Emerging Subsea Technologies –
New Solutions to Increase Recovery
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Aker Solutions in brief

- Aker Solutions is a global provider of products, systems and services to the oil and gas industry
- Built on more than 170 years of industrial tradition
- Employs approximately 17,000 people in about 20 countries

Employees: **17,000**
Revenues: **33.0 bn**
EBITDA: **2.7 bn**
EBIT: **2.0 bn**
Market Cap: **11.9 bn**

Revenue and profits are in NOK and pro forma for 2014. Market capitalization as of March 3rd, 2015.
Subsea boosting and separation – Why?

- **Subsea Boosting:**
  - Increase production
  - Accelerate production
  - Enable staged development
  - Enable development of low pressure reservoirs
  - Reduce OPEX

- **Subsea Separation:**
  - Address flow assurance issues
    - Hydrates, slug, etc.
  - De-bottleneck topside facilities

![Enhanced Production Diagram](image)

![Extended Production Diagram](image)
Subsea pump systems
IOR case example – Tyrihans project

Oil recovery rate increased by 10%

Subsea raw seawater injection system
Subsea pumping technologies

Key features
- Liquid filled motor
- Rigid coupling
- Opposed impeller design
- Full condition monitoring
- High pressure boosting at high GVF%

Common system design

Applications
1. Oil and condensate boosting
2. Sea water injection – raw or filtered
3. Produced water re-injection
4. De-bottleneck topside facilities
Game changing in several aspects...

Subsea motor:
- 6 Megawatt
- 6000 RPM
- 6,6 kV

Condition monitoring:
Proximity probes in motor and pump

Gas tolerant impeller/diffuser
Åsgard subsea compression project

Project details
- Shut in pressure: 220 bar
- High power: 2 x 11.5 MW
- Flow rate: 21 MSm3/d
- Compressors: 2+1
- Step-out: 40 km
- Water depth: 250 m
- Topside frequency converter

Project Schedule
- 2006 - 2010: Studies, Pre FEED, FEED
- 2010: EPC contract
- 2013: Equipment testing
- 2014: Assembly and System testing
- 2015: Delivery and start-up

Statoil - “add a formidable 278 million barrels of oil equivalent to our production”
Subsea compression technology going forward

Key features
- Compact footprint, reduced weights (WSC™)
- High efficiency
- High compression ratio
- High capability to manage well-stream with high liquid content

Applications
1. Small-medium size gas fields
2. Stranded gas developments
3. Long subsea tie-backs
4. Solve flow assurance accelerating gas flow
Subsea separation systems
Subsea Gas Processing technologies

Technologies
- Subsea passive / active cooling
- Gas / Liquid separation (gravity based and compact)
- Compact subsea gas dehydration system through membrane

Applications
1. Pipeline corrosion protection
2. Gas fields with associated liquid
3. Address flow assurance issue
4. Subsea dehydration
5. Long subsea tie-backs
Subsea Oil / Water separation technologies

Technologies
- Oil / Water separation (gravity based, pipe and compact)
- Water treatment with hydro-cyclones
- Oil polishing with Electric Coalescer
- De-sanding cyclones solutions

Applications
1. Oil fields with high water content
2. Topside de-bottlenecking
3. Subsea water reinjection
4. Address flow assurance issue
5. Long subsea tie-backs
Subsea power systems

Reliable subsea power solutions
Subsea power systems

- **Type 1**
  - Topside VSDs
- **Type 2**
  - Topside VSDs
  - Subsea transformers
- **Type 3**
  - Subsea VSDs
  - Subsea Switchgear
- **Type 4**
  - Low Frequency AC
  - 4a - Subsea VSDs
  - 4b - Topside VSD, RotoConverter™
- **HVDC – limited industry focus today**
  - No connectors
  - No switchgear
  - Large / heavy
  - N/A next 10-20 years
Case study
Case study – Marginal tie-back to FPSO

- Oil production – 50,000 bpd (for the field that will be tied-back)
- Water depth – 1000 m
- Tie-back distance – 30 km
- API – 39.9°
- GOR – 251 SCF/stb
  - (GVF – 20%)

3 development cases considered:
1. Natural Flow
2. Gas lift at XMTs
3. Subsea multiphase pump
Case study – Marginal tie-back to FPSO

HYSYS Simulation:
Case study – Marginal tie-back to FPSO

HYSYS Simulation:

Huge limitation on production
Case study – Marginal tie-back to FPSO

HYSYS Simulation:

Case 3

Considering WHP of 50 bar:

- Only Multiphase pump solution (Case 3) can ensure good production to host
Summary
Summary

- Advance Subsea Production (ASP) systems include, **SPS**, **pump**, **compression** and **separation**

- These technologies are available today and **ready to be deployed**

- They offer alternative development scenario for challenging **deep water**, **marginal** and **stranded reservoirs**

- Building blocks approach to provide **standardization**, **flexibility** and cost reduction.
Ready for the Advanced Subsea Production systems

Uniquely positioned to **design, equip, build and maintain** the subsea systems of the future
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