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#7 SCALING UP STORAGE: INSIGHTS ON DEVELOPING OPERATIONAL STORAGE CAPACITY IN EUROPE

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MODERATOR

15 April

Workshop #7 Scaling up storage: Insights on developing operational storage capacity in Europe

16:00-17:30

Sarah Gasda

RESEARCH DIRECTOR

NORCE RESEARCH

Sarah Gasda is Research Director at NORCE and Professor II at the University of Bergen. She leads the national research centre CSSR and has responsibility for the gigaCCS Mission Area Storage.

She has 25 years of experience within storage modeling and simulation and is internationally recognized for her contributions to legacy wells and leakage risk, long-term trapping, and regional-scale pressure interference.

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Rachael Moore

MANAGING DIRECTOR

CARBSTRAT

Rachael Moore, the Managing Director of CarbStrat, has worked in the carbon management space for over 10 years. At CarbStrat, her work focuses on technical and policy aspects of industrial decarbonization and carbon management. Prior to CarbStrat, she supported the World Bank Group's CCS Trust Fund during its final two years of operation and was the International Energy Agency's subject matter expert on CO_2 storage for two years. She is the author of several reference documents on CCUS including the IEA CCUS Handbook: CO_2 Storage Resources and their Development.

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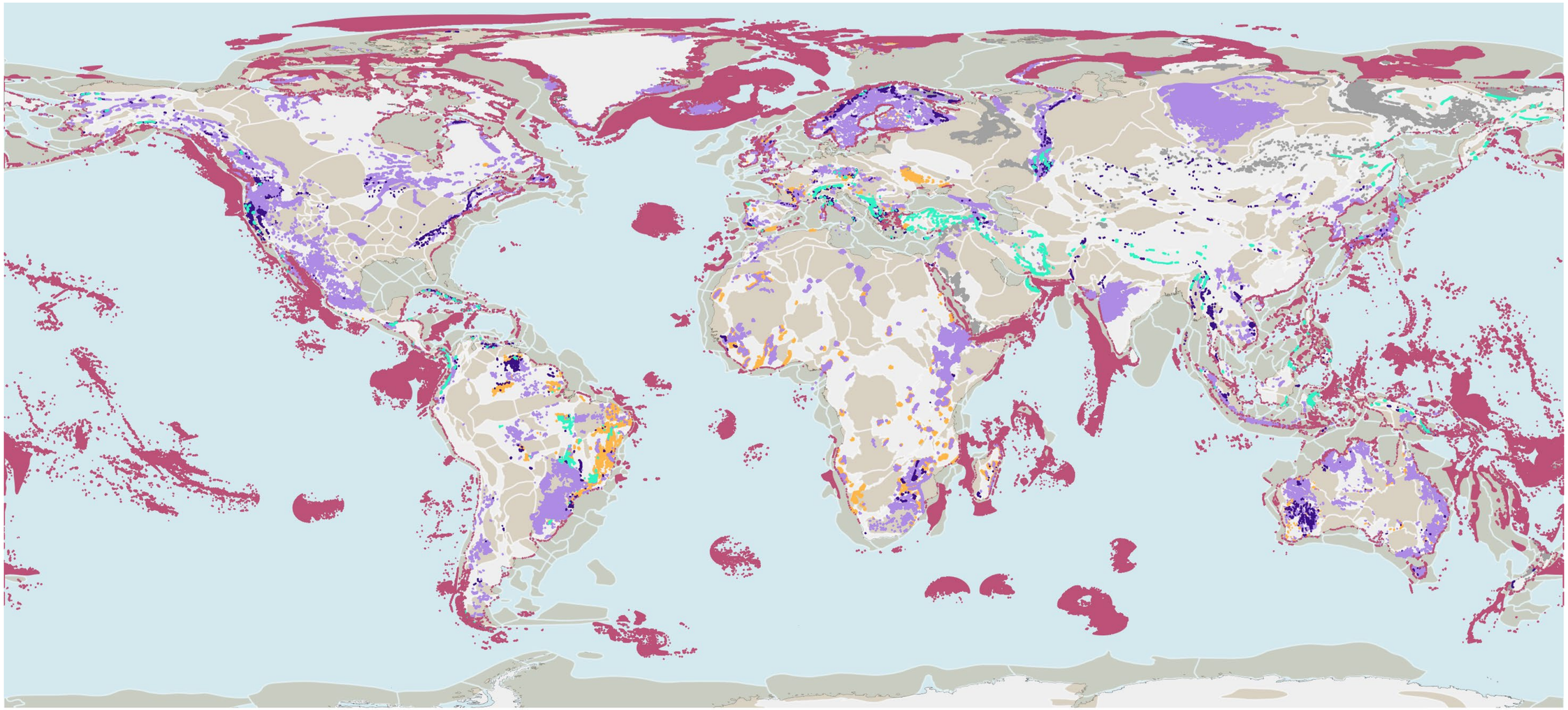
Mafic and ultramafic CO_2 storage: where are we and what is needed

Rachael Moore | r.moore@carbstrat.com

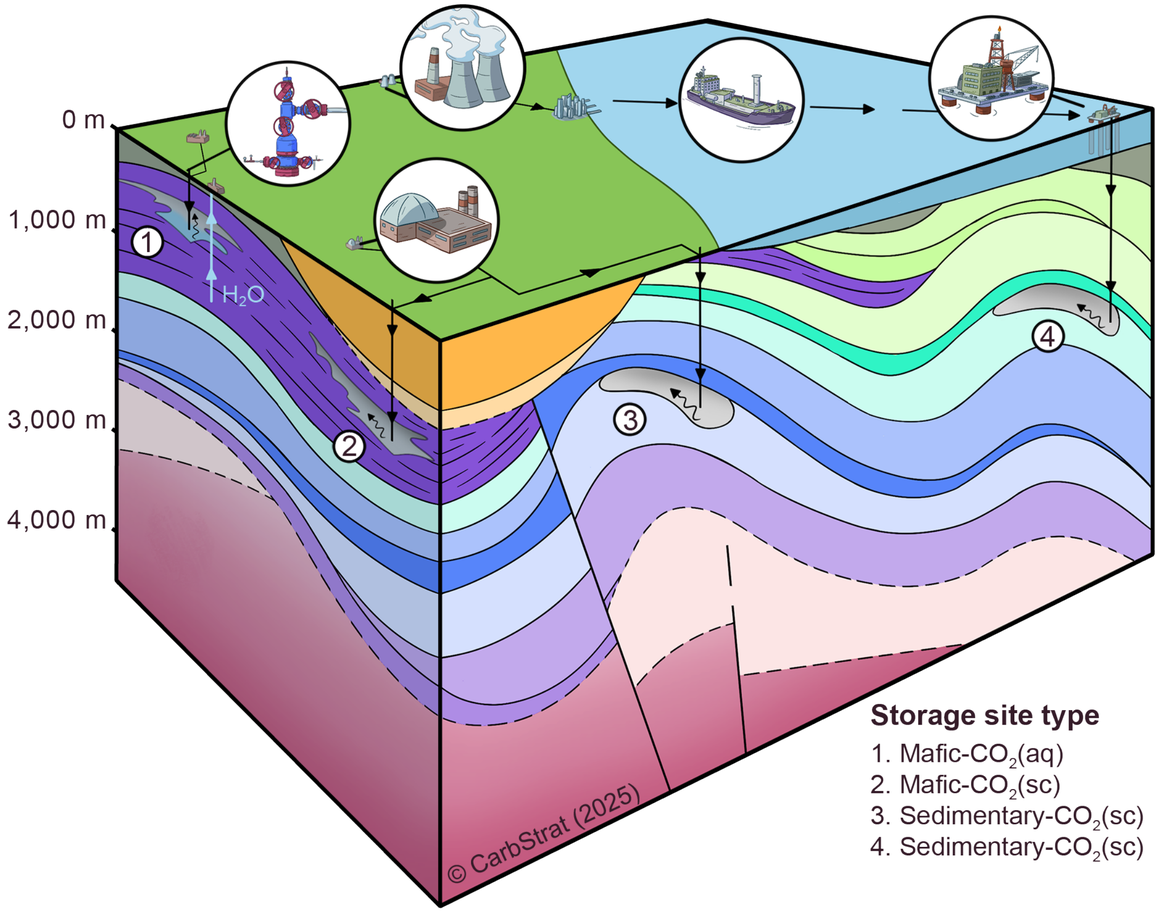
Knowledge Sharing 2026: Workshop 7 | 15 April

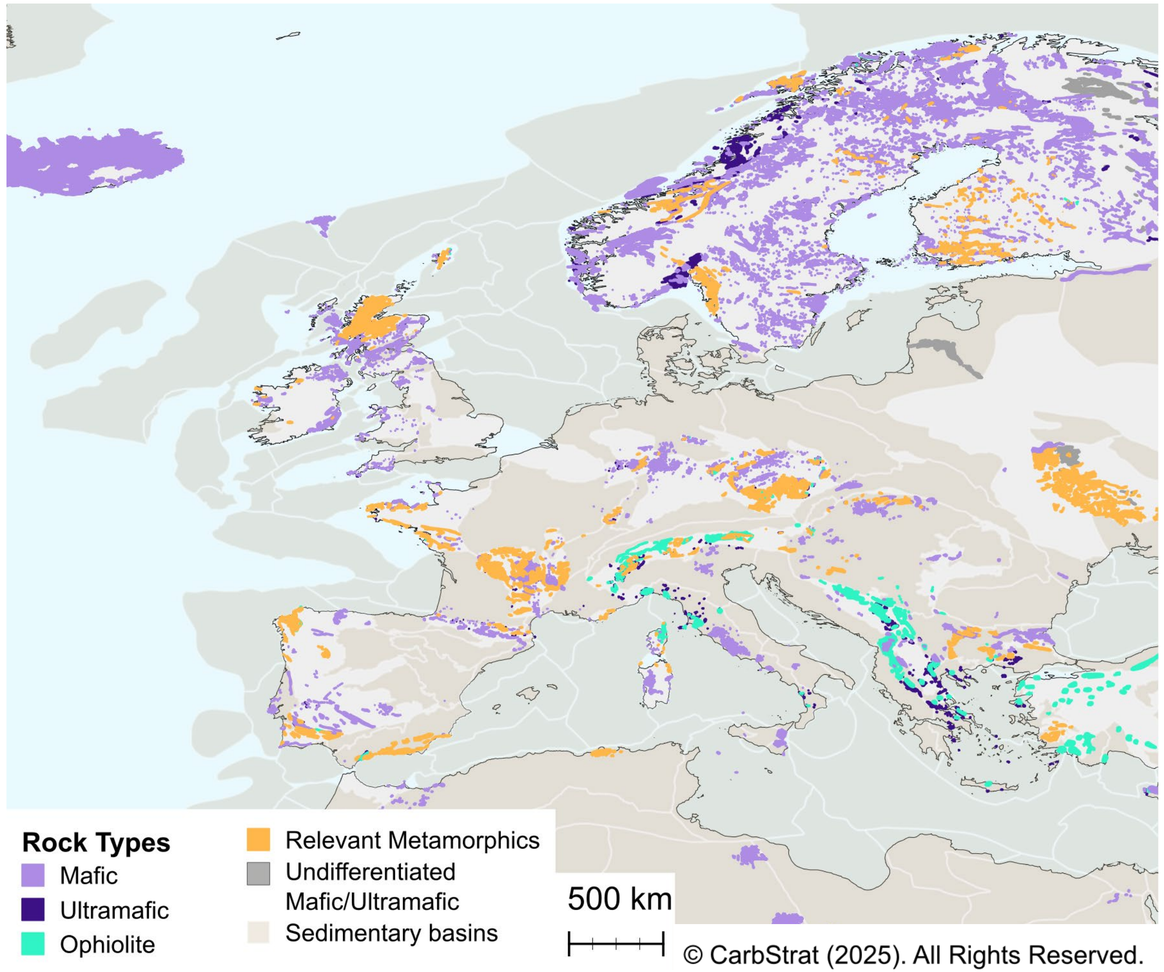
Mafic and ultramafic rocks are found all over the world



The world needs more CO_2 storage

Sedimentary CO_2 storage is more mature than mafic and ultramafic CO_2 storage, but it may not be sufficient in the future





R&D can contribute to scale up efforts

The largest permitted injector is 47 ktpa CO_2. Outside of Iceland no project has announced that it has injected more than 1 kt of CO_2

Resource assessment:

- Primary identification of relevant rocks and their properties (sequence thickness, porosity/permeability, rock type, etc.)
- Pre-competitive exploration for the purpose of CO_2 storage

Modelling efforts:

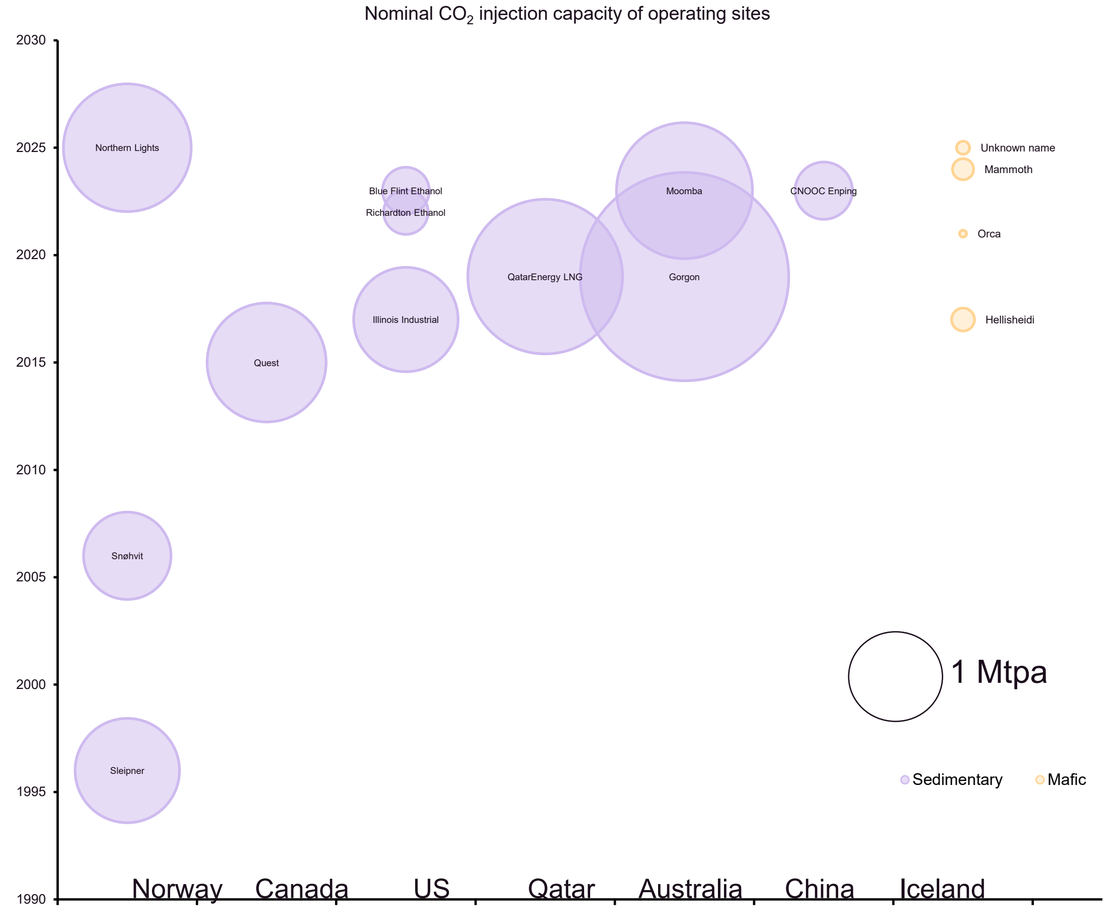
- Coupling reactive-transport models with reservoir models

