# Class 6

**Oil and Natural Gas Production**

## History of Petroleum

1859 – First well at Titusville, PA
1870 – Rockefeller founds Standard Oil
1873 – Baku (Russia) oil field opened
1882 – Thomas Edison discovers electricity
1896 – Henry Ford builds his first car
1901 – First gusher, Spindeltop in Texas
1903 – Wright Brothers' first flight
1905 – Russian revolution, Baku fields torched
1905 – Glenn Pool discovered in Oklahoma
1907 – First drive-in gas station, St. Louis
1908 – Discovery of oil in Persia
1911 – US Supreme Court dissolves Standard Oil

**Table 7.1** World oil production 1900–2000[1]

| Year | World production (millions of barrels per day) | Percentage accounted for by: North and Central America | Middle East | FSU[2] |
|---|---|---|---|---|
| 1900 | 0.4 | 43 | – | 50 |
| 1910 | 0.9 | 65 | – | 22 |
| 1920 | 1.9 | 87 | 2 | 6 |
| 1930 | 4.1 | 66 | 3 | 15 |
| 1940 | 6.0 | 66 | 5 | 13 |
| 1950 | 10.9 | 57 | 17 | 8 |
| 1960 | 21.9 | 40 | 24 | 16 |
| 1970 | 48.0 | 28 | 29 | 15 |
| 1980 | 62.7 | 23 | 30 | 20 |
| 1990 | 65.7 | 21 | 27 | 18 |
| 2000 | 74.5 | 19 | 39 | 11 |

1 Figures include crude oil, shale oil, oil from tar sands, 'heavy' oil and natural gas liquids.
2 Area covered by the former Soviet Union.
Source: Shell, 1966; BP, various years

**Table 7.2** World trade in crude oil, 1960–2000, in millions of barrels per day

| Year | Total | Imports to: US | Europe | Japan | Rest of world | Exports from: Middle East | North and West Africa | Canada and Latin America | Rest of world |
|---|---|---|---|---|---|---|---|---|---|
| 1960[1] | 10.0 | 2.0 | 6.0 | 1.2 | 0.8 | 6.0 | 1.0 | 2.5 | 0.5 |
| 1970 | 25.5 | 3.2 | 12.9 | 4.3 | 5.1 | 12.9 | 5.8 | 4.1 | 2.7 |
| 1980 | 31.4 | 6.2 | 11.8 | 5.0 | 8.4 | 17.5 | 5.3 | 4.3 | 4.3 |
| 1990 | 30.5 | 7.1 | 9.8 | 4.8 | 8.8 | 14.2 | 4.9 | 4.7 | 6.7 |
| 2000 | 38.8 | 10.2 | 9.7 | 5.3 | 13.6 | 18.9 | 6.0 | 6.5 | 7.4 |

1 Figures for 1960 are estimates extrapolated from Shell data.
Source: BP, various years

**Table 7.4** World natural gas consumption 1970–2000, millions of tonnes of oil equivalent

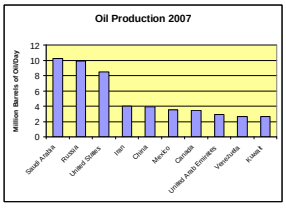
| Year | Total | North America | FSU | Japan[1] | Western Europe | Other |
|---|---|---|---|---|---|---|
| 1970 | 955 | 590 | 185 | negligible | 70 | 110 |
| 1980 | 1270 | 550 | 350 | 25 | 190 | 155 |
| 1990 | 1770 | 540 | 600 | 50 | 230 | 350 |
| 2000 | 2160 | 650 | 490 | 70 | 350[2] | 600 |

1 All Japanese consumption is imports.
2 Western Europe currently imports around 30% of its gas from Russia and 5% from Algeria.
Source: BP, various years

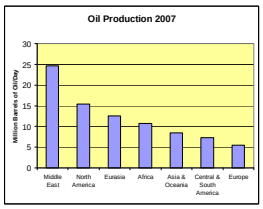
## Quiz!

