

Natural Gas

Basics

Fastest growing fossil fuel, about 5% per year

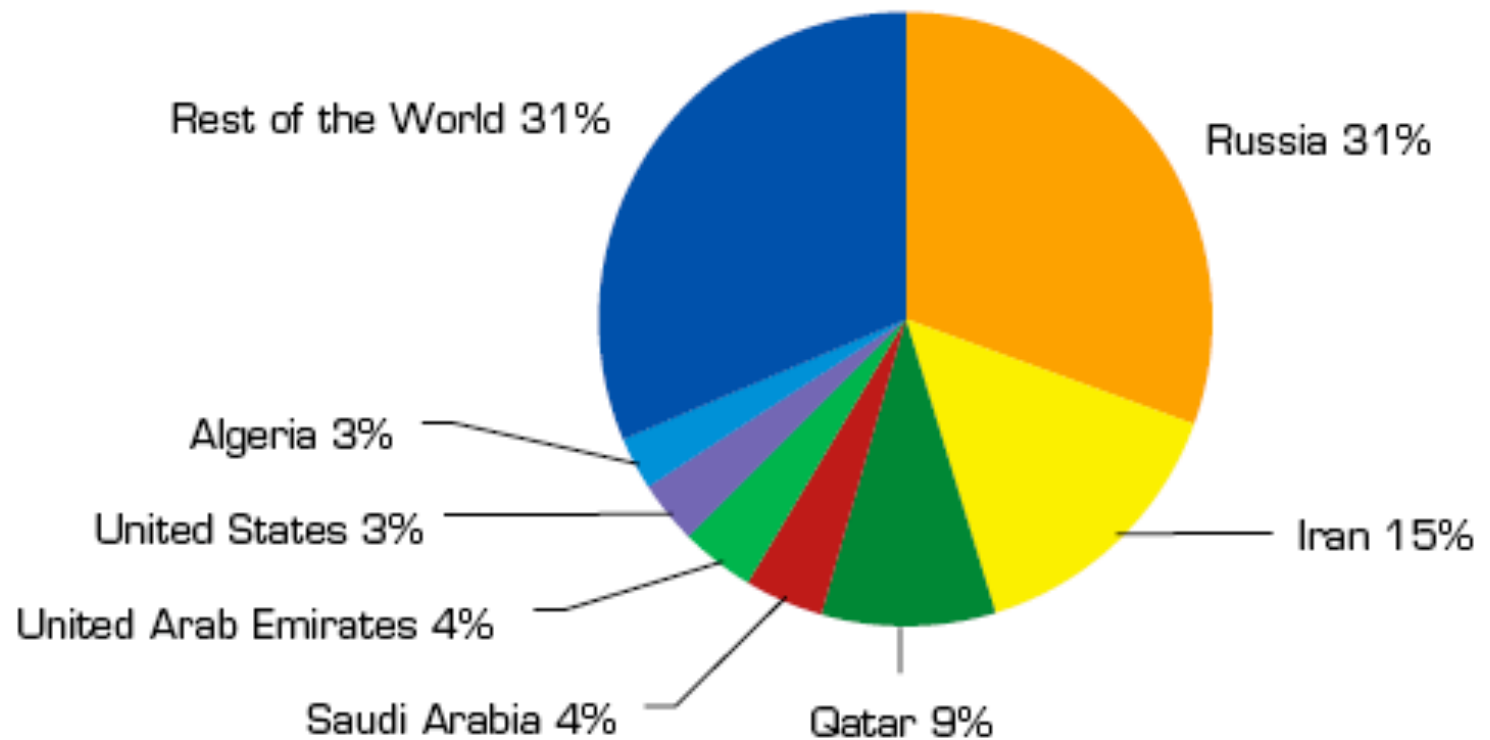
Mostly methane (CH_4)... but other carbon plus hydrogen gases as well (propane, etc...)

Less polluting than coal in sulfur oxides (SO_2) and particulates

Less polluting than oil in CO_2 ...about half as much CO_2 for the same energy released... why?... methane burns both carbon (to CO_2) and hydrogen (to water)

