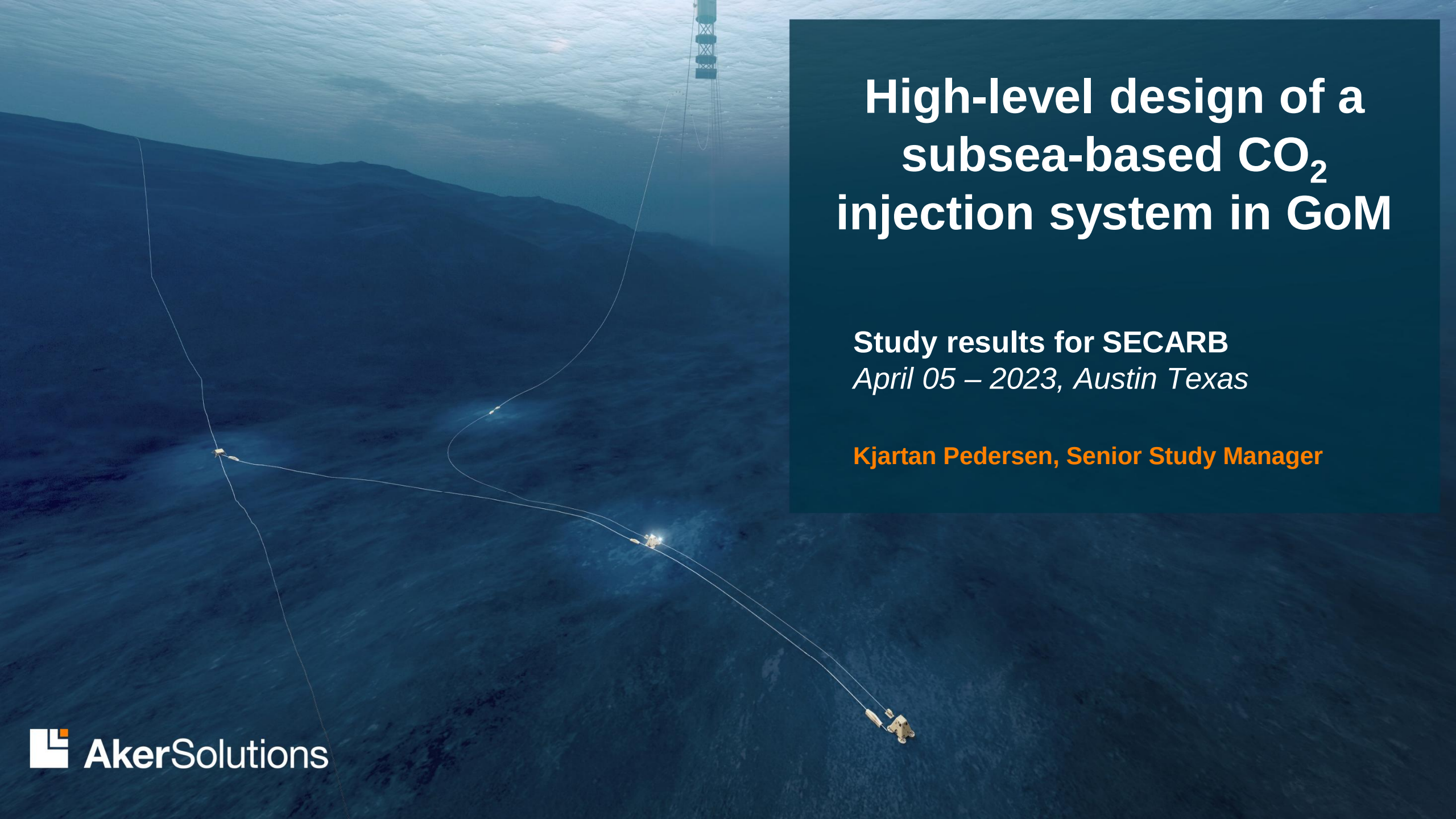
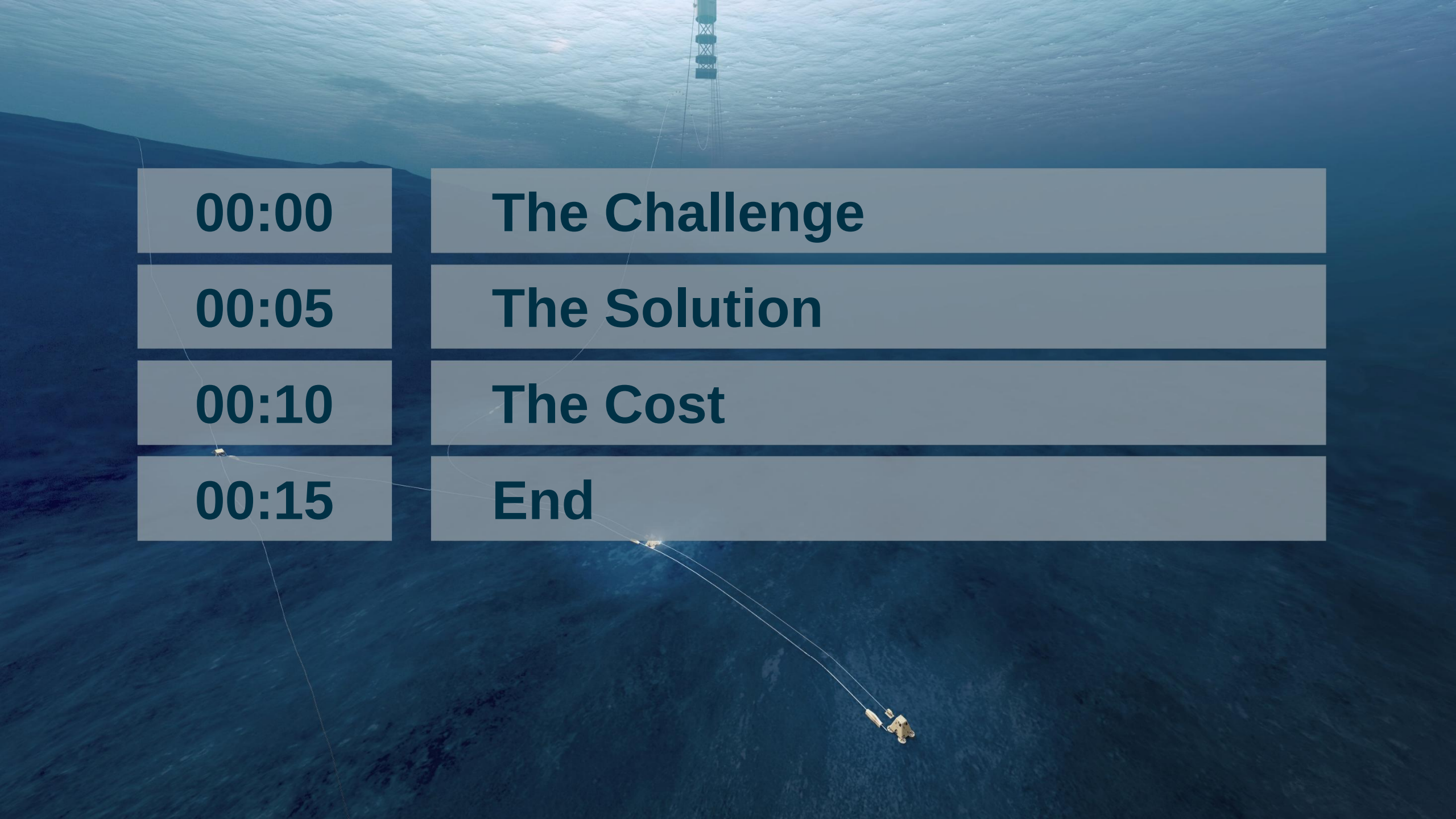


