SUBCOMP – A new solution for CO_2 EOR

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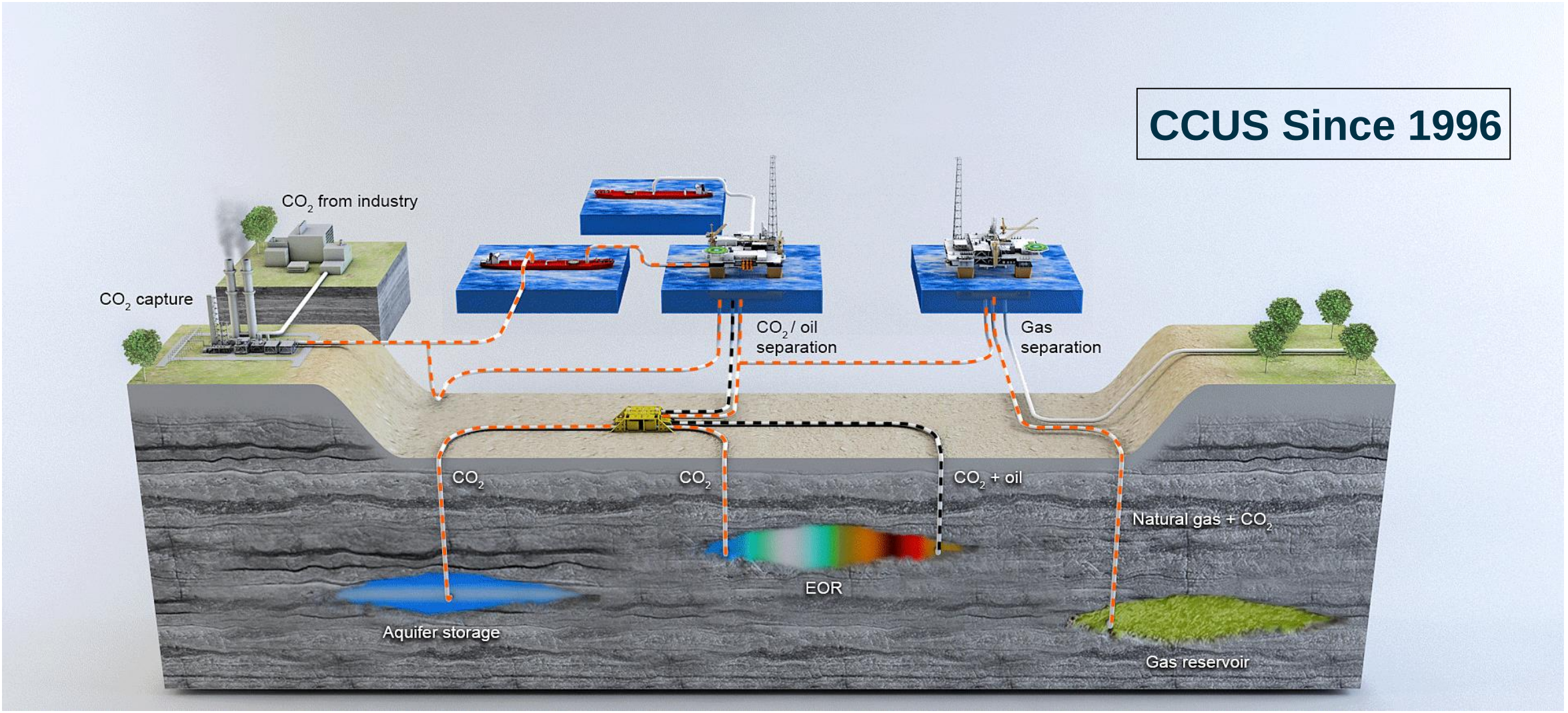
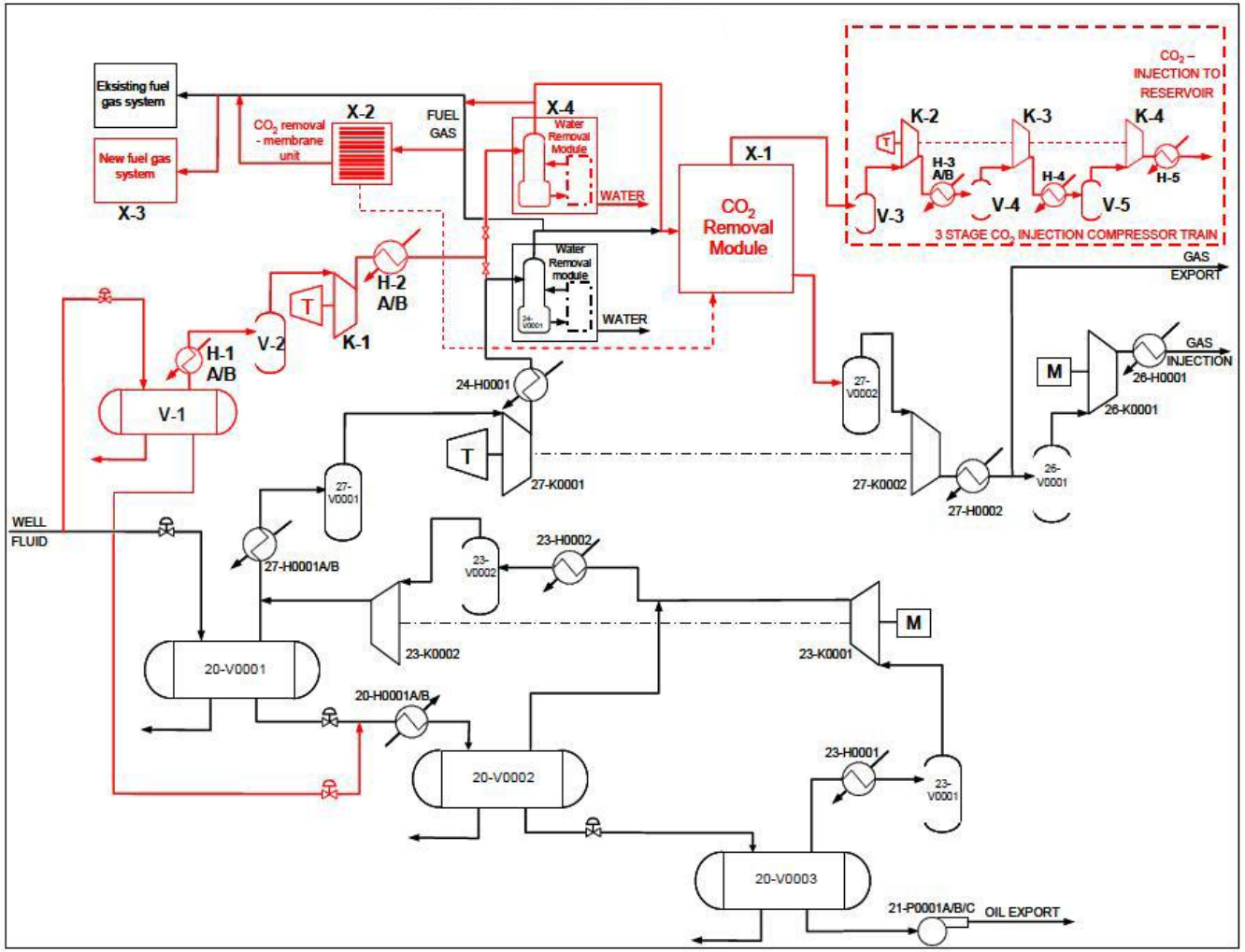
Aker Solutions offers technology and solutions for the entire carbon capture, utilization and storage (CCUS) value chain:



