CO_2 TRANSPORT & STORAGE R&D

FILIP NEELE

CATO COMMUNITY GATHERING, RIJSWIJK,
26 SEPTEMBER 2023

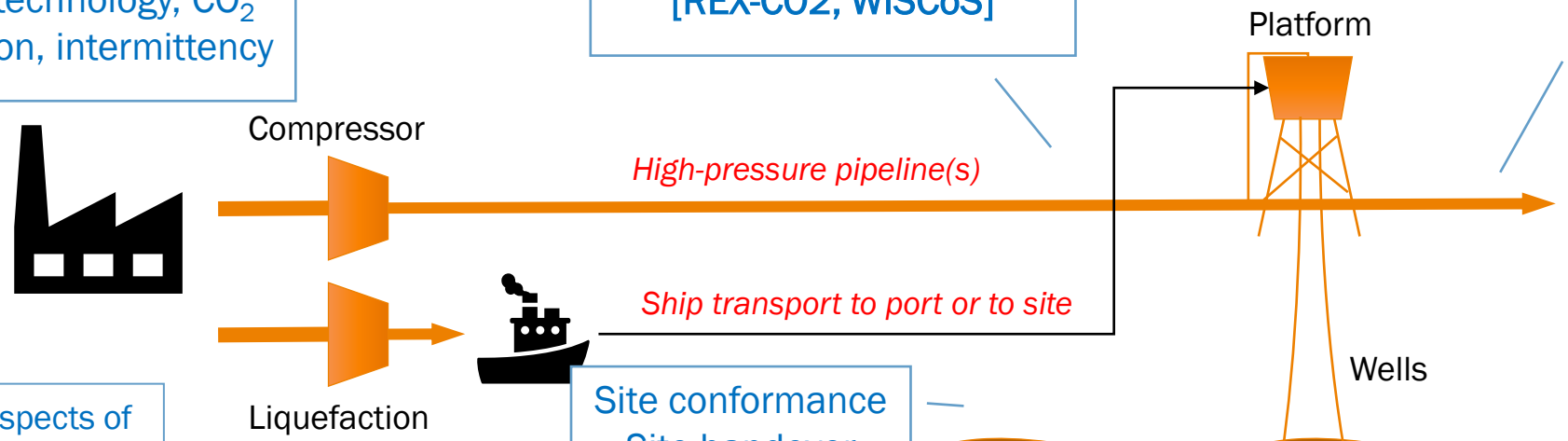
CAPTURE, TRANSPORT & STORAGE SYSTEM

CCS SYSTEM

Capture technology, CO_2 composition, intermittency

Re-using platforms, wells, pipelines **[REX-CO2, WISCoS]**

Transport network development - flexibility, robustness **[ACTiON]**



Large pressure drops in system – management of CO_2 temperature is key element of operations

Covers *all* aspects of a storage feasibility study:
- response of the storage system to injection of CO_2
- management of risks during injection

Site conformance
Site handover
[RAMONCO]

Near-well and well-based processes **[RETURN]**
Legacy well integrity
Well re-use **[WISCoS]**

Risk management plan
Detailed monitoring plan
[RAMONCO]

Well integrity, fault stability, flow rates, intermittency, low-temperature cycling, ...

Pressure and temperature distribution and development in reservoir (injection of cold CO_2) Hydrate formation, seismicity **[RETURN]**

CCS R&D @ TNO

R&D TO SUPPORT OPERATIONAL PHASE OF CCS

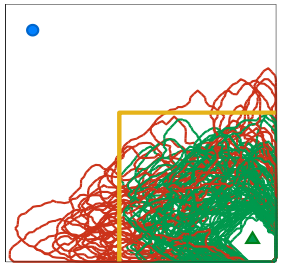
- Conformance assessment & MMV – interpretation in terms of storage system performance / conformance
  - Forecasting data, back-projection of differences with measured data into geological model updates
  - Involves assessment of risks in the system; support designing monitoring programmes
  - R&D work done in TNO; a project starting under the CETP programme (**RAMONCO**, Q4 2023)
- Improve understanding of near-well processes (ERA-NET ACT **RETURN**)
  - Reduce uncertainty in reservoir – well coupling
- Prepare for network evolution (ERA-NET ACT **ACTION**, next slides)
  - Understand how newly developed depleted fields can be added to an operational T&S network
- Continue work on re-use of gas wells for CO_2 injection (JIP **WISCoS**)
  - Screen / workover / estimates of cost and efforts
- CO_2 flow loop (TNO labs, Rijswijk) to study flow behaviour near chokes and valves and impact of CO_2 composition
  - TNO flow loop operational 2024, to support operational phase of CCS projects

