

Subsea Processing – Beyond Pump and Compressor

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Agenda

- Subsea Processing Building Block
- Large portfolio of subsea separation equipment / technology
- Applications
 - Produced Water Injection
 - Seawater Treatment and Injection
 - CO2 Removal

Global responsibility

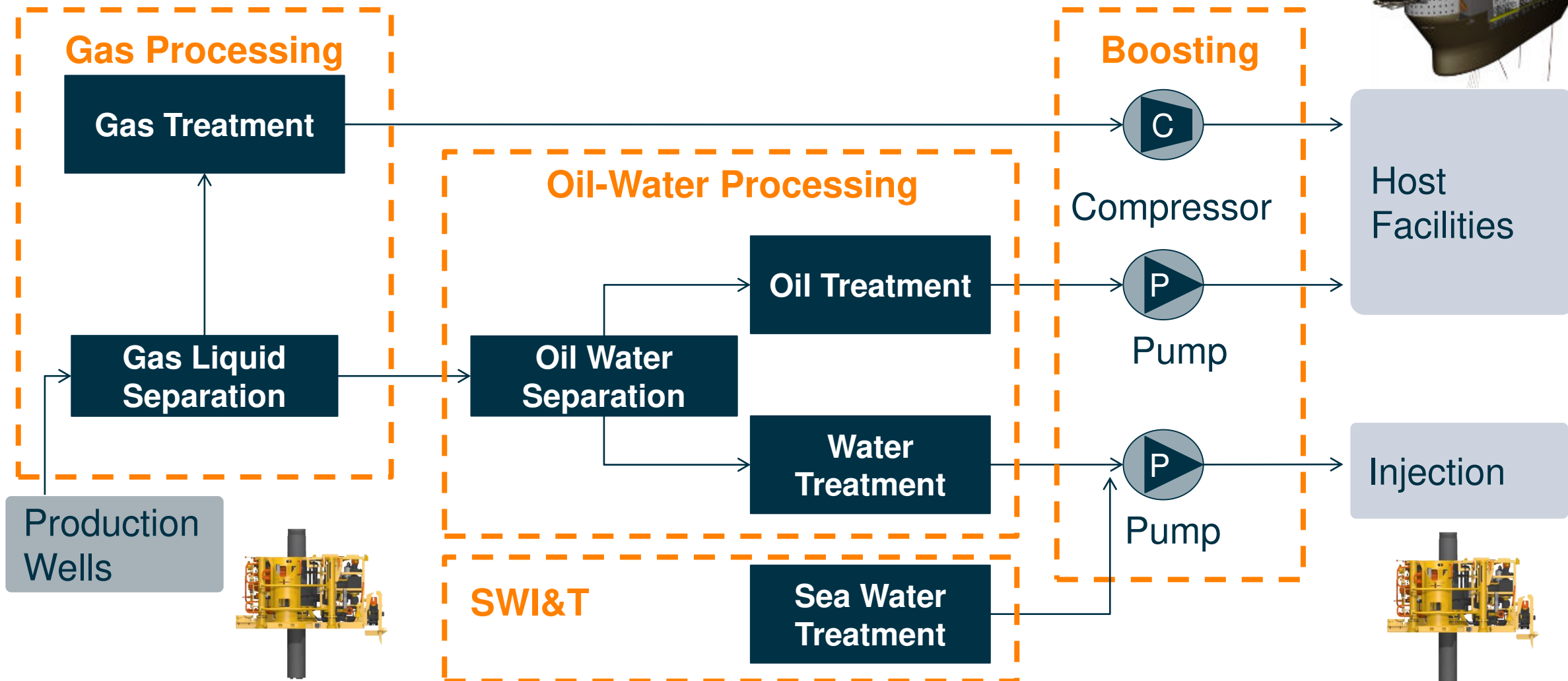


A leader in forging a sustainable future
for our industry and the world it serves