# Top Oil Producers

A. Top 10 oil producing nations

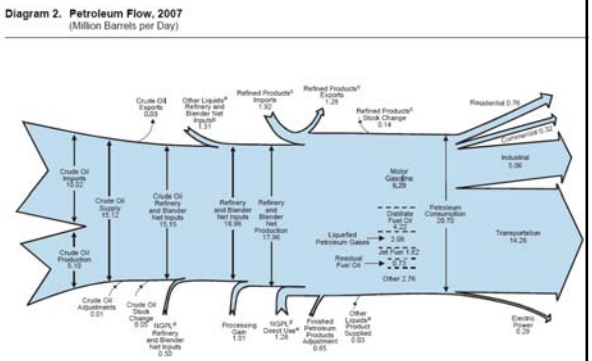



B. Top oil producing regions

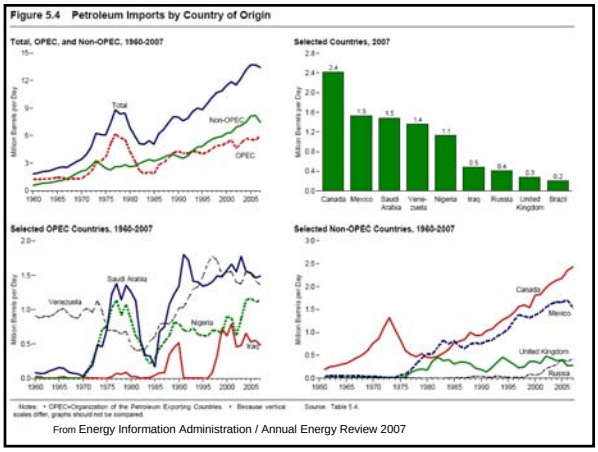



# Petroleum Flow Diagram

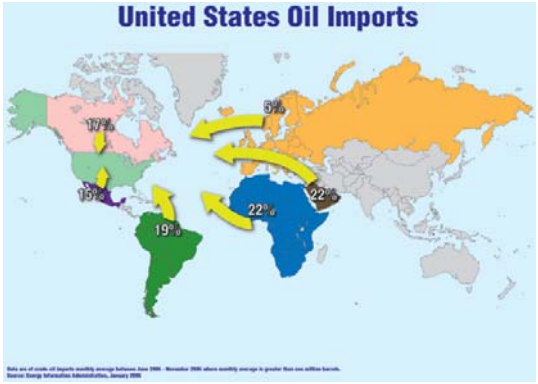
DOE Annual Energy Review, 2007

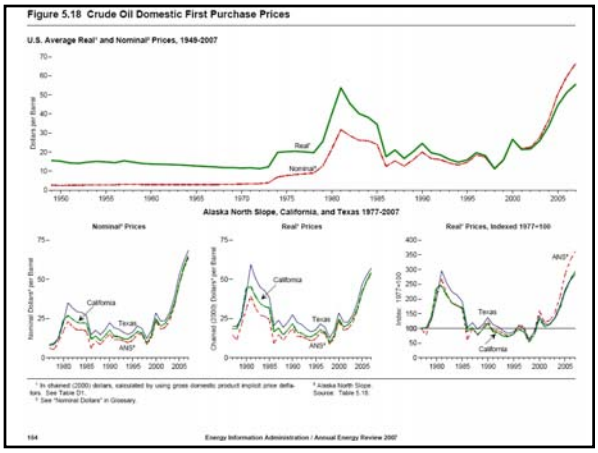


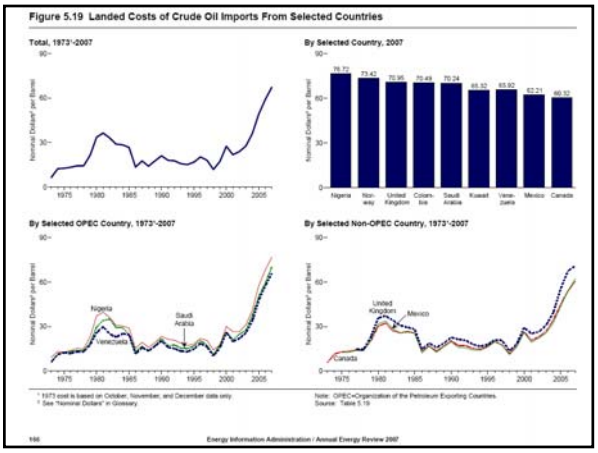

http://www.eia.doe.gov/emeu/aer/pdf/pages/sec5_3.pdf



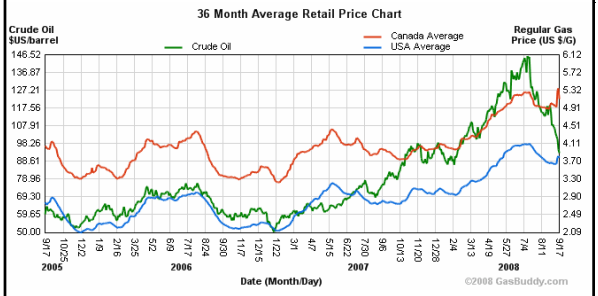

From Energy Information Administration / Annual Energy Review 2007



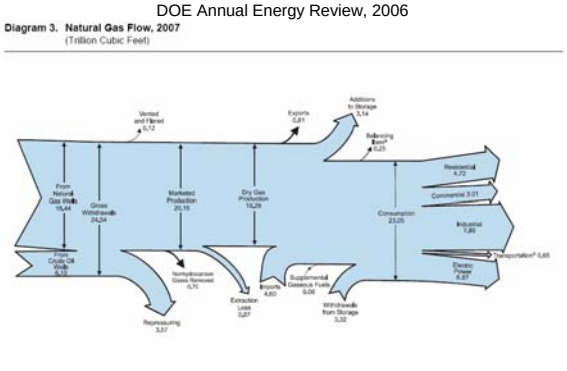
# More Recent Prices




http://www.gasbuddy.com/gb_retail_price_chart.aspx

# Natural Gas Flow Diagram

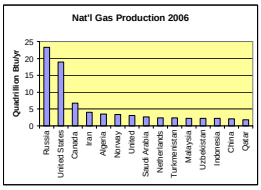
DOE Annual Energy Review, 2006

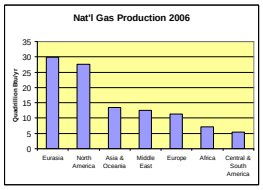



http://www.eia.doe.gov/emeu/aer/pdf/pages/sec6_3.pdf

# Natural Gas Production

Who are the top producers?




# Article from C&E News

Sept 2007

VALUING FLARED NATURAL GAS

RESOURCE CONSERVATION: World Bank urges an end to burning the resource as waste

*Flames rise out of a gas flare on an oil well.*

LAST YEAR, enough natural gas to supply 27% of U.S. needs was burned off as waste around the world, according to a new report by the World Bank. Flared natural gas is a by-product of petroleum production and is not generally considered worth capture and sale, the bank adds.

However, the bank estimates the gas could be worth as much as $40 billion if sold on the U.S. market, where natural gas demand is high because of its use as a chemical feedstock and fuel.

Global gas flaring releases about 400 million tons of carbon dioxide to the atmosphere each year, and the practice has remained mostly stable at 150 billion to 170 billion m³ annually over the past 12 years, according to the World Bank report.

