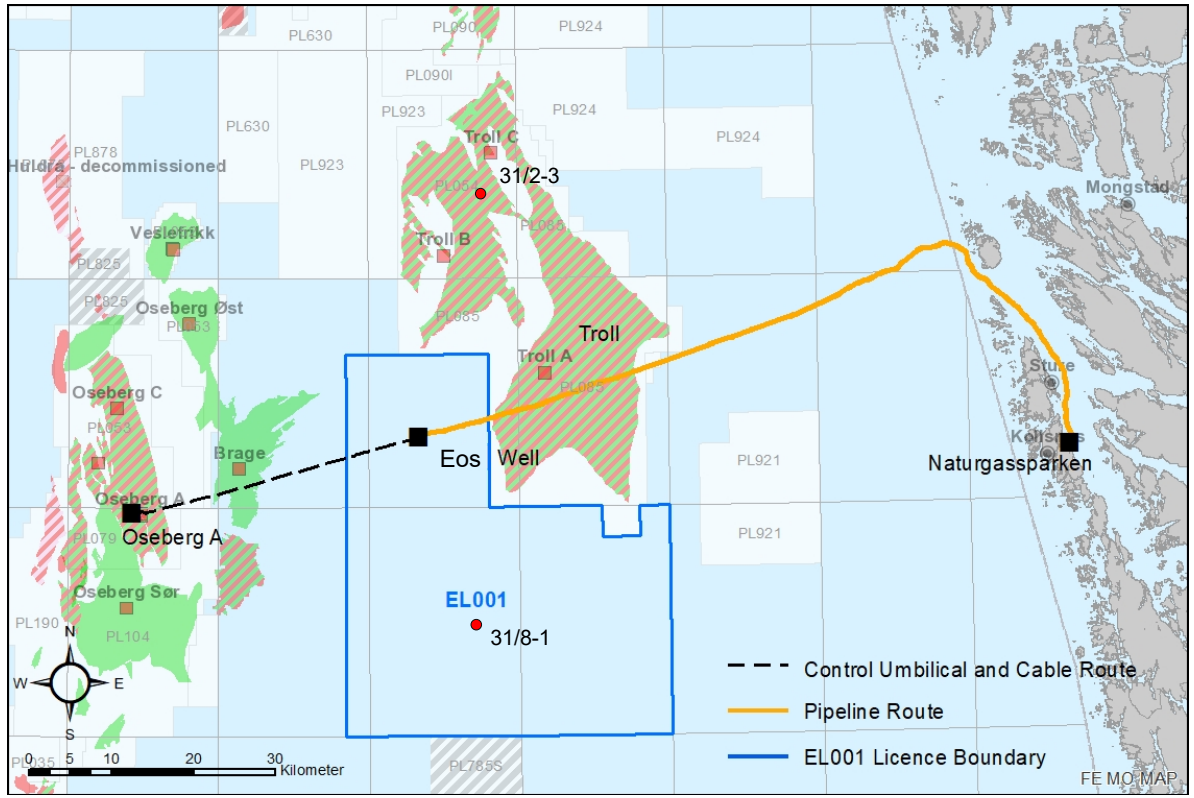
Northern Lights

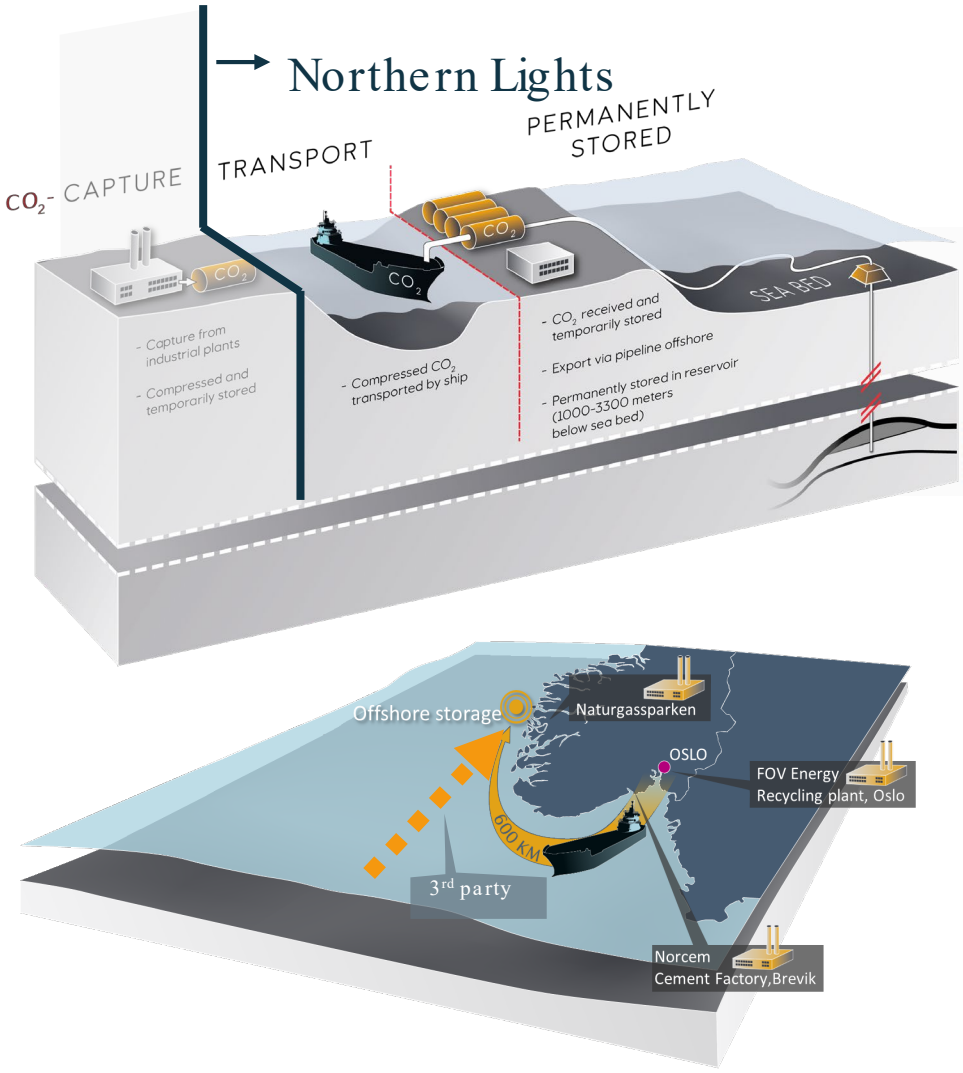
A European CO_2 transport and storage network

Subsurface contributions to the Northern Lights CO_2 storage project sanction: Planning for success in an unexplored license

Renata Meneguolo, Tonje Målbakken, Laurent Galvani, Silvia Kassold, Diego Alejandro Vazquez Anzola