Reserves

Proved World Natural Gas Reserves, January 1, 2003



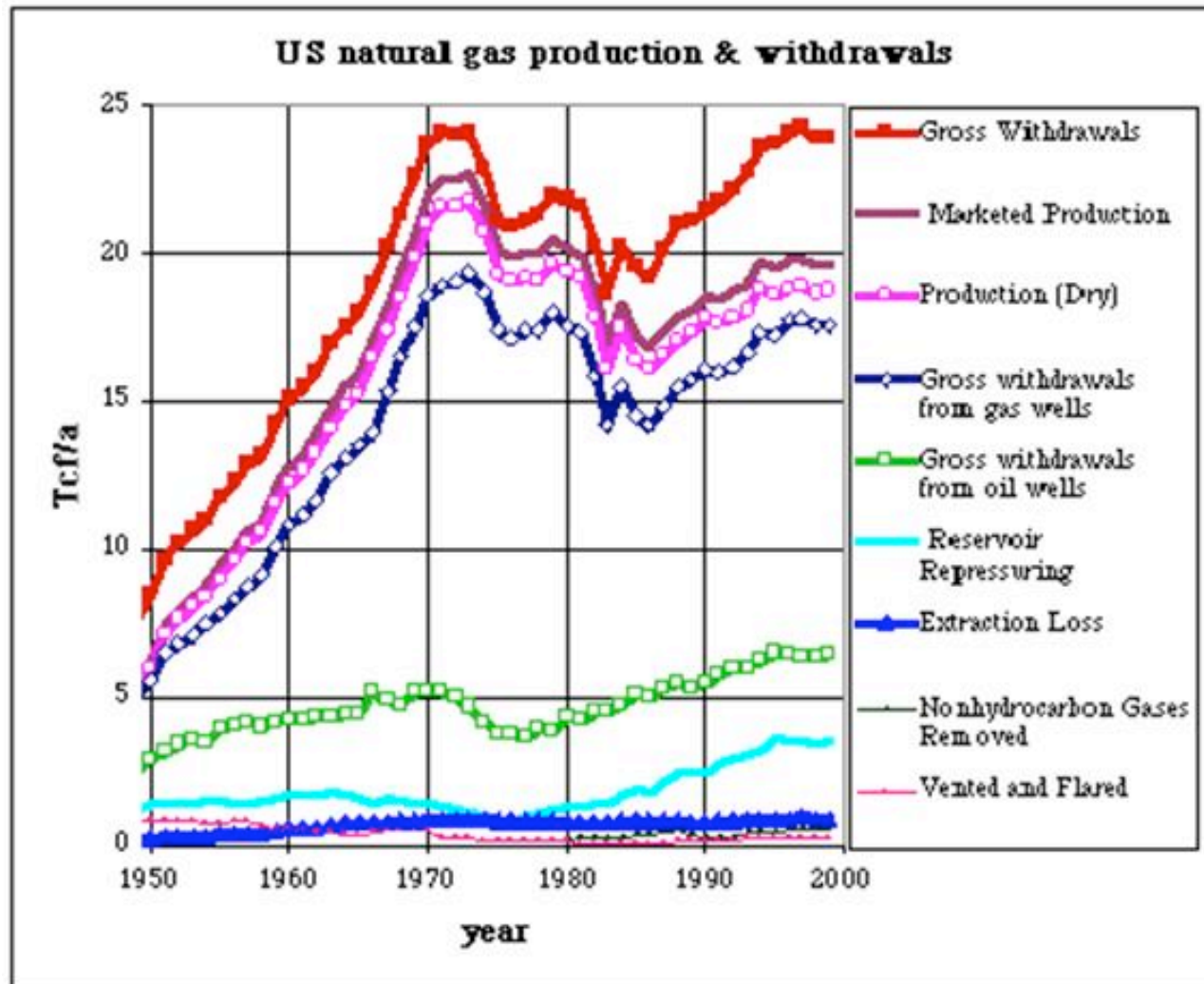
Source: *Oil & Gas Journal*, December 23, 2002

Reserves

Natural Gas Reserves by Country

Country	Proved Reserves End 1/1/2003 (Tcf)	Percent of World Reserves
TOTAL WORLD	5501.4	100.0%
Select Countries	5097.4	92.7%
Russia	1680.0	30.5%
Iran	812.3	14.8%
Qatar	508.5	9.2%
Saudi Arabia	224.7	4.1%
United Arab Emirates	212.1	3.9%
United States	183.5	3.3%
Algeria	159.7	2.9%
Venezuela	148.0	2.7%
Nigeria	124.0	2.3%
Iraq	109.8	2.0%

