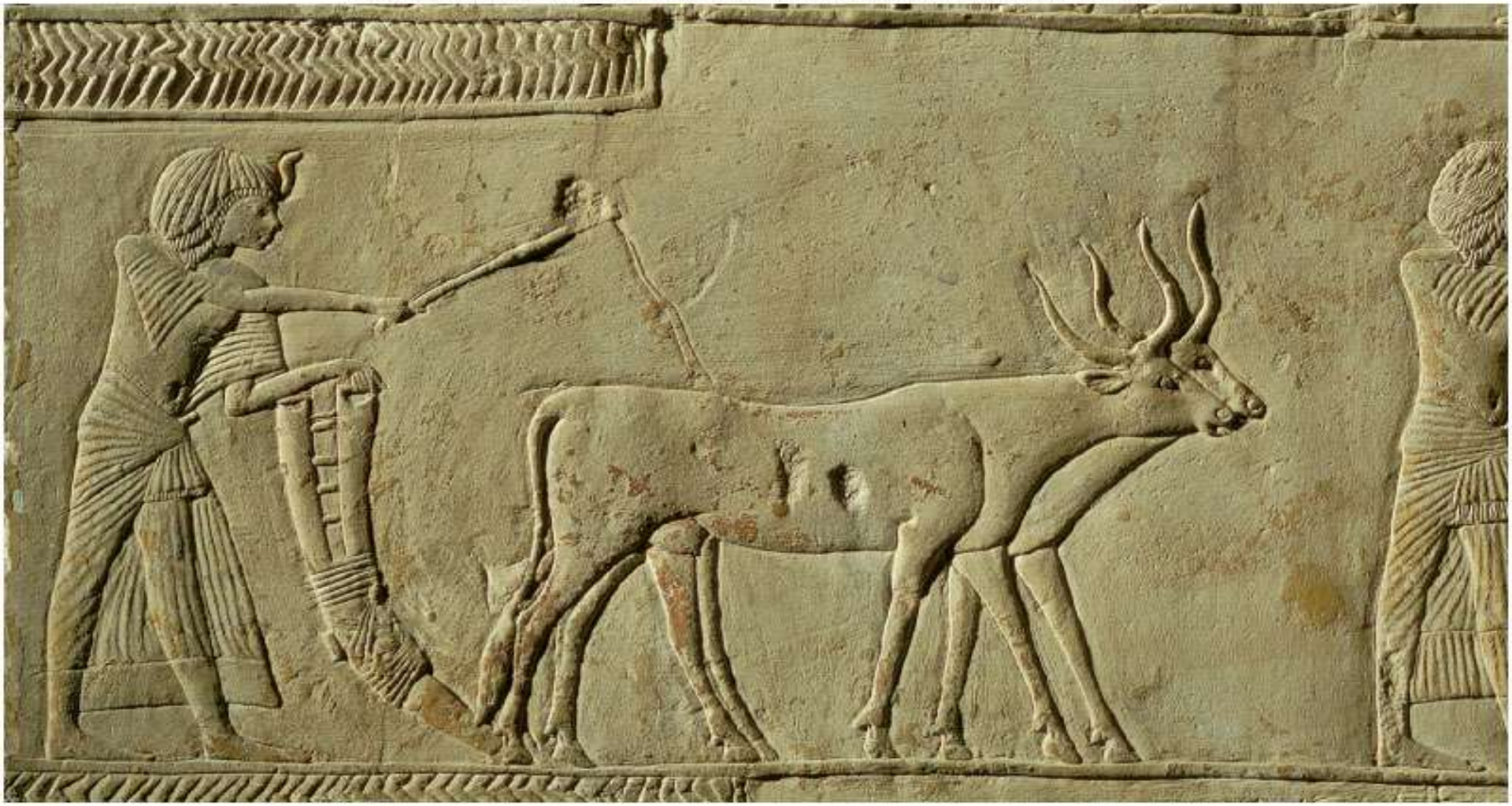
Energy and Civilization: Patterns of Consumption

