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Bureau of Economic Geology, The University of Texas at Austin

# LNG Update

## *Texas CPAs, May 2006*

*Dr. Michelle Michot Foss, CEE, BEG-UT Austin*

## Balancing Our Energy Future

| *What do we want?* | *How do we get there?* |
|---|---|
| "Safe, clean, affordable, (abundant) energy" | Natural gas is a desirable alternative, but resource and infrastructure must be developed |
| "Reduced risk of disruptions, price volatility" | Portfolio including both supply diversity, demand-side response; can imported LNG help? |
| "Secure, commercially successful operations" | LNG import facility design is subject to market and commercial constraints |

**Best practice design at a price the market will bear.**

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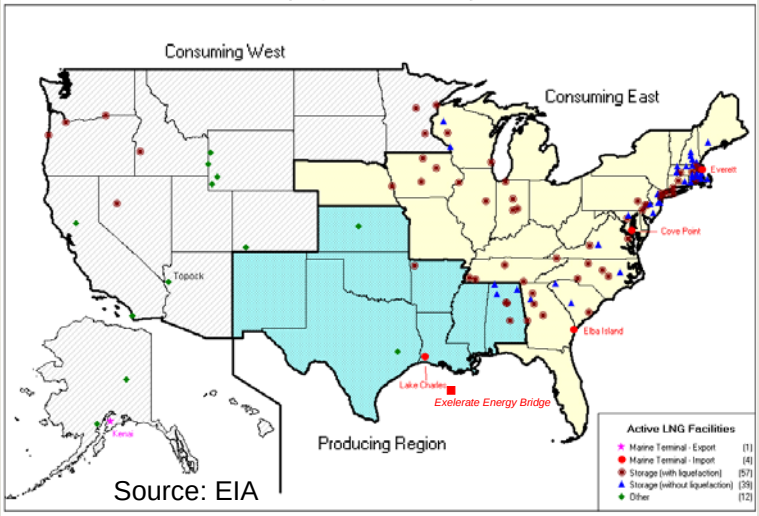
# Key Points

- LNG is already an important part of the U.S. energy mix, both imported and domestic storage/peak management



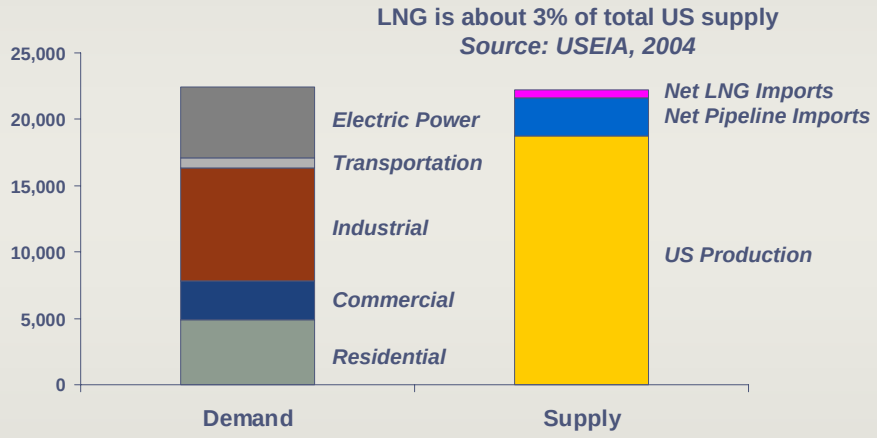


# We Have 114 Active LNG Facilities




Source: EIA

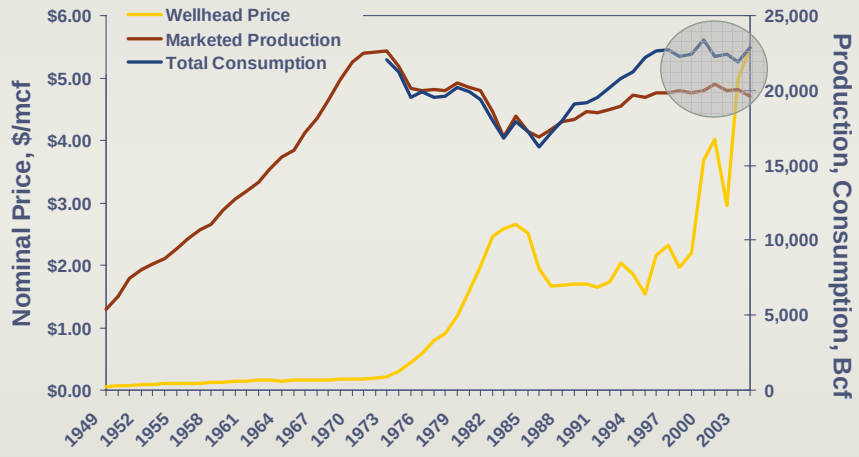
# How Do We Use Natural Gas?








