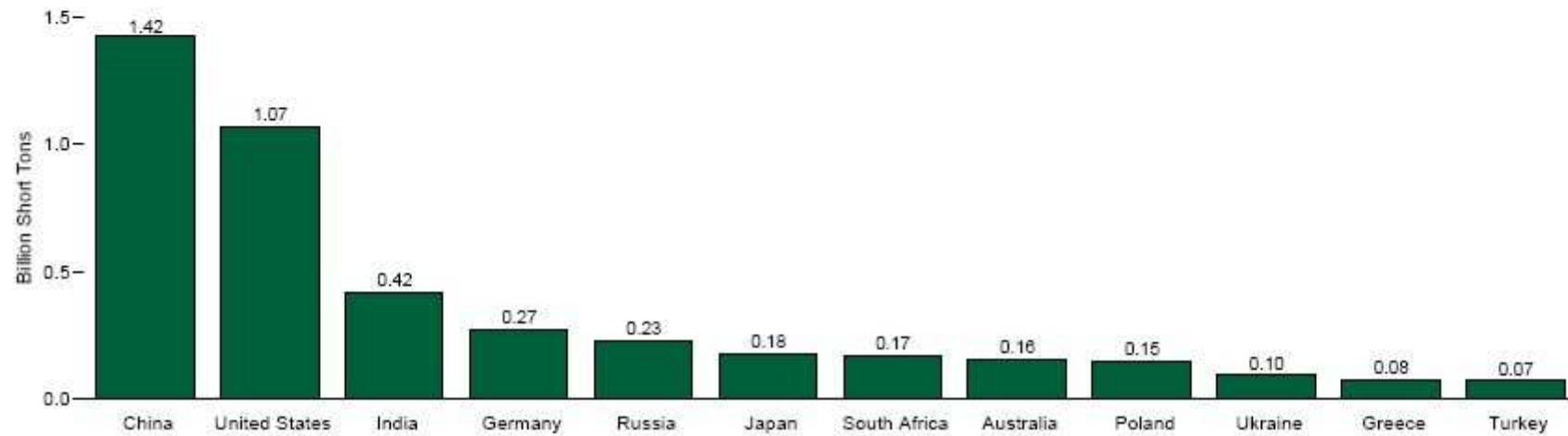
World Total, 1980-2002



Selected Countries, 1980-2002



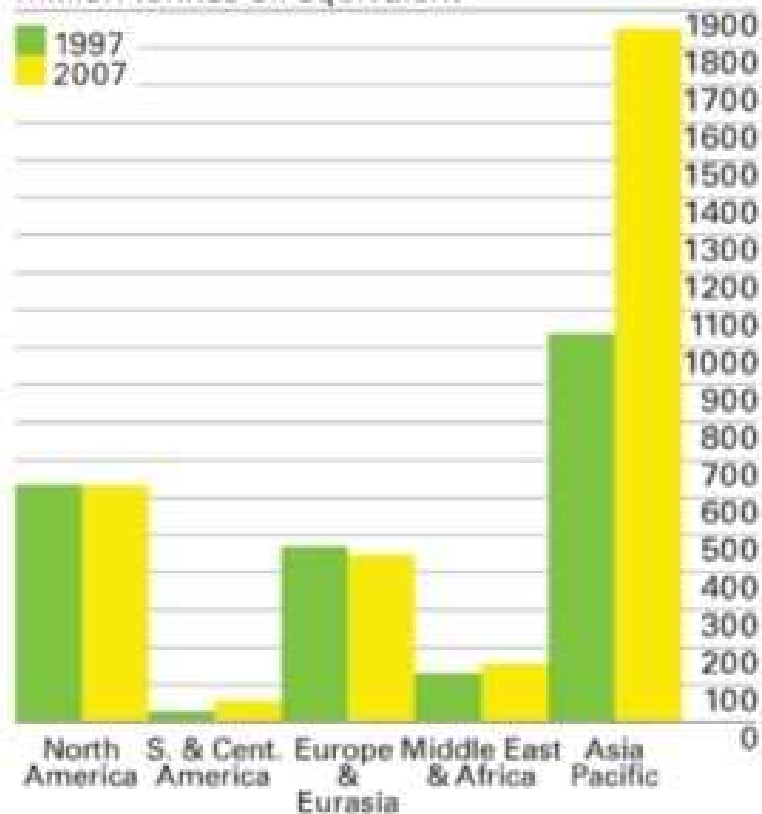
Top Consuming Countries, 2002



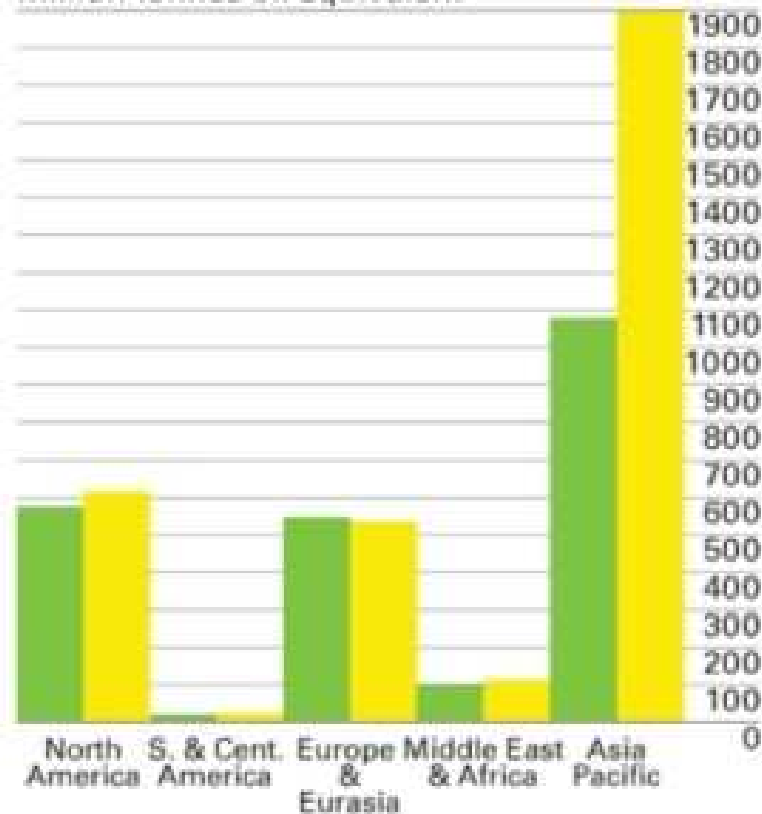


Coal production – Coal consumption

Production
Million tonnes oil equivalent

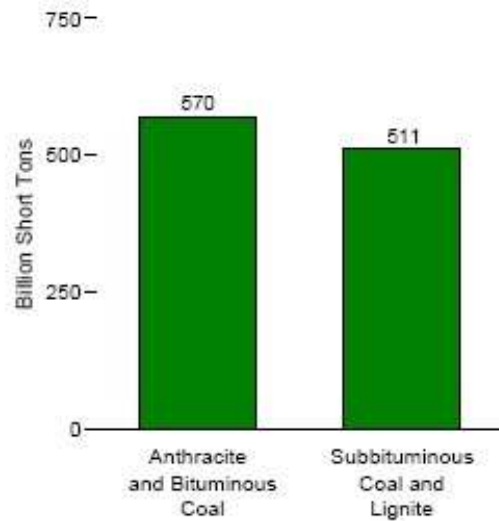


Consumption
