Transport of Light Gases Blended with LNG
LNG Transport Industry Summary
LNG Production Worldwide

Country Share of World LNG Production 2008

- Qatar 17.5%
- Algeria 9.7%
- UAE 3.3%
- Egypt 6.2%
- Libya 0.2%
- Equatorial Guinea 2.3%
- Nigeria 9.1%
- Australia 8.9%
- Indonesia 11.9%
- Brunei 4.1%
- US 0.4%
- Belgium 0.0%
- Norway 1.0%
- Oman 4.8%
- Trinidad & Tobago 7.7%
Large, Global Market

- LNG shipping capacity
  - 48 Million cubic meters (20.3 Million Tonnes)
  - 800 Million cubic meters annual transport capacity

LNG annual transport
- 390 Million cubic meters (165 Million Tonnes) in 2008
- 520 Million cubic meters (220 Million Tonnes) in 2010
300 LNG Tankers
Shipping LNG: Supply & Demand

- LNG Tankers – Plentiful, Many Sizes
- LNG Sources – Growing Number
- LNG Receiving – Slowly Growing Number
- Excess Capacity
  - Construction Contracts Awarded when Gas selling at $13/MSCF
  - Poorer Countries Need to Monetize Gas
  - US Gas Supply *Surprisingly* Increasing
Growing Industry & Transport Capacity

Number of LNG ships built 1965-2006

Source: Maritime Business Strategies, LLC
Figure 1: The LNG Value Chain

Upstream
- Exploration & Production
- Wellhead Gas Price

Midstream
- Pipeline
- Gas Merchant
- Pipeline Tariff
- Merchant Margin

Downstream
- LNG Market Price (Henry Hub + Location Margin)
- NG Marketing Margin
- Regas Margin
- Regas Terminal
- LNG Ship
- Shipping Margin
- LNG Marketer
- Gas Consumer
- LNG Plant
- Processing Fee
High Cost of Transporting LNG

- If Natural Gas sells for about $5/MSCF
- If Natural Gas costs $1/MSCF
- Manufacturing and Transport and of LNG costs about $3.50/MSCF ($170/tonne) for 5000 km

Profit is only about $0.50/MSCF
Established LNG Sea Links

**Atlantic Basin**
- US = deep, liquid market
- Market sets price
- Spot cargo sink / source

**Pacific Basin**
- Spot at premium prices
- Strong seasonal pull
- Long-term at discount to HH
Qatar Gas
– Major LNG Source
A Cross-Section of the LNG Ship’s Hull and Containment System – In Total More Than Six Feet in Width.
LNG Storage

A Cross-Section of the Storage Tank Walls – In Total About Five and One-Half Feet Thick.

- Reinforced Concrete
- Perlite (Balls) Insulation
- Inner Tank (Walls and Base) 9% Nickel Steel Alloy
- Stainless Steel
- Secondary Base
- Base Insulation foam Glass
- Heating Ducts to Prevent Ground Freezing

Typical Liquefied Natural Gas Storage Tank with Double Walls
The LNG Transport Cycle
Blended LNG Transport of Valuable Gases:

Ethylene, Propylene, Acetylene
Ethylene: Prime Raw Material for Chemicals

- Traditionally made from Ethane and Naphtha Cracking
  - Ethane reserves are falling
  - Ethane Uneconomical for Shipping as Gas
- Naphtha (liquid) easily shipped to Manufacturers (has destination value)
- Future Ethylene Production Growth in Africa, USA, Middle East and Far East
Ethylene Production
Chemical Production needs Raw Materials
New Ethylene Technology

- Synfuels GTE makes Ethylene from Low Cost Natural Gas Economically

- GTE Ethylene market needs:
  - Local Chemical Industry
  - Mode of Transport to Traditional Market
Ethylene Transported with LNG

Very Few Changes to Existing LNG Facilities are Needed

Cryogenic Separation of Ethylene from LNG
• LNG Gasification Facilities Gasify LNG and Deliver Natural gas to Pipelines

• Ethylene/LNG Gasification Facility will Separate Ethylene from Methane
  – Deliver Natural Gas to Natural Gas Pipeline
  – Deliver Ethylene to Ethylene Pipeline
Liquifaction Equipment
Additions are Minimal

- Pipeline from Ethylene source to LNG Liquifaction Plant
- Cross exchanger for Ethylene/LNG
- Pumps to Move Blend to Storage Tank
- Optional Separate Storage Tank for Cryogenic Blend
Gasification Equipment
Additions are Minimal

• Cryogenic Tower to Separate Ethylene from Natural Gas
• Cold Box Condenser
• Fin-Fan Air-heated Reboiler
• Ethylene Pipeline Extension at Destination
Destination Value of Gases
(for following example)

• Methane - $262/tonne
• Propylene – $1084/tonne
• Ethylene - $1184/tonne
Example Case
– Load Value

• **Ship Size** – 138,000 cu meters
  • 58320 tonnes displacement*

• **100% Methane** - $15.3 Million
• **75% Propylene** - $54.3 Million
• **75% Ethylene** - $58.4 Million

*All examples above for equal weight displacement
Example Case
– Shipment Size

• Ship Size – 138,000 cu meters
  • 58320 tonnes displacement*

• 75% Propylene  -  105 Million lb.
• 75% Ethylene   -  103 Million lb.

*All examples above for equal displacement
Market Opportunity is Enormous

- LNG annual transport – 520 Million cubic meters (220 Million Tonnes) in 2011
- Worldwide Ethylene Production – 130 million tonnes per year in 2011
- Projected ethylene production growth in Asia and Middle East – 20 MTY for 2011 - 2013
Opportunity A  
(add greater value to existing LNG)

1. Build GTE plant at site of existing LNG Liquification Plant
2. Convert some low value methane to ethylene instead of LNG
3. Cool and liquify the ethylene with existing LNG refrigeration
4. Blend the ethylene with LNG and ship in existing LNG tanker
Opportunity B
(add value to existing steam cracker sites)

• Locate Excess Ethylene Capacity in Remote Manufacturing Locations Near Existing LNG Liquification Plants

• Cool and liquify the ethylene with existing LNG refrigeration

• Blend the ethylene with LNG and ship in existing LNG tanker
Potential GTE/LNG Sites

Co-Locations of Ethylene production and LNG Loading (Blue) and Receiving (Green)