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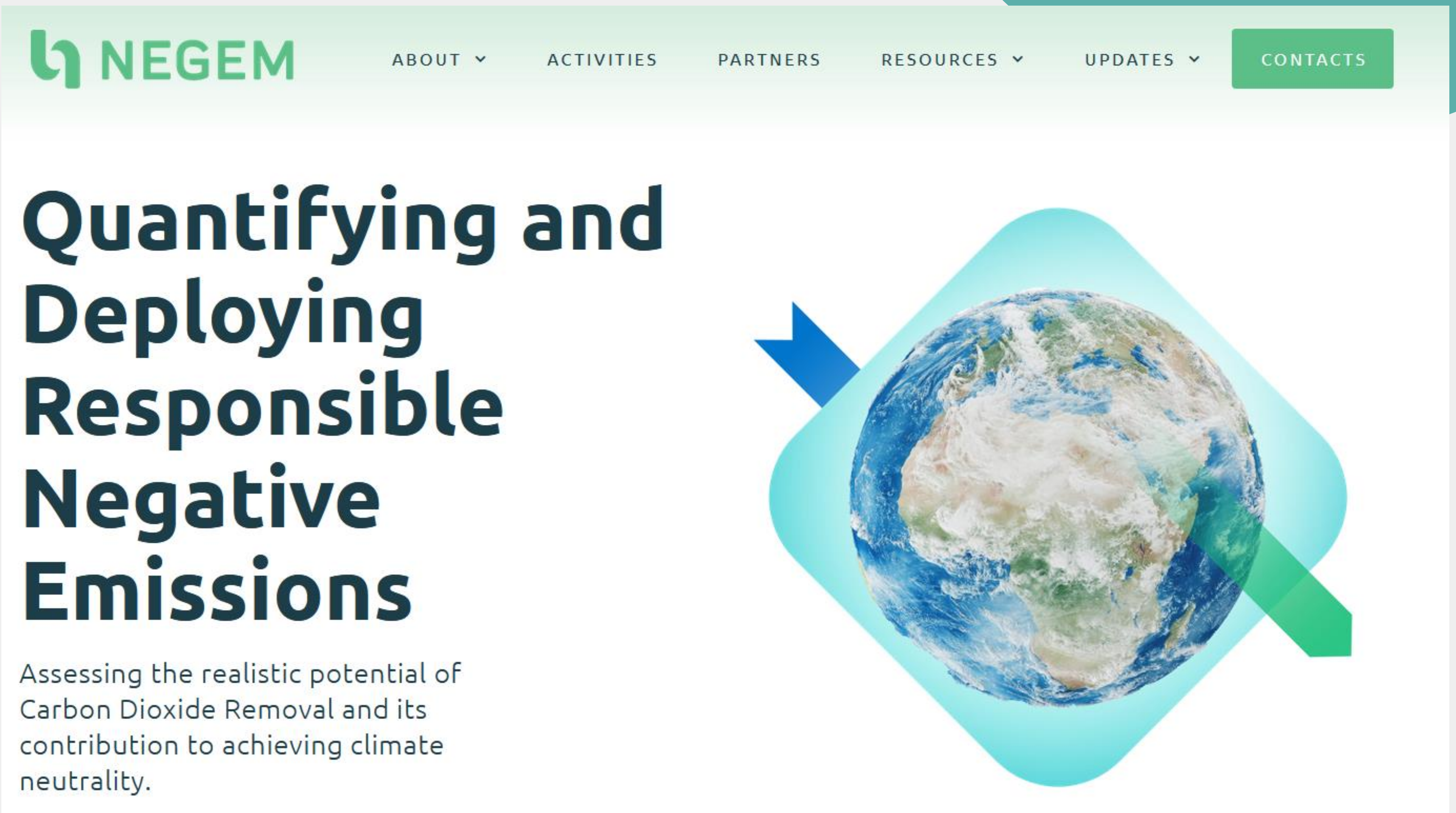
Assessing the realistic potential of Carbon Dioxide Removal (CDR) and its contribution to achieving climate neutrality

The European NEGEM Project

https://www.negemproject.eu/



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16	Partners	3	Research and Technology Organizations
11	Countries	2	NGOs
6	Universities	5	Companies

Project partners

VTT Technical Research Centre of Finland coordinator	Potsdam Institute for Climate Impact Research
Imperial College of Science Technology and Medicine	University of Cambridge
Eidgenoessische Technische Hochschule Zuerich	Bellona Europa
ETA Florence Renewable Energies	Norwegian Institute for Water Research
University of Groningen	Institut National des Sciences Appliquées de Toulouse
Carbon Market Watch	University of Oxford
Stockholm Exergi AB	ST1 OY
Drax Power Limited	Sappi Netherlands Services

This project received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 869192.

