

# CH1002 Energy Management in Chemical Industries

## Unit - I

# Global Energy Reserves

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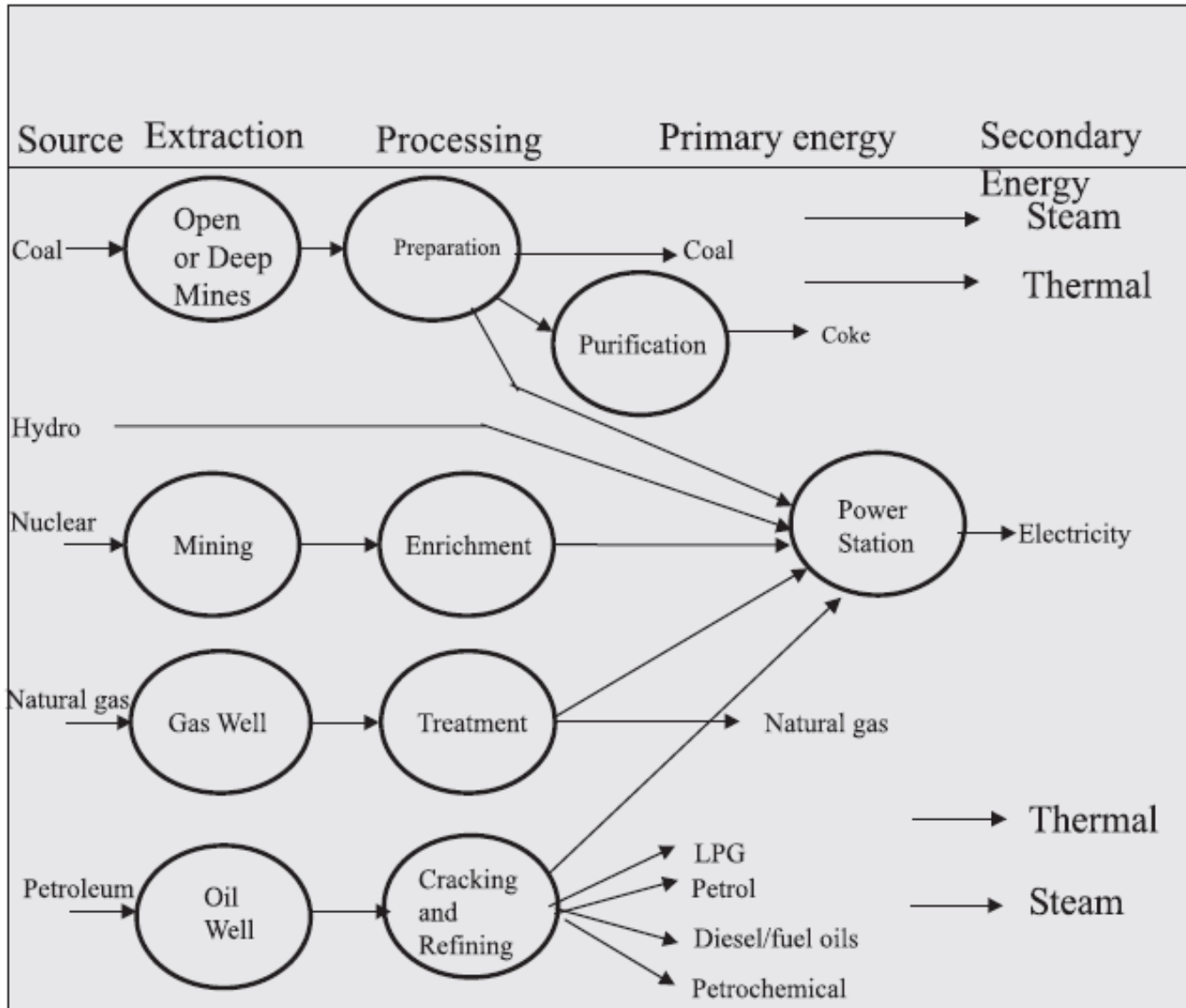
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# Contents

- Classification of energy sources
- World's primary energy consumption
- Fossil fuel – reserves, energy content, reserves distribution
- Renewable energy potential

# Classification of Energy Sources

- Primary and secondary energy
  - Primary energy sources are those that are either found or stored in nature (coal, oil, natural gas, biomass, nuclear, geothermal, wind, solar, etc.)
  - Secondary energy sources such as steam and electricity are obtained from conversion of primary energy sources in industrial utilities.
- Commercial and non-commercial energy
  - Commercial energy: the sources that are available in the market for a definite price (electricity, lignite, coal, oil, etc.)
  - Non commercial energy: firewood, cattle-dung, agricultural wastes, etc.
- Renewable and non-renewable energy