Million tonnes oil equivalent

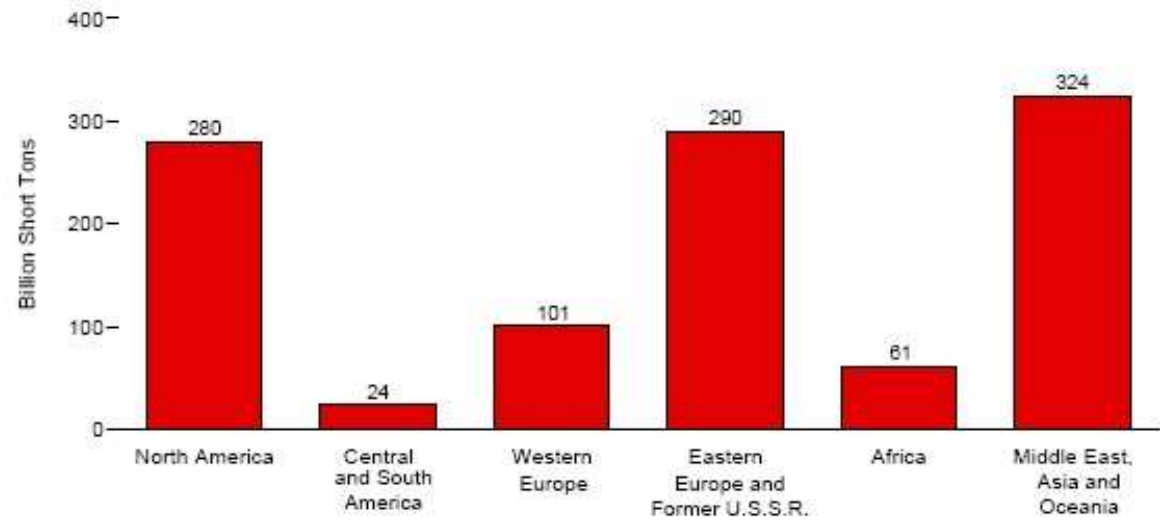


World coal consumption grew by 4.5%, well above the 10-year average. Coal was the world's fastest-growing fuel for the fifth consecutive year. Growth was above average in all regions except the Middle East. Chinese consumption growth accounted for more than two-thirds of global growth.

