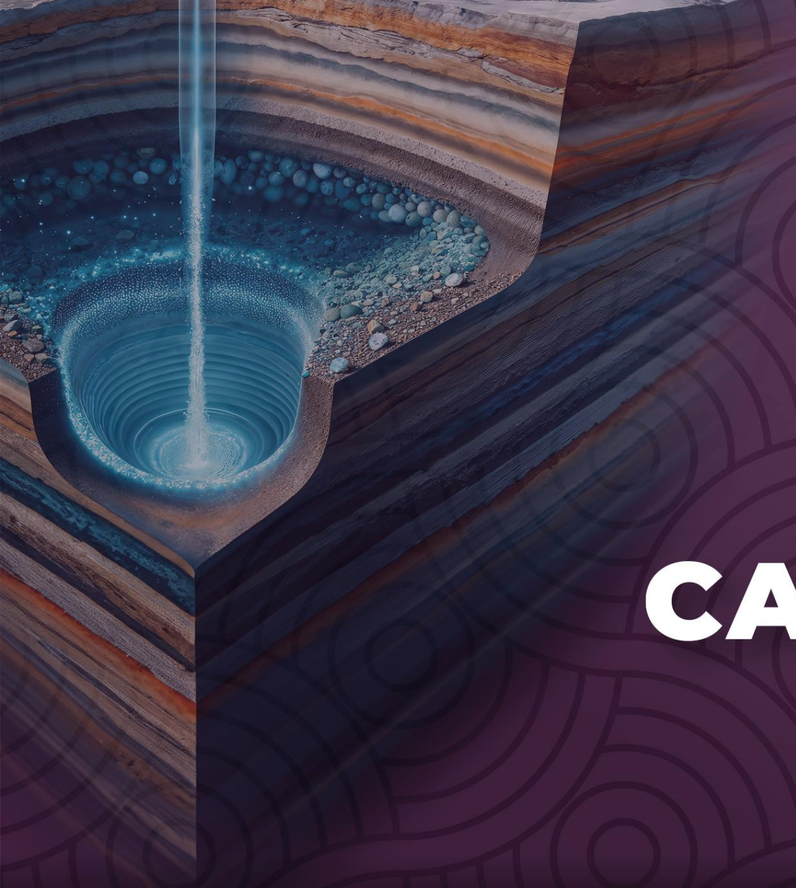

4-7 NOVEMBER 2024
ROTTERDAM, THE NETHERLANDS

GET2024

CARBON CAPTURE & STORAGE

CONFERENCE

MONITORING OF CO_2 STORAGES

A Dutch Perspective & Outlook

Gloria Thürschmid

AGENDA

1. CCS in The Netherlands
2. The 5 W’s of MMV
3. Case Study: Porthos MMV
4. Outlook – Where do we need to go?
5. Summary & Conclusions

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1. **CCS in The Netherlands**
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CCS IN THE NETHERLANDS

CCS IN THE NETHERLANDS

The Facts

	Porthos	Aramis
Who?	Public-private partnership → Dutch state-owned parties in the lead: EBN, Gasunie, Port of Rotterdam	Public-private partnership → EBN, Gasunie, Shell, Total Energies
What?	Transportation and offshore storage project	Transportation project enabling offshore storage → Connected to Porthos onshore system & CO2next
Storage type?	Depleted gas fields	Depleted gas fields (from Shell, Total Energies, ENI)
Volumes and rates?	37 Mt (2,5 Mtpa)	ca. 400 Mt (7,5 to 22* Mtpa) *from 2030
FID?	taken in October 2023	expected 2025
Ready for Injection?	expected 2026	expected 2028/29

IN THE NEWS

A selection from 2024

- Porthos onshore construction started
  - ➞ Drilling under seawall
  - ➞ Focus on onshore pipeline through harbor
  - ➞ Start of all onshore construction

- Milestones achieved
  - ➞ Members of the House of Representatives are visiting Porthos & Aramis
  - ➞ Celebration: Construction of the Porthos CO_2 network
  - ➞ Public consultation meetings of Aramis held

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THE 5 W'S OF MMV → WHAT?

