

**Synapse**  
Energy Economics, Inc.

# Liquefied Natural Gas: Current Trends and Future Directions

ASPO  
Boston World Oil Conference  
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# What's in store with LNG?

- **LNG Basics**
- **Current and Future Sources of LNG**
- **Global competition for LNG**
- **US Natural Gas Production**
- **LNG and Security Issues**
- **US Untapped “Reserves”**



# LNG Basics

- Gas is liquefied by cooling to  $-259^{\circ}\text{F}$  /  $-161^{\circ}\text{C}$
- Volume decreased by a factor of 600
- 95% pure methane (NG is ~80% methane)
- Extremely capital intensive infrastructure
- Cost effective relative to pipelines for long distances (800 mi offshore, 2000 onshore)



EXPLORATION &  
PRODUCTION



LIQUEFACTION



SHIPPING

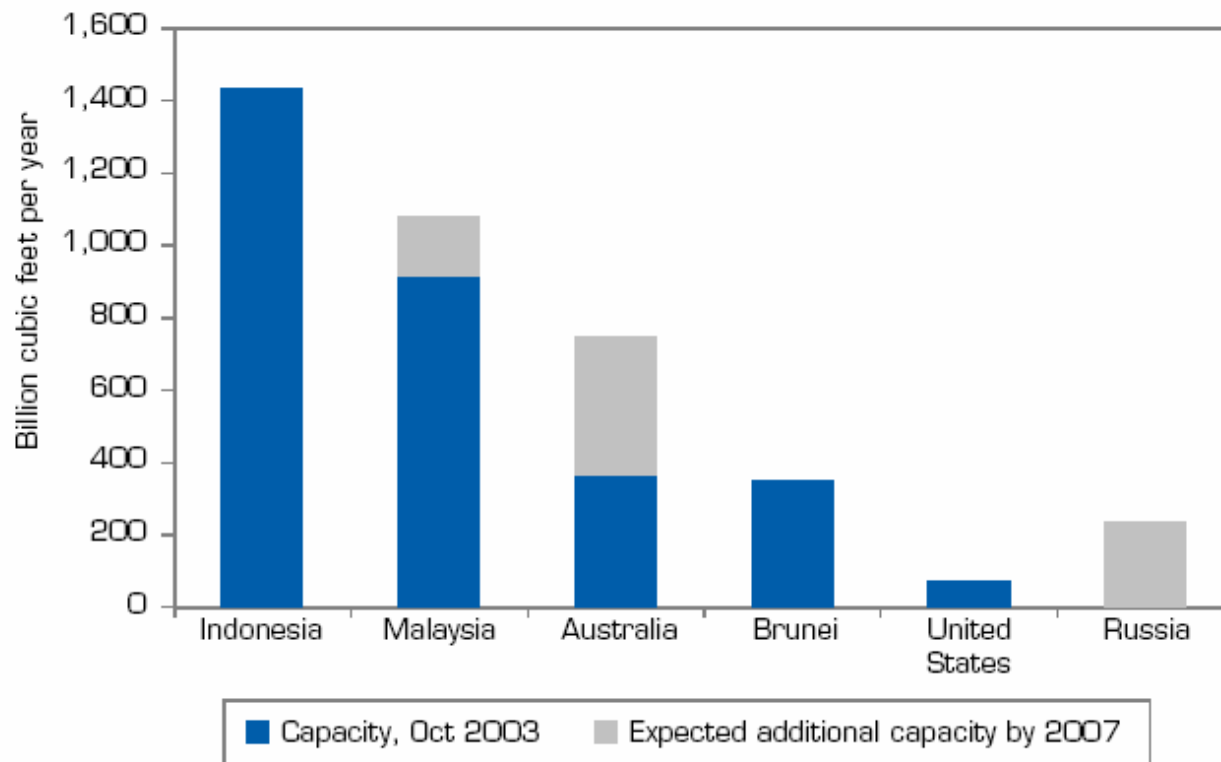


REGASIFICATION  
& STORAGE



# Global Production Capacity

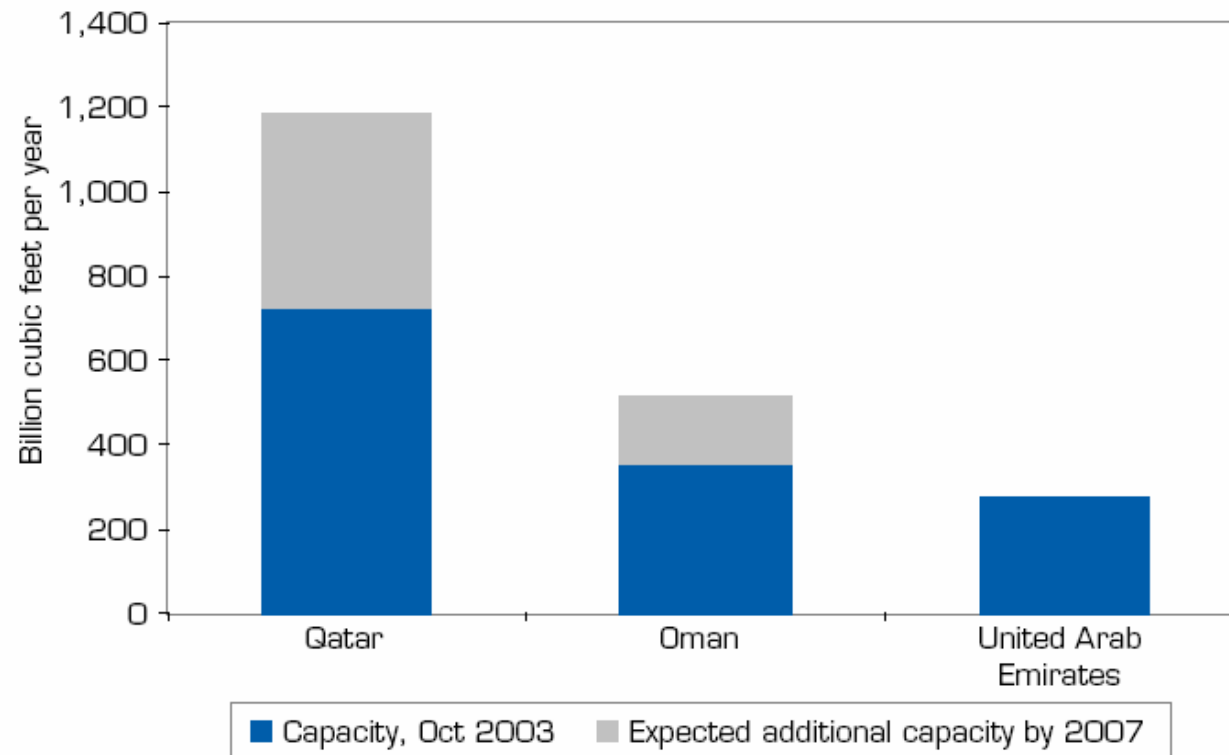
## Pacific Basin Liquefaction Capacity, October 2003



Data from IEA 2003 *Natural Gas Information*, and updated based on trade press reports as assembled by the Gas Technology Institute.