High-level design of a subsea-based CO_2 injection system in GoM

Study results for SECARB
April 05 – 2023, Austin Texas

Kjartan Pedersen, Senior Study Manager

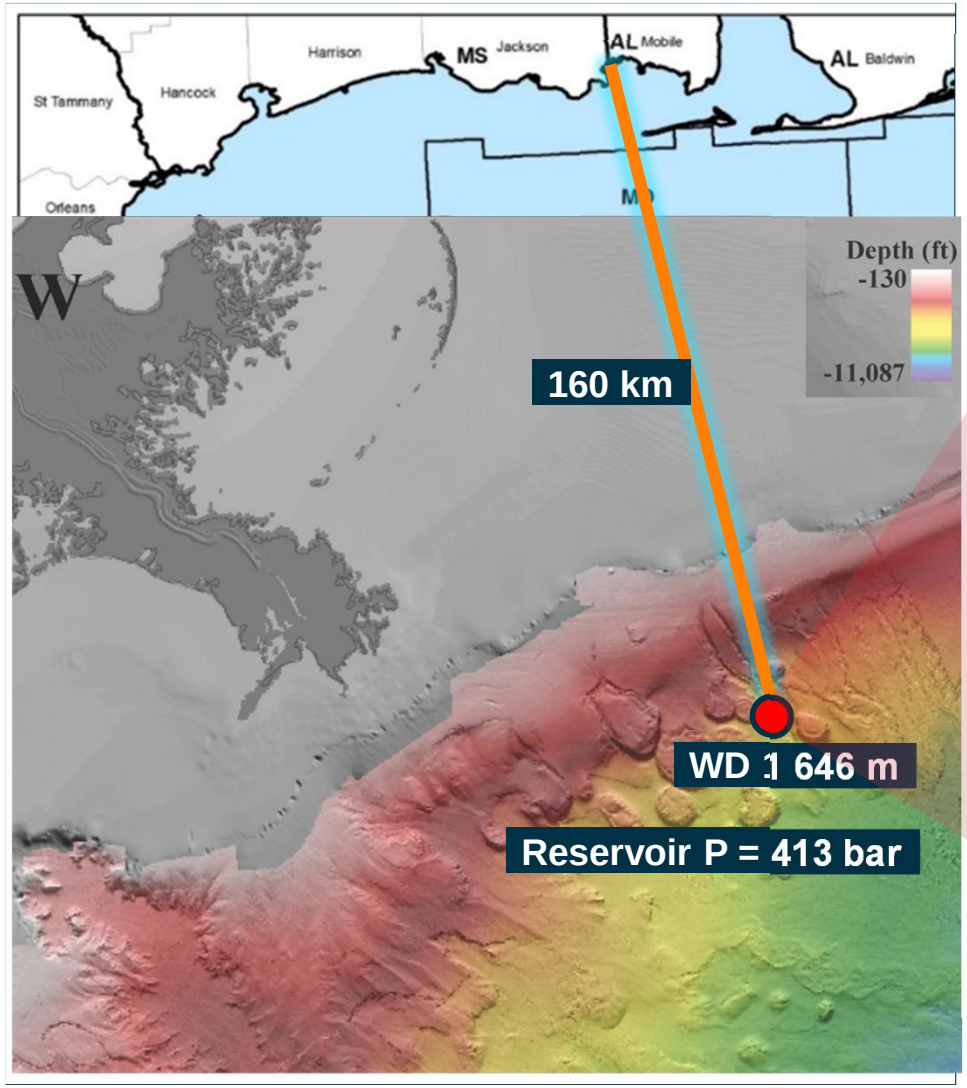
AkerSolutions

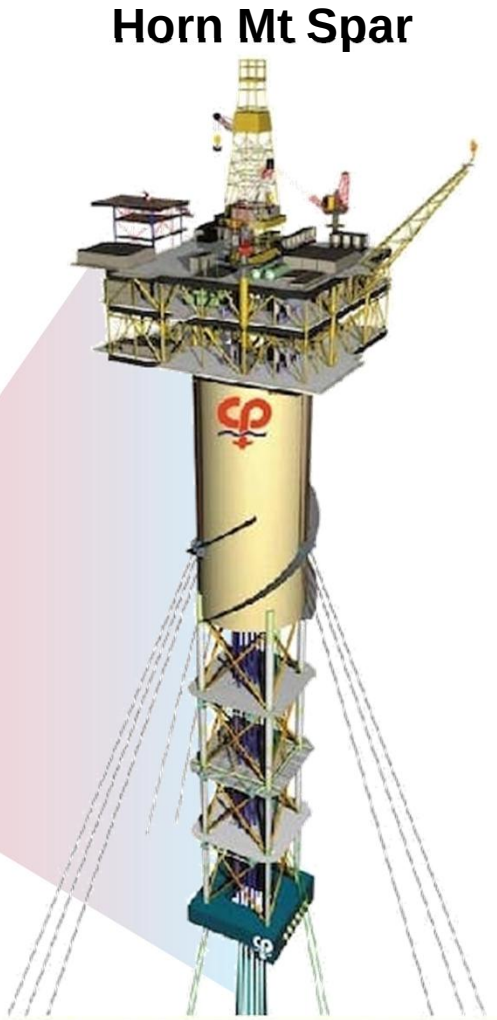

00:00
The Challenge
00:05
The Solution
00:10
The Cost
00:15
End

The Challenge: Get CO_2 into the Horn Mt reservoir

- Provide high-level design and cost estimate of a subsea-based CO_2 injection system in the GoM

Study parameter	Value
Distance to shore	160 km SE of New Orleans
Number of Wells	2 injection
Distance to host (Horn Mt Spar)	10 km
Water depth	1646 m
Reservoir depth	3,380 m
Reservoir P	413 bar
Reservoir T	93.3°C