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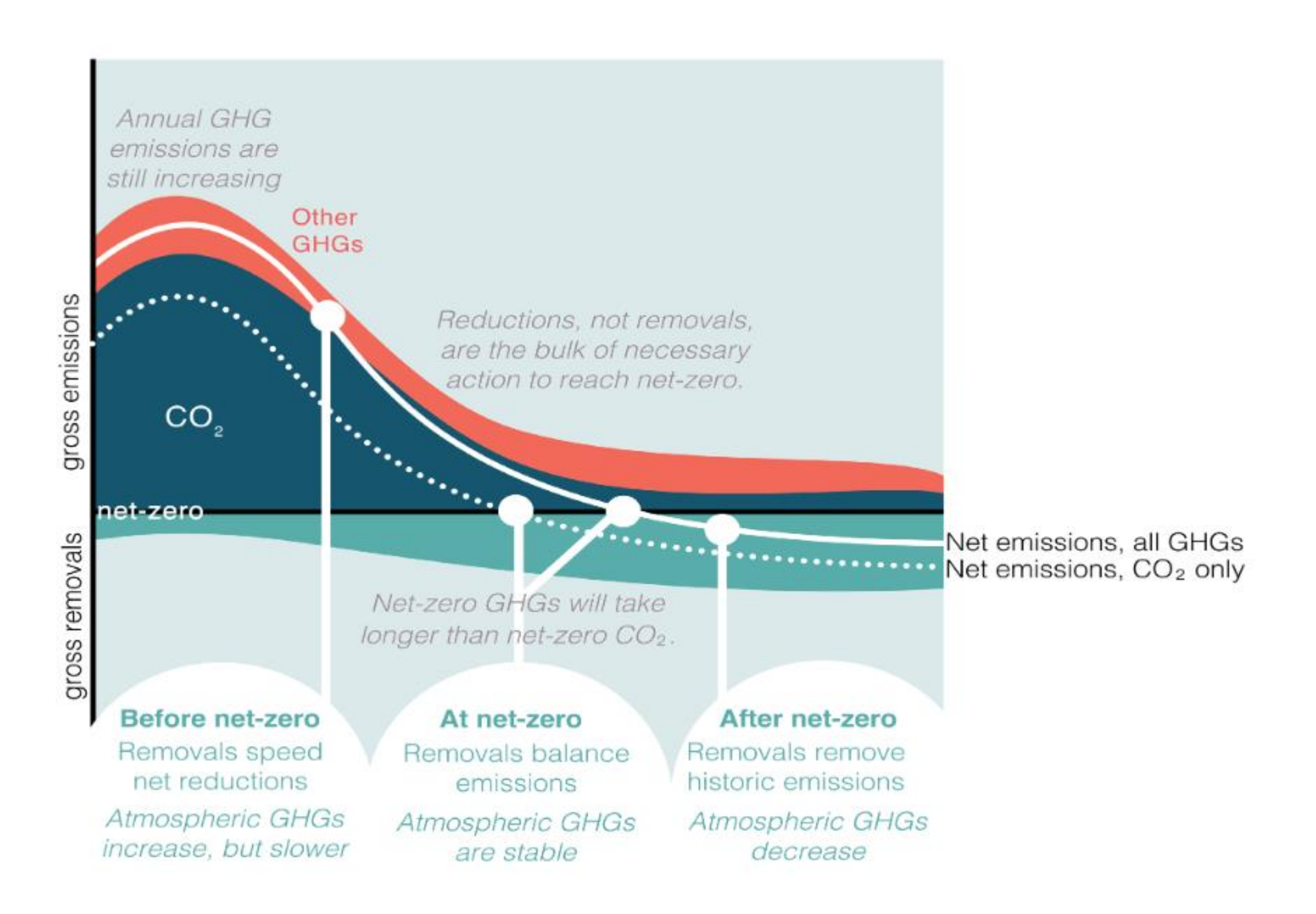
Carbon Dioxide Removal is unavoidable to meet Net-Zero targets

- To accelerate climate action
- To balance out residual GHG emissions
- To reduce global CO_2 concentrations