Main challenges for CO_2 EOR on the NCS

- 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

CO_2 EOR - Modifications of topside process facilities



Existing equipment

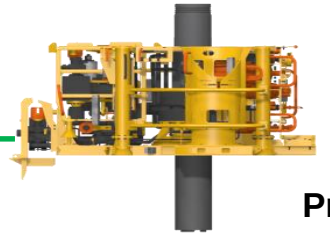
Modifications from CO_2 rich well stream

AkerSolutions

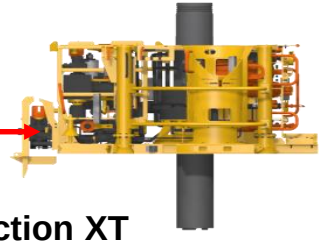
Subsea systems qualified

- ☑ 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

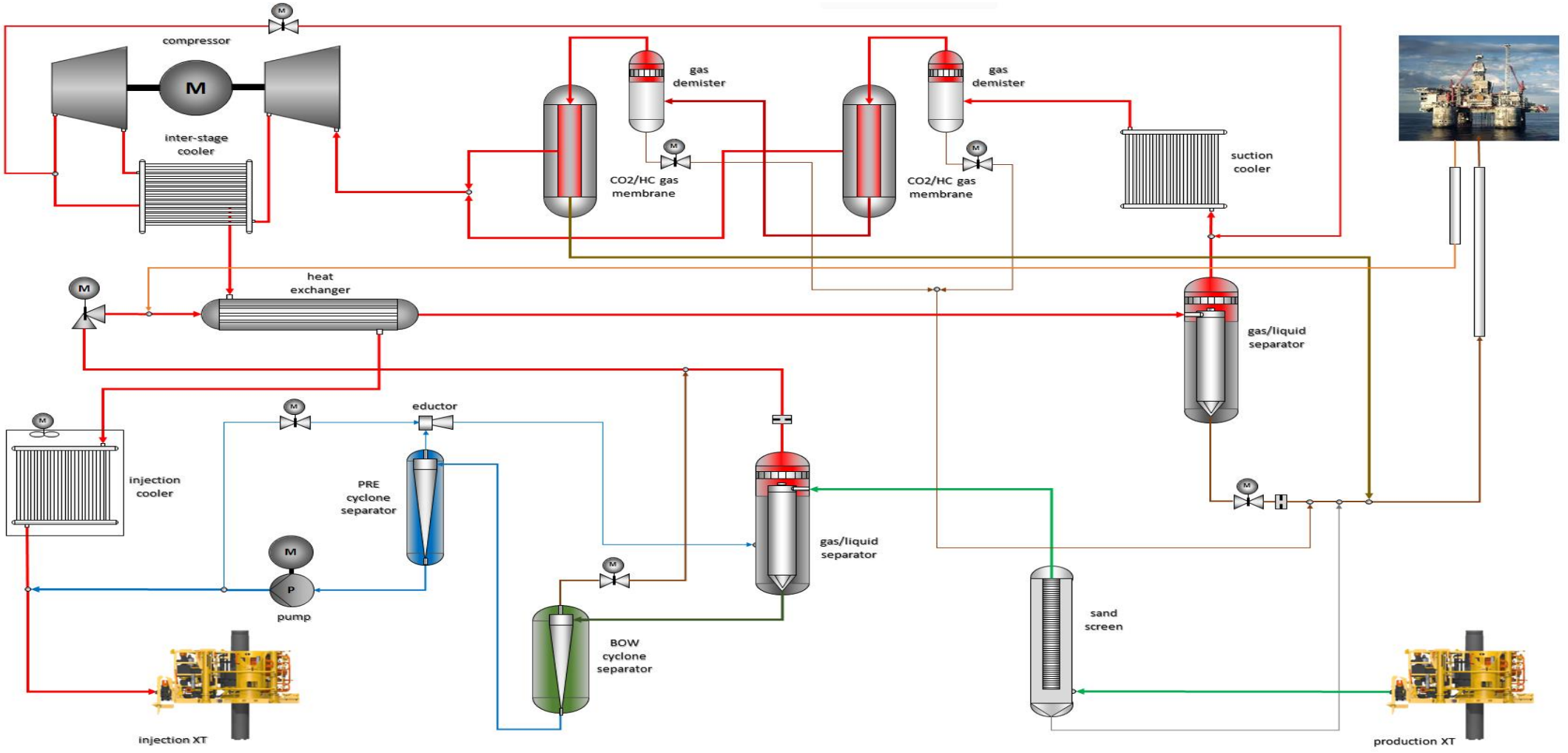


Production XT

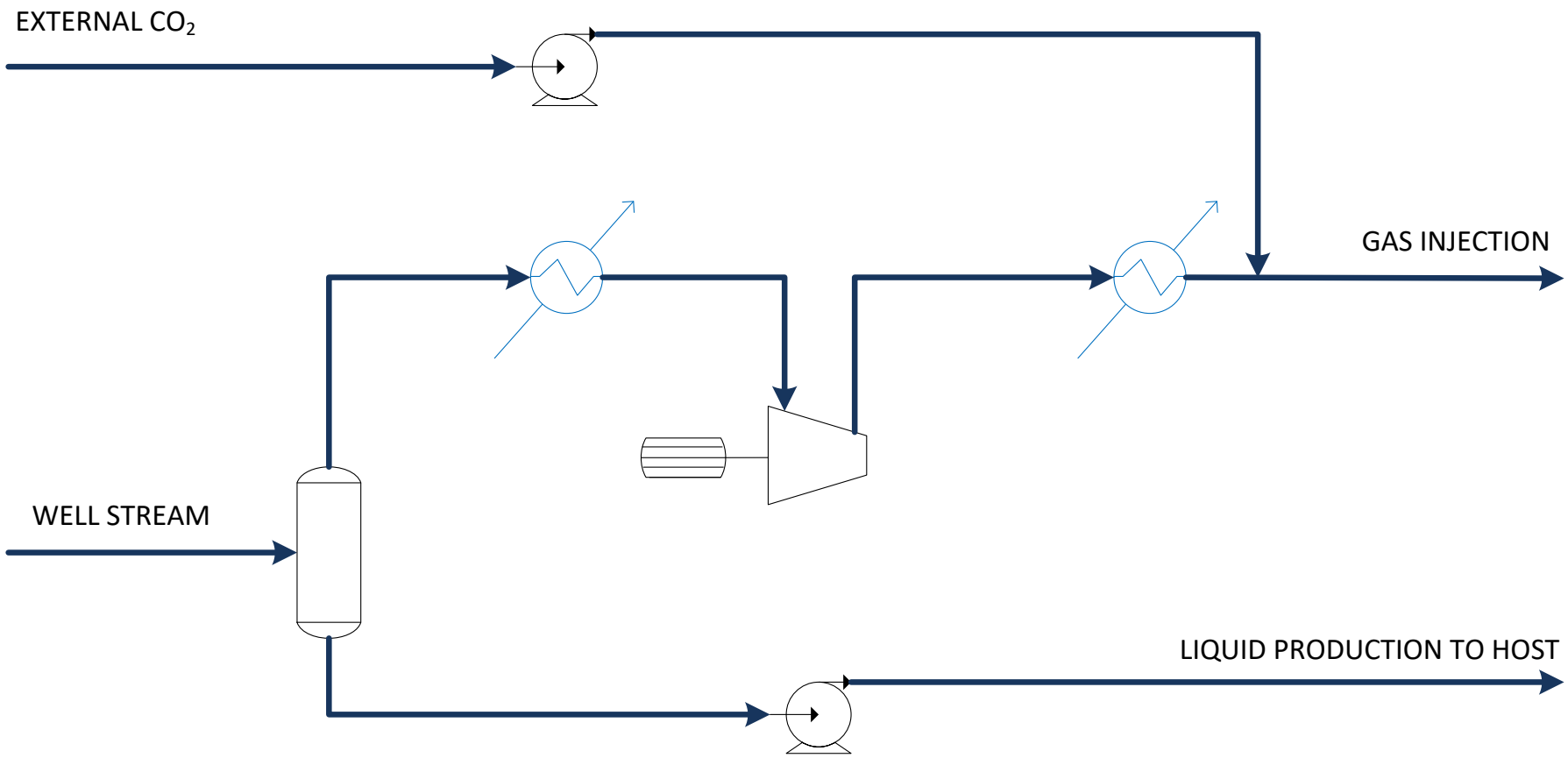


Injection XT

Comprehensive subsea concept – can it be simplified?