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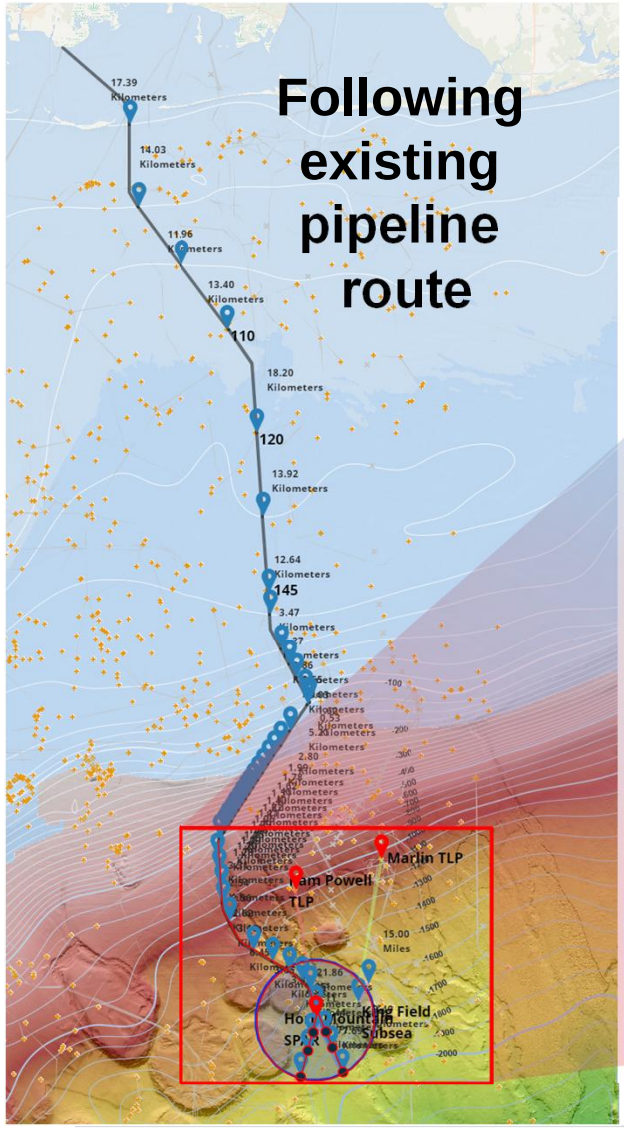
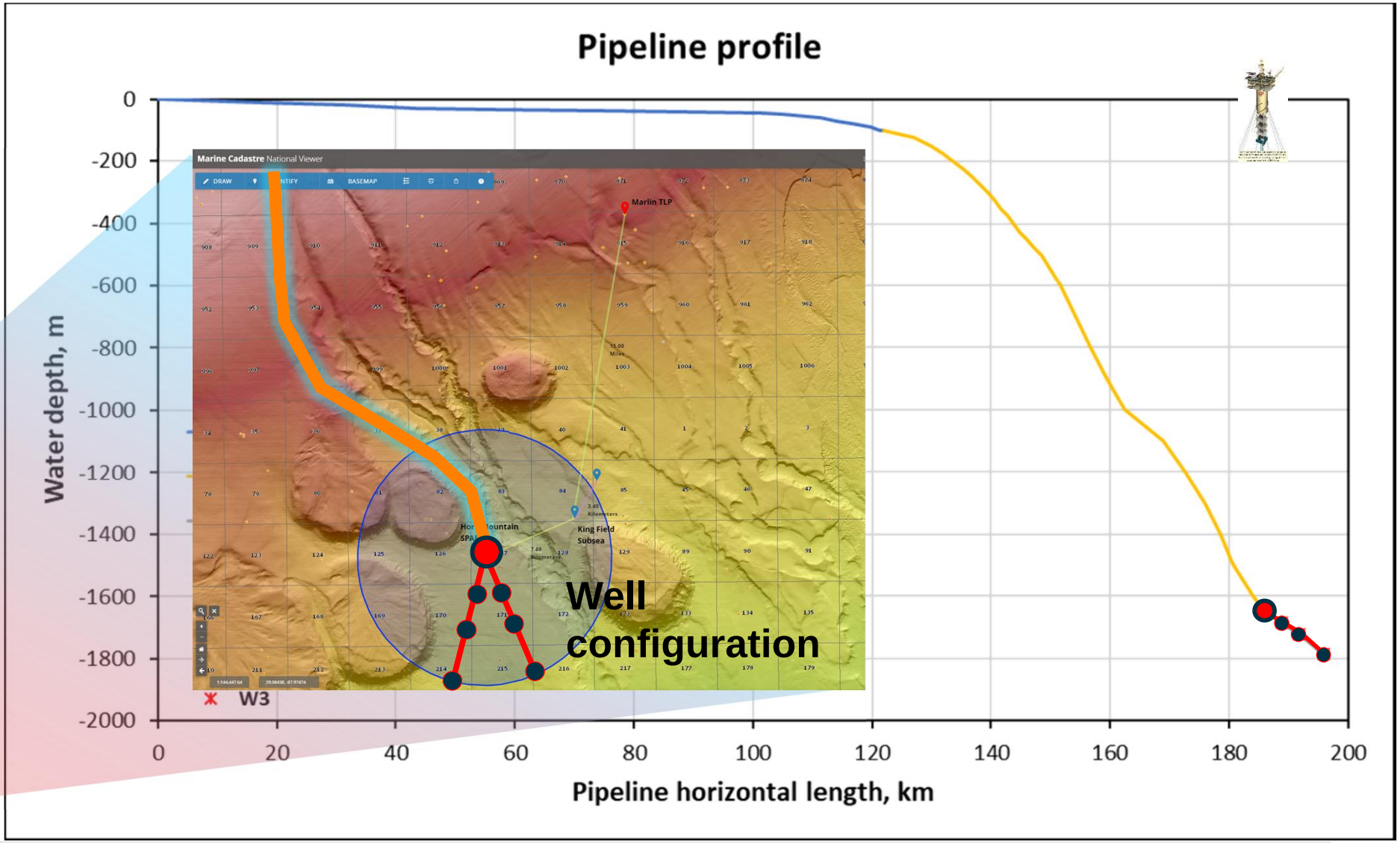
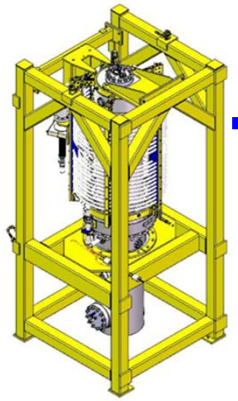
Finding the solution: Starts with the pipeline route