**Figure 1.1 Major Primary and Secondary Sources**

# World Primary Energy Consumption

N. Lior / Energy xxx (2009) 1–8

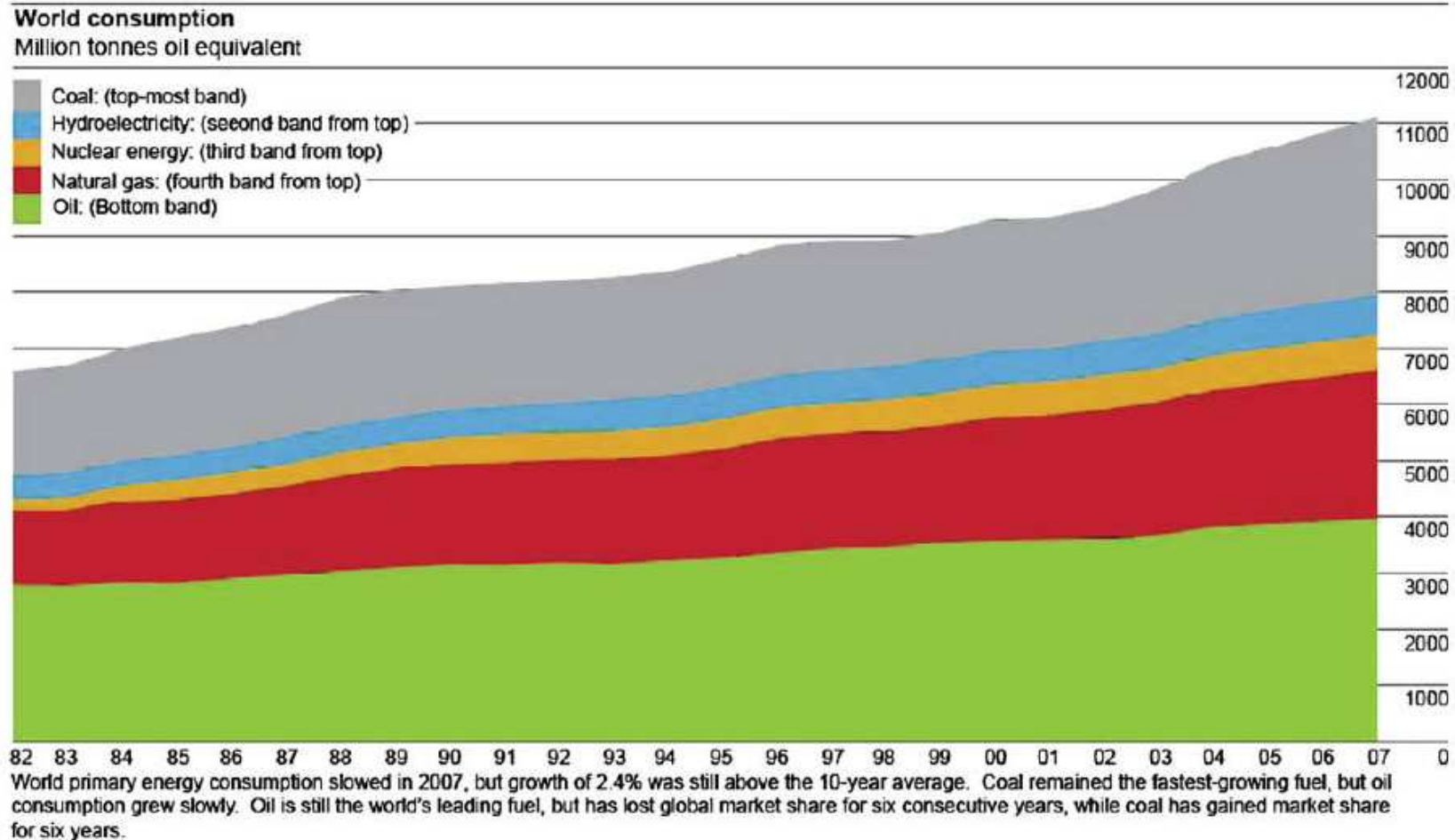
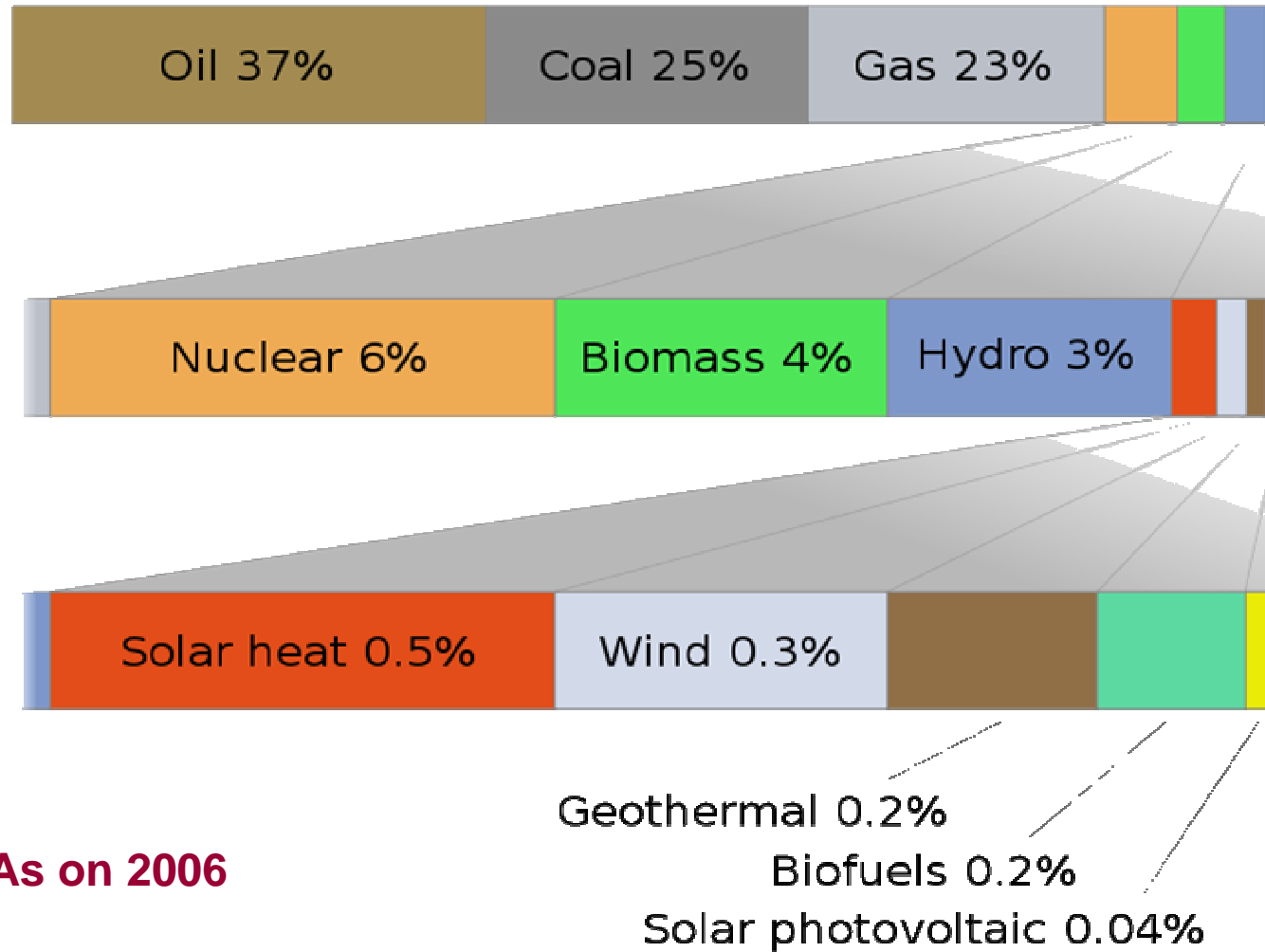


Fig. 1. World primary energy consumption 1981–2007 [1].

# Share of Various Sources for Primary Energy



# Fossil Fuel Reserves

- Coal - 1 trillion ton (as on 2003)
- Oil - 0.2 trillion m<sup>3</sup> (in 2003)
  - Saudi Arabia – the largest share of 23%
- Gas - 176 trillion m<sup>3</sup> (2003)  
~ 0.16 trillion ton
  - Russia has the largest share of 27%