Measurement – Monitoring – Verification

"The monitoring, measurement, and verification (MMV)
of injected CO_2 into the subsurface is essential
for **assuring conformance** to its expected behaviour
or **detecting irregularities** over **time**
so that leakage and environmental **impacts are avoided**"

DNV, 2024

THE 5 W'S OF MMV → WHY? HOW?

"MMV Principles"

- Complying with **regulations**
- **Risk-based**
- **Site-specific** & **Fit-for-purpose**
- **Flexible** & adaptable
- Based on **best practices**

→ CCS Directive & National Law

→ TECOP analysis

→ Monitoring goals & domains

→ Contingency & modifications

→ Screening for new technologies

THE 5 W'S OF MMV → WHERE?

Monitoring domains

→ Identify weak spots!

Wells

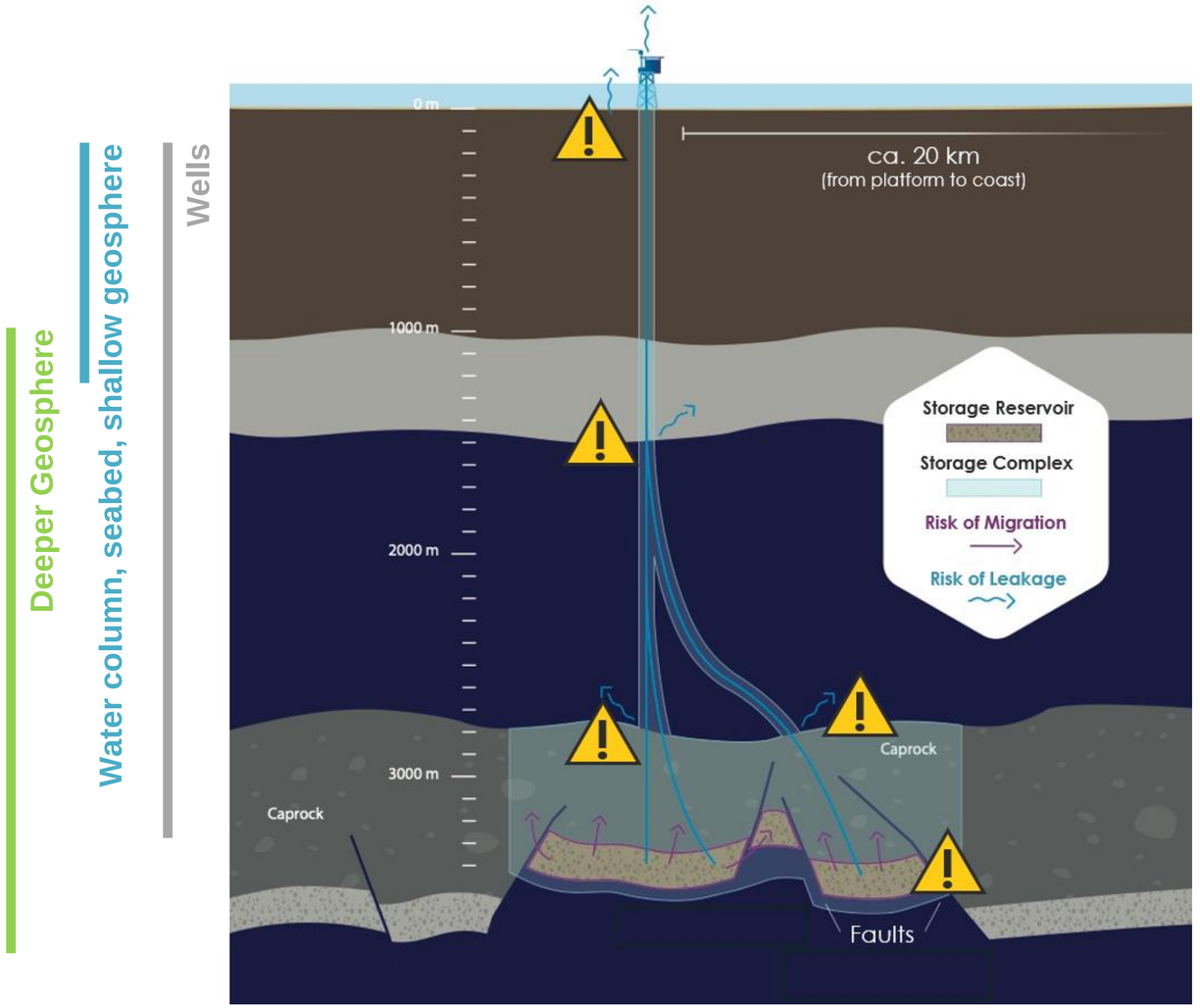
- Legacy wells?
- Re-used injector wells?