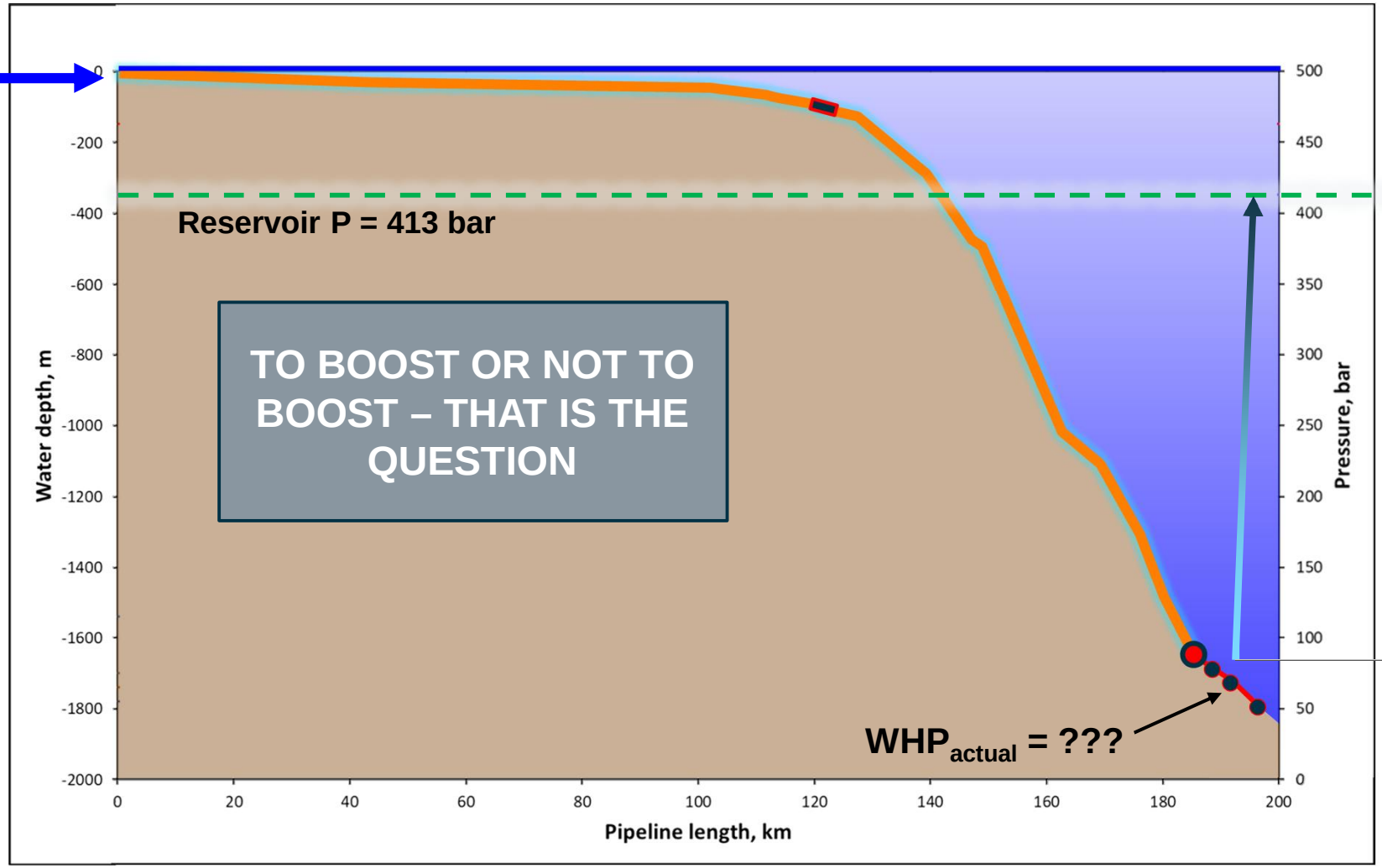




Finding the solution: Depends on WHP_{actual} vs. $WHP_{minimum}$



Pressure at WH depends on boosting pressure onshore



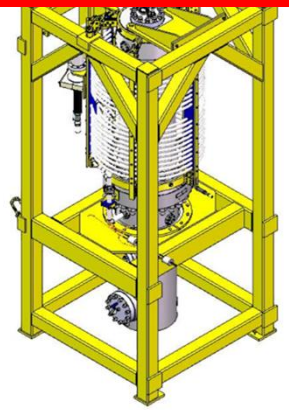
413 bar

3 380 m well depth with ≈ 1 000 kg/m³ gives P from well of about 325 bar

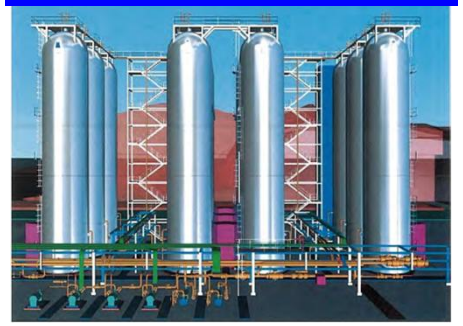
$WHP_{minimum}$ 88 bar

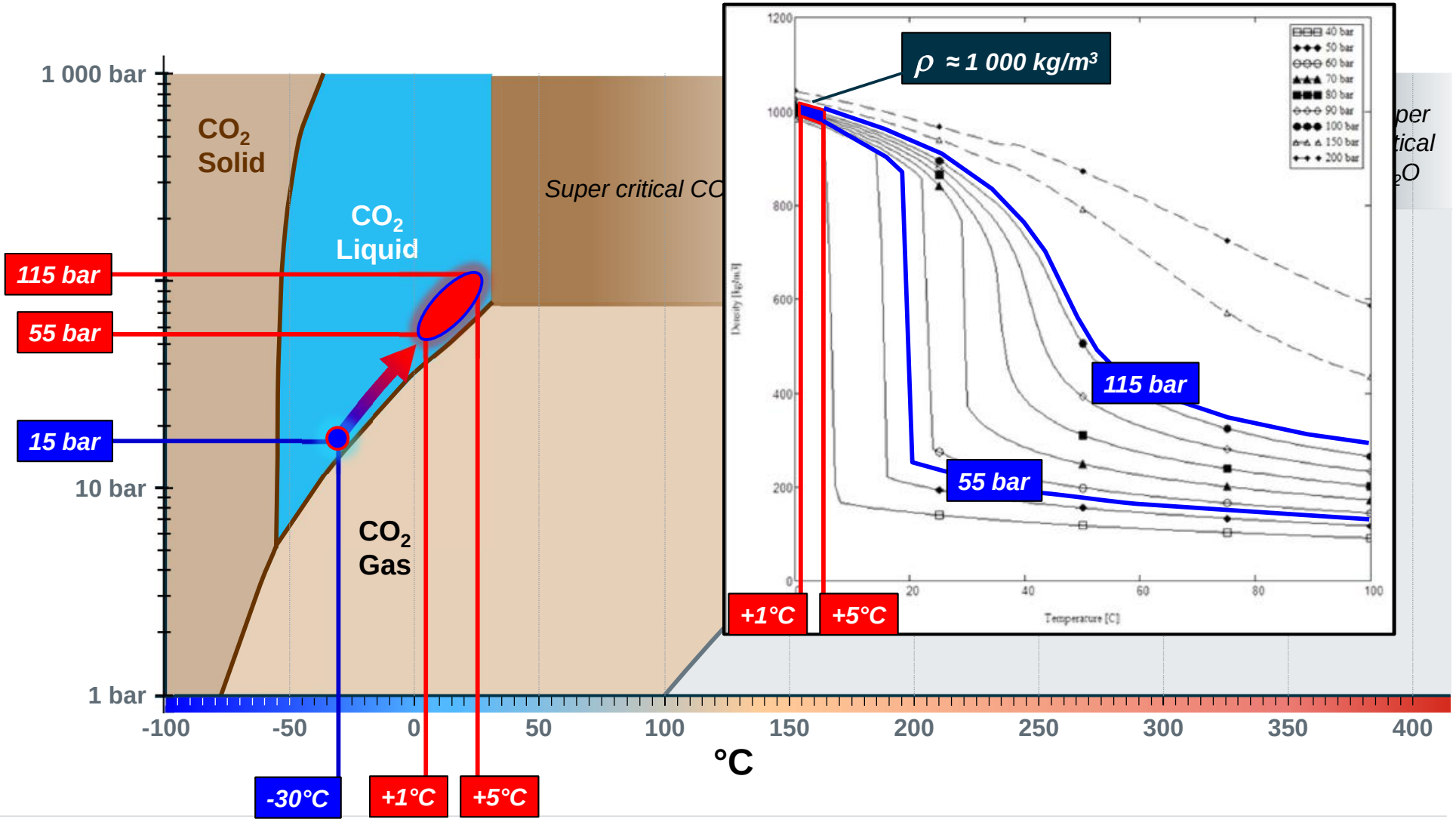
Onshore pumping P & T: We want to pump liquid phase