Drilling and well design:

- Improving drilling techniques, for the purpose of fluid injection, in crystalline rock

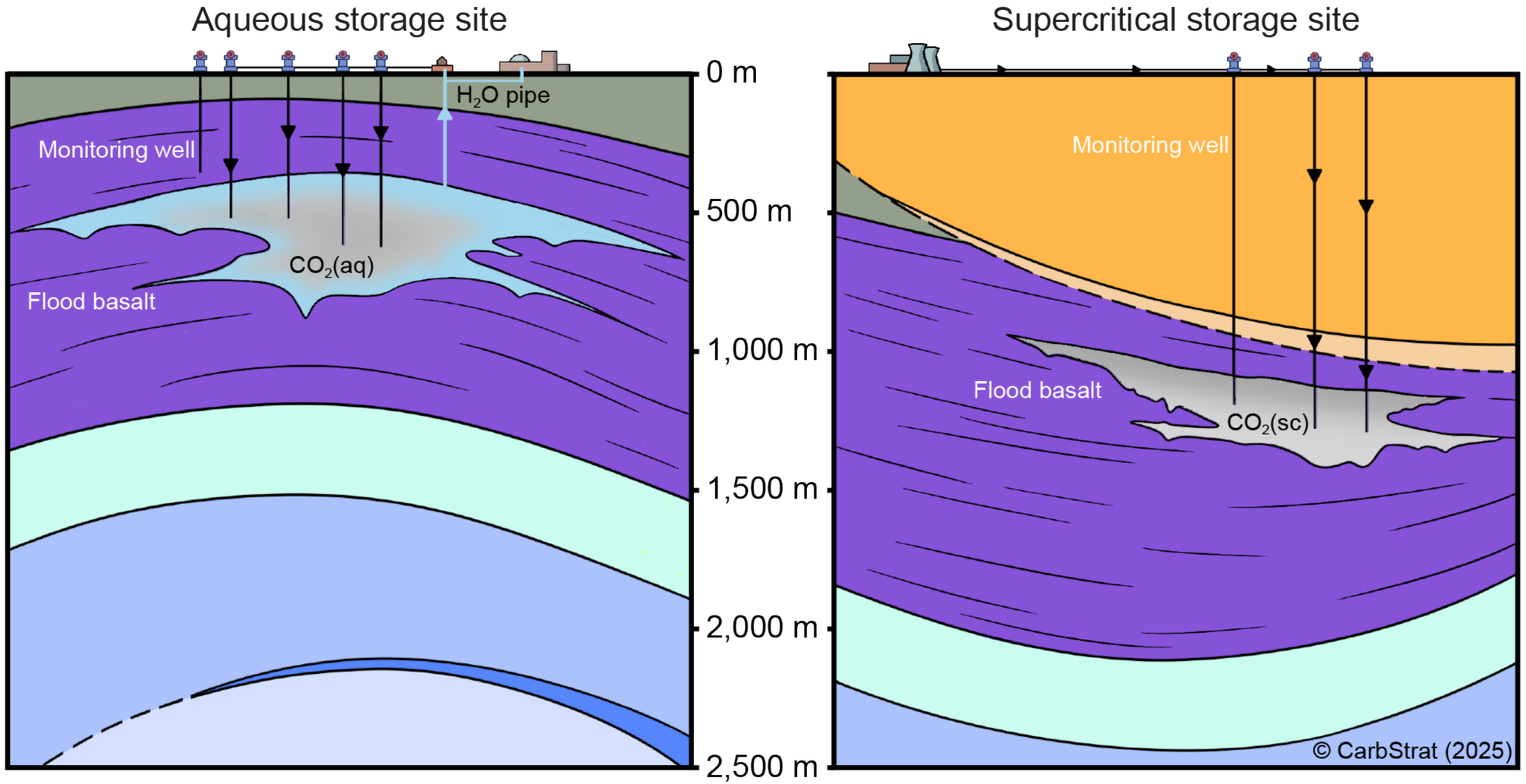
MMV of injected CO_2:

- Coupling imaging and geochemical techniques to improve quantification of mineralization
- Defining what conformance looks like for these types of sites



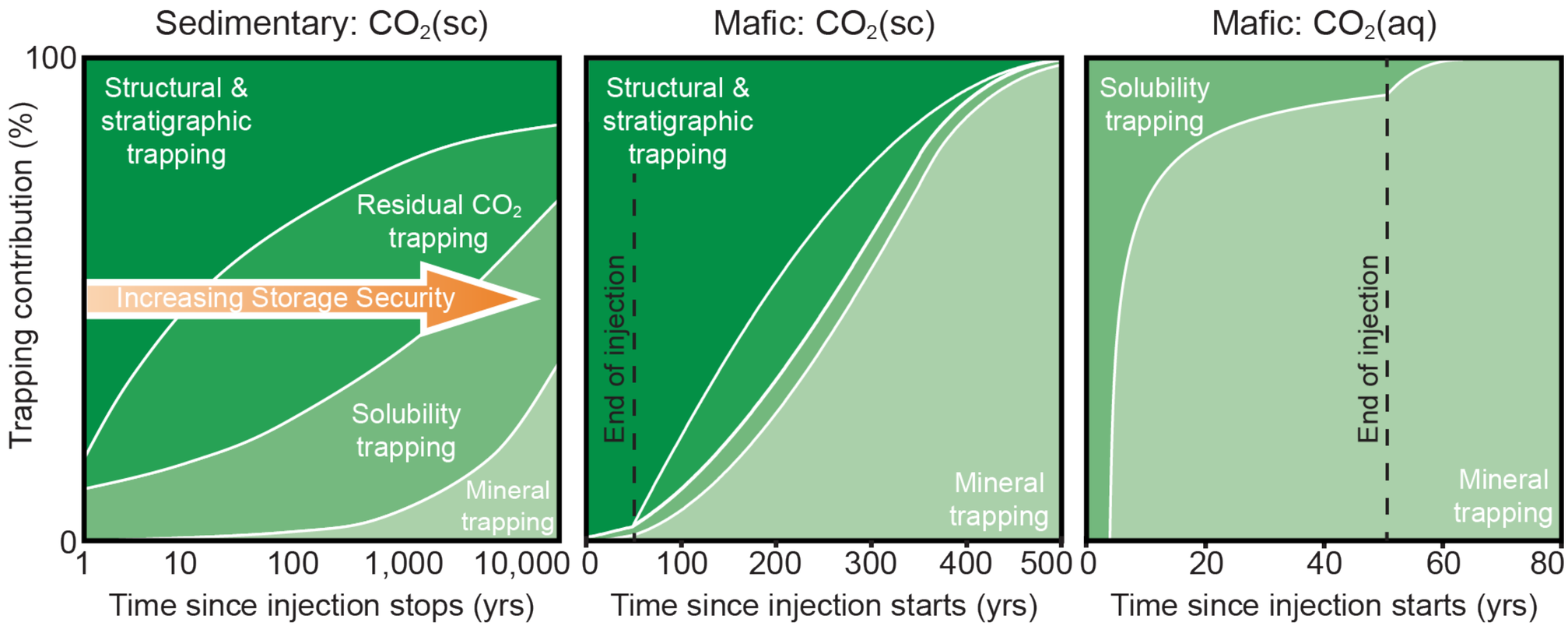
Multiple injection styles to demonstrate

Aqueous projects inject at least 20-30 times more fluid but likely have faster mineralization



Injection style will influence trapping mechanisms

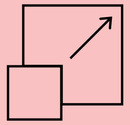
Mineral trapping is expected to be more rapid in aqueous CO_2 injections than supercritical CO_2 injections. Both are more rapid than in sedimentary storage



Left: Reproduction of Figure 5.9 from IPCC (2005). Centre and right: Adapted with permission from modelling done by Postma (2022).
Note: The sketches are theoretical and not based on actual behaviour from a specific site.

Shifting from small-scale to large-scale is needed

To contribute to emissions reduction and removal, mafic and ultramafic storage needs to demonstrate scalability, commerciality, the security of injected CO_2, and safety



Scalable

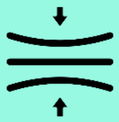
- **Problem:** Current projects are too small scale to contribute to addressing the climate crisis
- **Solution:** Develop pilots and demos that test resource performance at climate relevant injection rates (>100 ktpa)

Commercial

- **Problem:** Potentially elevated drilling costs and more infrastructure needs
- **Solution:** Assess cost differences between aqueous and supercritical injections

Secure

- **Problem:** Rock properties, injection styles, and the potential for mineralization increase the complexity of MMV
- **Solution:** Develop and trial monitoring techniques that can detect mineralization and improve existing monitoring techniques used in sedimentary storage



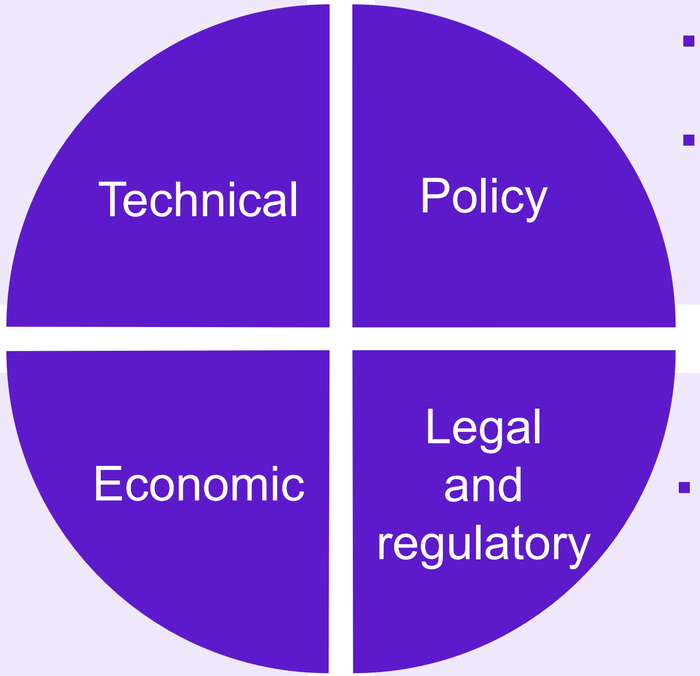
Risk

- **Problem:** Insufficient fluid injection experience in these rock types to assess and model the risks of large-scale storage
- **Solution:** Pilot and demonstration projects and support data sharing to improve modelling efforts

Actions to support scale up

The feedback loop between technical, policy, legal and regulatory, and economic aspects of project development needs to be addressed

- Improve primary understanding of mafic/ultramafic rocks, their distribution, and the properties of individual sequences
- Develop large-scale pilots across a range of rock types, geographies, and injection styles

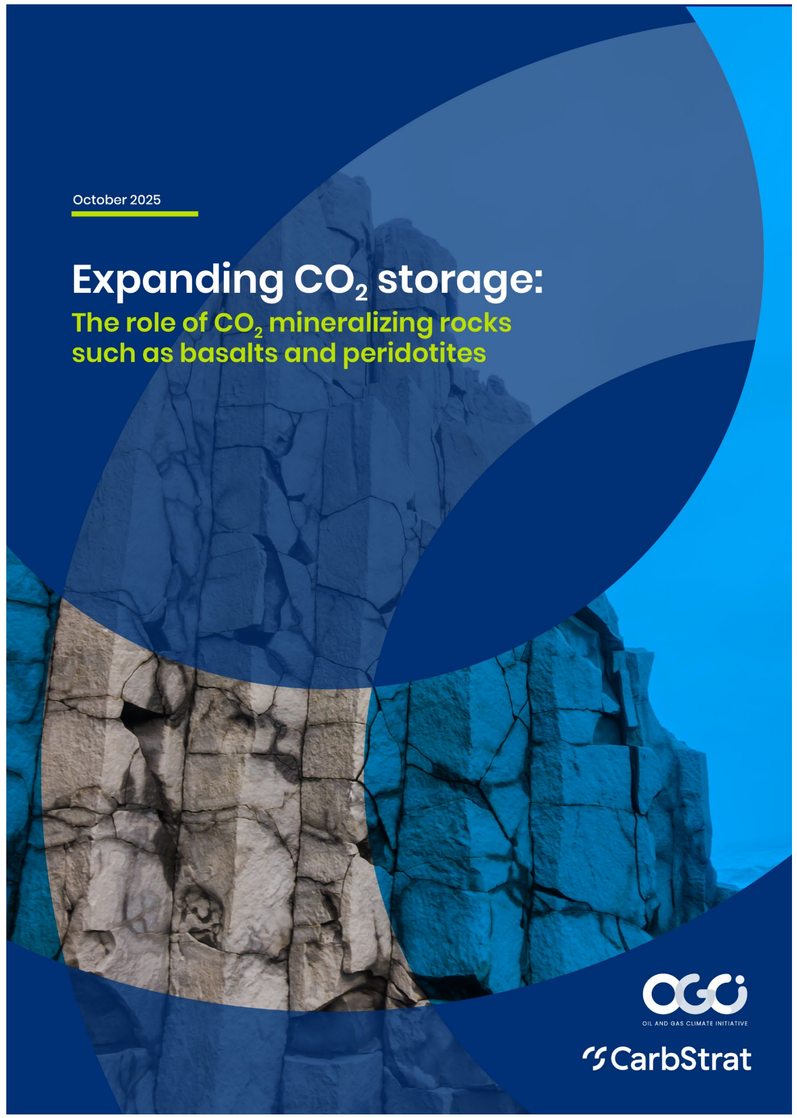


- Establish policies that support the development of CO_2 storage in general
- Include mafic and ultramafic CO_2 storage in research and development schemes

- Improve understanding of the cost differences between aqueous and supercritical injections related to energy demands, infrastructure, monitoring needs, etc.

- Ensure legal and regulatory frameworks for storage are agnostic to storage resource type and allow for different injection styles

Explorable map and in-depth report available



In October 2025, the OGCI released a report on the state-of-the-art of CO_2 storage in mafic, ultramafic, and certain CO_2-reactive metamorphic rocks. It outlines where we are today with CO_2 storage in these rock types, how they compare to sedimentary CO_2 storage resources, and the risks and opportunities presented by this type of CO_2 storage.

The report is supported by an online map showing where these resources can be found globally and how their distribution compares to sedimentary basins.