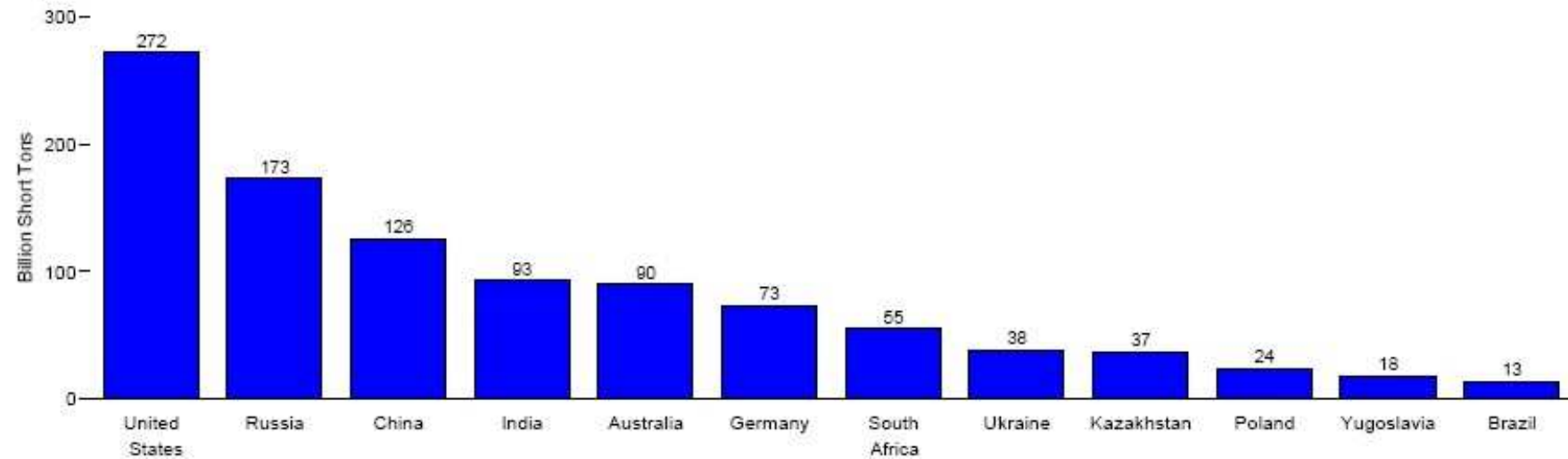
By Type



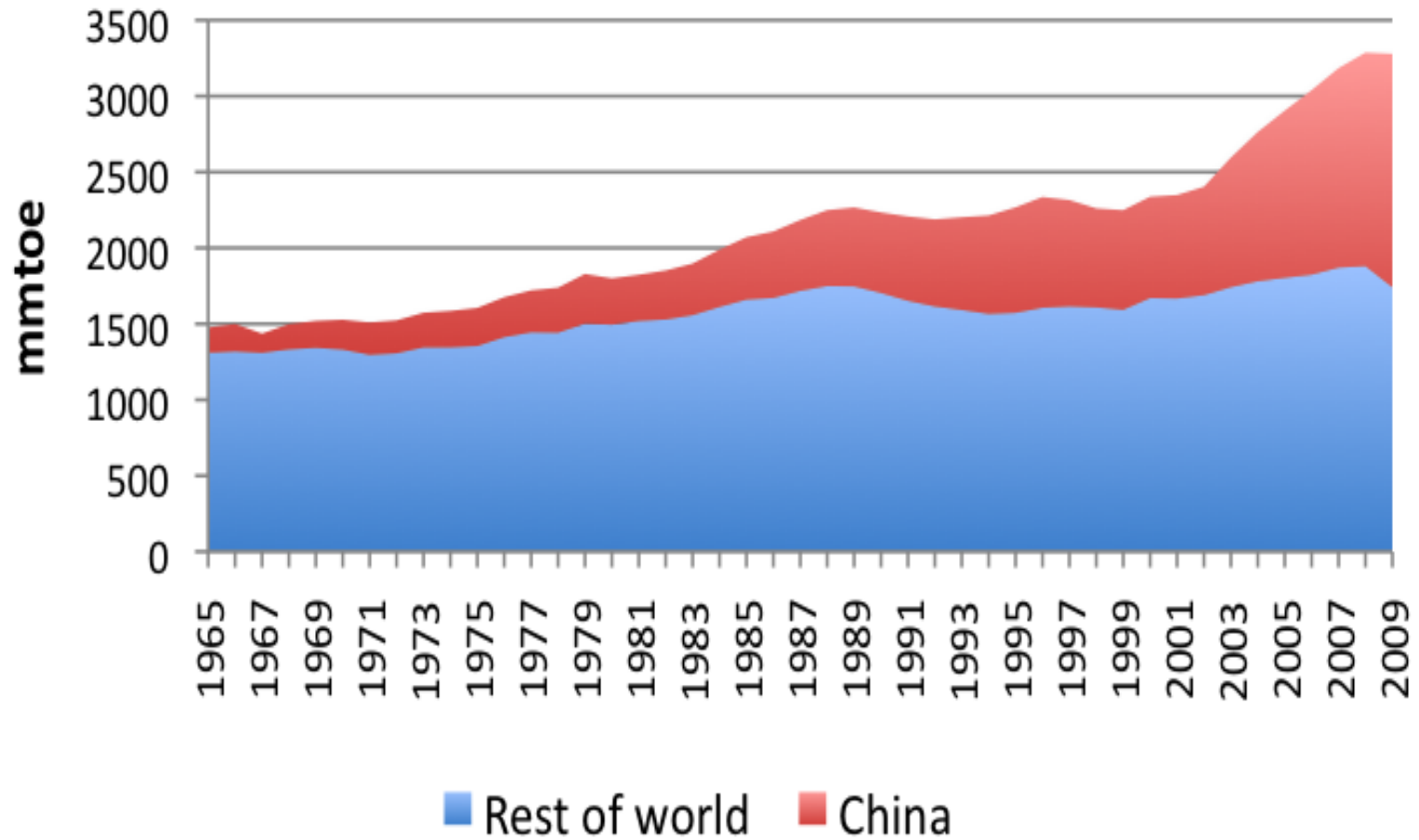
By Region



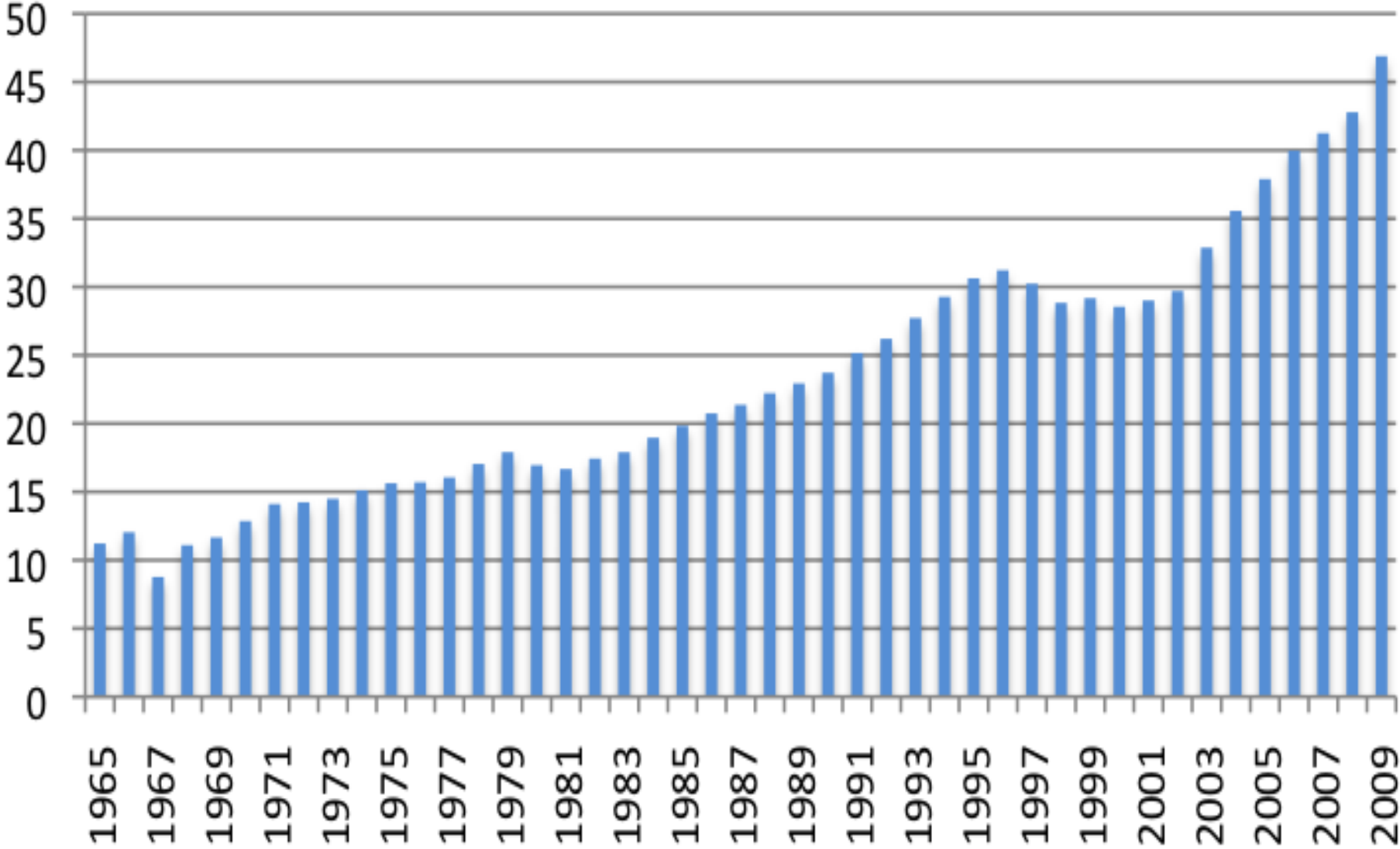