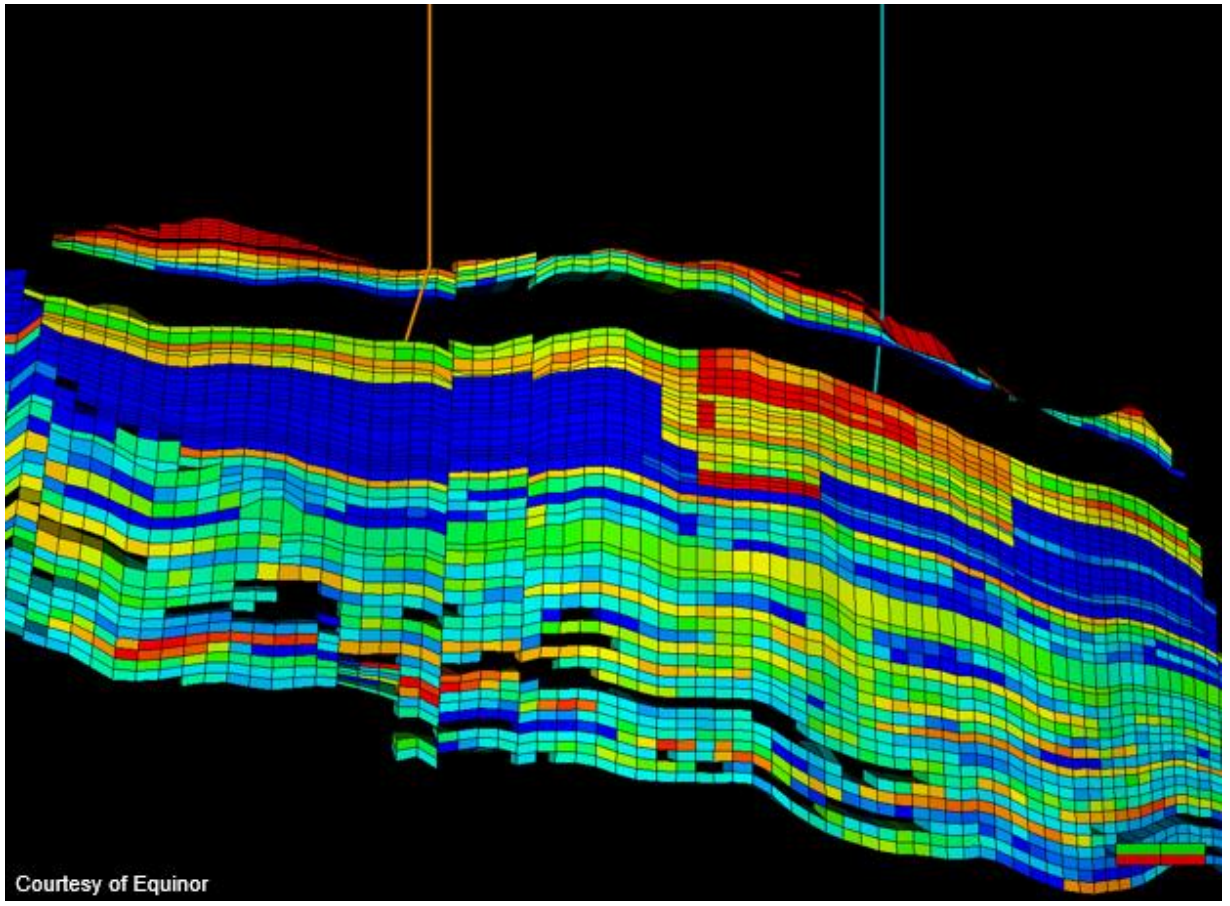


Simplified concept - SUBCOMP



Reservoir simulations

- Equinor performed extensive reservoir simulations
- Simulations performed on segments of actual reservoir
- Reuse of existing wells – not optimized with respect to EOR performance
  - Concept requires continuous gas injection
  - Simultaneous water and gas (SWAG) used as injection strategy
- Recirculation of the gas phase means increased gas rates over time
  - The concept is suitable for smaller fields
- Simulation results used as input for other study activities