The report and map can be found at the following link: https://ccushub.ogci.com/minerals-map/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Kristoffer Engenes

PRINCIPAL ENGINEER / GEOLOGIST

NORWEGIAN OFFSHORE DIRECTORATE

Kristoffer Engenes is a geoscientist with 25 years of experience in Norwegian oil and gas exploration, including international assignments to Germany, India, and Oman. His work has focused on geophysical and geological activities spanning from geophysical data acquisition through subsurface screening, drilling, appraisal, and reserves booking. Since 2023, he has worked at the Norwegian Offshore Directorate (Sokkeldirektoratet), with a particular focus on CO_2 storage projects.

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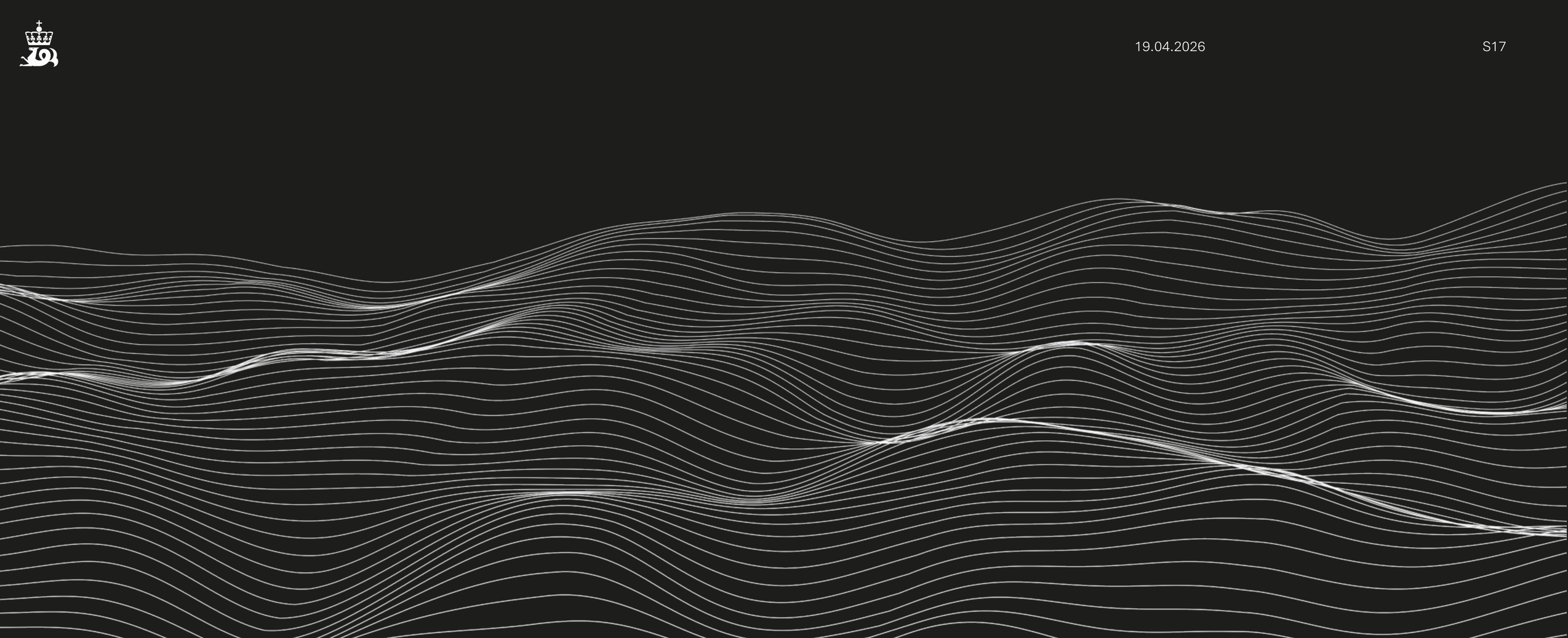


Enabling effective upscaling of CO_2-storage; A regulator's view

Gassnova Knowledge Sharing Summit 2026

Presented by Kristoffer Engenes, Geologist, Norwegian Offshore Directorate

Sandefjord, 14-16 April 2026

What are the Norwegian Offshore Directorate's perspectives for scaling up CO_2-storage?

How to scale-up from 13 licenses to a much larger portfolio?

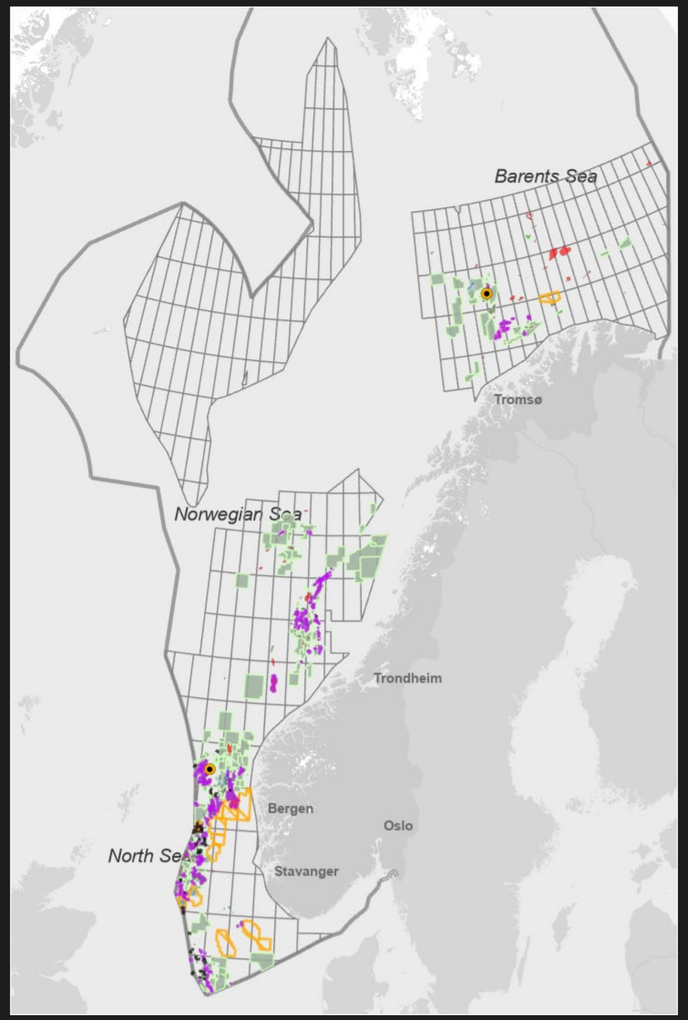
What is NOD's estimated prospective storage potential on the Norwegian Continental Shelf (NCS)?

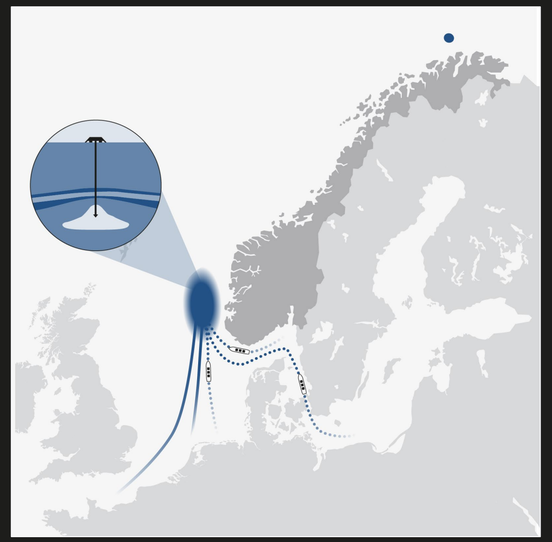
Any updates to the NCS CO_2 Storage Atlas?

What can be done to mature further the CO_2 Storage Atlas?

First a quick introduction to Norwegian Offshore Directorate

- Norwegian Offshore Directorate (NOD, Sokkeldirektoratet) was established in 1972
- NOD acts as the Ministry of Energy's technical adviser for petroleum, CO_2 storage, and seabed mineral activities on the Norwegian Continental Shelf (NCS)
- NOD employs around 200 staff across a wide range of relevant disciplines
- NOD represents deep technical expertise and extensive subsurface experience
- NOD hosts offshore subsurface data through the Diskos database
- NOD has been fundamental in defining Norway's CO_2 offshore storage potential
- NOD emphasizes the optimization of CO_2 storage potential on the NCS





Source: Norwegian Offshore Directorate

Data

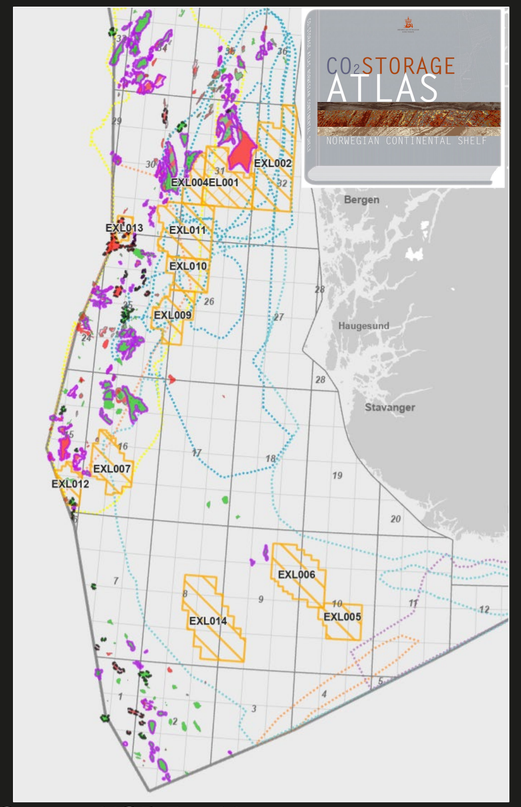
Regulative framework

Access to suitable area

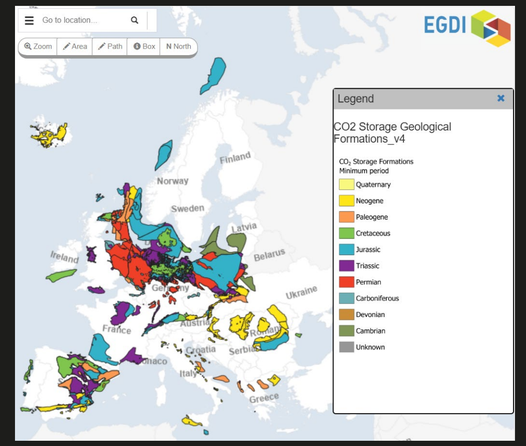
Upscaling enabler:

NCS CO_2 STORAGE ATLAS – The legacy carries on

- Norwegian North Sea CO_2 Storage Atlas was published in 2011
- The complete Norwegian Continental Shelf CO_2 Atlas was published in 2014
- Known reservoirs from petroleum exploration form the basis
- CO_2 storage complexes are evaluated using decades of subsurface data
- Saline aquifers are the main storage option in the atlas
- Depleted fields carries additional potential
- The atlas has defined the starting point for many related activities
- The atlas has been inspirational for other regions and countries
- The atlas is now being incorporated into the new EU CO_2 Storage Atlas



Source: NOD FactMaps



Source: GSEU Project. Map of CO2 storage potential areas at the EU-scale. Version 1.0. Access information on March 26, 2026

Upscaling enabler:

ACCESS TO DATA – Take some and give some

- NCS data repository is hosted by NOD through the Diskos database
- Most NCS subsurface data becomes public
- Legal regulations define when data is made publicly available
- Public data access enables reuse for other projects
- Data sharing creates strong cross-sector synergies
- Common datasets support petroleum, CO_2-storage, and research
- Transparency is a key principle of Norwegian data management
- We don’t compete on data – we compete on knowledge

Diskos Subsurface Database

More than 22.00 Terrabyte (TB)

Seismic

5 810	Seismic Surveys
11 280	Navigation sets
83 226	Seismic Datasets
93 589	Seismic Documents

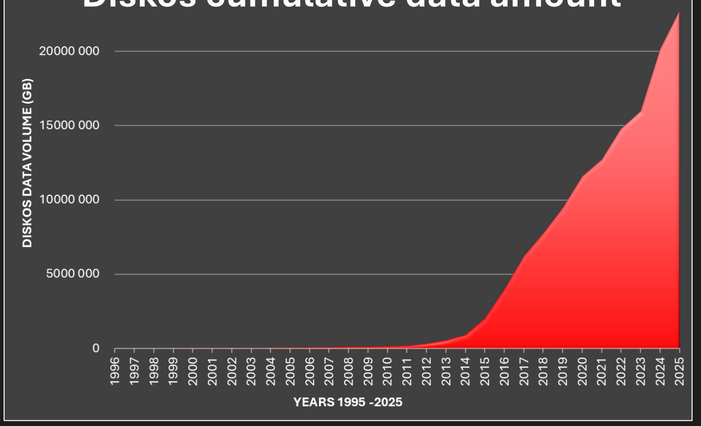
Well

12 032	Wellbores
5.5 mill	Well Files

Production

Monthly production data field/well

Diskos cumulative data amount

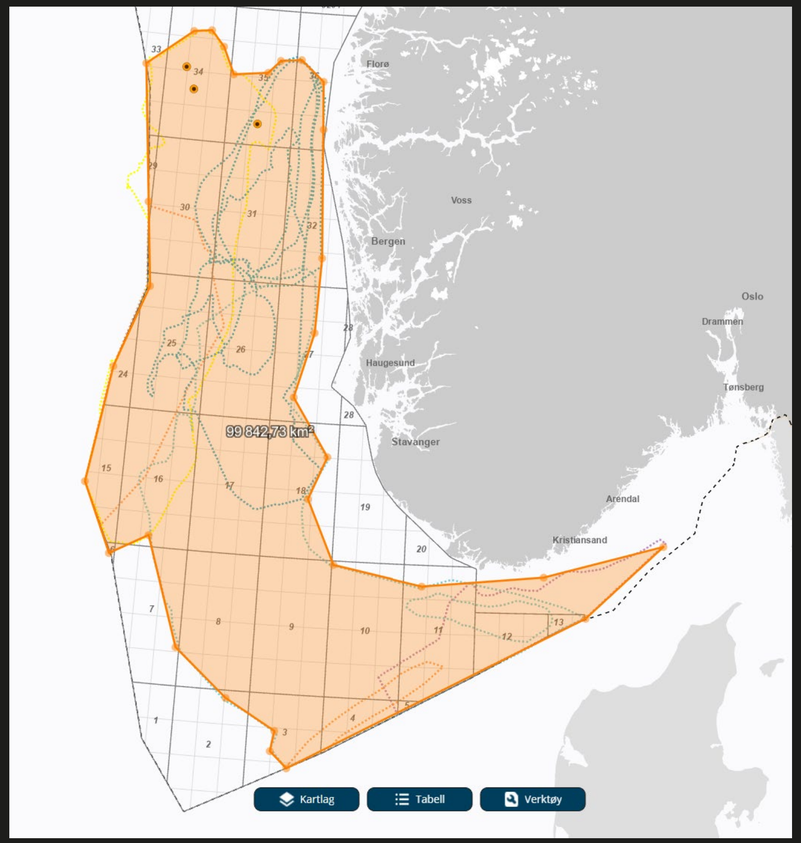


Source: Diskos/Norwegian Offshore Directorate

Upscaling enabler:

ACCESS TO SUITABLE AREA – Lots of area!