Northern Lights – transport, injection and permanent storage of CO_2





GASSNOVA

equinor

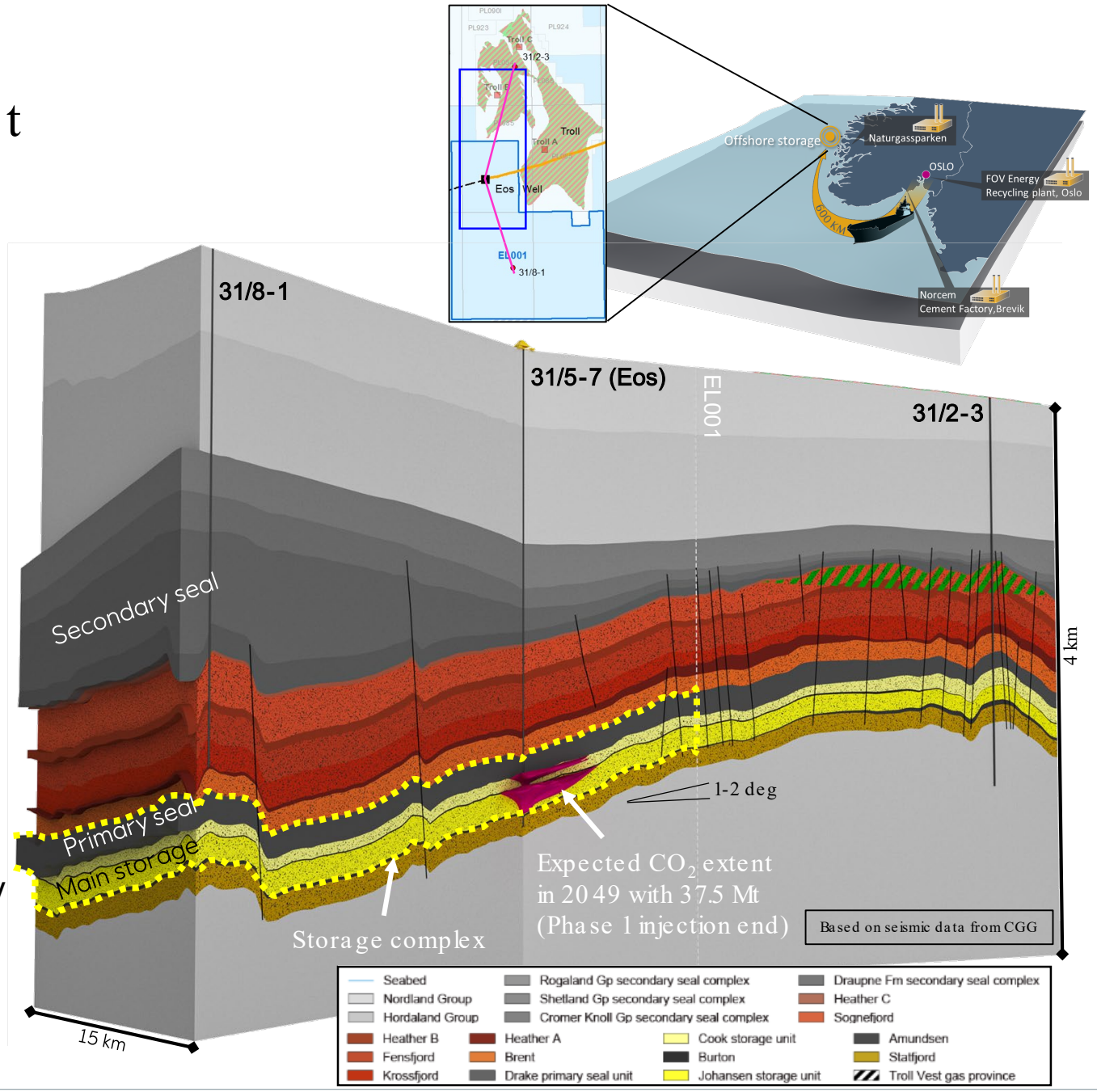
TOTAL

Volume ambitions and timeline pre-set
Pre-investment for onshore storage location made