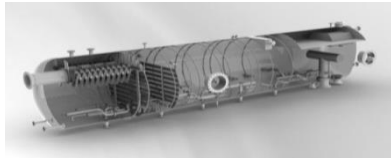
*"We see ourselves as a key partner in helping provide the sustainable energy solutions the world needs – it's both **the right thing to do** and also good business."*

Luis Araujo, CEO of Aker Solutions

Subsea Processing Building Blocks



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

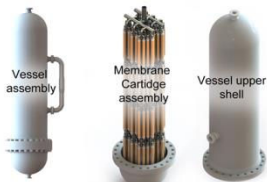
Qualified



Water treatment

- Produced water
- Sea water

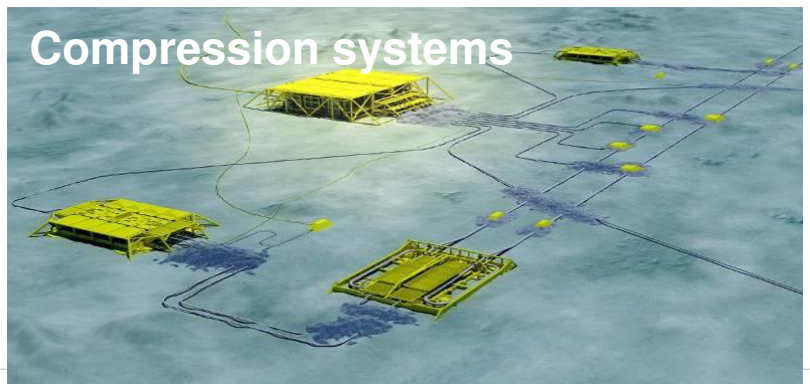
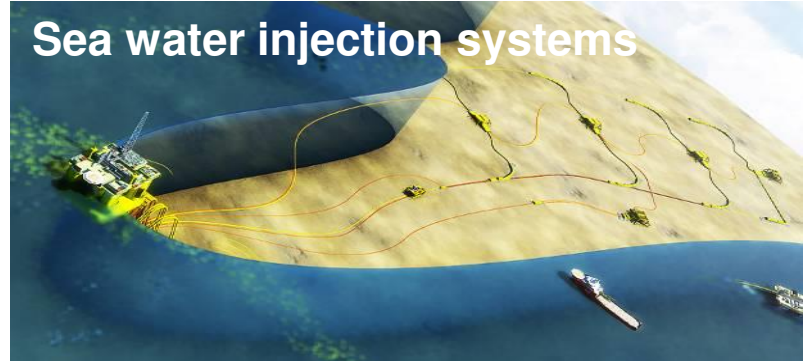
Qualification
ongoing