Chapter 9



History of Energy Consumption

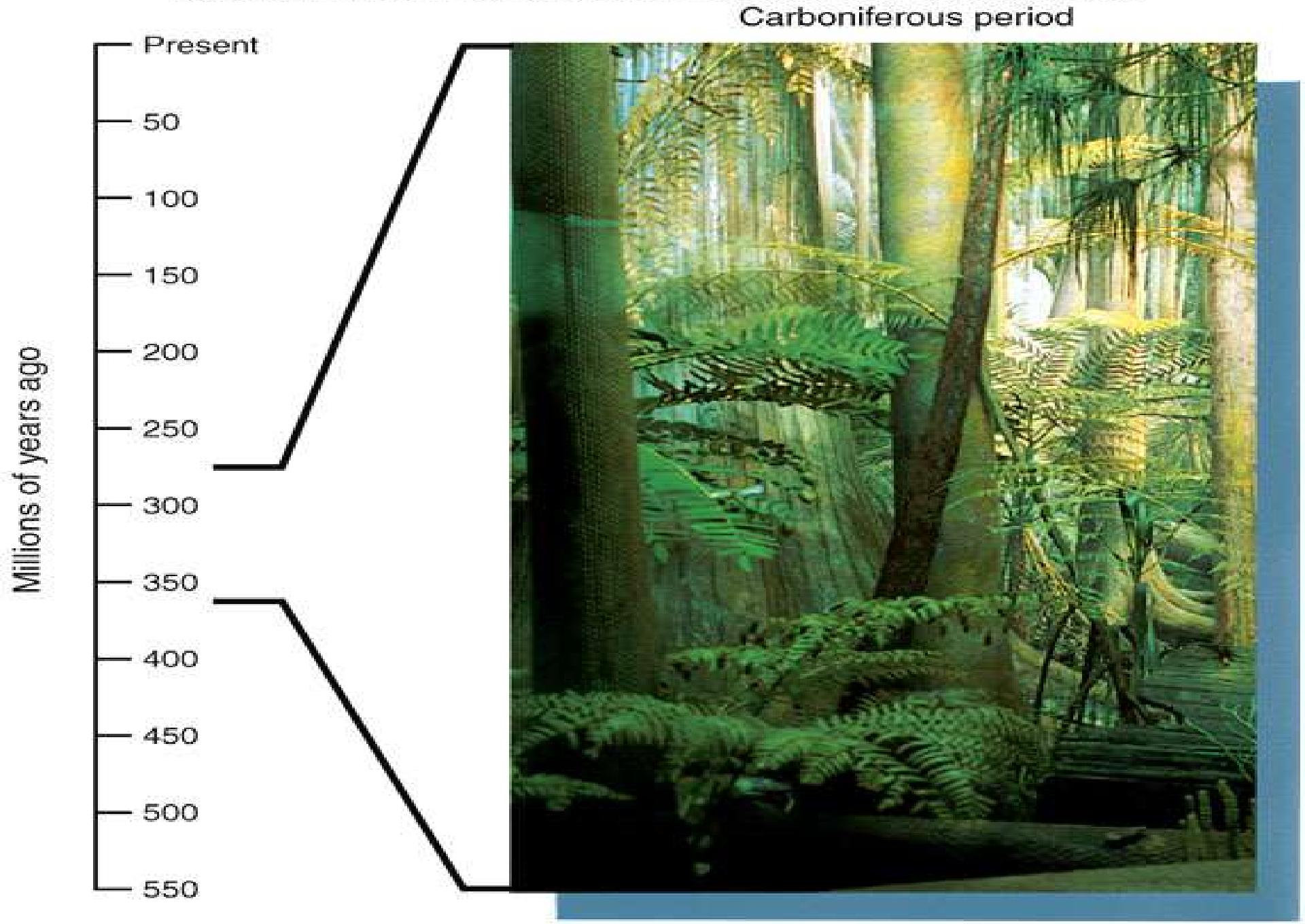
- Biological Energy Sources
  - Initial energy transfer occurs through photosynthesis.
  - Very early in history humans began to exploit additional energy sources to make life more comfortable.

Increased Use of Wood

- Early civilizations used human muscle power as their primary energy source.
  - Energy provided by burning wood enabled people to cook food, heat living areas, and develop primitive metallurgy.
    - Dense, rapidly growing settlements quickly outstripped wood production, thus new fuel sources had to be utilized.
      - By 1890, coal had replaced wood as the primary energy source.

Fossil Fuels & The Emerging Industrial Revolution

- During the Carboniferous period, (286-362 mya) conditions were right for the build-up of large deposits of plants, animals, and microorganisms.
  - Led to the formation of fossil fuel deposits.
    - Oil and natural gas formed primarily from one-celled marine organisms.
      - Heat and pressure from sediment layers converted organic material.



Industrial Revolution

- Industrial Revolution - Machines replaced human and animal labor in the manufacture and transportation of goods.
  - Steam engines converting heat energy into forward motion was central to this transformation.
    - Countries or regions without large coal deposits were consequently left behind.

Industrial Revolution

- Prior to the Industrial Revolution, goods were manufactured on a small scale in private homes.
  - Expanding factories needed larger labor pools, thus people began congregating around factories and cities.
    - Within 200 years, daily per capita energy consumption of industrialized nations increased eight fold.
      - Increased levels of air pollution.

Industrial Revolution

- Edwin L. Drake – 1859. Started the petroleum era in Pennsylvania.
  - First 60 years the principal use of oil was to make kerosene for lamps.
  - Gasoline was discarded as a waste product.
  - Oil prices very cheap. (No Demand)

Role of The Automobile

- Growth of automobile industry led to roadway construction; required energy.
  - Better roads - Higher speeds
    - Higher speeds - Bigger faster cars
      - Bigger faster cars - Better roads
- Convenience of two-car families.
  - Job growth in automobile-related industries.
    - Major role in development of industrialized nations.

Role of The Automobile

- Cars altered people's lifestyle:
  - Greater Distance Travel
    - Sprawling Cities
      - Suburbs
  - Vacations (Summers have the greatest demand for gas)

