Floating Regasification
Progressing the LNG Value Chain

Governor's Energy Conference, Richmond, VA

October 14, 2010
• LNG; Globally - Why & How Quickly?
  ➢ But what about the US?

• Virginia
  ➢ Infrastructure
  ➢ Demand Potential

• Excelerate
  ➢ Who we are & What we do
  ➢ “Expanding Natural Gas (LNG) – Supplies & Opportunities?”
Section 1

LNG GLOBALLY
“Why should we import LNG?”

• Insufficient resources to fuel economies will hinder growth and wealth of various nations
  ➢ Indigenous natural gas supply gap
    ○ Available gas infrastructure; domestic production in decline
  ➢ Fuels replacement
    ○ Predominantly diesel oil for power generation
  ➢ Supply security
    ○ Political/economic conditions potentially creating traditional supply disruption
Indigenous Natural Gas Supply Gap (e.g. Alaska & Bangladesh)

• Alaska (USA)
  - Expected supply gap in 2013 due to limited incremental exploration in the Kenai region
  - Kenai export facility export license for two more years helps balance system
  - North slope pipeline expensive and still at early development stage – 2017 in-service at earliest

• Bangladesh
  - Sangu field the only source of offshore indigenous natural gas
  - Field declined from 250 Mmcf/day down to 30 Mmcf/day
  - Shortage of gas supply causing country wide brownouts, fast-track need for new supply sources
- Power system effective capacity is 1500 MW+, against a need of 2000 – 2100 MW
  - Brown-outs and interruptions are countrywide and vary from 3 hours to 12 hours daily depending on region

- Two newer plants are CCGT’s (435 MW’s each), installed in 1990’s but poorly maintained and in need of upgrades

- The two CCGT plants were designed for gas use, however no gas supply to either plant has been available until 2009
  - Limited supply of Egyptian gas to northern plant via “swap” with Syria began late summer 2009
  - Access to supply through Arab Gas Pipeline

- CCGT plants currently run mostly on Distillate (Diesel) Oil, which is more expensive than Crude or Heavy Fuel Oil
  - Tariff to end-users assumes crude oil pricing of $25 – $35/Bbl
  - Fuel supply costs tied to oil are single biggest burden on system
• Limay Power Generation facility
  - The Limay plant is currently fueled using Diesel (#2) Oil, and is operated as a baseload facility (Designated as a “Must Run Unit”)
  - The expected requirements are 100,000 Mcf/day for natural gas
    - 30 days FSRU storage similar to current diesel storage
  - LNG facilities on the Bataan Peninsula to support diesel fuel replacement at generation facilities
  - Platform to support Batcave and Batman 2 pipeline expansions
    - Challenge is for smaller initial volumes hard to justify land based facility and slow gas demand ramp up
- **Wilhelmshaven, Germany**

  - Russian gas a major component of western Europe (Germany) gas supply portfolio
  - Russian economic policies and gas supply to Ukraine, Georgia, and Poland have Germany considering LNG as a 3rd option to north sea & Russian gas

<table>
<thead>
<tr>
<th>Country</th>
<th>Gas Consumption (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>100</td>
</tr>
<tr>
<td>Latvia</td>
<td>100</td>
</tr>
<tr>
<td>Lithuania</td>
<td>100</td>
</tr>
<tr>
<td>Slovakia</td>
<td>100</td>
</tr>
<tr>
<td>Greece</td>
<td>87</td>
</tr>
<tr>
<td>Austria</td>
<td>81</td>
</tr>
<tr>
<td>Turkey</td>
<td>73</td>
</tr>
<tr>
<td>Hungary</td>
<td>66</td>
</tr>
<tr>
<td>Slovakia</td>
<td>63</td>
</tr>
<tr>
<td>Poland</td>
<td>61</td>
</tr>
<tr>
<td>Germany</td>
<td>50</td>
</tr>
<tr>
<td>Estonia</td>
<td>45</td>
</tr>
<tr>
<td>France</td>
<td>28</td>
</tr>
<tr>
<td>Italy</td>
<td>27</td>
</tr>
<tr>
<td>Switzerland</td>
<td>26</td>
</tr>
<tr>
<td>Netherlands</td>
<td>11</td>
</tr>
<tr>
<td>Belgium</td>
<td>10</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
</tr>
</tbody>
</table>

*GazProm’s percent share of total gas consumption in Europe*
• FSRU operations have been accepted as industry norm at fraction of cost and construction time compared to traditional LNG import terminals

➤ Existing “non-traditional” LNG import facilities
   ○ Excelerate solutions: Northeast Gateway®, Gulf Gateway®, Teesside GasPort®, Bahia Blanca GasPort®, Mina Al Ahmadi GasPort®
   ○ Others: Pecem and Guanabara Bay (Brazil), Neptune (US northeast), Mejilones (northern Chile), Dubai