# We Have Long Relied on Imports



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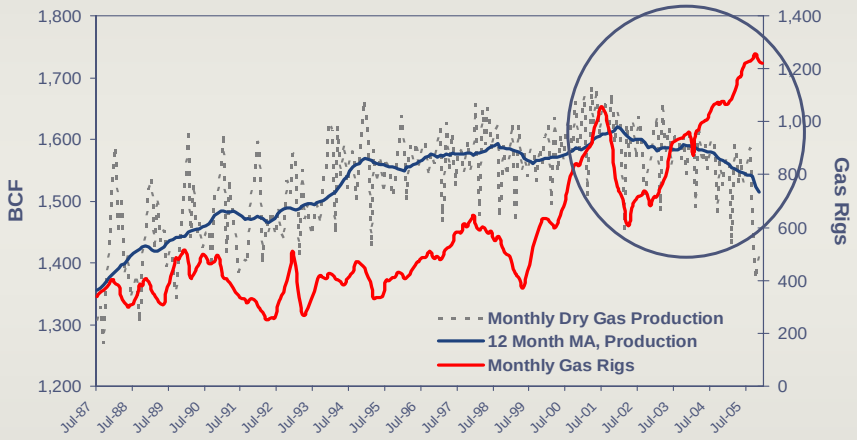
# U.S. Gas Resource "Just in Time" Development: Reality is Perception

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*Source: U.S. EIA, Baker Hughes*



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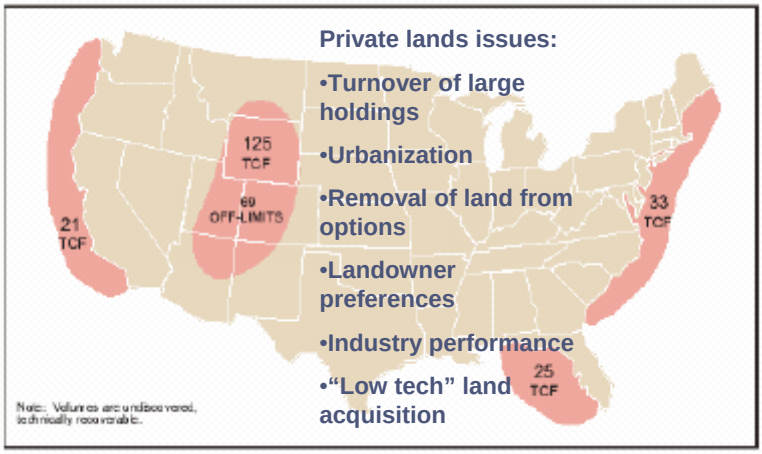
# Access for Resources and Infrastructure is a **Real** Issue




**Private lands issues:**

- **Turnover of large holdings**
- **Urbanization**
- **Removal of land from options**
- **Landowner preferences**
- **Industry performance**
- **"Low tech" land acquisition**

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*Source: NPC, IPAA*

# Key Points

- LNG is already an important part of the U.S. energy mix, for both imports and domestic storage/peak management
- The cost of the LNG value chain is such that economies of scale matter





# LNG Value Chain

| EXPLORATION & PRODUCTION | LIQUEFACTION | SHIPPING | REGASIFICATION & STORAGE |
|---|---|---|---|
| $0.5-$1.0/MMBtu | $0.8-$1.20/MMBtu | $0.4-$1.0/MMBtu | $0.3-$0.5/MMBtu |

**TOTAL = $2.00 - $3.70**

***Greatest variability is in upstream feedstock for liquefaction and shipping distance.***



*Sources: Industry (estimates exclude some O&M and tax costs)*

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- Safety and security are well-established across the value chain

