



IEAGHG

CCUS Scene Setting and Status

- EPFL CCUS Stakeholder Workshop, 15 June 2026
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Technology Collaboration Programme

by **iea**

Who are we?

Our internationally recognised name is the IEA Greenhouse Gas R&D Programme (IEAGHG).

We are a Technology Collaboration Programme (TCP) and are a part of the International Energy Agency's (IEA's) Energy Technology Network.

Disclaimer

The IEA Greenhouse Gas R&D Programme (IEAGHG) is organised under the auspices of the International Energy Agency (IEA) but is functionally and legally autonomous. Views, findings and publications of the IEA Greenhouse Gas R&D Programme do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.



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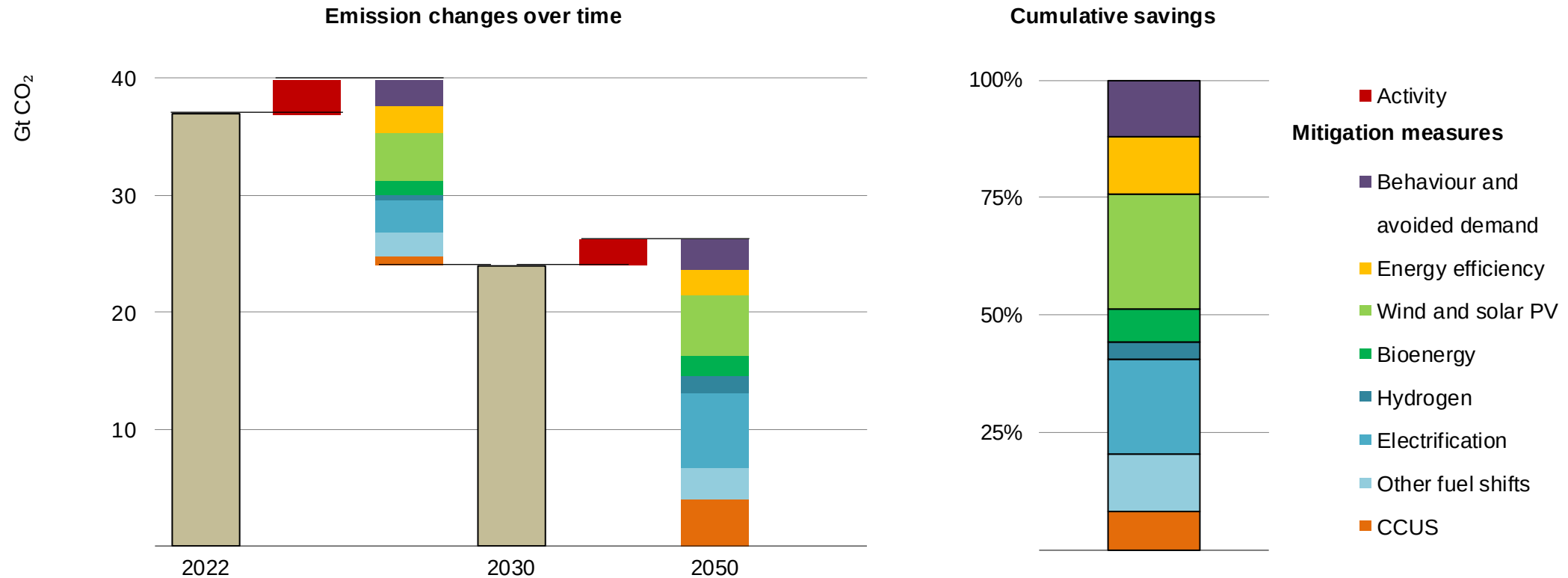
IEAGHG – at a glance

- Established in 1991. 39 Member countries and organisations
- Funds research into development and deployment of CCUS technologies
- Technical Reports > 420 reports published on all aspects of CCUS
- International Expert Networks:
 - Monitoring; Risk Management; Modelling; Environmental Research; High Temperature Solid Looping; Costs; Social Research; Offshore CCS (with UT GCCC); Network of National CCUS CoE in Global South (with UT GCCC)
- Conferences
 - GHGT conferences (the largest global conference on CCS)
 - GHGT-17 : 20-24 Oct 2024, Calgary
 - GHGT-18 : 25-30 Oct 2026, Perth
 - PCCC conferences – PCCC8, Marseille, 15-17 Sep 2025
 - International CDR Conference – 10-12 June 2026 Milan
- International CCS Summer Schools – #17, 803 alumni. **2026 – Copenhagen**



The strategic role of CCUS in clean energy transitions (NZE 2022)

CO₂ emissions reductions by mitigation measure in the NZE Scenario, 2022-2050



Expansion of renewables, energy intensity improvements and direct electrification of end-uses combined contribute to around 60% of emission reductions by 2050; CCUS (including removal) contributes to 8%

UNFCCC Paris Agreement

Nationally Determined Contributions (NDCs)

- NDC updates (to 2030): (as of 18 Aug 2024):
- ~195 submitted, 23 include CCS (Norway, UAE, Australia, Iceland, USA, Canada, Malawi, Qatar, Tunisia, Pakistan, Kuwait, Togo, Bahrain, Saudi Arabia, China, Mongolia, Japan, El Salvador, Thailand, Turkey, UK, Vietnam, Oman) and 2 that implicitly include CCS (EU, Indonesia)
- **2025 Updates** (to 2035) with CCS (as of 3 Feb 2026)
- **53 include CCS:** UAE, UK, Brazil, USA, Botswana, Uruguay, Switzerland, Singapore, Canada, Moldova, Norway, Cambodia, Bangladesh, Nigeria, Iceland, Malaysia, Zambia, China, Thailand, EU (27), Azerbaijan, Qatar, Bahrain, Rwanda, Colombia, Korea, Saudi Arabia