Pumping Assumption:
55 bar < P < 115 bar
+1°C < T < +5°C

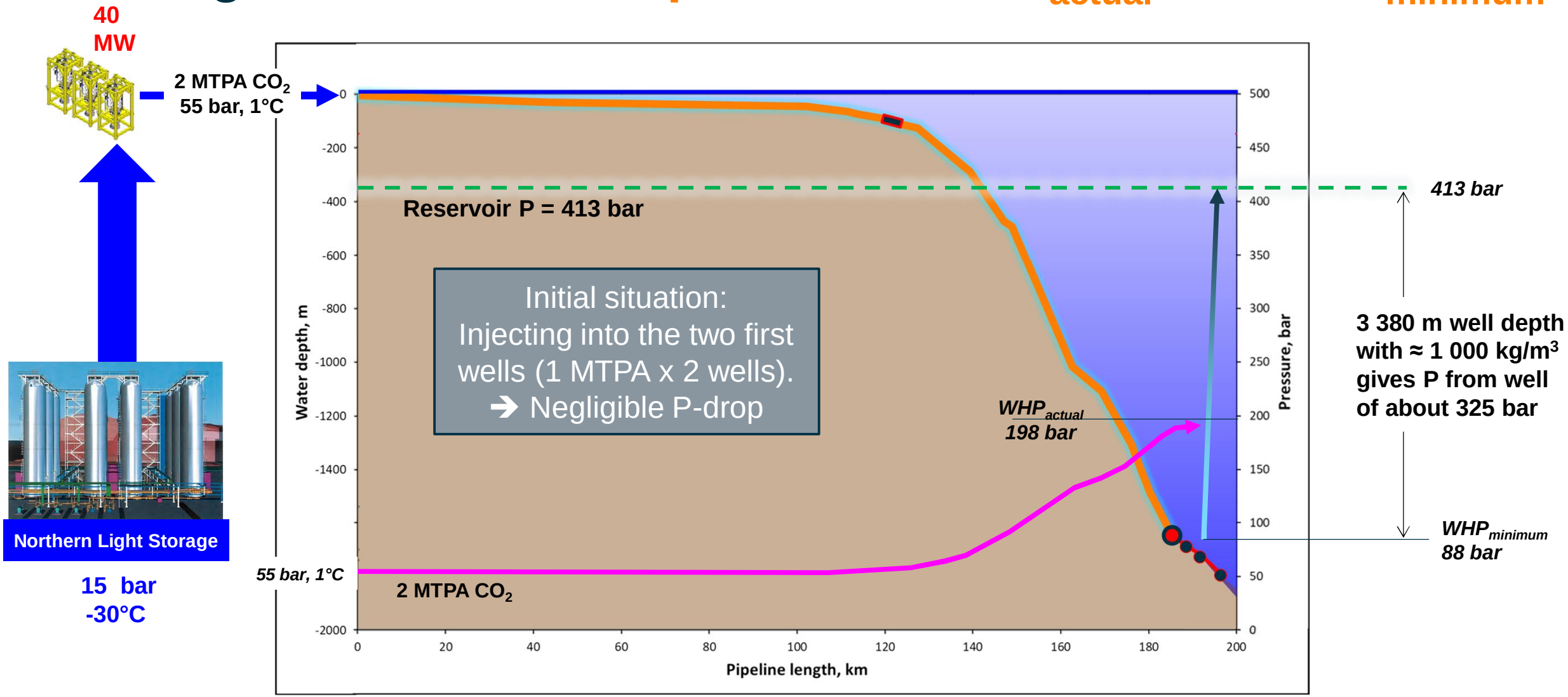


Northern Light Storage

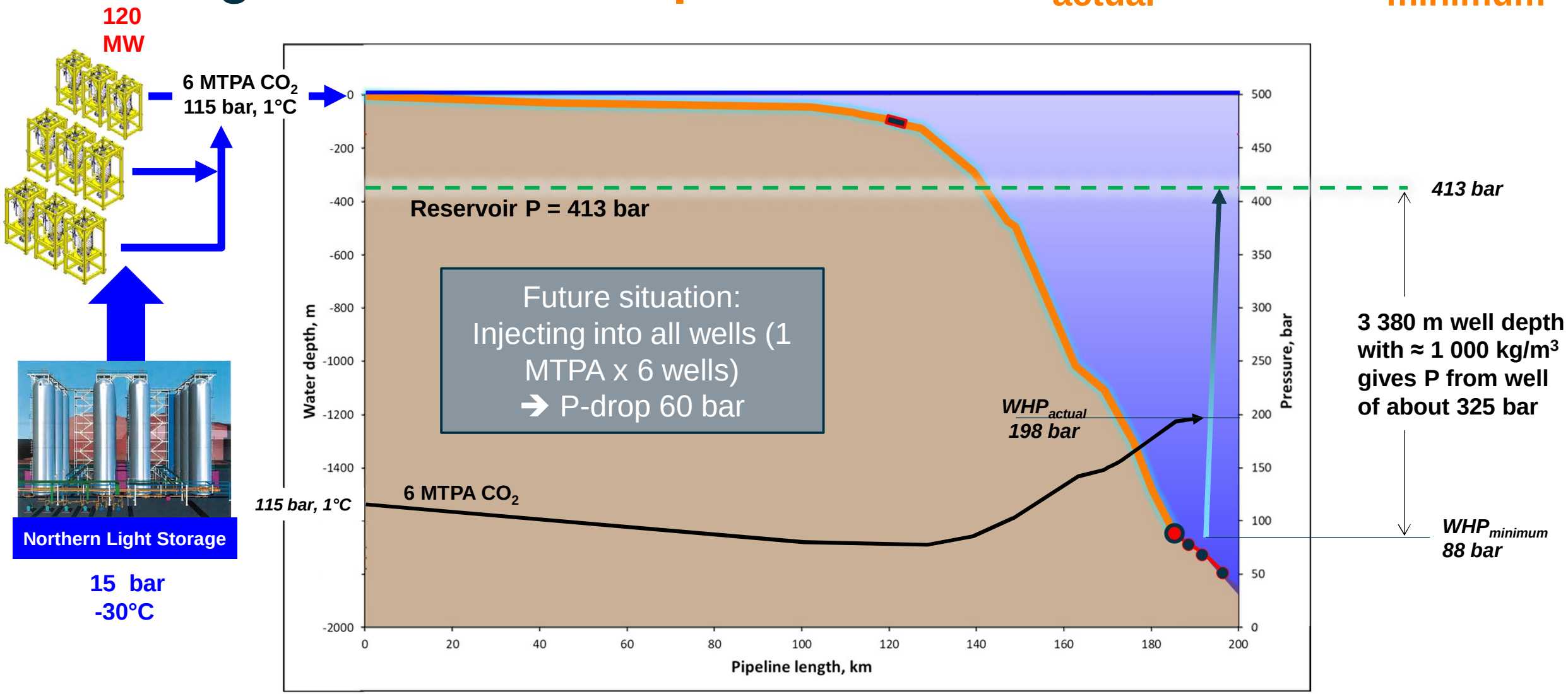




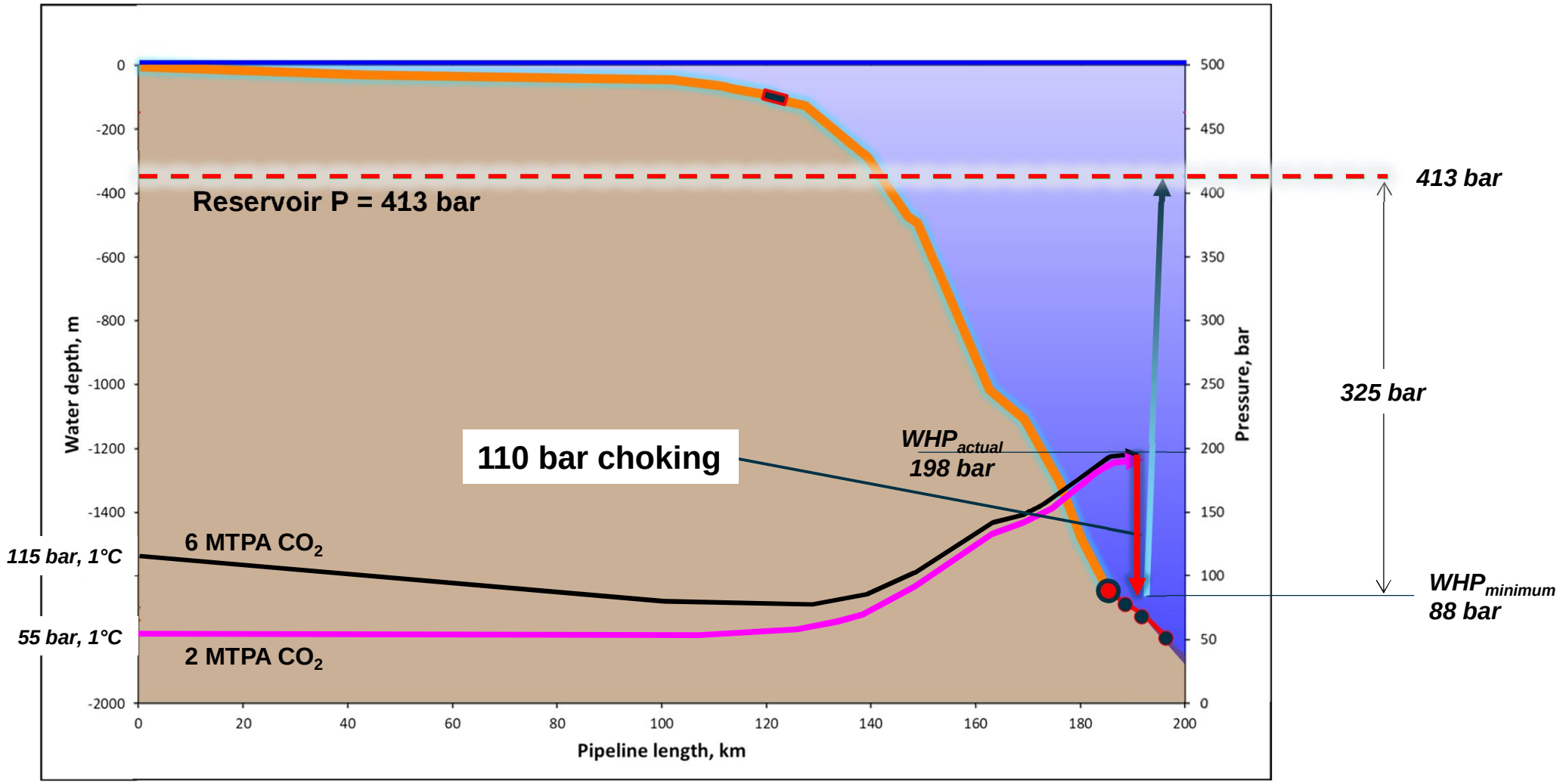