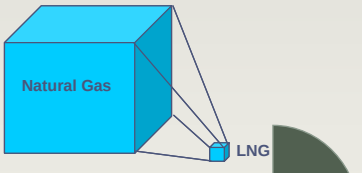




# What Is LNG?

**LNG is an extremely cold liquid formed through refrigeration of natural gas**

- Temperature about -256°F (-161°C)
- Atmospheric pressure
- Volume is reduced **600 times** making LNG economical to store and transport locally and between continents in specially designed ocean vessels
- LNG technology makes natural gas available throughout the world

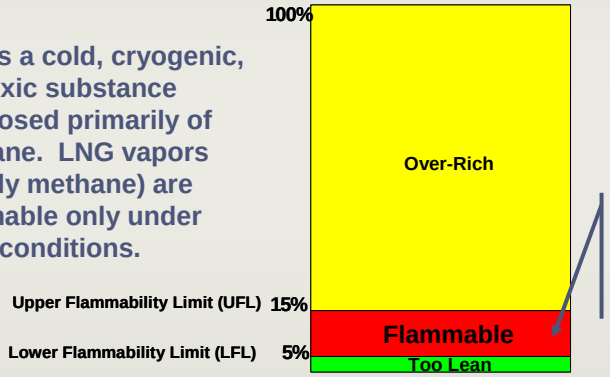




***Fernando Tapias***, 140,500 cbm, built 2002 by Daewoo, owned by Naviera F. Tapias

# LNG Properties

**Flammable Range for Methane (LNG)**




**LNG is a cold, cryogenic, nontoxic substance composed primarily of methane. LNG vapors (mainly methane) are flammable only under strict conditions.**

***Density*** *– 3.9ppg (vs. water, 8.3ppg); LNG floats on water*

Auto-ignition only at 1,004°F or higher

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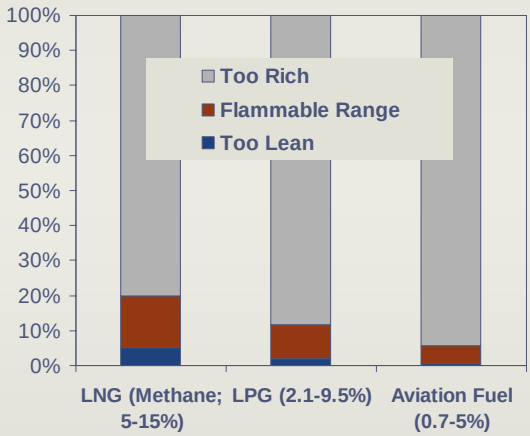
# Comparative Fuel Properties

**Flammability (fuel to air mixture, percent)**




**Auto-ignition:**
**LNG (methane) = 1,004°F**
**LPG = 850-950°F**
**Aviation Fuel = 480°F**

**In summary:**
***Fuel properties are different but all fuels can be managed safely***

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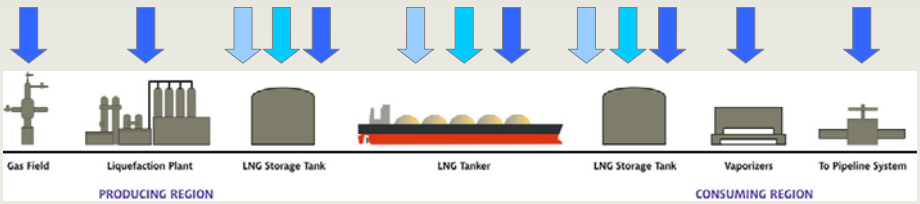
# Multiple Layers of Protection Along the LNG Value Chain




Primary Containment | Secondary Containment | Safeguard Systems

Separation Distance

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# Key Points

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- The cost of the LNG value chain is such that economies of scale matter
- Safety and security are well-established across the value chain
- North America provides a crucial link between Atlantic and Pacific Basin LNG trade

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## Global Gas Market Evolution and Arbitrage: Why North America Matters

Orange arrows are generally LNG cargo flows to U.S. Green arrows are generally price information flows with other markets.