CONFORMANCE ASSESSMENT, MMV

CETP RAMONCO (STARTS Q4 2023)

Starting point for CCS (and MMV) system design (pre-FEED), and for conformance assessment (operational phase)

Some models suggest possible migration outside of the bounds of the storage complex



What we must be robust against:

- Subsurface properties
- CO_2 supply conditions

Uncertain variables

Input file

Optimization variables

Input file

What we must choose:

- Injection rates
- Well locations
- Monitoring system

Model chain

How the system behaves / responds:

- Reservoir flow models
- Geomechanical models
- Geophysical models
- Wellbore / facility network models
- Coupled solutions of the above

Output file

Simulated obs. data

What monitoring data could look like

Constraint function

What is acceptable

Objective function

What is performance

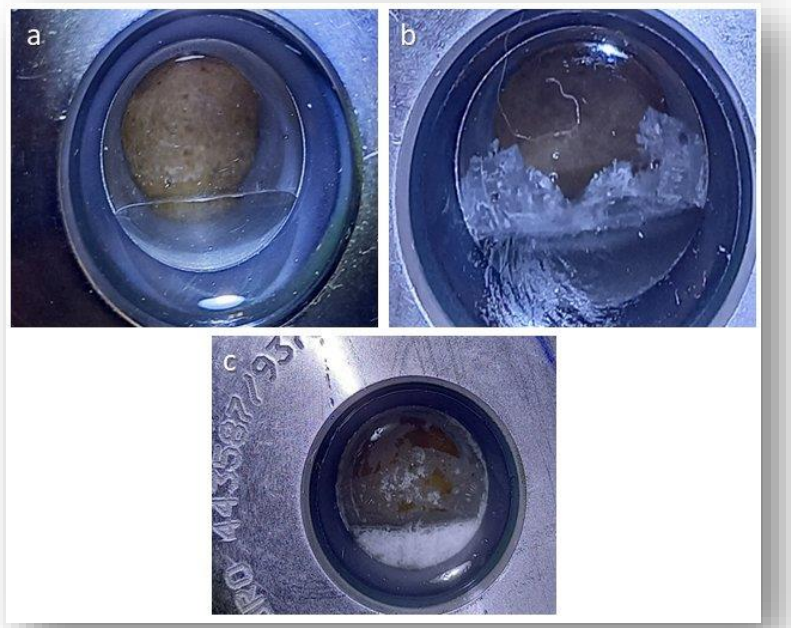
See Barros et al., IJGGC (2022)

WELL-BASED AND NEAR-WELL PROCESSES IN DEPLETED FIELDS

ERA-NET ACT3 ‘RETURN’

- Project started Q2 2022
- Duration 3 years, lead: SINTEF (NO)
- Goal: improve understanding and simulation capabilities of processes acting near injection wells in depleted fields
- Relevance: such knowledge and simulation capabilities will be needed when interpreting MMV data and assessing system conformance