Top Reserves Countries



China coal consumption



China % share of global coal consumption



China coal production and consumption

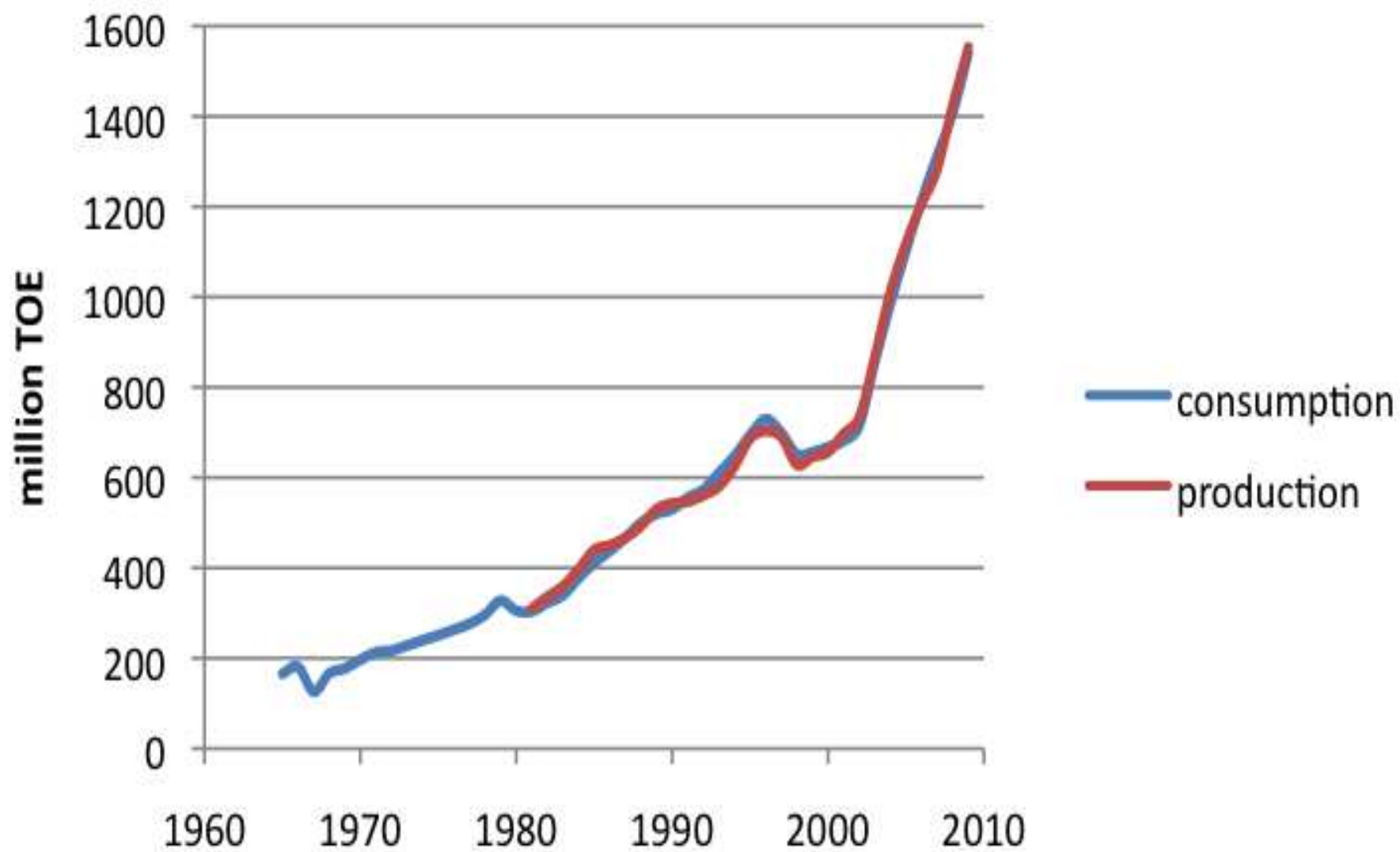
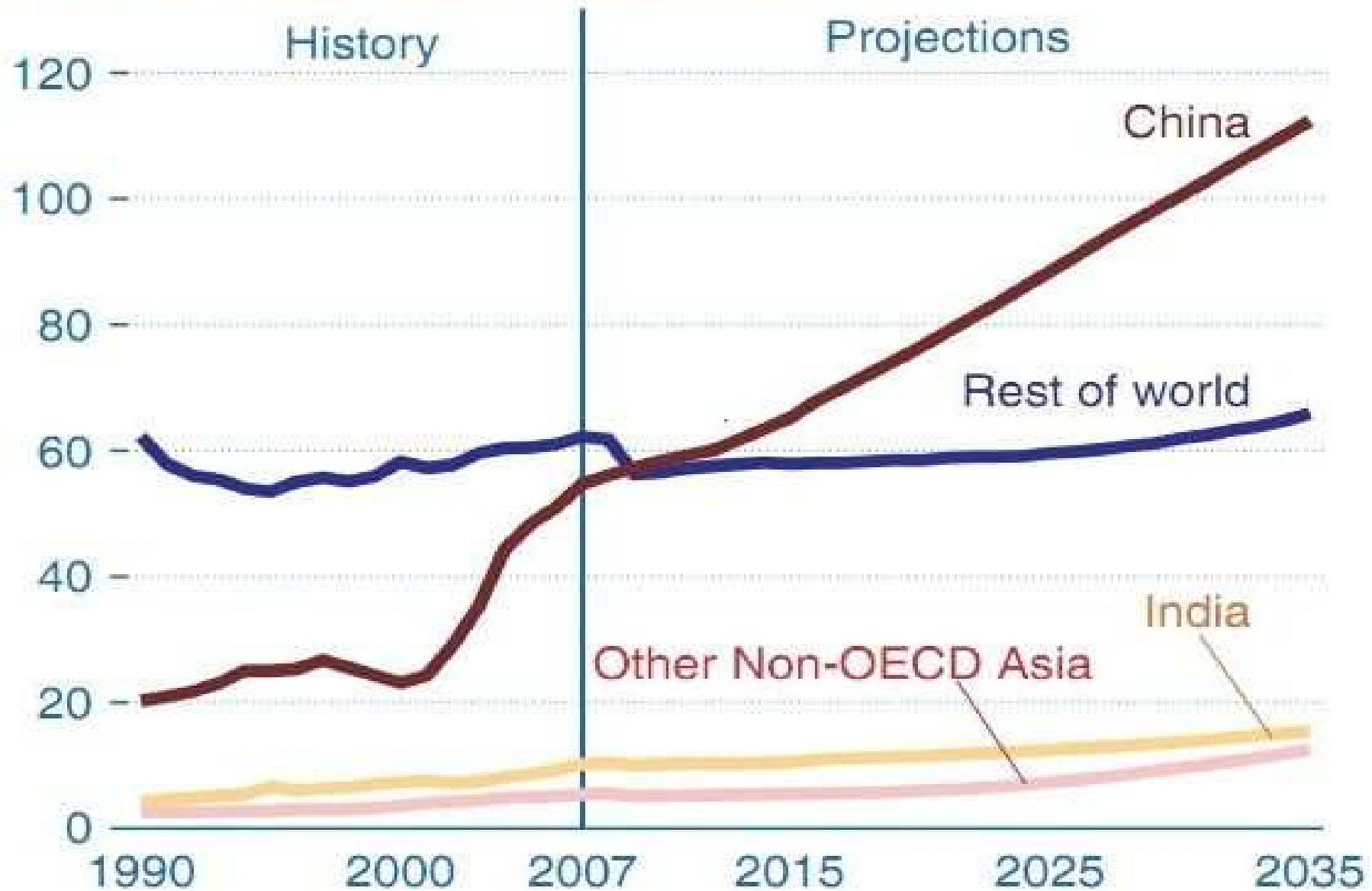
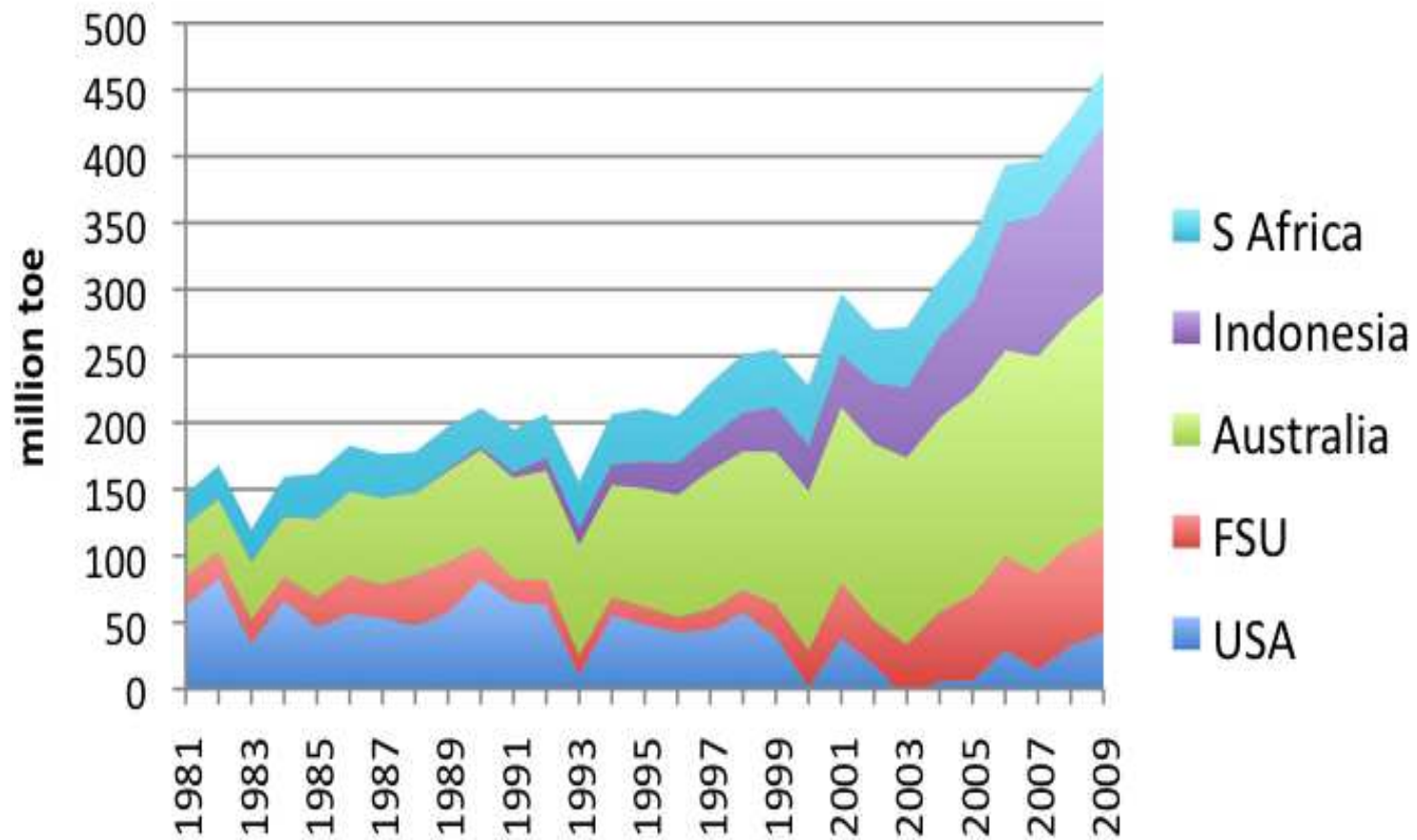