US reserves history



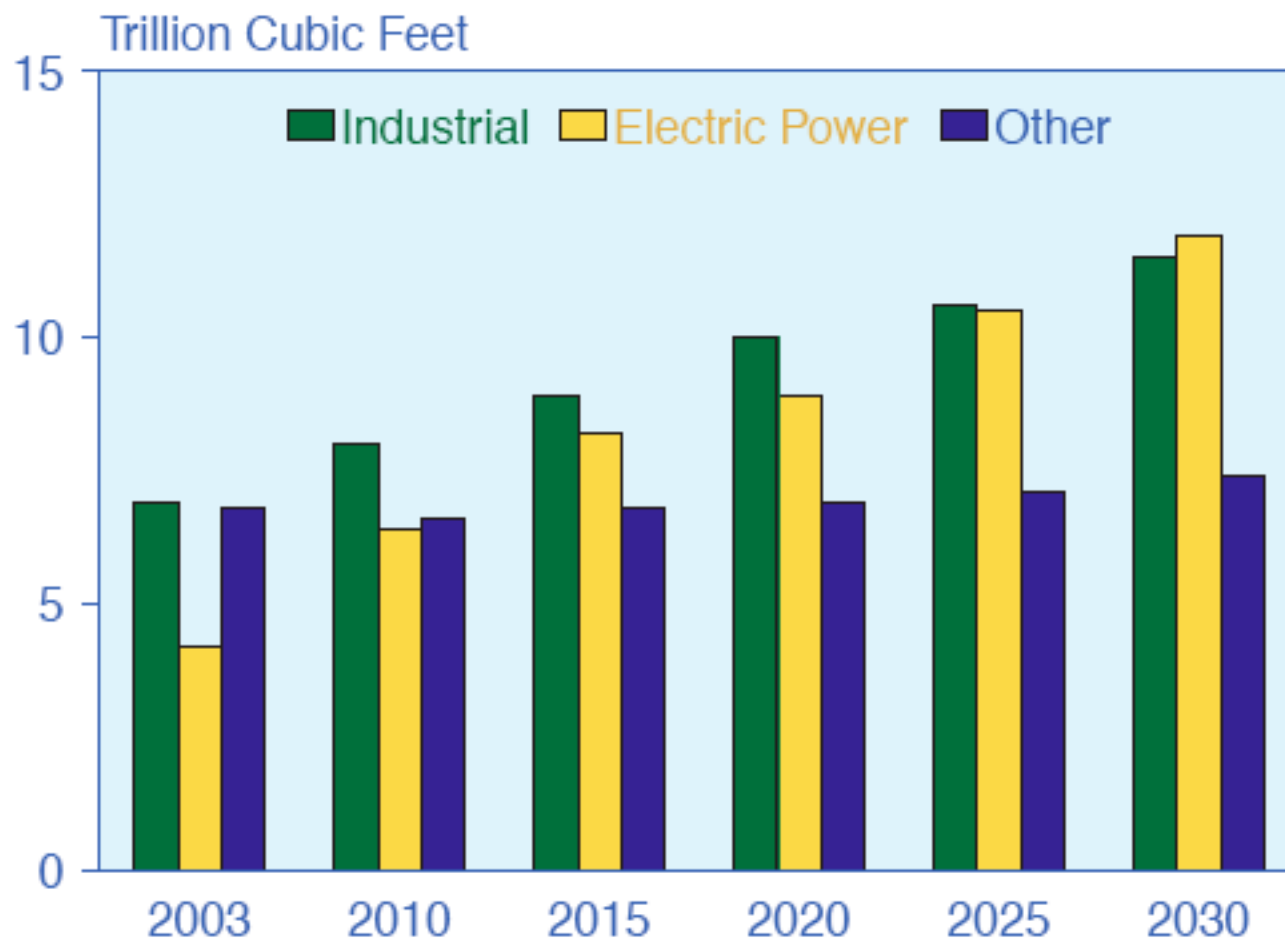
R/P

The current lifetime is about 50 to 60 years
Very dependent currently on price
(competes with oil in some applications)
We may find more... or not.

