OIL & GAS

Pipelines vs LNG transport
Competing or complementing transport solutions in tomorrow’s energy markets?”

Nils Andreas Masvie, VP DNV GL AS
Regional Gas markets (only illustrative)
The Golden Future of Gas?

- Unlike oil, gas is primarily a transportation business; not a production business.
- There are abundant resources, and multiple export routes will secure better market liquidity.
- Russia’s size and location, i.e. distance to markets, requires long transport routes.
- LNG and ship transport are not always an option.

Three drivers for gas growth:
- Economic and population growth
- Switching from other energy carriers into gas
- Creating a new market
New uses for gas – i.e. a new market

LNG used as fuel for power plants

Break-bulk and small scale distribution

LNG used as a maritime fuel
Pipelines, CNG and LNG; distance and volume matrix
Technological advances are bringing more transport options

- Pipeline
- LNG
- CNG
- NON-COMMERCIAL
Some relevant Variables to consider before choosing your transport solution

<table>
<thead>
<tr>
<th>HAZARD – resulting from...</th>
<th>PL</th>
<th>PNG, CNG</th>
<th>LNG</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPEX (relative)</td>
<td>HIGH</td>
<td>LOW</td>
<td>HIGH</td>
<td>Large volumes and long amortization periods needed for PL &amp; LNG.</td>
</tr>
<tr>
<td>OPEX (relative)</td>
<td>LOW</td>
<td>MEDIUM</td>
<td>MEDIUM</td>
<td>Contributing: Energy loss</td>
</tr>
<tr>
<td>Increased cost of financing, more risk aversion.</td>
<td>+</td>
<td>+</td>
<td>_</td>
<td>PLs may more easily secure mutual commitments, speculative LNG projects may struggle</td>
</tr>
<tr>
<td>Less demand for gas/energy</td>
<td>_</td>
<td>+</td>
<td>+</td>
<td>LNG/CNG-ships can more easily find alternative markets</td>
</tr>
<tr>
<td>Well tested technology</td>
<td>++</td>
<td>0</td>
<td>+</td>
<td>(CNG is, however, ready to go)</td>
</tr>
<tr>
<td>Scale economies</td>
<td>++</td>
<td>-</td>
<td>+</td>
<td>PLs – capacity increase on the margin: cheap to add.</td>
</tr>
<tr>
<td>Break-even on small volumes, medium distance</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>CNG best solution for marginal fields, far from existing infrastructure.</td>
</tr>
</tbody>
</table>
What is the trend in relative PL vs LNG costs*

- *Roughly* how many kilometers of installed offshore large diameter pipe – standard/typical project - did you get for the price of a large standard (160 000 m3) LNG vessel in:

  - 1995: 73 km ($1,65m pr km / $120 mill pr vessel)
  - 2010: 91 km ($2,75m pr km / $250 mill pr vessel)

*internal DNV GL calculations*
Regulatory Compliance – high on the agenda

<table>
<thead>
<tr>
<th>Risk Ranking</th>
<th>2013</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>The risk of a health, safety or environmental incident, and in ensuring</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>regulatory compliance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price volatility; managing long-term investment with the potential for</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>extreme price volatility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to reserves or markets</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Cost escalation and inflation</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Uncertain energy policy</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Worsening fiscal terms</td>
<td>6</td>
<td>4</td>
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</table>

*Ernst & Young; “Business Pulse – Exploring dual perspectives on the top 10 risks and opportunities in 2013 and beyond”*
Report facsimile, page 20: Figure 2

X axis: Time – 1996-2013

Y axis: Annual, accumulated number of pipeline kilometres (green: infield lines, red: export lines)
Report facsimile, page 78: Figure 34

X axis: Time – 1996-2013

Y axis: Annual number of leakages – all installations
Report facsimile Page 88; Figure 46
Comparison of leakage frequencies Norwegian vs British sectors; North of 59’N
Blue: Gas
Red: Oil
Report facsimile, page 99: Figure 60

X axis : Time – 1996-2013

Y axis: Annual leakages inside the safety zone – risers and pipelines
Blue Stream 2*24” Gas Pipelines – Technical & Regulatory challenges
Nord Stream 2*48” Technology and Regulatory Challenges
South Stream Offshore Route 4*32” Technical and Regulatory Challenges
Blue Stream, Nord Stream and South Stream – same codes

<table>
<thead>
<tr>
<th></th>
<th>Main Design Code</th>
</tr>
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<tbody>
<tr>
<td>Blue Stream</td>
<td>2*24” DNV’96</td>
</tr>
<tr>
<td>Nord Stream</td>
<td>2*48” DNV OS-F101</td>
</tr>
<tr>
<td>South Stream</td>
<td>4*32” DNV OS-F101</td>
</tr>
</tbody>
</table>

DNV OS-F101 (DNV’96 is an earlier version) is used all over the world, and focuses on Technical Integrity = Safety
New Gas supplies will add liquidity, volumes, reliability, and stability to gas markets (only illustrative)
Thank you

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