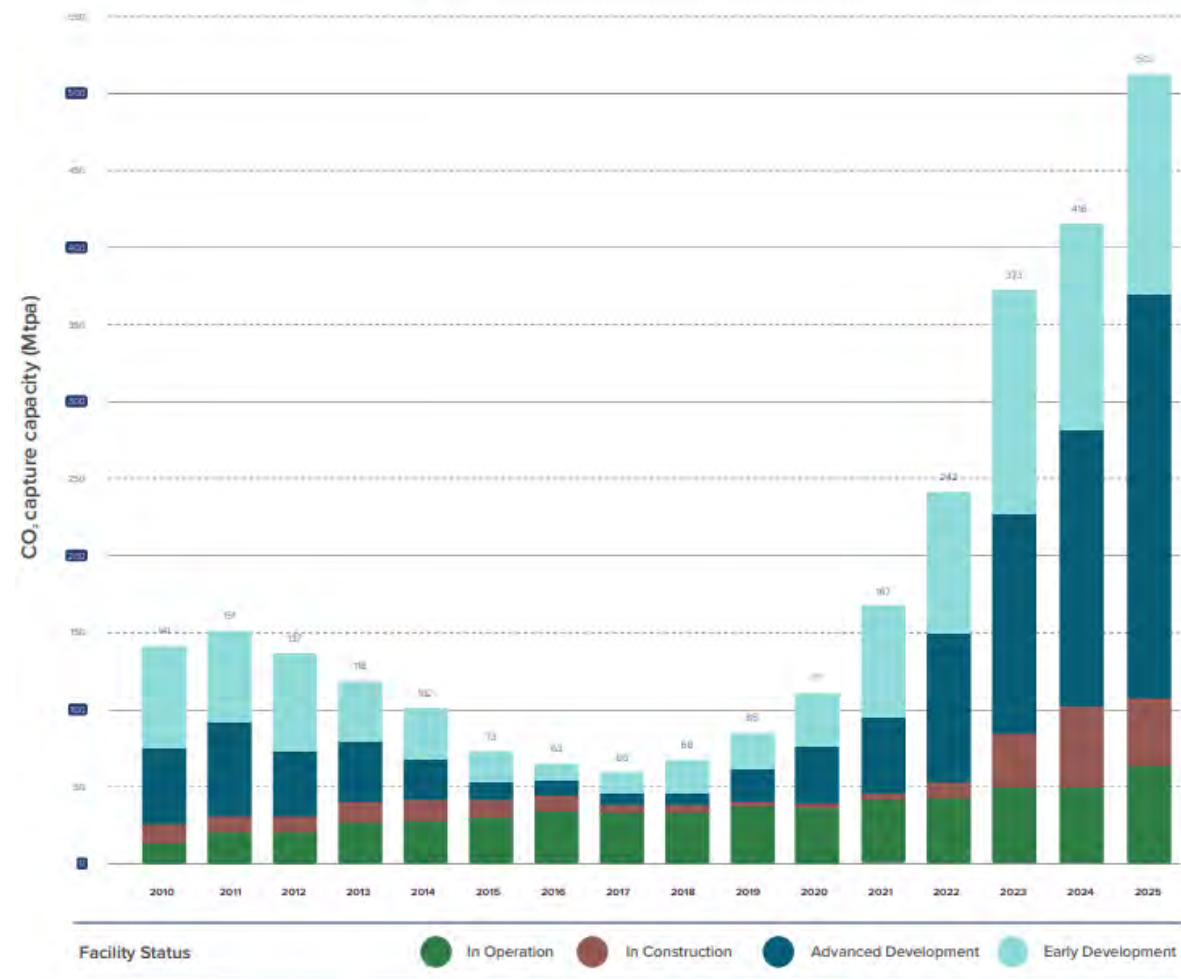
UNFCCC Paris Agreement

Low GHG emission development strategies (LT-LEDS)

- Longer-term, the Paris Agreement invited Parties to communicate *'long term low GHG emission development strategies'* to the mid-century.
- As of 19 Feb 2026, **80** countries have submitted these, and **55** contain CCS as a mitigation activity (USA, Canada, Germany, Mexico, France, Czech Republic, UK, Ukraine, Japan, Portugal, Slovak Republic, Singapore, South Africa, Finland, Norway, Latvia, Belgium, Spain, Sweden, Netherlands, Austria, Korea, Denmark, Switzerland, Indonesia, Slovenia, Hungary, China, Iceland, Australia, Thailand, New Zealand, Nigeria, Cambodia, Morocco, Malta, Lithuania, Russia, India, Singapore, Tunisia, Cyprus, Ethiopia, Ireland, Oman, Armenia, UAE, Kazakhstan, Turkey, Burkina Faso, Equatorial Guinea, Jamaica, Czech Republic)
- **Majority of Strategies include CCS**

GCCSI – Global Status of CCS 2025

CO₂ capture capacity of commercial CCS facility pipeline since 2010



Number of projects continues to rise



77

Total number of commercial CCS projects in operation

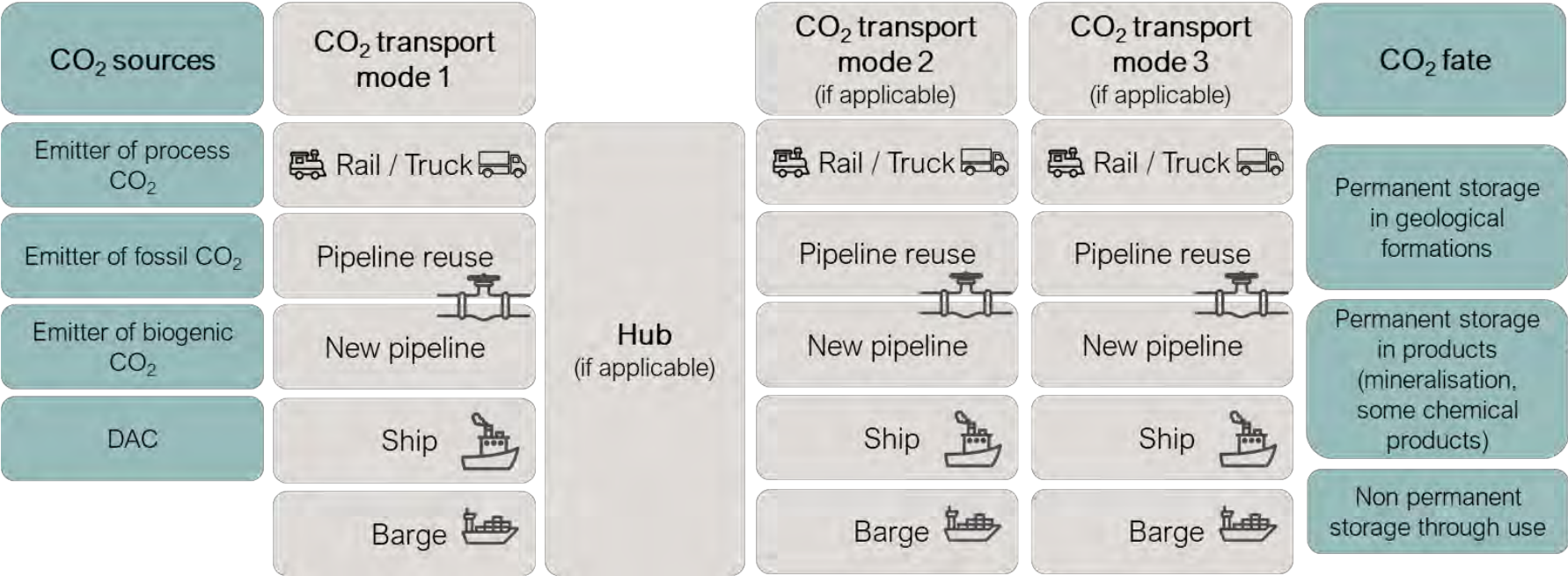
- 47 in construction
- 610 in development
- 734 projects in pipeline, up 17% year on year



106

CCS facilities added to project pipeline since Global Status of CCS 2024 Report

Carbon Capture Transport Utilisation and Storage – a growing smörgåsbord of options and configurations



Carbon capture pipelines have struggled to advance. A project in Nebraska found success



CARBON LIMITS



Industrial CCS is shifting toward hubs, shared T&S, and cross-border logistics

The emergence of bankable capture + transport + storage chains

Big recent milestones (late 2024–2025) matter because they de-risk replication:

- UK, Teesside (FID/financial close)
- Denmark, Greensand (FID)
- Norway Longship chain (Brevik capture + Northern Lights storage), and
- Early operational scale-up in Australia (Moomba)
- BECCS is moving from concept to financed build-out: Stockholm Exergi targets up to 0.8 MtCO₂/yr of removals from 2028.

The bottleneck is increasingly infrastructure coordination, permitting and risk-sharing, not whether capture can work in principle



CEMENT

Brevik, Norway

First industrial-scale CCS in cement, an important template for process-industry decarbonisation.



TRANSPORT & STORAGE

Northern Lights

Europe's storage backbone is becoming tangible: shipping, intermediate storage and offshore injection are now real operating assets.