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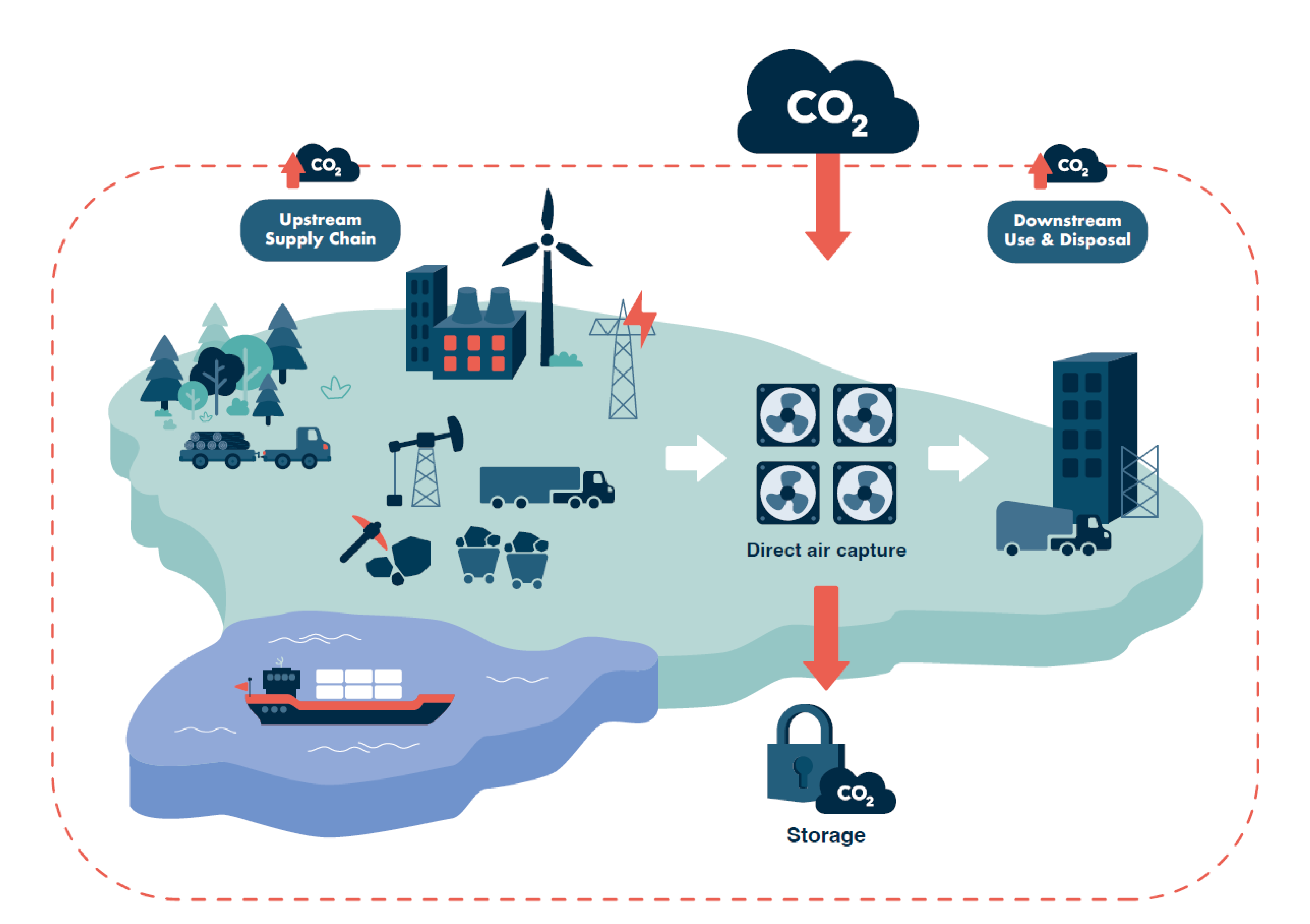
What is Carbon Dioxide Removal (CDR)



