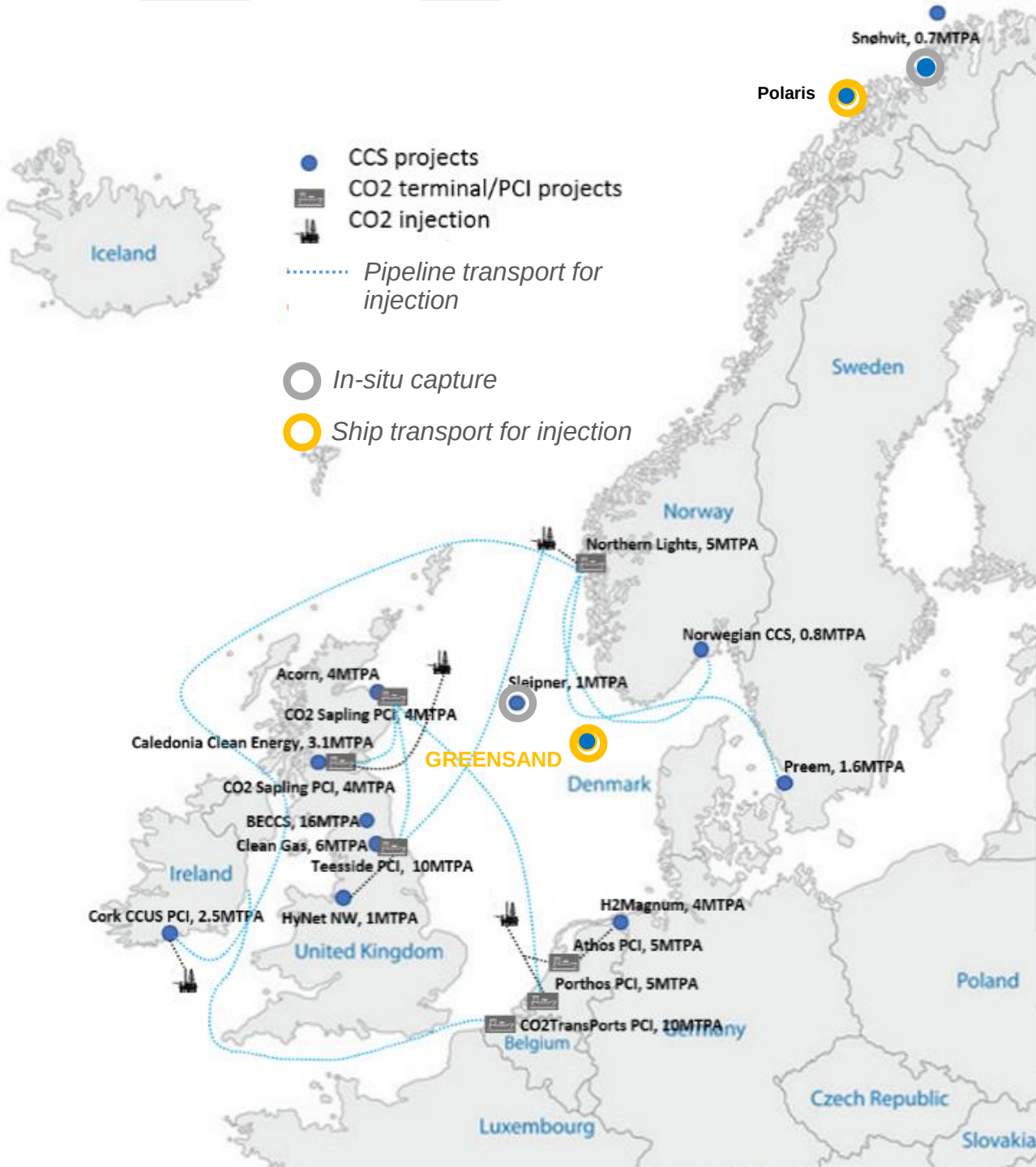
Greensand Project

CO2 Transport and Storage

INEOS Energy & Wintershall Dea

By Søren Reinhold Poulsen, Greensand Project Director

Ship-based CCS concept Phase 2 Pilot Project



Greensand Phase 2 Work Package Set-up – derisking further before the Final Investment Decision