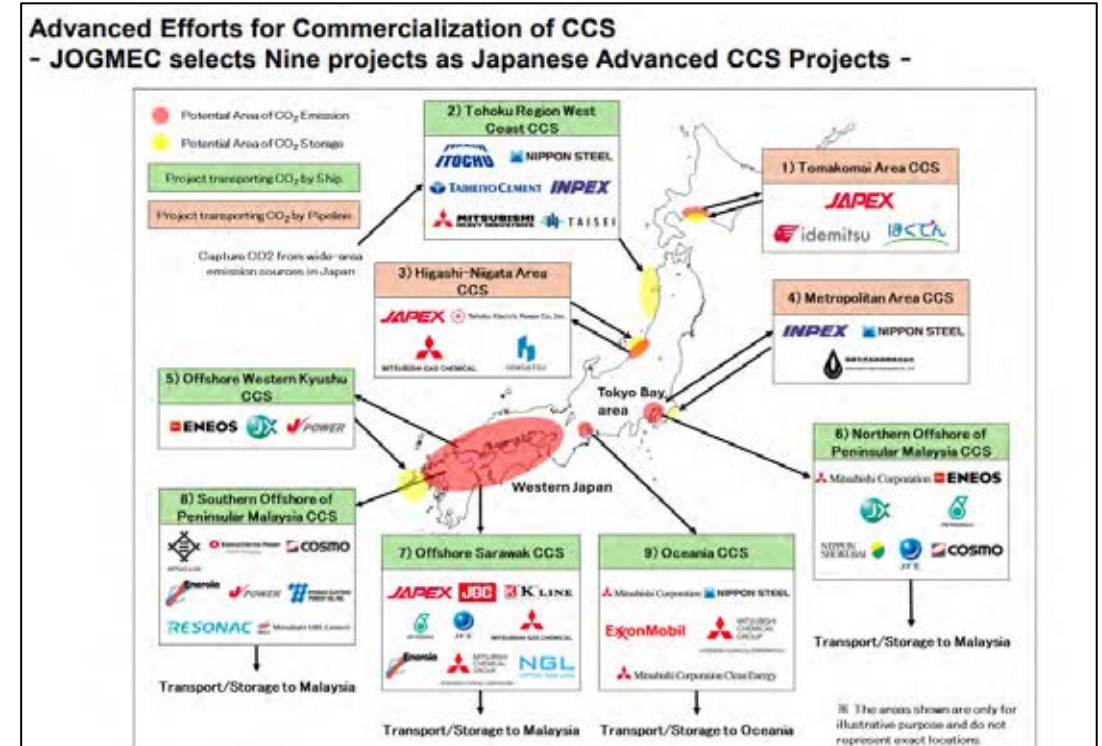
Northern Lights Phase 2 is progressing and aimed at increasing T&S capacity from today's 1.5 Mt to 5Mt CO₂/yr

Cross-border CCS Projects

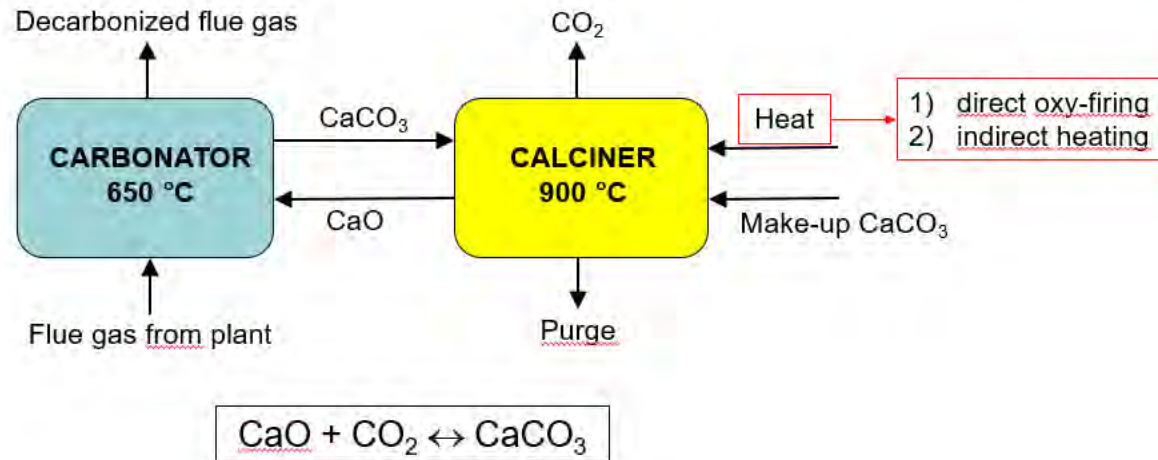
- **London Convention and London Protocol.** Important marine treaties for CCS and geoengineering, and world leading in dealing with these. IEAGHG sits at the table.
- The Export amendments enabled the Northern Lights project to proceed, and others following, e.g. Japan.
- UNFCCC Paris Agreement Article 6.4 – Framework for international carbon credits – Standards on Removals (and CCS) and on Reversals



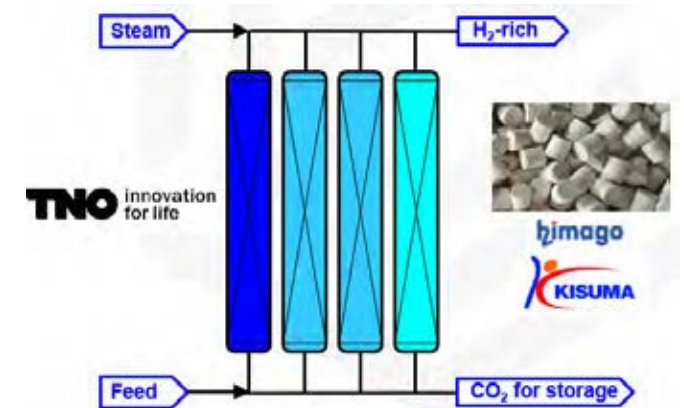
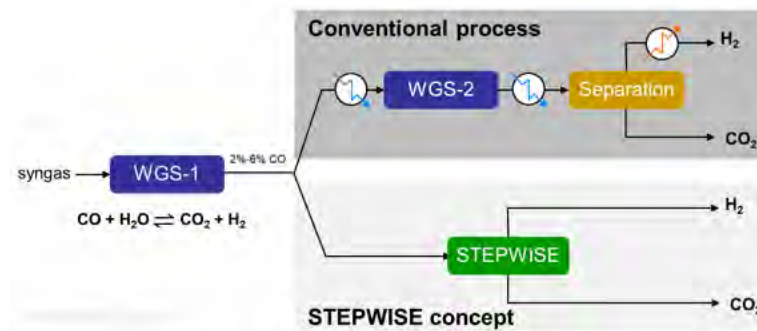
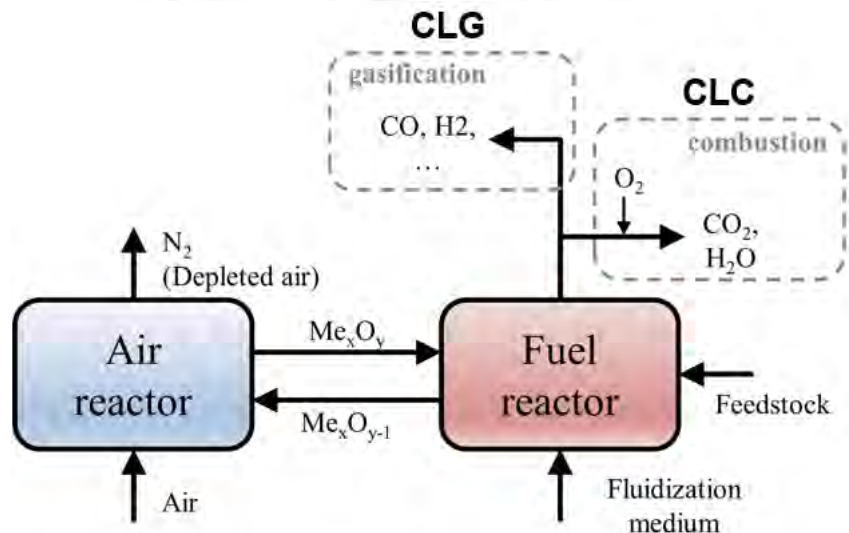
Kilde: PCI-søknad fra **Northern Lights** (Equinor, Shell og Total) (2019)