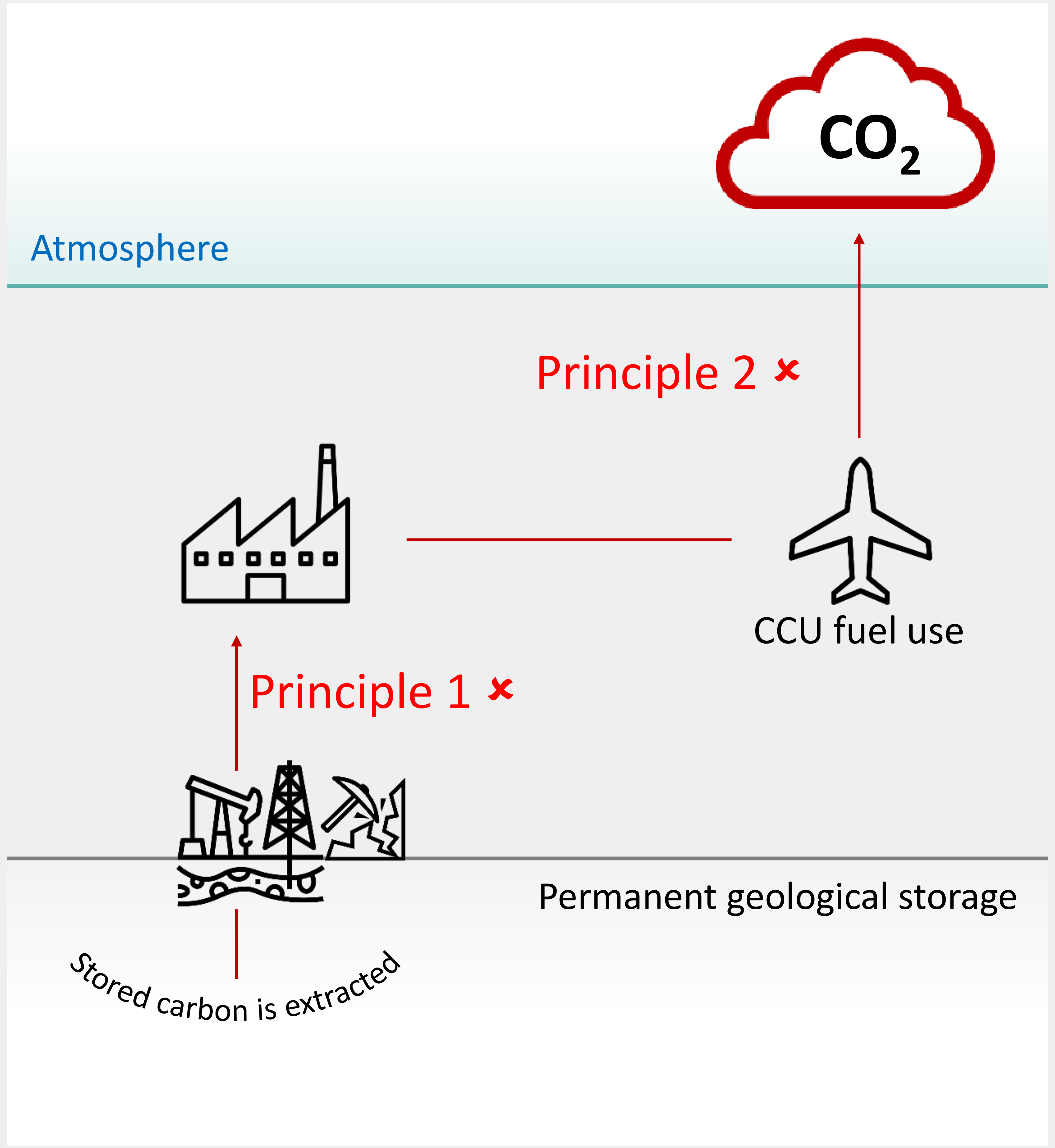
Key requirements

1. CO_2 physically removed from the **atmosphere**
2. Removed CO_2 is stored **permanently** (at least several centuries)
3. It is **additional** to natural processes.
4. All **associated emissions** estimated and accounted for
5. Total permanent removals **exceed** total associated emissions

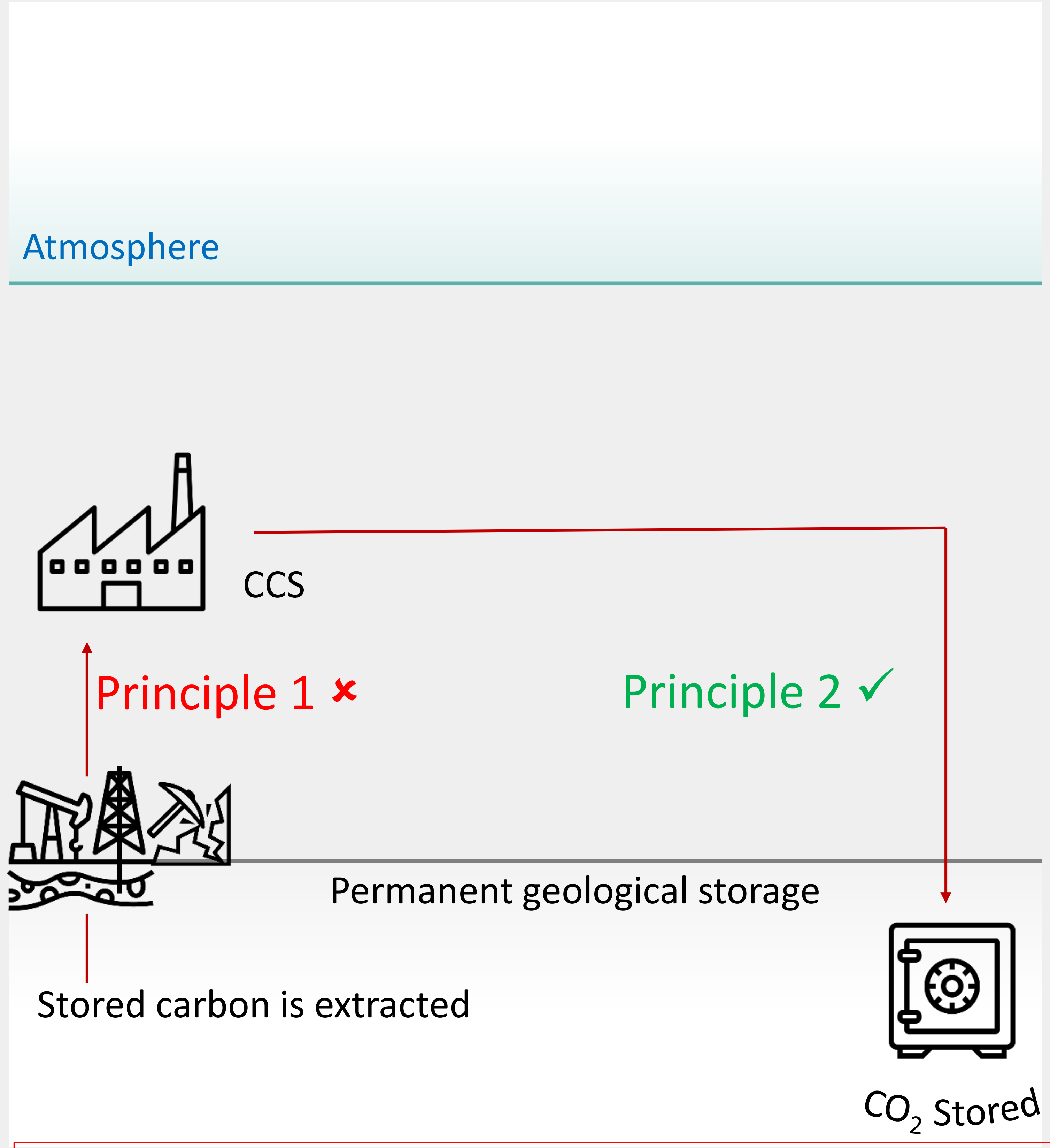
Tanzer and Ramirez (2019), "When are negative emissions negative emissions?", Energy & Envir. Sci
Smith et al. (2024), State of CDR, 2nd Edition.