Rank	Country	% share
1	USA	25.4
2	Russia	15.9
3	China	11.6
4	India	8.6

**Coal reserves**

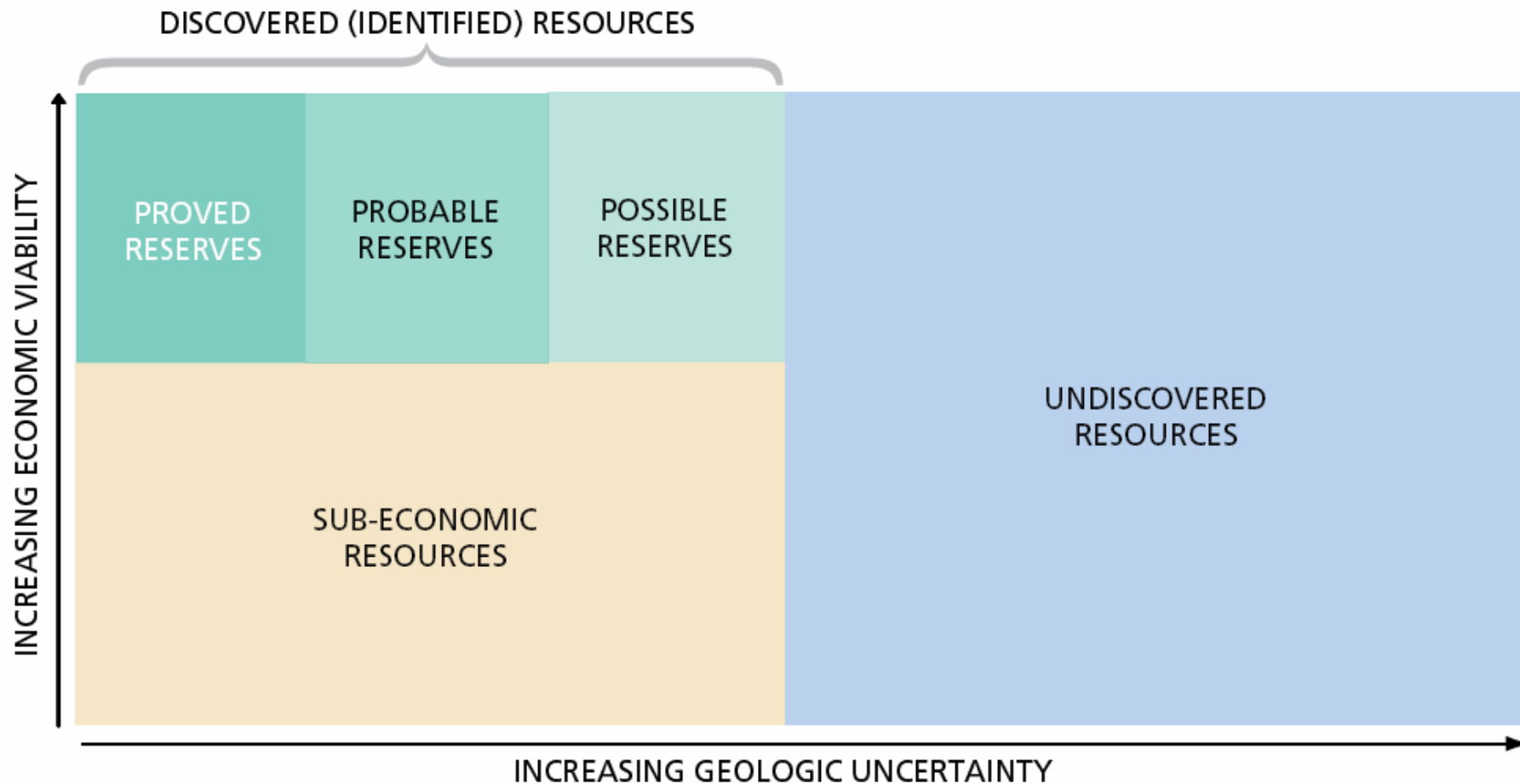
# Fossil Fuel Reserves

As on 2003	Global Reserves (trillion toe)	India's Reserves (% of global)
Coal	0.5	10%
Oil	0.18	0.41%
Gas	0.15	0.61%
Total Fossil fuels	0.83	7.4%

Proven reserves, expected to last for:

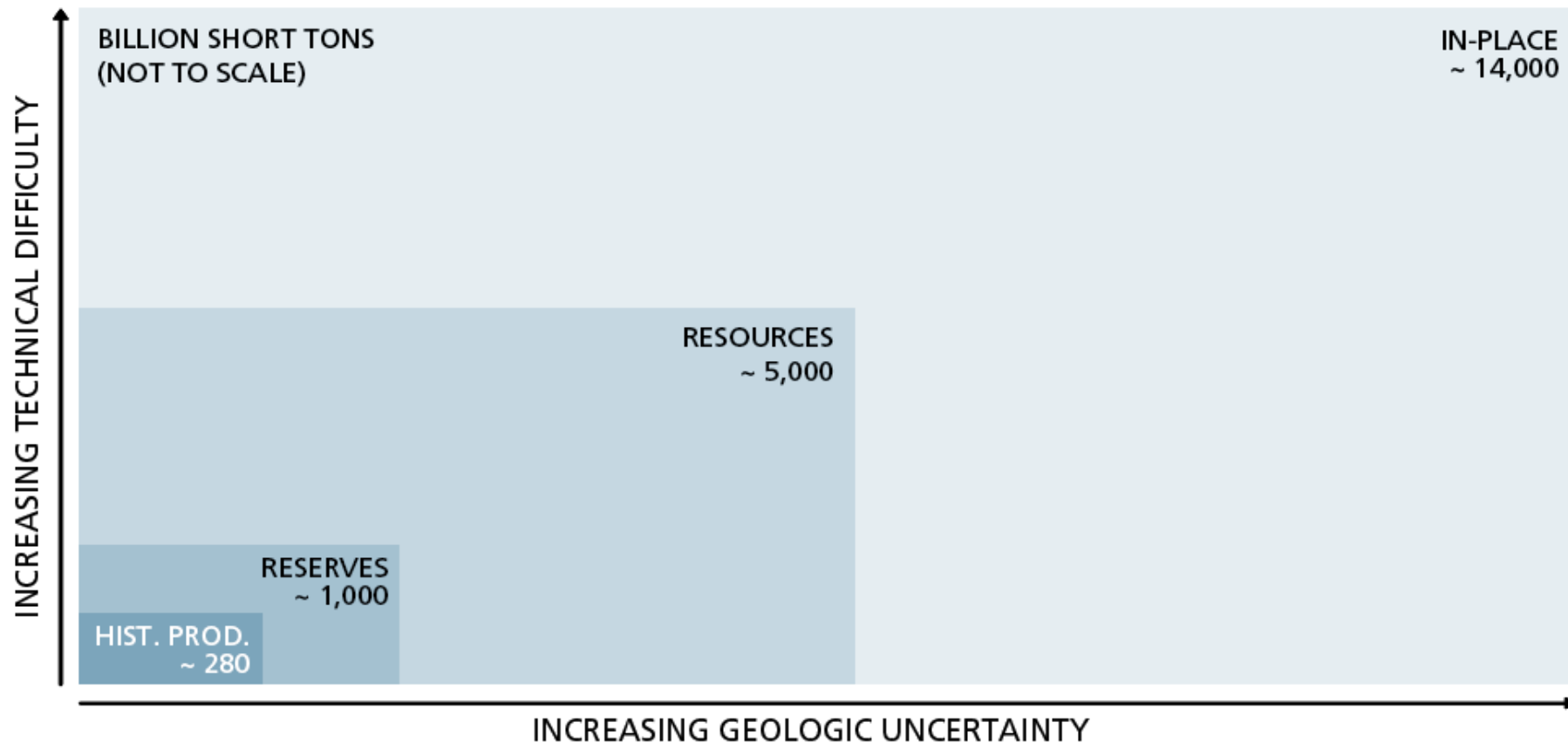
Coal	122 years
Oil	42 years
Gas	60 years

# Reserves and Resources



Source: McKelvey, V.E., "Mineral Resource Estimates and Public Policy," *American Scientist*, 1972.