Deliverables/results of work package
D3.1 Flooding experiments to de-risk injectivity issues related to chemical alterations
D3.2 Effects of residual hydrocarbons in the reservoir on injectivity and storage capacity
D3.3 Key injectivity risk factors registered in Greensand Phase 1: fines migration, glauconite swelling and CO_2 impurities de-risked
D3.4 Risks related to salt clogging evaluated
D3.5 TOUGHREACT, full field ECLIPSE and full field Petrel geostatic models developed based on experimental and analytical results
Technical (TM) and commercial milestones (CM)
TM3.1 Flooding experiments mimicking near- to far-wellbore flow together with flooding experiments
TM3.2 Determination of the impact of impurities.
TM3.3 Full compositional description of the effect of CO_2 flow on the residual oil.
TM3.4 Completed seal complex analysis, including petrophysical model.
TM3.5 Reactive flow and geostatic models and uncertainty analysis for input to the overarching numerical model.

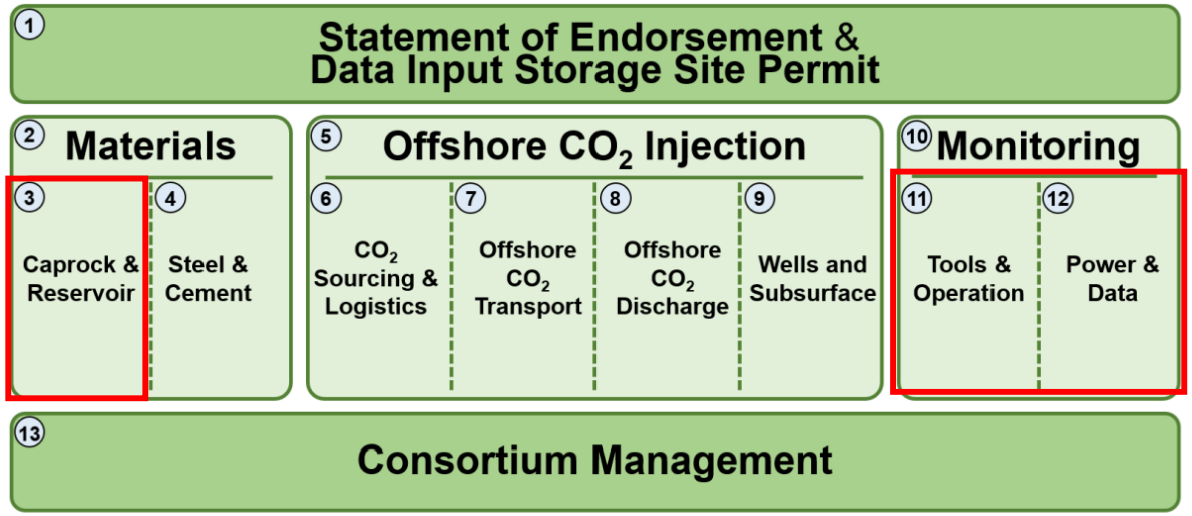


Figure 4: Overview of the main areas of Project Greensand Phase 2. Numbers in blue circles refer to the work packages described in this application.

- Learn for others (industry and academia) through collaboration
- But further confidence and experience is required
- An offshore CO2 injection pilot test is therefore in the planning

Greensand Pilot: Subsurface

What do we know?