What is (not) CDR

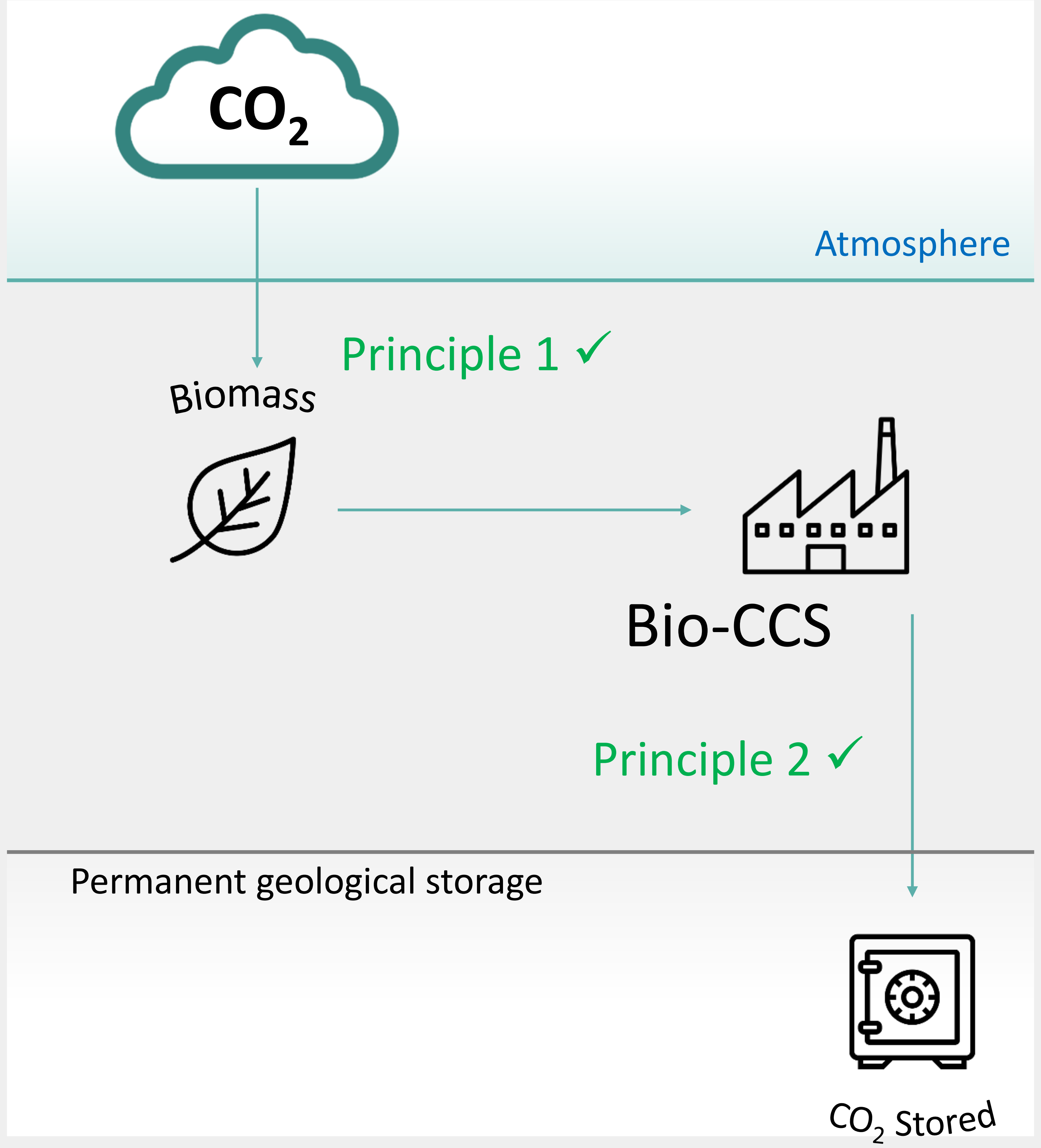
CCU
delaying hard-to-abate emissions



CCS
reducing hard-to-abate emissions



CDR
counterbalancing residual emissions