Changes in Energy Sources

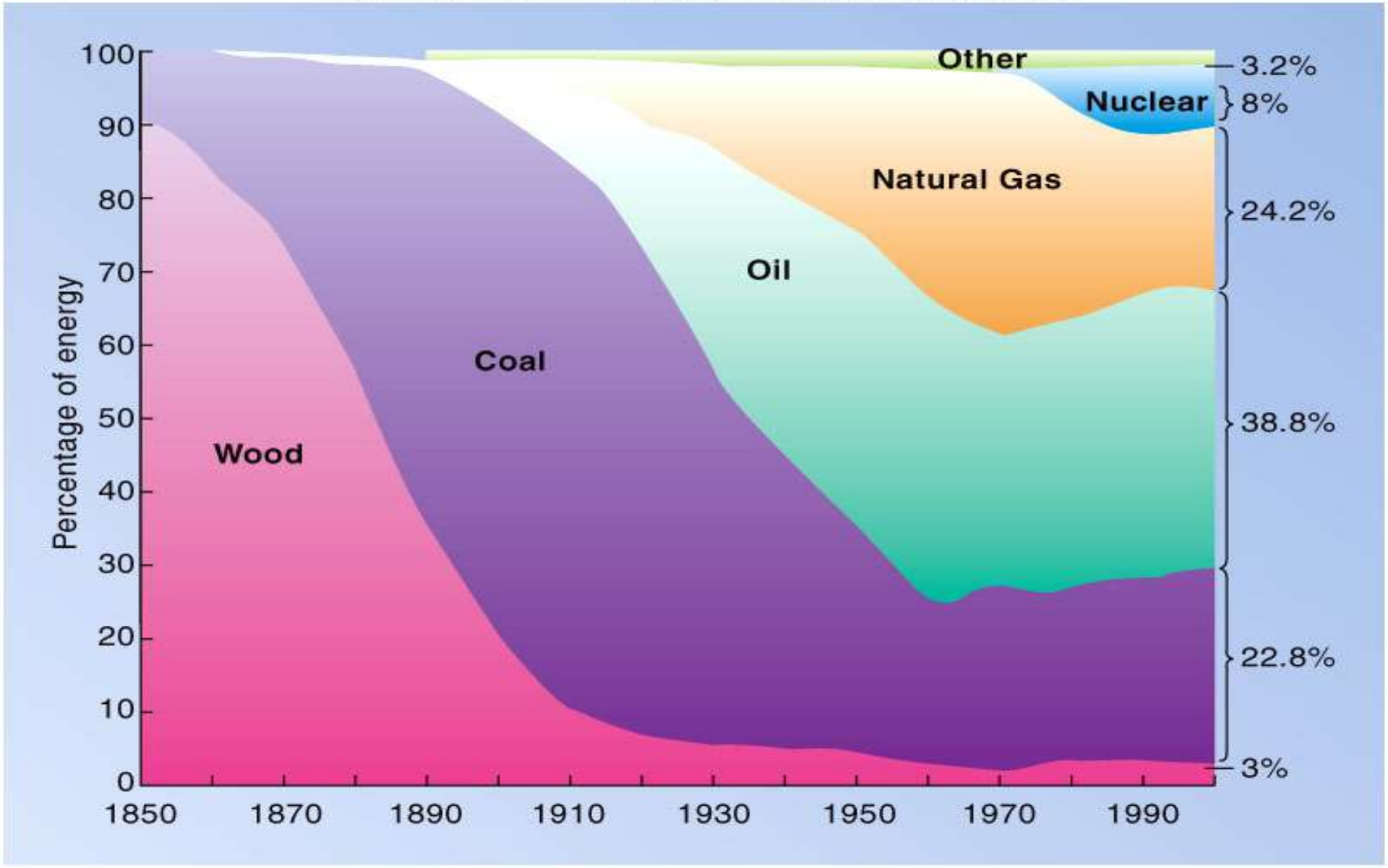


Fig. 9.5

(a)

(b)

Growth in the Use of Natural Gas

- Initially, natural gas was burned as a waste product at oil wells.
  - Before 1940, accounted for less than 10% of energy consumption in United States.
    - By 1970, accounted for about 30% of energy needs.
      - Currently, accounts for 25% of U.S. consumption.
  - Primarily used for home heating and industrial purposes.

Growth in the Use of Natural Gas

- The US Government financed an oil transport pipeline during WW II.
- After the war, the Government sold the pipelines to private corporations who in turn converted them to transport Natural Gas.
  - NG fields in the SW were connected to markets in the Midwest and E.

How Energy is Used

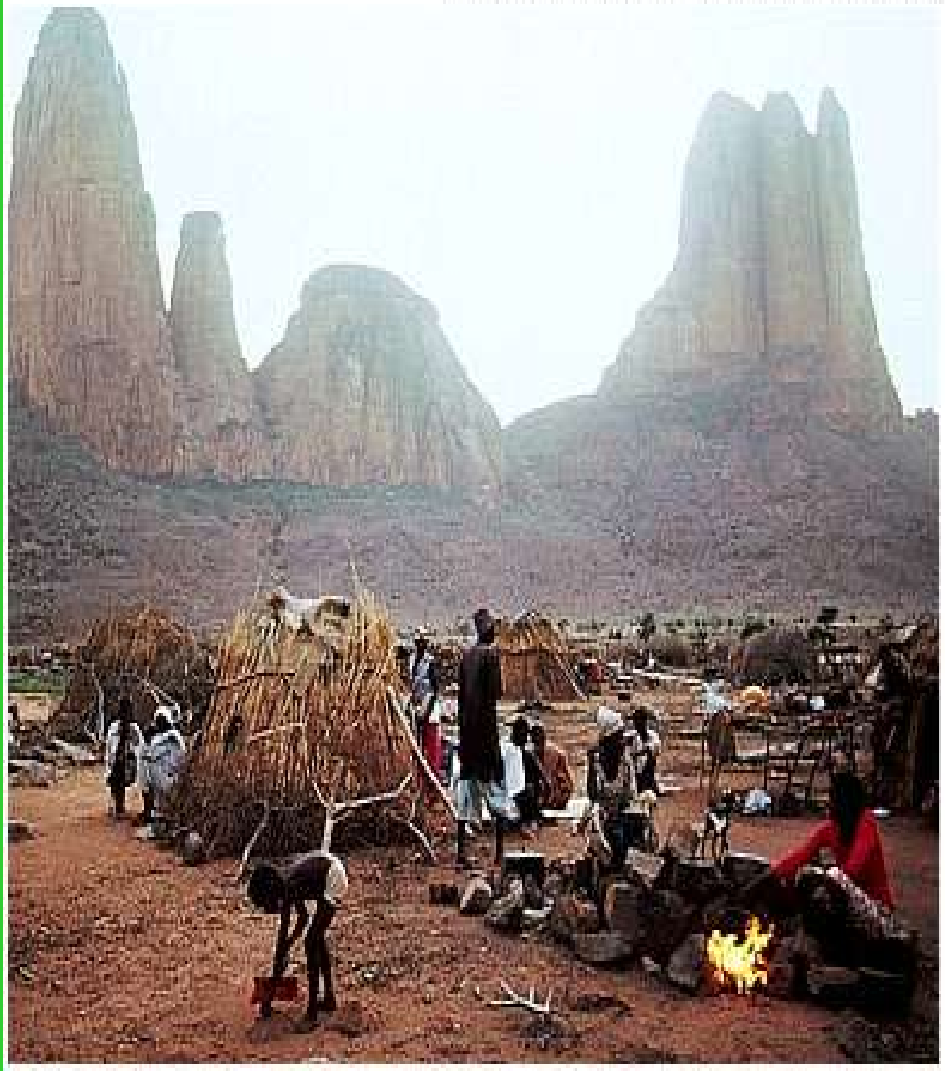
- Industrialized nations use energy for:
  - Residential / Commercial uses
  - Industrial uses
  - Transportation
- Less developed countries use most energy for residential purposes.
  - Cooking and Heating
- Developing countries use much of their energy to develop industry.