➤ Total FSRU/ LNGRV fleet in the industry to date
   ○ Excelerate: 8 vessels
   ○ Others: 5 vessels
What We Are Doing
Long Term 3rd Party Terminals

- Operational
- Under Development Or Initial Project Discussion

- Alaska GasPort
- Gulf Gateway
- Caribbean Gateway
- Pacific Mexico GasPort
- Central America GasPort
- Northeast Gateway
-Teesside GasPort
- Mediterranean & Eastern Euro. GasPorts (5)
- Bangladesh GasPort
- Pakistan GasPort
- Mid-East GasPort
- Bataan GasPort
- Indian GasPorts (3+)
- Australian GasPort
- Mina Al Ahmadi GasPort
- Bahia Blanca GasPort
- Buenos Aires GasPort
- Indonesian Gateway (2)
LNG is still not a totally globally traded commodity, so prices can vary substantially from region to region.

- **US**: Competitive gas market prices linked to Henry Hub, LNG is competing with pipeline gas.
- **Europe**: Northwest Europe evolving, spot market in UK, Belgium & Netherlands. Continental Europe, in the absence of a reliable & liquid enough spot market, gas prices are set to compete with oil products i.e. gasoil and fuel oil.
- **Asia**: Generally linked to crude oil prices, specifically the Japan Crude Cocktail (JCC) price. The extent to which the LNG & JCC are linked has changed in recent contracts.
Section 2

VIRGINIA
Most long distance natural gas interstate pipelines telescope downward in diameter, reducing capacity as they reach local markets.

- Pipeline transport charges accumulate or “pancake” over distance, increasing delivered cost to end-users.
  - LNG terminals creating value need to be located at the small end of the pipe, squarely within these PREMIUM market areas………..
  - However traditional “mega” terminal volumes CANNOT be accommodated by current market area pipeline infrastructure
Northeast LNG Terminals

- **Cove Point LNG, MD**
  - Shell, BP, Statoil/Sonatrach
  - In-Service 2007/08
- **Distrigas, MA**
  - In-Service 2009/10
- **Yankee Gas, CT**
  - In-Service 2007/08
- **UGI Utilities, PA**
  - In-Service 2009/10
- **Sparrows Point, MD (AES)**
- **Crown Landing, NJ (BP)**
- **Safe Harbor LNG**
- **Blue Ocean LNG (Exxon)**
- **Broadwater LNG (Shell)**
- **Excelerate**
- **GDF/Suez**
- **Weavers Cove (Hess)**
- **KeySpan LNG (BP)**

New Peak-shaving facilities with no opposition
Existing LNG Import terminals
Proposed LNG Import Terminals
Despite adding “supply” through a doubling of Cove Point, the incremental volumes do not get to the markets in SE VA & NJ.

2009:
- 25 Cargoes
- 72.3 Bcf (0.198 Bcf/day)

2010:
- 15 Cargoes
- 37.7 Bcf (0.143 Bcf/day)
Market Analysis: John Kibler, Virginia Natural Gas/AGL Resources; constraints on delivery in the eastern portion of the state. There were 22 days of natural gas shut-offs to Hampton Roads interruptible customers post Katrina

Market Coverage
TCO Mkt. Area 34
Columbia, TCOVA, VNG

Too small for the traditional “mega” terminal (not enough demand, access to north east limited).

Traditional “Mid Size” - 400 - 500 MMcf/day (3.0 – 3.5 Mtpa) base load too expensive.

Can Floating Storage and Regasification Units (FSRU’s) be the answer?

A Virginia LNG Hub?
Virginia Demand (Power Market)?

**PJM January 2007 Load Forecast:**
PJM expected to grow by 16.7% over the next 10 years.

That translates into needing 22,861 MW. Dominion Virginia Power forecasts for their service territory are ~4,000 MW.

**ODEC Cyprus Creek Power Plant:**
750 MW – 1,500 MW coal & biomass facility in Surry, VA. Two phased construction base load facility for required new demand growth with both units being fully operational by 2016.