*Emissions **Avoidance is not**, and never can be Carbon Dioxide Removal*

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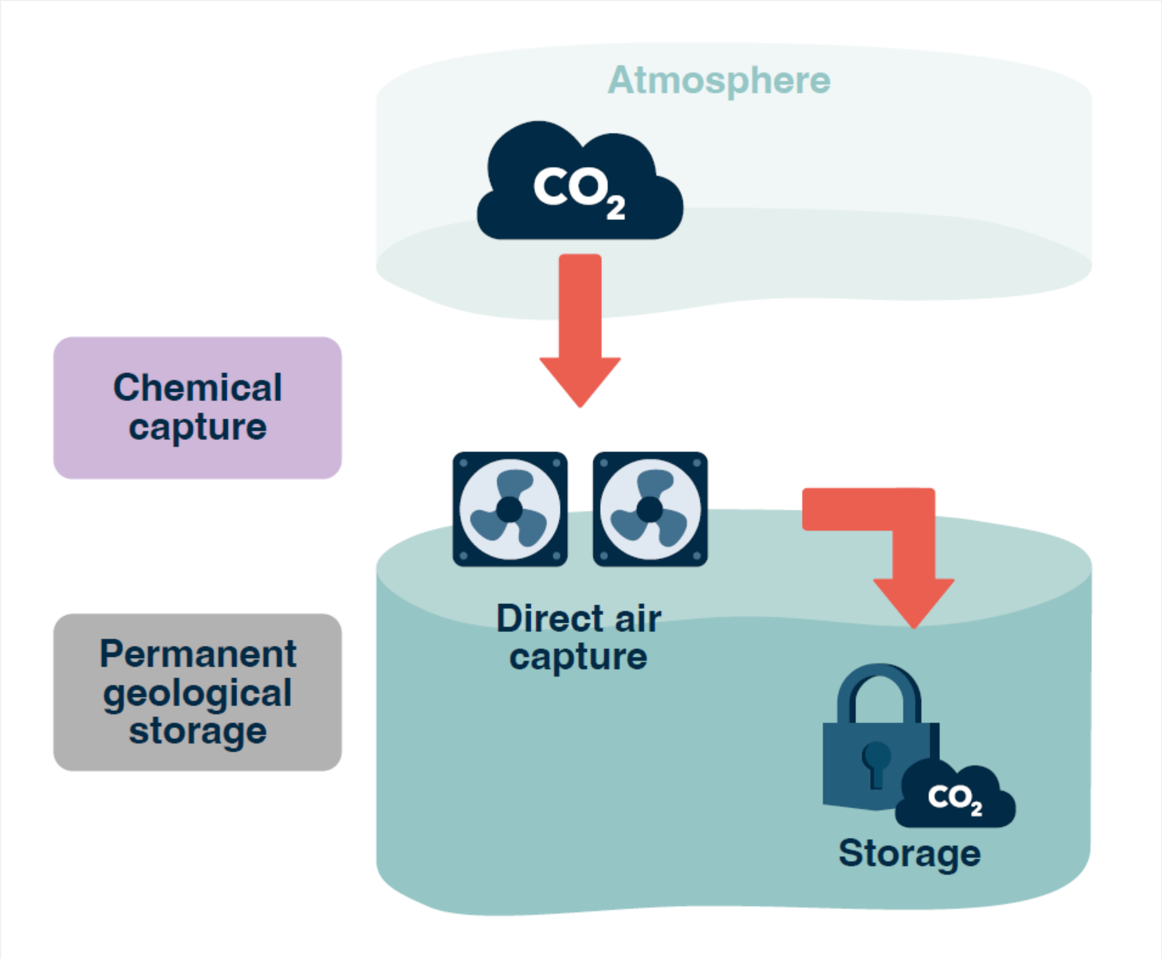
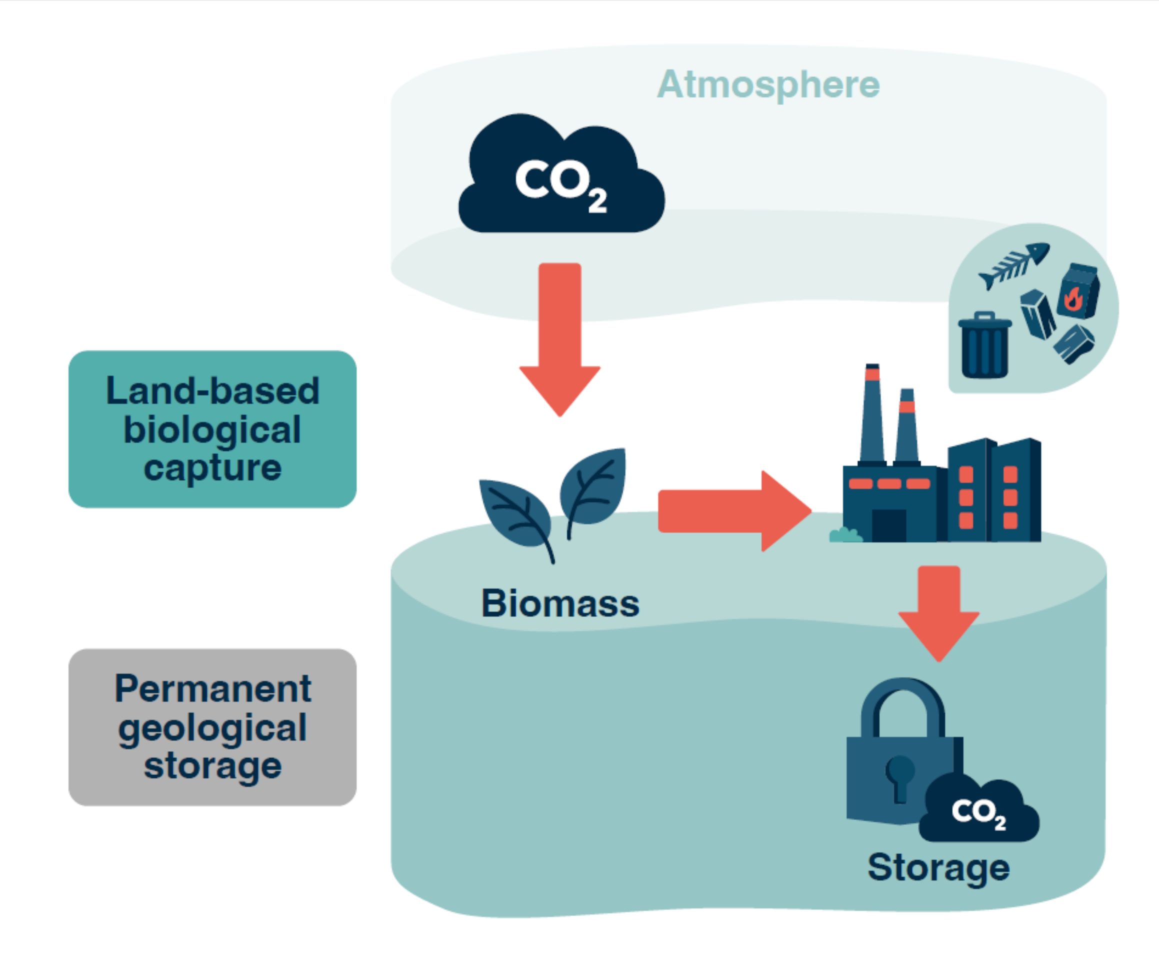
CDR approaches