# Coal Availability

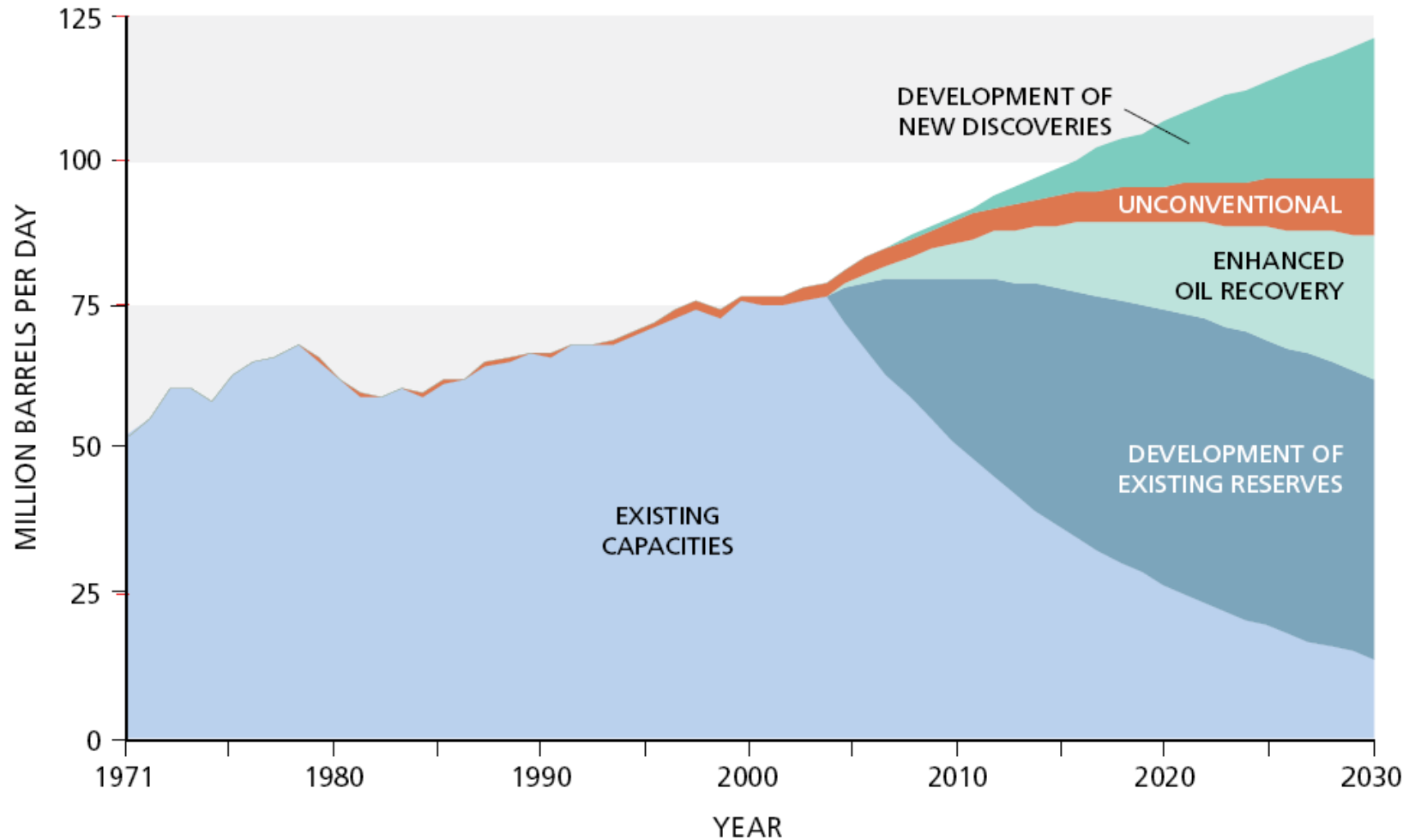


Sources: (1) 1800 to 1980: Bernardo F. Grossling, "World Coal Resources," Financial Times Business Information, London, 1981; 1981 to 2005: Energy Information Administration, *International Energy Annual*. (2) World Energy Council, "Survey of Energy Resources," 2004. (3) Rogner, H-H., "Annual Review – Energy Environment," Institute for Integrated Energy Systems, 1997.

**FIGURE 2-58.** *Global Coal Endowment*

Hard Truths , National Petroleum Council, July 2007, Washington

# Oil Usage



Source: IEA, *World Energy Outlook 2004*.

**FIGURE 2-3.** *Illustrative Total Liquids Supply*

Hard Truths , National Petroleum Council, July 2007, Washington

# Energy Content of Fuels

- Coal: energy content  $\sim$  24 GJ/Ton
- Oil: 42 GJ/Ton
- Natural Gas: 54 GJ/Ton

# Coal

- Readily combustible material, black or brownish-black material
- Coal was formed from layer upon layer of annual plant remains accumulating slowly that were protected from biodegradation by usually acidic covering waters that gave a natural antiseptic effect combating microorganisms and then later mud deposits protecting against oxidization
- Coal, a fossil fuel, is the largest source of energy for the generation of electricity worldwide, as well as one of the largest worldwide anthropogenic sources of carbon dioxide emissions
- Approximately 40% of the world electricity production uses coal

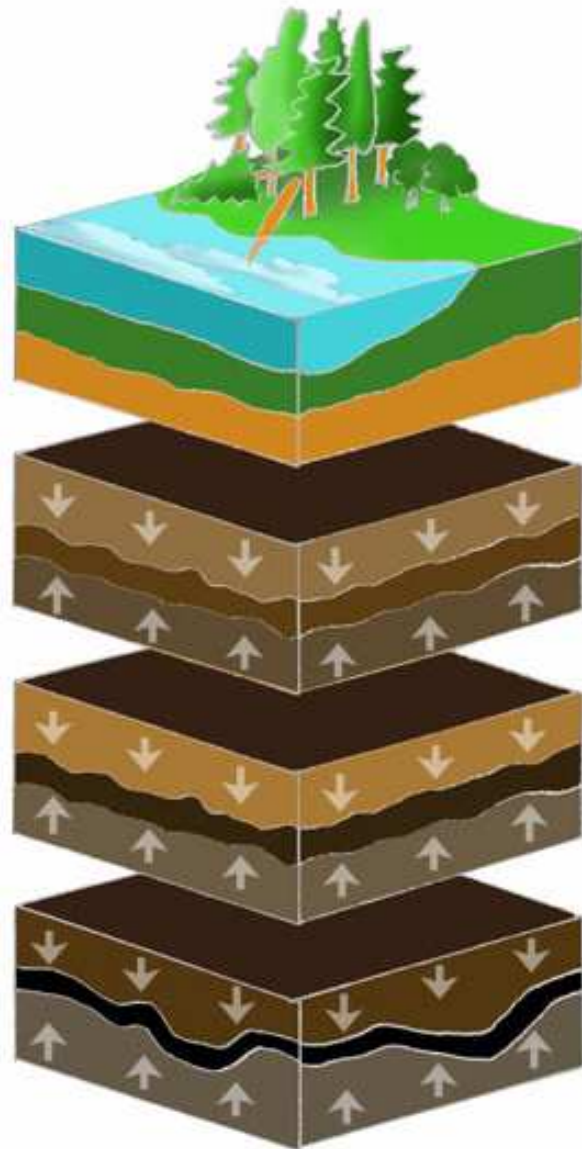
# Coal



# Stages in Formation of Coal

- Heavy growth of vegetation
- Burial of debris, and compression
- There are four stages in coal formation: peat, lignite, bituminous and anthracite. The stage depends upon the conditions to which the plant remains are subjected after they were buried - the greater the pressure and heat, the higher the rank of coal. Higher-ranking coal is denser and contains less moisture and gases and has a higher heat value than lower-ranking coal.