Use

- Mostly
- Industry
 - Home heating
 - electricity

Figure 42. Natural Gas Consumption in OECD Europe by End-Use Sector, 2003-2030

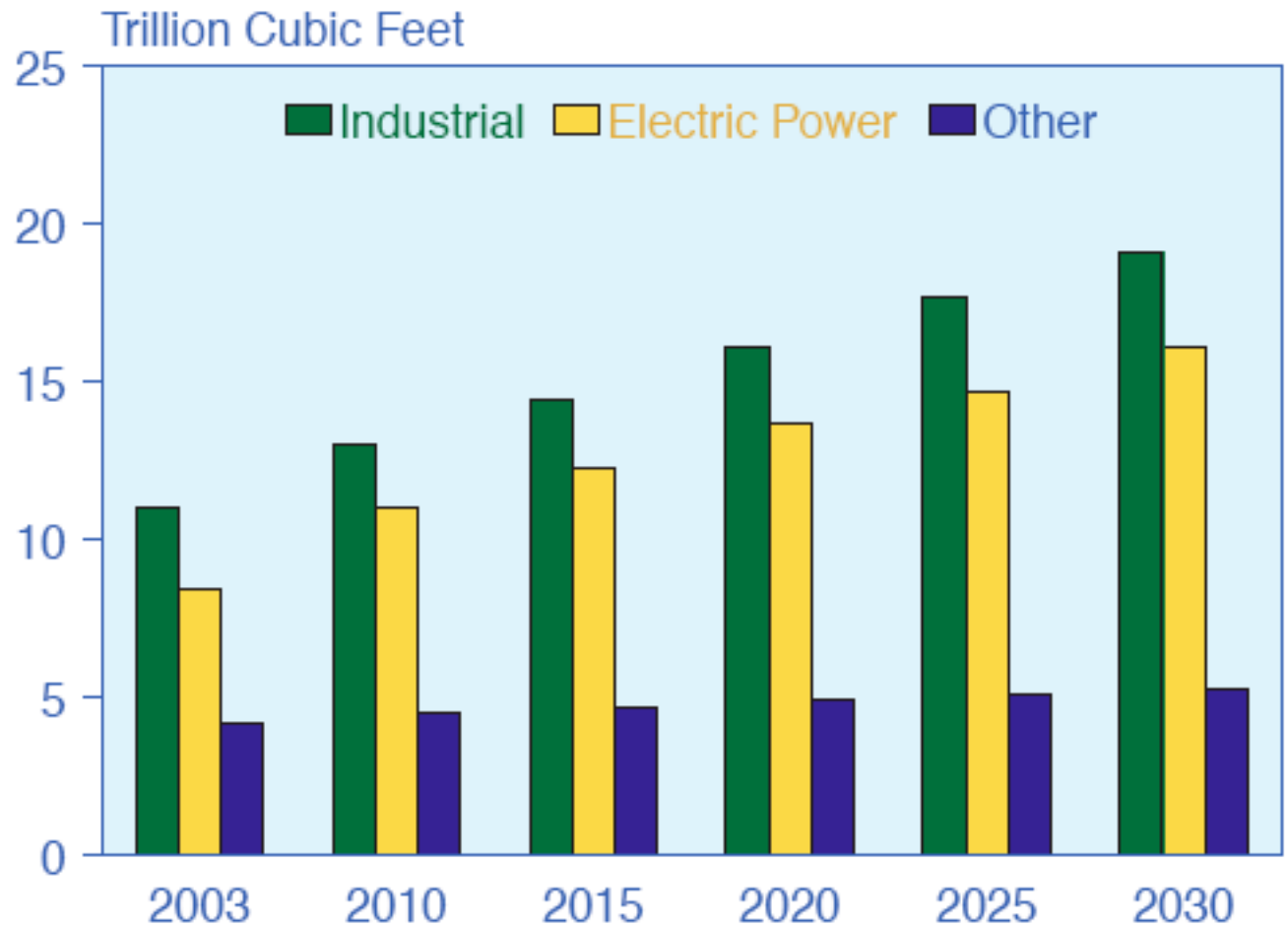


Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *System for the Analysis of Global Energy Markets* (2006).

Use

In
developing
countries:
Less home
heating

Figure 44. Natural Gas Consumption in Non-OECD Europe and Eurasia by End-Use Sector, 2003-2030



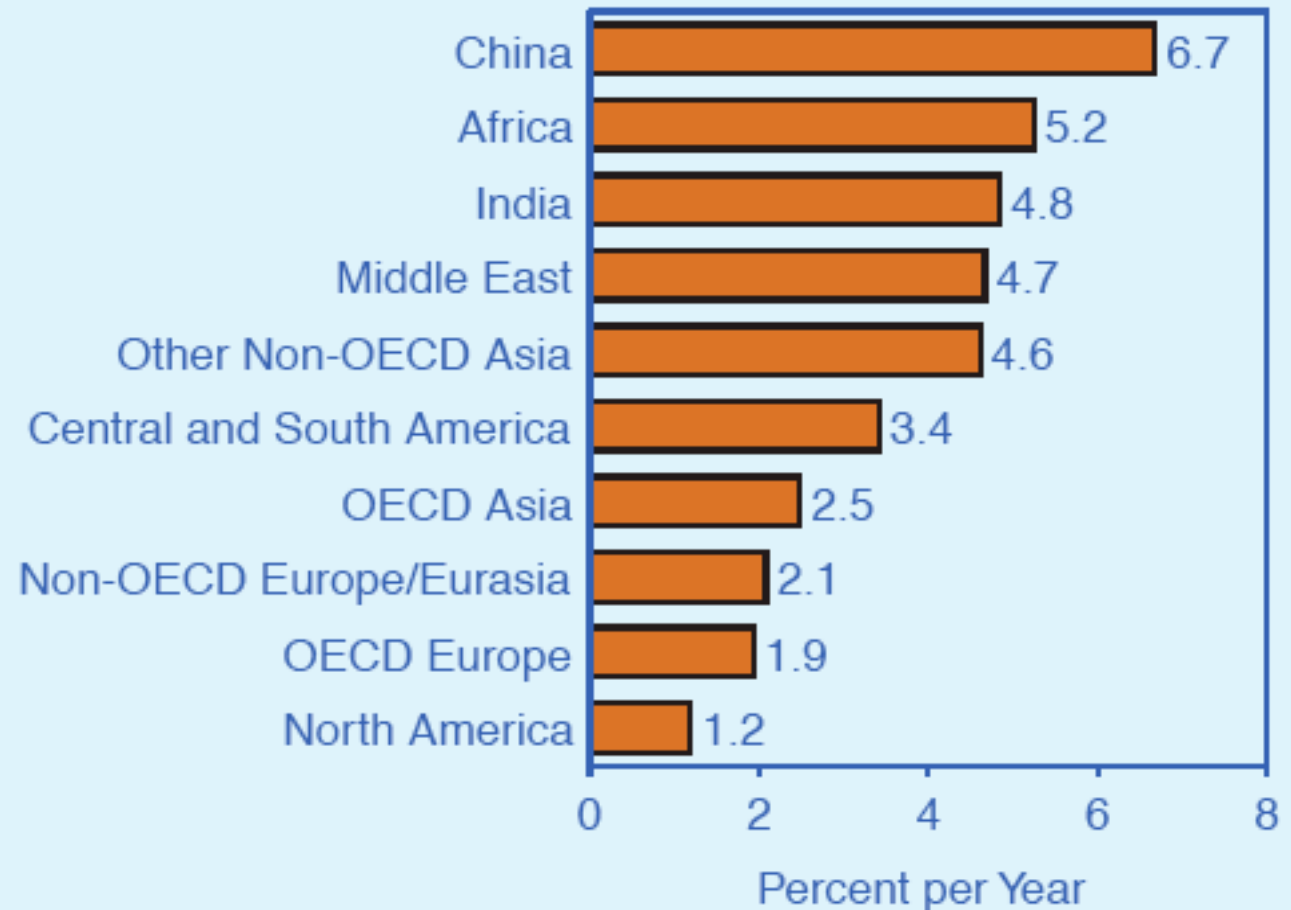
Sources: **2003:** Derived from Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, *System for the Analysis of Global Energy Markets* (2006).