DACCS



BioCCS



Afforestation

Technologically Cost, effectiveness, technological readiness, CO_2 reduction potential

Commercially Potential value and option value (willingness to pay) negative emissions

Environmentally Impacts on planetary boundaries (land, biodiversity, human safety and ecosystems) and resource flows (food security, water, biomass, metals and minerals)

Socially Public perception of cost, risks and benefits

Assessing the realistic potential and responsible deployment of CDR

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Life cycle assessment (LCA)

How does the sustainability of different CDR approaches (biological, chemical, geochemical) compare?

Target-based approach (IAM)

How is CDR deployed to counterbalance residual emissions and reach mitigation goals at lowest cost?

Supply-constrained approach

How much CDR can be achieved within resource limitations (e.g. land, water, biomass, energy) and without further straining planetary boundaries?

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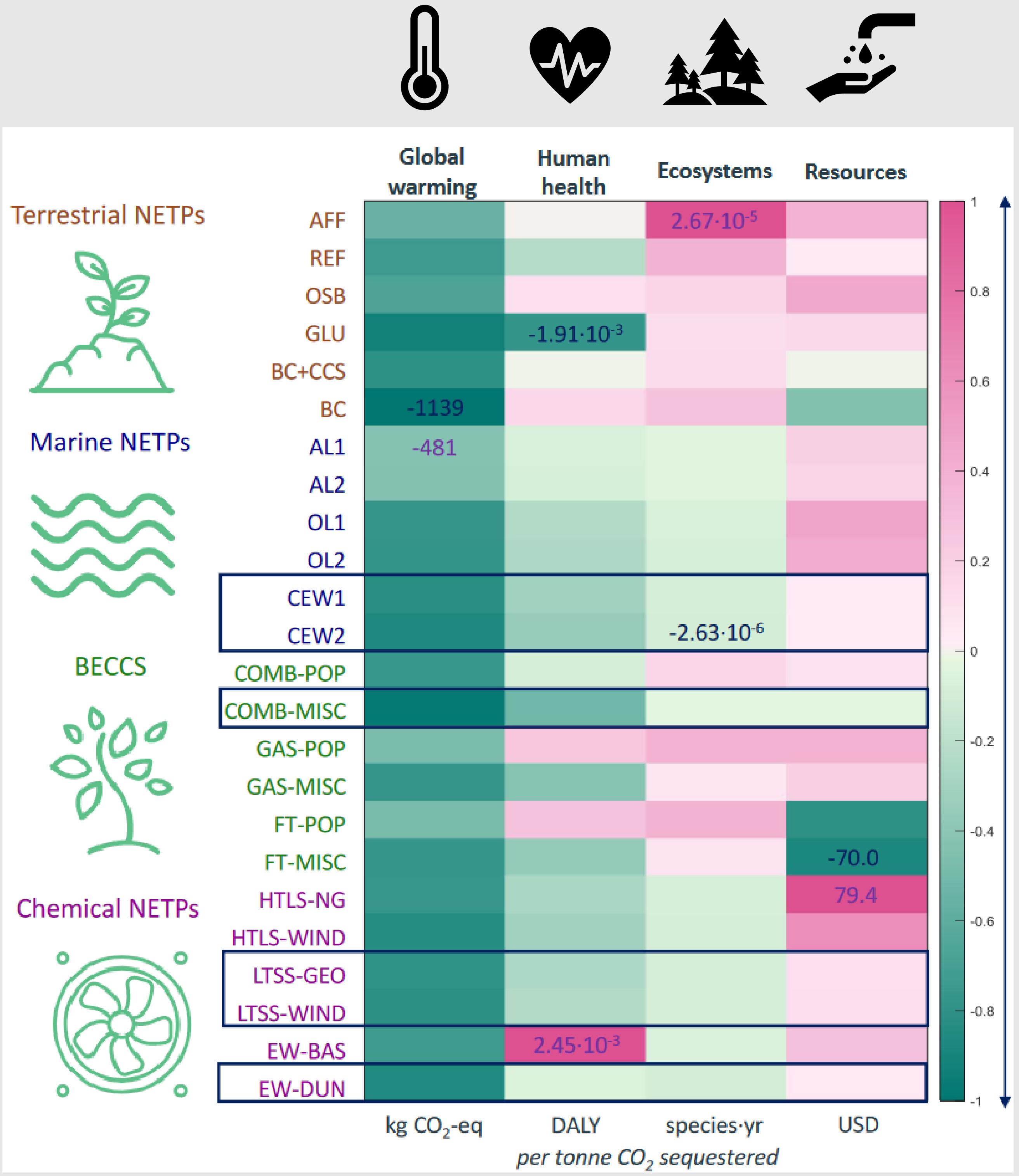
Cradle-to-grave life cycle assessment (LCA)

There is no NETP (CDR method) without a negative impact in at least one category.