High-temperature solid looping cycles (HTSLC)



- HTSLC are technologies where a solid material is cycled between multiple reactors at elevated temperatures, e.g. Calcium/Carbonate Looping (CaL), Chemical Looping Combustion/Gasification (CLC/G), Sorption-Enhanced Water-Gas-Shift (SEWGS)
- Currently demonstrated at 1-1.7 MW_{th} scale in EU (CSIC-INCAR, TU Darmstadt), and at 5 MW_{th} in China (CHEERS)
- Horizon Europe project CaLby2030 currently demonstrating HTSLC technologies for three sectors: iron and steel, cement, and waste-to-energy

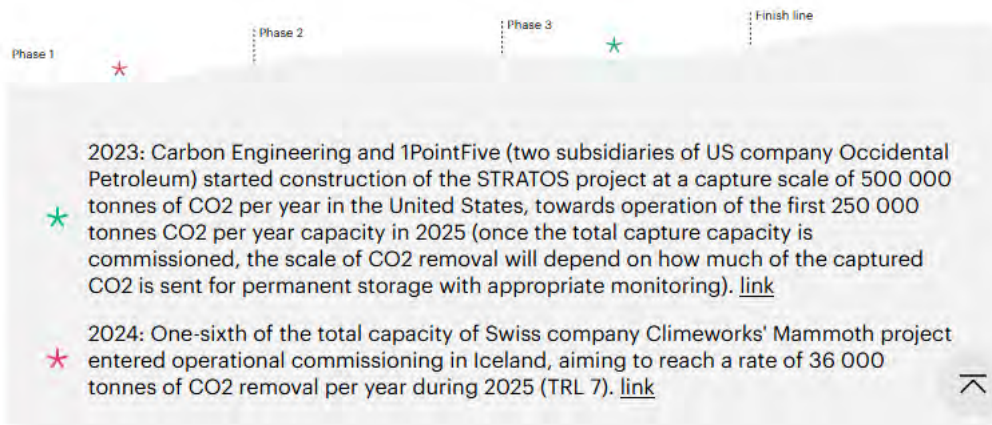


IEA's 'Race to be first projects'

Emissions reduction

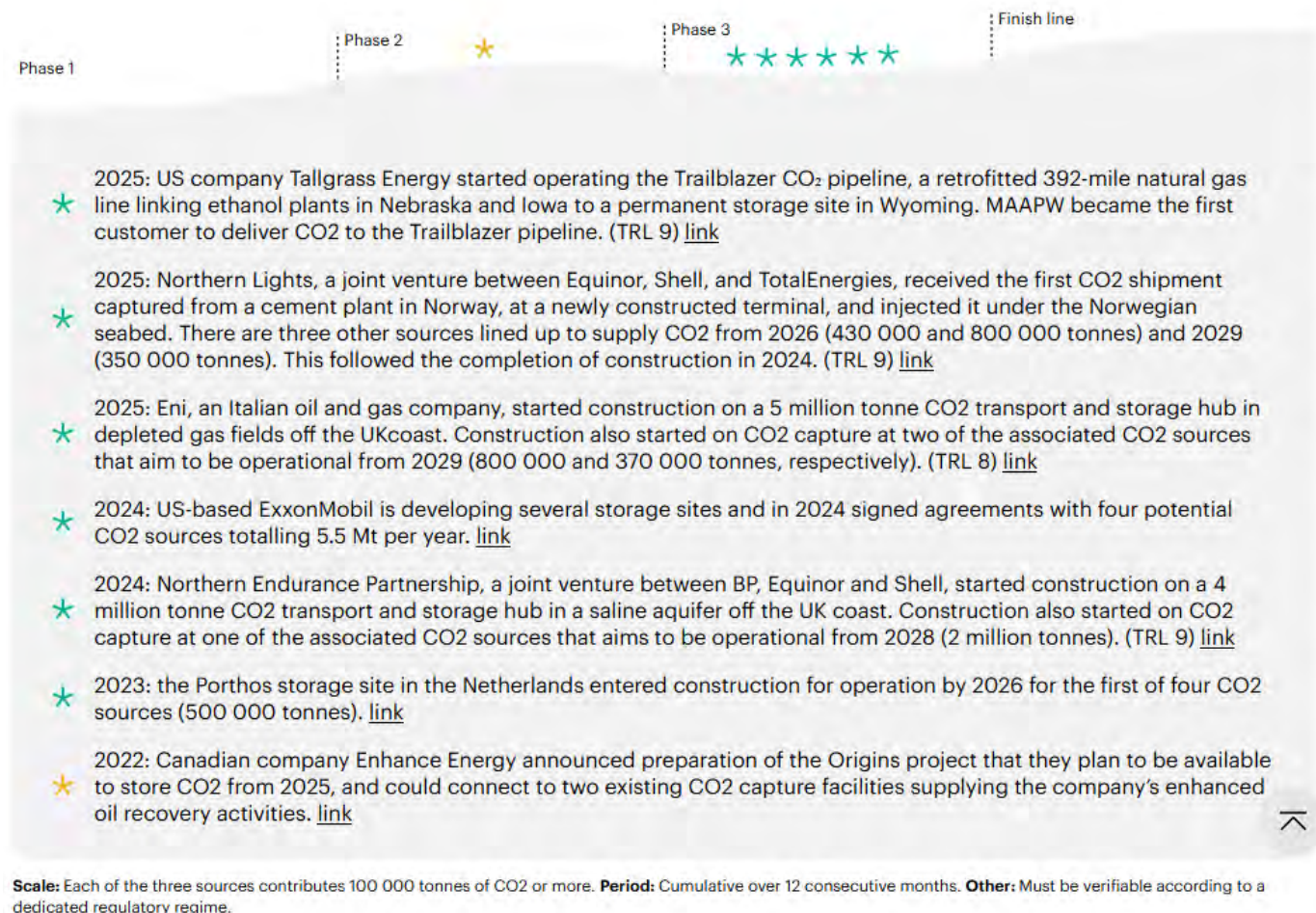
The first half-a-million tonne CDR plant

CO2 removed from the atmosphere by a single facility using a non-photosynthetic approach and in a way that is reasonably expected to have a permanence of over 10 000 years.



