

# High-level design of a subsea-based CO<sub>2</sub> injection system in GoM

**Study results for SECARB**  
*April 05 – 2023, Austin Texas*

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The background is an underwater scene. At the top center, a vertical structure, possibly a diving bell or part of a submersible, extends from the surface. A diver is visible in the lower right quadrant, connected to the structure by a thin line. The water is dark blue with some light filtering through from above.

**00:00**

**The Challenge**

**00:05**

**The Solution**

**00:10**

**The Cost**

**00:15**

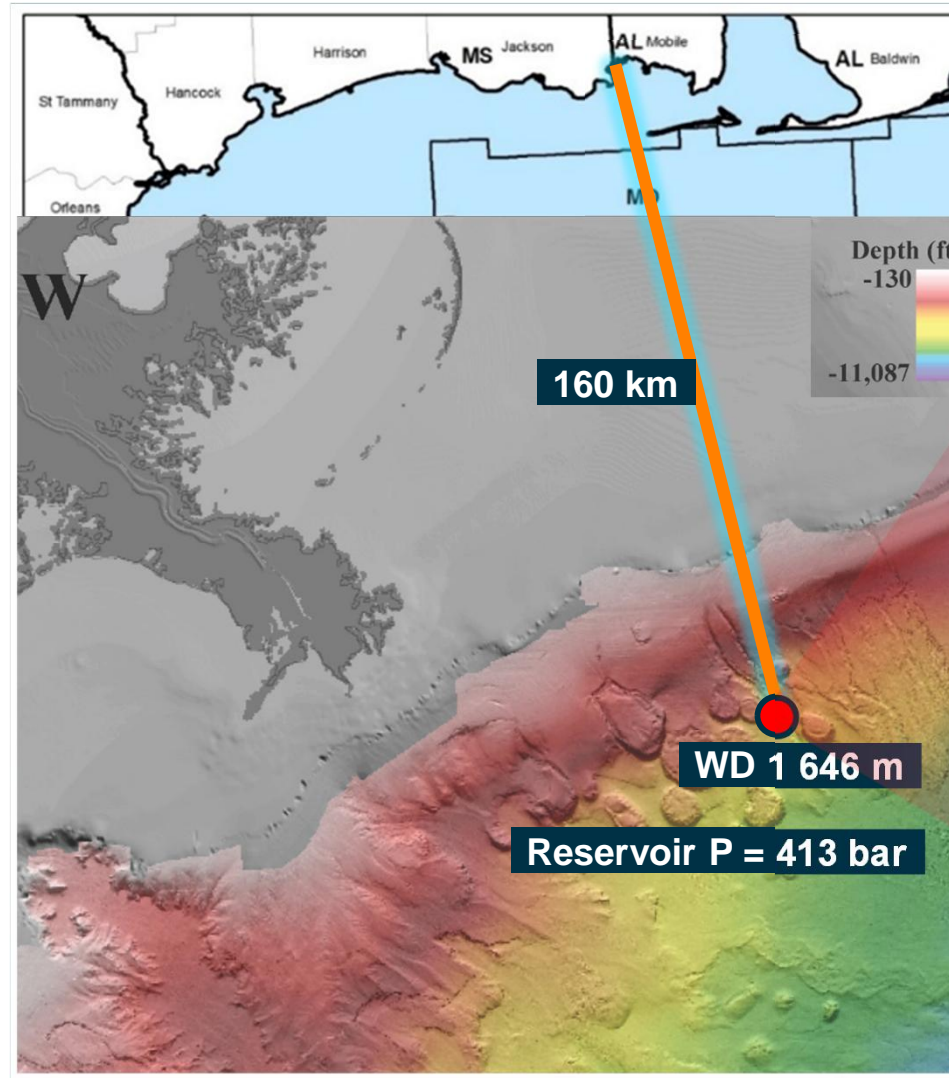