Water column, seabed, shallow geosphere

- Gas bubbles?
- (Active) pockmarks?

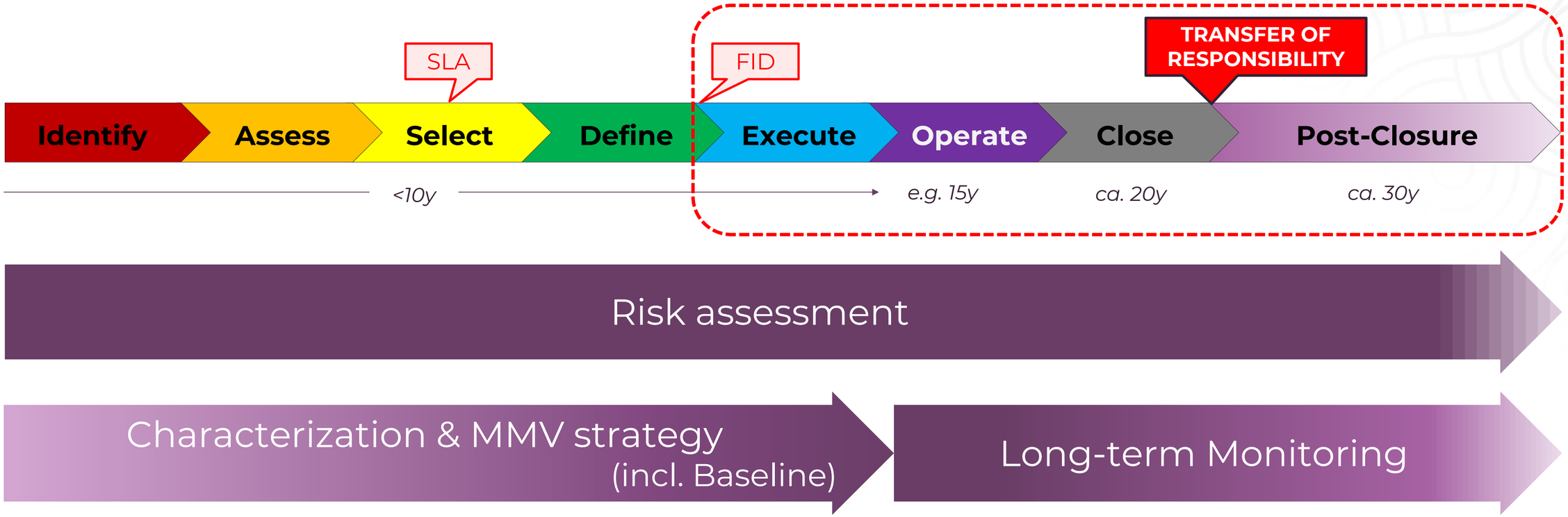
Deeper geosphere

- Faults cross-cutting caprock?
- Reservoir-reservoir juxtaposition?
- Spill-points?
- Critical stressed faults?



THE 5 W'S OF MMV → WHEN? (& WHO?)