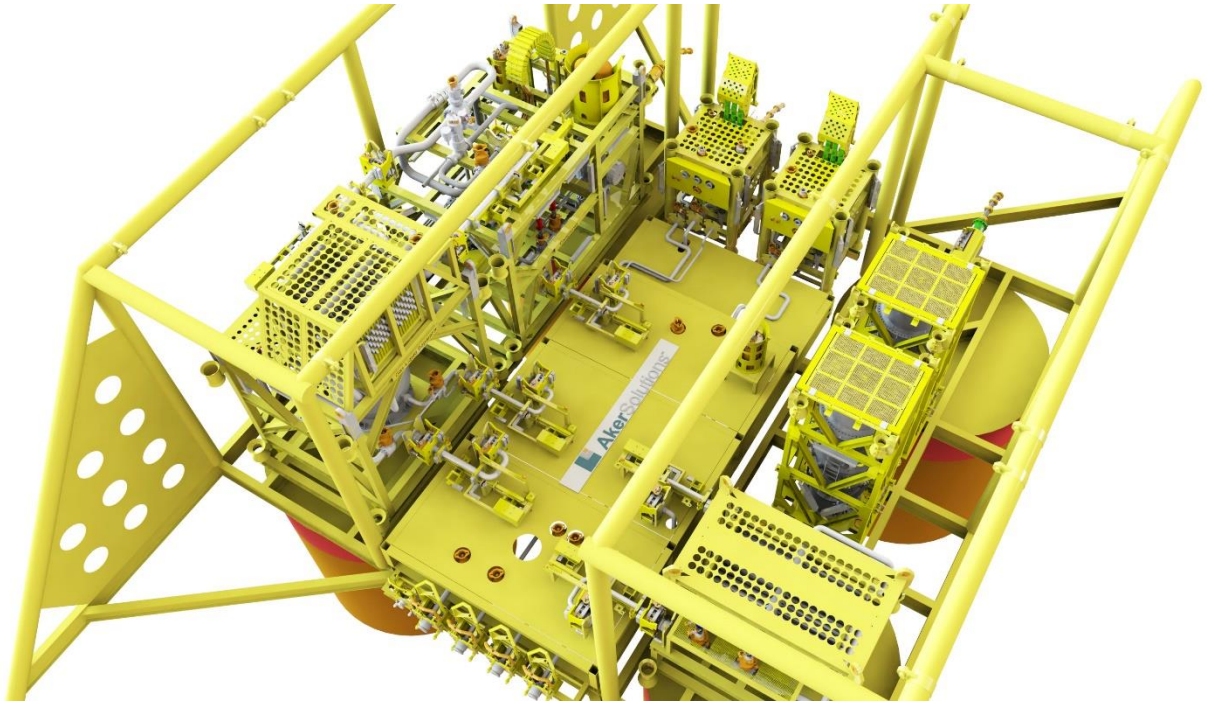


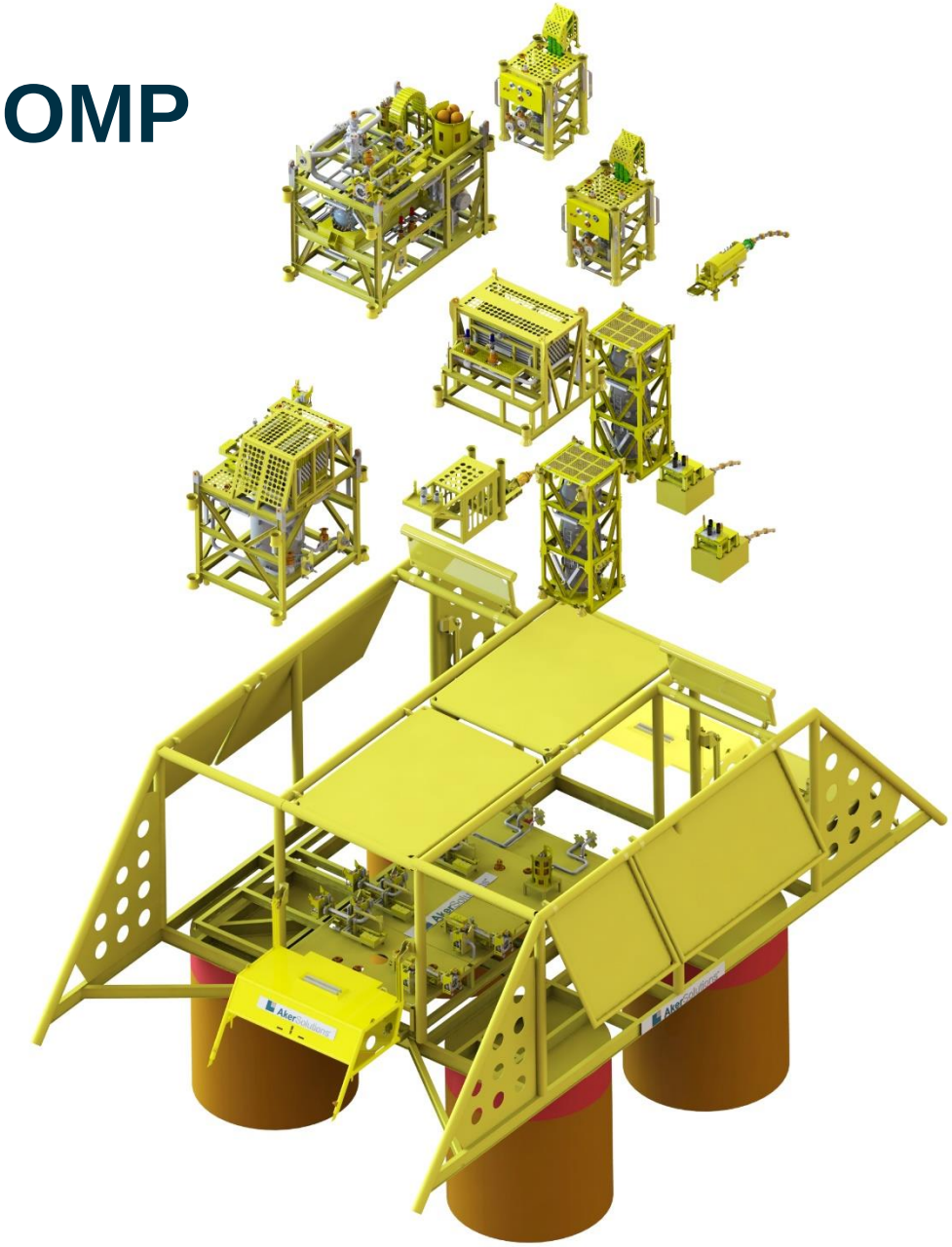
Subsea compressor

- Based on the proven technology of the Åsgard Subsea Compression system by MAN Energy Solutions
- Main challenges assessed for the simplified concept
  - Large variations in flow rate and pressure ratio
  - Large variations in gas composition (CO_2 content)
  - High CO_2 concentrations
- Robust compressor technology can handle variations in flow rate, pressure ratio and gas composition
- Specific design and operation concept for high CO_2 content

Subsea processing station - SUBCOMP

- Equipment is placed on separate, retrievable modules to simplify maintenance
- Total weight 1500 tonnes
- Total footprint 44 m x 25 m, process area 27 m x 25 m



