Next Generation Subsea Technology: Key Challenges and Technology Trends

André Mærli, Statoil Research Centre Rio
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Shaping the future of energy

Competitive at all times

Transforming the oil and gas industry

Providing energy for a low carbon future
The world’s first subsea compression: x2!

<table>
<thead>
<tr>
<th>Åsgard Subsea Compression</th>
<th>Gullfaks Subsea Compression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased recovery from Midgard and Mikkel estimated to <strong>306 million boe</strong></td>
<td>Increased recovery from Gullfaks south estimated to <strong>22 million boe</strong></td>
</tr>
</tbody>
</table>

Start-up: September and October 2015

Technology step: **Substantial recovery and lifetime increase**
ÅSC Commissioning Control Centre at Stjørdal

Full control system access from onshore

Åsgard A on video conference call

It’s the future!

Onshore team performing controls testing during installation, complete control system check and operation of train with nitrogen and MEG.

- Control room personnel brought onshore
- Independent of offshore cabin capacity
- Short mobilization time for vendor personnel
- No offshore certificates needed
- No undesired event caused by working remote
- Close communication with Åsgard technical staff
- Utilized test personnel from previous testing.
- Efficient execution of commissioning with high quality
Marine Operations
• Training in Simulator
• 3D Online Visualization
Subsea in Statoil

Using history to create history

**Pioneering**
1985 - 1990

1. generation
- Gullfaks
- Tommeliten

2. & 3. generation
- Sleipner og Statfjord sat.
- Heidrun, Norne
- Yme, Lufeng, Åsgard, Gullfaks sat2, Sygna, Sigyn, Troll

**Standardization**
1991 - 2000

3. & 4. generation
- Kristin, Morvin, Snøhvit, Ormen Lange
- Vega, Gjøa

**Pushing Limits**
2004 - 2012

**Fast Track & IOR**
2007 - 2015

**Industrialization**
2015 - 2025

Cost reduction through:
- Simplification
- Standardization
- Industrialization
- Innovation

BROWNFIELD Solutions
Njord, Visund, Snorre, +

SUBSEA-TO-HOST

Extended Reach

DEEP WATER

**Subsea catalogue and Subsea processing**
- Fast track I, II and III
- Aasta Hansteen
- Tordis SSBI, Tyrihans RSWI
- ASC, GSC
- Pazflor, Marlim; Rosa; Clov, J&SM, Julia, OL Pilot.
Shaping the future of Subsea

**Work Differently**
- Radically new ways of working and collaborating
- Collaboration: DNV-GL JIP on subsea boosting and IOGP JIP 33 on Subsea Trees
  - *Transform our way of working and the way the industry work*

**Simplify Standardize Industrialize**
- Simplify and standardize to stay competitive at all times
- Design to Cost (DtC) approach, with step-wise cost-benefit analysis
- Re-use solutions, concepts and processes

**Innovate and Implement**
- Technologies for lower cost and a low carbon future
- Radical and innovative solutions to transform the industry
- Develop new value chains
Standardisation – key to succeed

Deliver year 2000 cost-level again - more than 50% reduction!

**Simplify**
- Design-to-cost - always minimum solution as starting point
- Drive for significant efficiency improvements in all cost elements

**Standardise on the simplified solution**
- Standardise on cost effective design and limit variations
- Extensive effort to remove company’s specific requirements

**Industrialise**
- Systematically strive for re-use and repeatability
- Maximise use of industry standards and supplier solutions
Johan Castberg
Simplification, Standardization and Innovation

1) Capex numbers in real term NOK 2016
The Statoil Subsea Factory™
Technology needs going forward
<table>
<thead>
<tr>
<th>PRODUCT LINE</th>
<th>BUSINESS NEED</th>
<th>CONCEPT/FOCUS</th>
<th>KEY CUSTOMERS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BROWNFIELD FACTORY</strong></td>
<td>50 % reduced facility CAPEX</td>
<td>Simplification &amp; Standardization</td>
<td></td>
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<tr>
<td></td>
<td>60 % recovery from existing fields</td>
<td>Simplified Subsea Compression &amp; Boosting</td>
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<td>Reducing CAPEX/OPEX through less topside</td>
<td>Subsea Power &amp; Controls</td>
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<td></td>
<td>modifications</td>
<td>CO2 measures</td>
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<td></td>
<td>Increase tie-back optionality by debottlenecking</td>
<td>Gas-2-Pipe™ System</td>
<td></td>
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<tr>
<td><strong>SUBSEA-TO-HOST FACTORY</strong></td>
<td>Allow subsea production and transport to remote</td>
<td>Lean Extended Reach System</td>
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<tr>
<td></td>
<td>host</td>
<td>Subsea Produced Water Treatment</td>
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<tr>
<td></td>
<td>up to 250 km for gas</td>
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<tr>
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<td>up to 100 km for oil</td>
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<td></td>
<td>Enable production from new fields to existing</td>
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<td></td>
<td>host/new facility down to 3000m water</td>
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<tr>
<td><strong>EXTENDED REACH FACTORY</strong></td>
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<td><strong>DEEP WATER FACTORY</strong></td>
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*) UPP = Unmanned Processing Platform

**COST** <40 $/bbl Technology Solutions

**COMMERCIAL MINDSET** First/Multiuse Focus

Industry Collaboration to reduce cost

**CARBON EFFICIENCY** Reduced Carbon Footprint
The next generation(s) of subsea

Subsea processing roadmap

1997
Lufeng Subsea pump

2000
Troll pilot Subsea separation and Injection

2007
Tordis Subsea sep, boosting and injection

2012
Pazflor Subsea sep

2013
Tyrihans RSWI

2014
Jack / St Malo HP pumps

2015
ÅSC & GSC subsea compression

2017/18
Pressure tolerance, VSD, SWG, long distance transmit

2020
Deep water SURF Solutions

2025
Asset Long distance compression

2025 Gas-2-Pipe™
Gas dehydration

2027 Snøhvit Long distance compression

2027 Asset Ultra deep water processing

2027 Gas-2-Pipe™
Pipe TM
Gas dehydration

2015 Subsea separation systems

2021 Asset Boosting

2019 Asset water inj. Boosting, separation

2016 Subsea compression portfolio

2016: Simplified subsea compression

2017 CAP’X
Subsea Smart Manifold

2015 Standard Pump Station

2016 Subsea pump portfolio

2016 SSP Standard Interfaces

2017 Seawater treatment

2019 Subsea compression

2015 Åsgard & Gullfaks Subsea compression

2010 - Next Gen subsea Compression - Ormen Lange Pilot

2012 WGC 4000

Reference Cases

Activities

Achievements

Classification: Open 2016-02-02
There's never been a better time for good ideas
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There’s never been a better time for good ideas

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