Long-term perspective is key



Timeline not to scale

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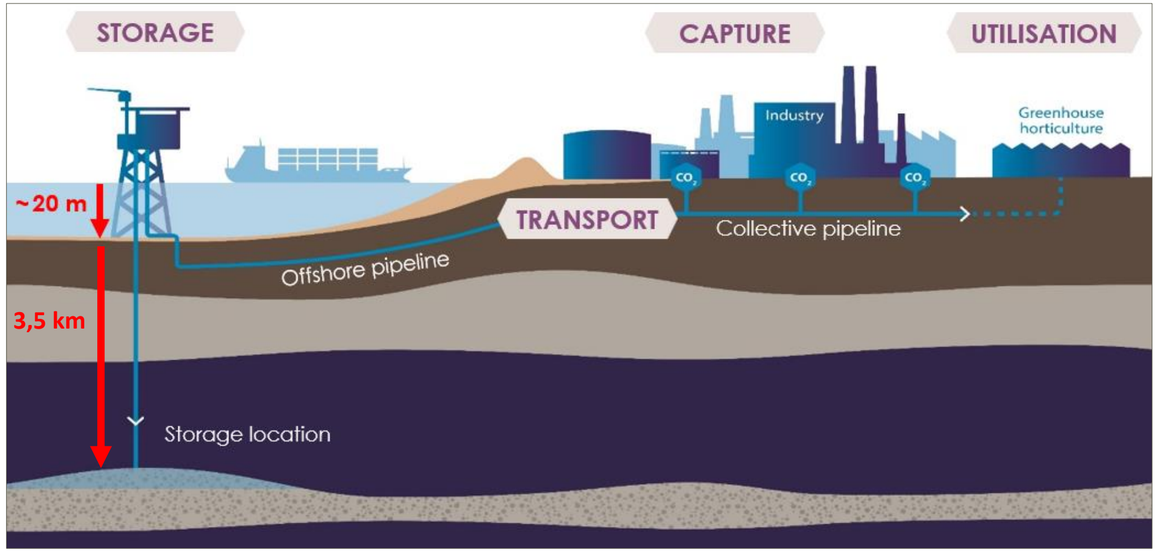
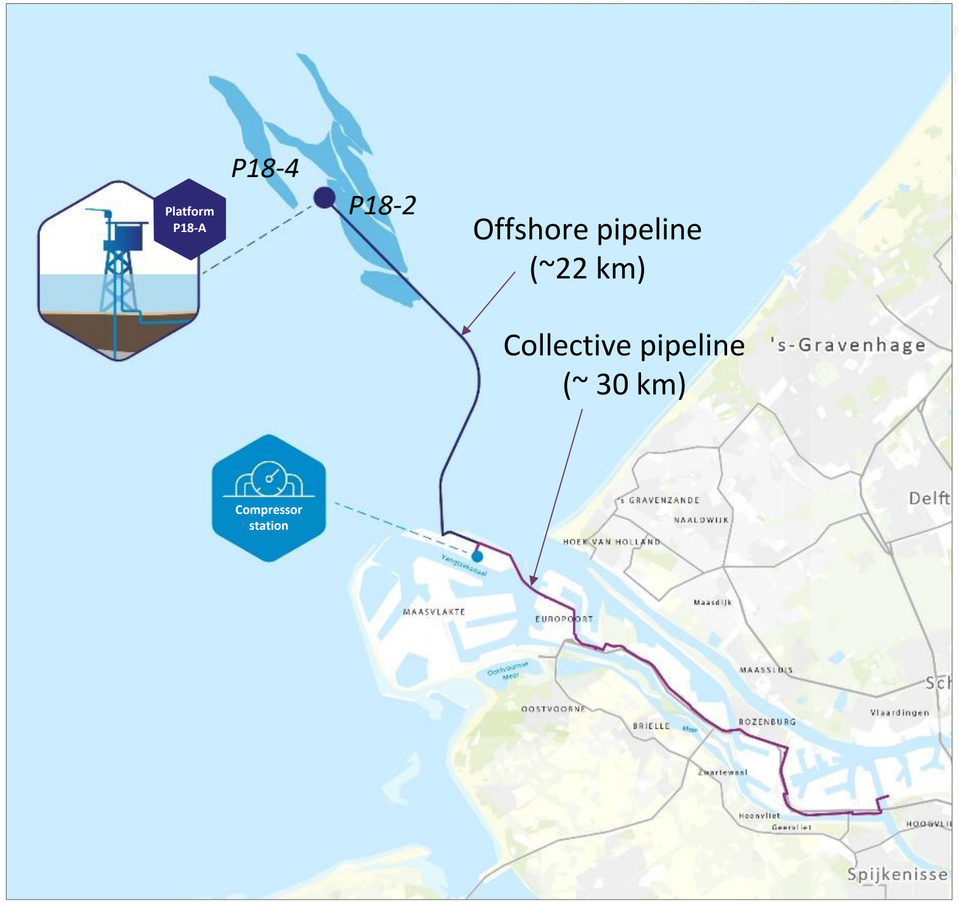
PORTHOS