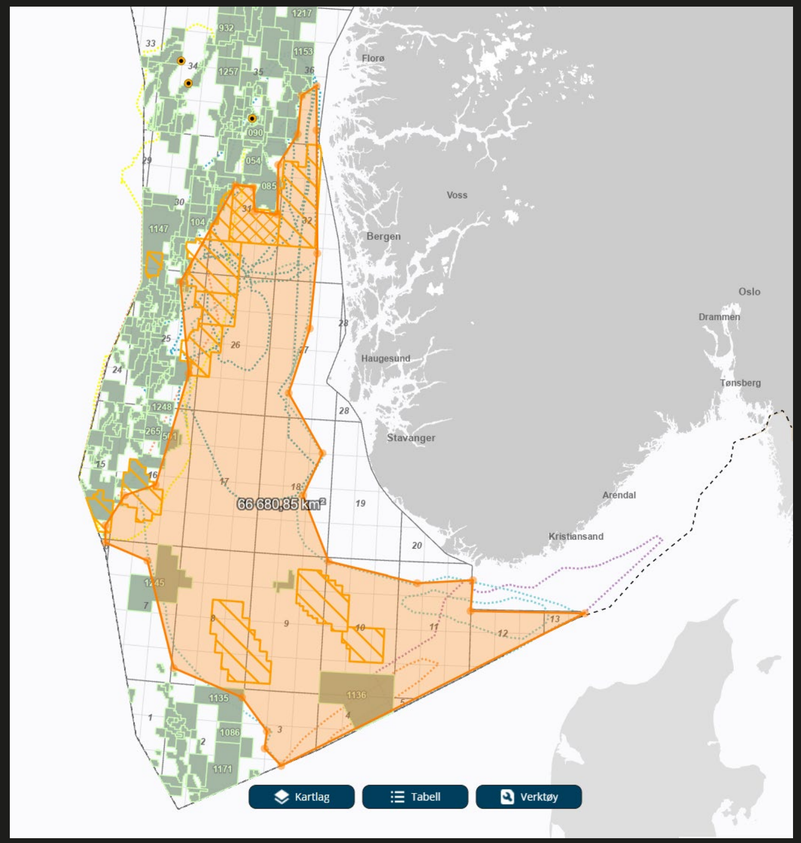
North Sea saline aquifers in CO_2 Atlas



~ 100.000 km²

1/1

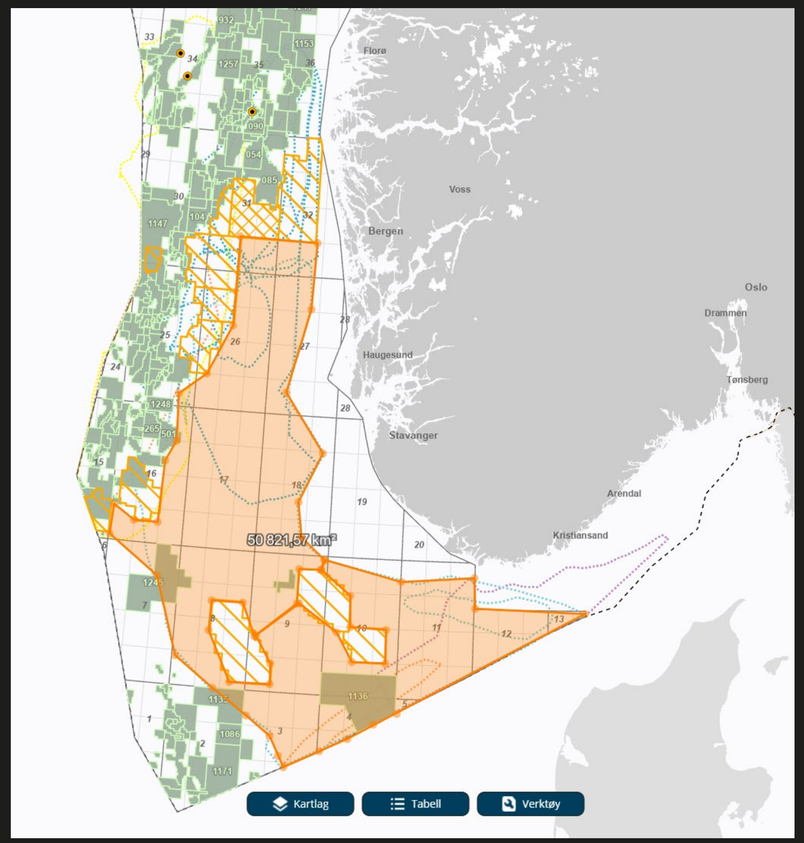
Discounted by petroleum licenses



~ 66.000 km²

2/3

Further discounted by CO_2 licenses



~ 50.000 km²

1/2

Upscaling enabler:

ACCESS TO SUITABLE AREA – Lots of area!

"BACK OF THE ENVELOPE EXERCISE" (based on EAGE 2025 NOD presentation)

Source: EAGE 2025 NOD presentation

What if all aquifers mapped in the North Sea were licensed for CO_2 storage? (Based on trends seen in the awarded areas to date)

- → 100.000 km² = "1/1" — North Sea mapped aquifers area in the CO_2 Atlas
- → [illegible] — [illegible]
- → 50.000 km² = "1/2" — Half of the area is not licensed to any other activities
- → 13.500 km² — Area awa[illegible]
- → 20 Gt — Storage capacity using Area Utilization Factor for 100.000 km² (100.000 x 0.2)
- → 13 Gt — Storage capacity using Area Utilization Factor for [illegible] (65.000 x 0.2)
- → 10 Gt — Storage capacity using Area Utilization Factor for 50.000 km² (50.000 x 0.2)
- → 2.5 Gt — Cum. storage capacity for available [illegible] assuming similar injection profile
- → 10 Gt — Cum. storage capacity for available 50.000 km² assuming similar injection profile

NOTE:

This exercise includes Norwegian North Sea aquifer areas as mapped in the atlas.

Additional potential is expected near/in depleted fields.

CO_2 licenses near/at petroleum areas are being awarded.

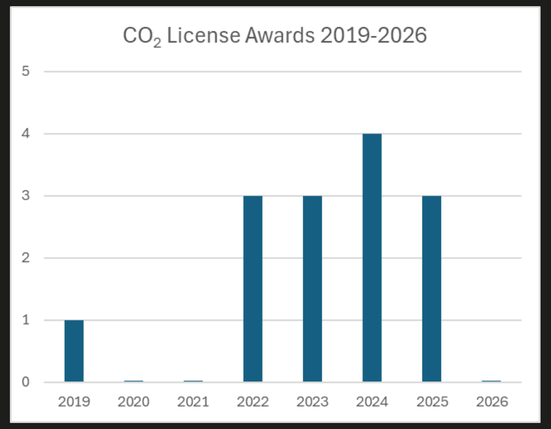
Other activities can of course be obstacles, but …

<u>… most areas with suitable conditions for CO_2 storage are in principle available</u>

Upscaling enabler:

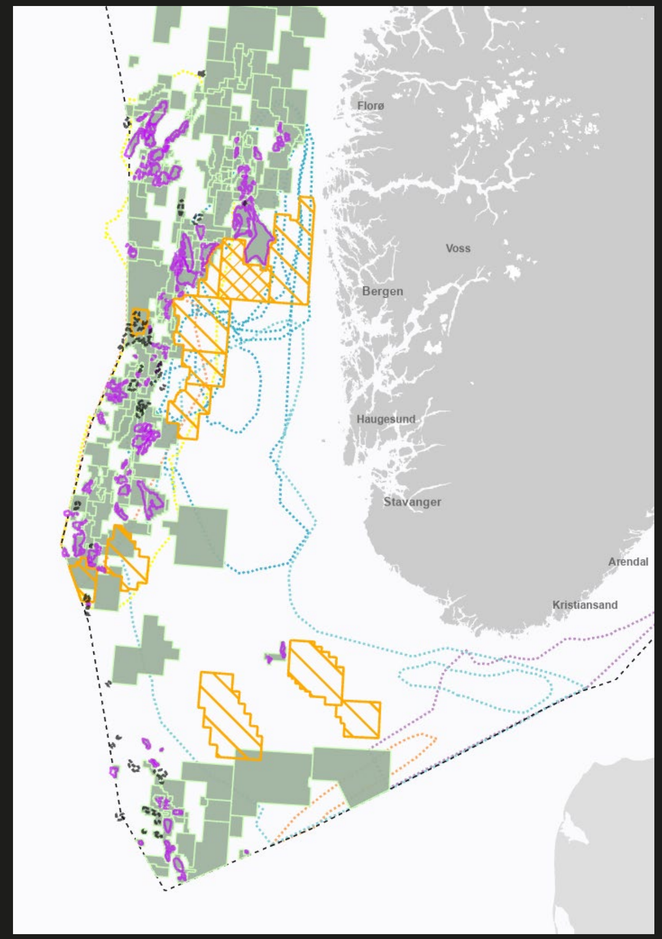
REGULATIVE FRAMEWORK – Licensing is not the barrier

- A dedicated regulative framework for CO_2 storage on the NCS is in place
- The legal framework is building on the 2009 EU CCS Directive
- Areas opened for petroleum are in principle also open for CO_2 storage
- Extensive unlicensed areas with mapped aquifer systems are available
- NCS activity levels are generally high; openness prevents surprises



Award	License	FID (PDO)
2019	EL001 Aurora	2020/2025
2022	EXL002 Smeaheia	2028
2022	EXL003 Polaris	2029
2022	EXL004 Luna	2029
2023	EXL005 Poseidon	2030
2023	EXL006 Havstjerne	2028
2023	EXL007 Trudvang	2027
2024	EXL008 Albondigas	2028
2024	EXL009 Iroko	2030
2024	EXL010 Kinno	2028
2024	EXL011 Atlas	2028
2025	EXL012 Kaupang	2029
2025	EXL013 Forsete	2029
2025	EXL014 Fritos	2031

- License awards peaking 2022-25
- No awards in 2026 to date
- EXL008 has been relinquished
- Further portfolio optimizations expected
- Pre FID work program duration 4-6 yrs
- Post FID construction time 3-4 yrs

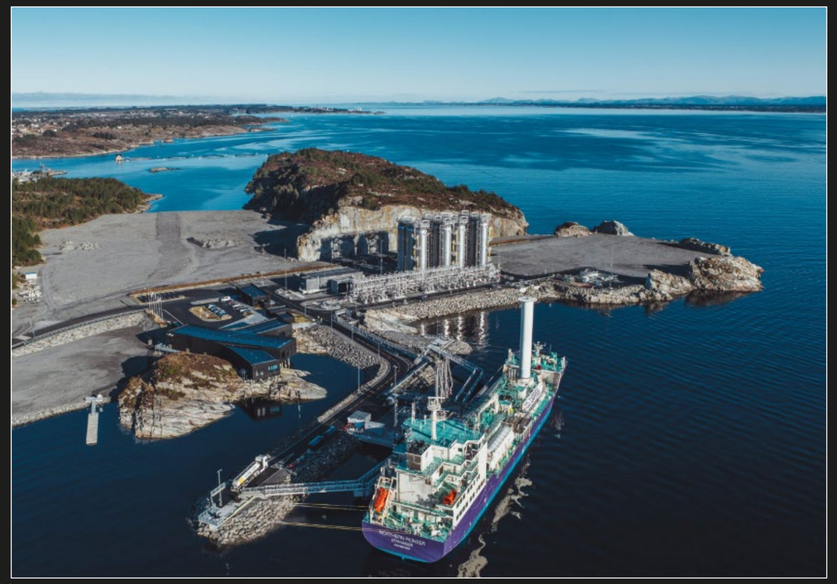


Source: Norwegian Offshore Directorate

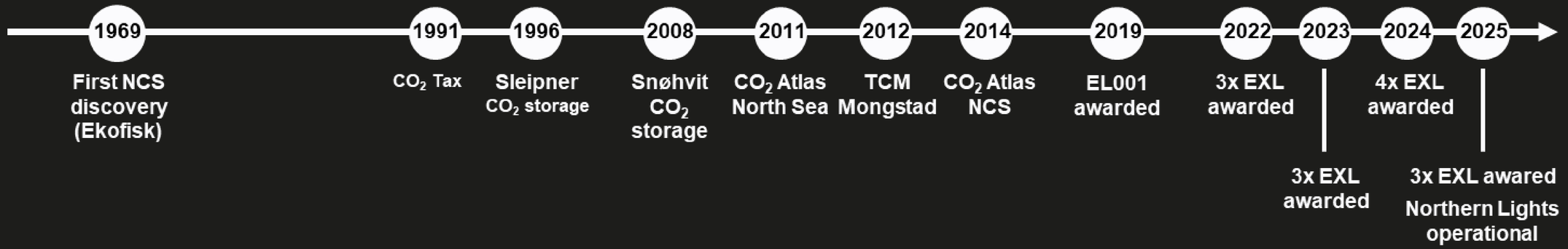
Upscaling enabler:

EXPERIENCE – Building decades of confidence through action

- 60 years of subsurface data has built a solid foundation
- 30 years of storage on Sleipner demonstrates doability
- Longship has operationalized a full CCS value chain
- Northern Lights offers CO_2 storage as a shared service
- Decades of monitoring turns uncertainty into managed risk
- Long term experience builds trust in CO_2 storage



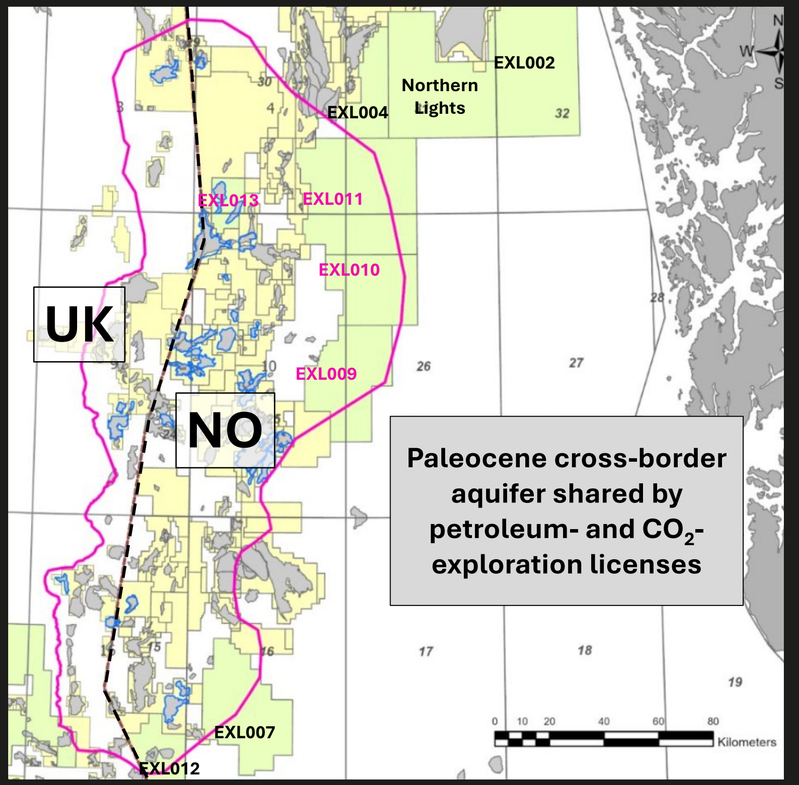
Source: www.norlights.com



Upscaling enabler:

COEXISTENCE AND TRANSPARENCY – Sharing is caring!