**End**



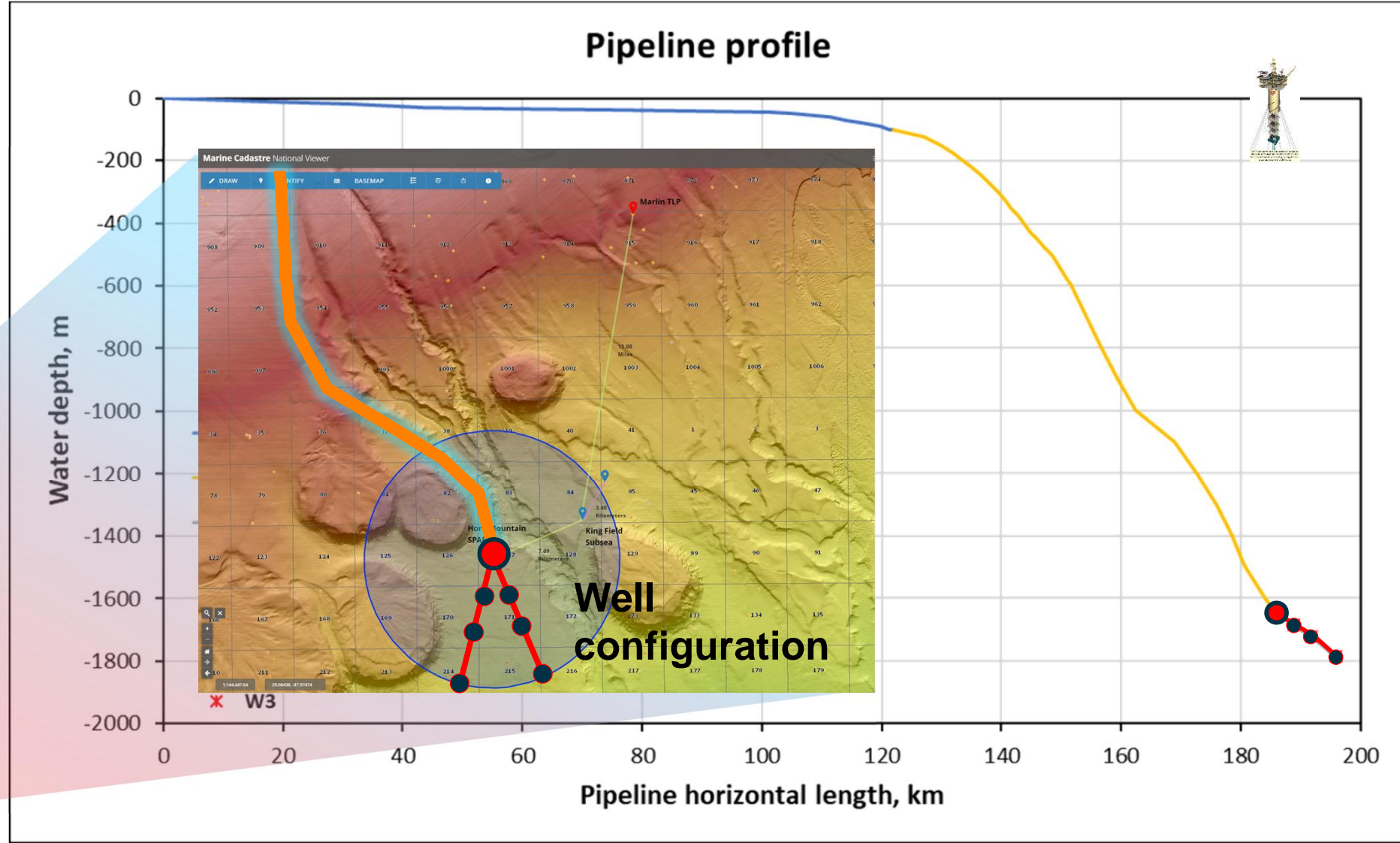
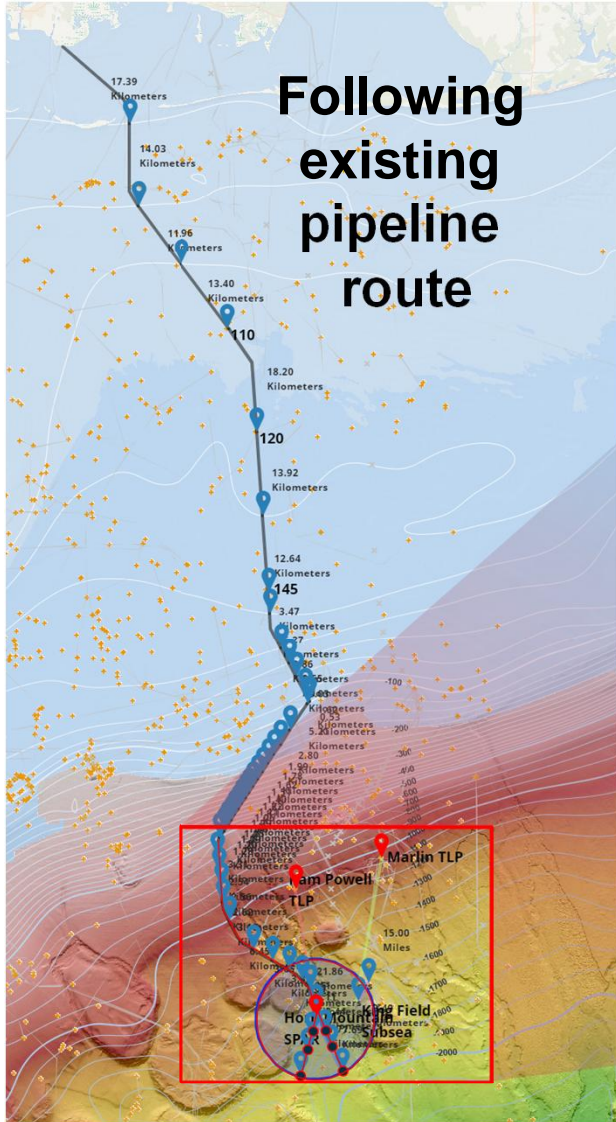
# The Challenge: Get CO<sub>2</sub> into the Horn Mt reservoir

- Provide high-level design and cost estimate of a subsea-based CO<sub>2</sub> injection system in the GoM

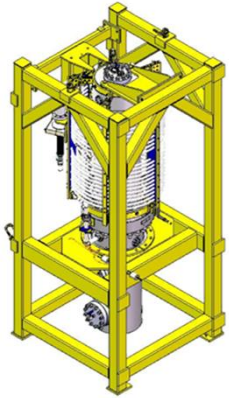
Study parameter	Value
Distance to shore	160 km SE of New Orleans
Number of Wells	2 injection
Distance to host (Horn Mt Spar)	10 km
Water depth	1646 m
Reservoir depth	3,380 m
Reservoir P	413 bar
Reservoir T	93.3°C