Gas treatment

- Dehydration
- CO2

Qualification
ongoing

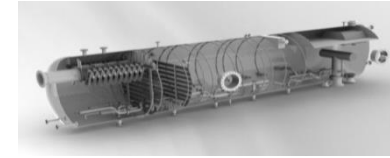


Wide range of system solutions – some examples

Bulk oil/water separation

- 3-phase gravity separators
- Internals, solids management

Qualified



Gas compression

- Scrubbers
- Internals, solids management

Qualified



Flow conditioning

- Multiphase pump systems
- Wellstream compression systems

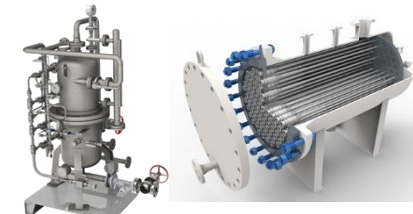
Qualification ongoing



Produced Water treatment

- Hydrocyclones
- Subsea CFU

Qualification ongoing



Bulk gas/liquid separation

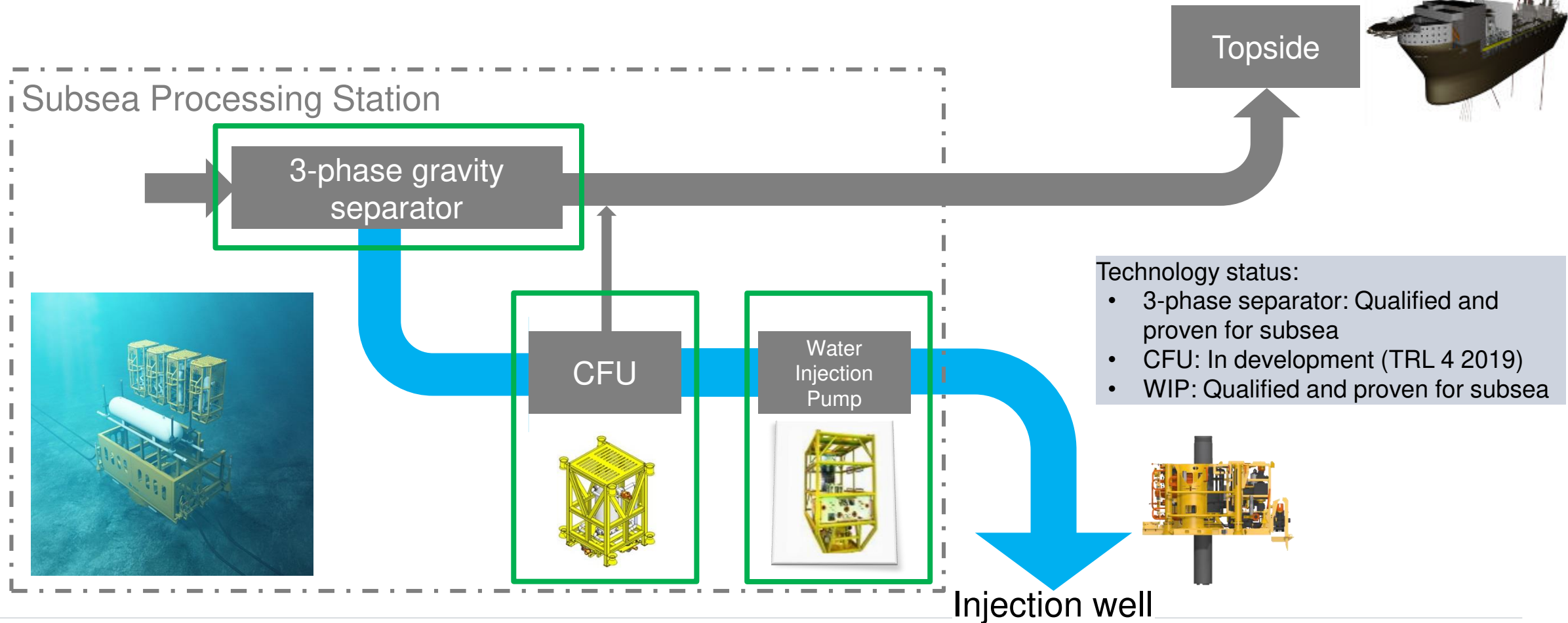
- Simple scrubber design
- Cyclones

Qualified



Produced Water Injection

- Produced water quality requirements for injection in production reservoirs vary, but typically <100 ppm Oil in Water

