Aker Solutions CCUS engagement

- a glimpse of our offerings

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Outline

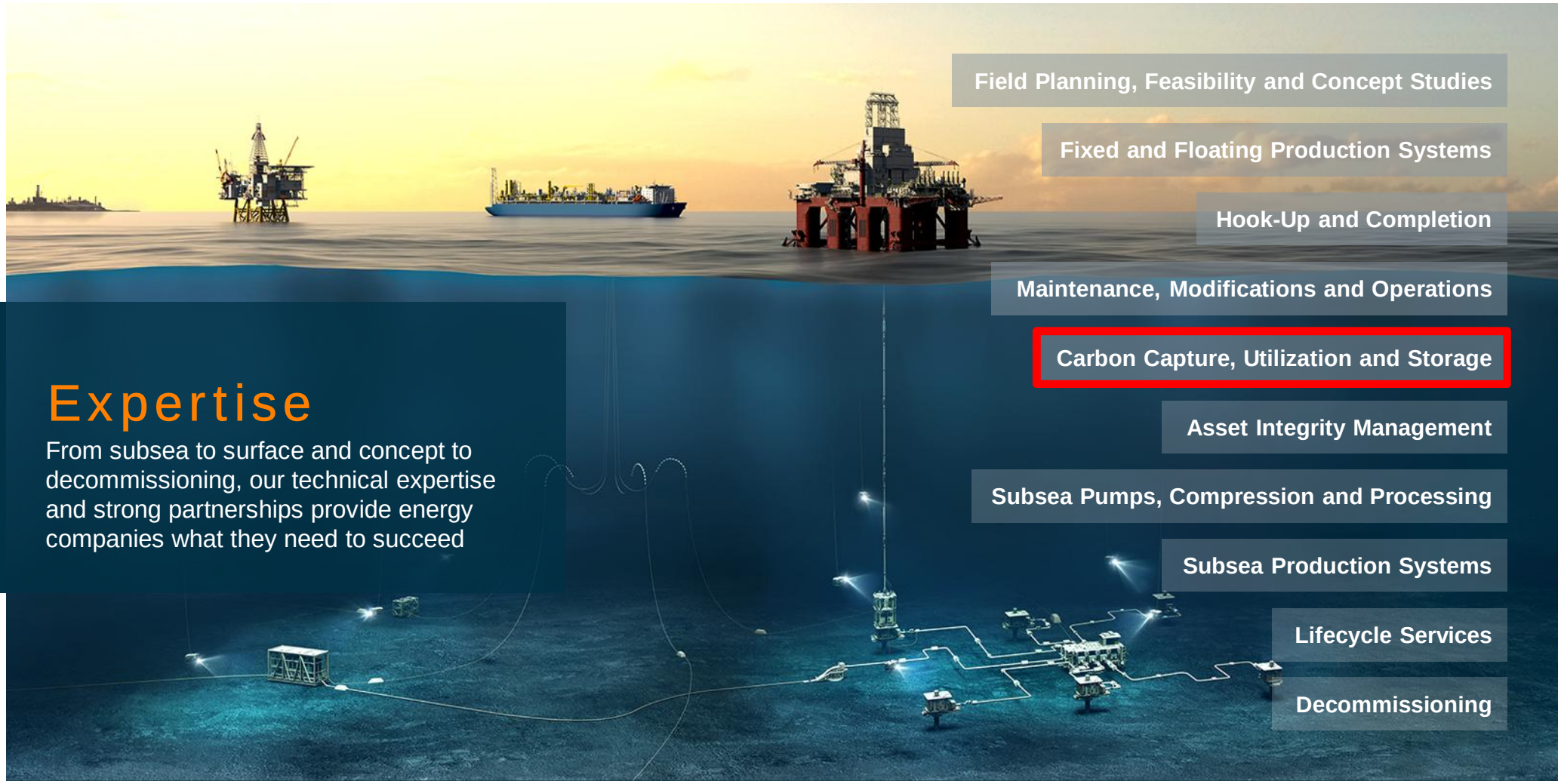
- Short intro about Aker Solutions
- Challenges offshore CO2 EOR
- Relevant subsea processing systems
- Summary

Our Vision

A leader in forging a sustainable future for our industry and the world it serves

Aker Solutions creates solutions to unlock energy safely and sustainably for future generations