# Global Production Capacity

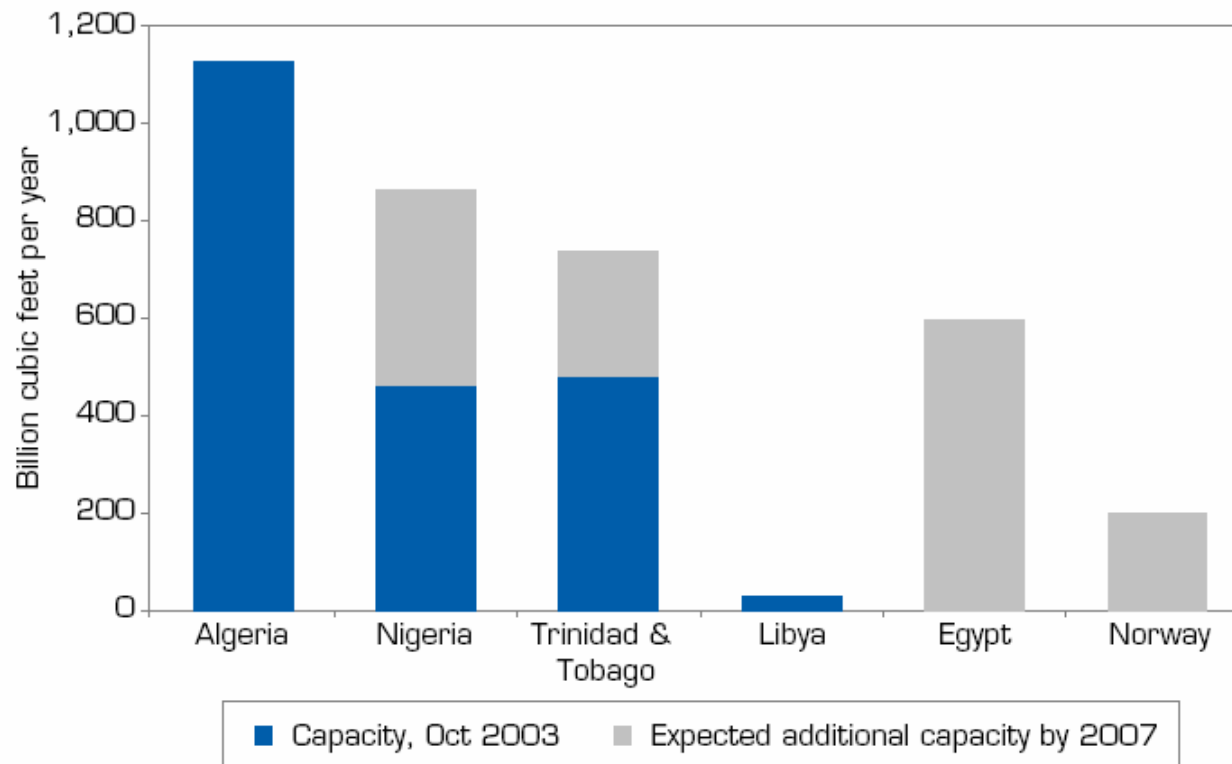
## Middle East Liquefaction Capacity, October 2003



Data from IEA 2003 *Natural Gas Information*, and updated based on trade press reports as assembled by the Gas Technology Institute.

# Global Production Capacity

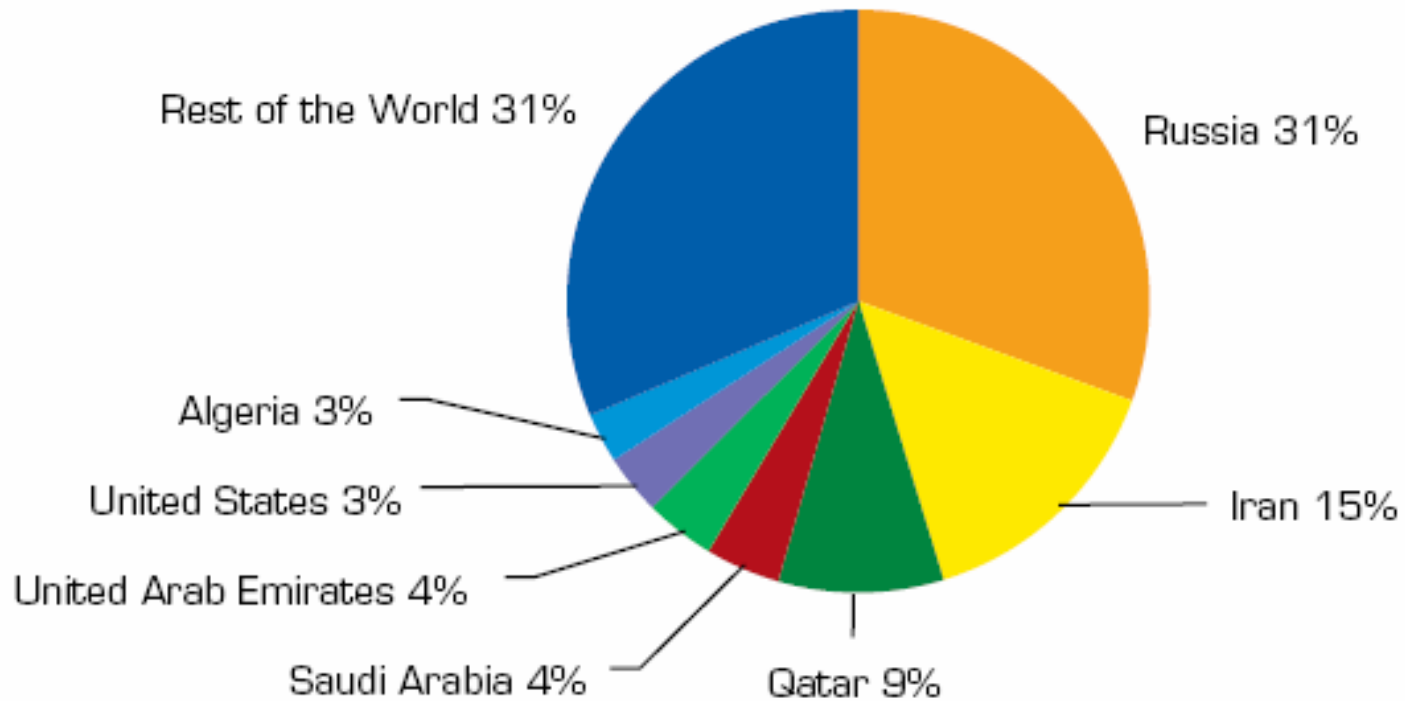
## Atlantic Basin Liquefaction Capacity, October 2003



Data from IEA 2003 *Natural Gas Information*, and updated based on trade press reports as assembled by the Gas Technology Institute.

# Where are the gas reserves?

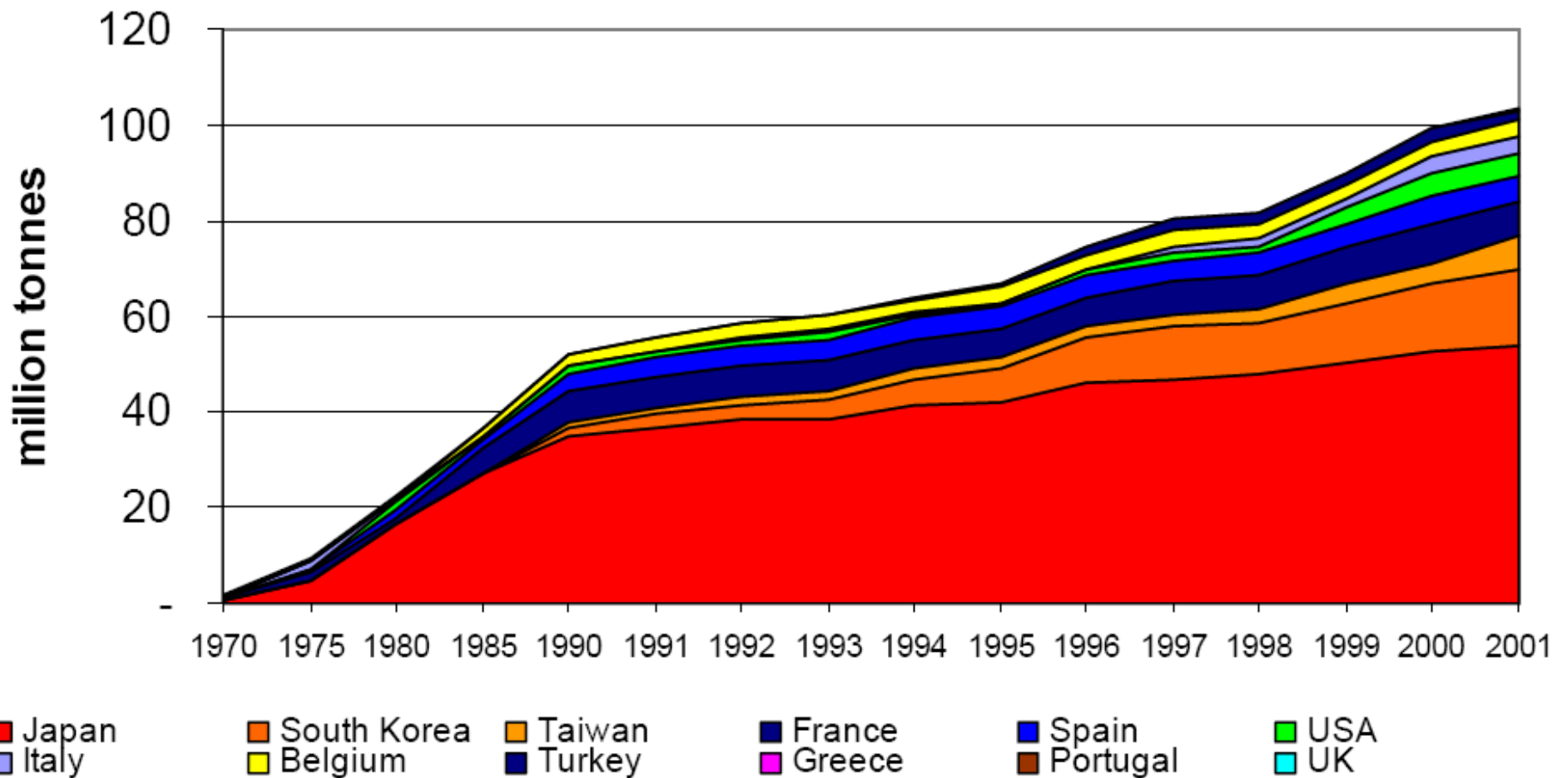
Proved World Natural Gas Reserves, January 1, 2003