**Key considerations:**

- Economic regulation of terminals
- Pipeline takeaway capacity
- LNG cargo interchangeability vs. terminal design and pipeline standards
- Evolution of short term LNG contracting mechanisms
- Oil vs. gas Btu pricing






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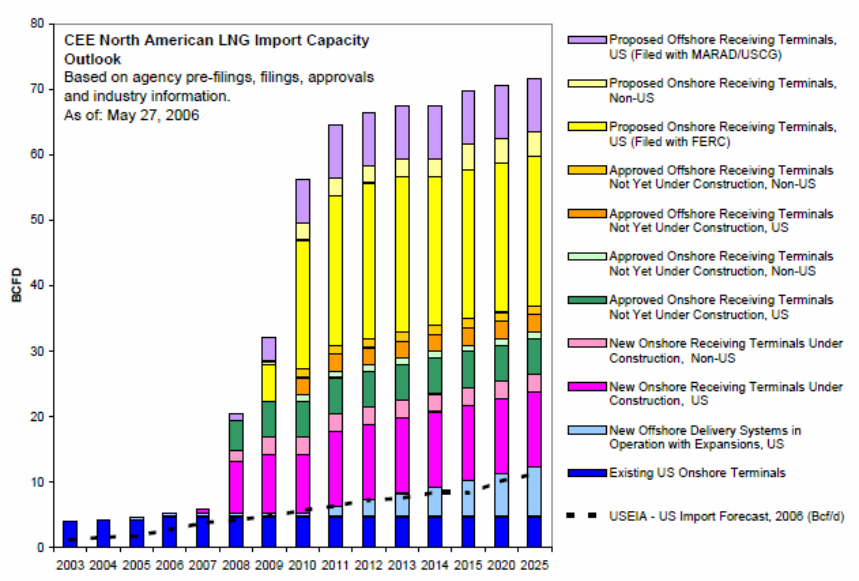
- Even conservative natural gas demand outlooks are difficult to supply without LNG

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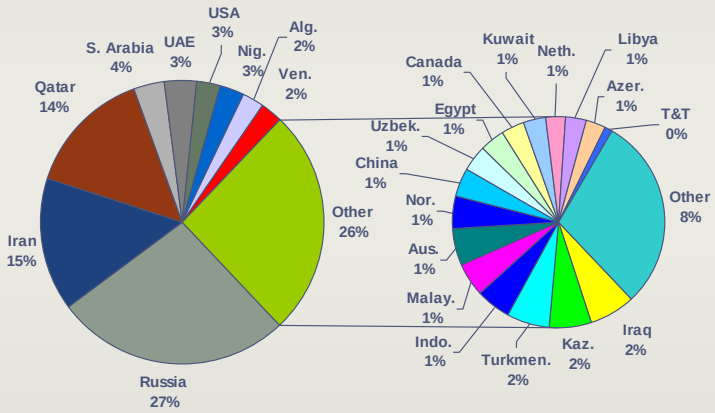
# World Natural Gas Reserves Proved, Year End 2004, 6,337 Tcf

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- We can learn a great deal from international experience

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# Case Study: Japan

| | U.S. | Japan |
|---|---|---|
| Liquefaction/export terminal | 1 | |
| Import terminals | 5 | 23 |
| Peakshaving facilities | 57 | |
| Satellite storage facilities (w/ and w/o liquefaction) and other | 51 | 26 |

- Historically strong collaboration between industry and government given lack of land area for large setbacks
- 10-year planning cycle with METI
- Binding agreements with prefecture/local governments
- Going forward – public concerns toward industrial development; lack of developable sites means more creative use of existing infrastructure and new commercial arrangements

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Source: CEE

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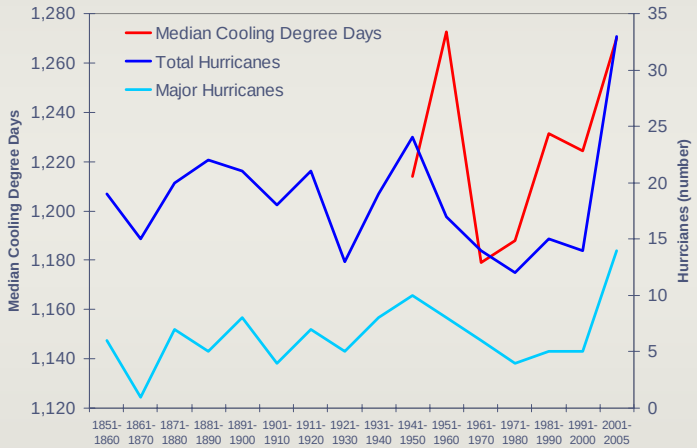
- Even conservative natural gas demand outlooks are difficult to supply without LNG
- We can learn a great deal from international experience
- **America enjoys privileged status with respect to private sector investment for energy infrastructure**