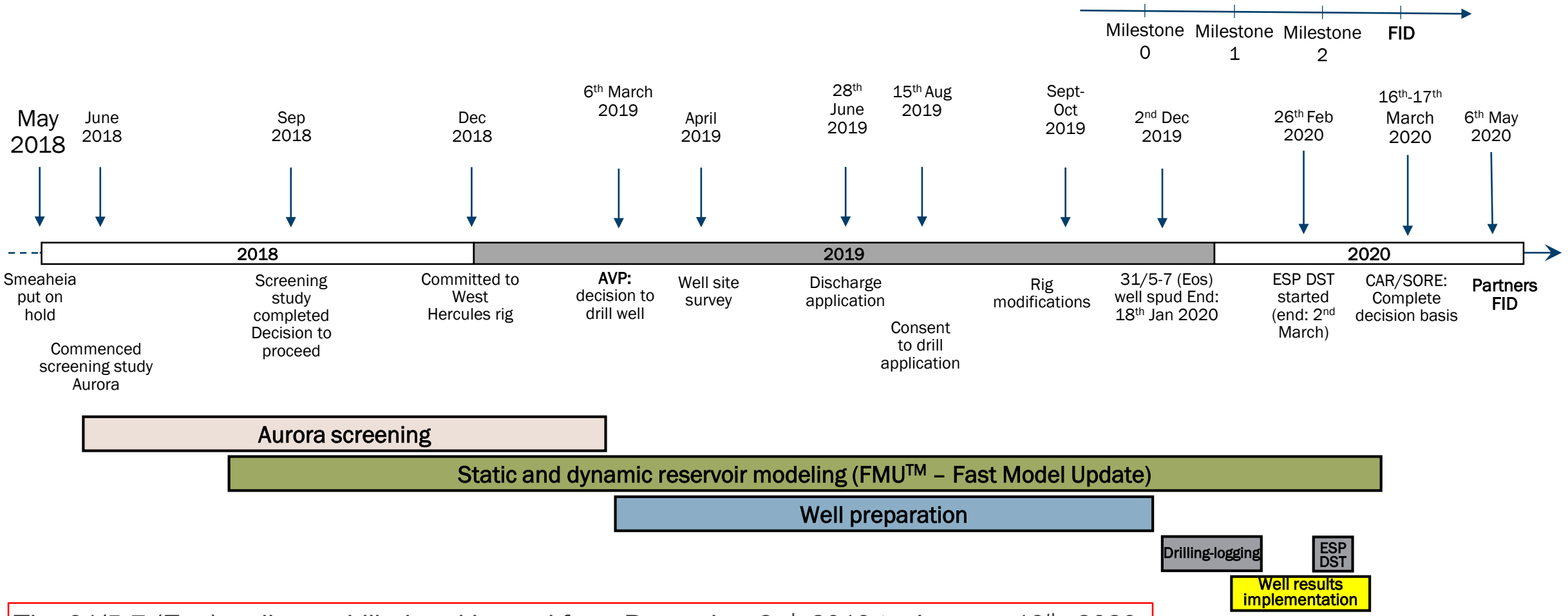
Northern Lights CO_2 storage concept

- Storage Complex: Lower Jurassic Dunlin Gp. *within EL001*
  - Johansen and Cook fms. main storage units
  - Drake Fm. primary seal (seismic reflector)
  - 2500 m below sea level, secondar seals exist
- Semi-regional sloping aquifer, underexplored
  - No well penetration within EL001 until 2019
  - 18 m core from well 31/2-3 ~ 20 km N of license
- High-energy shallow marine depositional environment
  - N-S trending coastline, E-W deepening trend
  - Sand presence, quality and extent main uncertainty

Storage Complex defined stratigraphically and areally, CO_2 to remain within EL001



Timeline for subsurface work



The 31/5-7 (Eos) well was drilled and logged from December 2nd, 2019 to January 18th, 2020
A production test was performed from February 26th to March 1st, 2020

Subsurface methodology – preparing for swift decisions

Geomodelling input: capturing uncertainty span

Geophysics:
- Seismic envelope
- T/D conversion
- Attribute maps

Geology:
- Large-scale correlations
- Five depositional concepts incorporating attribute maps
- Vertical and lateral trends

Geomodelling approach: full flexibility

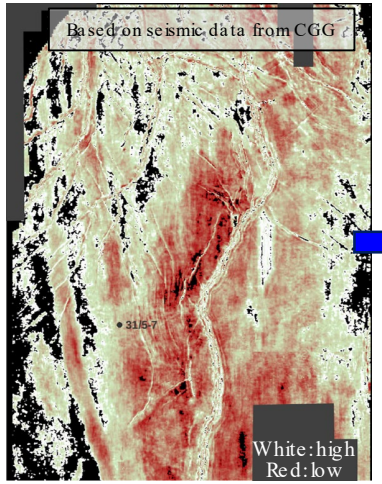
Definition of imiting factors for storage capacity
- Constrain: license boundary
- Testing of crucial parameters