See project website: return-act.eu

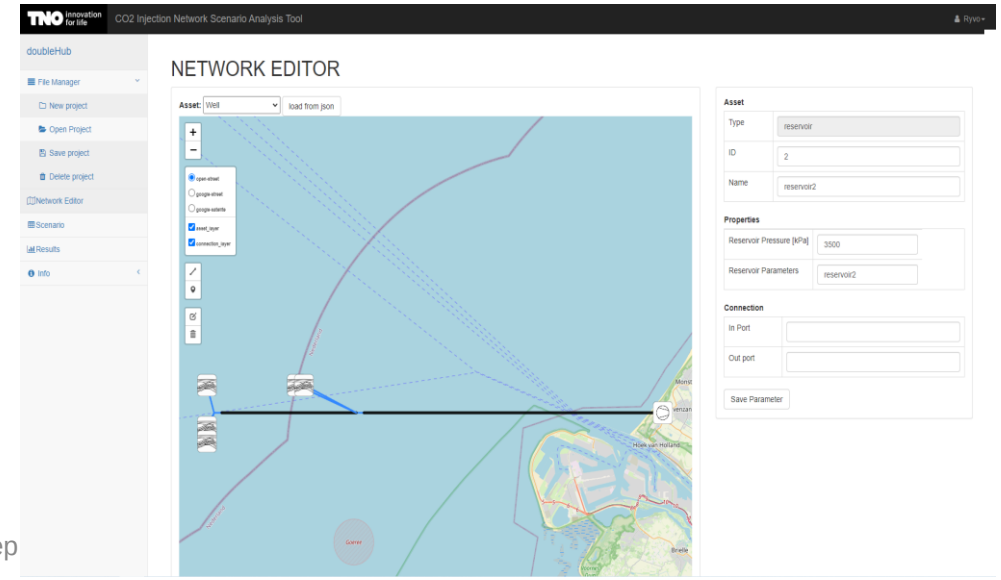


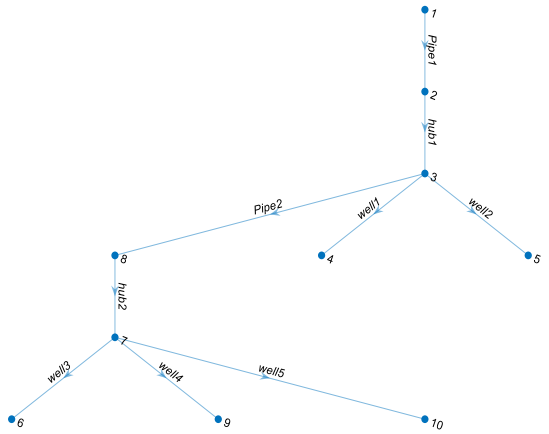
CO_2 rich gas mixture, hydrate formation tests performed at TU Bergakademie Freiberg, Germany

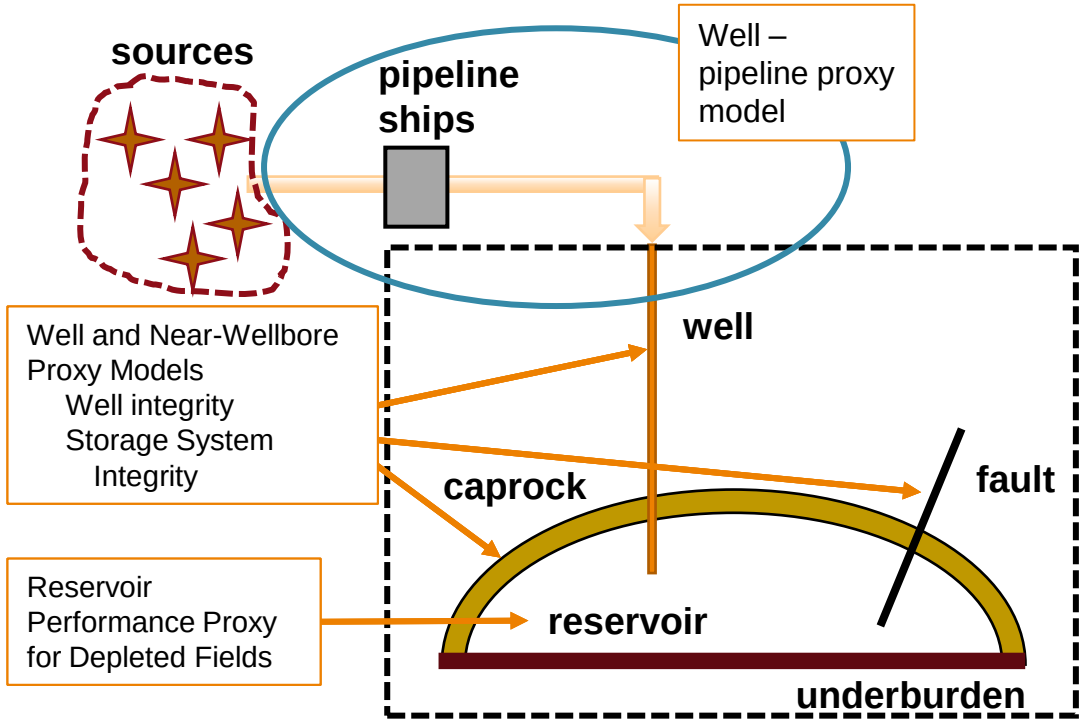
- Impurities and salinity retard hydrate formation