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



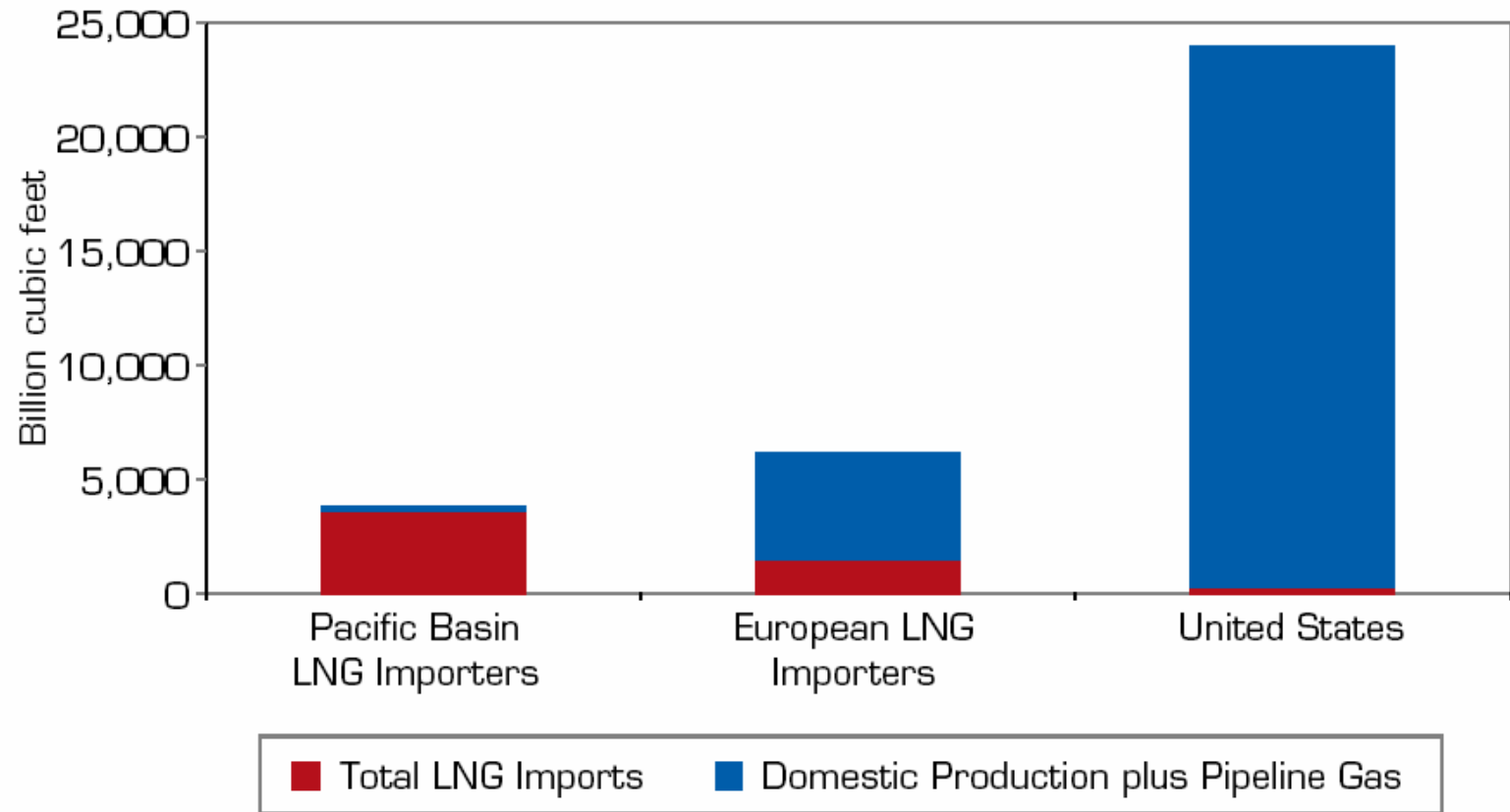
# Growth in LNG Demand Worldwide



Source: Cedigaz, BP Statistical Review of World Energy June 2002

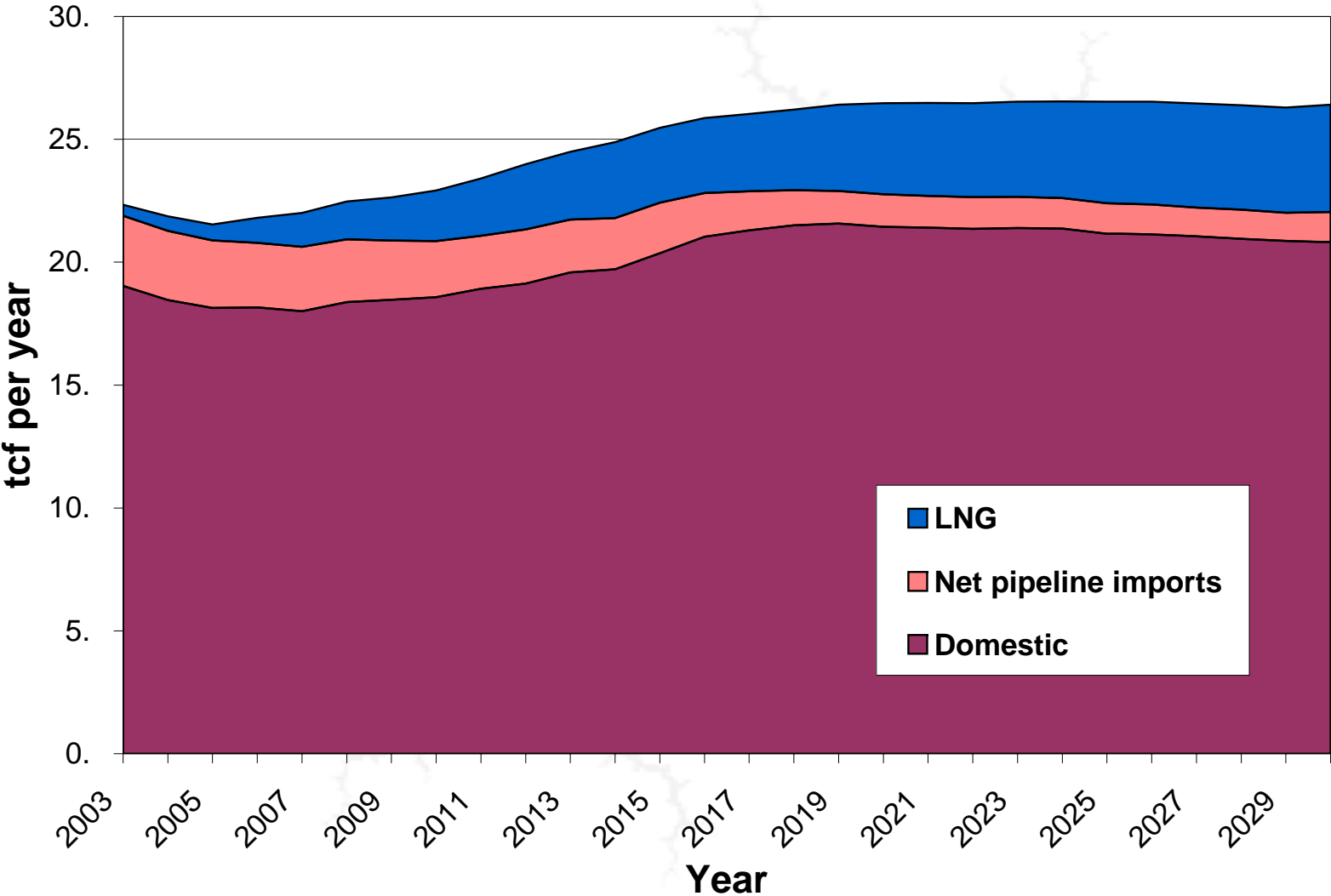
# US vs. Competing LNG Importers

## LNG Imports and Total Gas Consumption by Region, 2002



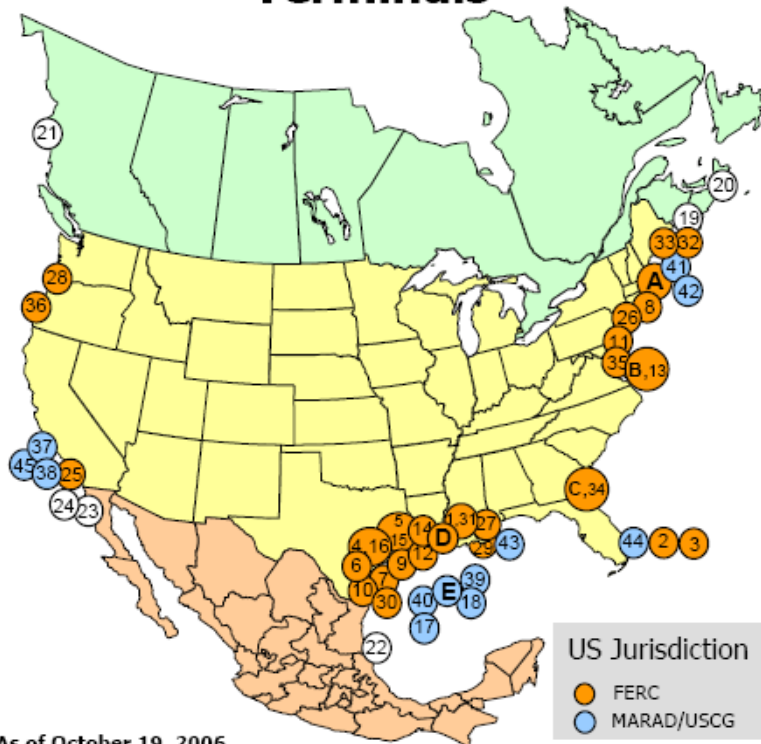
From EIA 2003 report, *The Global Liquefied Natural Gas Market: Status & Outlook*

# AEO 2006 Projects growth in LNG Imports



**FERC**

## Existing and Proposed North American LNG Terminals



As of October 19, 2006

\* US pipeline approved; LNG terminal pending in Bahamas  
 \*\* Construction suspended

*Office of Energy Projects*

**CONSTRUCTED**

- A. Everett, MA : 1.035 Bcf/d (SUEZ/Tractebel - DOMAC)
- B. Cove Point, MD : 1.0 Bcf/d (Dominion - Cove Point LNG)
- C. Elba Island, GA : 1.2 Bcf/d (El Paso - Southern LNG)
- D. Lake Charles, LA : 2.1 Bcf/d (Southern Union - Trunkline LNG)
- E. Gulf of Mexico: 0.5 Bcf/d (Gulf Gateway Energy Bridge - Excelerate Energy)

**APPROVED BY FERC**

- 1. Hackberry, LA : 1.5 Bcf/d (Cameron LNG - Sempra Energy)
- 2. Bahamas : 0.84 Bcf/d (AES Ocean Express)\*
- 3. Bahamas : 0.83 Bcf/d (Calypto Tractebel)\*
- 4. Freeport, TX : 1.5 Bcf/d (Cheniere/Freeport LNG Dev.)
