

Natural Gas

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Background

- Gas consisting primarily of Methane (CH_4)
- Home: Heating, Cooking
- Power Generation
 - 900 out of 1000 US power plants will use natural gas
- Industrial Use
 - Production of ammonia
 - Manufacture of fabrics, glass, steel, plastics
 - Fuel: Cars & Airplanes

Advantages

- Cleanest Fossil Fuel
 - Carbon content 75 %
 - Generates less CO₂ per unit of released energy
 - Coal: 25 kg C/GJ
 - Refined Fuel: 19 kg C/GJ
 - Natural Gas: 14 kg C/GJ

Problems

- Potent Greenhouse Gas
 - Global Warming Potential (GWP)
 - Traps 20 times more radiation than CO₂
- Leakage (from Pipe Lines)
 - Former Soviet Union: 47 ~ 67 Gm³ (6 ~ 9% of Total Extraction)
- Expensive Infrastructure
 - Storage and Transportation can be difficult and costly
 - Liquefied Natural Gas (LNG)
 - Compressed Natural Gas (CNG)

World Natural Gas Reserves (Jan. 1, 2009)

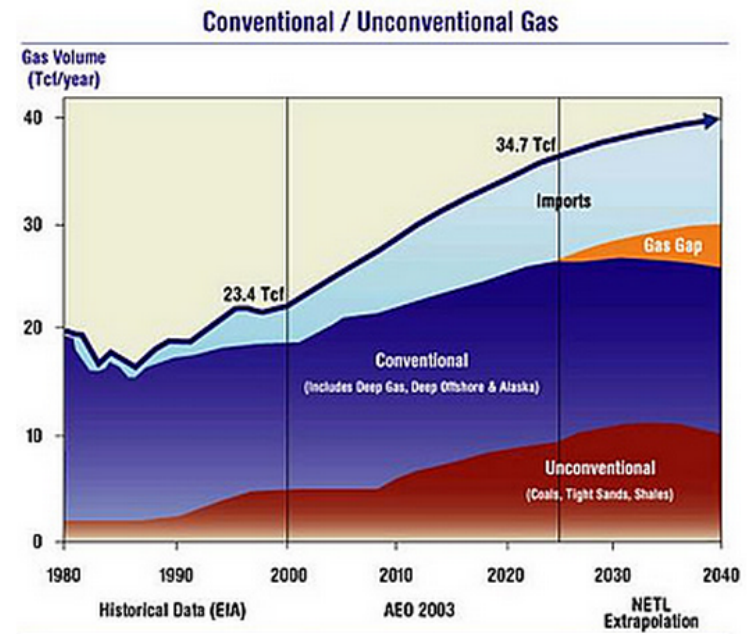
- R/P Ratio: 63 years
 - Central & South America: 48 years
 - Russia: 78 years
 - Africa: 79 years
 - Middle East: 100+ years
 - U.S.: 10 years

Country	Reserves (Trillion Cubic Feet)	Percent of World Total
World	6,254	100.0
Top 20 Countries.....	5,674	90.7
Russia.....	1,680	26.9
Iran	992	15.9
Qatar.....	892	14.3
Saudi Arabia.....	258	4.1
United States.....	238	3.8
United Arab Emirates.....	214	3.4
Nigeria.....	184	2.9
Venezuela.....	171	2.7
Algeria.....	159	2.5
Iraq.....	112	1.8
Indonesia.....	106	1.7
Turkmenistan.....	94	1.5
Kazakhstan.....	85	1.4
Malaysia.....	83	1.3
Norway.....	82	1.3
China.....	80	1.3
Uzbekistan.....	65	1.0
Kuwait.....	63	1.0
Egypt.....	59	0.9
Canada.....	58	0.9
Rest of World.....	581	9.3

Source: "Worldwide Look at Reserves and Production," *Oil & Gas Journal*, Vol. 106, No. 48 (December 22, 2008), pp. 22-23.

Only 63 Years?

- Conventional Natural Gas Reserves
 - 6,254 TFC
- Non-Conventional Gas Reserves
 - Deep Natural Gas
 - Tight Natural Gas
 - Shale Gas
 - Coalbed Methane
 - Geopressured Gas (110x)
 - Hydrates (6x)



EIA, 2003

World Natural Gas Production

(Trillion Cubic Feet)