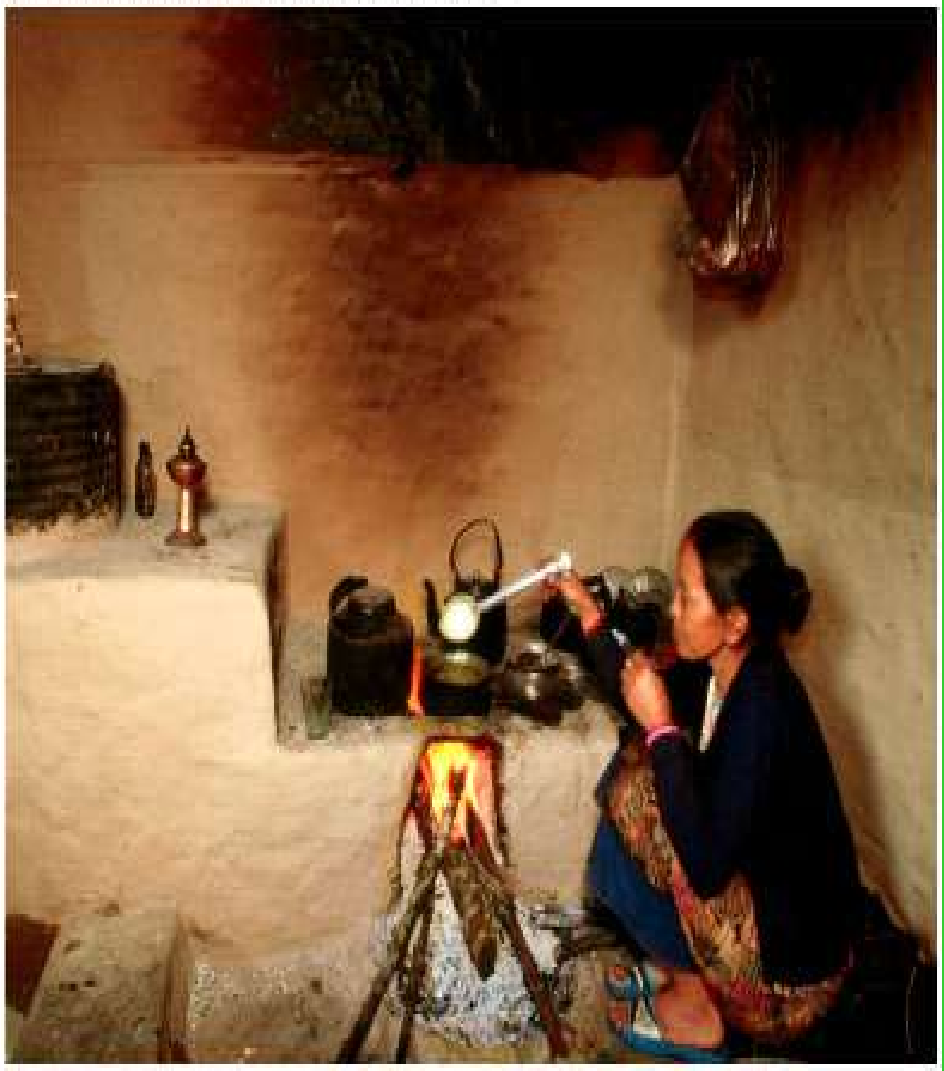
Table 9.1 Per Capita Energy Consumption, 2002

Country	Metric Tons of Oil Equivalent
Bangladesh	0.11
India	0.31
Egypt	0.71
China	0.78
Brazil	1.02
Mexico	1.31
Germany	3.99
Japan	4.00
France	4.33
Australia	5.73
United States	7.98
Canada	9.22

Source: Data from *BP Statistical Review of World Energy*, June 2003, and Population Reference Bureau, 2002 Population Data Sheet.

Fig. 9.6





Residential and Commercial Energy Use

- N. America - 16% of energy used for residential and commercial purposes.
  - 75% used for air conditioning and heating as well as water heaters.
- India - 57% used for residential and commercial purposes.

Industrial Energy Use

- Total amount of energy required in a country's industrial sector depends on industrial processes in use.
  - Many countries use inefficient processes and could reduce energy consumption by converting to more efficient means.
    - Need capital investments.
      - Many LDC's don't have the necessary capital.