To generate the data, the World Bank collaborated with the U.S. National Oceanic & Atmospheric Administration to pinpoint the extent of flaring through close examination of satellite imagery gathered from 400 miles above ground.

"Gas flaring harms the environment and wastes a cleaner source of energy that could generate much needed electricity in poor countries," says Bent Svensson, manager of the World Bank's program to reduce gas flaring. Cutting gas flaring can be costly, however, Svensson notes, adding that alternatives encouraged by the bank include reinjecting natural gas to increase oil production, liquefying it for international shipment, piping it to markets, using it on-site for electricity generation, or distributing it for use in nearby communities.

Svensson urges implementation of an international system of carbon penalties and credits to increase the value of natural gas as a cleaner fuel and to discourage flaring. The World Bank has projects to reduce gas flaring in eight countries.

The report found that the greatest amount of flaring of natural gas takes place in Russia (50.7 billion m³), Nigeria (23.0 billion m³), Iran (11.4 billion m³), and Iraq (8.1 billion m³). The U.S. was not among the top 20 gas-flaring countries, according to the report.

The report is available at www.worldbank.org.—JEFF JOHNSON

# Impact of Electricity Generation from Natural Gas

From Tom Robl, CAER, http://www.caer.uky.edu/energeia/PDF/vol19_35.pdf

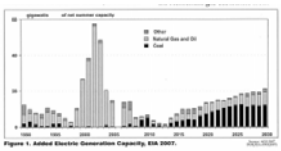


Figure 1. Added Electric Generation Capacity, EIA 2007.