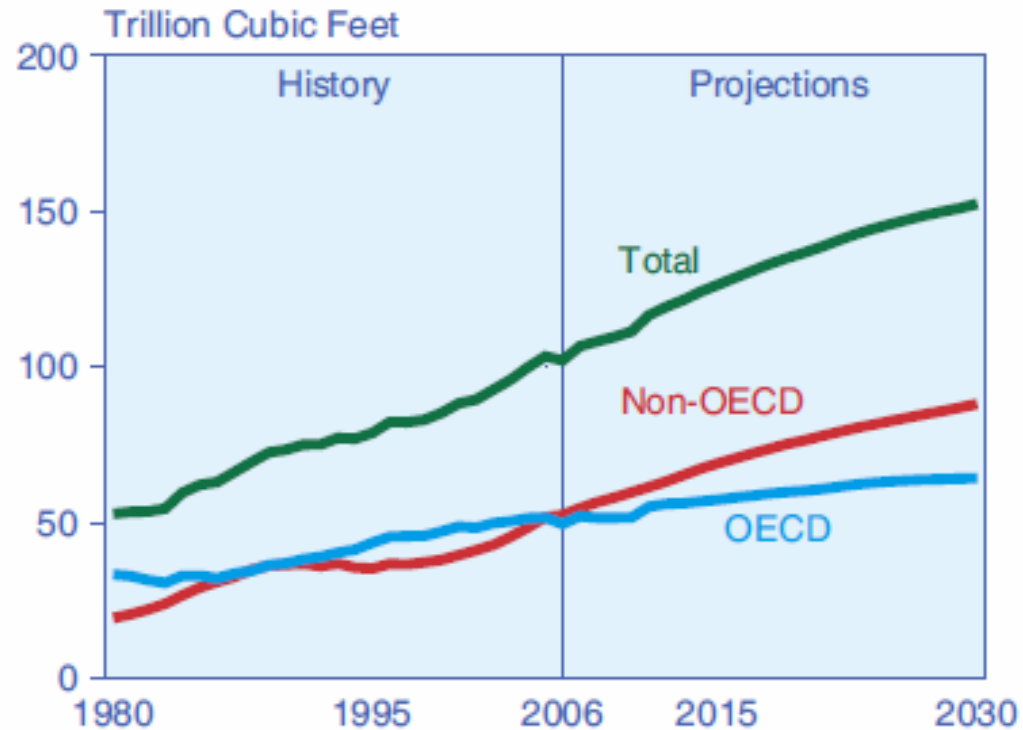
Region/Country	2006	Projections					Average Annual Percent Change, 2006-2030
		2010	2015	2020	2025	2030	
OECD North America	26.6	27.7	27.9	29.0	31.1	31.9	0.8
United States ^a	18.3	20.1	20.5	21.5	23.3	23.6	1.1
Canada	6.5	5.5	5.4	5.4	5.6	5.7	-0.6
Mexico	1.7	2.1	2.1	2.1	2.3	2.5	1.6
OECD Europe	10.7	10.9	11.0	10.9	10.7	10.4	-0.1
OECD Asia	1.8	2.3	2.8	3.6	4.0	4.6	3.9
Japan	0.2	0.2	0.2	0.2	0.2	0.2	0.0
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Australia/New Zealand	1.7	2.1	2.6	3.4	3.8	4.4	4.2
Total OECD	39.1	40.9	41.7	43.4	45.8	46.9	0.8
Non-OECD Europe and Eurasia	30.0	31.8	35.0	36.8	38.2	40.3	1.2
Russia	23.2	24.3	26.7	28.0	29.2	31.3	1.3
Other Non-OECD Europe and Eurasia ..	6.8	7.6	8.3	8.9	9.0	9.1	1.2
Non-OECD Asia	11.1	13.0	15.6	17.3	18.7	19.8	2.5
China	2.1	2.5	3.4	3.8	4.2	4.3	3.1
India	1.1	1.6	2.0	2.3	2.4	2.4	3.3
Other Non-OECD Asia	7.9	8.9	10.3	11.2	12.1	13.2	2.2
Middle East	12.0	14.8	17.8	19.9	22.0	22.6	2.7
Africa	6.6	7.9	9.6	11.6	12.8	13.9	3.2
Central and South America	5.1	6.2	7.0	7.8	8.6	9.1	2.5
Brazil	0.3	0.6	1.0	1.2	1.5	1.6	6.6
Other Central and South America	4.7	5.5	6.0	6.5	7.1	7.5	1.9
Total Non-OECD	64.6	73.6	85.0	93.4	100.3	105.8	2.1
Total World	103.8	114.5	126.7	136.8	146.1	152.7	1.6

^aIncludes supplemental production or forecast discrepancy. For details, see Energy Information Administration (EIA), *Annual Energy Outlook 2009*, p. 135, Table A13, "Natural Gas Supply, Disposition, and Prices."

Note: Totals may not equal sum of components due to independent rounding.