14,000	20	50	175
EMPLOYEES	COUNTRIES	LOCATIONS	YEARS OF EXPERIENCE



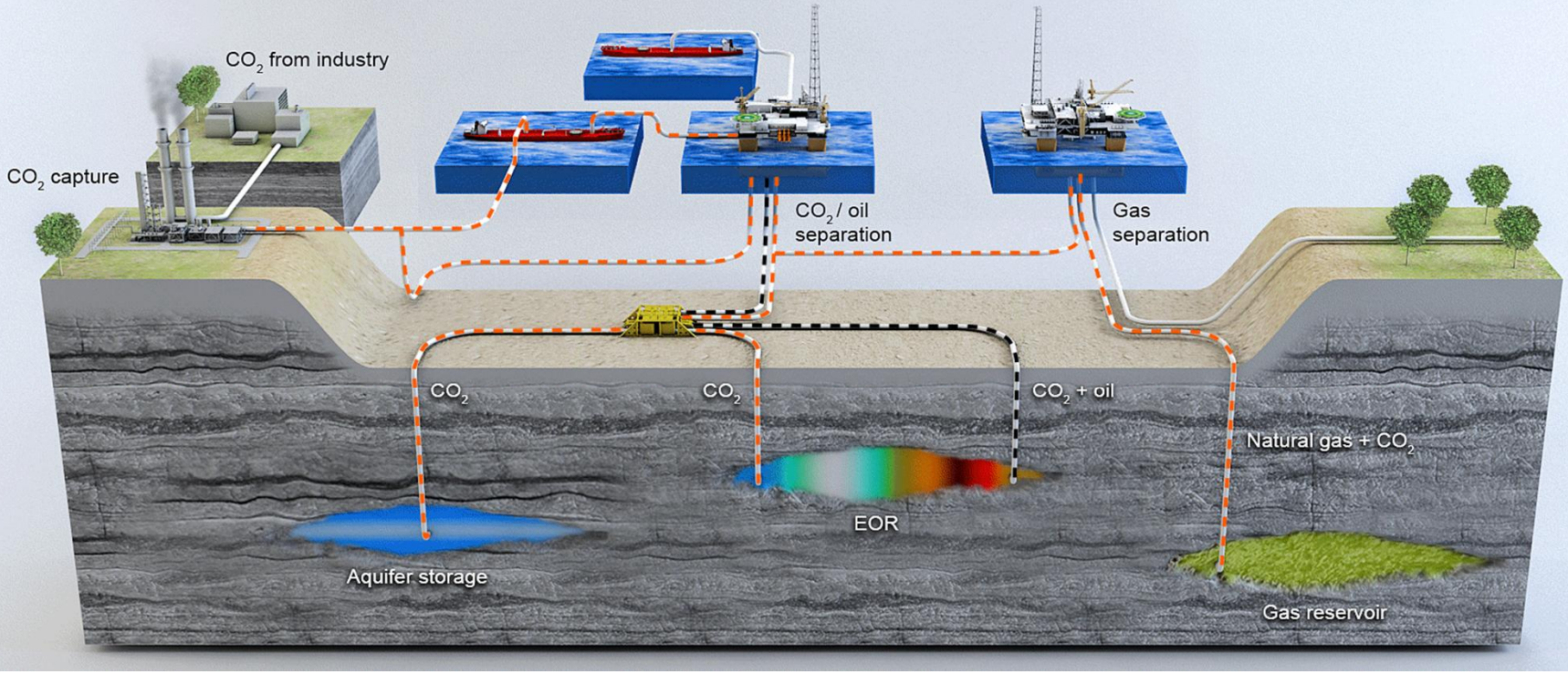
Expertise

From subsea to surface and concept to decommissioning, our technical expertise and strong partnerships provide energy companies what they need to succeed

- Field Planning, Feasibility and Concept Studies
- Fixed and Floating Production Systems
- Hook-Up and Completion
- Maintenance, Modifications and Operations
- Carbon Capture, Utilization and Storage
- Asset Integrity Management
- Subsea Pumps, Compression and Processing
- Subsea Production Systems
- Lifecycle Services
- Decommissioning

Carbon Capture, Utilization and Storage (CCUS) since 1996

Aker Solutions offers technology and solutions for the entire **carbon capture, utilization and storage** value chain



Main Challenges for offshore CO2 EOR

- CO_2 supply chain not established
  - limited availability of CO_2
  - forecasted need for large volumes
- Facilities and wells are not corrosion resistant
- Limited weight and space available for topside separation on most platforms
- Extremely costly retrofits and additional installations
- Loss of production due to shut down in retrofit period