FMU™ (Fast Model Update) setup
- Seamless static to dynamic interaction for stochastic simulations

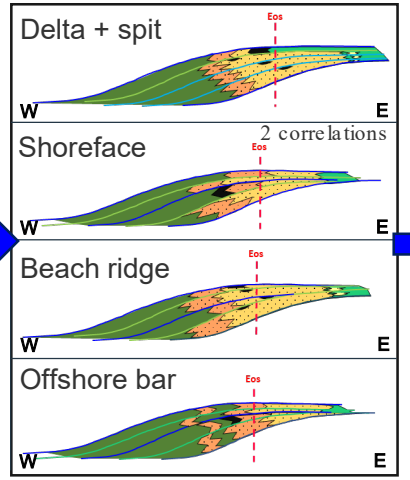
Readiness to incorporate well results
- Continuous and interactive process

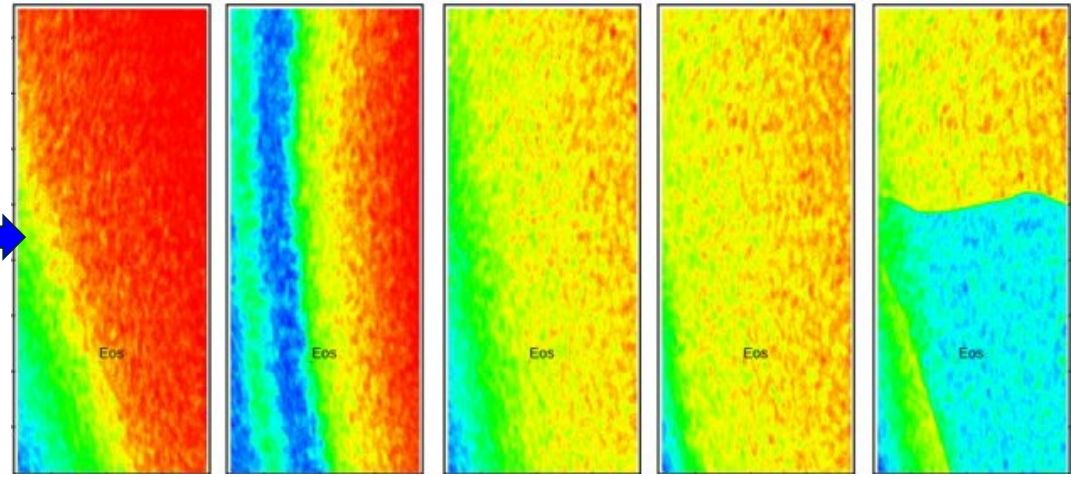
Benchmark for well results: Project Acceptance Criteria

Criteria to proceed to FID within time frame
- Sand presence and quality
  - Injectivity
  - Monitorability
  - Connectivity
- Pressure in Dunlin Gp.
  - Hydrostatic or ≤3 bar depleted
- Seal integrity
- Detailed well data acquisition, analyses and implementation program