Transportation Energy Uses

- Per capita energy use for transportation is high in developing countries and highest in highly developed countries.
  - Mass Transit systems are most efficient in countries with a dense population.
    - Most of these countries heavily tax fuel, increasing the appeal of mass transit.

Table 9.2 Per Capita Energy Use for Transportation 2002

Country	Metric Tons of Oil Equivalent	Percent of Energy Used for Transportation
Bangladesh	0.009	8.6
India	0.036	11.7
China	0.076	9.7
Egypt	0.183	25.8
Brazil	0.321	31.5
Mexico	0.531	40.5
Germany	1.069	26.8
Japan	1.124	28.1
France	1.325	30.6
Australia	2.223	38.8
Canada	2.628	28.5
United States	3.072	39.5

Sources: Data from BP Statistical Review of World Energy, June 2003; Population Reference Bureau, 2002 Population Data Sheet; and International Energy Agency online statistics.

Transportation Energy Uses

- In N. America, government policies have kept energy costs low, thus supporting the automobile industry.
  - Private automobiles in N. America consume over 40% of world gasoline production.
    - N. America only accounts for 5% or world population.

Electrical Energy

- Most electrical energy is produced as a result of burning fossil fuels.
- Because electricity is easily transported and its uses are so varied, electricity is a major world energy source.
  - Industrialized nations have 20% of the world's population, but use 60% of the world's electricity.
    - Per capita use in N. America is 25 times greater than that in less-developed countries.

The Economics and Politics of Energy Use

- A strong link exists between energy and productivity.
  - Most industrial societies want to ensure a continuous supply of affordable energy.
    - The higher the price of energy, the more expensive goods and services become.
      - Subsidies help keep energy costs down.

Fuel Economy and Government Policy

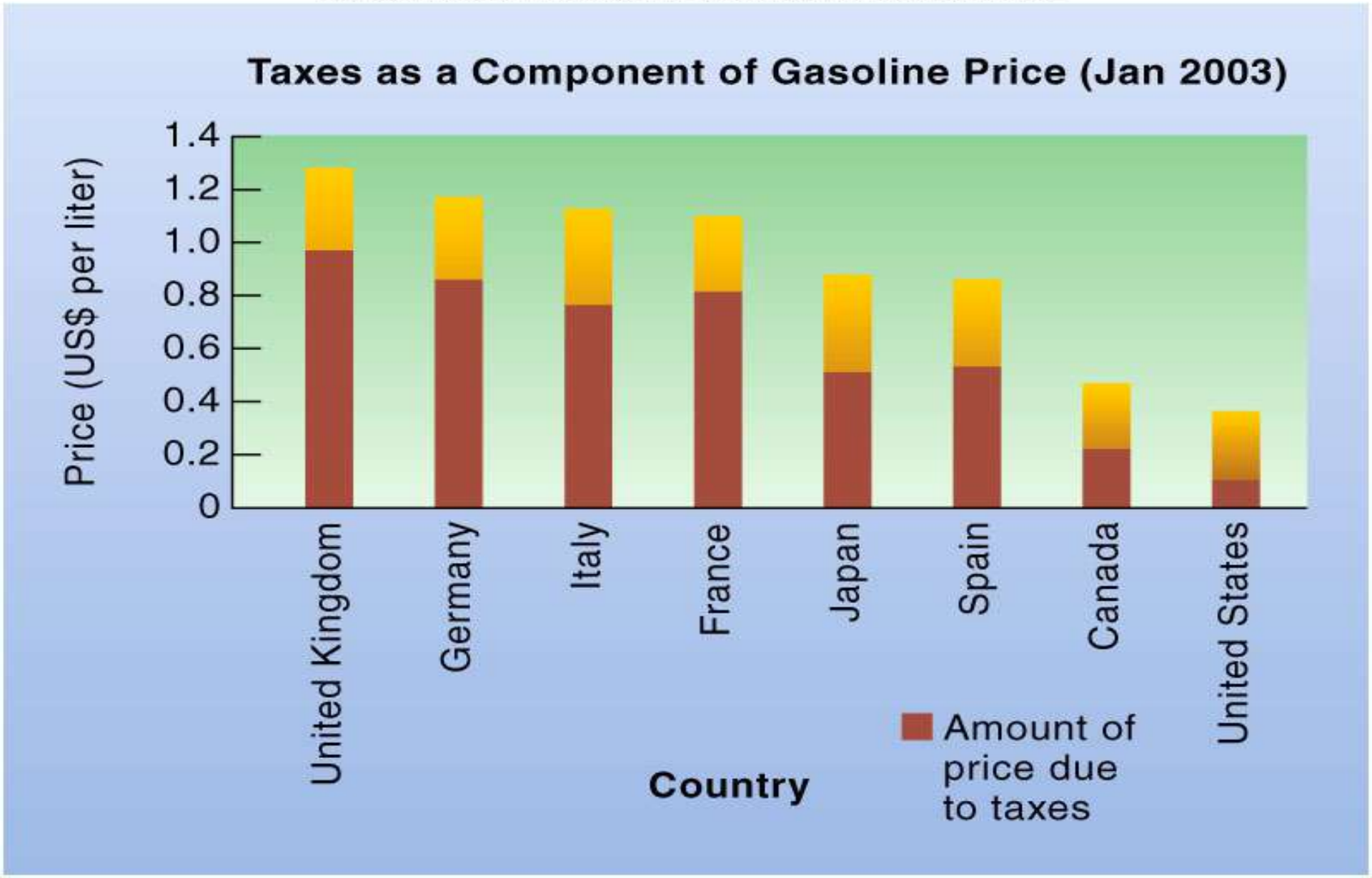
- Price of gasoline determined by two factors:
  - Purchasing and processing crude oil.
  - Taxes
    - Taxes in the U.S. represent less than 30% of retail gasoline price.
      - 40% in Canada
      - 50-75% in Japan and Europe

Table 9.3 U.S. Driving Habits

Average travel time to work in the United States in minutes:	25.5
In New York state	31.7
In North Dakota	15.8
Percent of Americans who get to work by:	
Driving alone	75.7
Carpooling	12.2
Taking public transportation	4.7
Staying home	3.3
Walking	2.9
Other	1.2

Source: U.S. Census Bureau, 2000.