Øyvind Hagen - Statoil ASA

Available Subsea Processing Building Blocks

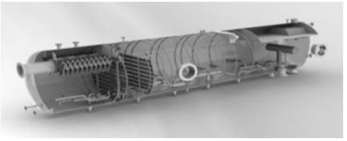
- ☑ Multiphase cooler
- ☑ Gas compressor
- ☑ Gas/liquid separator
- ☑ Liquid/liquid separator
- ☑ De-sanding equipment
- ☑ Produced water de-oiling equipment
- ☑ Liquid pump
- ☑ Multiphase pump
- ☑ Control systems
- ☑ Power solutions

Subsea process system building blocks

Production XT

Injection XT

Large portfolio of subsea separation equipment



Horizontal gravity separators

- 2 & 3 phase separators
- Pipe separator

Qualified

Scrubbers/Gas liquid separators

- Bulk separation
- Dry gas for compression

Qualified

Solids management

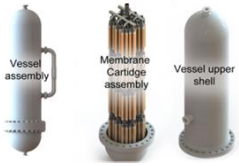
- Gravity separator internals
- Desanding cyclones

Qualified

Water treatment

- Produced water
- Sea water

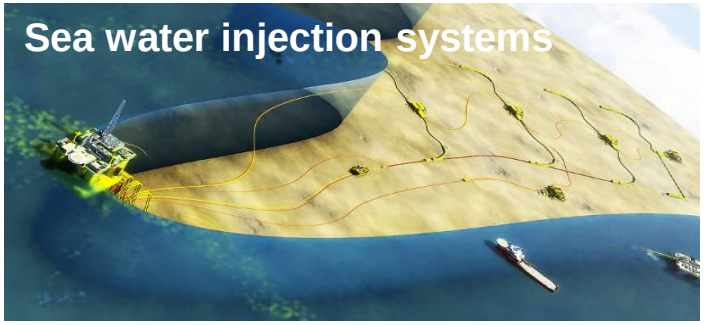
Qualification ongoing



Gas treatment

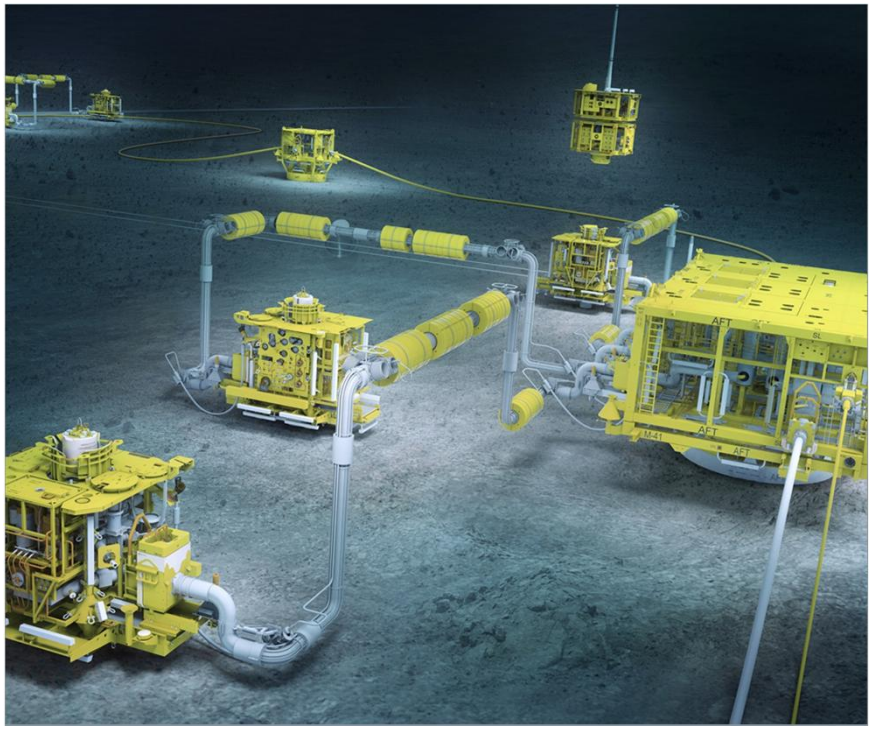
- Dehydration
- CO_2

Qualification needed