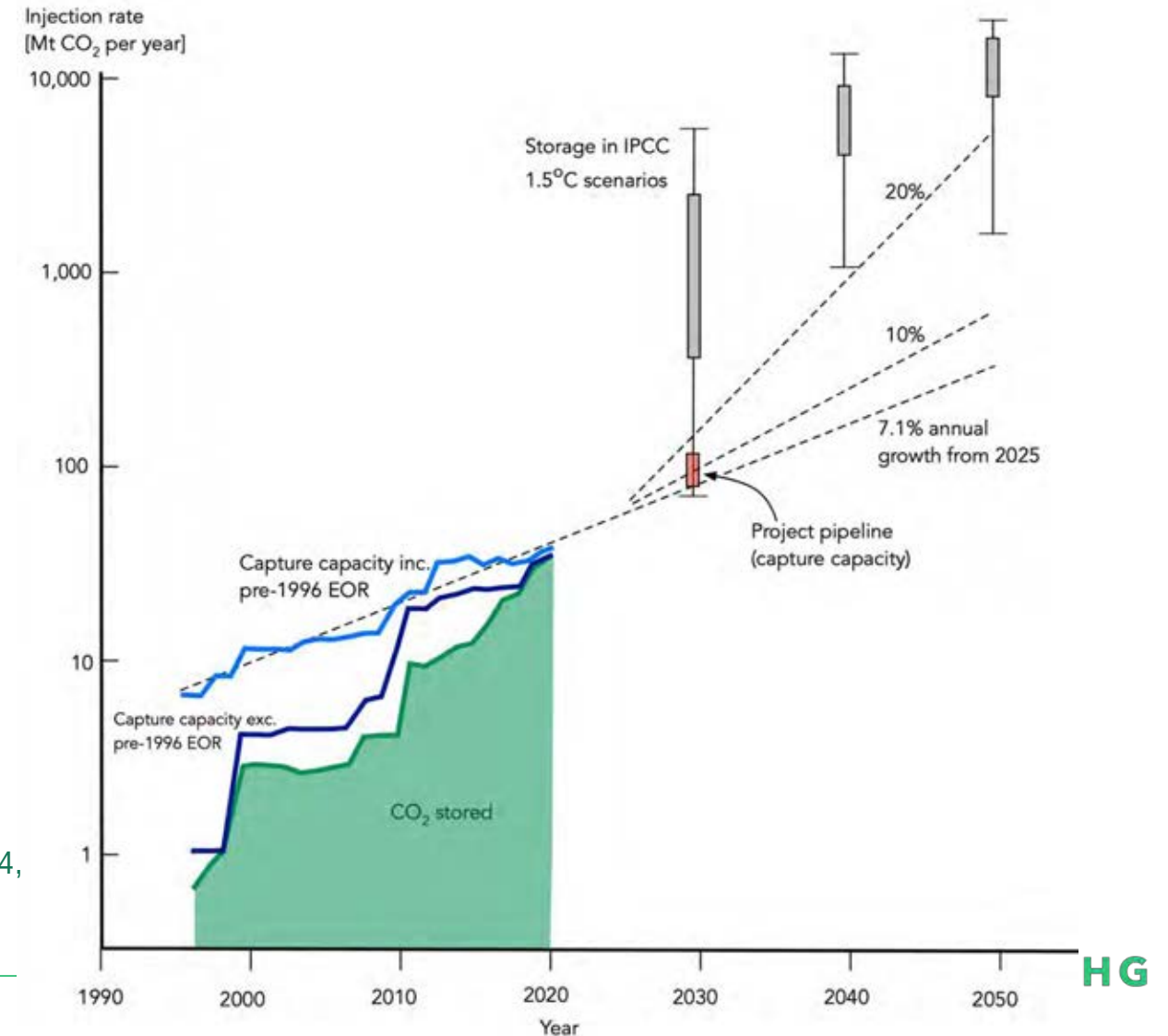
First large-scale multi-source CO2 storage hub in operation

A single CO2 storage site stores CO2 from at least three different sources.



Intergovernmental projections: 1–30 Gt of CO₂ storage is needed per year by 2050

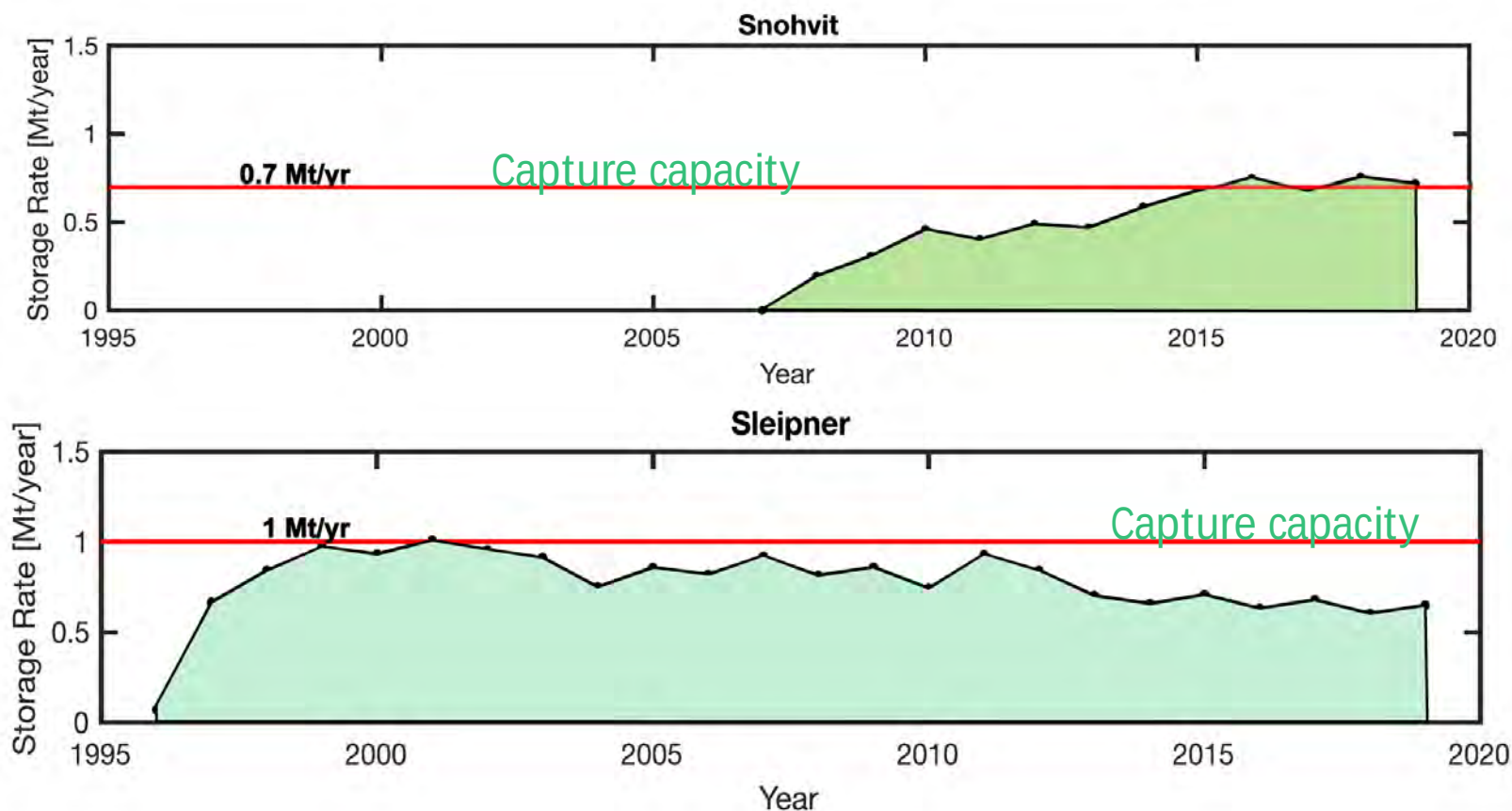
But where are we now?