Gasoline Taxes and Fuel Efficiency



Fuel Economy and Government Policy

- Governments often charge road users to help build and repair roads by taxing fuel.
  - Can also discourage use via increases.
  - U.S. only raises 60% of monies needed for roads from fuel taxes.
    - Keeps fuel costs low and encourages consumption.

Table 9.4 The Relationship Between Price and Consumption of Electricity

Country	Price for Industry (US Cents/Kilowatt-Hour) 2001	Price for Households (US Cents/Kilowatt-Hour) 2001	Annual per Capita Consumption (Kilowatt-Hours) 2001
Canada	3.9	6	16,746
Sweden	3.4	10.3	16,013
Finland	4.6	9.1	15,687
United States	4.7	8.3	12,896
Japan	14.3	21.4	7,907
Austria	9.2	13.6	7,500
Germany	7.9	16.7	6,806
United Kingdom	5.4	11	6,192
South Korea	6.6	8.5	5,607
Spain	4.1	10.9	5,482

Source: Data from International Energy Agency, Key World Energy Statistics 2003.

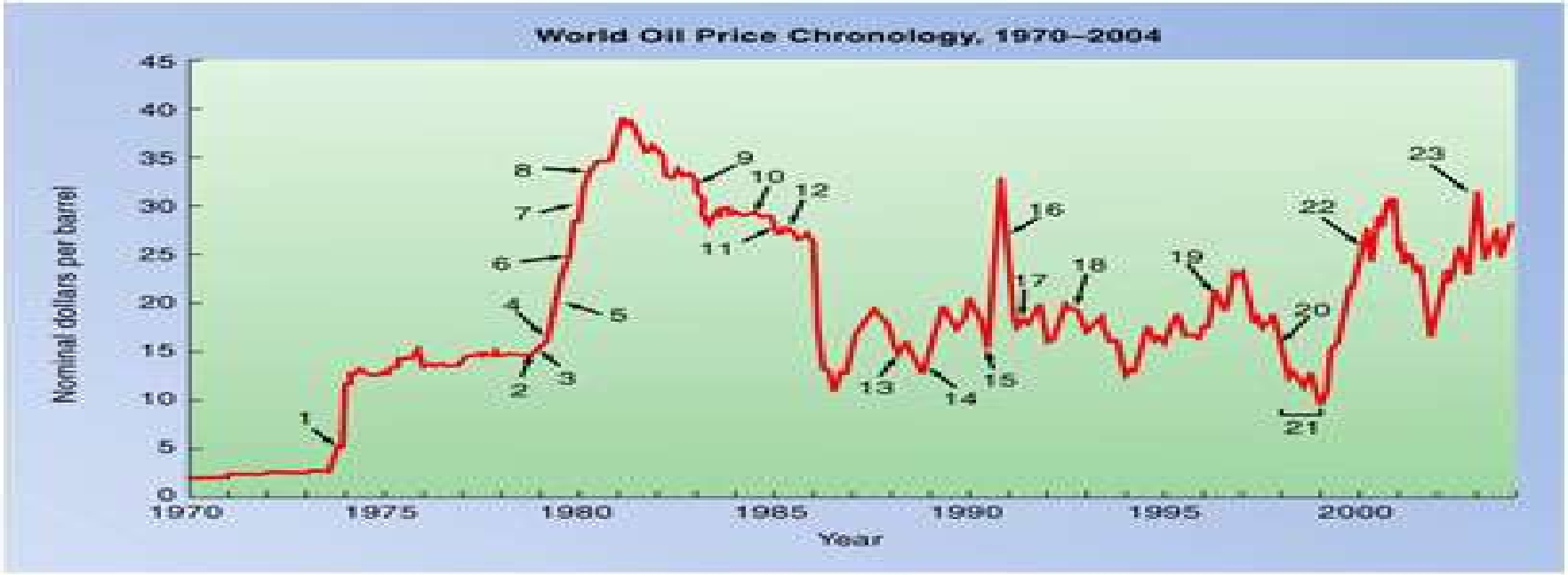
The Importance of OPEC

- Organization of the Petroleum Exporting Countries
  - Oil Producing and Exporting Countries
  - Twelve members (7 Arab states – Saudi Arabia, Kuwait, Libya, Algeria, Iraq, Qatar, and United Arab Emirates. 5 non-Arab members – Iran, Indonesia, Nigeria, Gabon, and Venezuela)
    - 40% of the world's oil production is controlled by OPEC countries.
    - Control over 78% of world's estimated oil reserves.
      - 1,000 billion barrels.