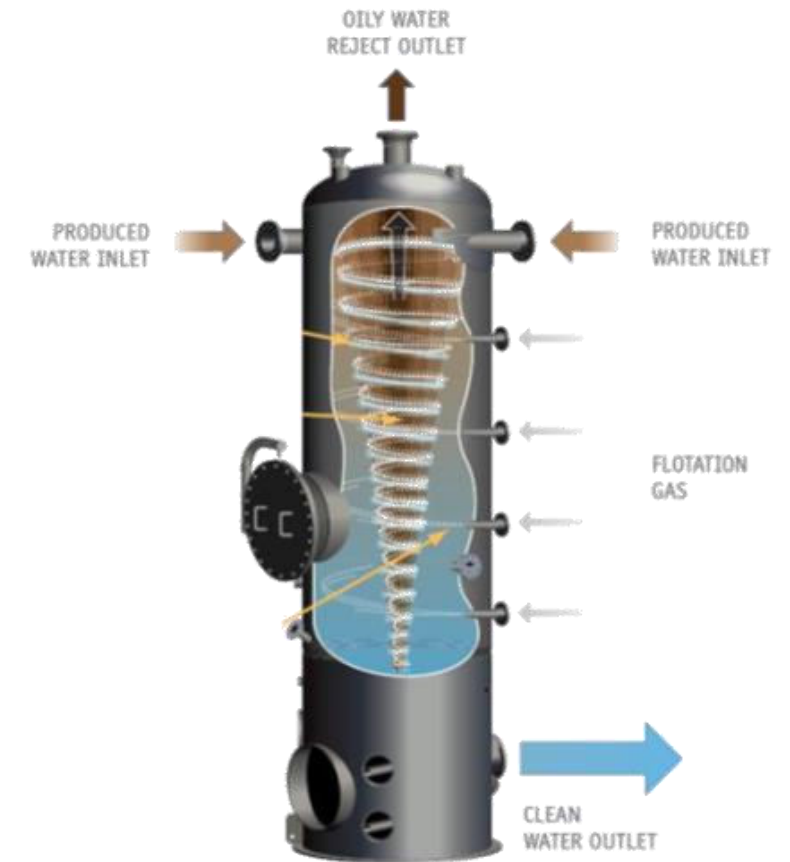


Compact Flotation Unit (CFU)

- Field proven topside
- High performance
 - Can achieve <30 ppm OiW
- Large operating range
- Robust, low risk of clogging
- High turndown capability
- Ongoing JIP activities to qualify for subsea – TRL 4



The Research Council
of Norway



Pilot: Test at Statoil P-lab (Norway)

- Objectives: Verify performance and function in high pressure operation. Map performance and operational envelope



CFU Test Skid



Subsea seawater injection system

Delivered System:

Tyrihans Subsea Raw Sea Water Injection (SRSWI)

- No filtering or chemical treatment of the injected water
- 2 x 2.7 MW subsea pump modules
- 2 x subsea transformers
- Overtrawlable structure
- SCM and CM modules