Krevor, S., de Coninck, H., Gasda, S.E. *et al.* Subsurface carbon dioxide and hydrogen storage for a sustainable energy future. *Nat Rev Earth Environ* 4, 102–118 (2023). <https://doi.org/10.1038/s43017-022-00376-8>

Most storage projects report publicly and are operating well

- “Capture capacity” is not well defined, but in aggregate storage amounts annually are around 70% of the capture capacity of the operating projects
- No CO₂ leaked back to the atmosphere, no felt seismicity
- Challenges in pressure management at Gorgon, and in overpressure at In Salah are notable examples where project operation was impacted



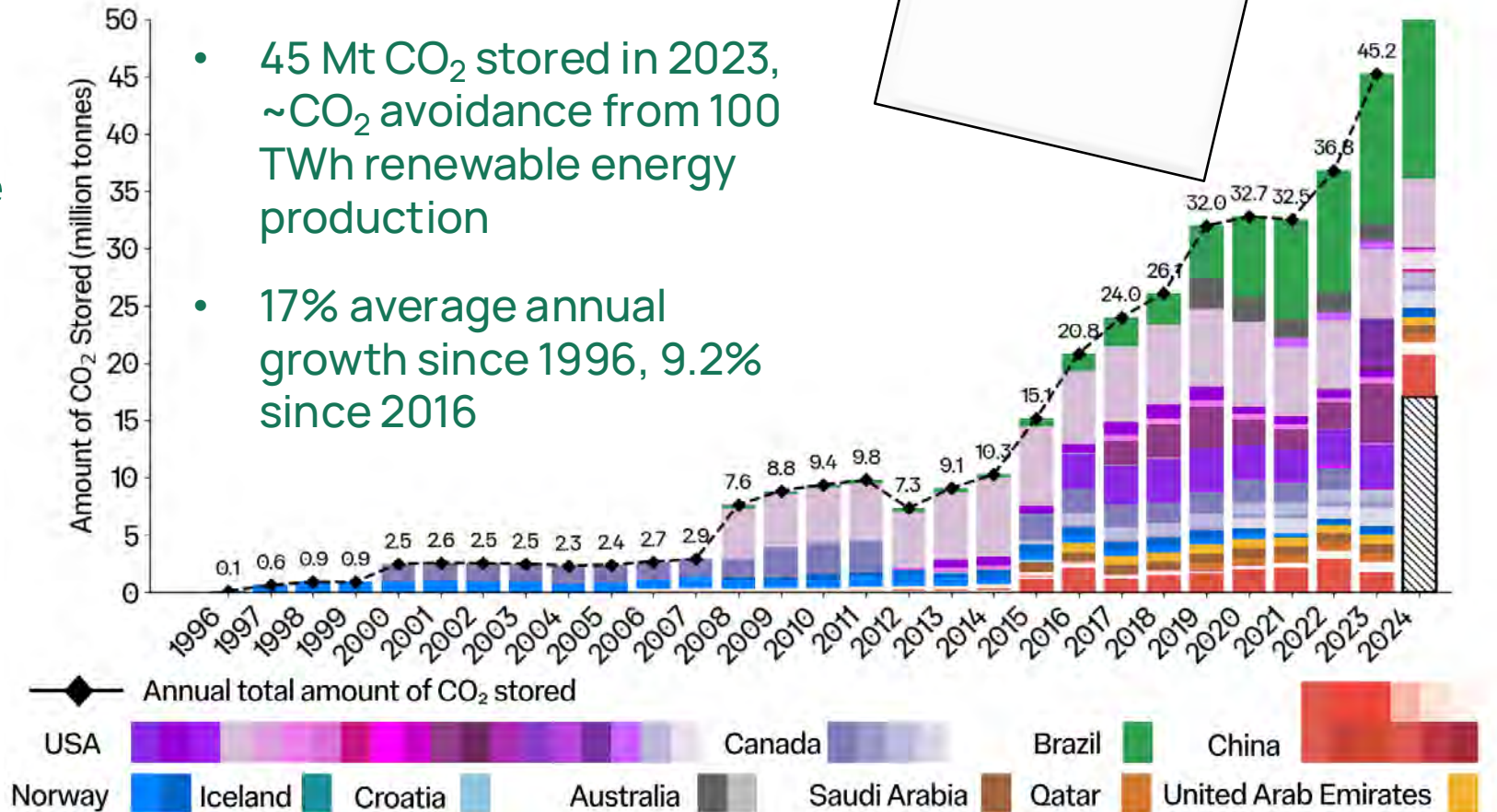
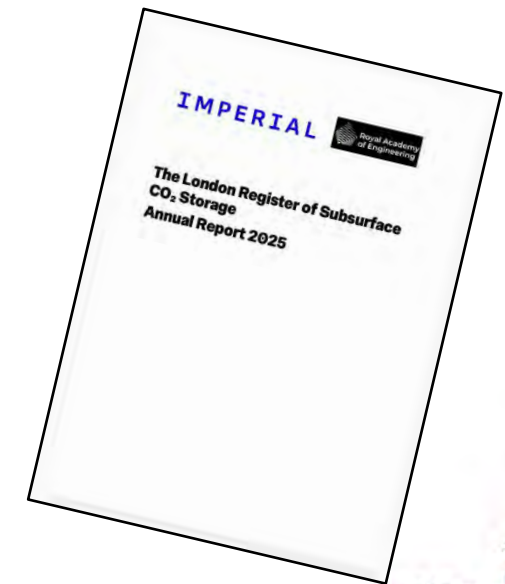
Zhang, Y., Jackson C., & Krevor, S. An estimate of the amount of geological CO₂ storage over the period of 1996-2020. Environ. Sci. Technol. Lett. 9(8), 693-698 (2022).
<https://doi.org/10.1021/acs.estlett.2c00296>

London Register of Subsurface CO₂ Storage 2025

Three Phases

1. Pioneering 1996 – 2007: Sleipner and Weyburn-Midale
2. N. American Expansion 2008–15: CO₂ storage with oil recovery becomes dominant
3. 2016 – 2025 Global growth: Projects in China and Brazil, and development in the USA lead to sustained growth

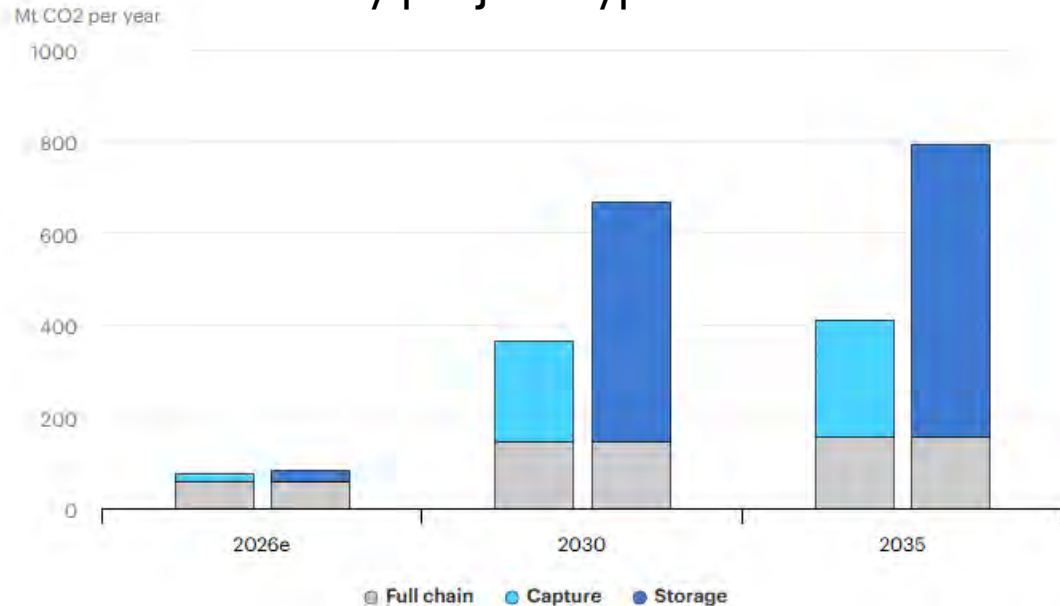
- 384 Mt CO₂ stored since 1996
- 45 Mt CO₂ stored in 2023, ~CO₂ avoidance from 100 TWh renewable energy production
- 17% average annual growth since 1996, 9.2% since 2016