Table 9.5 Source of U.S. Crude Oil Imports

Country	Thousand Barrels per Day (2003)	Percent of Total Imported
Saudi Arabia (OPEC)	1,754	19.2%
Mexico	1,572	17.2%
Canada	1,537	16.7%
Venezuela (OPEC)	1,181	12.9%
Nigeria (OPEC)	828	9.0%
Iraq (OPEC)	450	4.9%
Angola (OPEC)	370	4.0%
United Kingdom	355	3.9%
Kuwait (OPEC)	205	2.2%
Norway	169	1.8%
Other nations	756	8.2%
Total imports	9,177	100%
Total from OPEC countries	*4,788*	*52.2%*
U.S. production	5,710	

Source: U.S. Energy Information Administration.

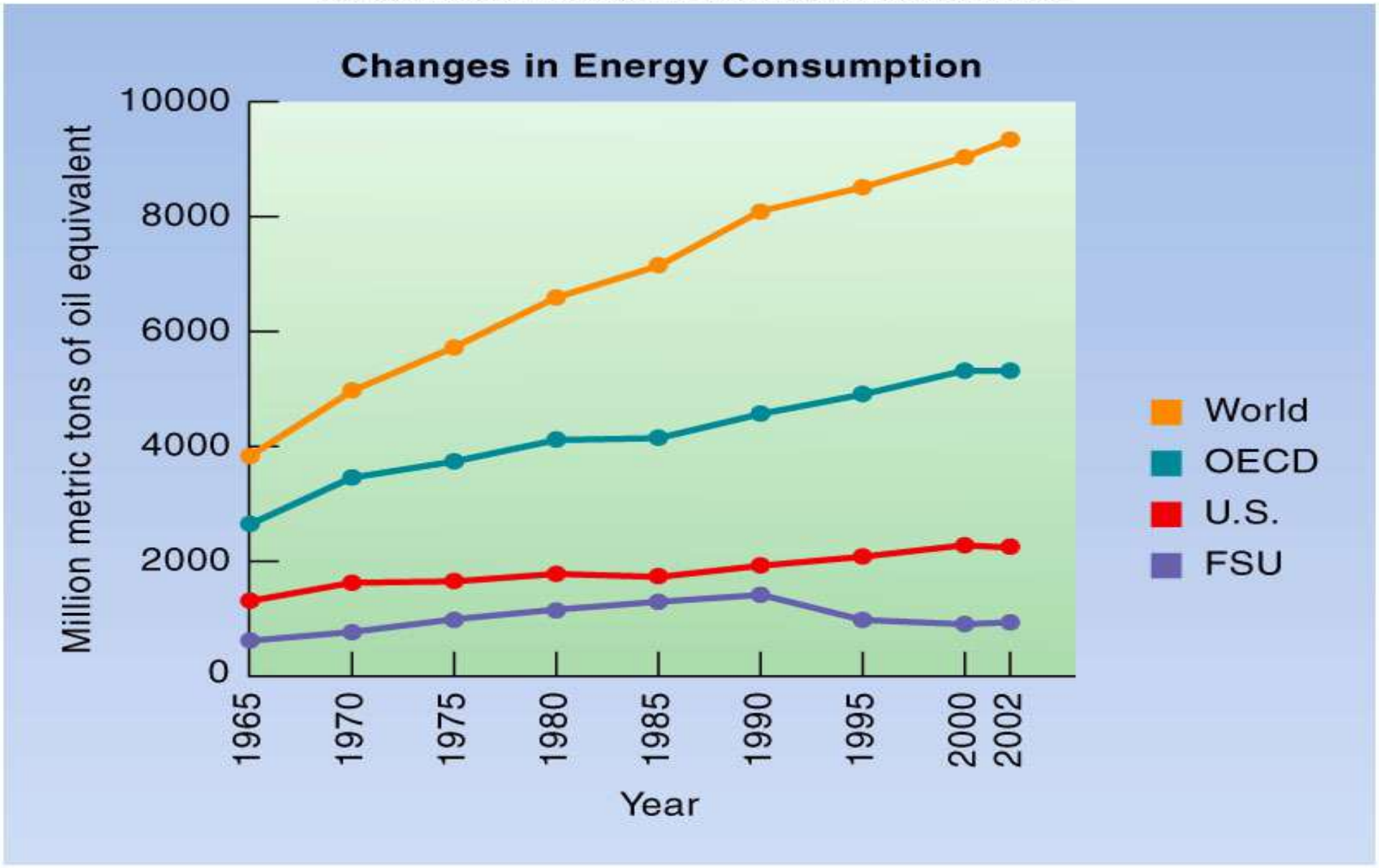


1. Organization of Petroleum Exporting Countries (OPEC) oil embargo begins (October 19–20, 1973).
2. OPEC decides on 14.5 percent price increase for 1979.
3. Iranian revolution; Shah deposed.
4. OPEC raises prices 14.5 percent on April 1, 1979.
5. OPEC raises prices 15 percent.
6. Iran takes hostages; President Carter halts imports from Iran; Iran cancels U.S. contracts; non-OPEC output hits 17.0 million barrels per day.
7. Saudis raise market crude price from $19 to $26 per barrel.
8. Kuwait, Iran, and Libya production cuts drop OPEC oil production to 27 million barrels per day.
9. OPEC cuts prices by $5 per barrel and agrees to 17.5 million barrels per day output.
10. Norway, United Kingdom, and Nigeria cut prices.
11. OPEC accord cuts Saudi Light price to $28 per barrel.
12. OPEC output falls to 13.7 million barrels per day.
13. OPEC/non-OPEC meeting fails.
14. Exxon's ***Valdez*** tanker spills 11 million gallons of crude oil.
15. Iraq invades Kuwait.
16. Operation Desert Storm begins; 17.3 million barrels of Strategic Petroleum Reserves crude oil sales are awarded.
17. Persian Gulf war ends.
18. OPEC production reaches 25.3 million barrels per day, the highest in over a decade.
19. Extremely cold weather in the United States and Europe.
20. OPEC raises its production ceiling by 2.5 million barrels per day to 27.5 million barrels per day. This is the first increase in four years.
21. Oil prices continue to plummet as increased production from Iraq coincides with no growth in Asian oil demand due to the Asian economic crisis and increases in world oil inventories following two unusually warm winters.
22. Oil prices triple between January 1999 and September 2000 due to strong world oil demand, OPEC oil production cutbacks, and other factors, including weather and low oil stock levels.