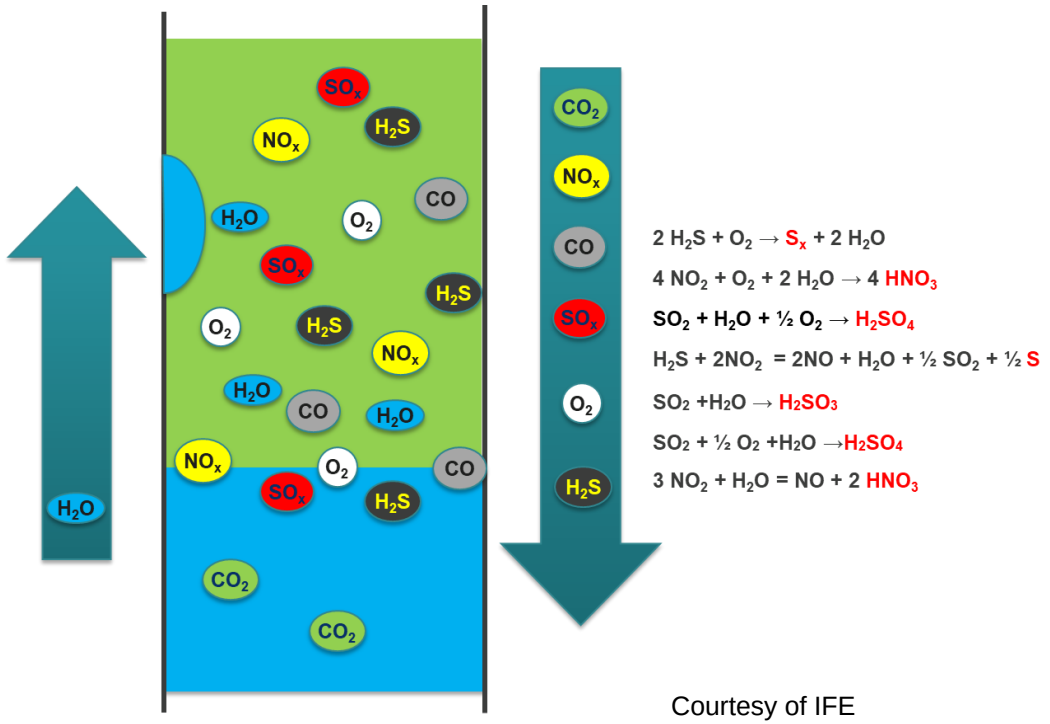


Host facility

- Assessment of generic topside facility
  - Liquid phase produced to host facility will contain CO_2 that will flash off in the separator train
- Assessment identified no major bottlenecks, some equipment will need to be checked when evaluating a specific case
  - Effect of minor changes in gas composition to be evaluated for compressors, fuel gas system, dehydration system etc.
  - The CO_2 content in the export gas will increase
  - Amount depends on subsea separator operating conditions and amount of production from non-EOR wells
- Material assessment
  - High corrosion rate on carbon steel for most parts of the system
  - For medium and high pressure parts of the system corrosion resistant alloys are needed
  - Carbon steel may be acceptable for parts of the low pressure system
  - Most platforms on NCS built in the last 20 years are built with corrosion resistant alloys in the process systems

Injection well material assessment

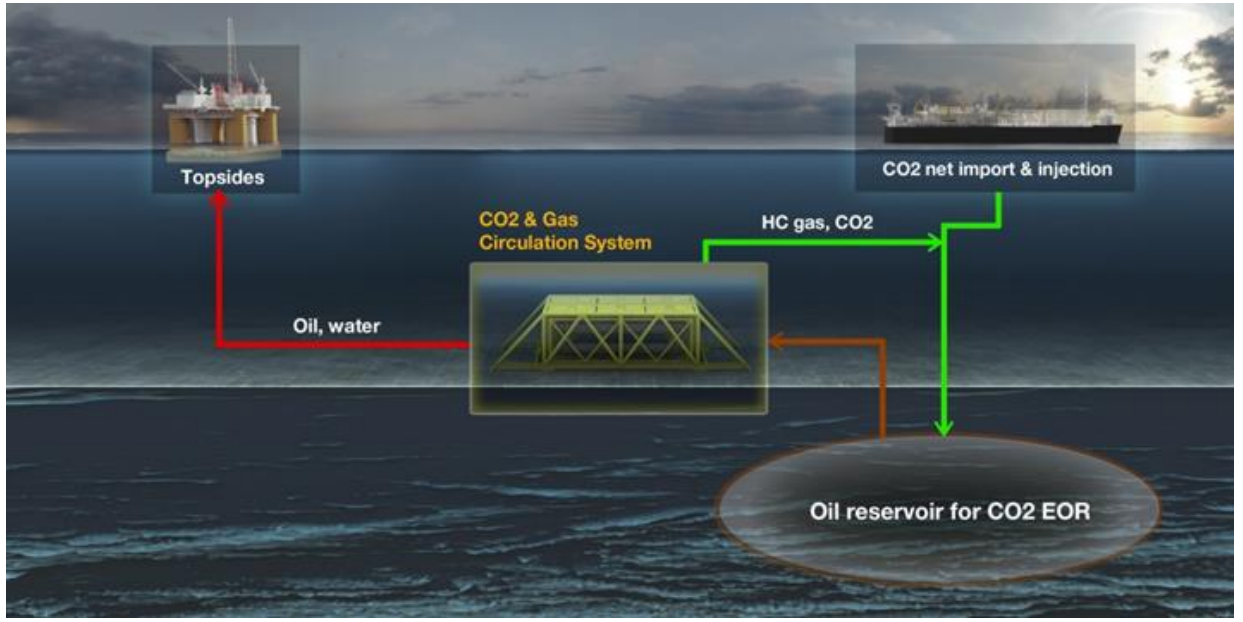
- CO_2 captured from exhaust gas or industrial processes will contain impurities (SO_x, NO_x, O_2, CO)
  - No consensus on the limits
- When all impurities are present experiments have shown that cross-chemical reactions and formation of new products can take place
- More work is needed to definitively conclude on the material selection for the injection system



Courtesy of IFE

Storage effect

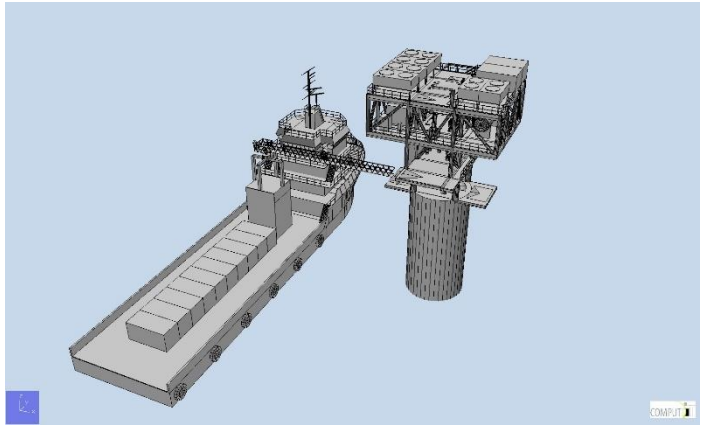
- CO_2 injected: 1.5 Mt/y x 5y ➡ 7.5 Mt
- Emitted CO_2:
  - Not estimated in supply chain
  - Weighted average flashed: 0.17 Mt (20 y)
- Gross CO_2 storage: 98 %