Figure 17. Coal consumption in selected world regions, 1990-2035 (quadrillion Btu)



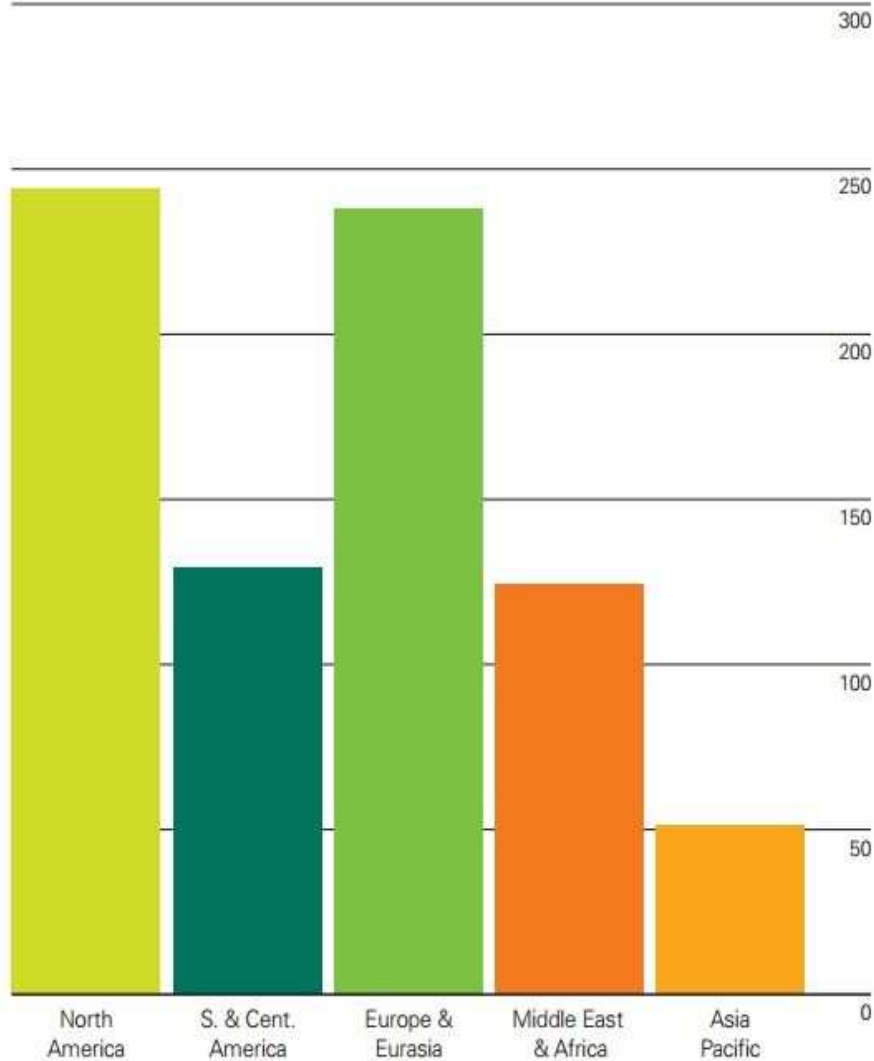
Coal exports - 5 largest exporters



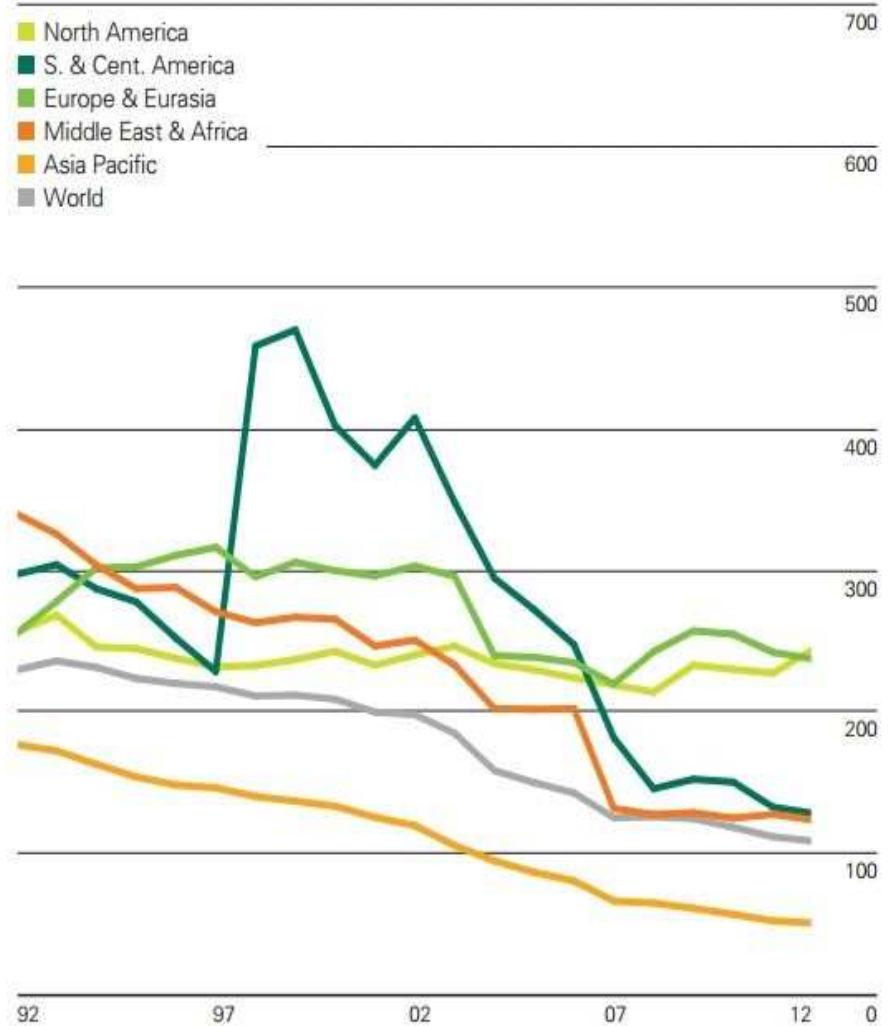
Reserves-to-production (R/P) ratios

Years

2012 by region



History

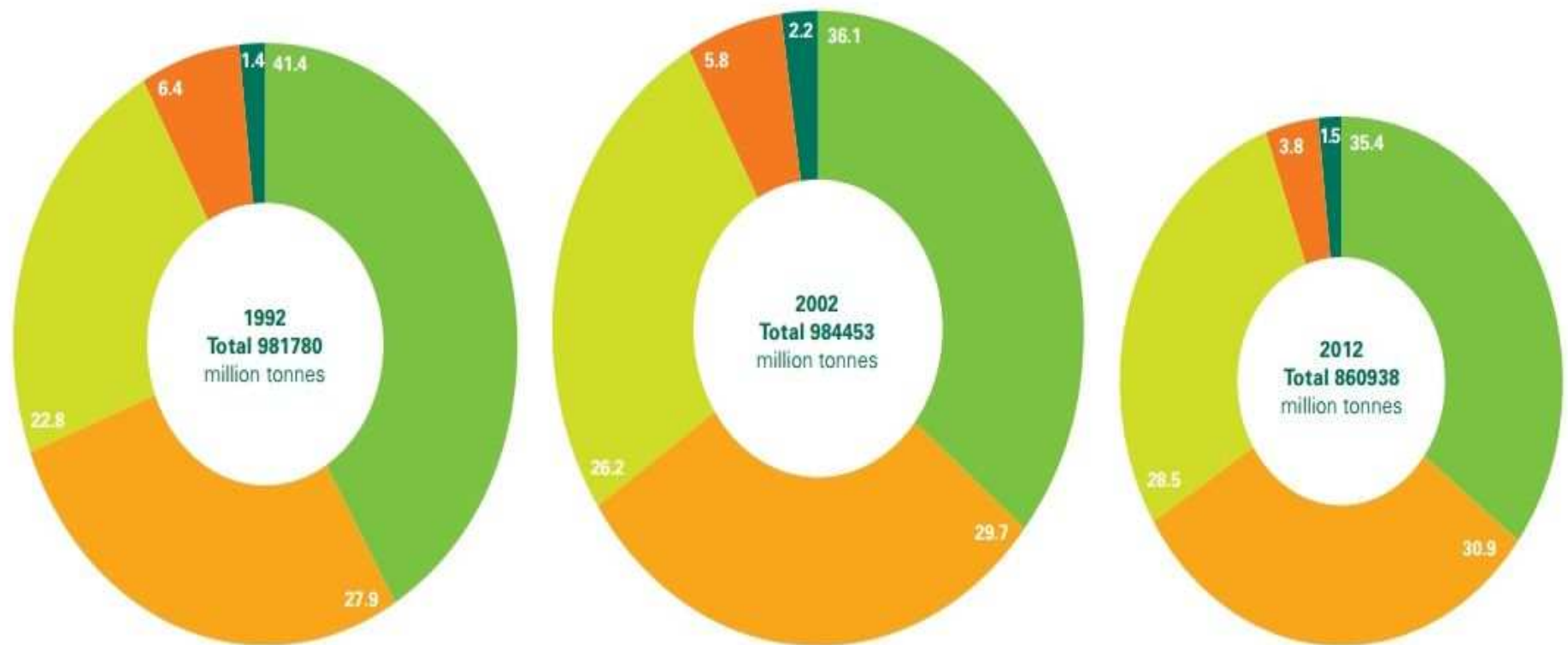