# Stages in Formation of Coal



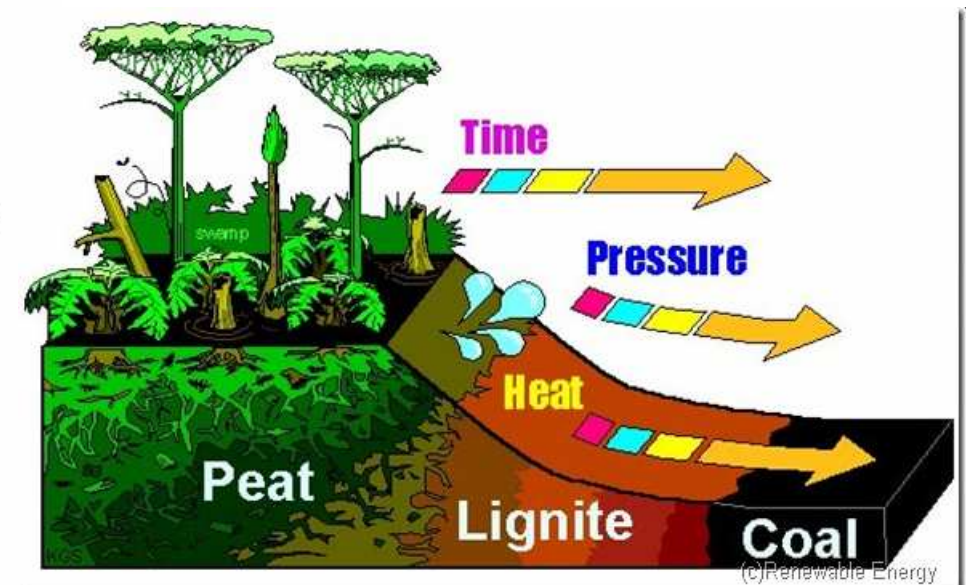
HUGE FORESTS GREW AROUND  
300 MILLION YEARS AGO  
COVERING MOST OF THE EARTH

THE VEGETATION DIES AND  
FORMS PEAT

THE PEAT IS COMPRESSED BETWEEN  
SEDIMENT LAYERS TO FORM LIGNITE

FURTHER COMPRESSION  
FORMS BITUMINOUS AND  
SUBBITUMINOUS COAL

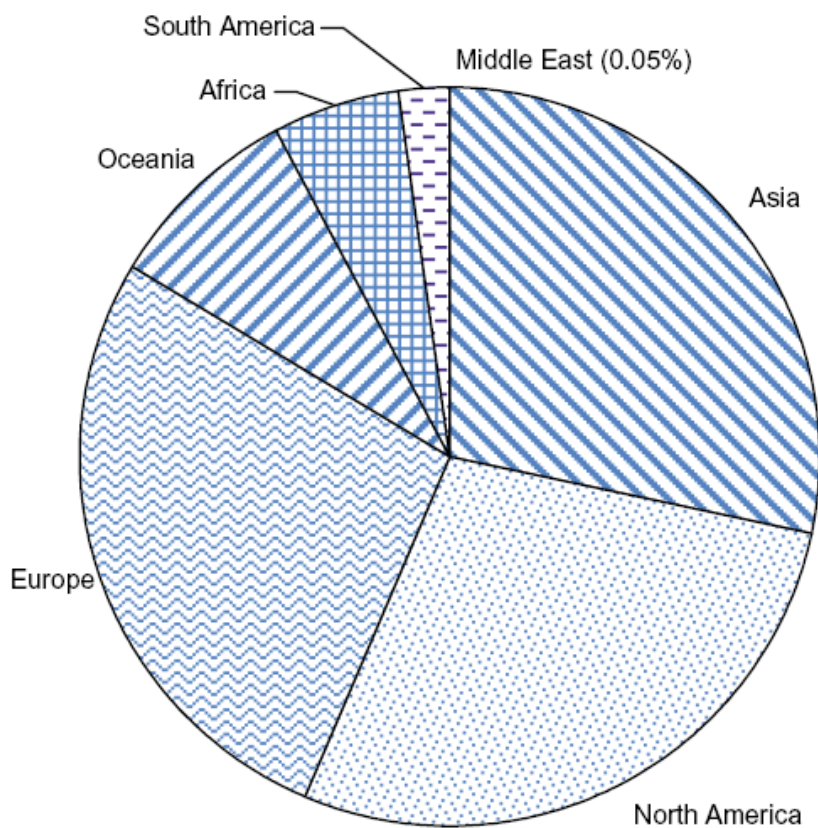
EVENTUALLY ANTHRACITE FORMS



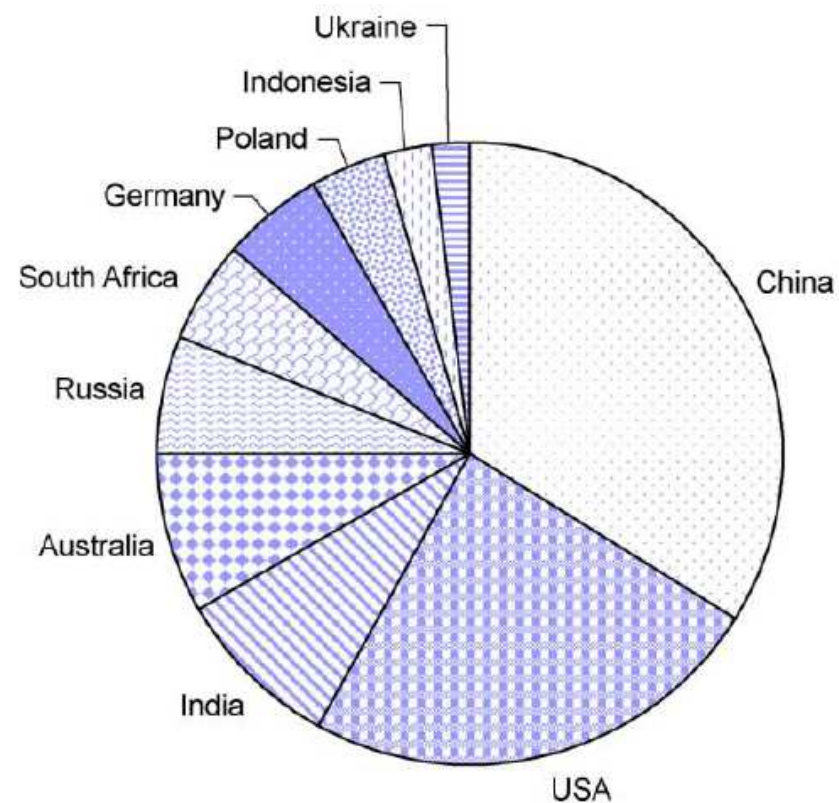
# Types of Coal

- Peat – a precursor of coal
- Lignite – brown coal, the lowest rank of coal, exclusively used for electricity generation
- Sub-bituminous coal – used as fuel for electricity generation, synthesis of light aromatic hydrocarbons
- Bituminous – fuel for electricity, coke
- Anthracite – residential and commercial space heating
- Graphite – difficult to ignite, used for producing lubricants