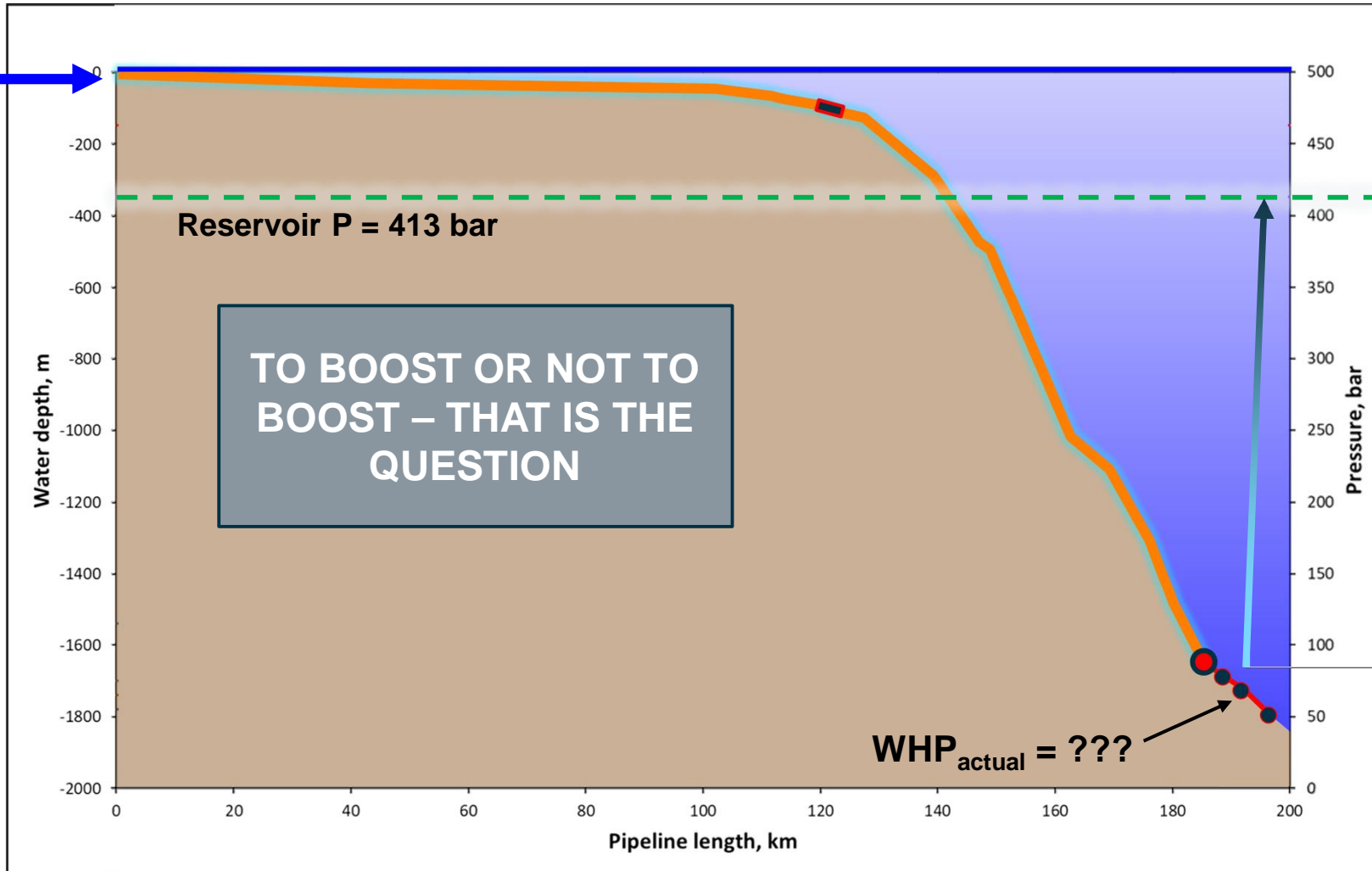
# Finding the solution: Starts with the pipeline route



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



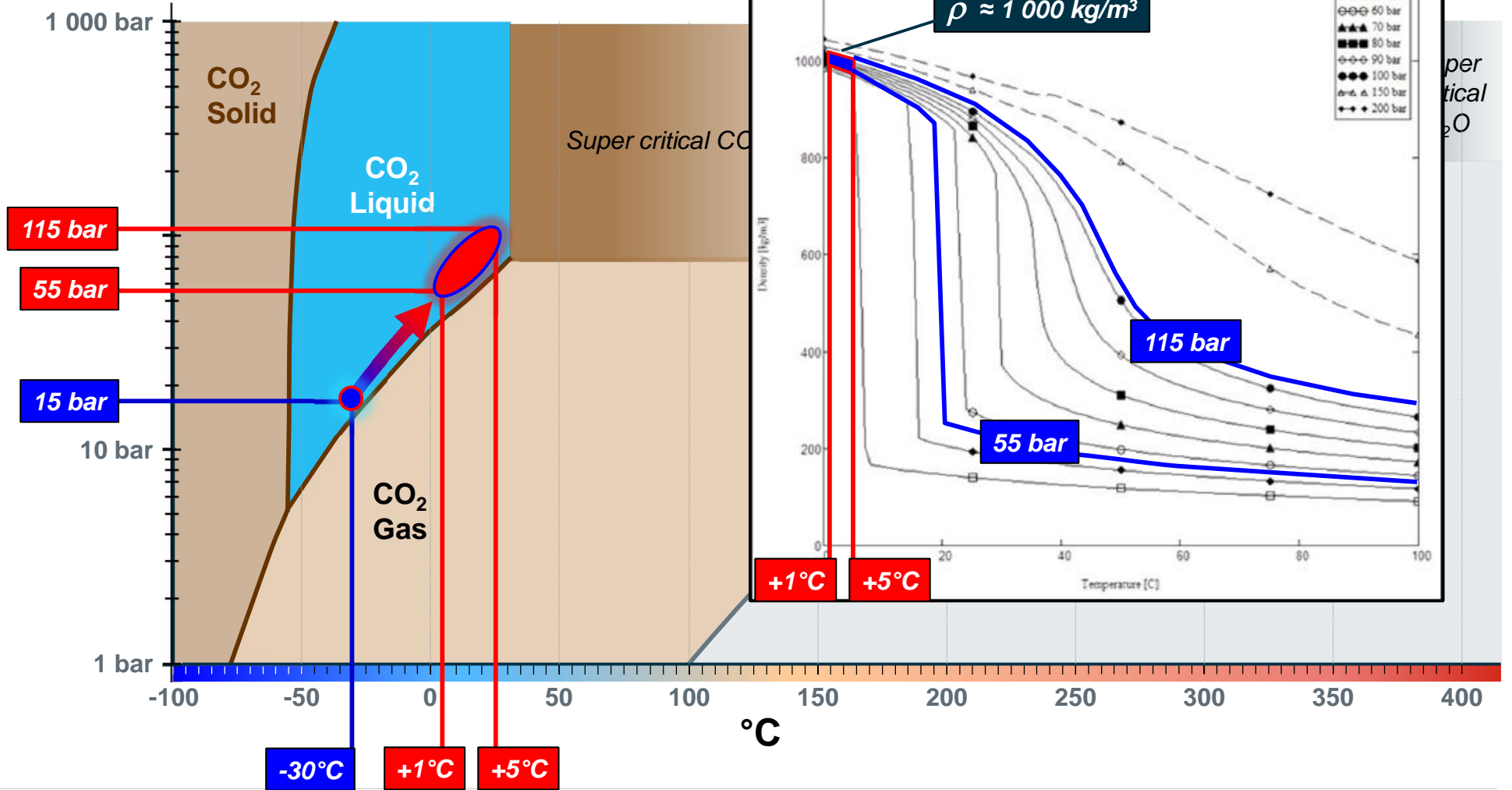
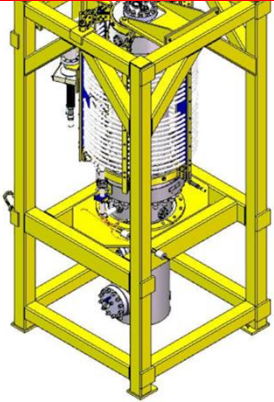
Pressure at WH depends on boosting pressure onshore