Energy Consumption Trends

- Over half of world energy consumption is by the 25 member countries of the Organization for Economic Co-Operation and Development (OECD).
  - Available Energy Sources
    - Oil 38%
    - Natural Gas26%
    - Coal24%

Changes in World Energy Consumption

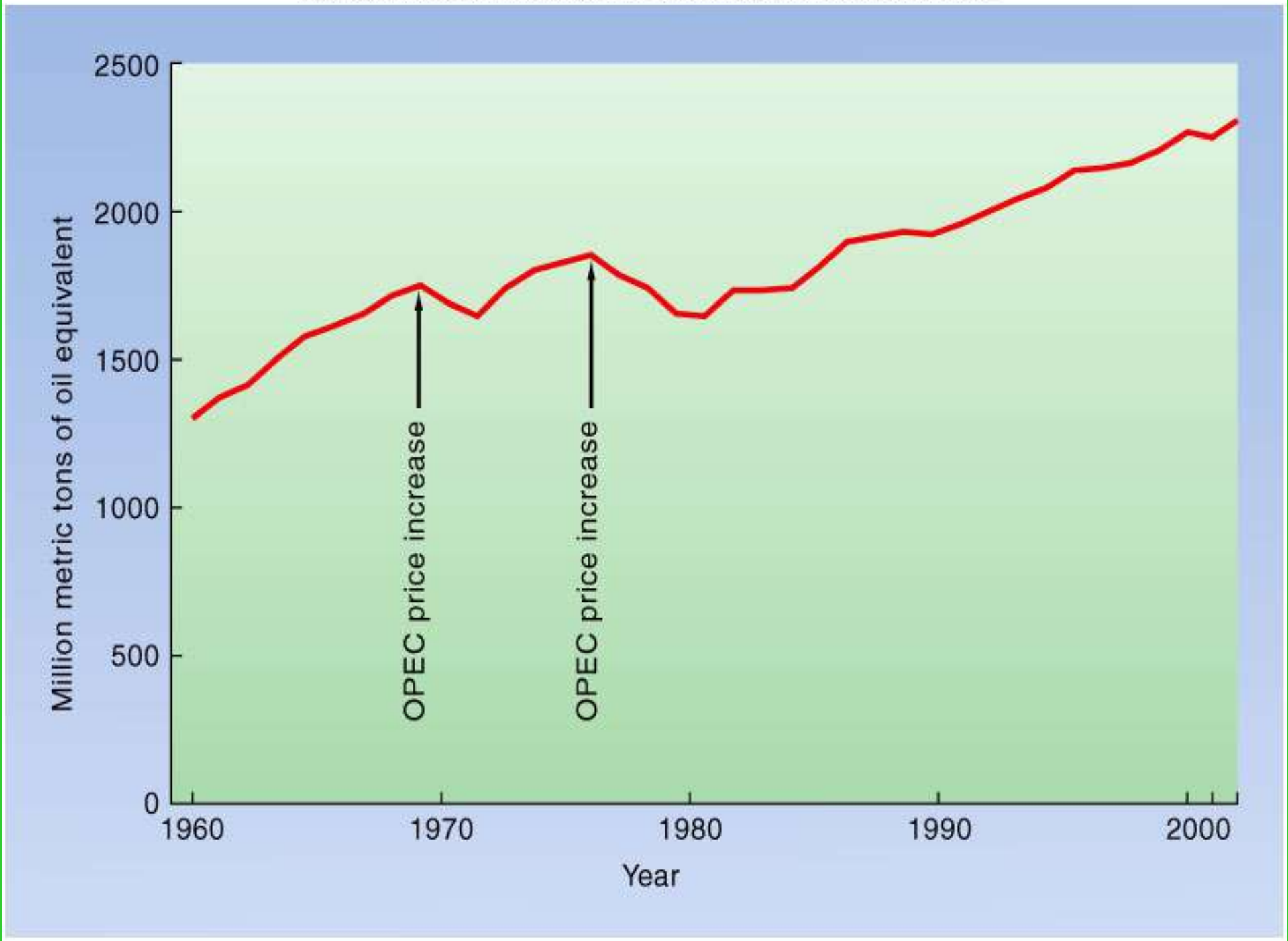


Political and Economic Factors

- During the 1980's, energy costs in N. America and Europe declined, thus people became less concerned about energy consumption.
  - 1979 - oil = $40 / barrel
  - 1998 - oil < $15 / barrel
- Primary factors determining energy use:
  - Political Stability
  - Price of Oil

Energy Consumption Trends

- Energy consumption behavior of most people is motivated by economics rather than a desire to wisely use energy resources.
- Over the past several years, world oil prices have been extremely volatile.
  - Oversupply
  - OPEC Actions
  - Persian Gulf War
  - Iraq War



United State Strategic Reserve

- The reserve, with about 670 million barrels of oil stored in underground salt caverns in Texas and Louisiana, was created by Congress in 1975 after the Mideast oil embargo, in a bid to protect American consumers against supply disruptions, including natural disasters.