CURRENT STATE AND PROSPECTS OF LNG IN THE UNECE REGION

Group of Experts on Gas

14th April 2014 - Geneva
Structure of the study

- Executive Summary
- Chapter 1: LNG Market
- Chapter 2: LNG Value Chain and Technology
- Chapter 3: Regulation
- Chapter 4: Interoperability
Participants

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Next steps

- Feedback
- Final Wording
Chapter 1: LNG Markets

- Definitions
- Key market drivers
- Structure and Pricing
- Directions and outlook
- Discussion
Chapter 1: LNG Markets

Japan Nuclear Power Generation (TWh/month)

Japan LNG Imports

Chapter 1: LNG Markets

Terminal Approximate Quantity, mtpa

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Approximate Quantity, mtpa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sabine Pass, TX</td>
<td>16.5</td>
</tr>
<tr>
<td>Freeport, TX</td>
<td>13.5</td>
</tr>
<tr>
<td>Lake Charles, LA</td>
<td>15.0</td>
</tr>
<tr>
<td>Cove Point, MD</td>
<td>5.8</td>
</tr>
<tr>
<td>Cameron, LA</td>
<td>12.8</td>
</tr>
<tr>
<td>Jordan Cove, OR</td>
<td>6.0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>69.5</strong></td>
</tr>
</tbody>
</table>

Chapter 1: LNG Markets

Comparison of US LNG Delivered Costs

Chapter 1: LNG Markets

- Factors pointing to greater North American LNG Exports
  - Durable price differential
  - Domestic markets evolving slowly
- Factors pointing to less North American LNG Exports
  - Global gas & shale development
  - Environmental/other restrictions
  - Export licensing issues.
Chapter 1: LNG Markets

Global LNG Supply in 2013, Highlighting Top 10 Countries (BCM)

- Qatar: 78.02 BCM
- Malaysia: 25.14 BCM
- Australia: 22.91 BCM
- Indonesia: 18.36 BCM
- Nigeria: 16.47 BCM
- Trinidad & Tobago: 13.67 BCM
- Algeria: 10.81 BCM
- Russian Federation: 10.69 BCM
- Oman: 10.35 BCM
- Brunei: 8.35 BCM
- All Others: 10.69 BCM

Chapter 1: LNG Markets

Distribution of LNG Imports in the UNECE Region, 2013

Chapter 1: LNG Markets

Comparison of Spot Gas Prices in Key LNG Markets

Source: EEG, 2014.
Chapter 1: LNG Markets

Global Gas Markets, BCM

Chapter 1: LNG Markets

LNG Importation into the UNECE Region, mtpa

Source: BP, 2013; various estimates.
Chapter 1: LNG Markets

- LNG is increasing faster than pipeline trade.
- Global markets remain price-segmented.
- The UNECE region is raising its LNG market involvement.
- US, Canada and Australia will be major new suppliers in the next decade.
Chapter 2: LNG value chain
Chapter 2 Outline & Scope

- History of LNG
- Segments in the LNG value chain
- Upstream / Reserves
- Technology
  - Liquefaction
  - Regasification
  - Shipping
- Floating LNG
- End user markets
  - Power generation; Industrial process; Feedstock; Residential
  - NGV
  - Satellite & Peak Shaving Plants
- Economics (CAPEX; Business Models; Risk Analysis)
Chapter 2: LNG value chain

LNG Value Chain. Trends

US brownfield bidirectional projects
Vs
Australia&E. Africa greenfield projects

Floating popularity
Regas/Liquefaction
Mature technology

Europe: ↓ Short term, ↑ mid term due to domestic production decline
Asia: ↑ (but nuclear uncertainty Japan)
Coal vs Gas competition
↑ gas in US, ↑ Coal in Europe
Innovative uses: GTL, NGV
↑ weight of LNG in global gas consumption

Upstream
Liquefaction
Shipping
Regasification
Transport by pipeline

Trading
Distribution
Marketing
Demand

Shale gas boom in the US
Huge gas discoveries E. Africa

Increasing number of players
NOC, IOC, Utilities, Banks, Final Customers, Shipping Cos