Containment ✓

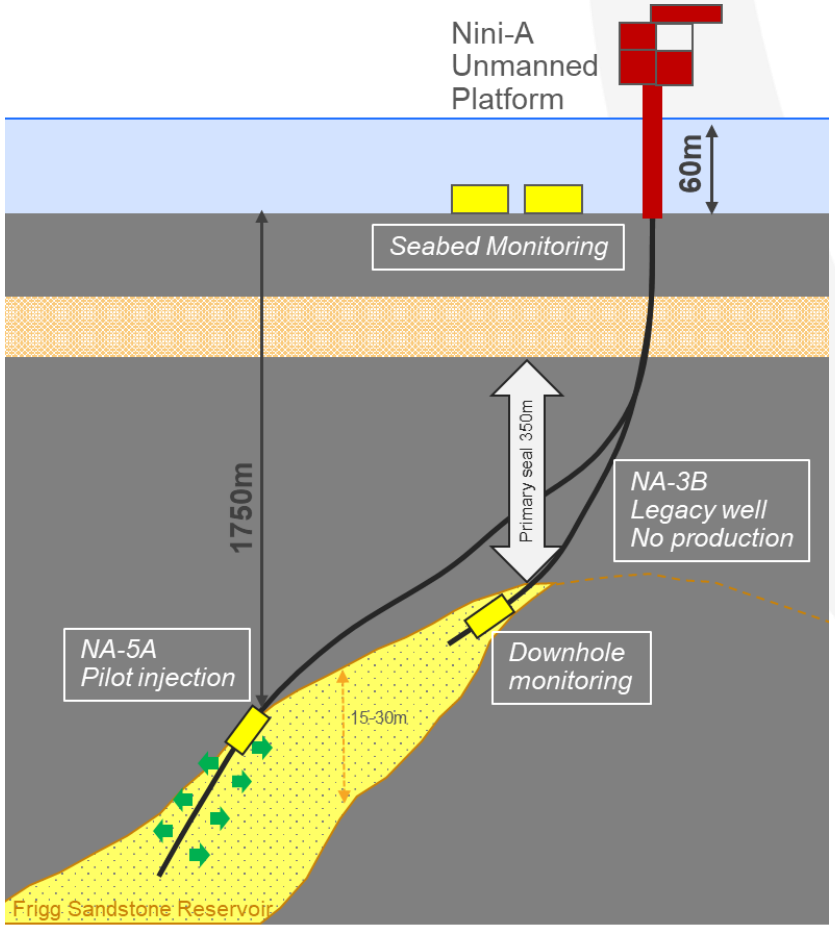
Siri Area reservoir seals proven

Capacity ✓

Storage capacity/volumes quantified through production

CO2 Injectivity ?

Upscaled CO2 injectivity unknown



Nini West Reservoir

Pilot Injectivity Test

Well

- Injectivity and Integrity issues due to **thermal cycling**

Reservoir