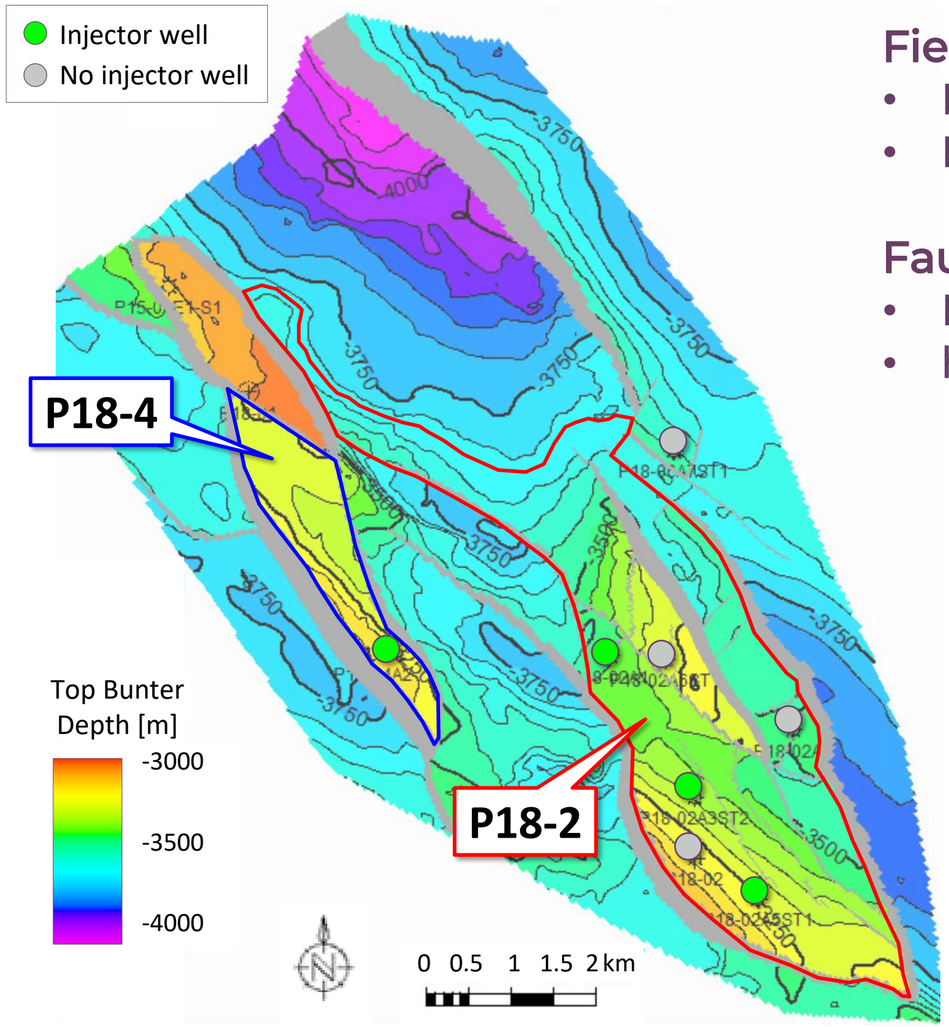
Port of Rotterdam CO_2 Transport Hub and Offshore Storage





PORTHOS

Subsurface details



Field details

- Discovery in 1989
- RF =98% (p_{res} approx. 20 bar)