Finding the solution: Depends on WHP_{actual} vs. $WHP_{minimum}$



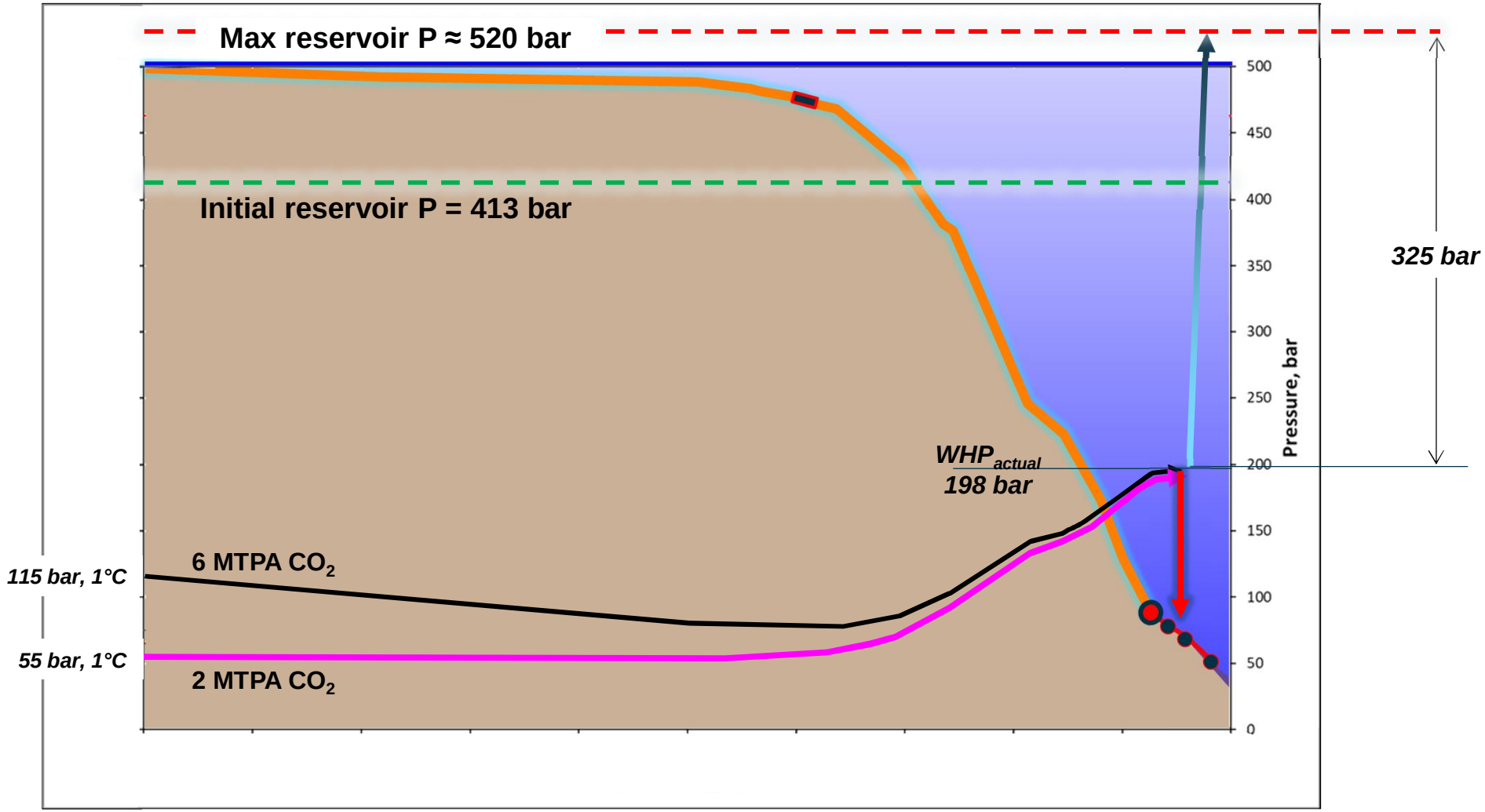
Finding the solution: Depends on WHP_{actual} vs. $WHP_{minimum}$