**Gas Volumes:**
- Dominion 2000 MW: 340 Mmcf/d
- ODEC 1500 MW: 250 Mmcf/d
- Total Potential: +500 Mmcf/d
Section 3
OPPORTUNITIES & IDEAS
Floating LNG
Excelerate’s Toolbox

- **8 Vessel fleet**
  - 3 x 138,000 m³
  - 5 x 151,000 m³

- **Energy Bridge®**
  - Regasification Vessel (EBRV®)

- **84 Ship-to-Ship Transfers**
  - 10 offshore
  - 32 double-banked
  - 42 across-the-dock

- **Ship-to-Ship LNG Transfer**

- **2 operating Gateways**
  - Northeast Gateway®
  - Gulf Gateway®

- **Gateway Offshore Regasification**

- **2 operating GasPorts®**
  - Teesside
  - Bahia Blanca
  - Mina Al-Ahmadi

- **GasPort® Dockside Regasification**

- **3 operating GasPorts®**

- **Global Trading Activities**

- **LNG Trading**

- **2 projects under development**
  - 3 MTPA with 250,000 m³ storage
  - ETA 2013

- **Energy Bridge Liquefaction Vessel (EBLV™)**
• **Gateways** - Ideal for sensitive/constrained areas
  - Quick to market at low cost
  - Shuttle service or Ship-to-Ship (StS) transfer on buoy
• **Gulf Gateway** was placed in service in 2005, followed by **Northeast Gateway** in 2007
• Interesting history of usage
  - Busy through the first half of 2007
  - But through 2008, bringing LNG cargoes to the US was challenging
• **Winter 2009/2010** has been busy at **Northeast Gateway**
  - Steady volumes from Dec-Feb
  - 7 cargoes in 2.5 months
GasPorts – flexible and adaptable
- Also quick to market, low cost
- Single vessel mooring, side-by-side LNG transfer, and tandem (across-the-dock) transfer possible
- Each project has unique attributes
  - Teesside is a flexible delivery point, providing exposure to NBP pricing
  - Bahia Blanca started as S.A. winter supply, but has operated year-round since May 2009
  - Mina Al-Ahmadi is a summer supply project, with high baseload flows
- All allow for highly variable sendout rates to meet customer needs
• Excelerate has pioneered StS transfer of LNG
  ➢ 84 StS transfers have been completed to date in various locations (inshore & offshore)
    ○ Open water - 10
    ○ Double banked - 32
    ○ Across-the-dock - 42
  ➢ Equivalent to over 10,500,000 m³ of cargo
  ➢ Continuous regasification possible throughout transfer
• StS makes Gateways and GasPorts accessible by the global LNG shipping fleet
Double-banked STS Transfer with continuous send out at the Bahia Blanca GasPort

8-Inch Flexible Cryogenic Hoses (6 Liquid, 2 Vapor)
Virginia LNG HUB?

- Dockside facility inside Port of Hampton Roads
  - Major access point for new gas supplies to support VA – 500 Mmcf/day to support incremental power and industrial demand
  - Provides the platform for incremental gas/LNG opportunities
    - LNG refueling station in Port (see Port of Long Beach, CA)
    - Trucking options to vehicle refueling stations in SE VA (fleet vehicles, school buses etc)
    - LNG as shipping fuel, including Navy (see Norwegian LNG fueled vessels)
    - As Nodal/Transshipping point for US east-coast LNG deliveries

Teesside GasPort, UK, situated inside existing Port Facilities
Peaking LNG Facilities Accessible By Water

- Transshipping LNG to optimize existing LNG peak shaving facilities
- Facilities generally well piped to maximize last day send-out
- Multiple turns lower costs of facilities & liquefying commodity
- LDC or Capacity Holder contracts for “small ATB” capacity, as a “pipeline” alternative (Not on EE’s account)
Hub & Spoke: Smaller Volumes into Multiple Markets

- Mid Atlantic “Hub & Spoke” project if NIMBY concerns VA Port
  - LNG StS in Chesapeake Bay at existing hydrocarbon lightering site
  - Smaller volumes into two (2) separate markets avoiding basis collapse
  - Facilitating easier “take-away” due to smaller volumes in each market
  - Storage component to look like traditional peak shaving facility
  - Preserves LNG import opportunity for VA

Columbia & AGL (VNG):
Both have LNG facility operating experience
Both have assets in VA & NJ

Small Scale Terminal, NJ
2.0 Bcf Tank, Gloucester
250 Mmcf/day

Small Scale Terminal, VA
2.0 Bcf Tank, Chesapeake
250 Mmcf/day

Excelerate Direct Deliveries
Northeast Gateway
800 Mmcf/day

Excelerate energy

Excelerate Direct Deliveries
Northeast Gateway
800 Mmcf/day
Transshipping or Nodal Small Scale Delivery: North American Market

- ATB much smaller than typical LNG ships (20,000 M3)
- ATB design to visually look like all other ATB units in hydrocarbon trades
  - Combined with size, minimizes security concerns
- Smaller tanks to minimize consequences of collision – Sandia Report consideration
  - Study with ABS, USCG & Sandia on consequences is completed
- U.S. built & U.S. crewed
  - Flag and tax base
  - Addresses security issues with personnel
- Reduced Environmental Impact
  - Shallowere draft allows for limited dredging
  - Limits need for incremental pipeline infrastructure
US Gulf Terminals – Gas/LNG Supply Opportunity?