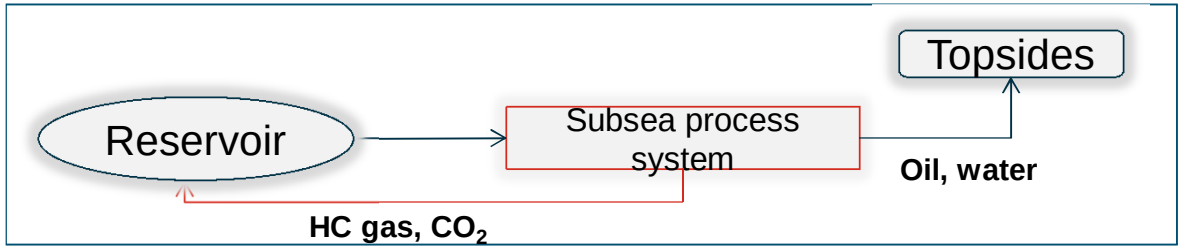


Conditions and considerations subsea CO2 processing

- Not only about choosing equipment……..
  - Operation at well head pressures – lower gas volumes
  - Sea water temperature – cooling – hydrate formation – condensation
  - Limited availability hold up volumes
  - Constraints in compression stages
  - Utilize physical/chemical conditions
  - Considerable advantages related to HSE – flaring, gas exposure, manning

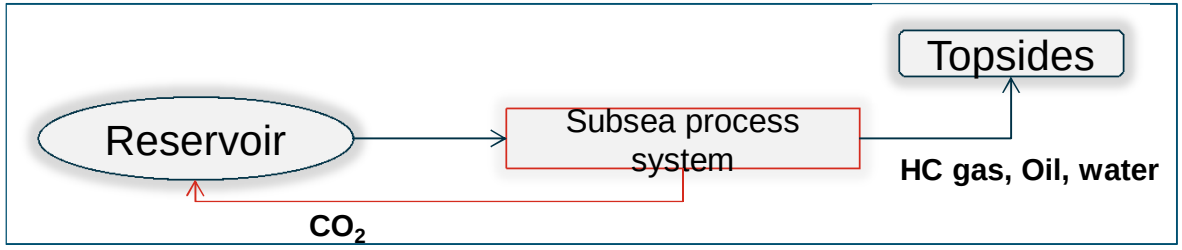


CO_2 Separation Performance



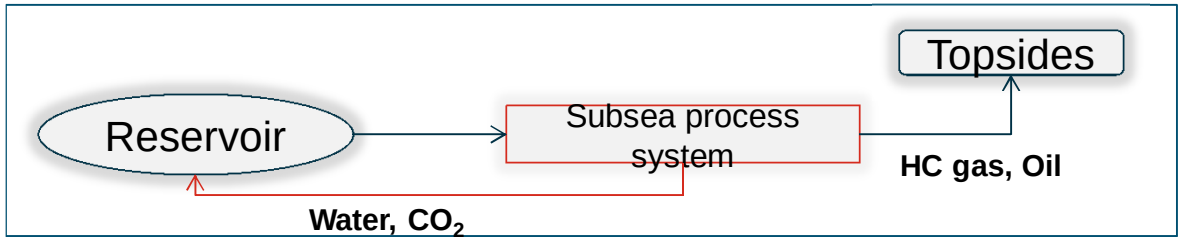
Simplest arrangement:

- Separation and reinjection of HC gas and CO2 using subsea compressor system



More advanced arrangement:

- Gas separation
- Reinjection enriched CO2



Advanced arrangement:

- Gas separation
- Water separation
- Reinjection enriched CO2

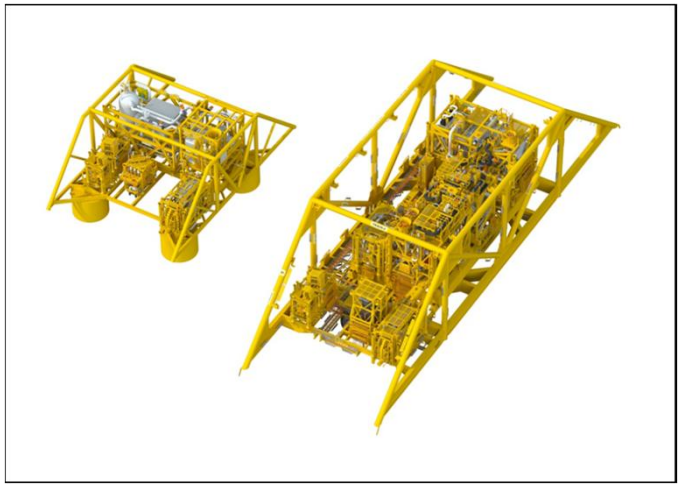
Depending on arrangement; 90 – 97 % CO2 can be separated from well stream.