- 5. Sabine, LA : 2.6 Bcf/d (Sabine Pass Cheniere LNG)
- 6. Corpus Christi, TX : 2.6 Bcf/d (Cheniere LNG)
- 7. Corpus Christi, TX : 1.1 Bcf/d (Vista Del Sol - ExxonMobil)
- 8. Fall River, MA : 0.8 Bcf/d (Weaver's Cove Energy/Hess LNG)
- 9. Sabine, TX : 2.0 Bcf/d (Golden Pass - ExxonMobil)
- 10. Corpus Christi, TX : 1.0 Bcf/d (Ingleside Energy - Occidental Energy Ventures)
- 11. Logan Township, NJ : 1.2 Bcf/d (Crown Landing LNG - BP)
- 12. Port Arthur, TX : 3.0 Bcf/d (Sempra)
- 13. Cove Point, MD : 0.8 Bcf/d (Dominion)
- 14. Cameron, LA : 3.3 Bcf/d (Creole Trail LNG - Cheniere LNG)
- 15. Sabine, LA : 1.4 Bcf/d (Sabine Pass Cheniere LNG - Expansion)
- 16. Freeport, TX : 2.5 Bcf/d (Cheniere/Freeport LNG Dev. - Expansion)

**APPROVED BY MARAD/COAST GUARD**

- 17. Port Pelican: 1.6 Bcf/d (Chevron Texaco)
- 18. Louisiana Offshore : 1.0 Bcf/d (Gulf Landing - Shell)

**CANADIAN APPROVED TERMINALS**

- 19. St. John, NB : 1.0 Bcf/d (Canaport - Irving Oil)
- 20. Point Tupper, NS : 1.0 Bcf/d (Bear Head LNG - Anadarko)
- 21. Kitimat, BC : 0.61 Bcf/d (Galveston LNG)

**MEXICAN APPROVED TERMINALS**

- 22. Altamira, Tamulipas : 0.7 Bcf/d (Shell/Total/Mitsui)
- 23. Baja California, MX : 1.0 Bcf/d (Energy Costa Azul - Sempra)
- 24. Baja California - Offshore : 1.4 Bcf/d (Chevron Texaco)