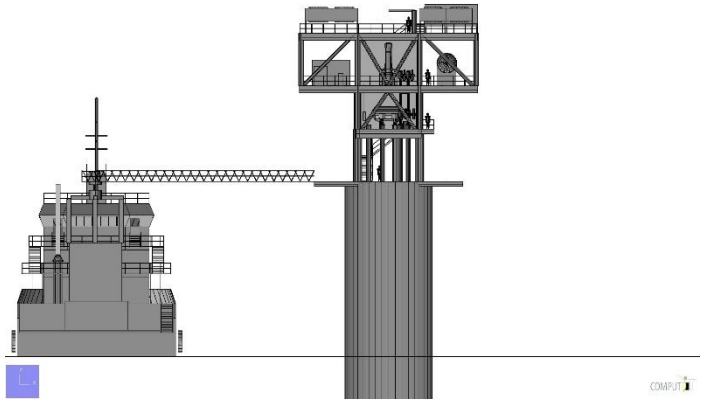


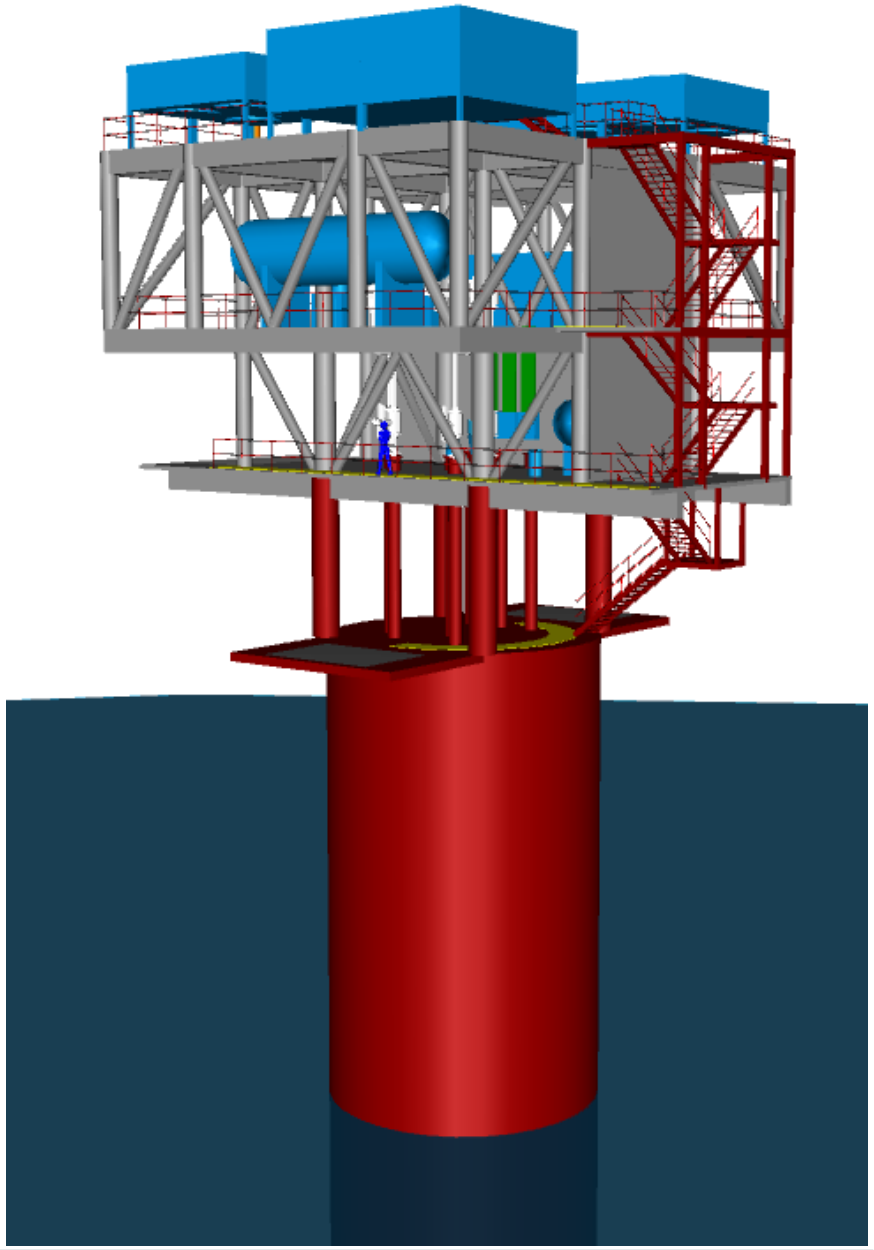
SUBCOMP – CO_2 EOR Production System

Topside alternative - SUBCOMP

- Separate topside facility
- Unmanned
  - No helicopter deck
  - No living quarters
  - Walk to work
- Substructure can be floating or bottom fixed depending on water depth