# Coal Reserves



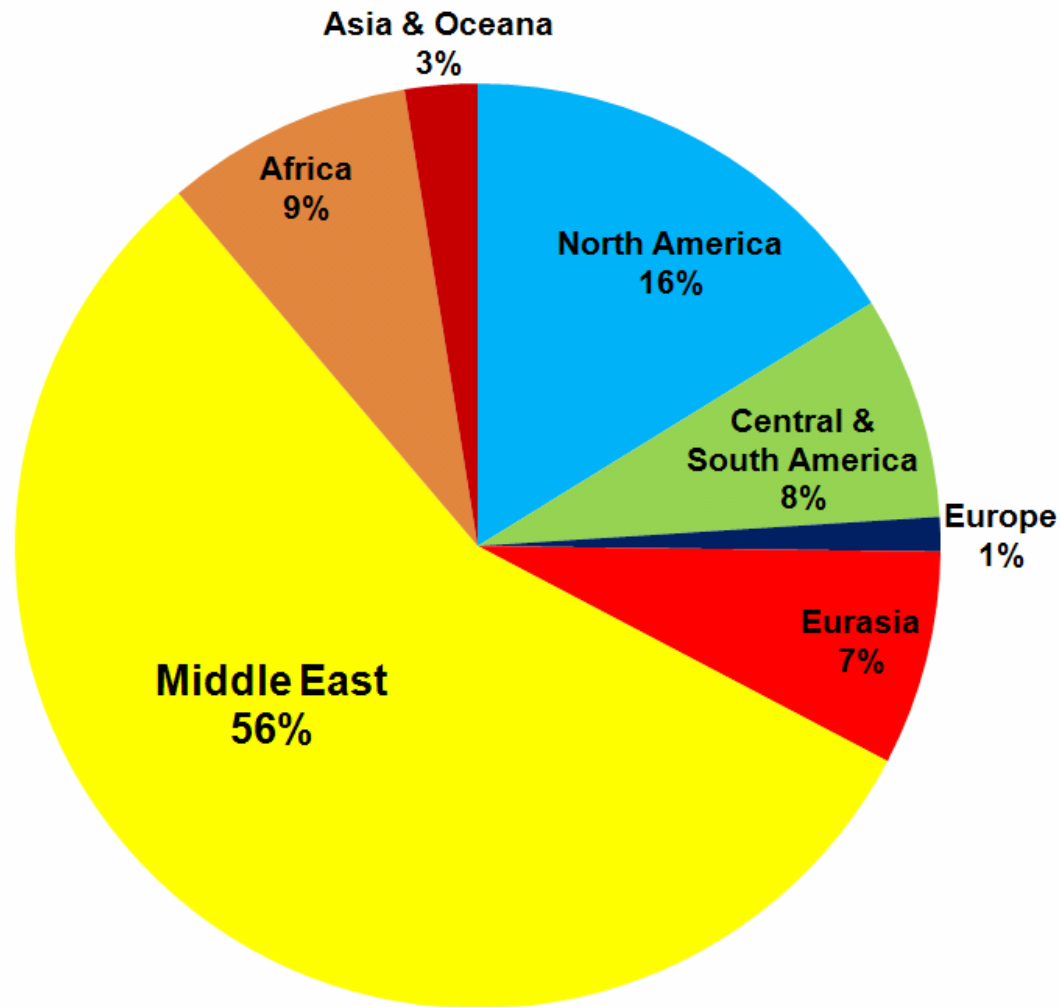
**FIGURE 1.1** Proved coal reserves at end-2002—regional distribution.



**FIGURE 1.2** The top ten coal producing countries in 2002.

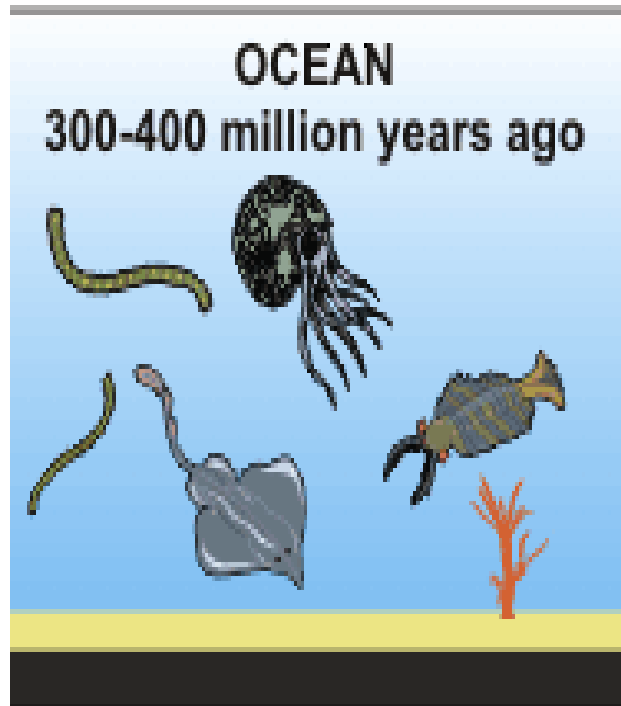
2004 Survey of World Energy Resources, World Energy Council

# World Oil Reserves by Region

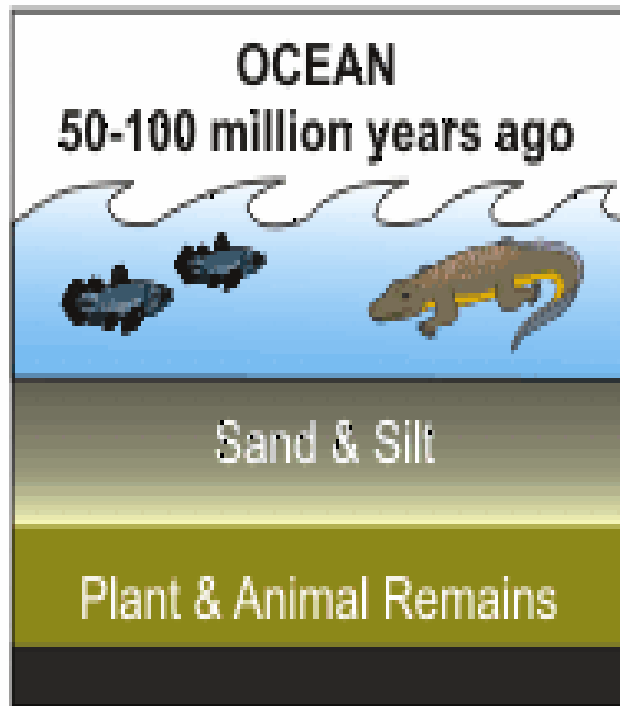


Data source: US Energy Information Administration from Oil and Gas Journal (2007)  
Oil includes crude oil and condensate

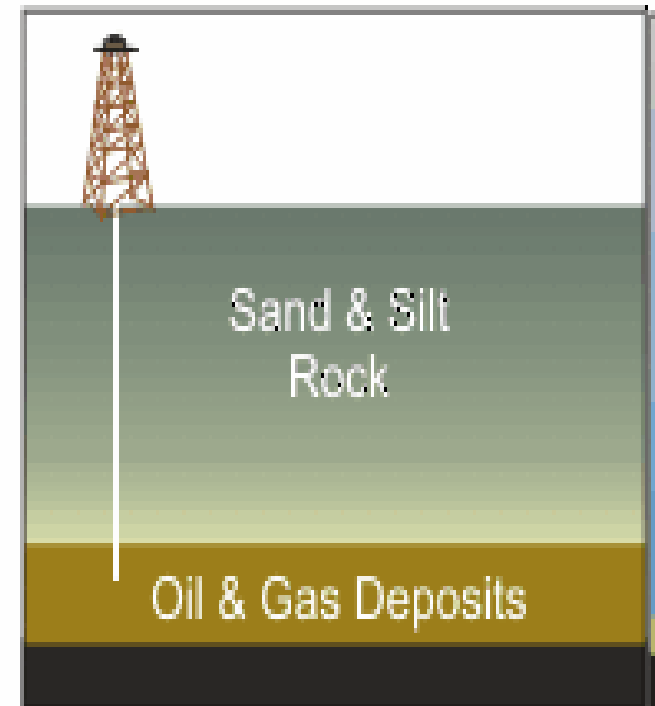
# PETROLEUM & NATURAL GAS FORMATION



Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of silt and sand.