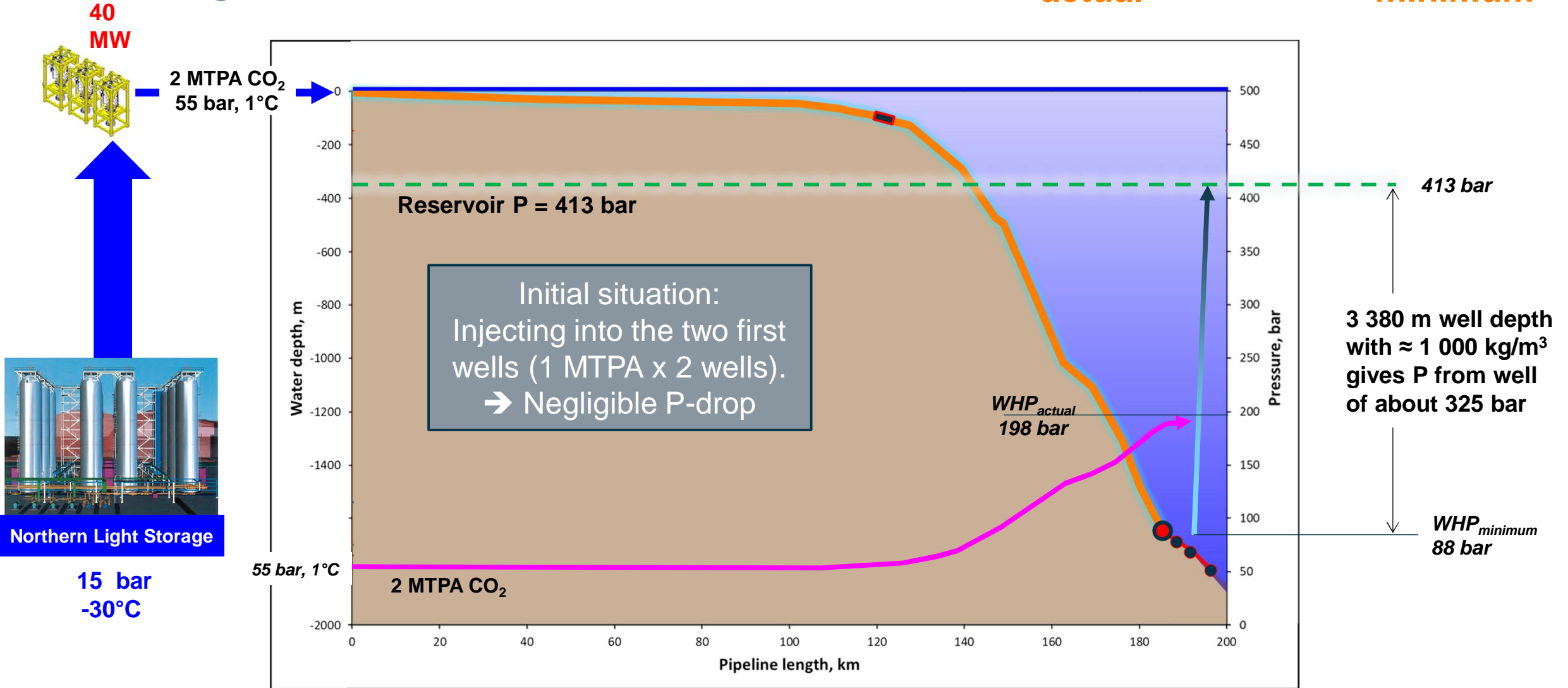


# Onshore pumping P & T: We want to pump liquid phase

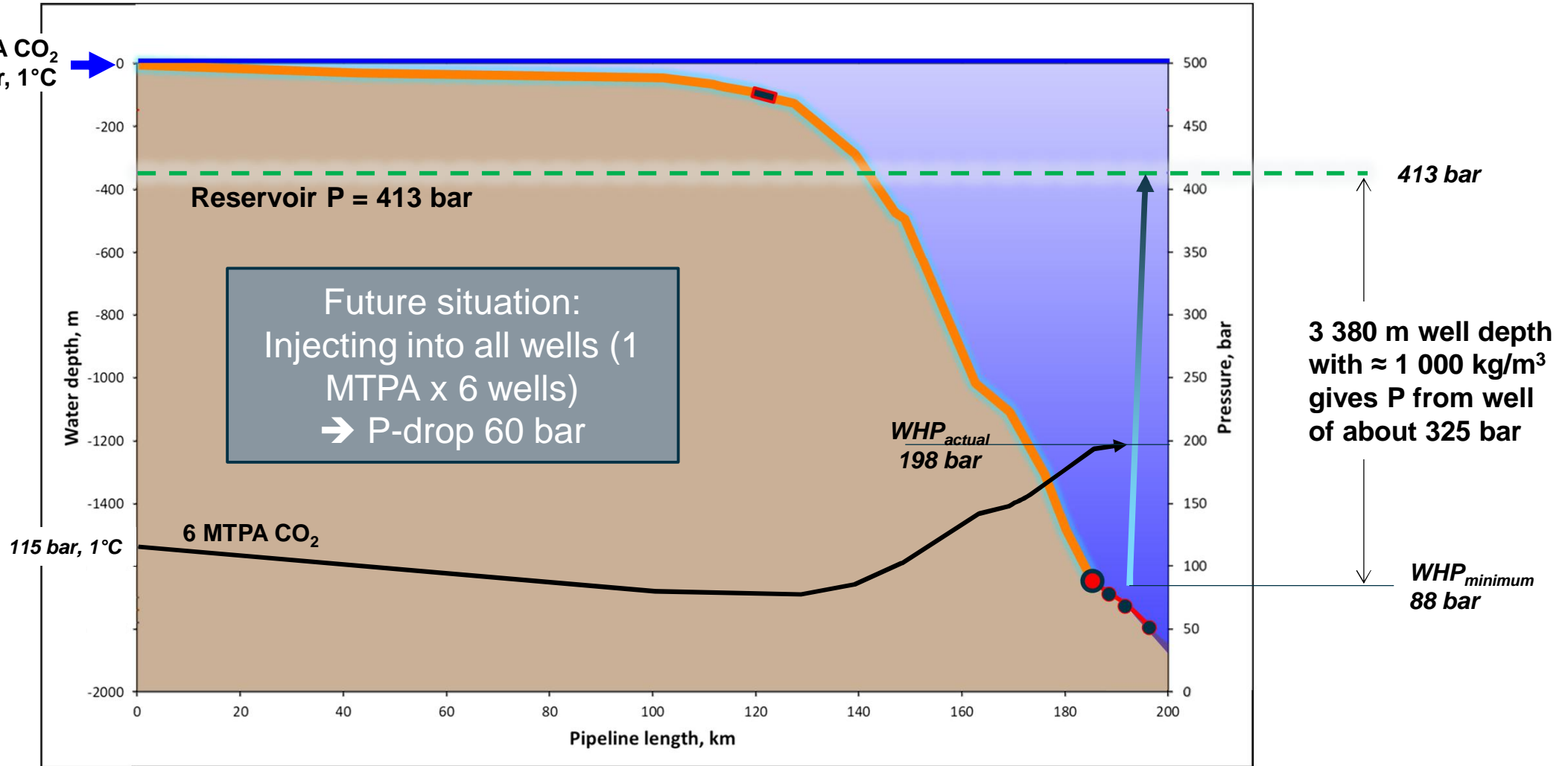