- **Mineral reactions & Multiphase behaviour issues**

Measure, Monitor & Manage

- **Pressure, Temperature, Rates**
- **Seismic monitoring of the plume**

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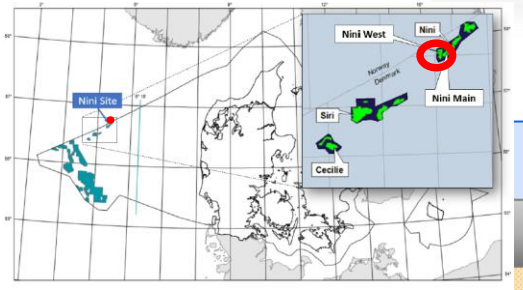
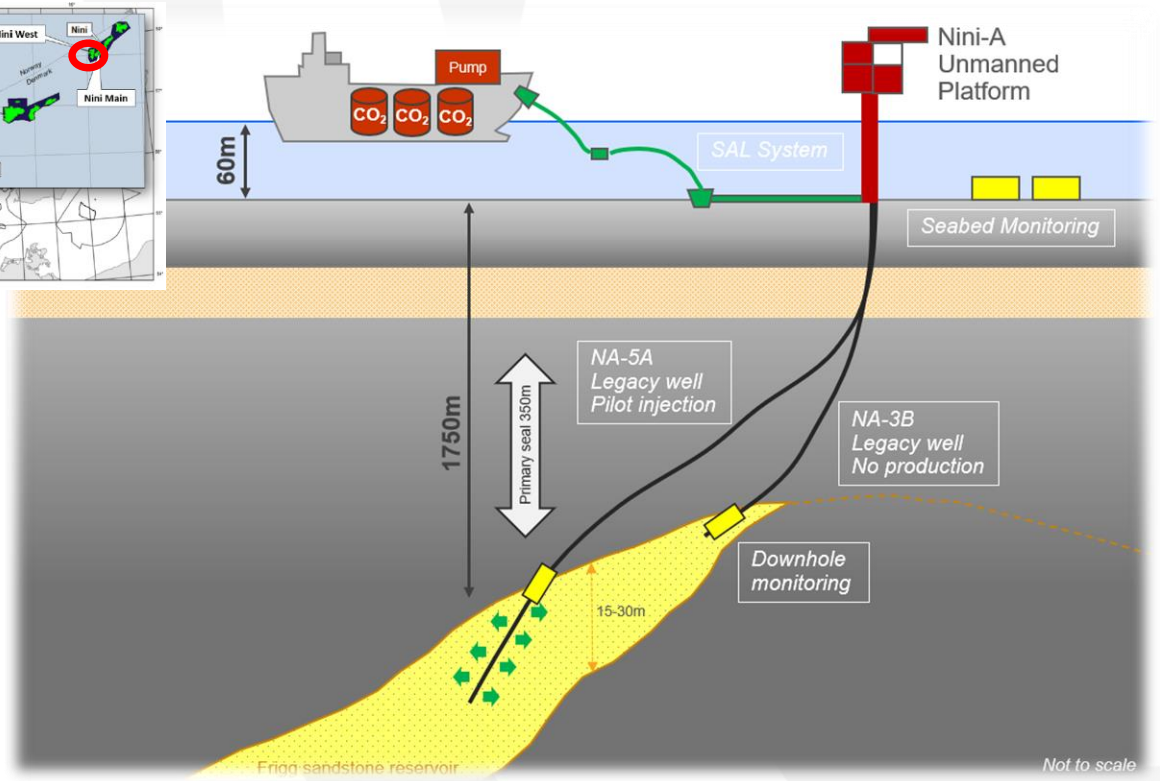
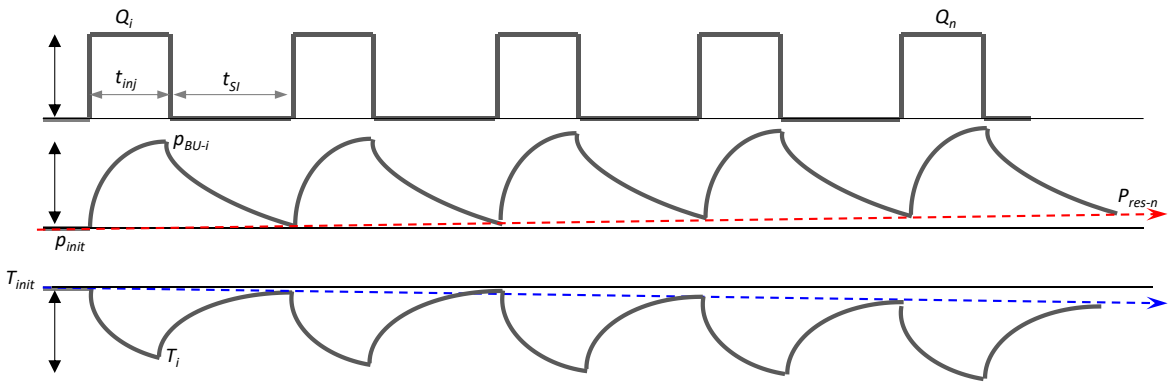
Nini West CCS