- Coexistence is governed through active license stewardship
- Transparency is secured by openness and sharing of data
- Key operational data is shared to track project development
- Shared understanding reduces the level of conflicting interests
- Cooperation Forums provide an arena to address mutual interests
- Pressure effects do not see license- or country borders
- Cross border dialogue is established to address impact
- Transparency is essential to enable trust
- NOD strongly emphasizes coexistence and transparency

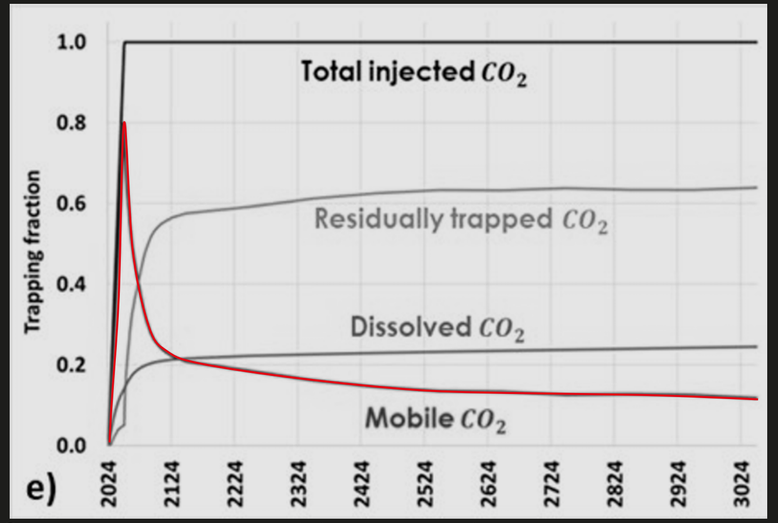


Source: Norwegian Offshore Directorate

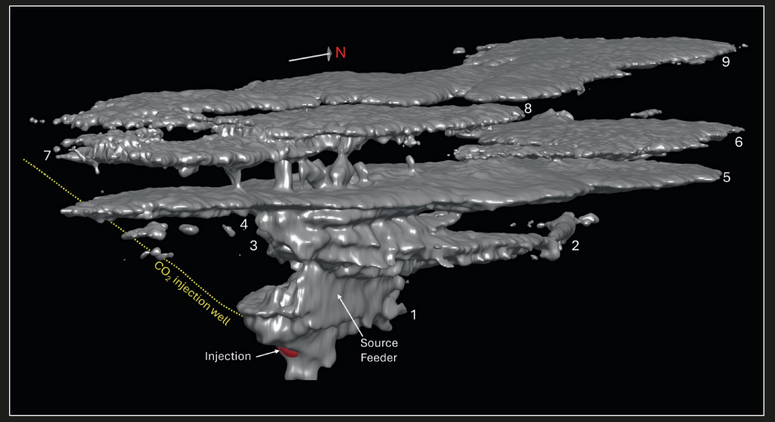
Upscaling enabler:

GEOLOGY MAY BE STATIC – But fluids are moving

- Pore fluids, formation water and hydrocarbons naturally migrate
- Injected CO_2 migrates along the same routes
- Some migrating hydrocarbons accumulate in traps
- Some migrating CO_2 also accumulates in traps
- Most CO_2 is residually trapped and dissolved in formation water
- A rapidly decreasing fraction of the injected CO_2 remains mobile
- CO_2 storage projects are matured and prepared to be safe by design
- Leakage risks and consequences must be described and understood
- Monitoring must be implemented to detect irregularities



Source: Northern Lights injection permit



Source: Sleipner CO_2 plume, Vinje et al., FB 2025)

Upscaling enabler:

In summary: NCS is ready to deliver!

- ✓ **DATA** The data required is publicly available
- ✓ **ACCESS** Policies and regulatory framework are in place
- ✓ **AREA** The CO_2 Atlas, active licences, and available areas demonstrate significant storage capacity and scalability
- ✓ **COMPETENCE** Building on decades of offshore activities, experience and knowledge
- ✓ **CULTURE** Norway is fostering a strong culture of transparency, dialogue and trust
- ✓ **PUBLIC ACCEPTANCE** More than 50 years of petroleum production and 30 years of CO_2 storage prove acceptance

THANK YOU FOR YOUR ATTENTION

NORWEGIAN OFFSHORE DIRECTORATE

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Randy Locke

CHIEF SCIENTIST, RESEARCH AND DEVELOPMENT

ILLINOIS STATE GEOLOGICAL SURVEY, UNIVERSITY OF ILLINOIS

Randy Locke is the Chief Scientist for Research and Development at the Illinois State Geological Survey, one of the largest geological surveys in the United States. He leads interdisciplinary programs focused on complex subsurface, energy, and environmental challenges, leveraging more than three decades of experience to deliver science-based insights that inform decision-making, policy, and sustainable resource management.

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European CCS & CDR Knowledge Sharing Summit – Workshop 7: Scaling Up Storage
Sandefjord, Norway, 15 April 2026

COMMERCIAL-SCALE CARBON STORAGE IN DECATUR, ILLINOIS: 15 YEARS OF SUCCESSFUL OPERATION

Randy Locke, P.G., Chief Scientist, Research and Development
Illinois State Geological Survey

PRAIRIE RESEARCH INSTITUTE
University of Illinois Urbana-Champaign

Topics

- Organizational role
- Site overview
- Key points

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isgs.illinois.edu

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For all stakeholders

- Repository for geologic and natural resource data
- Accurate, objective earth science research and information

We support

- Protection of environmental quality
- Economic development
- Public safety

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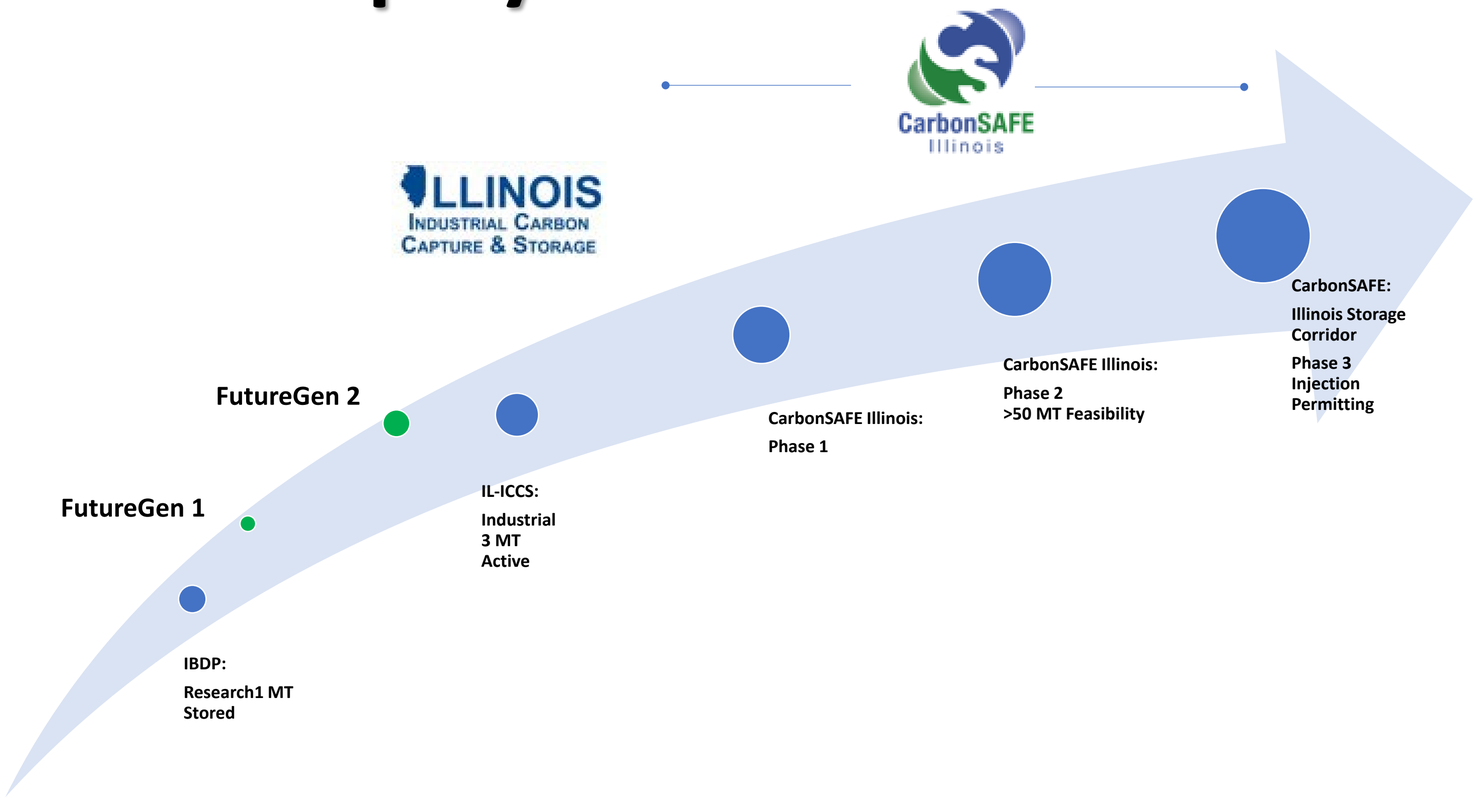
Mission: Conduct transformative science that benefits the people, economy, and environment of Illinois, the nation, and the world.

- **470+**

  total **personnel**

full-time **scientists** and **scholars**

20 Years of Leadership in Carbon Storage Research and Deployment



Basin Scale

2000's → 2020's

MGSC

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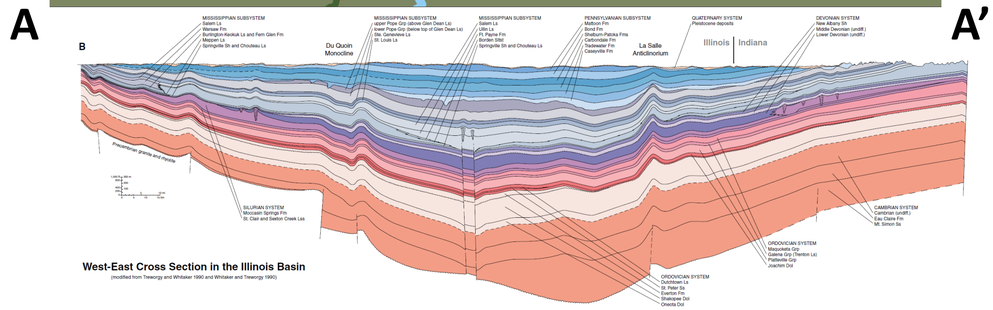
MRCI
Midwest Regional Carbon Initiative

Topics

- Organizational role
- Site overview
- Key points

Pioneering Carbon Storage Decatur, Illinois, USA

- **Objective:** Safely operate carbon storage at industrial scale
  - Comprehensive site characterization, monitoring, and modeling
  - First U.S. Class VI permits in operation CCS#1 (2011-2014), CCS#2 (since 2017)
  - Team of 100+ people, 10+ organizations; 1,000+ visitors, 30 countries
- **>5 MT stored in the Mount Simon Sandstone (2,000 m deep)**
- Illinois Basin Decatur Project (Phase I)
  Data: https://edx.netl.doe.gov/ and https://co2datashare.org/
  Final Report: https://www.osti.gov/biblio/1806192
  Publications: https://carbon.americangeosciences.org/vufind/

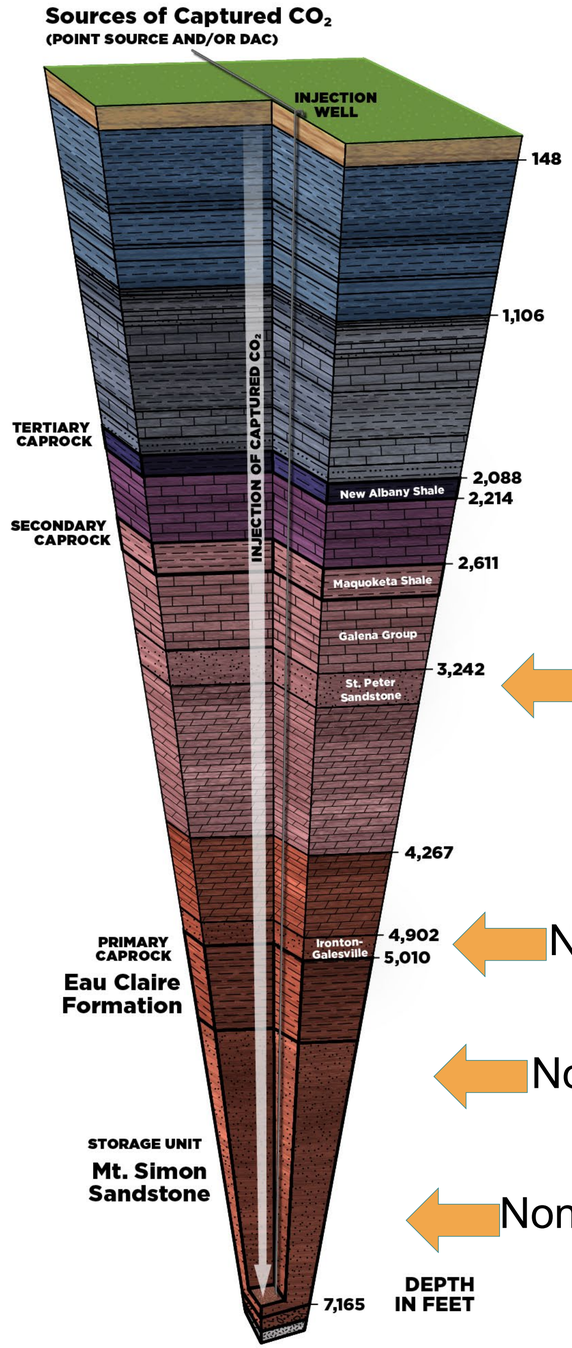


Reference: cross section B-B' from Kolata (2005). See https://resources.isgs.illinois.edu/maps/bedrock-geology-map-illinois

Graphics and information from the Illinois State Geological Survey

ILLINOIS BASIN GEOLOGY
(NEAR DECATUR, IL)

Source: Modified from 2022 PRI CCUS Report
https://hdl.handle.net/2142/116416



= Sampled zones

Shallow aquifers (<200 ft, 60 m)

Non-potable water (>500 ft, 150 m)

Lowermost Underground Source of Drinking Water (~3,300 ft, 1,000 m)

Non-potable water (~5,000 ft, 1,500 m)

Non-potable water (~5,700 ft, 1,700 m)

Non-potable water (~6,600 ft, 2,000 m)