Key Important Subsea Building Blocks

Compression System – Åsgard 1.0

- 21 MSm^3/d flow rate
- 2 x 11.5 MW compressor power

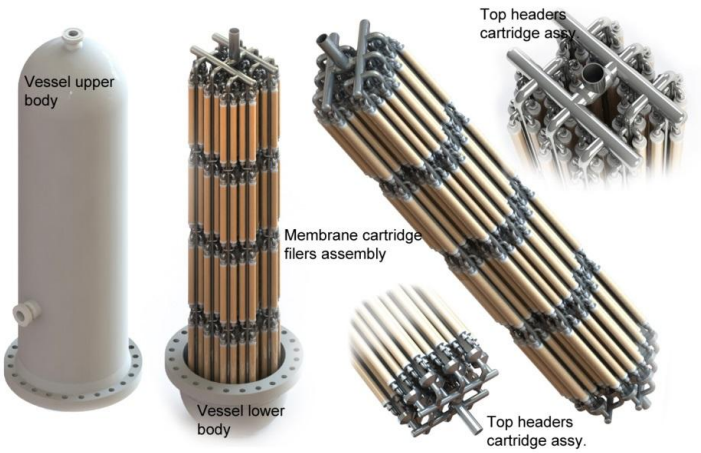
Improved – Åsgard 2.0



- Offers 50 % reduction in weight
- Easier installation

Key Important Subsea Building Blocks

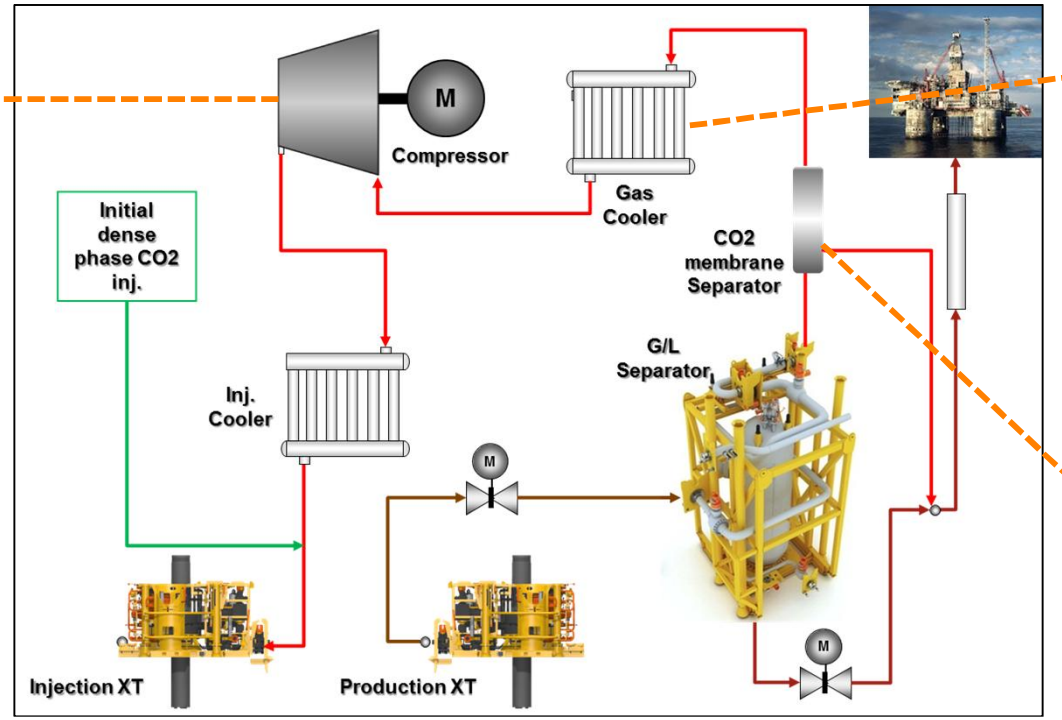
Selective Membranes

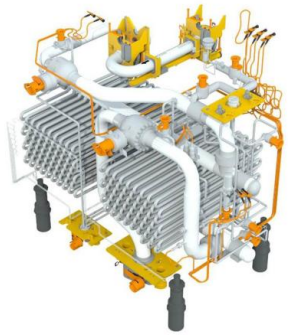


- New polymer qualities with robust properties
- Increased selectivity in combination with productivity
- Compact arrangement for subsea developed