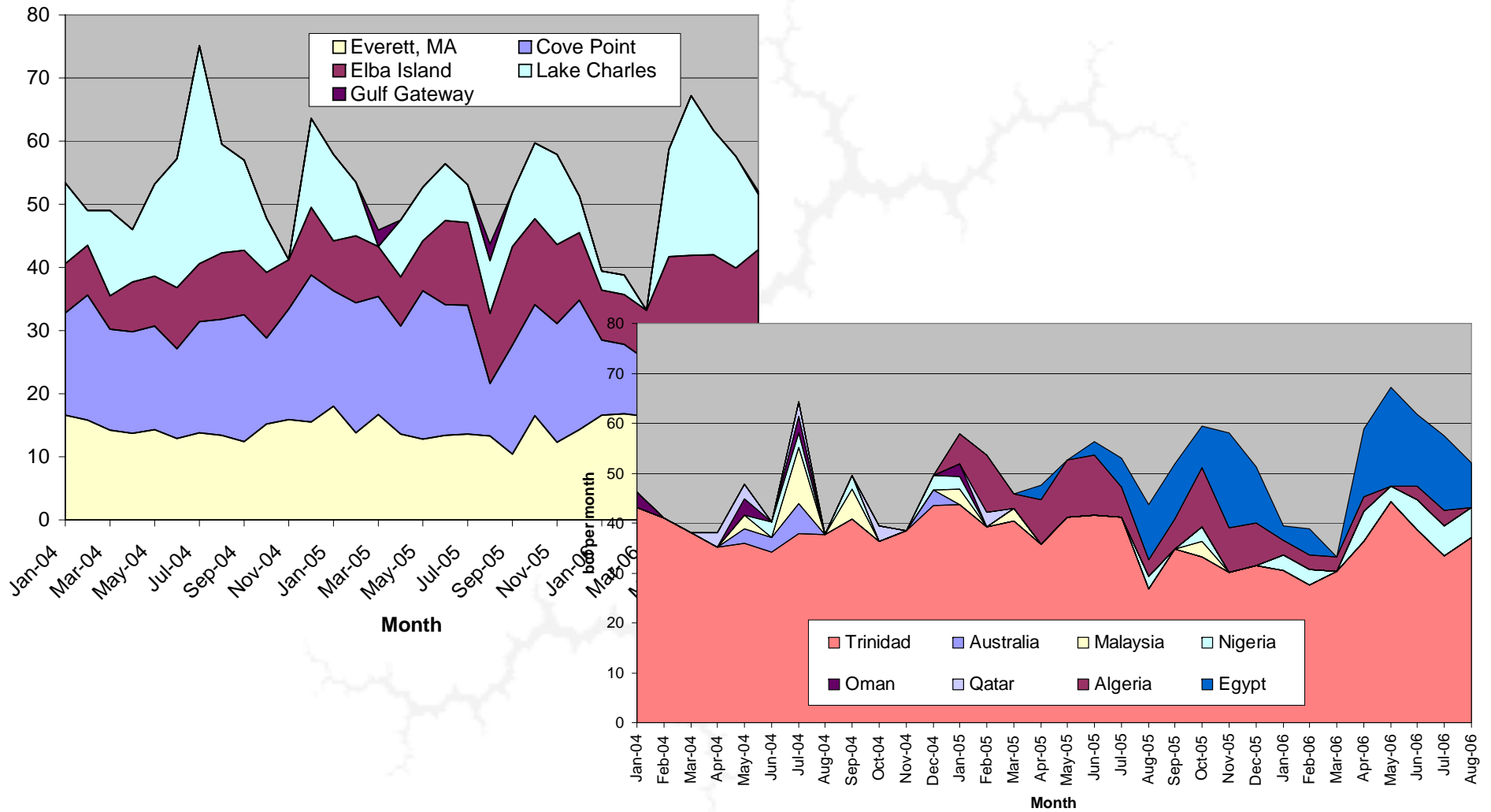
**PROPOSED TO FERC**

- 25. Long Beach, CA : 0.7 Bcf/d, (Mitsubishi/ConocoPhillips - Sound Energy Solutions)
- 26. LI Sound, NY : 1.0 Bcf/d (Broadwater Energy - TransCanada/Shell)
- 27. Pascagoula, MS : 1.5 Bcf/d (Gulf LNG Energy LLC)
- 28. Bradwood, OR : 1.0 Bcf/d (Northern Star LNG - Northern Star Natural Gas LLC)
- 29. Pascagoula, MS : 1.3 Bcf/d (Casotte Landing - ChevronTexaco)
- 30. Port Lavaca, TX : 1.0 Bcf/d (Calhoun LNG - Gulf Coast LNG Partners)
- 31. Hackberry, LA : 1.15 Bcf/d (Cameron LNG - Sempra Energy - Expansion)
- 32. Pleasant Point, ME : 2.0 Bcf/d (Quoddy Bay, LLC)
- 33. Robbinston, ME : 0.5 Bcf/d (Downeast LNG - Kestrel Energy)
- 34. Elba Island, GA : 0.9 Bcf/d (El Paso - Southern LNG)
- 35. Baltimore, MD : 1.5 Bcf/d (AES Sparrows Point - AES Corp.)
- 36. Coos Bay, OR : 1.0 Bcf/d (Jordan Cove Energy Project)

**PROPOSED TO MARAD/COAST GUARD**

- 37. Offshore California : 1.5 Bcf/d (Cabrillo Port - BHP Billiton)
- 38. Offshore California : 0.5 Bcf/d, (Clearwater Port LLC - NorthernStar NG LLC)
- 39. Offshore Louisiana : 1.0 Bcf/d (Main Pass McMoran Exp.)
- 40. Gulf of Mexico: 1.5 Bcf/d (Beacon Port Clean Energy Terminal - ConocoPhillips)
- 41. Offshore Boston: 0.4 Bcf/d (Neptune LNG - SUEZ LNG)
- 42. Offshore Boston: 0.8 Bcf/d (Northeast Gateway - Excelerate Energy)
- 43. Gulf of Mexico: 1.4 Bcf/d (Bienville Offshore Energy Terminal - TORP)
- 44. Offshore Florida: ? Bcf/d (SUEZ Calypso - SUEZ LNG)
- 45. Offshore California: 1.2 Bcf/d (OceanWay - Woodside Natural Gas)

# Recent US LNG Imports

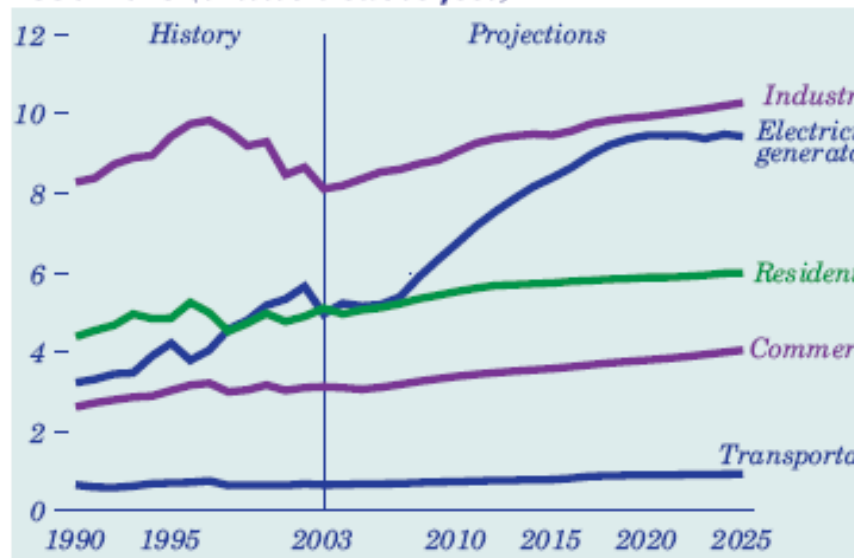


Source: Compiled from EIA monthly LNG reports

# Trends in Natural Gas Use

## Projected Increases in Natural Gas Use Are Led by Electricity Generators

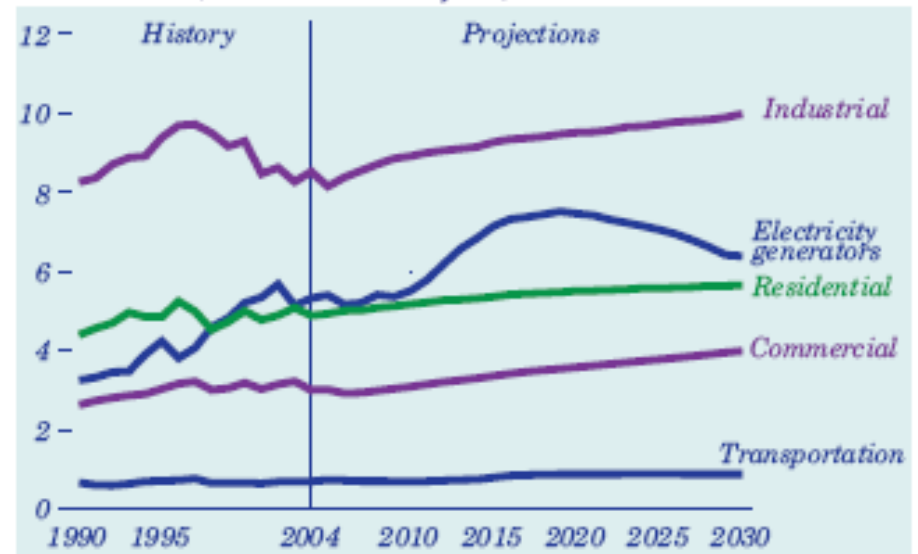
Figure 82. Natural gas consumption by sector, 1990-2025 (trillion cubic feet)