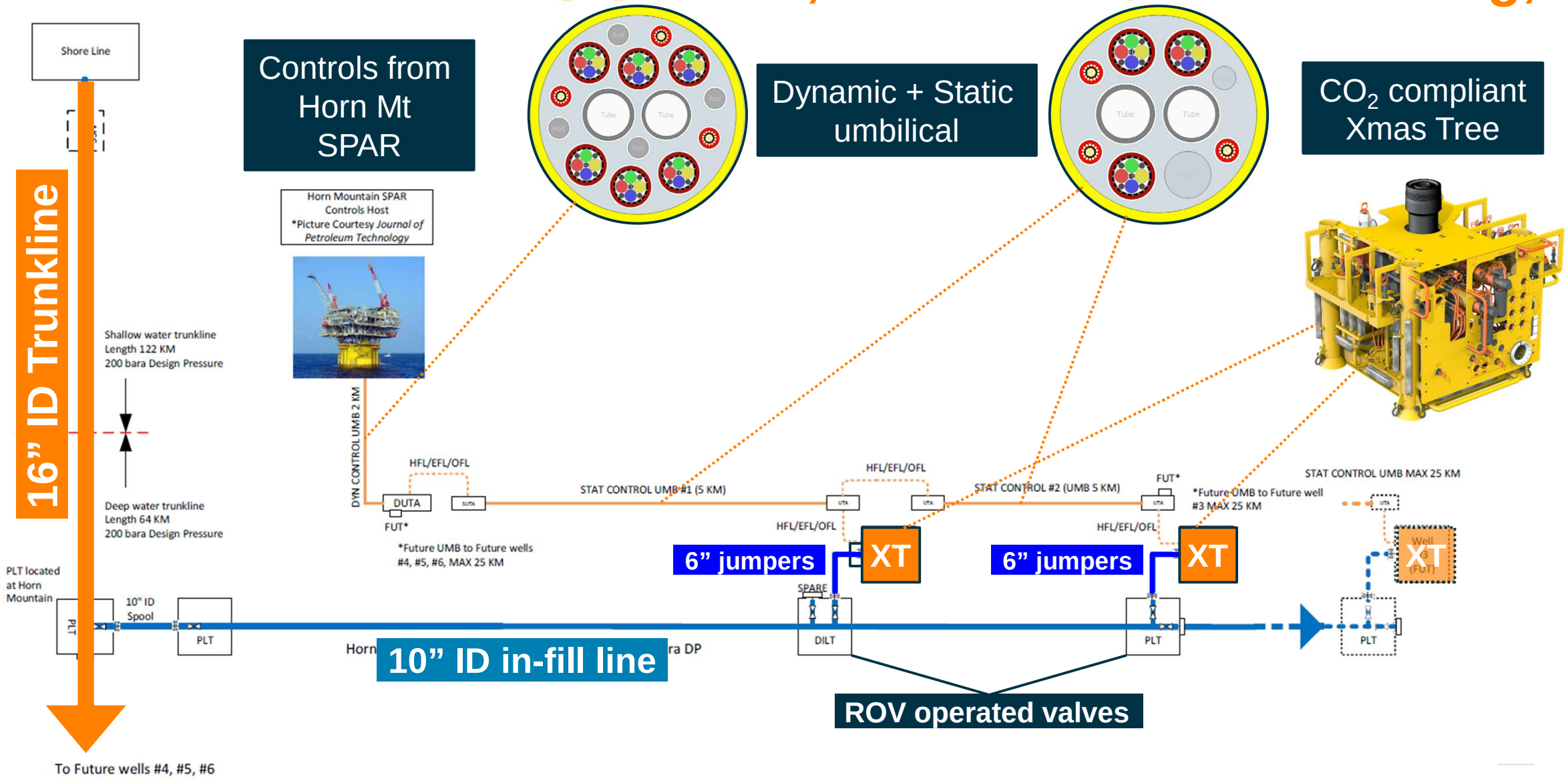
Finding the solution: WHP_{actual} > $WHP_{minimum}$ ➔ Choking



Robust solution: Can handle $P_{build-up}$ ≈ 100 bar w/o boosting

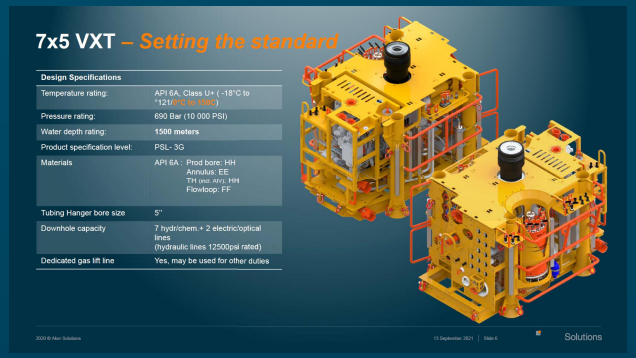


The solution: 16”+10”pipelines, Umbilicals, XT w/choking,

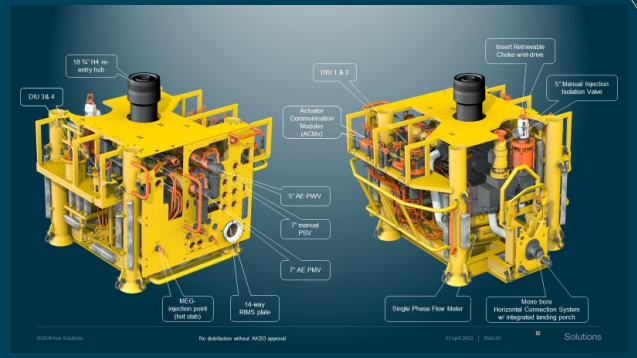


CO_2 compliant Xmas Tree – Selecting the right one

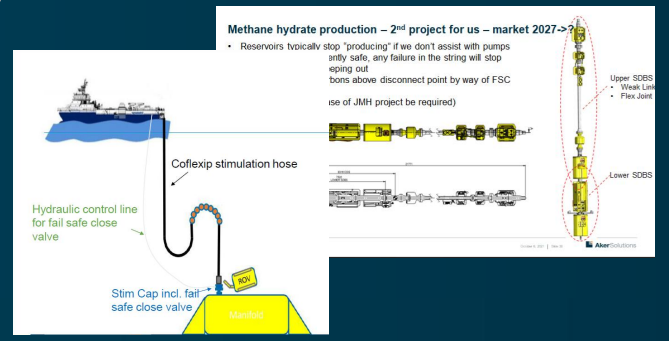
Mark 1



Mark 2



Mark 3



CCS

TODAY
Starting point and benchmark

Equinor: Northern Lights

- Typically standard XT system configured for Gas Injection
- Northern Lights is a standard 7" VXT with FCM configured for Gas Injection
- ISO / API dictating product layout and complexity
- Not cost optimized for simple CCS Wells

SHORT TERM
Simplified "available" solutions

What sort of cost reductions can we achieve with currently available technology?