- Cyclic injection following pilot test
- 1D sand, proven high water injecitity
- Depleted saturations but reservoir p>pinit
- Extensive aquifer
- Storage target: 0.5 MTA above FWL and aquifer







Pilot/Full scale CCS design

	No. of cycles n	Injection rate/cycle $Q_i=Q_n$ tonnes/day	Injection time, t_{inj}	Shut-in time, t_{SI}	Initial reservoir pressure, p_{init} bara	Initial reservoir temp. T_{init} deg.C	
PILOT	14	1.000	15 hrs	6 days	210-220	60	Existing well
FULL SCALE	50/yr	10.000	12-24 hrs	6 days	210-220	60	New CO2 injector

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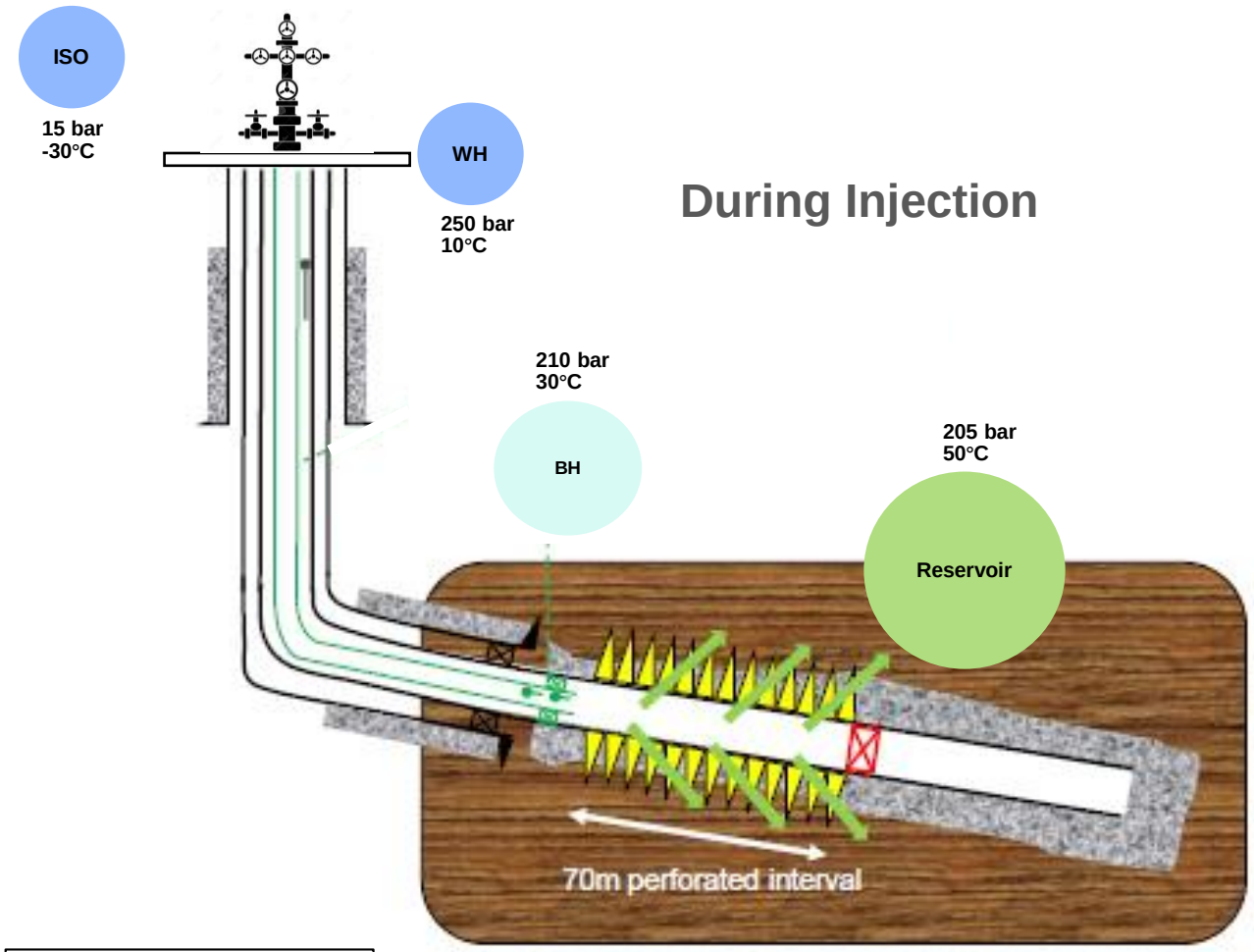
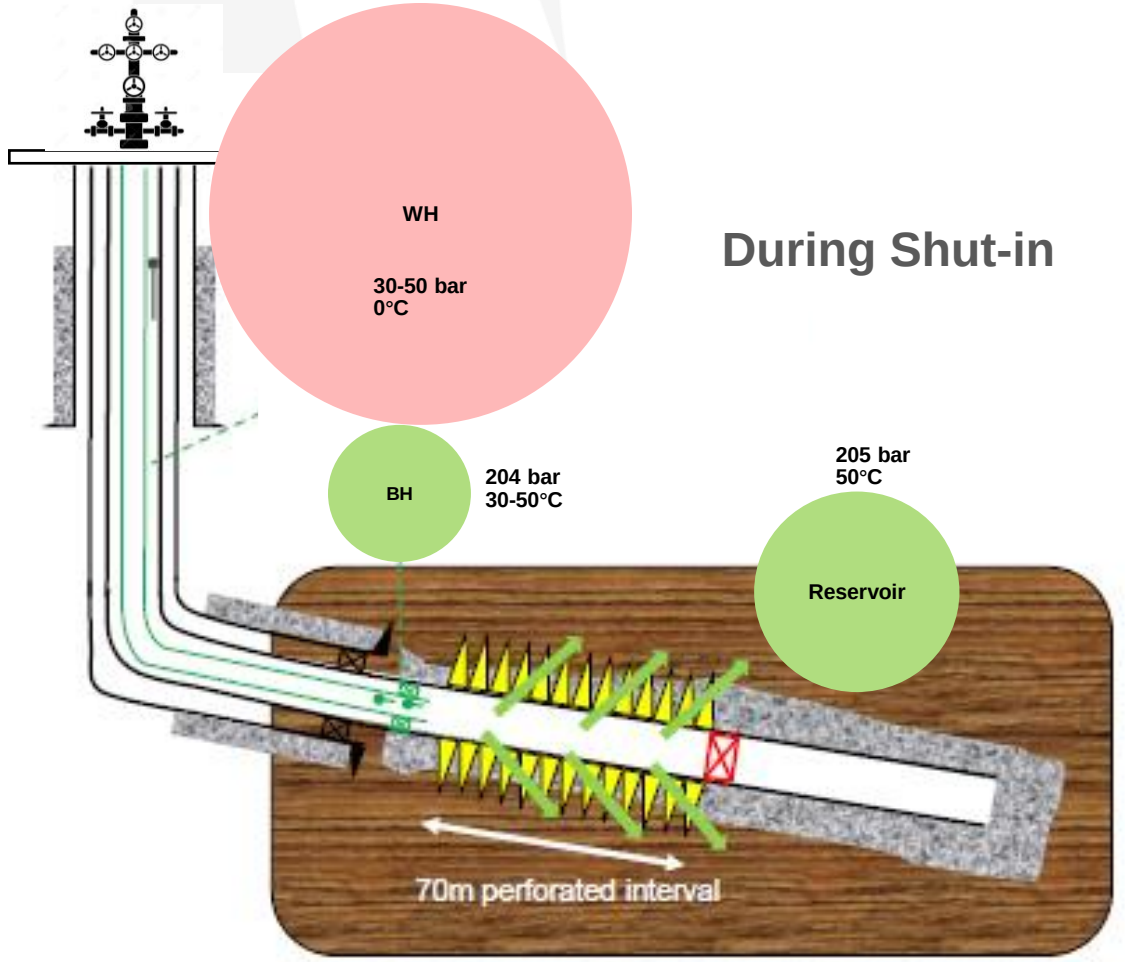
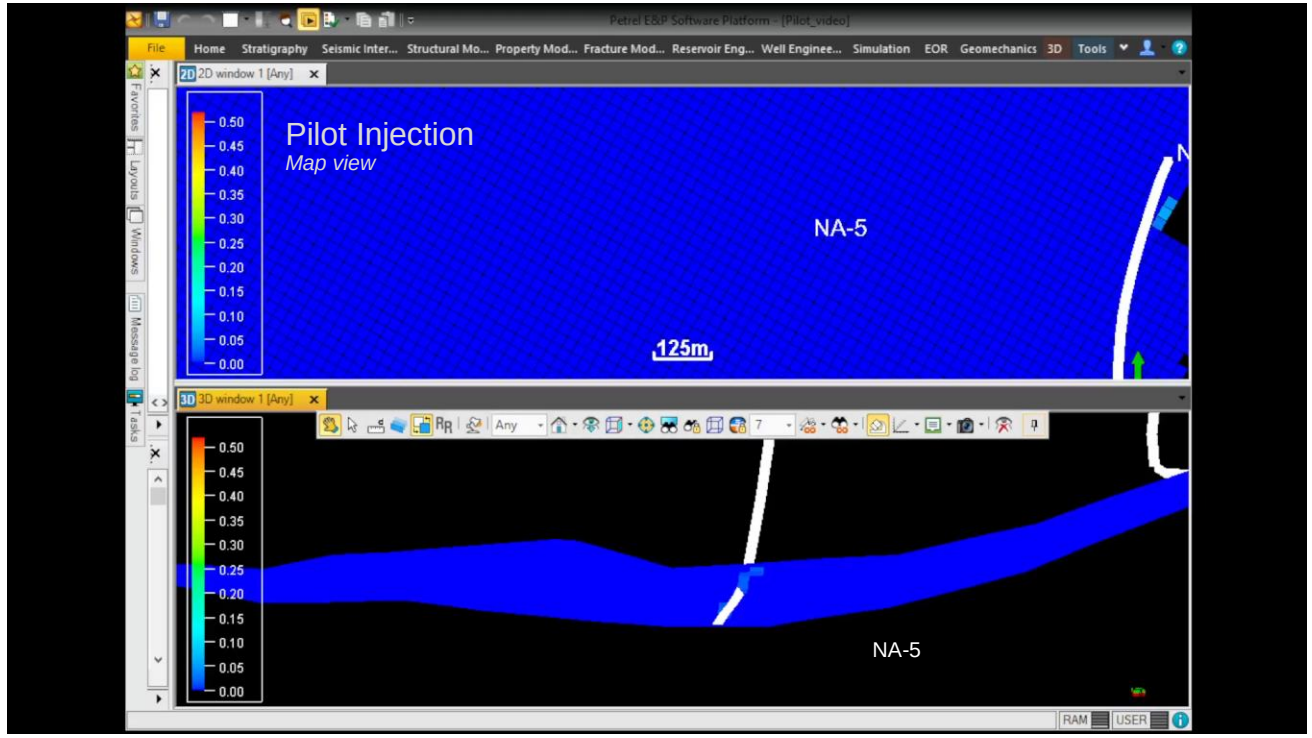
Pilot Injection Expected Phase Behaviour

