Balancing Our Energy Future

**What do we want?**
- "Safe, clean, affordable, (abundant) energy"
- "Reduced risk of disruptions, price volatility"
- "Secure, commercially successful operations"

**How do we get there?**
- Natural gas is a desirable alternative, but resource and infrastructure must be developed
- Portfolio including both supply diversity, demand-side response; can imported LNG help?
- LNG import facility design is subject to market and commercial constraints

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

LNG is about 3% of total US supply
Source: USEIA, 2004

We Have Long Relied on Imports

Source: U.S. EIA
**U.S. Gas Resource “Just in Time” Development: Reality is Perception**

- Monthly Dry Gas Production
- 12 Month MA, Production
- Monthly Gas Rigs

**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

Source: U.S. EIA, Baker Hughes

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

<table>
<thead>
<tr>
<th>Exploration &amp; Production</th>
<th>Liquefaction</th>
<th>Shipping</th>
<th>Regasification &amp; Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.5-$1.0/MMBtu</td>
<td>$0.8-$1.2/MMBtu</td>
<td>$0.4-$1.0/MMBtu</td>
<td>$0.3-$0.5/MMBtu</td>
</tr>
</tbody>
</table>

**TOTAL = $2.00 - $3.70**

Greatest variability is in upstream feedstock for liquefaction and shipping distance.
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
• 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
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**
  - 3.9 ppg (vs. water, 8.3 ppg);
  - LNG floats on water

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

**Density**

Lower Flammability Limit (LFL) 5%

Over-Rich

Flammable

Too Lean

Upper Flammability Limit (UFL) 15%

Comparative Fuel Properties

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

Multiple Layers of Protection Along the LNG Value Chain

- Primary Containment
- Secondary Containment
- Safeguard Systems
- Separation Distance

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
- Safety and security are well-established across the value chain
- North America provides a crucial link between Atlantic and Pacific Basin LNG trade
Global Gas Market Evolution and Arbitrage: Why North America Matters

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

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

Key Points
- LNG already is an important part of the U.S. energy mix
- 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
- Even conservative natural gas demand outlooks are difficult to supply without LNG
World Natural Gas Reserves
Proved, Year End 2004, 6,337 Tcf

Source: Industry and government data
Key Points

- LNG already is an important part of the U.S. energy mix
- 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
- Even conservative natural gas demand outlooks are difficult to supply without LNG
- We can learn a great deal from international experience

Case Study: Japan

<table>
<thead>
<tr>
<th></th>
<th>U.S.</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquefaction/export terminal</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>Import terminals</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td>Peakshaving facilities</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Satellite storage facilities (w/ and w/o liquefaction) and other</td>
<td>51</td>
<td>26</td>
</tr>
</tbody>
</table>

- 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
Key Points

- LNG already is an important part of the U.S. energy mix
- 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
- 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

Source: NOAA
U.S. LNG Regulations

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

- **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)
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/