Fault bounded compartments

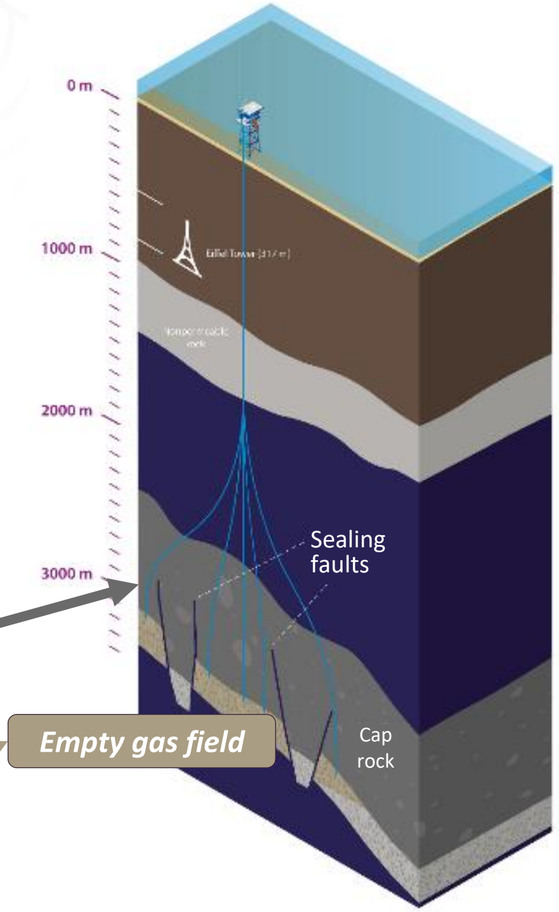
- P18-2 & P18-4
- hydraulically isolated

CAPROCK *[h~600m]*

→ ***Upper Germanic Trias Group***
→ ***Jurassic Altena Group***

RESERVOIR *[h~200m]*

→ ***Lower Germanic Trias Group (Main Buntsandstein Subgroup)***



CASE STUDY: PORTHOS MMV

From Concept to MMV Strategy

- ✓ p/T sensors
- ✓ Fibre-optics (DAS/DTS)
- ✓ Integrity & Micro-annuli tests/logging

Wells

- ✓ Acoustic surveys (pockmark & bubble detection)
- ✓ Water benchmarking
- ✓ Sediment benchmarking
- • Shallow overburden survey*

Water column, seabed, shallow geosphere

- • Active seismic survey*
- • Passive seismic survey**

Deeper geosphere

*not included in MMV version 1.0
**partly included in MMV version 1.0

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OUTLOOK

Where do we need to go? MMV in the future?

1. **Building & sharing knowledge**
   - Global exchange of knowledge and experiences within CCS sector (also negative lessons!)
   - Learning from related sectors (e.g. geothermal) and sectors active nearby (e.g. windparks)

2. **Looking beyond to join forces**
   - Increase in cost-efficiency (use of infrastructure/vessels, joint acquisition programme …)
   - Joint development of new technologies under real conditions (provide test locations etc.)

3. **Alignment with neighbors**
   - Cross-border agreements w.r.t. extent of storage complex (pressure interference)
   - Co-existence of various different activities in the same area (spatial claim)

4. **Support by guidance & transparency**
   - Support of development/update of CCS standards and guidelines
   - Clarity w.r.t. monitoring requirements for asset transfer after EOFL
   - Building confidence by open discussions about:
     - ✓ What can be measured? What are the uncertainties? What makes sense (cost-benefit)?
     - ✓ Zero tolerance for any level of leakage / seismicity regardless of likelihood or time scale?

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SUMMARY & CONCLUSIONS

- ✓ **Large-scale CCS projects** are under development in NL (focus on **depleted fields**) with operations starting in 2026
- ✓ Monitoring should provide **confidence** in the **containment** and **conformance** of a CO_2 storage project
- ✓ The **Porthos** project is currently preparing the **final MMV plan**, reviewing new opportunities and feasibility
- ✓ Outcomes of the **research project DICTUM** could be suitable for **passive seismic monitoring** offshore (under development)
- ✓ **Communication** and **collaboration** (beyond sector and country borders) will be key to identify **synergies** and build **trust** in CCS

- ❖ **Proof of concept & rapid upscaling** will be key, including options for storage of CO_2 in deep saline **aquifers**
- ❖ MMV shall be **fit-for-purpose, risk-based**, and **cost-effective**, while ensuring the **long-term safety and security** of CO_2 storage
- ❖ Continuous screening of **new developments** and **best practices** contributes to increased **flexibility and redundancy** in MMV
- ❖ Enabling the **development of low(er) TRL methods** is essential to the **whole sector** and should be supported
- ❖ Regulator could **stimulate search for synergies,** as **joint effort** is needed to achieve the global climate targets

ANY QUESTIONS ?

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ebn Energising the transition