Price indexation
Crude oil Vs Liquid Hubs

Value of flexibility for arbitrage opportunities
Chapter 2: LNG value chain

Liquefaction CAPEX

- Increasing differential between Greenfield and Brownfield projects
- CAPEX growing much faster than inflation
Chapter 2: LNG value chain
Project Economics

- Liquefaction requires the highest investment in the LNG chain
- Currently there is an excess of regasification and shipping capacities
- Massive additional liquefaction capacity proposed
- Only a limited number of the projects will advance

<table>
<thead>
<tr>
<th>% of Capital Costs</th>
<th>Exploration &amp; Discovery</th>
<th>Development &amp; Extraction</th>
<th>Transport &amp; Storage</th>
<th>Liquefaction</th>
<th>Shipping</th>
<th>Storage &amp; Regasification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15-20 %</td>
<td>30-45 %</td>
<td>10-30%</td>
<td>15-25%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Office of Fossil Energy, U.S. DoE
Chapter 2: LNG value chain
LNG Market expected growth
Chapter 2: LNG value chain
Offshore is booming

- **Floating regasification facilities in operation:**
  - 9 countries in less than 10 years
    - USA,
    - UK
    - Argentina (2)
    - Brazil (2-3)
    - Chile
    - Kuwait
    - UAE (Dubai)
    - Italy
    - Israel,

- **3 Floating Liquefaction facilities under construction:**
  - Prelude (Australia), the first to take FID in 2011
  - Petronas FLNG (Malaysia)
  - Pacific Rubiales (Colombia), expecting to start production in 2015

- Many more under development or being studied
## Chapter 2: LNG value chain

### Floating vs Conventional

<table>
<thead>
<tr>
<th></th>
<th>Floating</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Costs</strong></td>
<td>Lower CAPEX, Higher OPEX</td>
<td>Higher CAPEX, Lower OPEX</td>
</tr>
<tr>
<td><strong>Project Lead Time</strong></td>
<td>Faster, possible in less than 1 year</td>
<td>More difficult permitting process</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td>Considerably less required</td>
<td>Larger size to be economically developed</td>
</tr>
<tr>
<td><strong>Reserves &amp; Market required</strong></td>
<td>Small - Medium scale projects</td>
<td></td>
</tr>
<tr>
<td><strong>Loading / Unloading</strong></td>
<td>Could be affected by adverse environmental conditions</td>
<td>14-24h (typically around 10,000 m3/h)</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>The infrastructure can be moved to a different location</td>
<td></td>
</tr>
<tr>
<td><strong>Financing</strong></td>
<td>Unproven technology adds more risk</td>
<td></td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td>Offshore location and/or compact size make facility easier to protect</td>
<td>Harder to protect, particularly onshore pipelines</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>Limited storage</td>
<td>High capital cost associated</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td>Minimizes fixed infrastructure and environmental impacts</td>
<td>Larger footprints</td>
</tr>
</tbody>
</table>
Chapter 2: LNG value chain
Current trends in the LNG Value Chain

- Reserves/Development
  - Increasing costs x4 vs 2000
  - US Shale gas, new areas: Mozambique/Tanzania...

- Liquefaction:
  - Increasing costs: x4 vs 2000
  - Floating regasification

- Shipping
  - New generation of ships => minimum boil off losses and reduced fuel consumption.

- Regasification
  - Increasing costs
  - Spare capacity in Europe

- Markets
  - Three different dynamics: USA, Europe and Asia
  - New Opportunities: LNG for ships, trucks, cars. Small scale LNG
# Chapter 2: LNG Value Chain

## Current Trends in the LNG Value Chain

### Old LNG Business Model
- Highly regulated monopoly markets,
- Long Term Contracts (inflexible)
- One destination market: Diversion Restrictions
- Oil indexation Prices
- Fragmented LNG value chain
- From producer to consumer
- Sales from NOC to State Companies
- Regional Markets: low interbasin exchange
- Competition with alternative energies

### LNG Business Model Changes
- Open Market: multiple buyers and sellers from the same country
- Short and Medium Term contracts (options)
- Multiple destinations: flexibility - diversion with PSM
- Liquid Markets indexation (HH, NBP, JKM...)
- Vertically integrated companies (including NOCs)
- From producer to consumer/aggregator/trader/...
- Sales from NOC to Private utilities or State Companies
- Global Markets
- gas – gas competition
Chapter 2: LNG value chain
Comparing LNG - oil markets evolution

