Technical and Operational Innovation for Onshore and Floating LNG

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Outline

Snøhvit and Hammerfest LNG

Floating LNG – a new frontier

Technology Development and Innovation

Recent gas discoveries

Conclusion
Snøhvit
Snøhvit

**Facts:**
- Discovered: 1981 – 84
- Water depth: 250 – 340 m
- Distance to shore: 140 km
- Gas in place (GIP): 317 GSm³
- Recoverable reserves: 193 GSm³
- Condensate: 34 MSm³

**Owners:**

<table>
<thead>
<tr>
<th>Owner</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statoil ASA (Operator)</td>
<td>36.79%</td>
</tr>
<tr>
<td>Petoro AS</td>
<td>30.00%</td>
</tr>
<tr>
<td>Total E&amp;P Norge AS</td>
<td>18.40%</td>
</tr>
<tr>
<td>GDF Suez Norge AS</td>
<td>12.00%</td>
</tr>
<tr>
<td>RWE Dea Norge AS</td>
<td>2.81%</td>
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</tbody>
</table>
Field development concept

• Subsea templates
• Remote operation of subsea system
• Multiphase pipeline to shore
• Onshore gas processing and liquefaction
• Capacity 4.3 Mtpa LNG, plus Condensate and LPG
• Reinjection of CO$_2$ from feed gas (ca 5% CO2 content)
Snøhvit
Process barge in Cadiz, Spain
In-docking of process barge
Extending current skills
Combining the experience

Snøhvit LNG - Hammerfest
- Process facilities built on floating barge – an FLNG predecessor
- Compact layout
- Modularized and prefabricated facilities

Global floating production operations
- Floating production units in operation worldwide
- Offshore offloading in harsh conditions
- Gas processing and acid gas removal on floating unit
Snøhvit technology learning
Supporting FLNG development

- Snøhvit field development and Hammerfest plant – a full LNG value chain
- Direct feed to LNG plant from subsea wells
- Use of LM6000 aero derivative gas turbines
- Reinjection of CO$_2$ from feed gas
- Mixed refrigerant liquefaction process with sea water cooling
- Operation in harsh environment
## Statoil FLNG concept development history

<table>
<thead>
<tr>
<th>Concept</th>
<th>Capacity (Mtpa)</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kelp Deep</td>
<td>4</td>
<td>1985</td>
</tr>
<tr>
<td>Fylla/Snøhvit</td>
<td>5</td>
<td>1986</td>
</tr>
<tr>
<td>NnwaDoro</td>
<td>6-8</td>
<td>1987</td>
</tr>
<tr>
<td>Shtokman</td>
<td>3 x 5</td>
<td>1988</td>
</tr>
<tr>
<td>NnwaDoro</td>
<td>6 (incl oil)</td>
<td>1989</td>
</tr>
<tr>
<td>Snøhvit</td>
<td>3</td>
<td>1990</td>
</tr>
<tr>
<td>NnwaDoro</td>
<td>6</td>
<td>1991</td>
</tr>
<tr>
<td>Generic/Angola</td>
<td>1</td>
<td>1992</td>
</tr>
<tr>
<td>Generic HLG</td>
<td>1.5</td>
<td>1993</td>
</tr>
<tr>
<td>Feasibility</td>
<td>2.5</td>
<td>1994</td>
</tr>
<tr>
<td>Pre-FEED</td>
<td>3.3</td>
<td>1995</td>
</tr>
</tbody>
</table>

*Note: Years represent the years of development for each concept.*
Statoil FLNG

- Study phases completed
  - Feasibility
  - Concept / pre-FEED
- Varying feed gas composition
- DMR liquefaction process with mechanical compressor drivers
- Side-by-side or tandem offloading
- Developed in cooperation with major engineering contractor
- Supplier group participation

Statoil FLNG, base concept

| LNG Capacity | 3.0 - 3.5 Mtpa |
| Overall length | 425 m |
| Beam | 65 m |
| LNG storage | 225 000 – 275 000 m³ |
Technology to enable efficient and reliable FLNG

Acid gas removal
• Extensive technology qualification
• Safeguarding solution can be implemented

LNG offloading systems
• Tandem and side by side system developments

Deep sea water intake
• Riser system for cold deep water intake
• Technology development and qualification for 400+ m intake depth
Operational developments – Hammerfest LNG

Process optimization

• Optimization of operational parameters of Linde MFC liquefaction process with three MR circuits and integrated scrub column
• Use of detailed process model for data reconciliation and process optimization

Reduced start-up flaring

• Use of vaporized LNG as heat sink during controlled cool-down of cryogenic equipment
• Alternative to feed gas expansion
• Reduced start-up time and CO\textsubscript{2} emissions

![Graph showing CO\textsubscript{2} emissions over time]
Tanzania gas discoveries

- Three high impact discoveries made offshore Tanzania in 2012-2013
- Recoverable gas volumes in the range of 10-13 Tcf (280-370 GSm^3) brings further robustness to a potential LNG project
- Statoil operates the license on Block 2 on behalf of Tanzania Petroleum Development Corporation (TPDC)
- Statoil has a 65% working interest, with ExxonMobil holding the remaining 35%
- Recoverable volumes in Block 2 will support building of 1-2 onshore LNG trains
Conclusion

• The Snøhvit offshore field development and realization of the Hammerfest LNG plant has been a pioneering project for Statoil in terms of technology, project execution, location/environment, and operations.

• FLNG is a new technology frontier - emerging as a commercially attractive solution for many offshore gas fields.

• Partnerships become even more important to develop gas resources and manage risk, especially in frontier areas.

• Statoil builds on extensive offshore and onshore experience to realize new LNG projects.
Crossing energy frontiers
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