SumNeg soft relative acoustic impedance Intra Johansen proxy +10 ms - 15ms



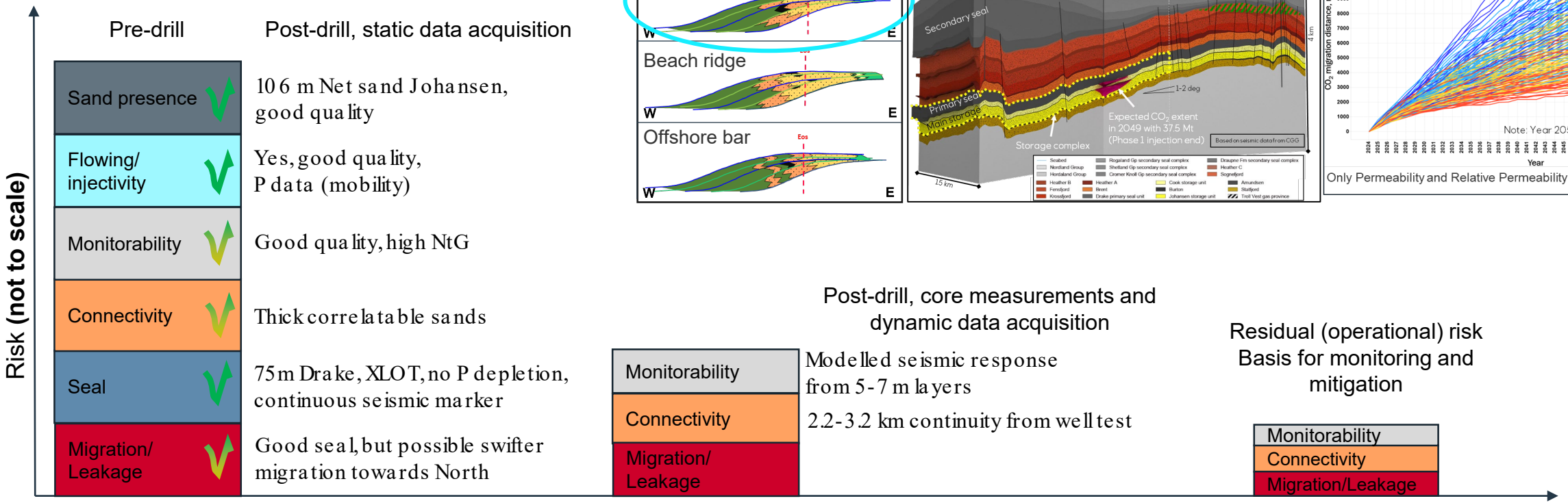


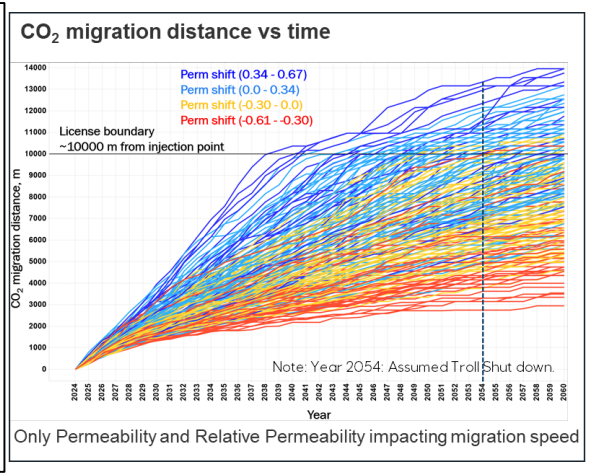
Static model
Net-to-gross maps

Front-end load

Well results impact on subsurface uncertainties

Risk summary, schematic





Summary and conclusions

The Northern Lights project's ambition is to create the infrastructure for industrial-scale transport, injection and permanent storage of CO_2

- Contingencies to subsurface work:
  - Storage area pre-selected
  - Pre-investments made on facilities (onshore storage, satellite)
  - Tight timeline to FID
- Storage concept:
  - Injection in sloping semi-regional aquifer (Lower Jurassic Dunlin Gp.) within EL001
  - No well penetrations
- Approach to subsurface evaluation in the time frame:
  - A range of geological concepts and relative likelihood developed
  - Swift evaluation process by testing pre-well assumptions with the well results
  - Modeling approach (FMU) flexible enough to incorporate the well results (while still in well planning phase!)
- Eos well results: success!
  - Screened out most of the proposed concepts
  - Re-assessed geological understanding (more resolution on depositional processes)
  - Confirmation than planned volumes can be stored
  - FID delivered on time
- Lessons learnt: crucial factors
  - Comprehensive front-end work
  - Detailed plan for analyses and implementation of well results in the time frame

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