World proved reserves of coal in 2012 were sufficient to meet 109 years of global production, by far the largest R/P ratio for any fossil fuel. Europe & Eurasia holds the largest regional reserves while North America has the highest R/P ratio. The US holds the largest individual reserves, followed by Russia and China.

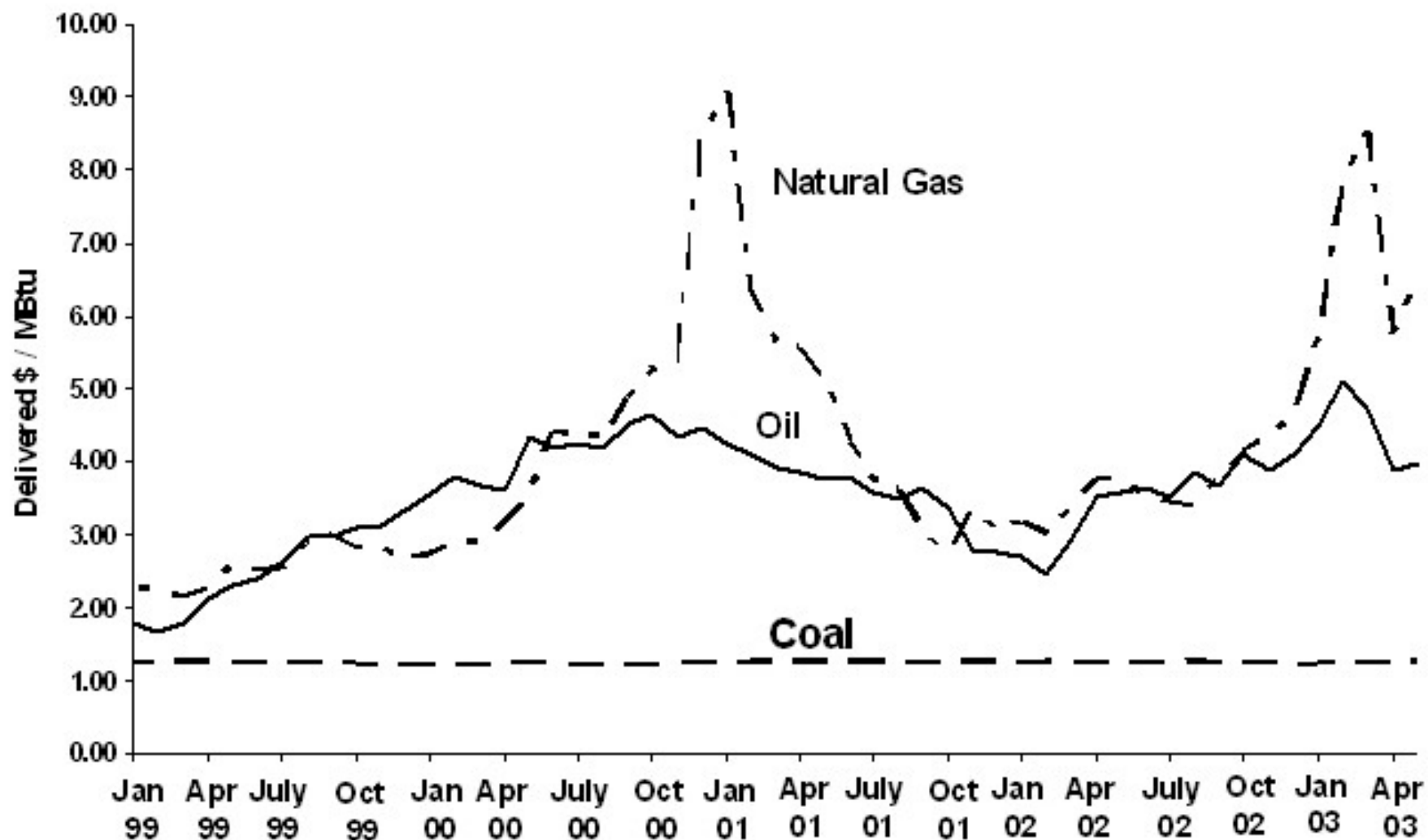
Distribution of proved reserves in 1992, 2002 and 2012