31 km step-out, 270 m water depth,
>500 m³/h injection rate at 205 bar

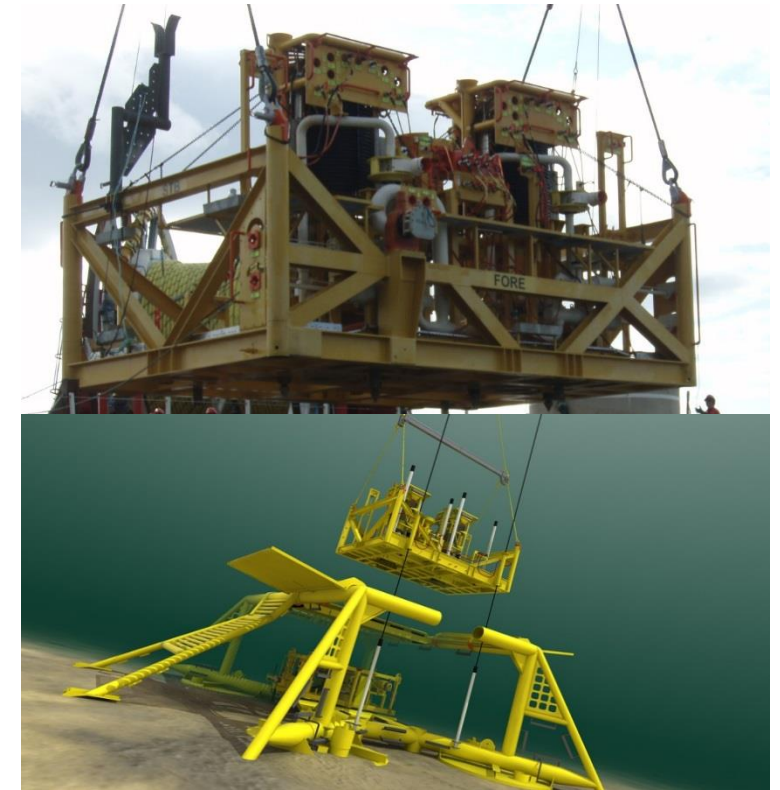
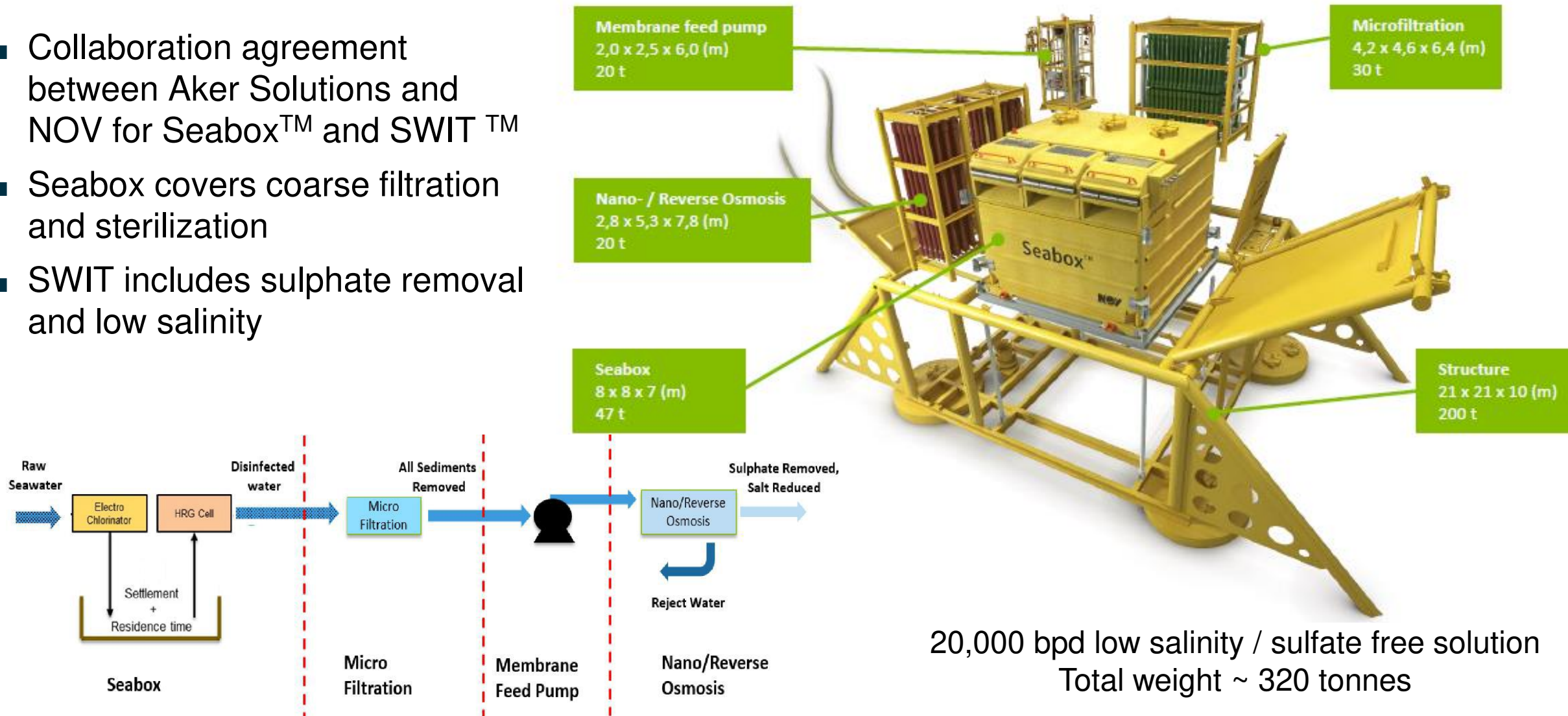