Use

Use is growing fastest in developing countries...

This affects R/P.

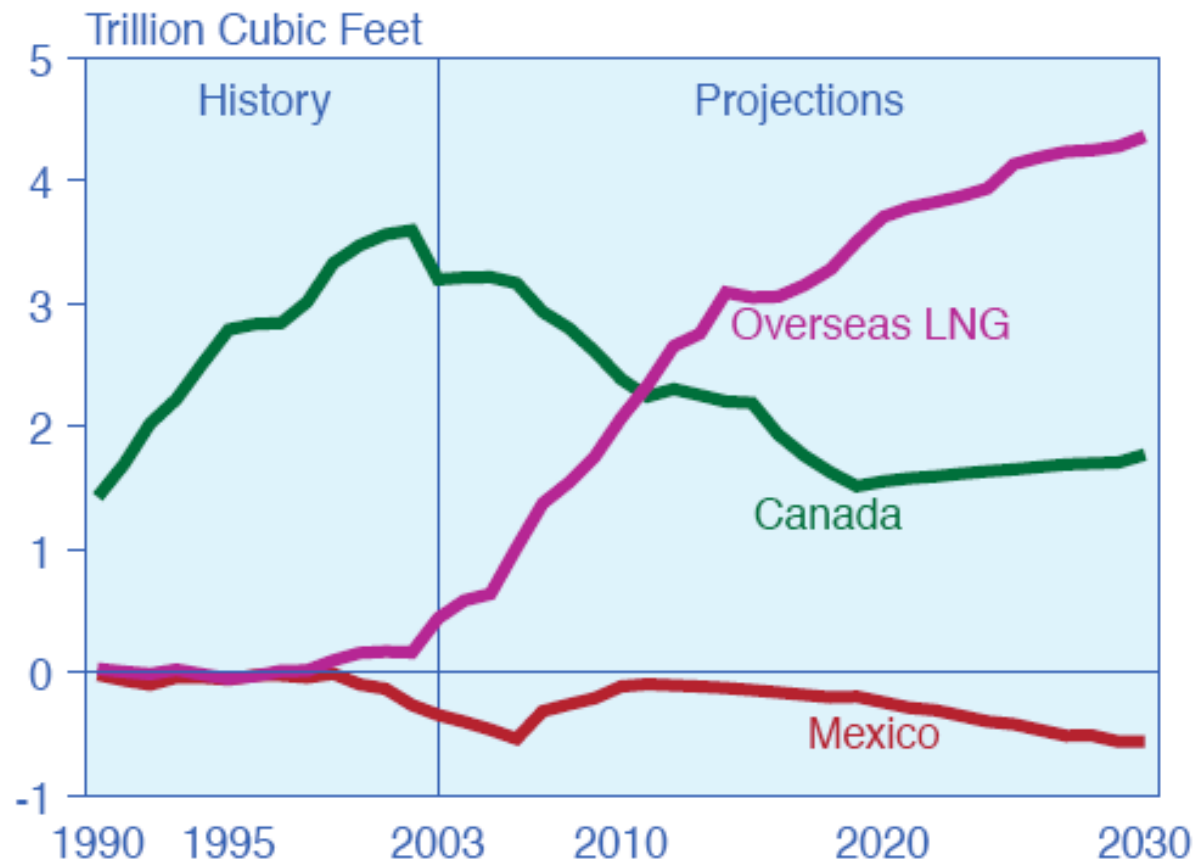
Average Annual Increases in Industrial Natural Gas Consumption, 2003-2030, by Region and Country



Sources: **2003:** Energy Information Administration (EIA), *International Energy Annual 2003*, DOE/EIA-0219(2003) (Washington, DC, July 2005), web site www.eia.doe.gov/iea/.
Projections: EIA, *System for the Analysis of Global Energy Markets* (2006).