- Ongoing conceptualization on VXT
  - OFTS
  - All-electric building block

Next:
How to simplify VXT stack-up & layout
Potential to modularize into simplified and cheaper solutions?

LONGER TERM
Distruptive products and solutions

- Based on new governing standards optimized for CCS (simplified)
- Target on significantly reduced cost level
- Assumed significant reduced complexity
- Introduction of the term "injection head" in stead of XT
- Novel solutions and assumed need for new core technology / TQPs
- Electrification
- OFTS

Northern Light based on fully standardized and field proven 7x5 VXT on WH (Latest used for Johan Castberg)

CCS

Northern Lights

AkerBP

equinor

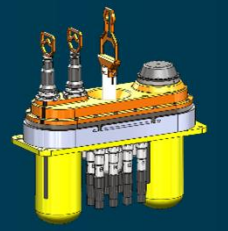
ConocoPhillips

AkerSolutions

MARK II | Simplified CCS XT

Significant cost savings

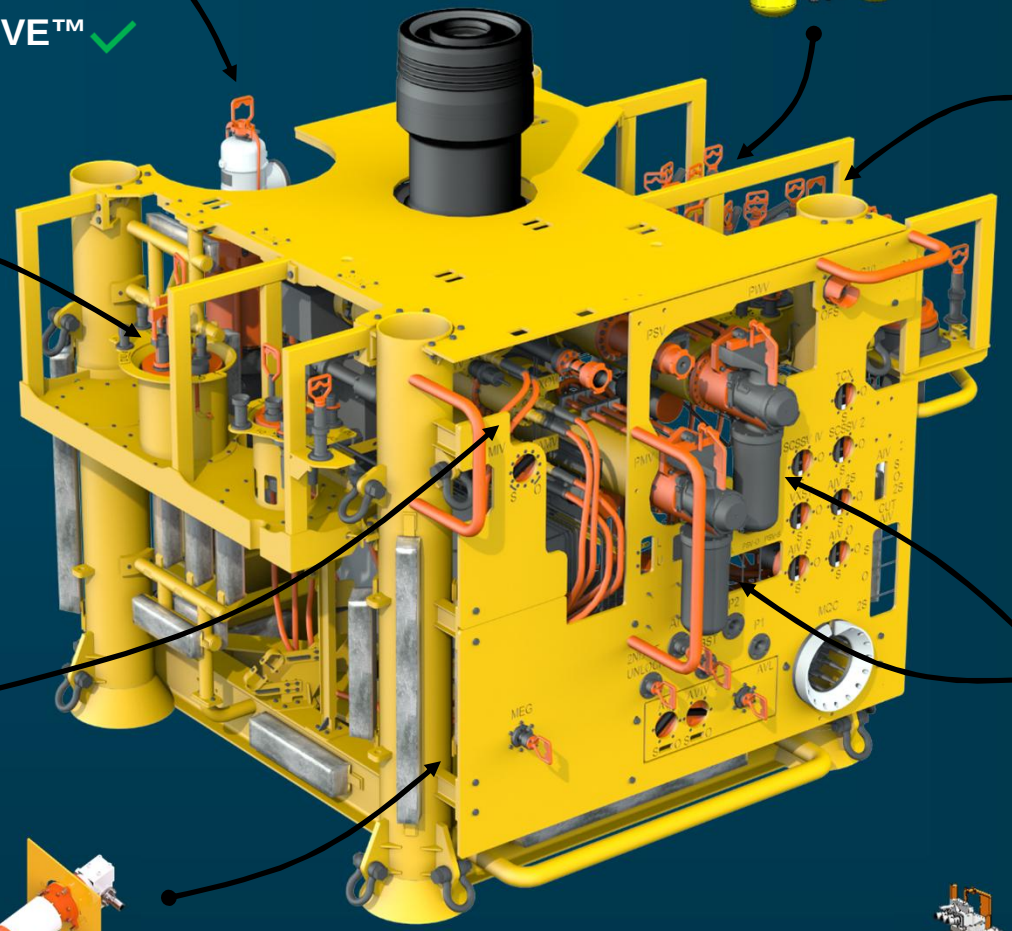
ELDRIVE™ ✓



SB-ACM ✓
Small Bore Actuator Control Module

DIU
For eSCSSV & eICV

PCGM ✓
Power & Communication Gateway Module



2”ALDM ✓
Actuator Linear Drive Module

ALDM ✓
Actuator Linear Drive Module

½” & 1” ✓
Drive Heads

LB-ACM ✓
Large Bore Actuator Control Module

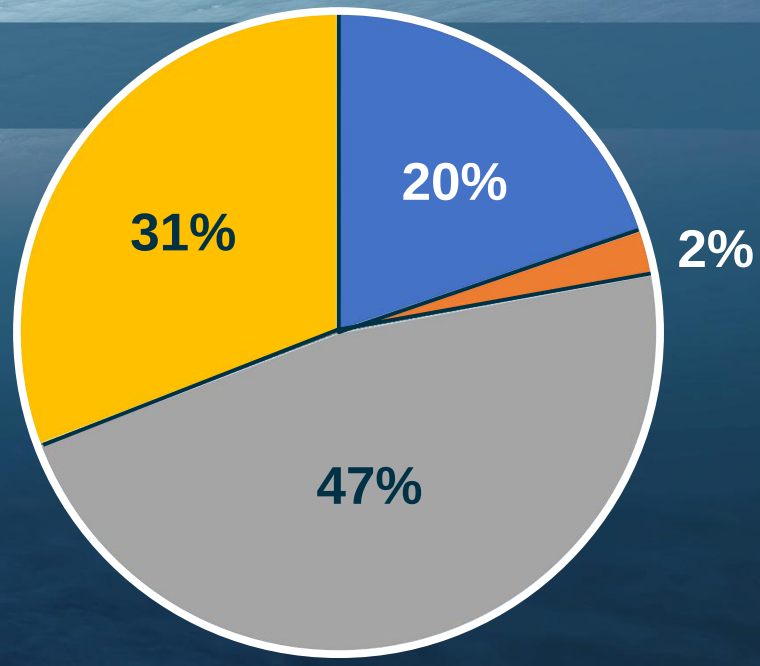
Same standard building blocks – just fewer, as CO_2 injection requires less functionality than O&G production

The Cost: 530 MUSD

Pipeline installation: 163 MUSD

Pipeline: 250 MUSD

Umbilicals: 12 MUSD



+/- 40%

Subsea injection system: 105 MUSD

If WHP_{actual} < $WHP_{minimum}$ ➔ Need Subsea Booster

Pipeline installation: 163 MUSD

Pipeline: 250 MUSD

590 – 630 MUSD

Umbilicals: 12 MUSD

Booster: 60 - 100 MUSD ready installed

Subsea injection system: 105 MUSD


Thanks – I am now ready to take your ~~orders~~ questions

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