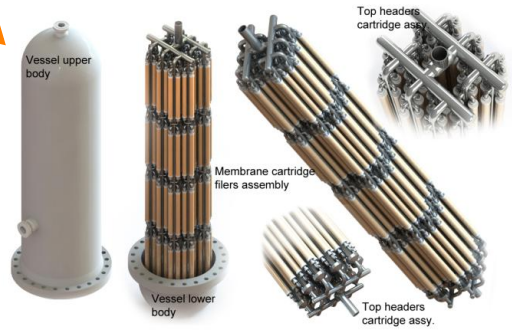
Concept involving CO2 membrane bulk separation

- Åsgard compression technology
- Adapted to CO_2
- Limitations in pressure ratio





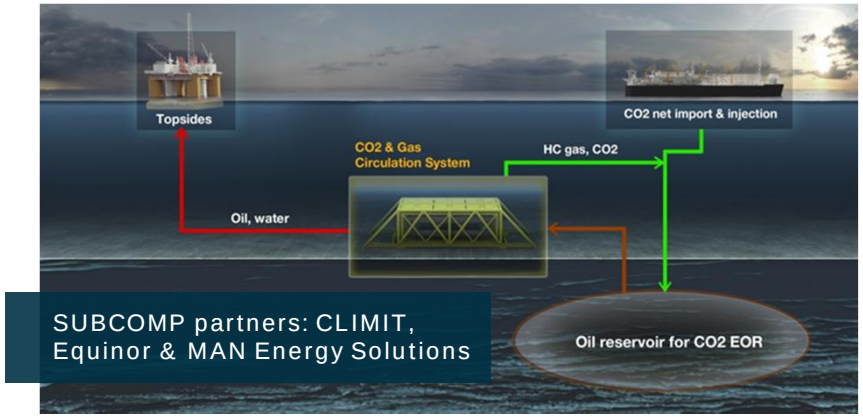
- Two stages membrane separation
- Constraints in available pressure ratio
- High G/L temperature favorable



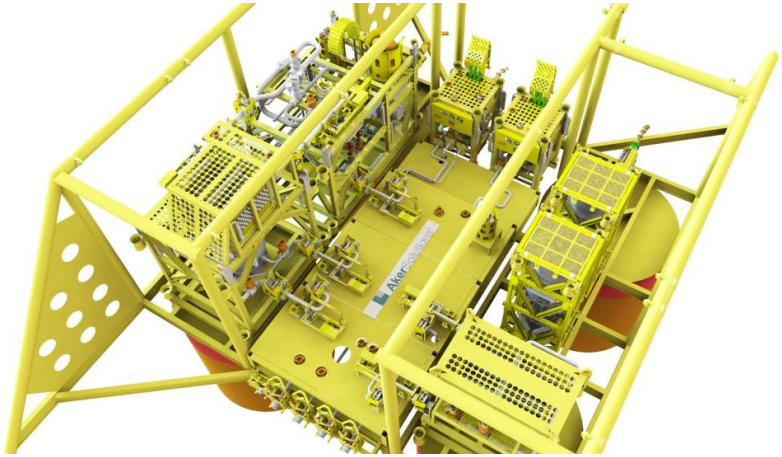
SUBCOMP

- Main idea: Simple and robust subsea process system to enable CO_2 EOR
  - Separation of produced gas and liquid
  - Produced sour gas (mix of HC and CO_2) is compressed and reinjected into the reservoir
  - Liquid is sent to existing topside process facility
  - Existing process facility have limited exposure to CO_2

- Objective: Assess the technical and economical feasibility of a CO_2 separation and reinjection system from a CO_2 flooded oil reservoir to avoid or minimize the need for topside modifications



SUBCOMP partners: CLIMIT, Equinor & MAN Energy Solutions

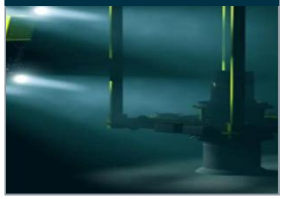


Relevant Subsea Injection Systems (for CO_2 Storage & EOR)