Illustration of Tyrihans SRSWI station

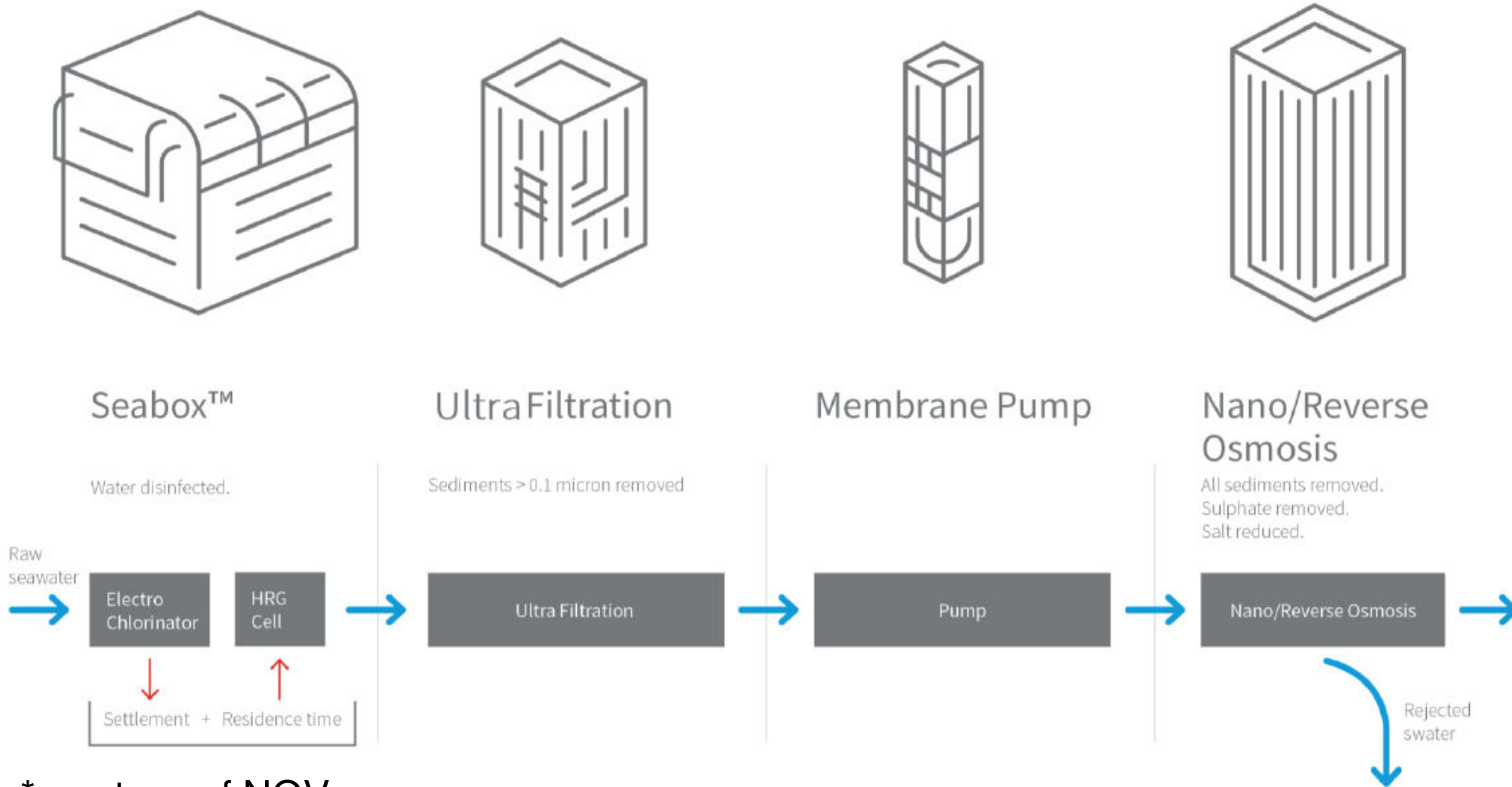
- Water to be injected may require treatment
- Aker Solutions has a cooperation with NOV to produce the required quality

Next steps in sea water treatment

- Collaboration agreement between Aker Solutions and NOV for Seabox™ and SWIT™
- Seabox covers coarse filtration and sterilization
- SWIT includes sulphate removal and low salinity