NETWORK EVOLUTION
ERA-NET ACT3 'ACTION'

- Project started Q2 2022
- Duration 3 years; lead: ICL (UK)
- Goal: create physics-of-CO_2-flow-based simulator of a CCS transport & storage network, study a network's behaviour, management and evolution
- Relevance: the behaviour depleted fields is likely to affect the development and operation of a network of storage locations – should be clarified as early as possible







Development of CO_2 network simulator

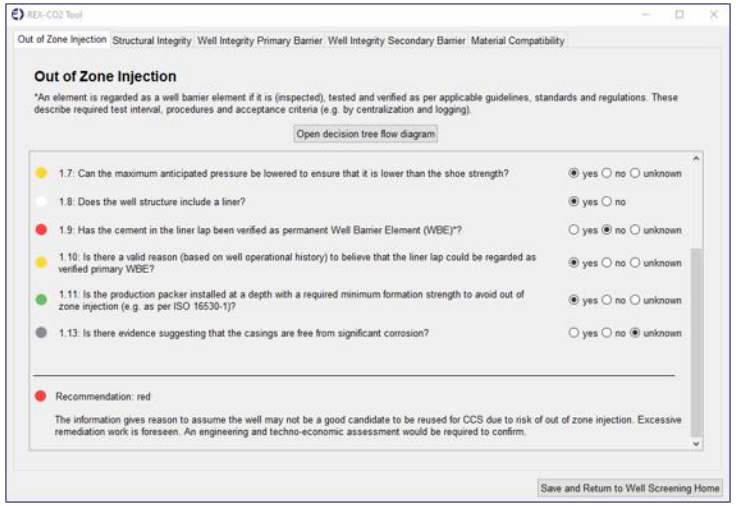
- Depleted fields
- Network operation & evolution
- Steady-state simulation

RE-USE OF GAS WELLS FOR CO_2 INJECTION

WISCOS

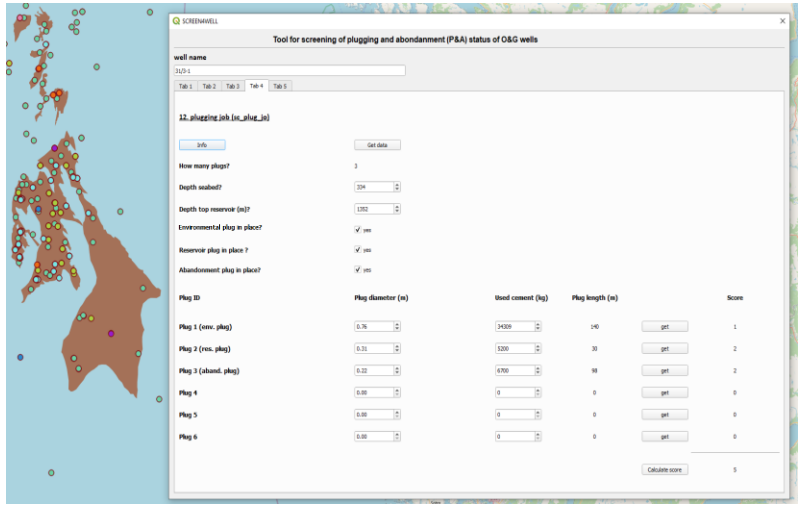
- Identification of potential well integrity issues for each well penetrating the caprock in the storage complex
- To add value for operators and regulators in storage license applications (SLA) for maturing CCS projects

- Built upon two existing frameworks: REX-CO2 and TOPHOLE
- Early project risk assessment
- Qualitative+ assessment (quantitative where possible)
- Provide a basis for engineering assessment
- North Sea specific