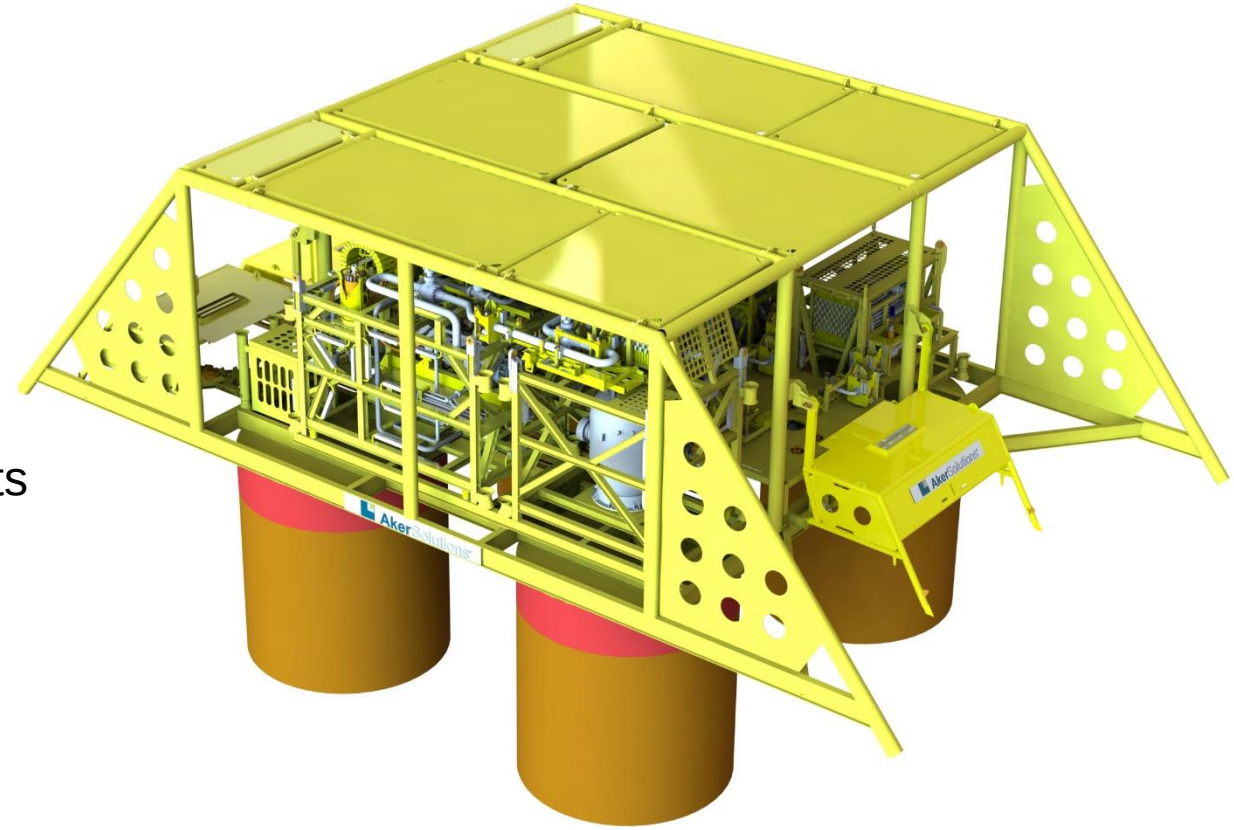






CO_2 EOR

- CO_2 EOR is a value-creating supplement to permanent CO_2 storage
- CO_2 EOR has a significant CO_2 storage effect as the produced CO_2 is re-injected into the reservoir
- Subsea solutions may be a key enabler for CO_2 EOR
  - Remove or minimize the need for costly retrofits of existing process facilities to handle sour gas
- The SUBCOMP simplified concept is suitable for smaller fields
  - No technical show stoppers have been identified
  - For larger fields bulk separation of CO2 is needed to avoid huge gas rates



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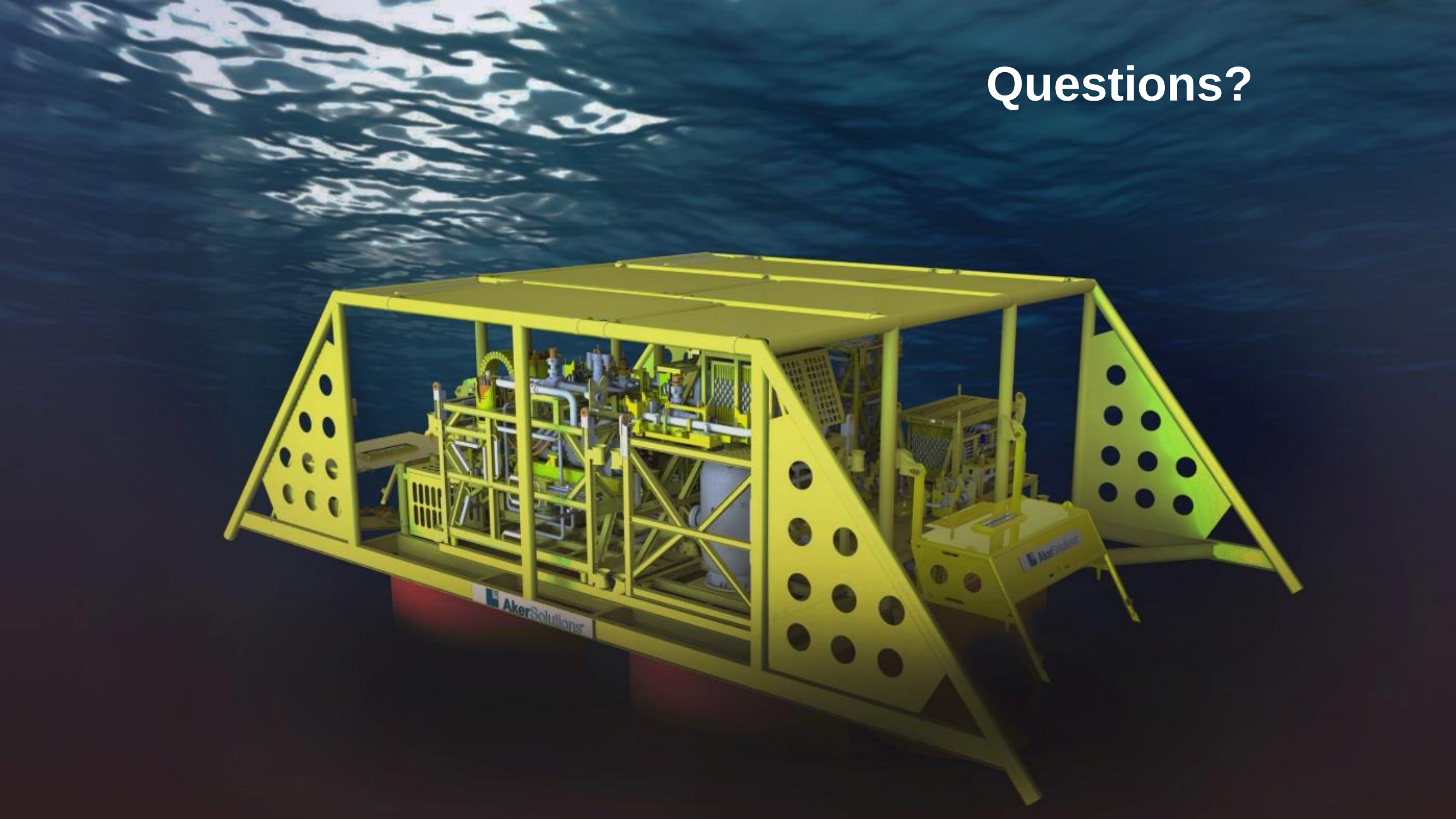
  - CLIMIT is the Norwegian national programme for research, development, piloting and demonstration of CO2 capture and storage (CCS) technologies for power generation and other industrial sources.

Questions?



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