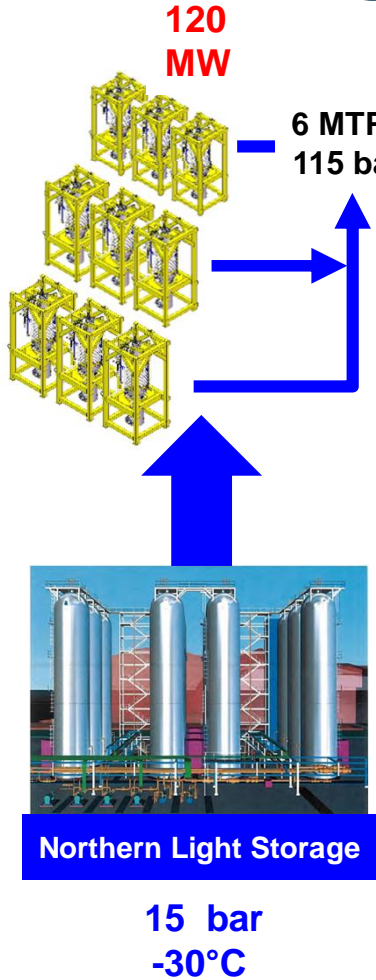
**Pumping Assumption:**  
 $55 \text{ bar} < P < 115 \text{ bar}$   
 $+1^\circ\text{C} < T < +5^\circ\text{C}$