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Administered markets</td>
<td>Growth of spot trading</td>
<td>Spot prices benchmark for all trades</td>
<td>Oil derivatives grow</td>
<td>Derivative markets mature – industry dis-integration and realignment</td>
</tr>
</tbody>
</table>

Oil

- Insignificant spot market – most trade on term
- Administered government and corporation pricing
- 19 producers (13 in OPEC)
- Production, purchasing, and refining dominated by the “7 sisters” oil majors
- Vertically integrated industry

- Spot sales only 5% of total sales; many traders enter spot market
- Rapid price escalation
- Term contracts increasingly linked to prices of spot benchmarks
- Nationalization of upstream operations breaks up vertical integration
- Sellers’ market became buyers’ market
- Additional non-OPEC production reduces preeminence of OPEC
- Spot trading over 30% of total sales
- 1983 – WTI futures listed on NYMEX
- OTC derivatives illegal in U.S. until 1987
- Increased price volatility
- 1986 crude price collapse
- “Netback pricing” by Saudis
- Forward and futures markets grow in importance
- Oil majors reduce costs
- 1987 – Chase completes first matched commodity swap
- Intermediary trades dwarf underlying physical markets
- Increased liquidity and derivatives competition
- Major oil companies restructure activities – role of refining and marketing reviewed

LNG

- (1962-2000)
- (2002->)

- Comparing the evolution of the oil market with LNG shows that this type of evolution of the LNG market could occur
- As the LNG market becomes fully arbitragable, efficient spot markets in LNG, shipping and regas capacity likely to emerge
Chapter 2: LNG value chain

Global LNG Demand

- Global LNG demand is growing dramatically. The main drivers are:

- After Fukushima, some countries have implanted non-nuclear policies. Different alternatives to meet the energy demand were considered and LNG was presented as the most competitive and safest option.

- New importers have emerged in Asia and Latin America, suppliers have diverted their volumes from the traditional Atlantic Market to the Pacific, affecting prices for the new Atlantic consumers.

LNG imports in 2010 and 2015 by region (bcm)

Source: IHS Cera
Chapter 2: LNG value chain
NG vs Renewables: the Spanish case

Power Generation by Source (TWh)

Gas Consumption (TWh)
Chapter 2: LNG value chain

LNG Hubs
Chapter 3: Regulation

Chapter 3: Detailed review of LNG regulation at a European level, in the USA, and in Japan, 3 areas where different regulatory models have been adopted.

Range of approaches to LNG access regulation

- Regulated and non-regulated regimes are not good or bad per se.
- These models are in constant evolution, as a result of the recurrent interaction between the industry and regulators.
Chapter 3: Regulation

Regulatory evolution and trends - US

- US: decision to remove access regulation from new terminals adopted in 2002 (Hackberry) and 2005 (EPAct).
- Two regimes coexist.
Chapter 3: Regulation

Regulatory evolution and trends - US

- The access model is not driving the regulatory debate nowadays, after the shale gas revolution. Several terminals plan to export LNG, the debate have shifted to export authorisation permits for non-free trade agreement countries.
Chapter 3: Regulation

Regulatory evolution and trends - EU

rTA and nTPA allowed

rTA as default regime. Exemptions allowed for new capacity

“3rd Package”


Directive 98/30/EC 1st Gas Directive
Regulation 713/2009 ACER
Regulation 715/2009 Third party access to Gas Pipelines (incl. LNG and storages)
Regulation 1775/2005 Third party access to Gas Pipelines

Regulation 1227/2011 REMIT: Regulation on Energy Market Integrity and Transparency
Regulation 994/2010 Security of Supply
Regulation 347/2013 Trans-European Energy Infrastructure

rTA as default regime. Exemptions allowed for new capacity.
Chapter 3: Regulation

Regulatory evolution and trends - EU

(*) 80% of the capacity is exempted, the remaining 20% is subject to rTPE.
Evolution of LNG regas capacity in Europe
Chapter 3: Regulation