# Post-KatRita: The Great Hurricane Activity Debate



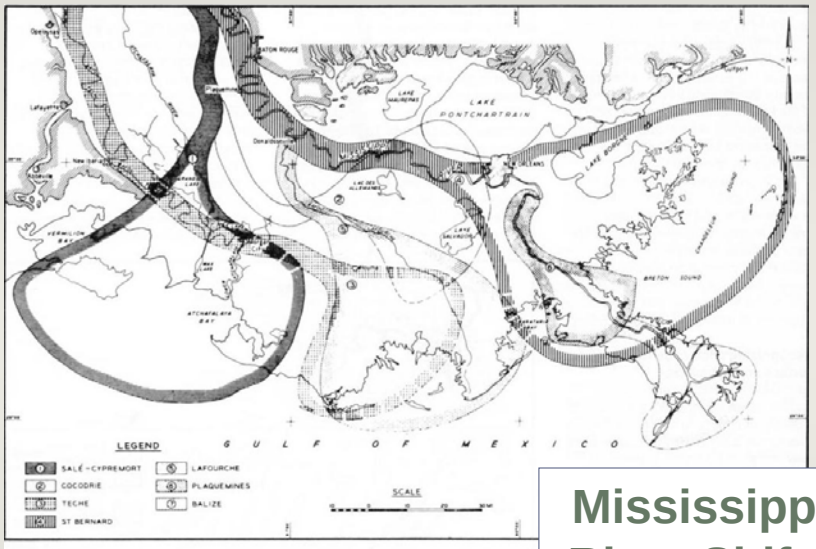



Figure 8
The seven partially overlapping lobes of the Mississippi delta which have developed during the last 5000 years (from Kolb and Van Lopik, Fig. 2, in Shirley, 1966).

## Mississippi River Shifts

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# U.S. LNG Regulations

Regulations are designed to prevent incidents from occurring and, if incidents do occur, to protect the public from any impact.

- **49CFR Part 193** *Liquefied Natural Gas Facilities: Federal Safety Standards*
- **33CFR Part 127** *Waterfront Facilities Handling Liquefied Natural Gas and Liquefied Hazardous Gas*
- **NFPA 59A** *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*
- **NFPA57** *Standard for Liquefied Natural Gas (LNG) Vehicular Fuel Systems*
- **International Regulations BS7777 and EN1473 (risk based)**

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# US LNG Regulators

**DOE** regulates natural gas imports/exports and helps to coordinate across federal agencies that have regulatory and policy authority for LNG

**FERC** is responsible for permitting new onshore LNG regasification terminals and ensuring safety at these facilities

**MARAD/USCG** are responsible for permitting new offshore LNG terminals

**DOT** regulates offshore terminals and LNG tanker operations

**Coast Guard** is responsible for assuring the safety of all marine operations at all LNG terminals and on tankers in U.S. coastal waters

**EPA** and state environmental agencies establish air and water standards with which the LNG industry must comply

**Others** include:

**Fish and Wildlife Service**

**Army Corps of Engineers** for coastal facilities and wetlands

**MMS** for offshore activities

**National Oceanic and Atmospheric Administration** for offshore environmental impacts and other considerations

**State, county and local (municipal)** agencies help ensure safe and environmentally sound construction and operation of LNG industry facilities and provide emergency response





# LNG Involvement

- The industry must continue building public confidence in its ability to construct and maintain safe and secure LNG facilities.
- Proponents and regulators need to do a better job addressing public concerns and establishing credibility and trust.
- Comprehensive stakeholder involvement in the development of LNG facilities could be essential to developing some degree of this credibility and trust.
- More coordinated effort between government agencies and industry to share information with host communities could resolve some of the concerns.

# For More Information

- Public education initiatives - examples
  - CEE-UT
    http://www.beg.utexas.edu/energyecon/lng
  - Center for LNG
    http://www.lngfacts.org/
  - The DOE/NARUC LNG partnership
    http://www.naruc.org/programs/lng/
  - Gas Processors Association (GPA) LNG committee
    http://www.gasprocessors.com/lng.html
  - Society of International Gas Tanker & Terminal Operators
    http://www.sigtto.org/