- Conceptual studies, FEED, EPC delivery
  - Optimizing system solution and client value from early client egagement, project execution and life of field
- Injection well system
  - Subsea Trees and Wellheads ensuring safe and reliable drilling and injection operations
- Control & automation systems
  - Integrated control systems built upon reliable, robust and commercially available building blocks
- Umbilicals
  - Provision of injection chemicals, hydraulic control, power and signal (electric & fibre optic)
- Injection template, manifold and tie-in solutions
  - Built on an extensive range of field proven products and concepts, while still allowing for project specific needs
- Workover, installation & intervention tooling
  - Open-water systems, turnkey landing string solutions for jackup and conventional rig applications and riserless well intervention systems
- Life of field services
  - Installation, commissioning and start-up
  - Maintenance, spare parts
  - Decommissioning

Subsea Injection Systems

Wellheads



Trees

Controls & Automation

Umbilical

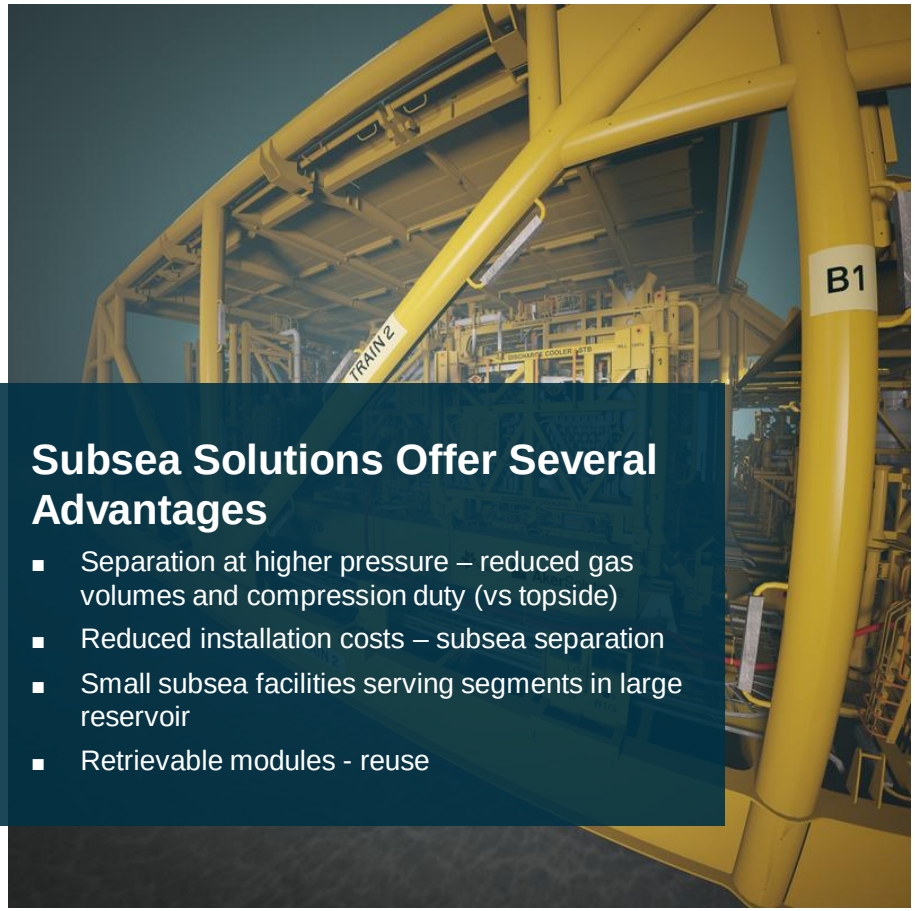
Tie-In

Structures & Manifolds

Workover Systems

CO_2 EOR – Subsea Solutions

- Key enabler for offshore CO_2 EOR concepts
- Solutions for pre-treatment of well stream to remove bulk CO_2 to minimize the need for costly retrofits of existing process facilities to handle sour gas
- Overlap of EOR production with conventional oil production
- Facilities available for injection of CO_2 for permanent storage as a final CCS stage
  - Offshore reservoirs provides a huge and reliable capacity for safe and permanent CO_2 storage
- Flexibility with regards to CO_2 transport
  - Ship delivery vs pipeline



Subsea Solutions Offer Several Advantages

- Separation at higher pressure – reduced gas volumes and compression duty (vs topside)
- Reduced installation costs – subsea separation
- Small subsea facilities serving segments in large reservoir
- Retrievable modules - reuse

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