Evolution of LNG storage capacity in Europe

LNG STORAGE CAPACITY

<table>
<thead>
<tr>
<th>Year</th>
<th>REGULATED</th>
<th>EXEMPTED</th>
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</thead>
<tbody>
<tr>
<td>2000</td>
<td>1,000,000</td>
<td>0</td>
</tr>
<tr>
<td>2001</td>
<td>1,200,000</td>
<td>0</td>
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<tr>
<td>2002</td>
<td>1,400,000</td>
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<td>2003</td>
<td>1,600,000</td>
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<td>2004</td>
<td>1,800,000</td>
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<td>2005</td>
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<td>2006</td>
<td>2,200,000</td>
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<tr>
<td>2007</td>
<td>2,400,000</td>
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<td>2008</td>
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<tr>
<td>2012</td>
<td>3,400,000</td>
<td>0</td>
</tr>
<tr>
<td>2013</td>
<td>3,600,000</td>
<td>0</td>
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</tbody>
</table>
Chapter 3: Regulation

Integrated & unbundled (ownership) operators

- In practice regulated LNG terminals (and some exempted terminals as well) are operated by regulated TSOs subject to ownership unbundling, except in France and in some Spanish terminals.

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>Transmission</th>
<th>LNG</th>
<th>UGS</th>
<th>Distribution</th>
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<tbody>
<tr>
<td>Enagas</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>Fluxys</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
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<td>Gasunete</td>
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<td>✓</td>
<td></td>
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<tr>
<td>Gaz System</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>National Grid</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>REN</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Snam</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tbody>
</table>
Chapter 3: Regulation

Unbundling situation in Europe

Ownership unbundling
- Pure infrastructure operators
  - Gate terminal
  - nationalgrid (Grain LNG)

EXEMPTED

REGULATED
- enagas
- FLUXYS
- SNAM
- GNL ITALIA
- GAZ system
- KLAIPĖDOS NAFTA
- AdriaLNG
- OLT Offshore LNG Toscana
- Dunkerque LNG
- SOUTH HOOK
- DRAGONLNG

Under construction
- Reganosa
- Saggas
- BBG1
- engery
- FOSMAX
- DESFA

Vertical integration
- Present at least in supply & regas
  - Gas Access To Europe
  - Atlântico
  - Gasprom
  - REN
  - SAFEGAS
  - GDF SUEZ

- Under construction
  - Gas Transmission System Operator S.A.
Chapter 3: Regulation

Basic and additional / ancillary services

- All LNG terminals offer the basic services of unloading, storage and regas. Additional services vary per country of terminal and are offered under different regimes

<table>
<thead>
<tr>
<th>Basic services</th>
<th>Unloading</th>
<th>Storage</th>
<th>Regasification</th>
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</thead>
<tbody>
<tr>
<td>Additional services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional storage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional regasification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional services</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Additional services</th>
<th>Tank to ship loading</th>
<th>Tanker cooling down</th>
<th>Tanker gassing up</th>
<th>Ship to ship loading</th>
<th>Truck loading</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Complementary services</th>
<th>Ship approval</th>
<th>Quality adjustments</th>
<th>Odorisation</th>
<th>Nitrogen servicing</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Trading specific services</th>
<th>Regasification capacity trading</th>
<th>LNG inventory exchange</th>
<th>Storage capacity trading</th>
<th>Unloading slot trading</th>
</tr>
</thead>
</table>
Chapter 3: Regulation

- The coexistence of regimes poses some questions.
- Regulatory developments are focused on implementation of the 3rd Package, CMPs and transparency.
- Tendency to make use of Open Seasons for new capacity, and sometimes to reallocate existing capacity.
TPA not implemented in Asia, but debated in some countries.

Operators in Japan are obliged to create manuals for negotiations about the use of LNG terminals. Not used in practice.