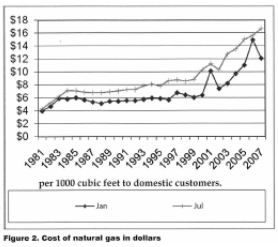
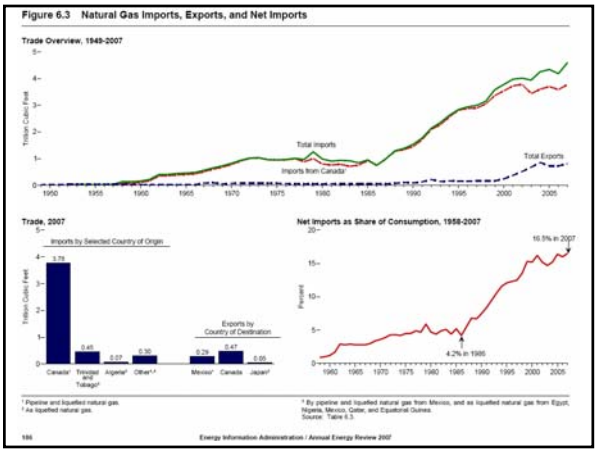
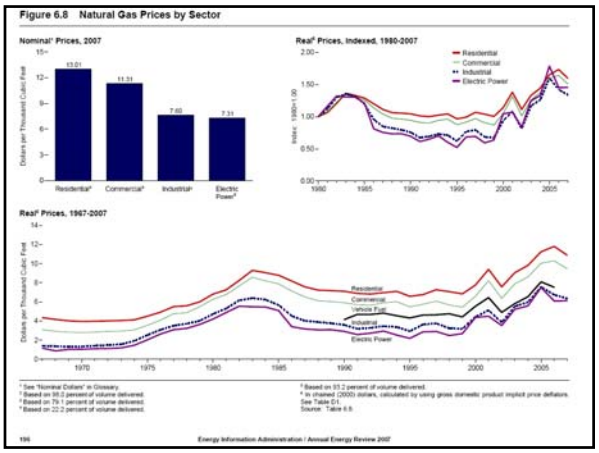
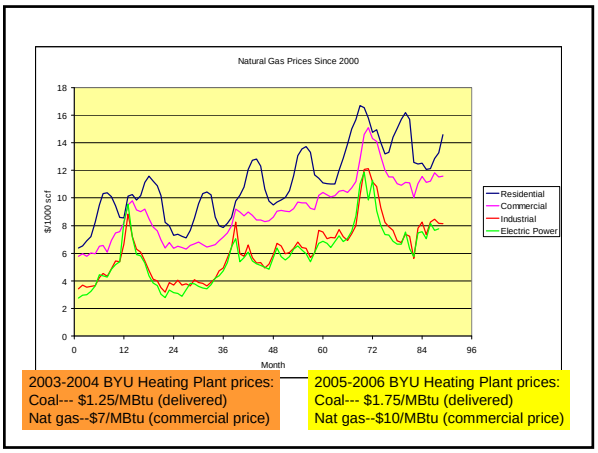



Figure 2. Cost of natural gas in dollars

- Rise of 2%/year in prices until 1999, then 9%/yr from 200-2006!
- Increased demand has caused instability in prices and more imports





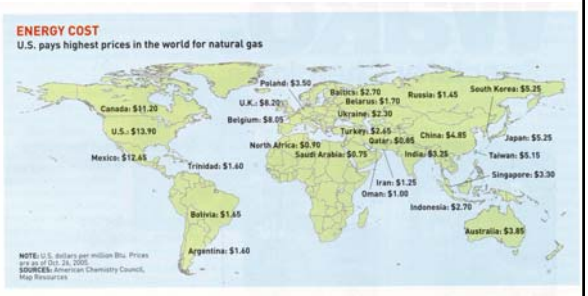




2003-2004 BYU Heating Plant prices:
Coal--- $1.25/MBtu (delivered)
Nat gas--$7/MBtu (commercial price)