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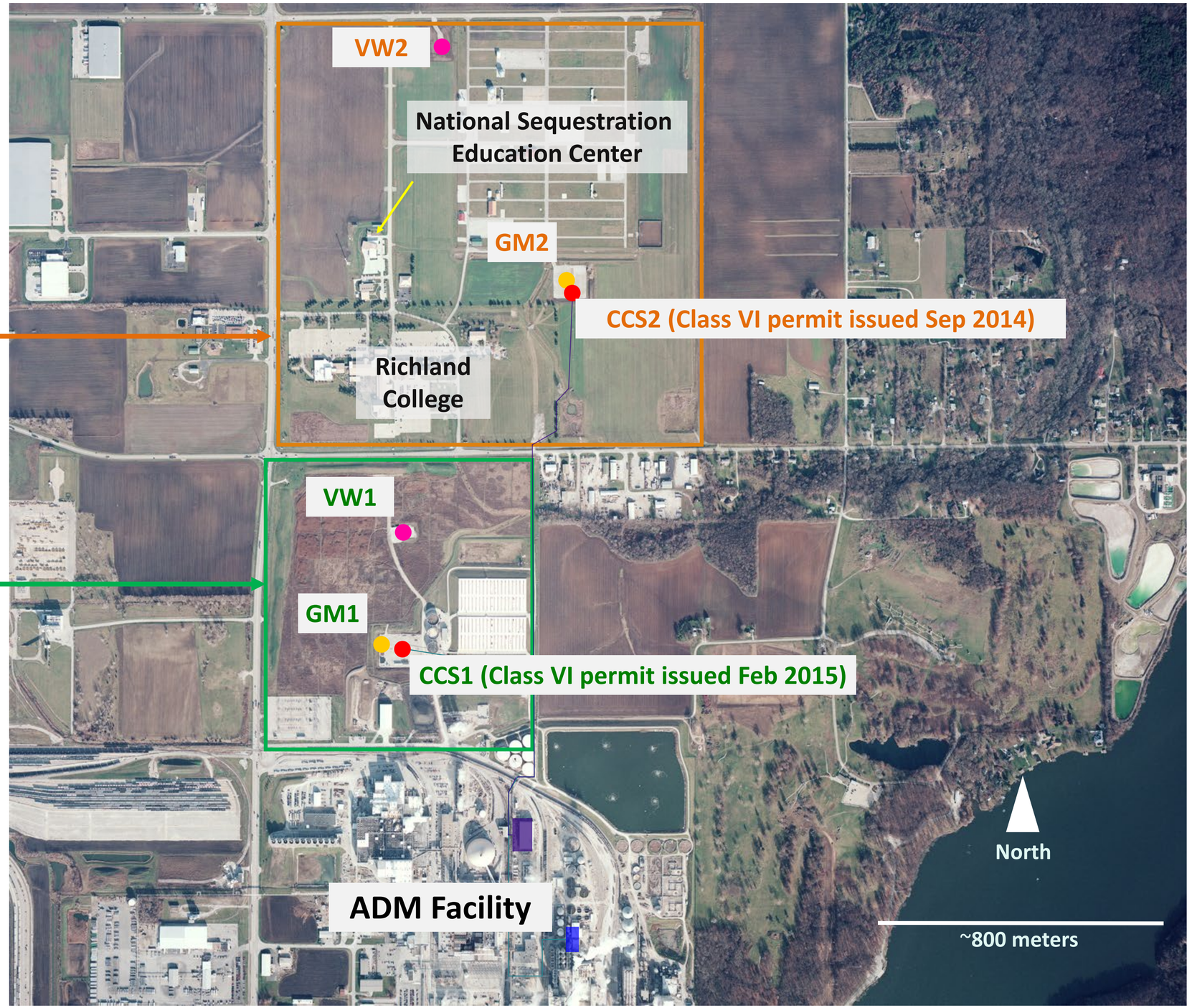
DECATUR STORAGE SITE

Illinois Industrial Sources CCS Project
2nd ongoing injection
>4MT
(2017-present)

Illinois Basin - Decatur Project
1st injection
1MT
(2011-2014)



Topics

Organizational role

Site overview

Key points

Key Points

- Developed extensive risk management framework early in Phase I
- Developed key subsurface knowledge with downhole data including coring, logging, testing, monitoring, and modeling
- Early learnings informed Phase II
  - Microseismicity → decrease downward pressure propagation → move injection zone
  - Well integrity → maintenance, rework → reduce well complexity, more proactive assessments

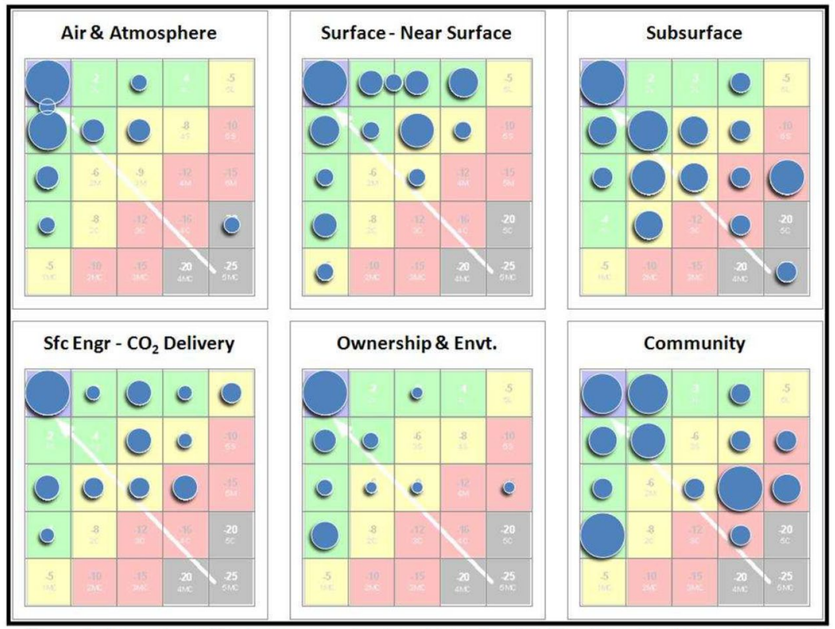
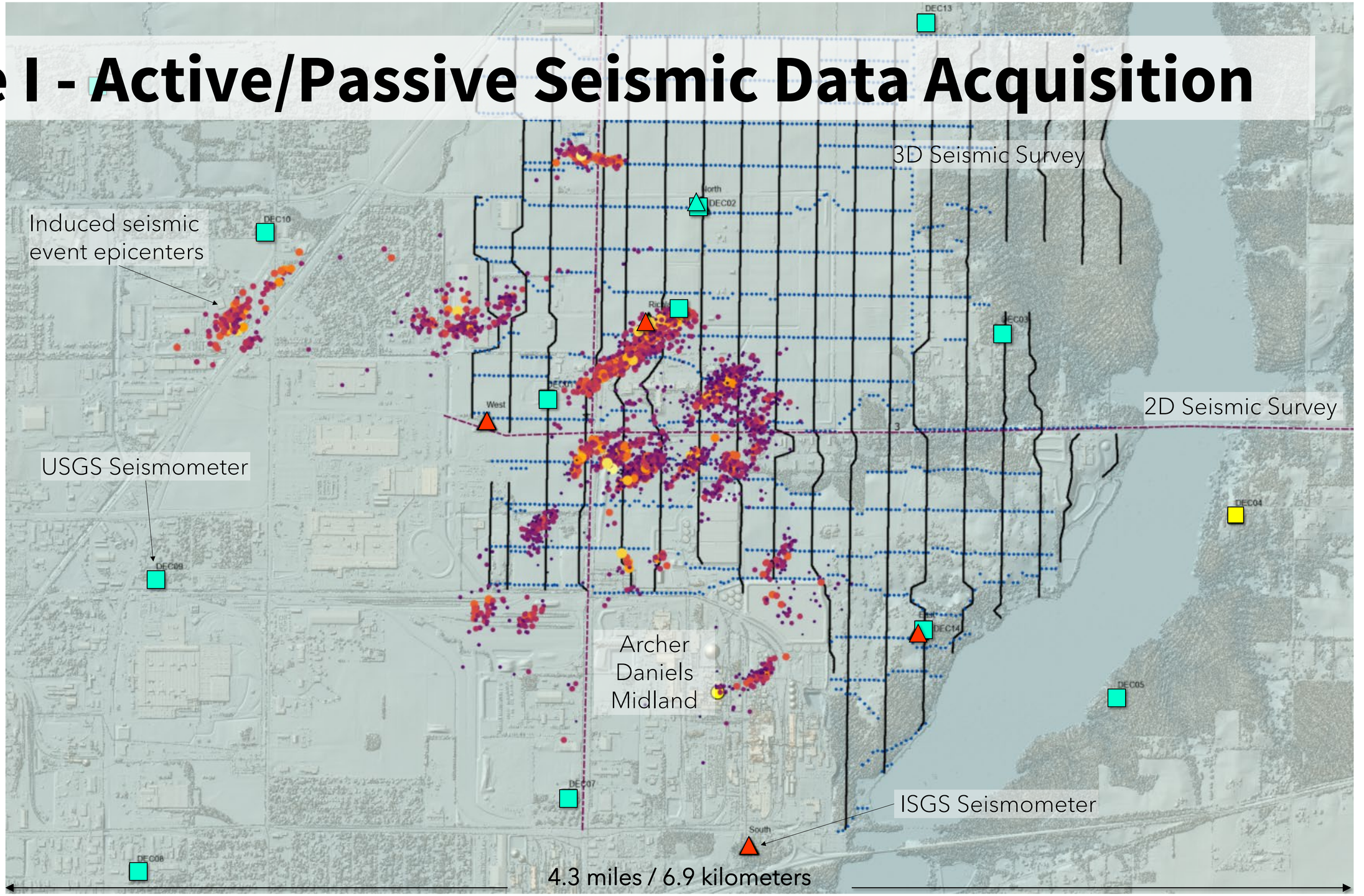


Figure 3: Consensus working-group results plotted on risk matrices. Likelihood increases rightward and Severity increases downward, so the highest risks plot to the lower right on each matrix. The smallest symbol on each plot represents one FEP; larger symbols indicate multiple FEPs with equal Likelihood and Severity coordinates.

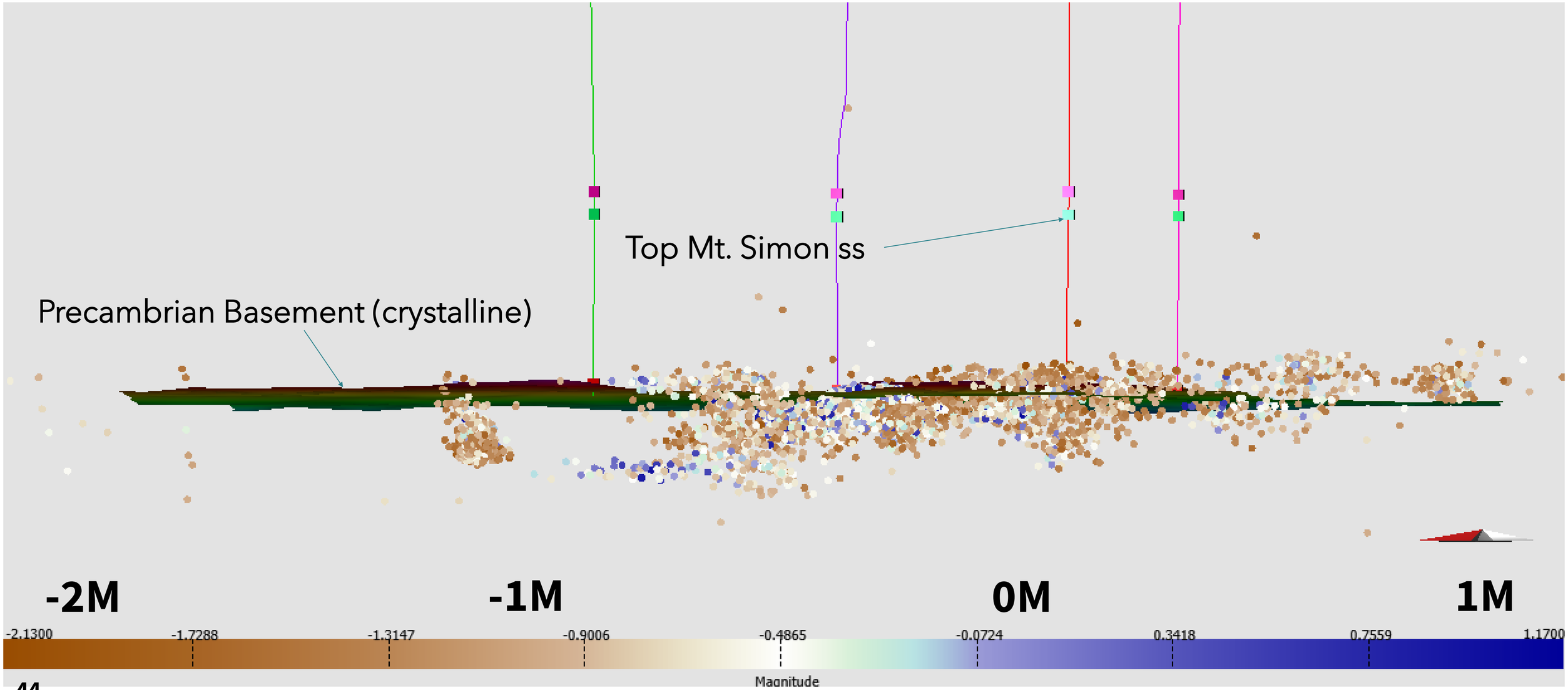
From Hnottavange-Telleen, https://doi.org/10.1016/j.egypro.2009.02.004

Phase I - Active/Passive Seismic Data Acquisition

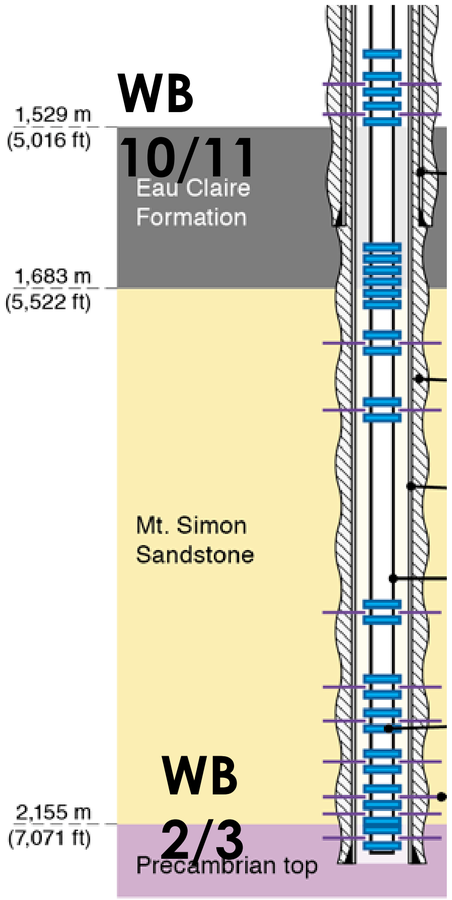
- USGS seismometer
- ISGS seismometer
- Injection and Monitoring wells
- 3D Seismic Survey
- 2D Seismic Survey