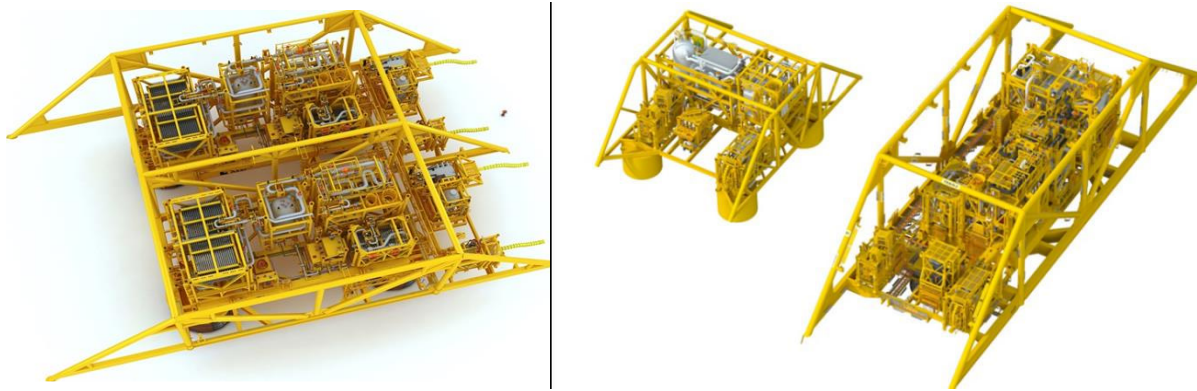
SWIT™ Technology In Full



*courtesy of NOV

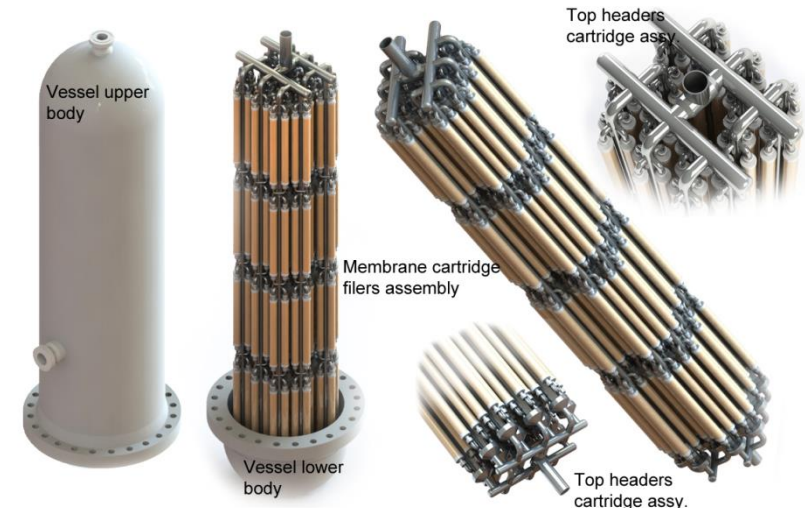
CO2 Removal - Two Important Subsea Building Blocks

Compression System



- Compression system proven by Åsgard
- SCS 2.0, offering 50% reduction in weight

Selective Membranes



- New polymer qualities with robust properties
- Compact arrangement for subsea developed