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

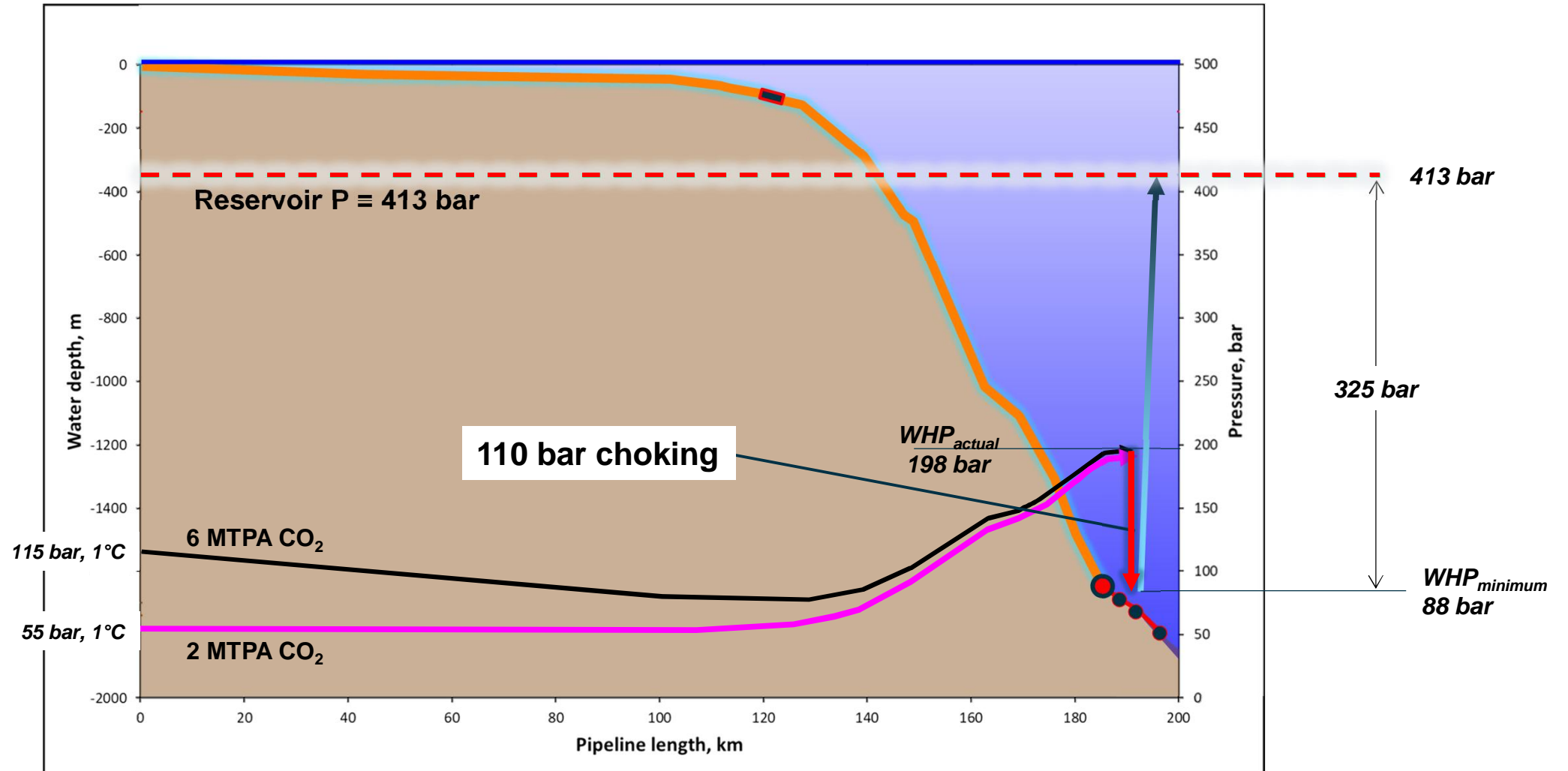


# Finding the solution: Depends on $WHP_{actual}$ vs. $WHP_{minimum}$

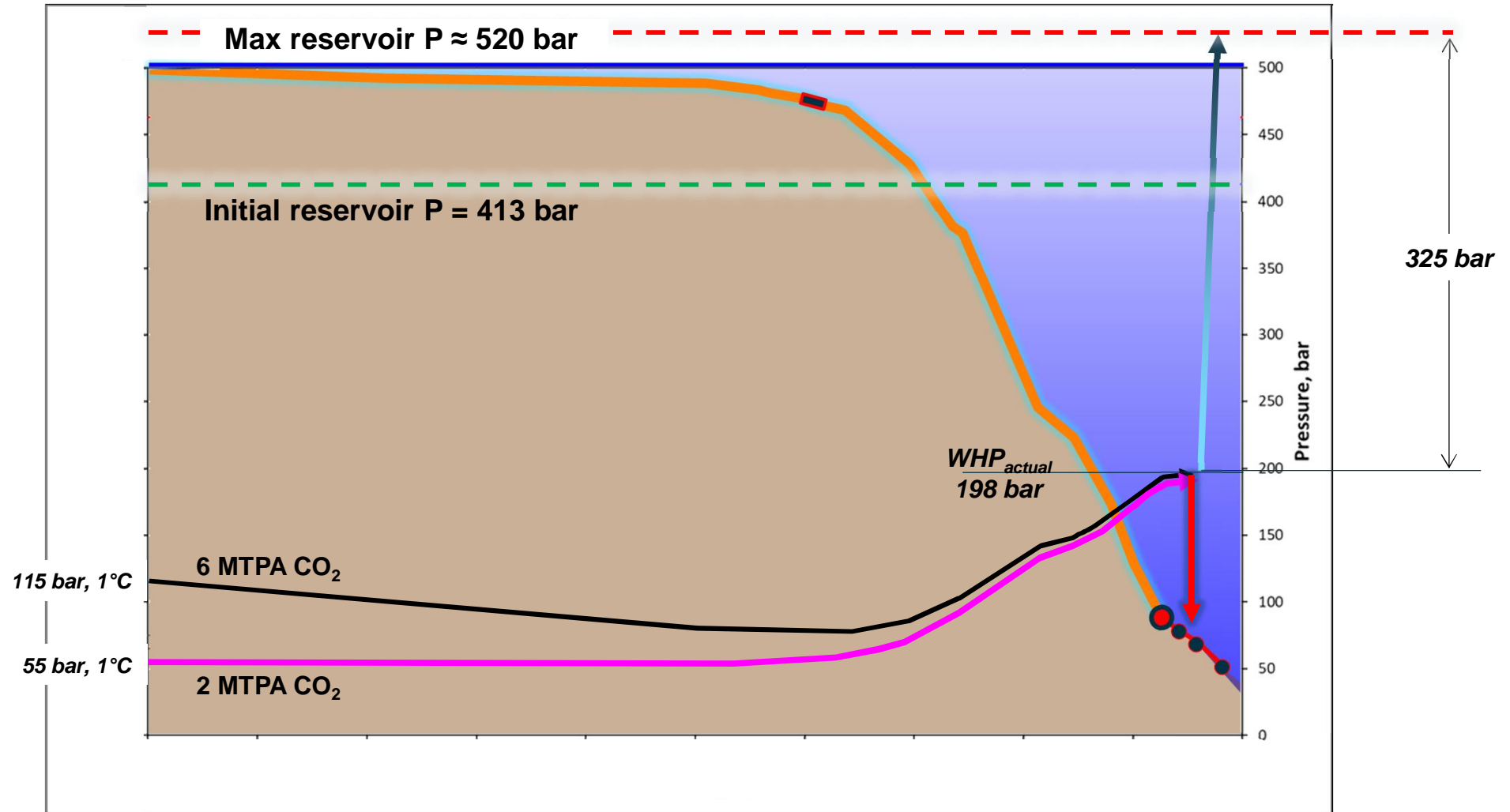




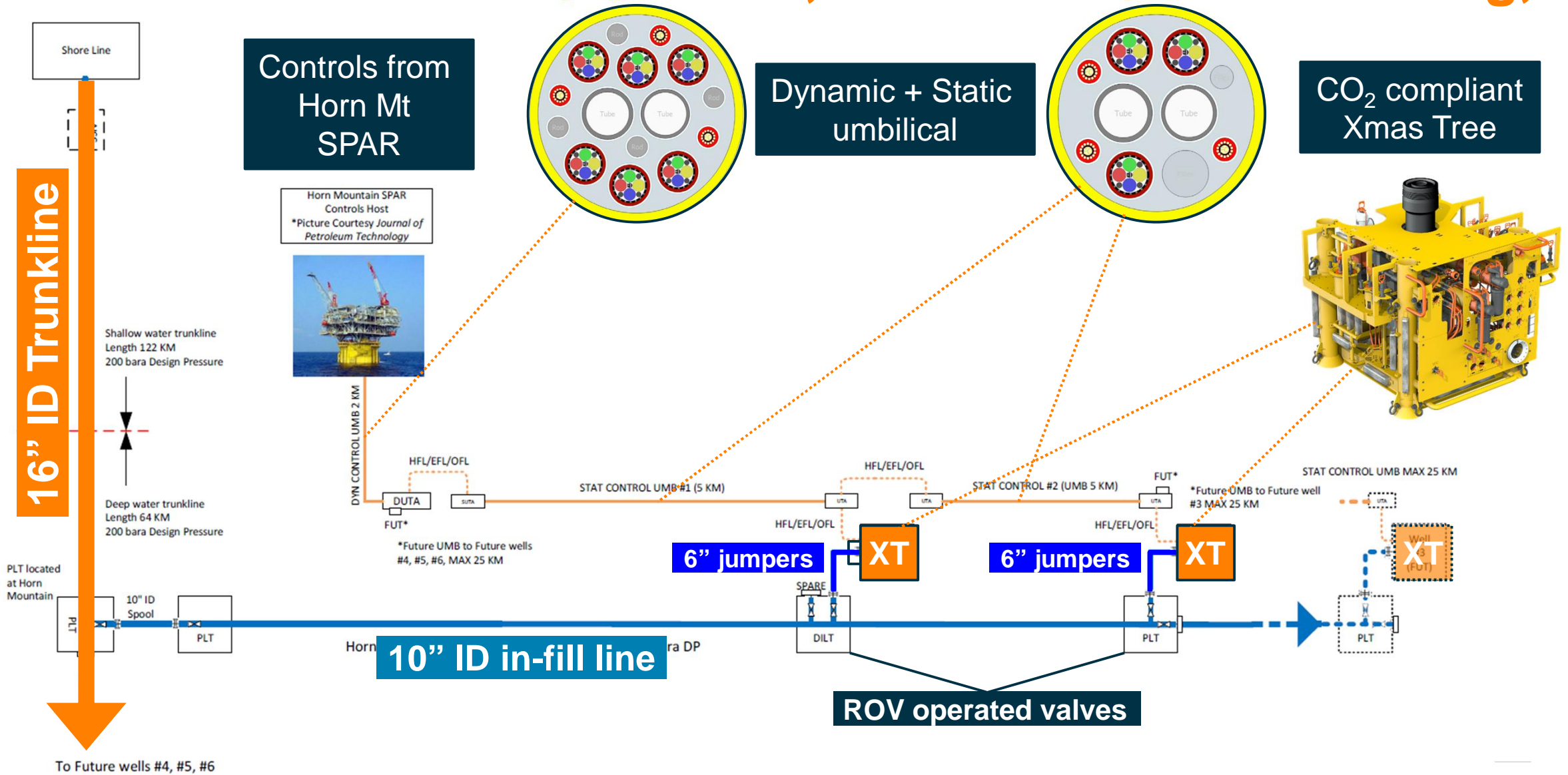
# Finding the solution: $WHP_{actual} > WHP_{minimum} \rightarrow$ Choking



# Robust solution: Can handle $P_{\text{build-up}} \approx 100$ bar w/o boosting



# The solution: 16" + 10" pipelines, Umbilicals, XT w/choking, ROV operated valves





# CO<sub>2</sub> compliant Xmas Tree – Selecting the right one

Mark 1

**7x5 VXT – Setting the standard**

Design Specifications	
Temperature rating:	API 6A, Class UV (-18°C to 120°C max. temp.)
Pressure rating:	690 Bar (10 000 PSI)
Water depth rating:	1500 meters
Product specification level:	PBL-3G
Materials:	API 6A: Prod bore: HH Annulus: EE TM line: ACS-101 Flowloop: FF
Tubing Hanger bore size:	5"
Downhole capacity:	7 hydraulic + 2 electrical lines (Hydraulic lines 12500psi rated)
Dedicated gas lift line:	Yes, may be used for other duties

Mark 2

Labels include: 10" N1 HH entry hub, DRU 1 & 2, Insertable Choke w/ drill-down, 5" Manual Isolation Valve, Actuator Communication Isolator (ACMI), 5" AE PMV, 7" AE PMV, 7" AE PMV, 14-way flange plate, MCO injection port (optional), Single Phase Flow Meter, Mono bore Horizontal Connection System w/ integrated landing catch.

Mark 3

**Methane hydrate production – 2<sup>nd</sup> project for us – market 2027->**

- Reservoirs typically stop "producing" if we don't assist with pumps until safe, any failure in the string will stop seeping out
- Borens above disconnect point by way of FSC (use of JM project is required)

Labels include: Coffexip stimulation hose, Hydraulic control line for fail safe close valve, Stim Cap incl. fail safe close valve, Mandrel, Upper SCBS, Weak Link, Flex Joint, Lower SCBS.