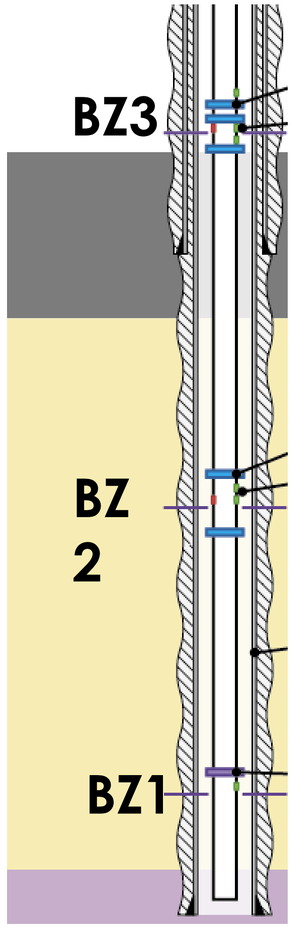
Most events are below the Mt. Simon Sandstone at very low energy levels (microseismic events)



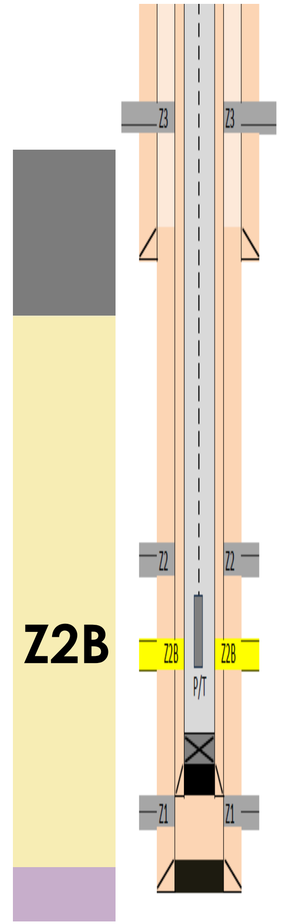
VW1 COMPLETIONS HAVE EVOLVED (2011 TO PRESENT)



2011 - 2017:
Westbay
11 zones



2017 - 2025:
Baker Hughes
3 zones

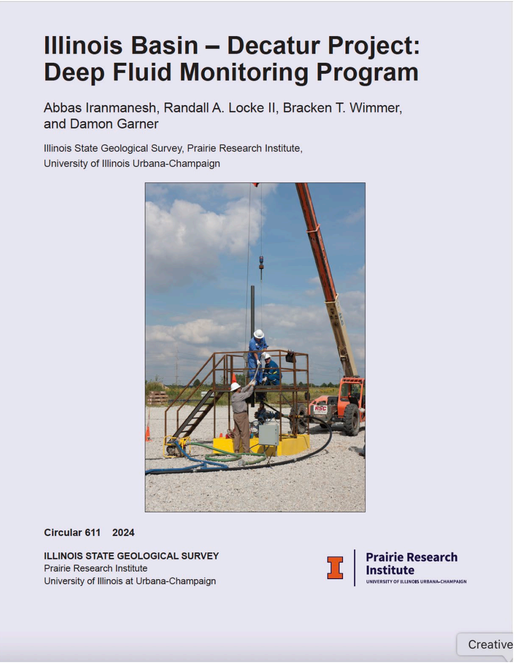


2025 - present:

1 zone

Key Points

- Document and integrate new data regularly
- Engage regularly with stakeholders, including landowners, regulators, public, local government, legislators, and non-governmental groups



From Iranmanesh et al.:
https://www.ideals.illinois.edu/items/132327

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Key Points

- Infrastructure and techniques will evolve over project lifespans (30-50 yrs)
- Decatur expansion with 5 new injectors
  - Carbon hub ecosystem developing
    - Broadwing power – natural gas with CCS (up to 2MTPA after 2030)
    - Super6 – high-quality CDR credits
    - OCO Chem – CO_2 conversion, electrolysis

CO2 Capture & Storage

OCO CHEM / ADM

ACKNOWLEDGEMENTS

This presentation is based on work conducted by the Illinois State Geological Survey, partners, and collaborators between 2003 and 2026. Thank you to everyone who has contributed!

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- The Illinois Industrial Carbon Capture and Storage project was administered by the U.S. Department of Energy's Office of Fossil Energy and managed by the National Energy Technology Laboratory (award number DE-FE-0001547) and cost share agreements with ADM, ISGS, SLB, & RCC.
- CarbonSAFE Illinois was funded by the U.S. Department of Energy (DE-FE00029381, DE-FE0031626 & DE-FE0031892)
- ADM provided well construction diagrams for VW1, key points, and feedback on this presentation.

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INDUSTRIAL CARBON
CAPTURE & STORAGE

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U.S. DEPARTMENT OF
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NATIONAL
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TECHNOLOGY
LABORATORY

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UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

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SHARING 26
CCS & CDR Summit

#KNOWLEDGESHARING2026

Caterina Topini

SENIOR RESERVOIR ENGINEER

ENI

Caterina Topini holds a Master’s Degree in Environmental Engineer. She has overall a 18-years experience in different roles within Eni. She has been working mainly as a geomechanics and reservoir engineer, covering different positions both in Italy and abroad. After several years working on different gas injection and EOR projects, she is currently involved in subsurface and storage modeling finalized for Carbon Capture Storage(CCS) Eni projects, actively contributing to the development of CCS within Eni.

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Subsurface Data Integration for CO_2 storage purposes

Caterina Topini (Eni SpA)

15/04/2026 – Sandefjord

Agenda

1. Introduction to Reservoir Modelling
2. Ravenna CCS Project
3. Ravenna CCS Project Phase 1
4. Ravenna CCS Phase 1 Storage Complex Model Construction
5. Ravenna CCS Phase 1 Downhole Well Monitoring
6. Ravenna CCS Phase 1 KPI Assessment & Lessons Learnt

Introduction to Reservoir Modelling in CCS context

Definition & Goals

In Carbon Capture and Storage (**CCS**) projects, **subsurface modelling** simulates the **CO_2 injection** into the subsurface to **guarantee** the **safety** and **effectiveness of the storage** and the **model conformance** to measured data in **full compliance with International and Local Regulations and Standards**.

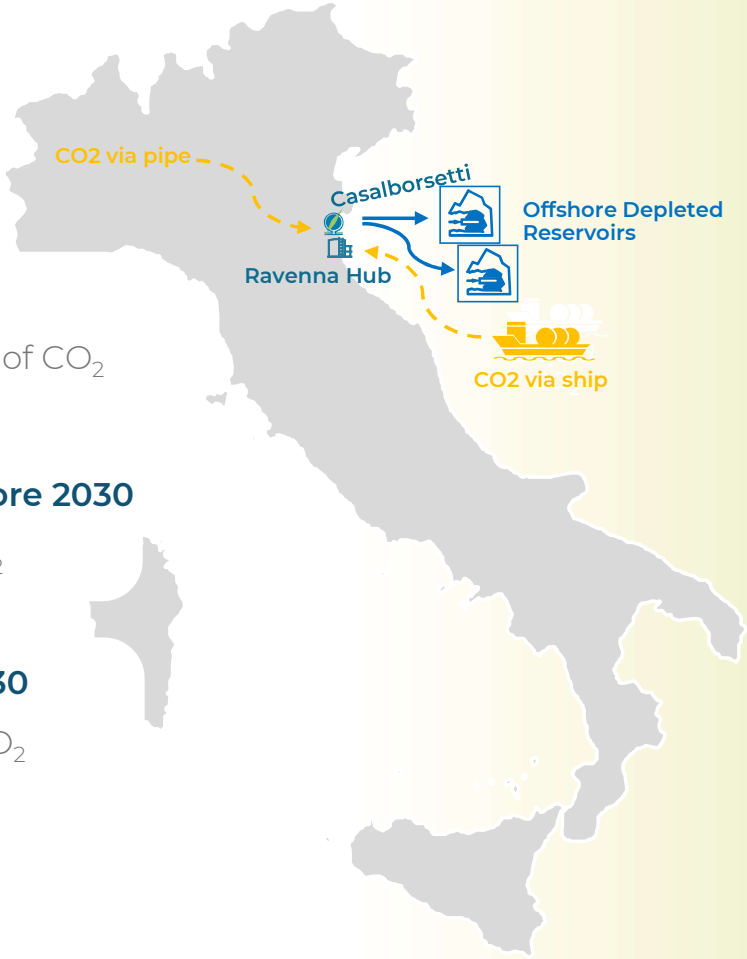
Methodology

The storage site is modeled through **specific software** representing both the **thermodynamic** and **hydraulic** behavior of the fluids in the subsurface porous medium and rock **mechanical** behavior.
Both **dynamic** and **geomechanical models** are built for this purpose.

Collaboration

The approach requires **as many data as possible** (from geophysics, sedimentology, petrophysics, geomechanics, fluids and rock properties, production&injection history). **Collaboration** with **other disciplines** is **fundamental** and it must include data from Flow-Assurance, Drilling & Completion, and Operations.
Monitoring during operations provides key information for **continuous improvement** of model **reliability** and **robustness** and **model conformance**.

Ravenna CCS



Phase 1 - 2024

Up to 25 KTPA of CO_2

Phase 2 – before 2030

4 MTPA of CO_2

Exp – after 2030

16+ MTPA of CO_2

- CCS Reference Hub for Southern Europe and the Mediterranean
- Supports the decarbonization of industrial clusters in Italy and the Mediterranean area
- Transportation network is being developed to receive the CO_2 both via pipeline and shipping
- Over 20 feasibility studies in collaboration with national and international industrial emitters
- Theoretical 500 Mton of CO_2 total capacity
- Phased expansion of the injection which in an initial phase will reach a storage capacity of 4 MTPA by 2030 and will increase up to 16MTPA after 2030

https://www.ravennaccs.com

Ravenna Phase 1

Main characteristics

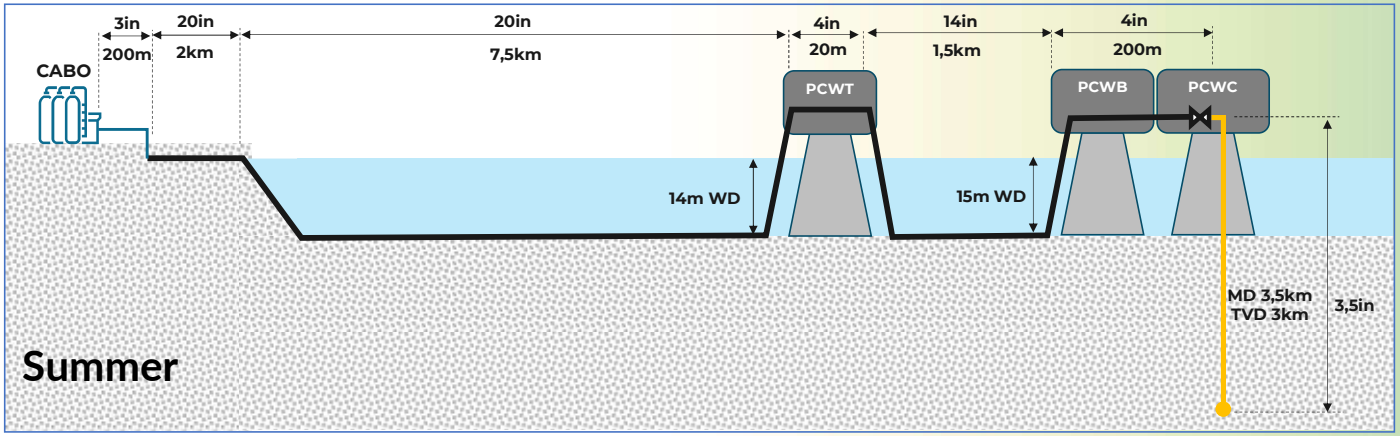
- Start-up: August 2024
- Maximum design injection rate: up to 25kTPA of CO_2 captured by the Casalborsetti gas treatment plant
- Capture through highly selective amine absorption process
- Amine capture system optimised for low pressure and low temperature operation
- 100% thermal energy from waste heat recovery from flue gas
- 100% renewable electric energy

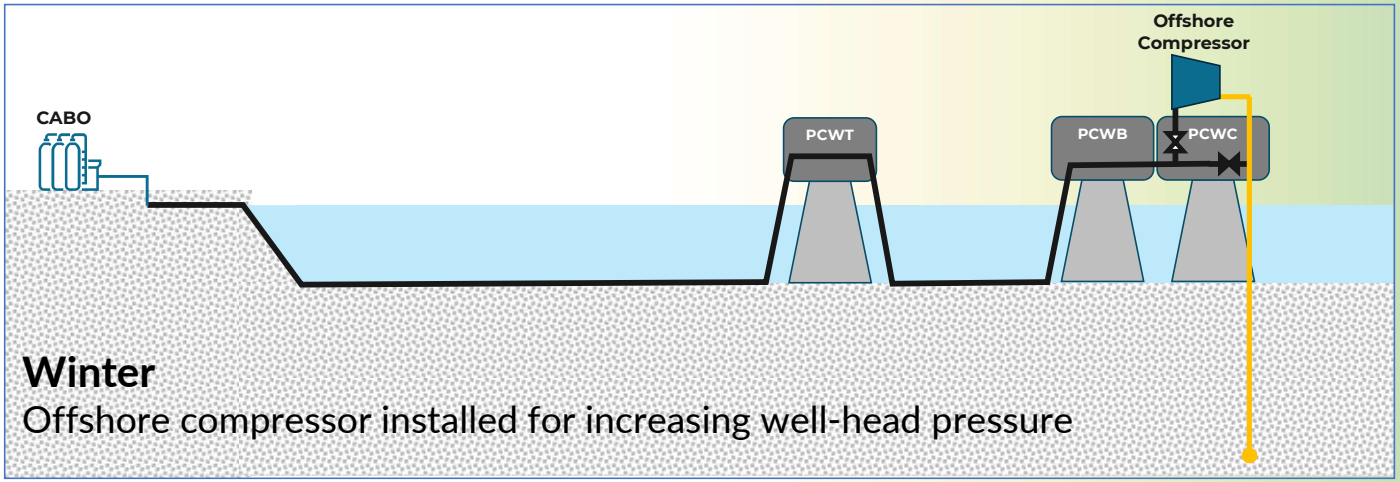
Performance

- CO_2 capture efficiency > 92%
- Purity of CO_2 > 99%

Ravenna CCS is considered an **excellence,** among the first **full-scale CCS projects** in Europe

Phase 1 - Offhshore Transport and Injection





Benefits:

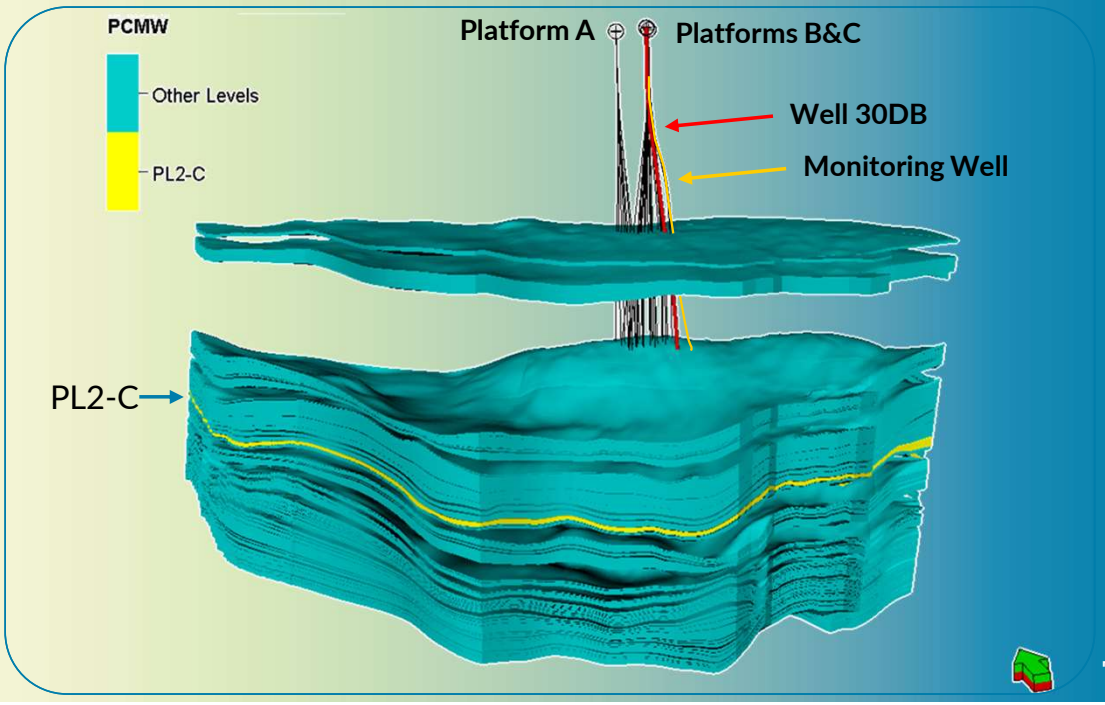
- Existing 20-inch pipeline has been re-used (pigged, inspected and re-certified)
- Transport in gas phase approach has been validated

Phase 1 - Porto Corsini Mare West Reservoir

- Location : 8 km offshore Ravenna
- Depth : 1500 – 3800 m ssl
- Production Layers: 40+ hydraulically separated
- Production Start-up: 1969
- Production perforated wells: 31
- Recovery Factor: 77%

Injection Phase 1 Target:

- Depth : 3000 m ssl
- Injection Layer : PL2-C
- Injection perforated well : PCMW 30DB
- Injection Start-up : August 2024



Storage Complex Model Construction

Geological Model:

- Geophysical and geological characterization of the storage site
- Gridding of the target area

Fluid Flow Model:

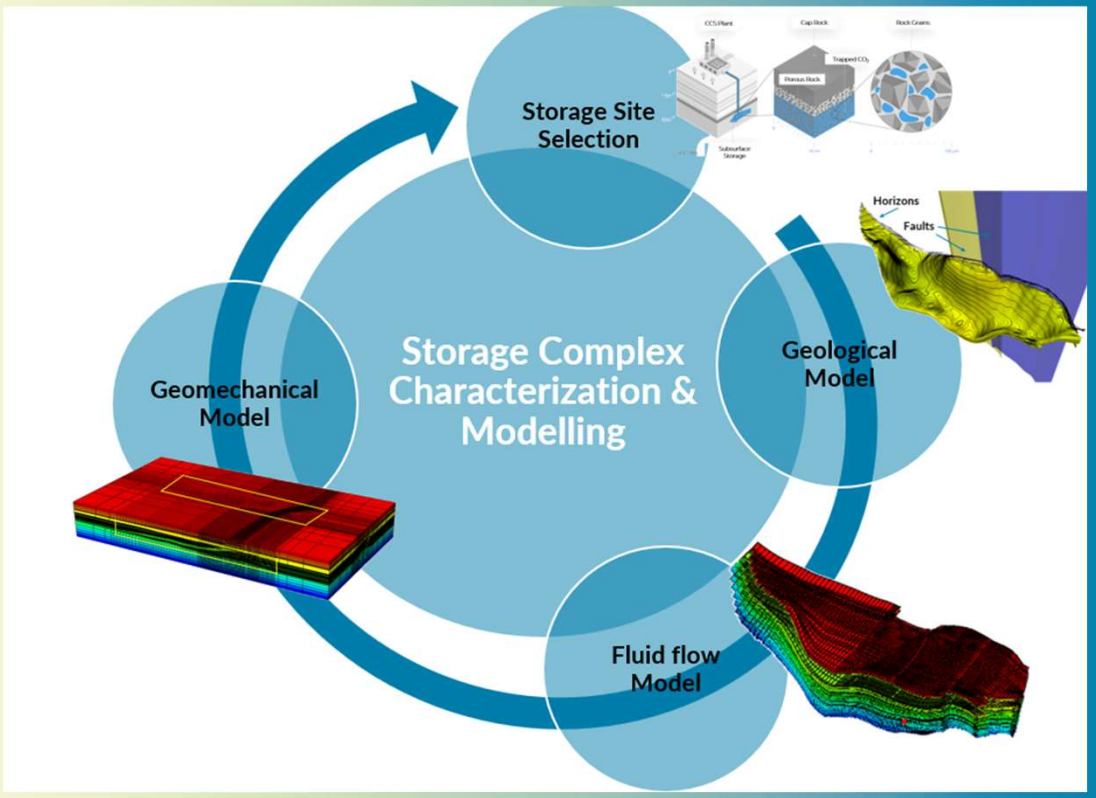
Fluid and pressure evolution over time during

- hydrocarbon production
- CO2 injection

Geomechanical Model:

evolution over time of stress and strain fields during

- hydrocarbon production
- CO2 injection



Predictive models to support and optimize operations and integrate monitoring plans in compliance with International Standards and local regulations

Downhole Well Monitoring

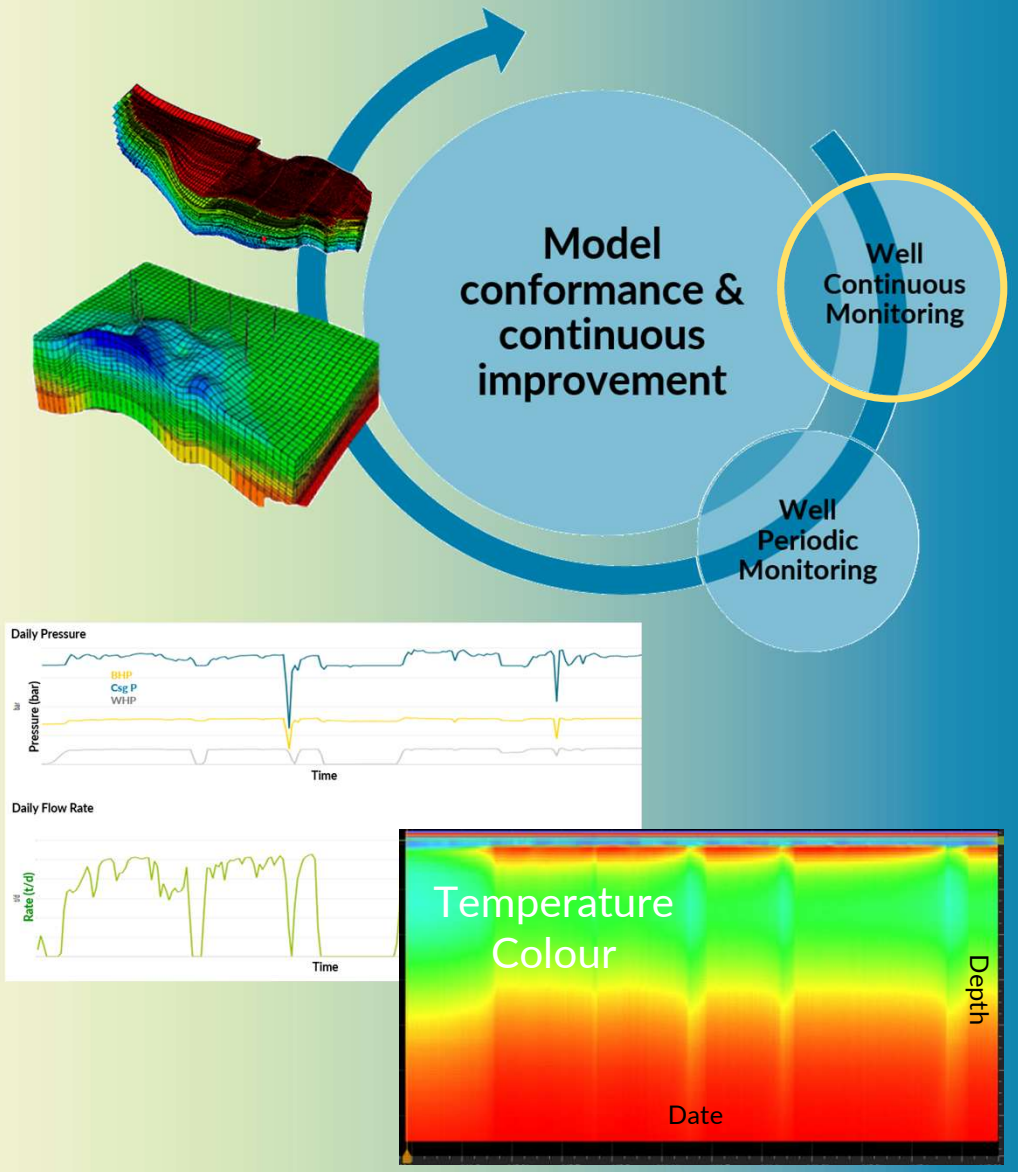
Continuous Monitoring

P/T and flow rate monitoring on injection well:

- Injection effectiveness and safety confirmed
- Fall-off well test analysis performed
- Model conformance validated

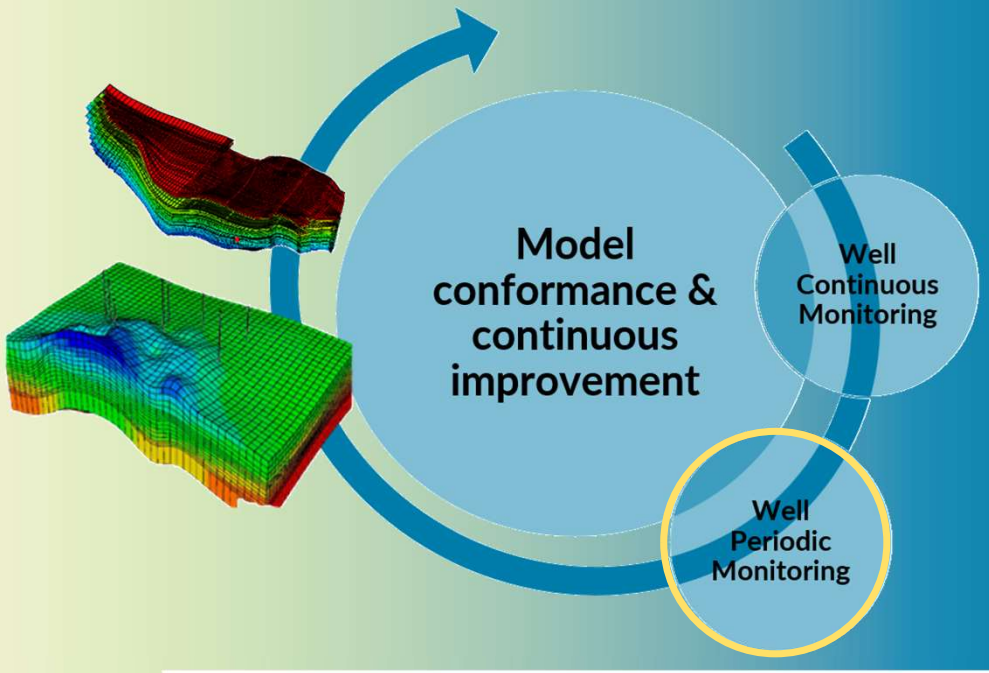
DTS fiber-optic monitoring on injection well:

- Start-up pressure monitored for flow-assurance model calibration
- Tubing and casing integrity confirmed (no leaks)



Downhole Well Monitoring

Periodic Monitoring



Cased-hole logging on injection well:

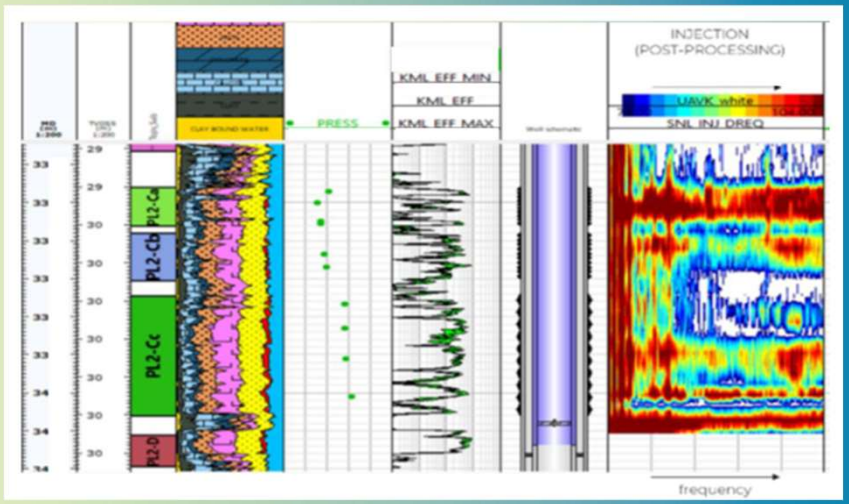
- Injection profile verified across the whole PL2-C level
- No CO_2 detected outside injection interval

Cased-hole logging on monitoring well:

- Model conformance and storage integrity (no leaks) confirmed

Static pressure log and fluid sampling on monitoring well:

- Model conformance (CO2 plume monitoring) validated



Ravenna Phase 1 – KPI Assessment & Lessons Learnt

Upstream technical subsurface competences can be easily applied to CCUS projects purposes

Reservoir modelling plays a fundamental role in CCS projects integrating data from different disciplines and monitoring plan results to predict storage behavior

Phase 1 demonstrated the effectiveness of well-based monitoring:

- pressure–volume behavior of the reservoir area during CO_2 injection has been confirmed
- injection performance has been assessed and validated during full-life operations of Phase 1 project
- injector well showed consistently positive performance, with no injectivity impairment after shut-ins

Well integrity and injection safety were validated via DTS fiber-optic data, complemented by micro seismic monitoring through both conventional networks and DAS

Experimental results proved the model conformance and provided useful insights for refining Project Phase 2 reservoir models and monitoring plan

The author would like to thank Eni and Snam for their kind support and for granting permission to present this work

Thank you

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PANEL SESSION

Sarah Gasda,
Moderator

Rachael Moore,
CarbStrat

Kristoffer Engenes,
Norwegian Offshore Directorate

Randy Locke,
University of Illinios

Caterina Topini,
Eni

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CLOSING REMARKS

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17:30-17:40 BREAK

Walk to conference hall - “Parksalen”

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