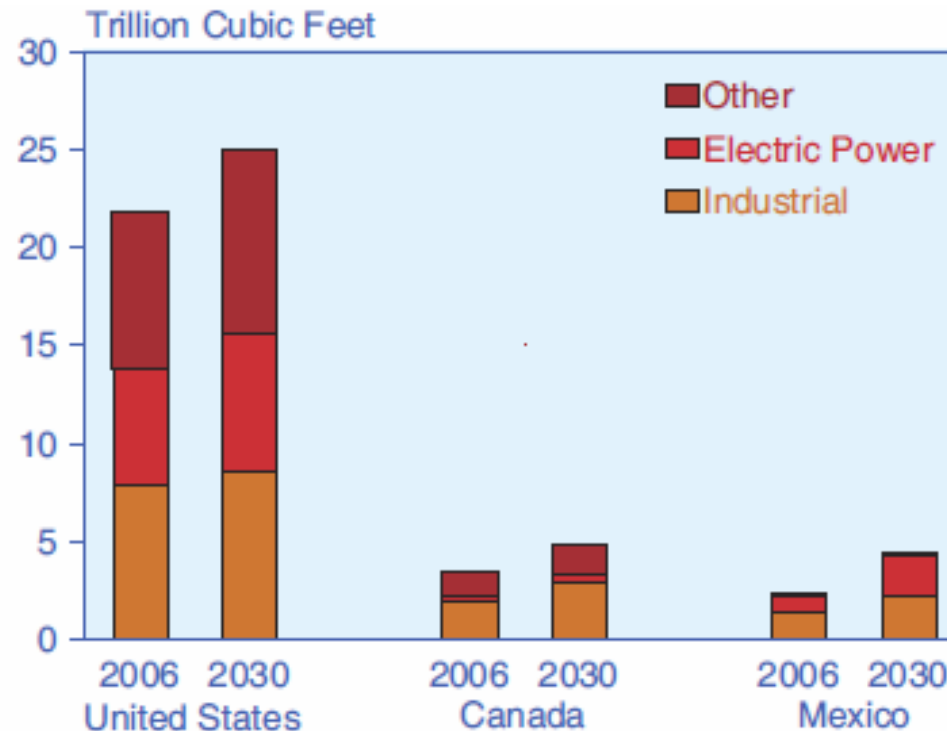
Sources: **History:** EIA, *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** **United States:** EIA, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009) (Washington, DC, June 2009), web site www.eia.doe.gov/oaia/aec. **Others:** EIA, *World Energy Projections Plus* (2009).

World Natural Gas Consumption



Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. **Projections:** EIA, *World Energy Projections Plus* (2009).

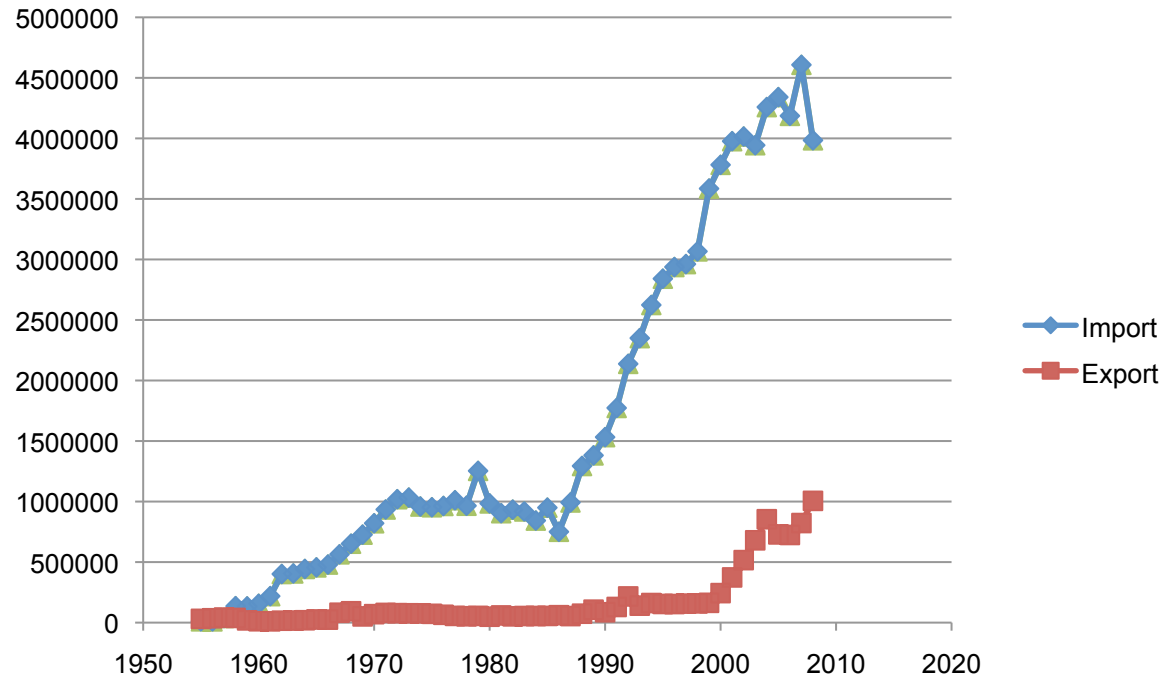
Consumption in North America



Sources: 2006: Energy Information Administration (EIA), *International Energy Annual 2006* (June-December 2008), web site www.eia.doe.gov/iea. Projections: EIA, *World Energy Projections Plus* (2009).

Natural Gas Import in the US

- **Historical Summary of U.S. Natural Gas Net Imports, 1955-2008 (Million Cubic Feet)**



Next Time...

- Chemical Processing of Natural Gas
 - Production
 - Coal -> Methane
 - LNG
 - CNG
- Non-conventional Natural Gas

Questions?