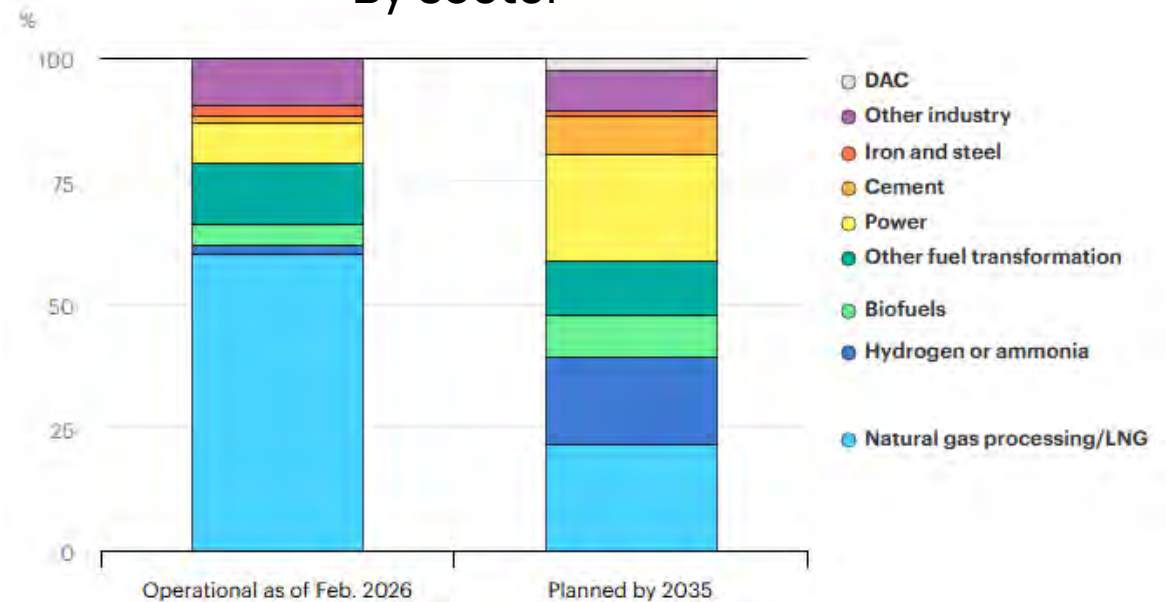
IEA Project database – 2026

- Storage volumes > capture
- Sector increase in power, H₂/ammonia & cement by 2035
- European projects increase share from 5-35% from now to 2035

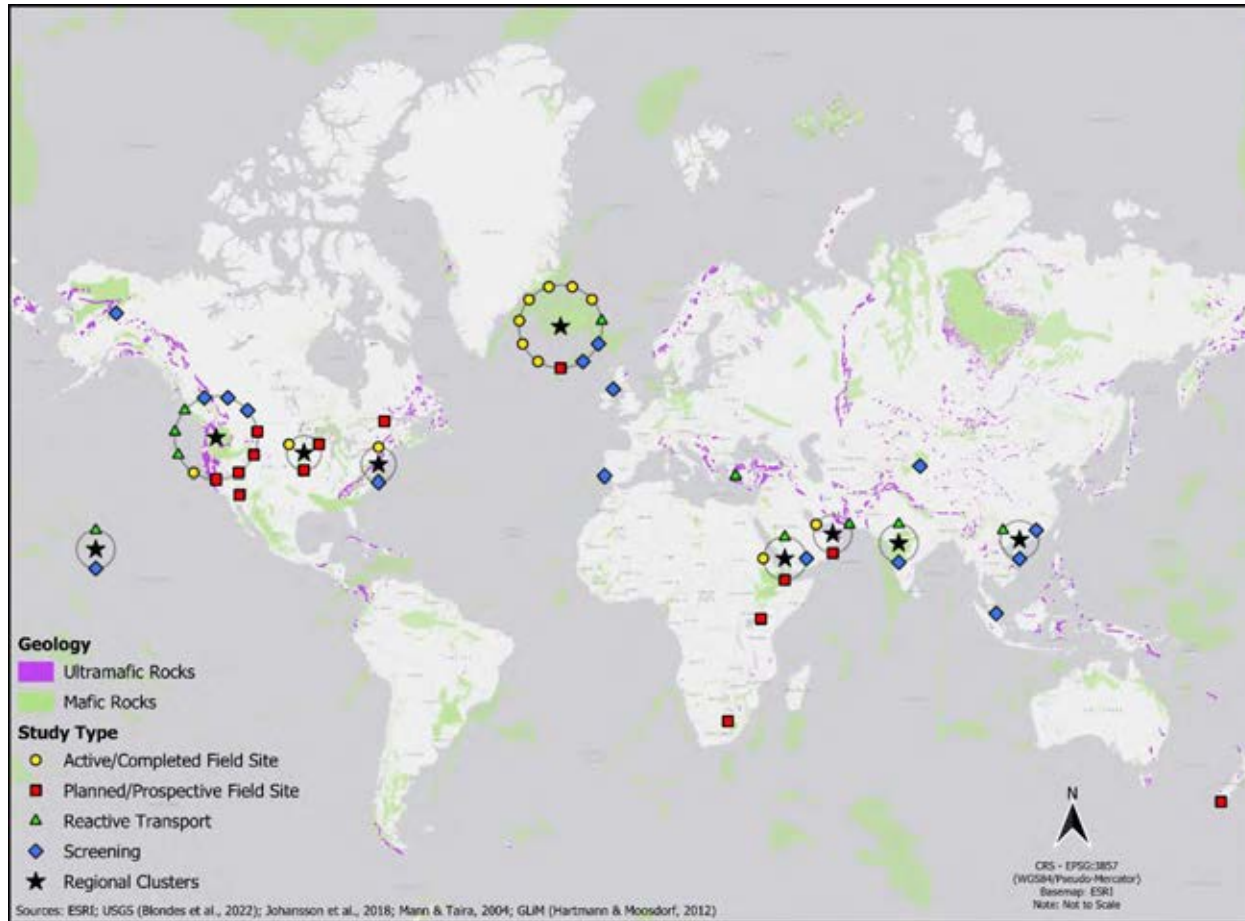
By project type



By sector



CO₂ Storage in mafic/ultramafic rocks



IEAGHG, “Review of CO₂ storage via in-situ mineralisation in mafic-ultramafic rocks”, 2025-03, August 2025,