REX-CO2 screening tool

+

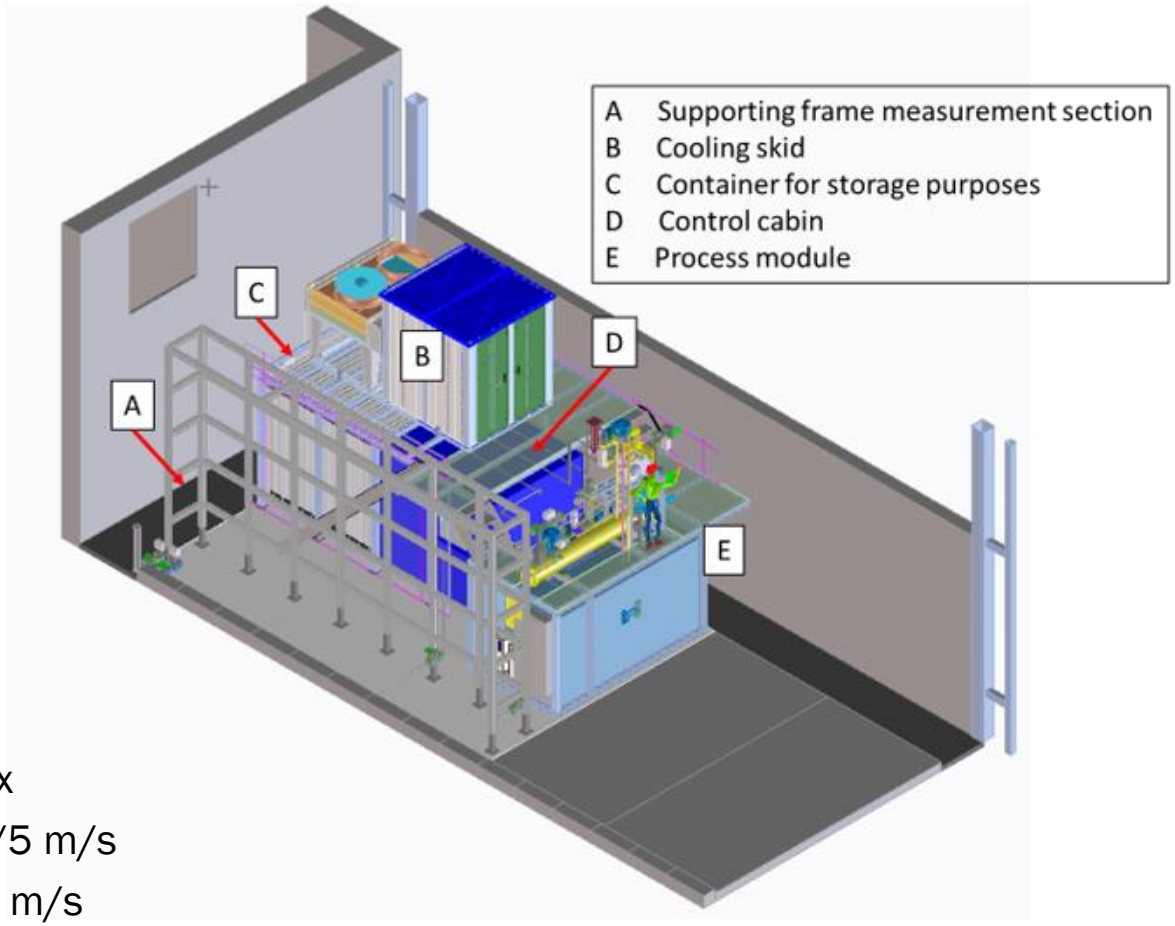


TOPHOLE P&A wells screening tool

End product is a stand-alone software tool to enable early identification of well integrity risks and required mitigation measures for safe and reliable CCS operation

CO_2 FLOW LOOP
CO_2-TIME, ENCASE

- Flexible and modular facility to investigate CO_2 behaviour for e.g. bends, valves, chokes, instruments , other vertical & horizontal appendages, porous media
- CO_2 composition: pure CO_2 and CO_2 mixtures
- Accurate control and read-out of pressure, temperature and flow rate
- Flow lines ID of ½”-1”
- Flow conditions



	Min	Max
Flow rate gas		20/5 m/s
Flow rate liquid		1-2 m/s
Pressure		100 bar
Pressure drop		75 bar
Temp	-50 °C	+ 40 °C

THANK YOU FOR
YOUR TIME

TNO innovation for life