Source: AEO 2005

## Increases in Natural Gas Use Are Moderated by High Prices

Figure 71. Natural gas consumption by sector, 1990-2030 (trillion cubic feet)

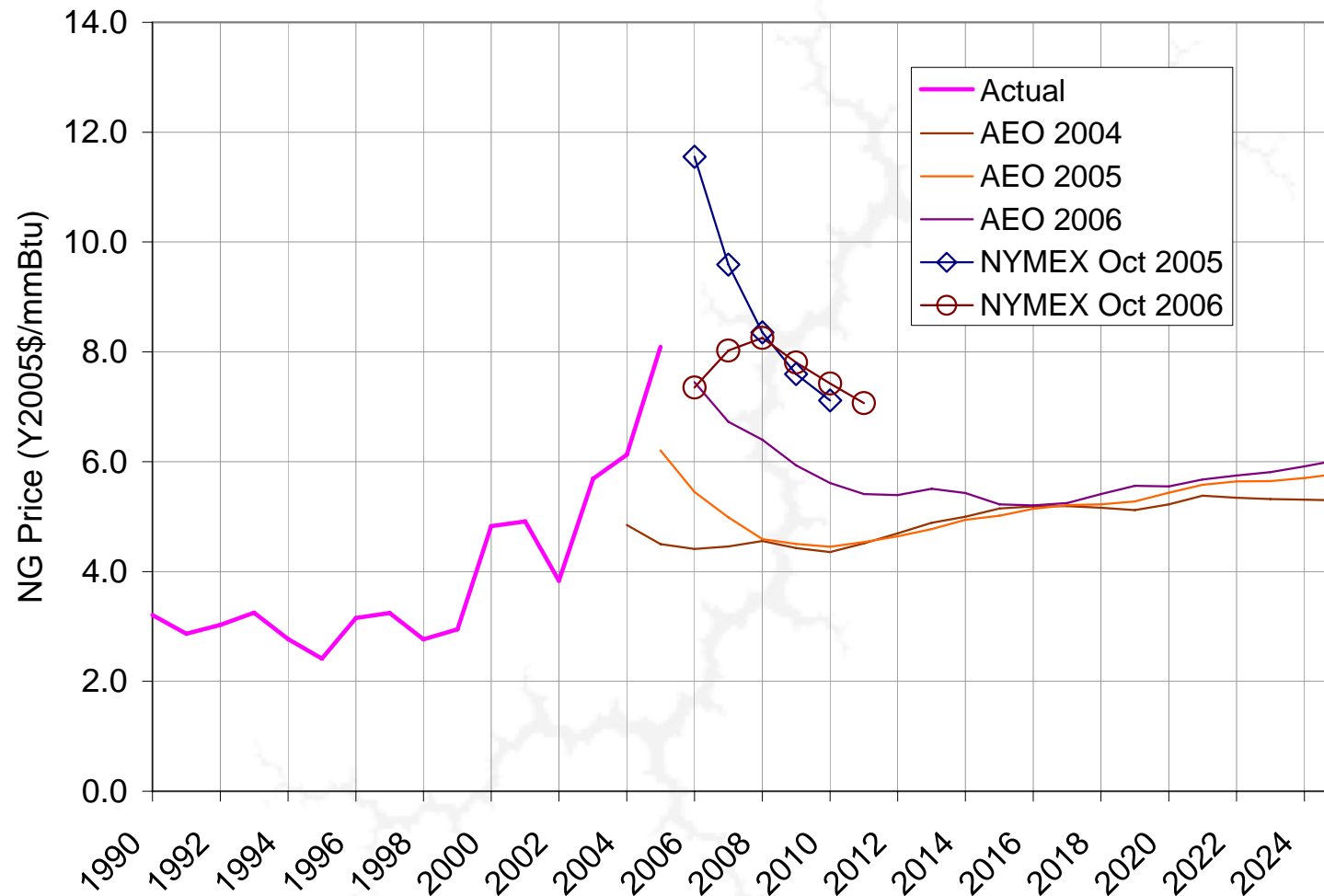


Source: AEO 2006

# Change in 2020 Outlook?

	2003	2006	2020 (AEO 2004)	2020 (AEO 2006)
<i>Domestic Dry Gas Production</i>	19.04	18.16	23.79	21.44
<i>Supplemental gas</i>	0.07	0.07	0.1	0.07
<i>Net Pipeline Imports</i>	2.85	2.63	2.33	1.32
<i>Net LNG Imports</i>	0.44	1.02	4.01	3.70
<b><i>Total Supply</i></b>	<b>22.40</b>	<b>21.88</b>	<b>30.36</b>	<b>26.54</b>

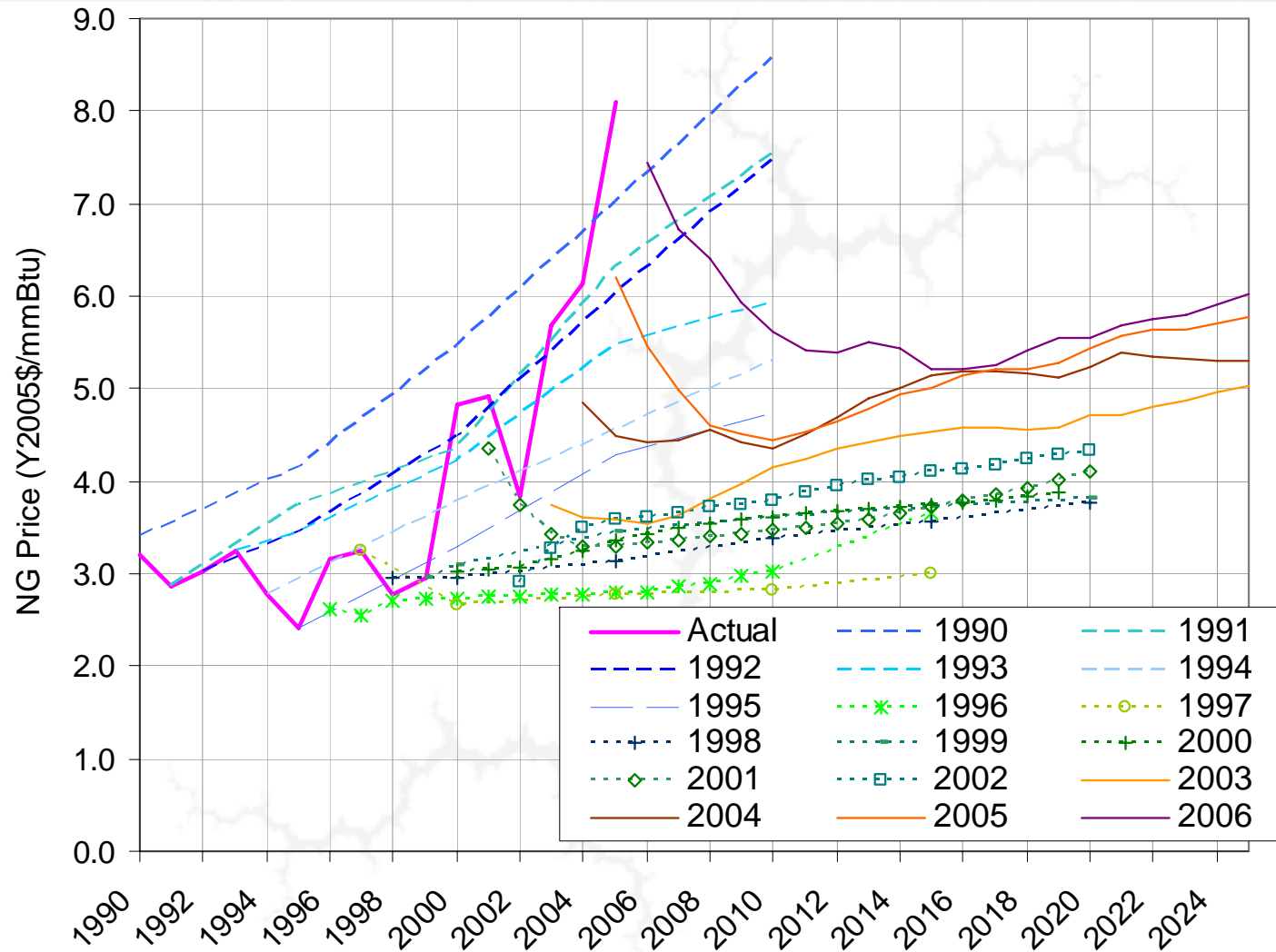
# AEO Natural Gas Prices and Price Forecasts



Source: Compiled by Synapse from EIA's AEO reports and NYMEX website.