In late 2013 a public debate has been opened about whether to have clearer rules about TPA to LNG terminals, as part of a series of policy discussions aimed at further deregulating the country’s natural gas market.
Chapter 3: Regulation

- Strategic issues affecting regulation in importing countries

- Flexibility of supply
- Development of new services (Small scale / Bunkering)
- Security of supply / Diversification of Supply
- Liquidity
- Prices

Import regulations
Chapter 4: Interoperability

- Critical aspect: ship to terminal interface compatibility
- Enormous range of coastal and port environments
- Differences in local operational procedures from port to port
- Increasing ship shore compatibility
## Chapter 4: Interoperability

### Limitation of vessels size

<table>
<thead>
<tr>
<th>Country</th>
<th>Port</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>Zeebrugge</td>
<td>135,000 m³</td>
</tr>
<tr>
<td></td>
<td>Barcelona</td>
<td>140,000 m³</td>
</tr>
<tr>
<td></td>
<td>Sagunto</td>
<td>266,000 m³</td>
</tr>
<tr>
<td></td>
<td>Cartagena</td>
<td>266,000 m³</td>
</tr>
<tr>
<td></td>
<td>Huelva</td>
<td>140,000 m³</td>
</tr>
<tr>
<td></td>
<td>Mugardos</td>
<td>145,000 m³</td>
</tr>
<tr>
<td></td>
<td>Bilbao</td>
<td>266,000 m³</td>
</tr>
<tr>
<td>Spain</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fos Tonkin</td>
<td>75,000 m³</td>
</tr>
<tr>
<td></td>
<td>Montoir de Bretagne</td>
<td>266,000 m³</td>
</tr>
<tr>
<td></td>
<td>Fos Cavaou</td>
<td>220,000 m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>Panigaglia</td>
<td>70,000 m³</td>
</tr>
<tr>
<td></td>
<td>Porto Levante</td>
<td>152,000 m³</td>
</tr>
<tr>
<td></td>
<td>Sines</td>
<td>215,000 m³</td>
</tr>
<tr>
<td>Portugal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Isle of Grain</td>
<td>205,000 m³</td>
</tr>
<tr>
<td></td>
<td>South Hook LNG</td>
<td>266,000 m³</td>
</tr>
<tr>
<td></td>
<td>Dragon LNG</td>
<td>217,000 m³</td>
</tr>
<tr>
<td>UK</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Revithoussa</td>
<td>135,000 m³</td>
</tr>
<tr>
<td>Greece</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Chapter 4: Interoperability

- Gas quality harmonization is an important effort
- Global harmonization or at least regional harmonization
- Accurate analysis and measurement of LNG quality is very important
Chapter 4: Interoperability

Wobbe Index
Chapter 4: Interoperability

- LNG industry: excellent safety record
- Increasing spot-trading cargoes and off-loading projects (FSRU, FSU, etc…)
- Encourage dialogue between: LNG producers and receivers, LNG shippers, etc…
- New bi-directional capability, regasification+liquefaction in the same plant
Chapter 4: Interoperability

- Summing up, the chapter Interoperability and safety identifies the current issues, trends, requirements and challenges to allow the LNG industry to grow in safety and interoperability worldwide
Some Conclusions

World Gas Consumption in 2012

- Consumed where produced: 69%
- Pipeline trade: 21%
- LNG trade: 10%

Total Consumption: 3314 Bcm

Source: BP Statistical Review 2013
Some Conclusions

LNG advantages specifically fitting emerging energy market needs:

- Balancing fuel for power generation
- New end-user oriented developments (Small Scale LNG)
- Spot and short term agreements
- Global business
Some Conclusions

Steep rise of non long-term contracts

Source: IHS (IGU World LNG Report 2014)
Some Conclusions

LNG is a global business

Source BG. March 2014
Some Conclusions

LNG industry priority challenges:

- Containing cost escalation
- Remaining competitive in power generation
- Attracting financial resources
Some Conclusions

The LNG plant cost challenge

Some Conclusions

Different CAPEX will impact on project competitiveness

Source: IHS, US DOE (IGU World LNG Report 2014)
Some Conclusions

Regas: the most economic step of the LNG chain

Source: IHS, Companies (IGU World LNG Report 2014)
Some Conclusions

Gas competitiveness under threat in Europe

Source: IEA, Gas Medium-Term Market Report 2013
Some Conclusions

Regional gas prices and LNG competitiveness

Source: IEA Medium Term Gas Market Report 2013
Thank you for your attention…and remember “LNG Makes Gas Global”

14th April 2014 - Geneva