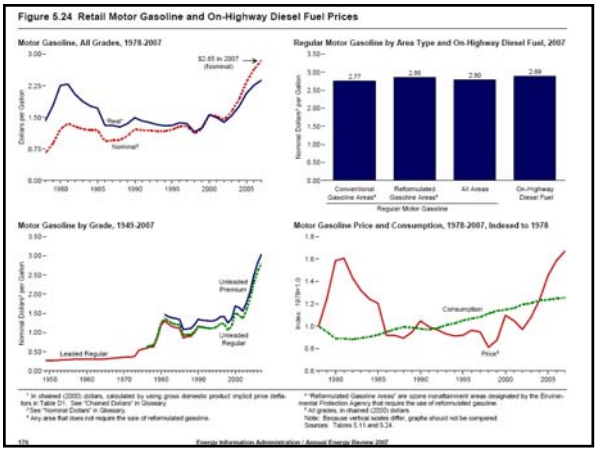
2005-2006 BYU Heating Plant prices:
Coal--- $1.75/MBtu (delivered)
Nat gas--$10/MBtu (commercial price)

# Wow!

(Price of natural gas paid by chemical companies)




From C&E News, Nov. 14, 2005

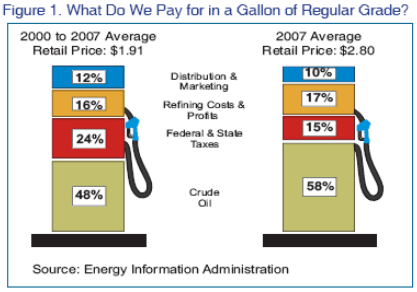



# Recent prices


http://zfacts.com/p/35.html

# Gasoline Price Breakdown

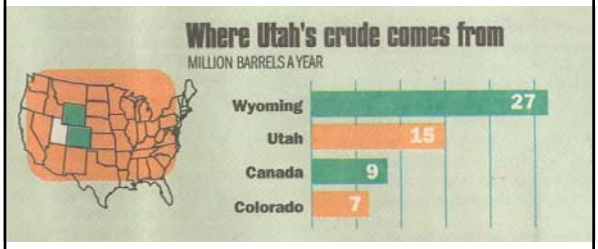
Figure 1. What Do We Pay for in a Gallon of Regular Grade?

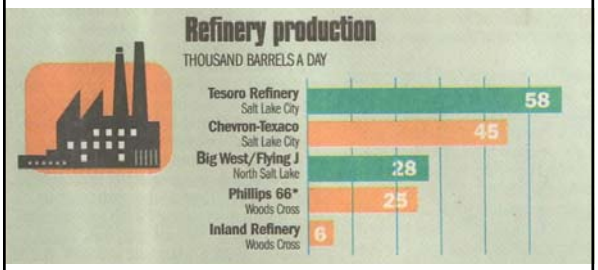


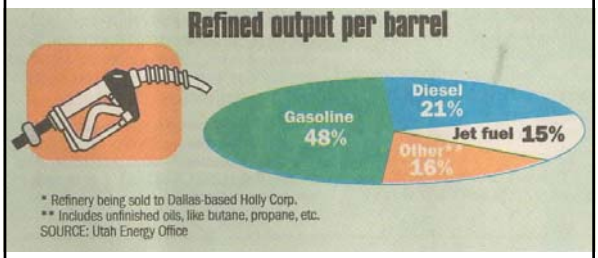

Source: Energy Information Administration

http://www.eia.doe.gov/bookshelf/brochures/gasolinepricesprimer/

Data from Deseret News, 2003




## Terms Used in the Refinery

- **Reforming** paraffin ➔ aromatic
  (hexane ⇒ benzene) …. increases octane rating
- **Isomerization** n-alkane ➔ iso-alkane
  (62 octane ⇒ 92 octane)
- **Alkylation** small olefin + small butane ➔ alkylate
  (butylene + butane ⇒ iso-octane)
- **Hydrotreating** $H_2$ + S or N ➔ $H_2S$ or $NH_3$
  ($H_2S$ and $NH_3$ are easier to separate)
- **Cracking** Long chain ($C_{20}$) ➔ Smaller chains
  ($C_8$ + $C_{12}$)
- **Desulfurization** sulfur removal
- **Dewaxing** removal of waxes (long-chain alkanes)
  (crude from Vernal area is high in waxes)