**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**  
Disruptive products and solutions

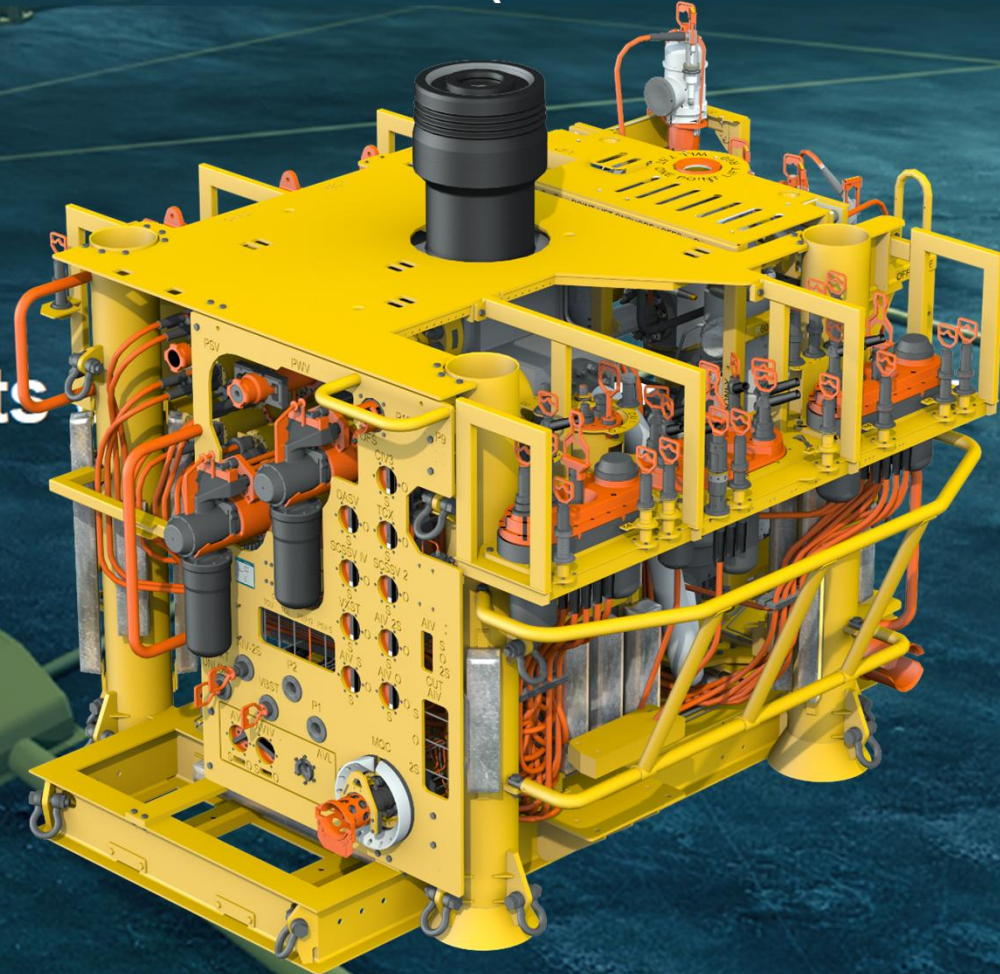
- Based on new governing standards optimized for CCS (simplified)
- Target on significantly reduced cost level
- Assumed significant reduced complexity
- Introduction of the term "injection head" in stead of XT
- Novel solutions and assumed need for new core technology / TQPs
- Electrification
- OFTS



CCS

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

Northern Lights





# MARK II | Simplified CCS XT

Significant cost savings

**DIU**  
For eSCSSV & eICV

**ELDRIVE™** ✓

**SB-ACM** ✓  
Small Bore Actuator  
Control Module

**PCGM** ✓  
Power & Communication  
Gateway Module

**2" ALDM** ✓  
Actuator Linear  
Drive Module

**ALDM** ✓  
Actuator Linear  
Drive Module

**1/2" & 1"** ✓  
Drive Heads

**LB-ACM** ✓  
Large Bore Actuator  
Control Module

Same standard building blocks – just fewer, as CO<sub>2</sub> injection requires less functionality than O&G production

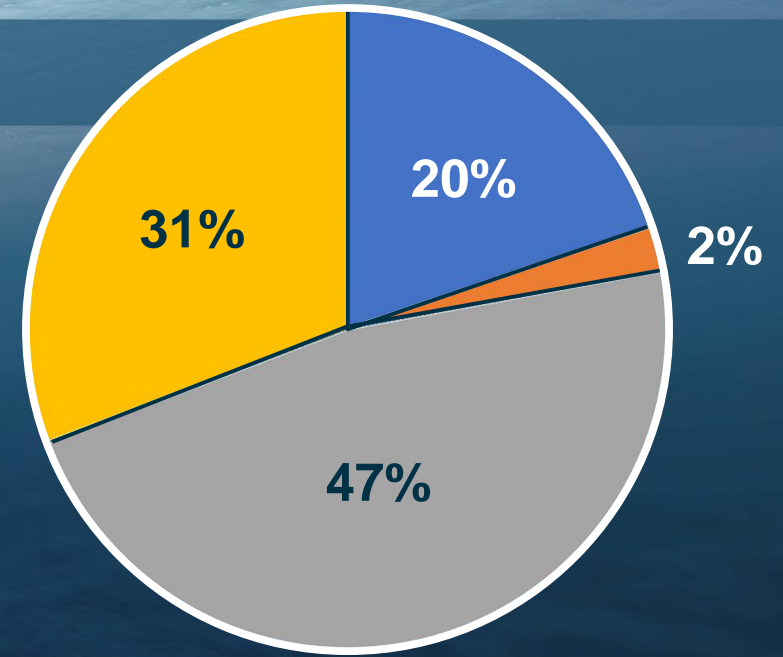


# The Cost: 530 MUSD

Pipeline installation: 163 MUSD

Pipeline: 250 MUSD

Umbilicals: 12 MUSD



**+/- 40%**

Subsea injection system: 105 MUSD

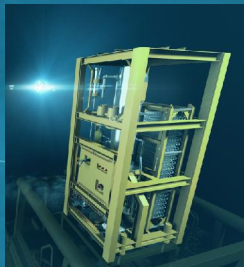
If  $WHP_{actual} < WHP_{minimum}$  → Need Subsea Booster

Pipeline installation: 163 MUSD

Pipeline: 250 MUSD

590 – 630 MUSD

Umbilicals: 12 MUSD



Booster: 60 - 100 MUSD  
ready installed

Subsea injection system: 105 MUSD



An underwater scene showing a diver in the lower right, connected by a line to a structure at the top center. The water is dark blue and slightly hazy. A semi-transparent grey box with white text is overlaid in the center.

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



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