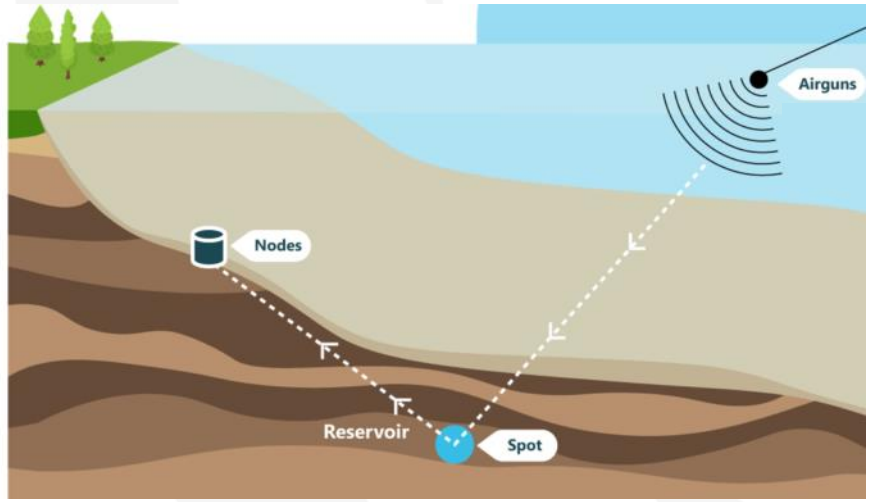


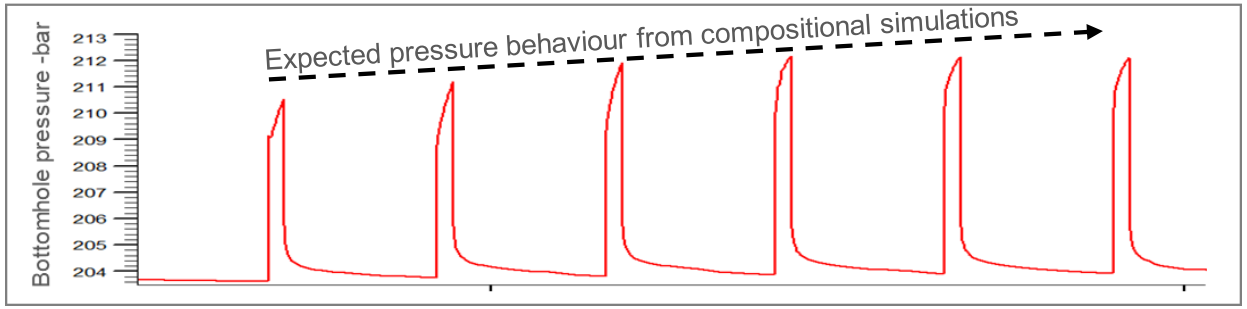


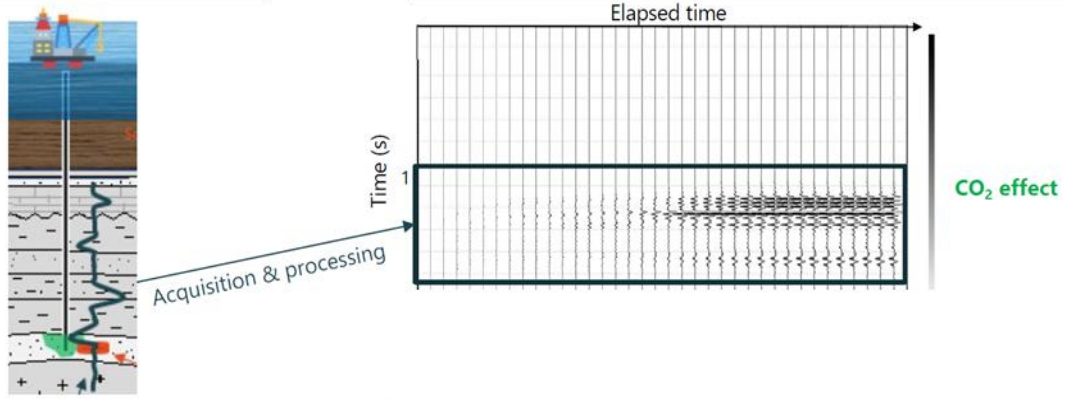
WH: Wellhead
BH: Bottomhole

Monitoring & Modelling



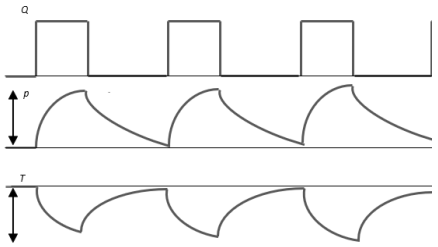




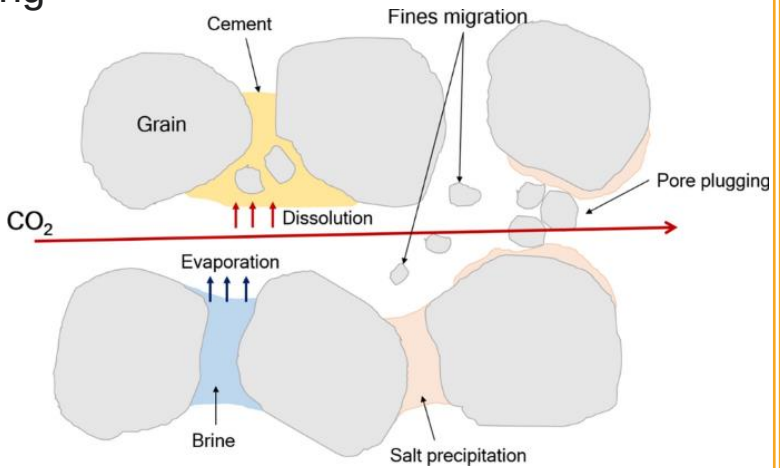


Nini West CCS Key Challenges

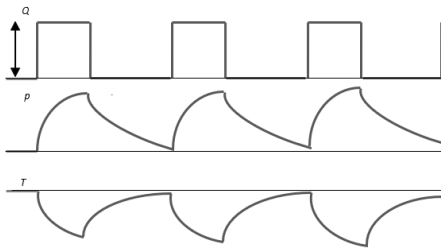
CYCLICITY



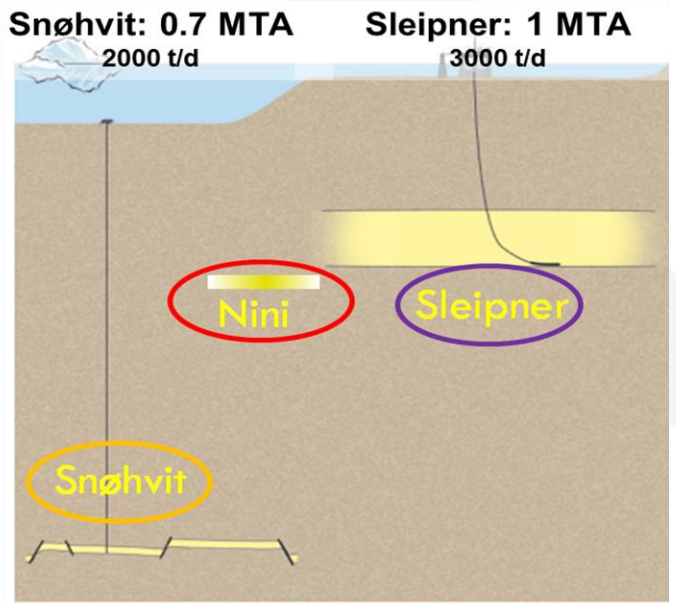
- Phase change in well during injection and shut-in
- CO2 mobility changes in reservoir
- Near-wellbore events affecting injectivity
- Salt precipitation
- Residual CO2 trapping
- Injection pressure management
- Logistics chain



HIGH INJECTION RATES



- High daily discharge rate due to cyclic injection
- Well length/count
- Reservoir, caprock and well integrity



Nini West: 0.5 MTA, 10.000t/day

Comparable yearly storage rates but very high instantenous injection rates due to cyclicity

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Thank you for your attention and please visit www.projectgreensand.com