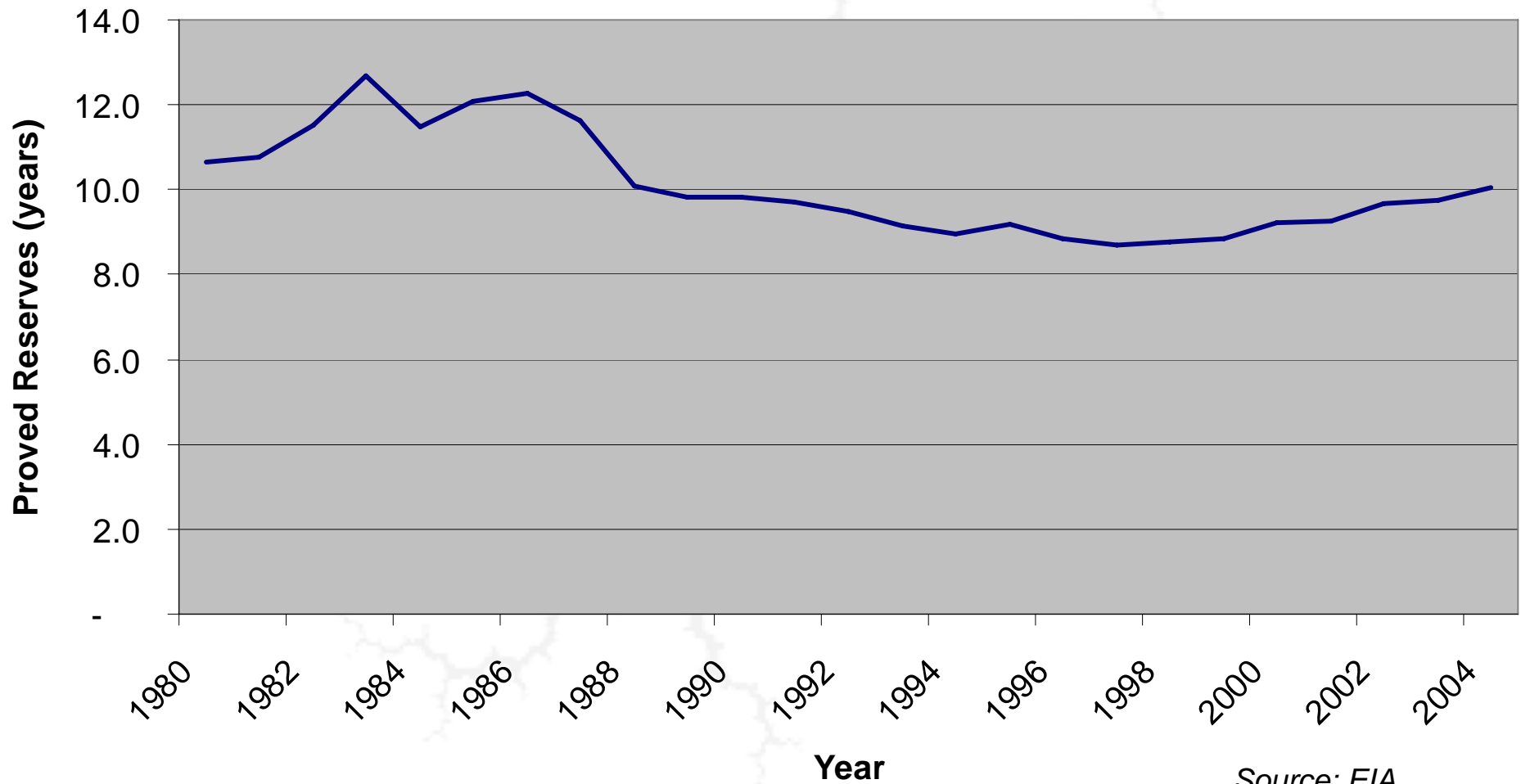


# Some Uncertainty in Gas Price Forecasts



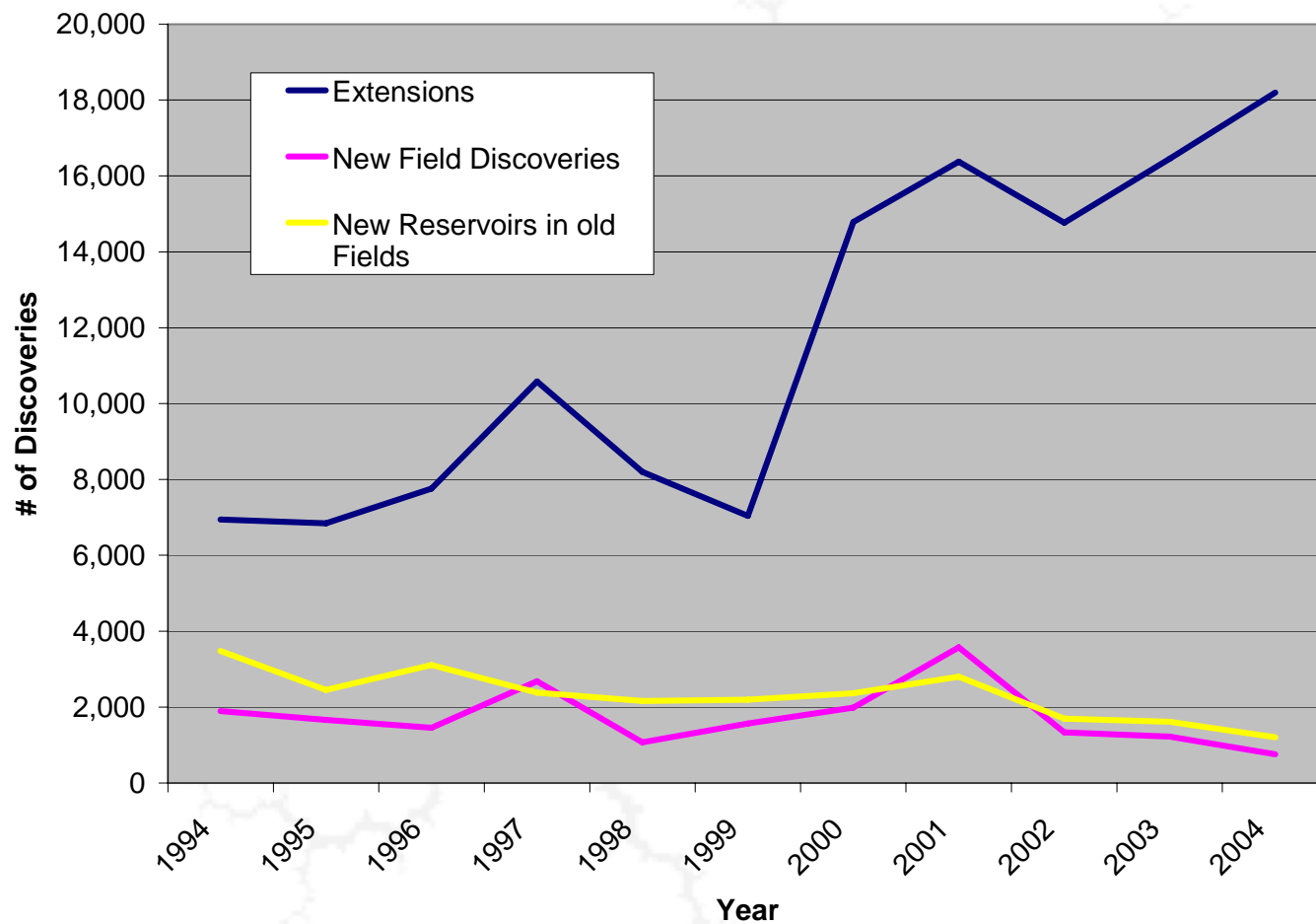
Source: Compiled by Synapse from EIA's Annual Energy Outlook reports.