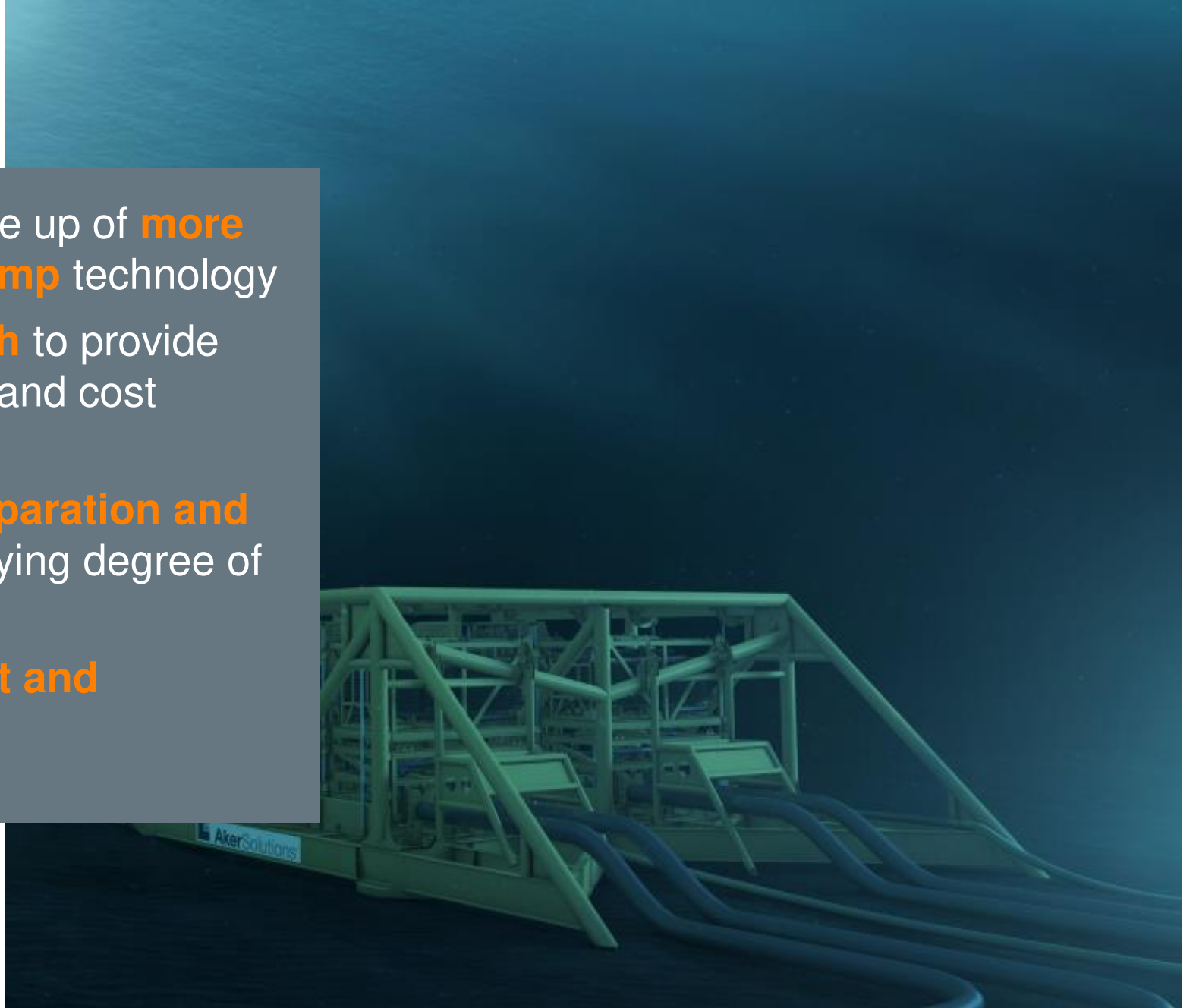
Depending on arrangement 90 – 97 % CO₂ can be separated from well stream.

Ongoing CO2 Membrane JIP Activities

- To obtain knowledge about the performance of various membrane qualities within the relevant operational subsea window
 - Data for membrane productivity (flux) and selectivity
- Specify the operational window for the most applicable membrane quality
- Obtain knowledge about the sustainability of membranes, potting materials and glued systems vs relevant conditions
 - Acidic water/gas phases @ HP and HT
 - Condensed HC's @ HP and HT
- Evaluate the technical and economic justification for subsea bulk separation of CO2 for offshore CO2 EOR applications
- Establish a milestone to justify further development of the technology concept

Summary

- Subsea processing is made up of **more than compressor and pump** technology
- **Building blocks approach** to provide flexibility, standardization, and cost reduction.
- Large range of **subsea separation and treatment** technology, varying degree of technology maturity.
- **Continuous development and qualification activities.**



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