The
future
is
imports

Figure 41. U.S. Natural Gas Supply by Source, 1990-2030

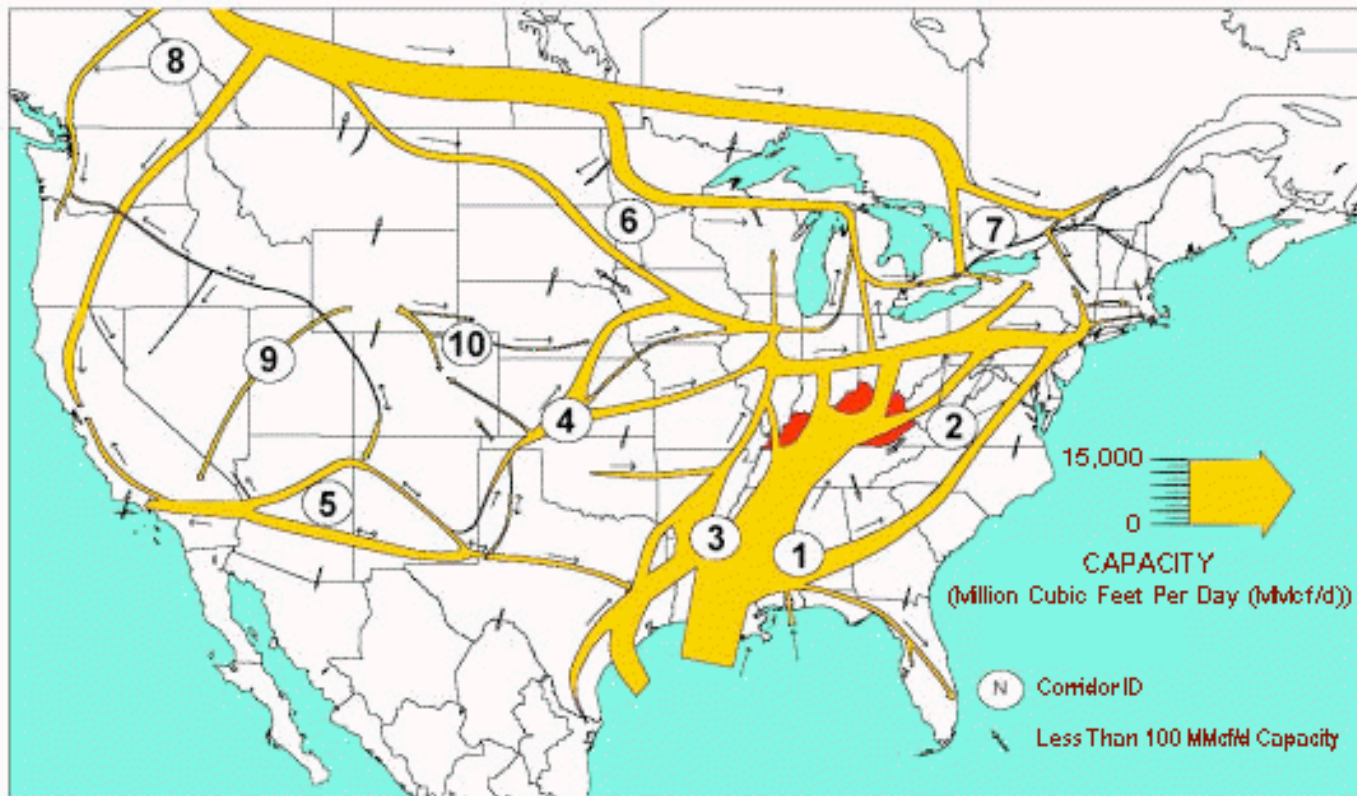


Sources: **History:** Energy Information Administration (EIA), *Annual Energy Review 2004*, DOE/EIA-0384(2004) (Washington, DC, August 2005), web site www.eia.doe.gov/emeu/aer/. **Projections:** EIA, *Annual Energy Outlook 2006*, DOE/EIA-0383(2006) (Washington, DC, February 2006), web site www.eia.doe.gov/oiaf/aeo/.