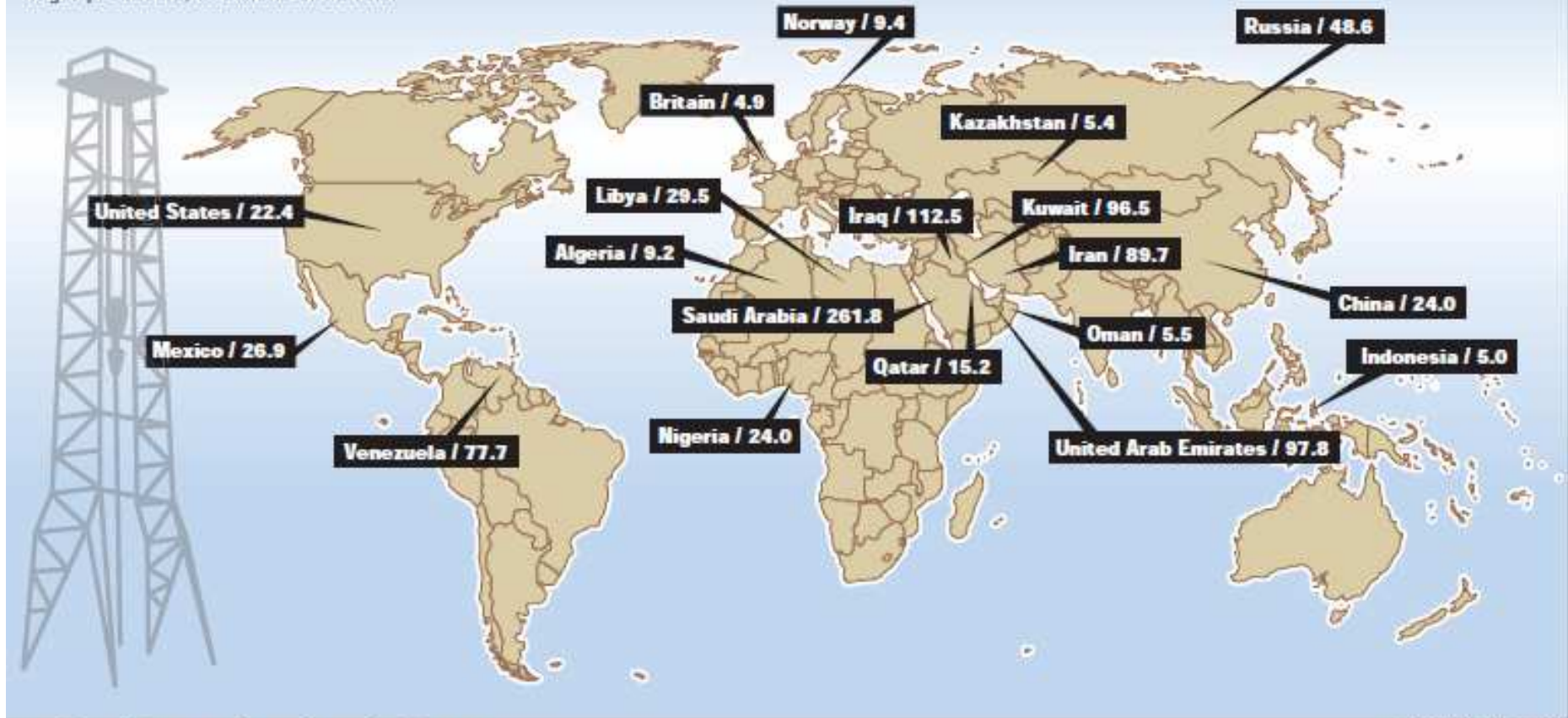
Over millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.



Today, we drill down through layers of sand, silt, and rock to reach the rock formations that contain oil and gas deposits.

## Crude oil reserves worldwide

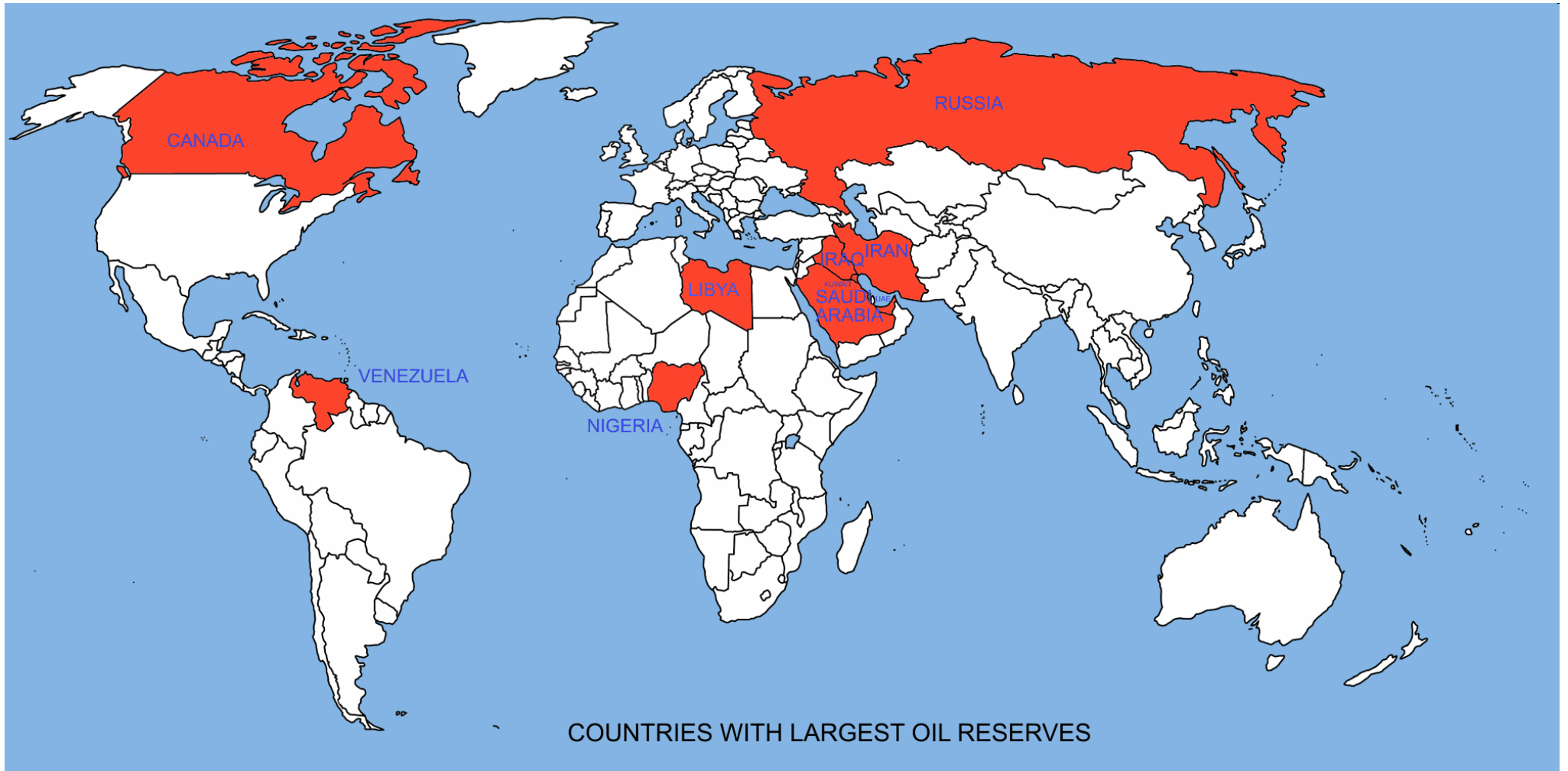
Of the globe's 1 trillion barrels of estimated reserves in 2002, some two-thirds of that was in the Middle East. Here are the reserves of major producers, in billions of barrels:



Source: Energy Information Agency/Oil and Gas Journal

SCOTT WALLACE - STAFF

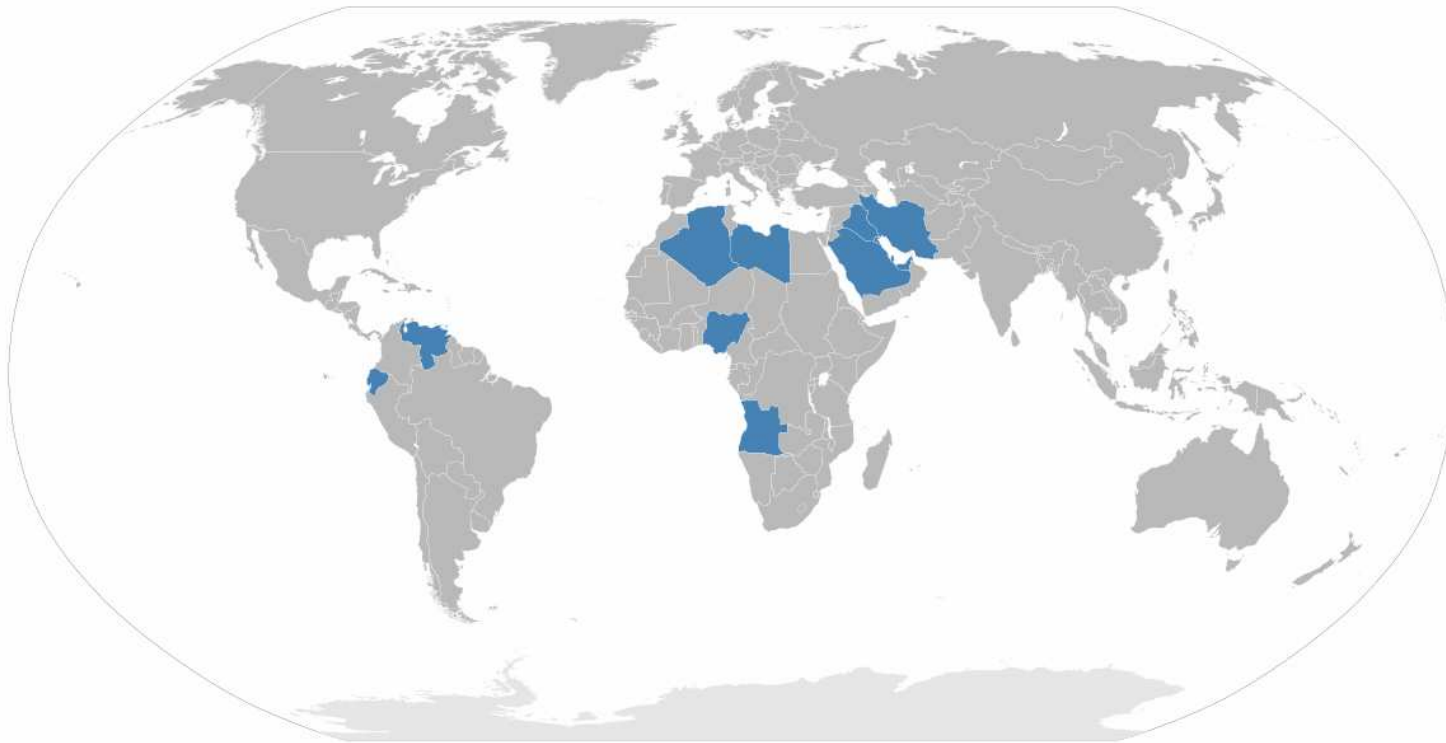
# Countries with Largest Oil Reserves



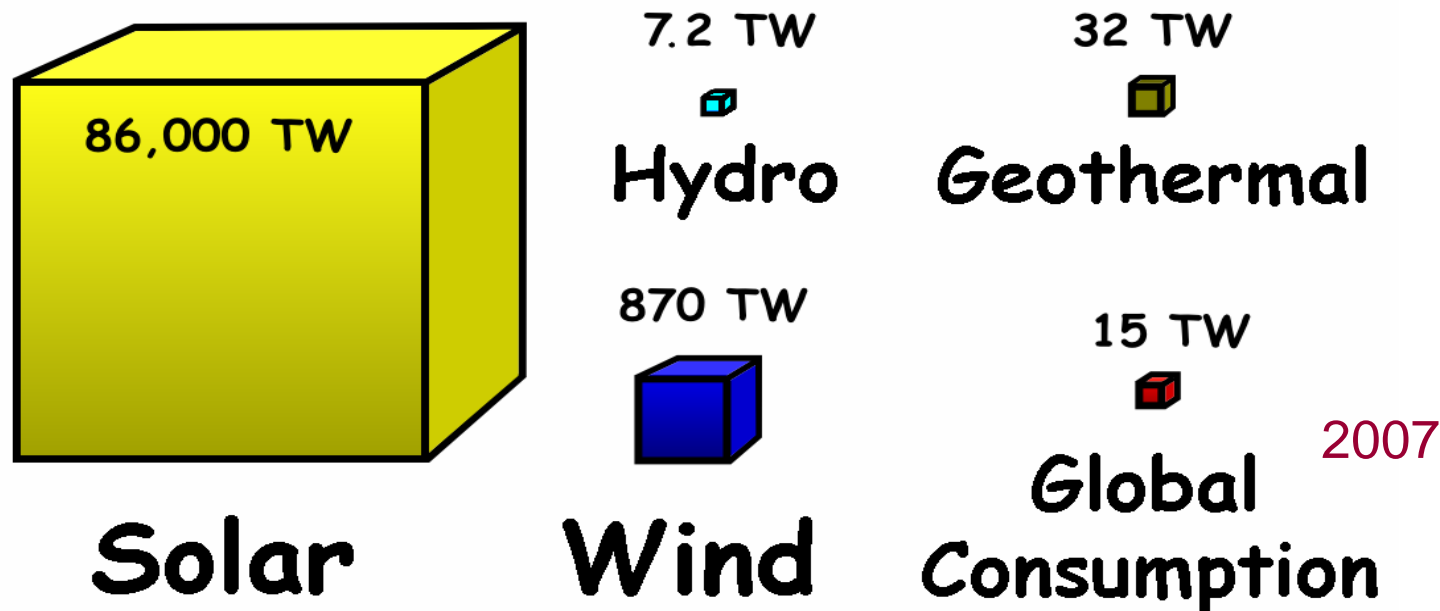
# OPEC

OPEC - Organization of the Petroleum Exporting Countries.

OPEC is a cartel of twelve countries made up of Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela.



# Renewable Energy Potential



Theoretical potential (global)

**World Fuel Reserves available**

**Annual World Use Yr 2000**

**World consumption 14 TWyr per year 2000  
55 TWyr per year 2100**