# Domestic Gas Reserves



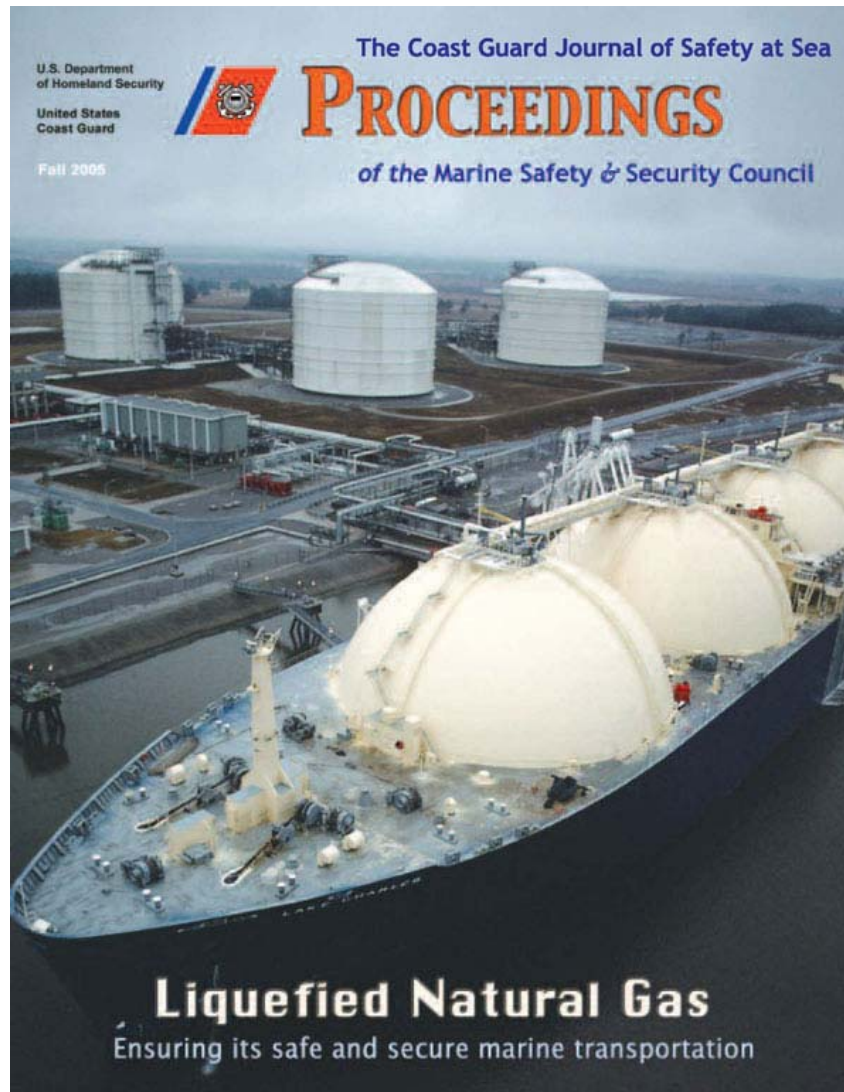
Source: EIA

# Sources of US Discoveries



Source: EIA

# Safety Concerns



## *Reasons for optimism...*

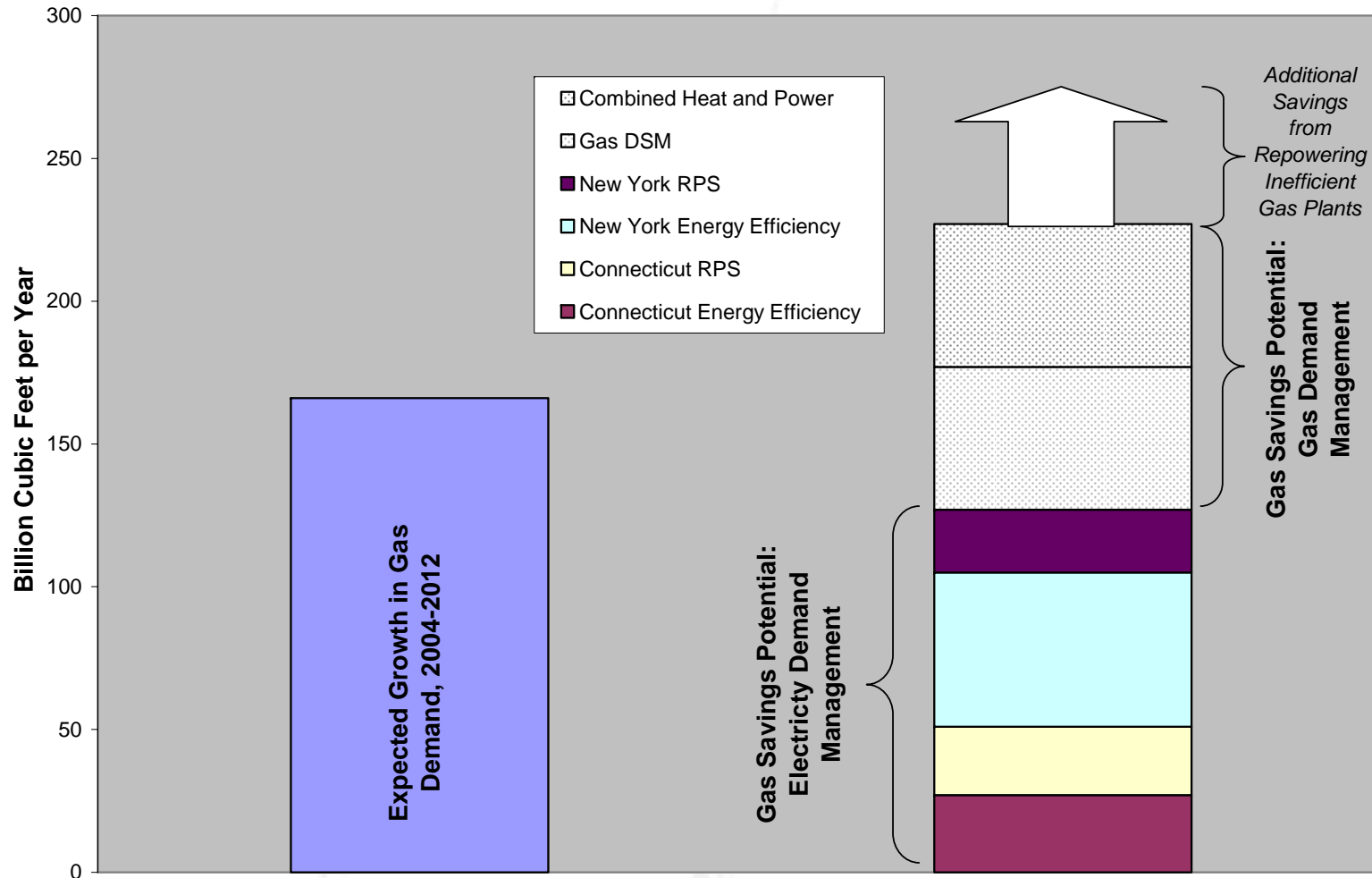
- Industry has superb safety record
- Gas in liquid form is *NOT* flammable
- Leaks will disperse as gas

## *Reasons for concern...*

- Industry structure changing rapidly, disaggregating
- Gas in vapor form *IS* flammable
- Leaks will disperse as gas

- Worldwide, Regassification capacity is growing faster than liquefaction capacity
- Competition for supplies and short-term contracting means *no good deals* on LNG
- New capacity in the US extends the high end of the supply curve
- Is there a cheaper, more reliable way to meet our natural gas needs?

# What About Proven Reserves of “Negatherms”



Source: 2006 Synapse Energy analysis of need for proposed Broadwater LNG terminal