Price Discount to Henry Hub

Henry Hub to Houston Ship Channel:
- 2006 ($0.36)
- 2007 ($0.30)
- 2008 ($0.35)
- 2009 ($0.17)

Gulf Coast – West: There are several terminals now proposing liquefaction development for the purpose of exporting LNG

Cheniere Energy leads the way, having currently filed at FERC for Liquefaction at their facility, Sabine Pass

Freeport LNG, to follow Cheniere with FERC filing
• Internationally, LNG is hot!

• Price, Price, Price (but BIMBY; bargains in my back yard?)

• Virginia Hub – Platform for in-State gas driven growth

• New/creative approaches to deliver to the end-user
Section 3

APPENDIX
Quite often, meaningful progress requires change
Energy Bridge Liquefaction Vessel
The Other End of the Value Chain

- LNG Transfer
- Liquefaction Modules
- Power and Utilities
- Gas Processing (As Required)
- Offshore Jetty
- Conventional LNG Carrier
- 3 MTPA Floating Liquefaction Vessel
Floating Liquefaction Vessel Characteristics

• **General Characteristics**
  - Production Capacity: 3 million tonnes per annum (MTPA)
  - Plant Design: 3 x 1.0 MTPA liquefaction modules
  - Production Process: Single Mixed Refrigerant (SMR)
  - LNG Storage: 250,000 m³
  - Inlet Gas Quality: Ability to handle varying levels of CO₂, N₂ and H₂S

• **LNG transfer process**
  - Side-by-side, tandem, and jetty-based LNG loading alternatives to be feasible
  - Exact design dependent on site physical characteristics
  - Offshore jetty design (across-the-dock transfer) is favored due to higher reliability and ability to accommodate global LNG fleet
Floating Liquefaction
The Challenges Ahead

• Prove up of a new concept, even if based on established technology, is a critical hurdle
  - Securing the first cargo for an EBRV was a challenge
  - Within a short time, ship-based regasification became an accepted tool
  - Floating liquefaction will also have to endure this trial, to some extent

• Lessons from experiences with floating regasification:
  - Continue to base new concepts on proven technology to minimize “novelty” risk
  - Build on a standardized, modular platform to minimize costs
  - Keep a view to the entire market, not just where conventional wisdom dictates
    - Dockside regasification – dockside liquefaction?
    - Why just offshore, stranded and not onshore? The cost savings are compelling…
• More than anything, floating liquefaction has a higher concentration of risk than regasification

  ➢ Higher vessel cost than regasification units

  ➢ Dependency on the functioning of the asset by both upstream producers and downstream customers

  ➢ No immediate alternatives if the liquefaction vessel fails to perform, so little mitigation possible

• Simply a matter of time to have the first unit operational by someone

  ➢ Technology challenges can be overcome, and have been historically

  ➢ We have yet to see or imagine the potential that this technology can unlock
Rockies Express (REX Pipeline)

Rates:
- Zone 1 to Zone 2: $0.7793/Mmbtu
- Zone 1 to Zone 3: $1.3663/Mmbtu

Total Transport Costs from Rockies Basin to Ohio: $2.1456/Mmbtu
Dominion Transmission (Largest owner & operator of underground natural gas storage in North America)

- Latest Storage Pool Development: USA Storage, In Service Nov 2009
  - 4.4 Bcf of working gas
  - 185,000 Mcf/day of deliverability
  - 25 day storage service
    - Base Demand GSS: $4.9599
    - Base Capacity GSS: $0.0827
    - Injection: $0.0154
    - Withdrawal: $0.0154

- Cost per Mcf: $3.404

- End-user must then pay for Transport to East coast City Gate
Recent price benchmarks in Asia

• Indonesia to the Japanese Western Buyers
  3mtpa from 2011-2015, 2mtpa from 2016-2020
  Price rumoured to be: \( P(\text{LNG}) = 0.154 \times \text{JCC} + 0.34 + \text{freight} \)

• Qatar to Petrochina and China
  3mtpa from 2011 to Petrochina, 2mpta from 2009 to CNOOC
  Price rumoured to be:
  \( P(\text{LNG}) = 0.16 \times \text{JCC} + 1.00 \) for Petrochina
  \( P(\text{LNG}) = 0.163 \times \text{JCC} + 0.57 \) for CNOOC

• Qatar to Thailand
  1mpta firm, 1 mpta option (which has since been declined)
  Price rumoured in same range as China price

• Tangguh to KOGAS
  1 mtpa from 2010-2012
  Price rumoured to be \( P(\text{LNG}) = 0.154 \times \text{JCC} + 1.00 \)

• BG Australia to China (CNOOC)
  3 mtpa
  Price rumoured to be between 0.145 and 0.148

• Papau New Guinea
  Targeting execution of HOA’s by mid-2009
  Price rumoured to be below 0.15