Percentage

- Europe & Eurasia
- Asia Pacific
- North America
- Middle East & Africa
- S. & Cent. America

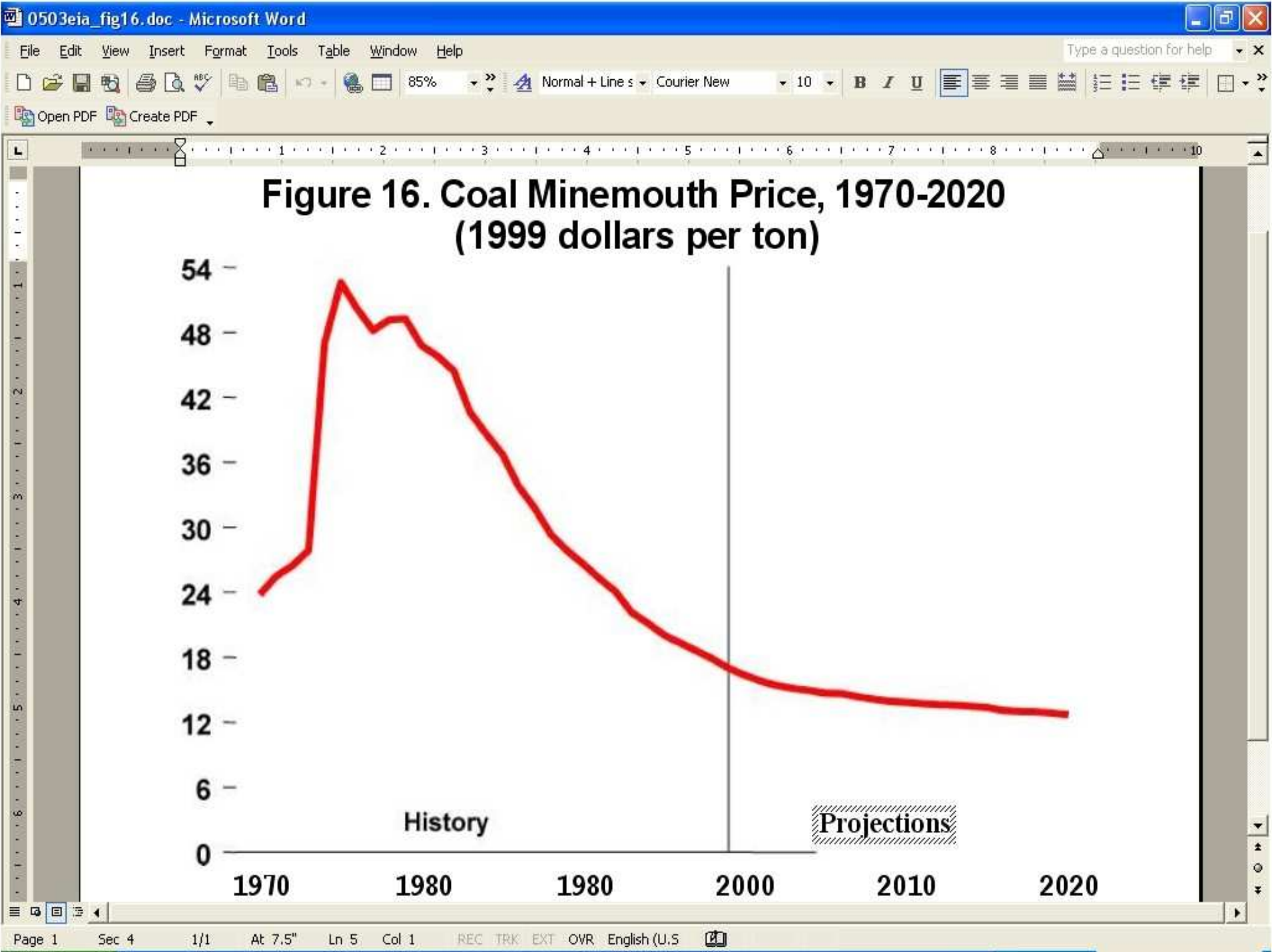


Source: Survey of Energy Resources 2010, World Energy Council.



Delivered cost of fossil fuel at steam electric utility plants.

Source: RDI Fossil-Fuel Receipts at Steam-Electric Utility Plants through January 2003; Energy



**Figure 16. Coal Minemouth Price, 1970-2020
(1999 dollars per ton)**

History

Projections