Screening studies

21 in 10 countries, 75% basalt

Terrestrial potential ~2.5-4.8 Tt

No standardised approach – 4 methods

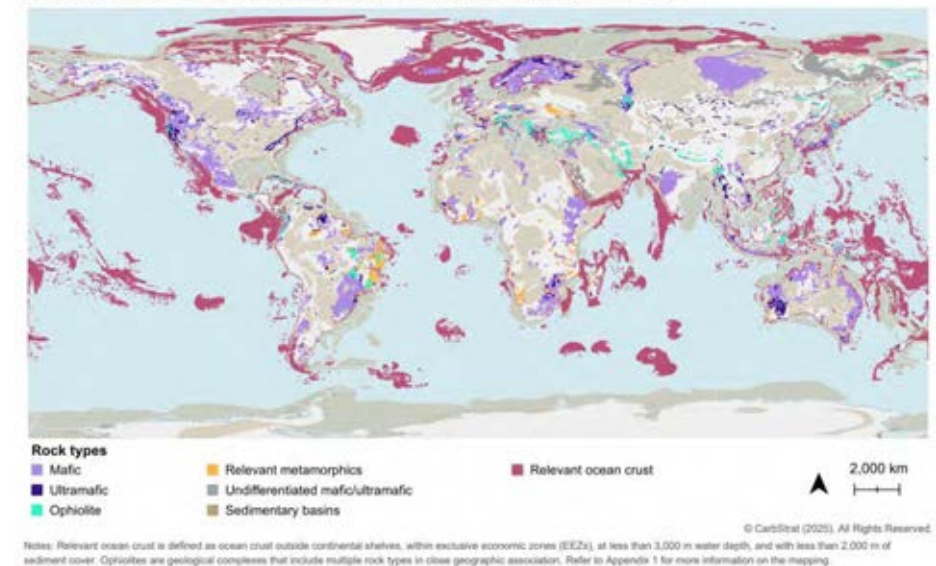
Mineral replacement

Pore filling

Unit mineralisation

Partial mineralisation

Figure ES 1. The global distribution of CO₂-reactive rocks compared to the location of sedimentary basins



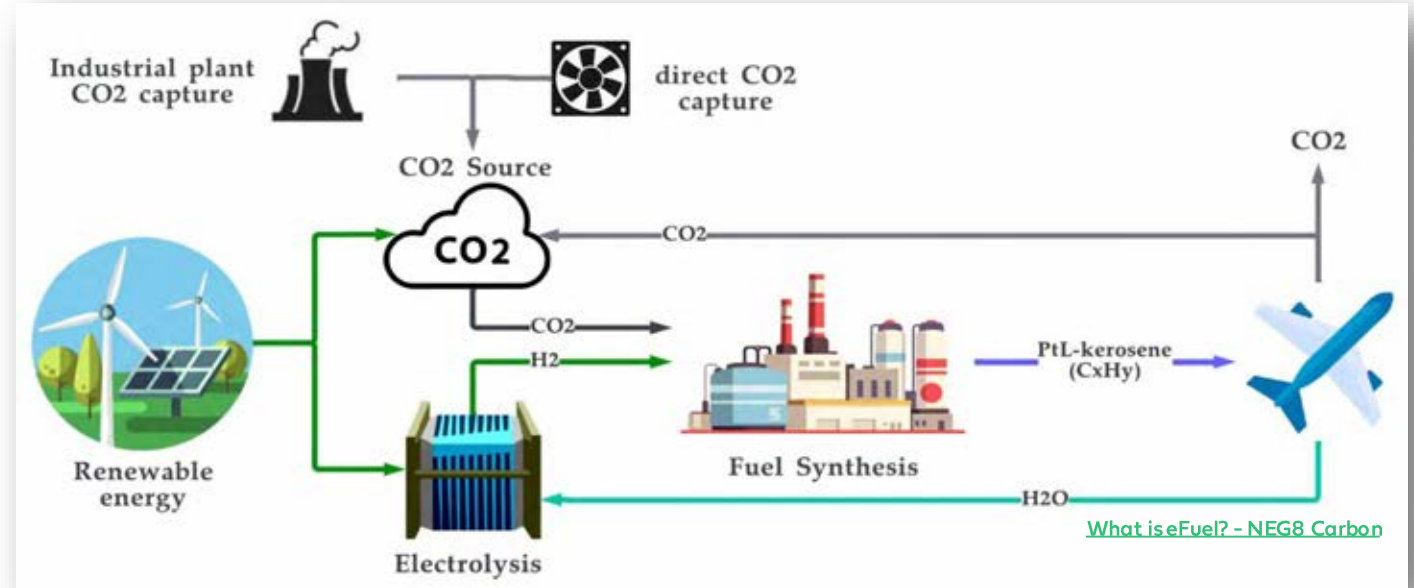
CO₂ Utilisation: the strongest near-term pull is synthetic fuels

Market pull

- ReFuelEU Aviation is now creating visible demand for SAF at EU airports, and a specific synthetic fuel sub-mandate starts in 2030

Policy mechanism

- EU airports must supply 2% SAF from 2025
- Share of SAF in all EU airports to increase by 70% from 2050



Norsk e-Fuel serves as a prime example of a market-led scale-up in the Power-to-Liquid (PtL) sector, driven by strong industrial demand for sustainable aviation fuel (SAF) rather than solely relying on government subsidies.

Three key messages

1

CCS is transitioning into an infrastructure driven system

Capture projects are more credible when storage access, shipping/pipeline routes, liability and revenue support are solved together.

2

CO₂ utilisation is strategic, but selective

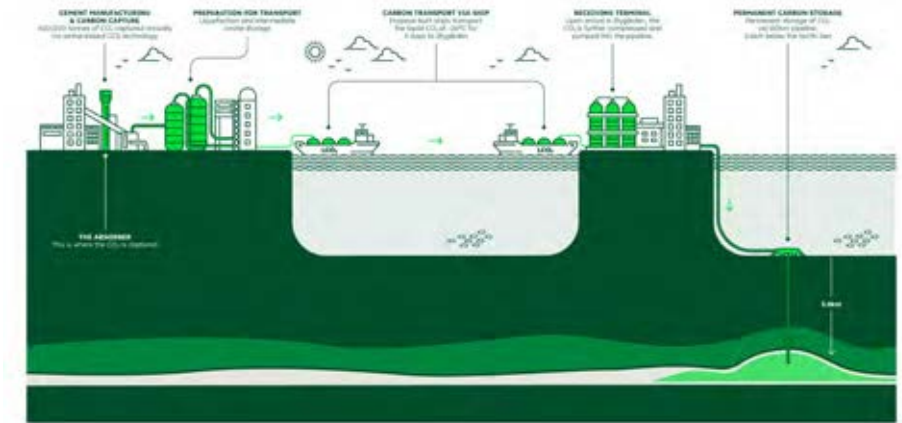
The clearest pull today is synthetic fuels; economics still hinge on low-cost clean power, hydrogen and strong policy support.

3

Oil & gas capabilities are directly relevant

Subsurface, marine logistics, hub development, contracting and MRV are increasingly the scarce capabilities in scaled deployment.

Heidelberg Materials' Brevik CCS project



CCS value chain logic is now easy to show, capture only matters if transport and storage land.

Watchouts

- Permitting and storage access can still delay capture FIDs
- The relevance of cross-border rules and accounting significantly increases as shipping expands

Thank you

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