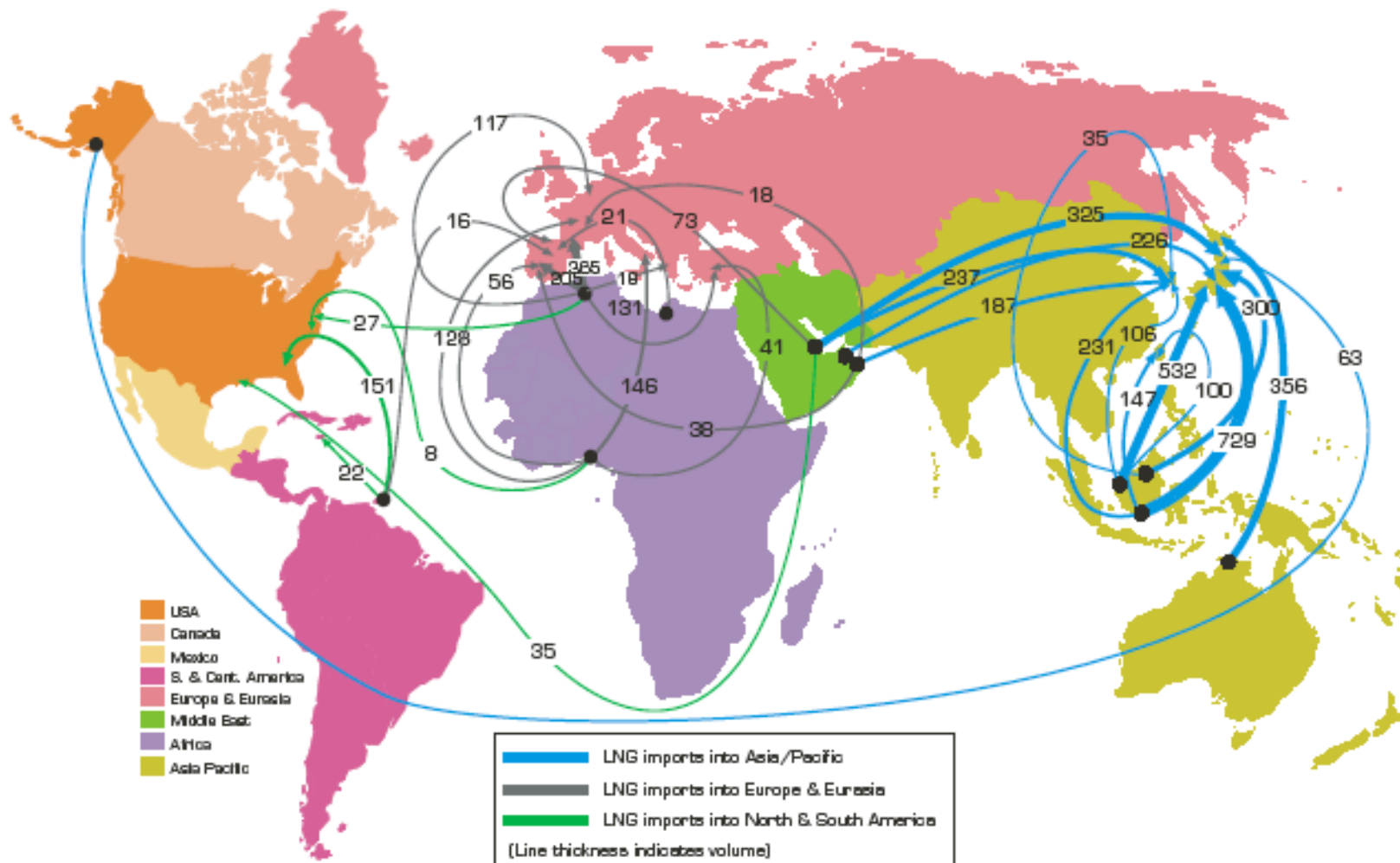
Pipelines and LNG

- Use was limited until pipelines were built
- Big push for pipelines in the US was during WWII (oil needed for war)
- Now, liquified natural gas (LNG) is shipped around the world
- LNG is natural gas compressed until it liquifies

Pipelines: main trunk lines



Major LNG Trade Movements, 2002 (Billion cubic feet)



Note: The map includes flows greater than 5 Bcf for imports into the United States, and flows greater than 15 Bcf for imports into all other Countries.

Source: Imports to the United States and Imports to Japan and Mexico from the United States: Energy Information Administration, *Natural Gas Monthly* (May 2003). All Other Countries: Organization for Economic Cooperation and Development, International Energy Agency, *Natural Gas Information 2003* (with 2002 data).

Ships

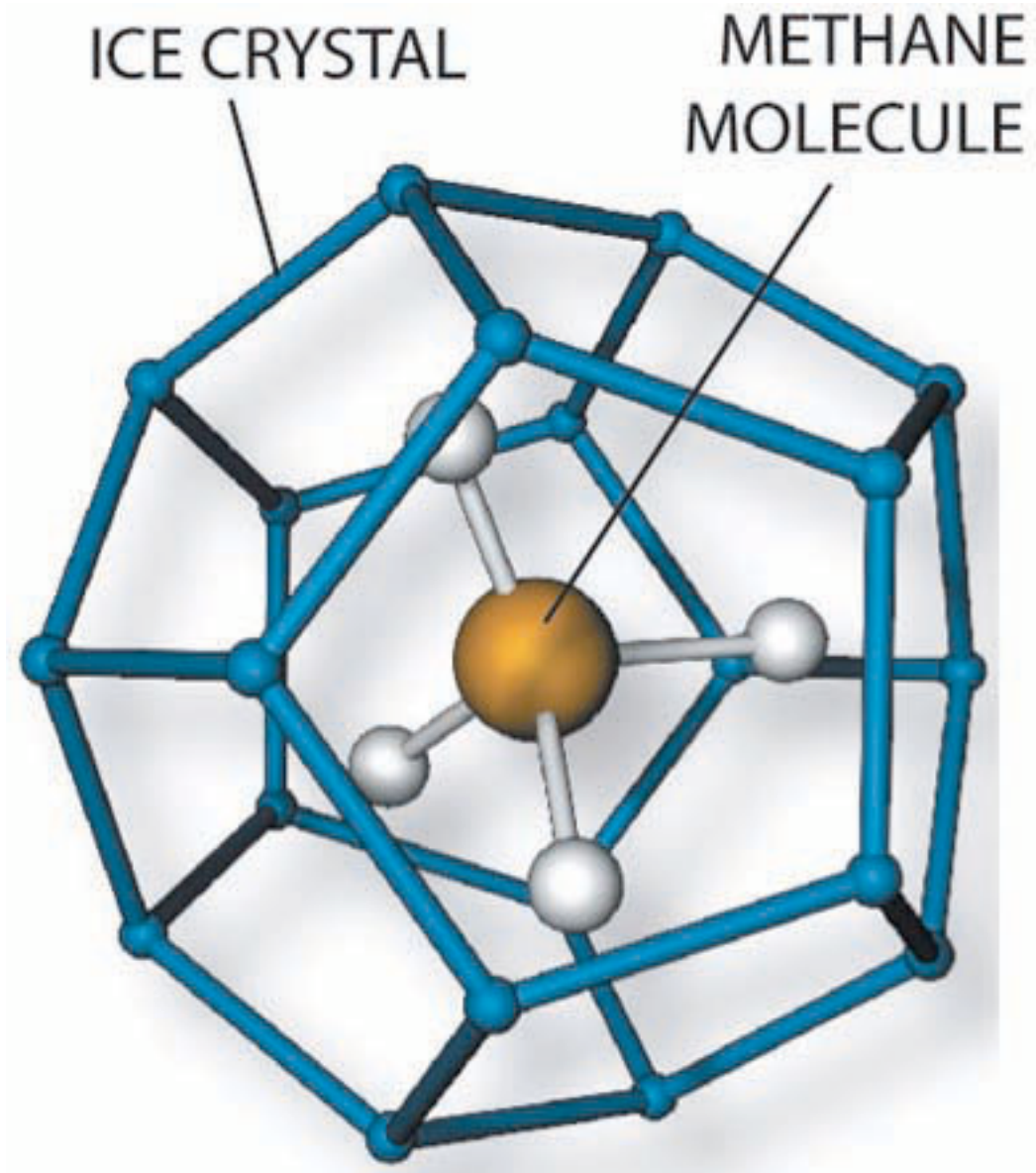


Methane clathrates

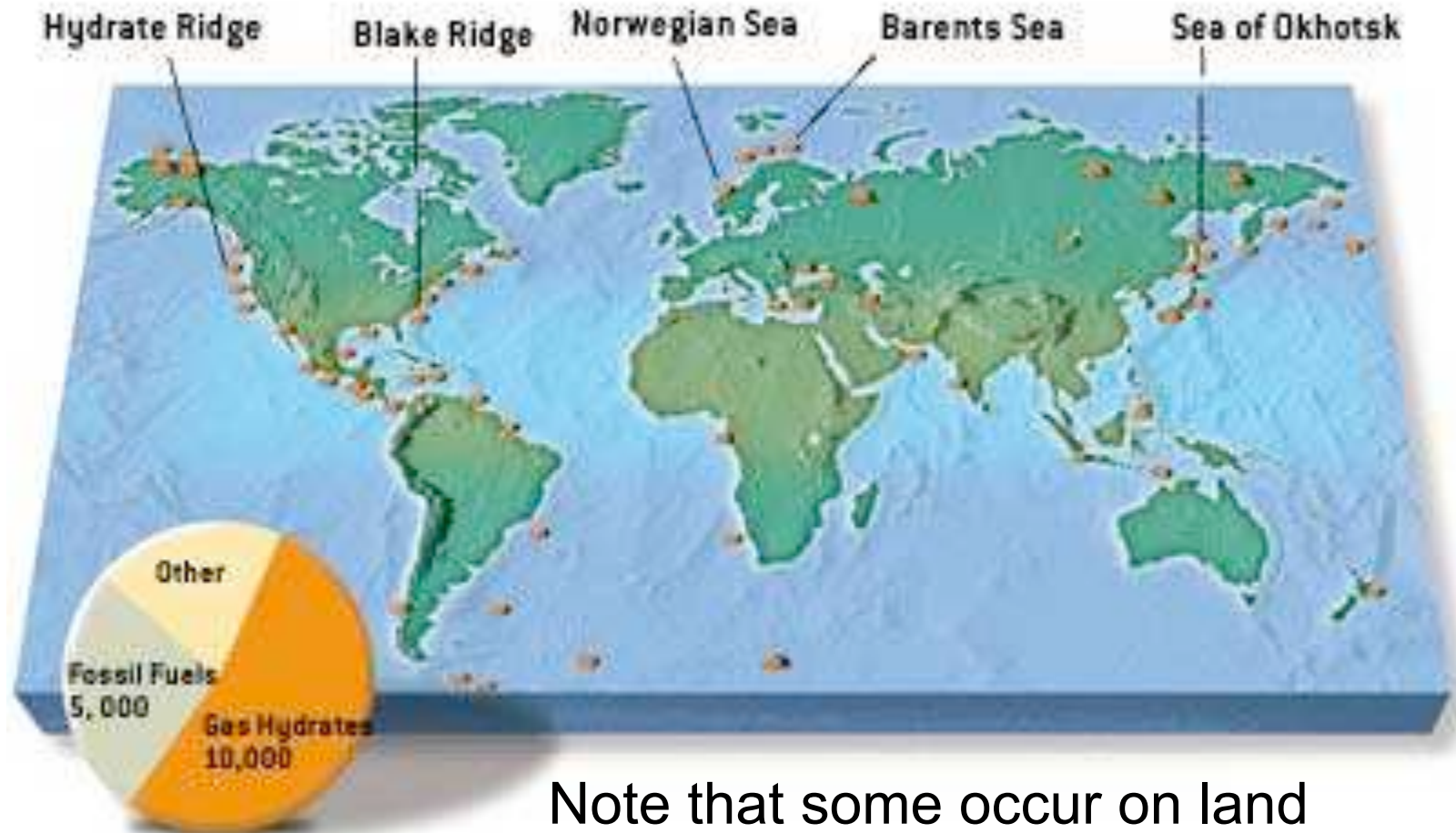
- Reservoir of methane ices, called **methane clathrates**.
- Mostly in ocean sediments.
- May represent more energy than in all fossil fuels
- But not easy to harvest

Methane clathrates

CH_4 inside of a cage of H_2O molecules



Currently known locations



The future of methane clathrates

Depends on:

- Cost to recover versus price
- Ability to burn these cleanly
- Alternative sources (biomass)