A portfolio is needed to balance trade-offs and minimise local risks.



Net additional impact

Net prevented impact

Cobo et al. 2022, “Report on comparative life-cycle sustainability assessment of NETPs for impacts on human health, ecological functions and resources” (D3.8)

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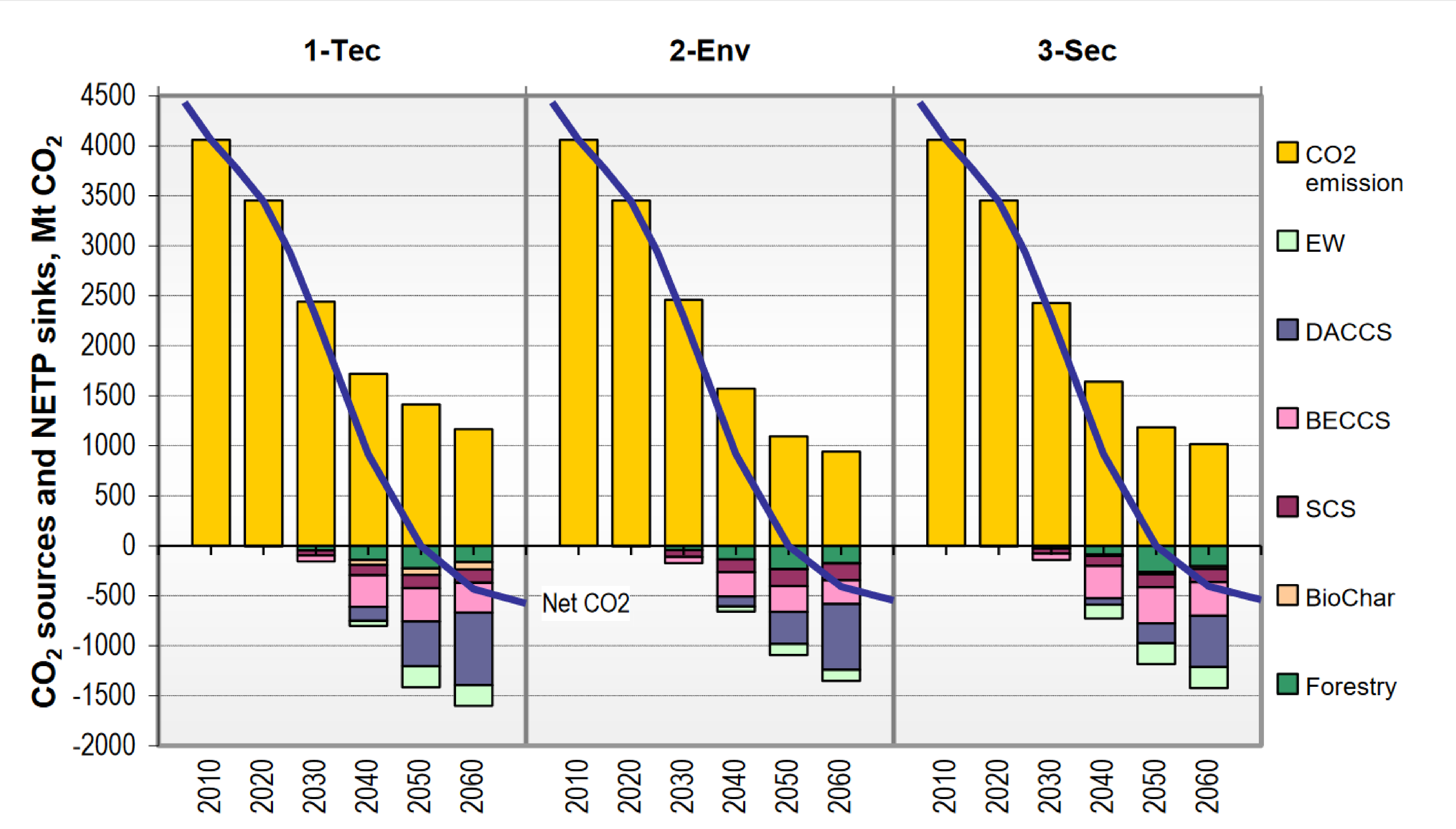
Target-based approach

Total EU CDR demand estimated at >1 Gt yr^{-1} by 2050.

A portfolio is needed to balance energy supply and demand systemically.

EU-31 NEGEM scenarios



Source: Lehtilä et al. 2023, Quantitative assessments of NEGEM scenarios with TIMES-VTT (D8.2)

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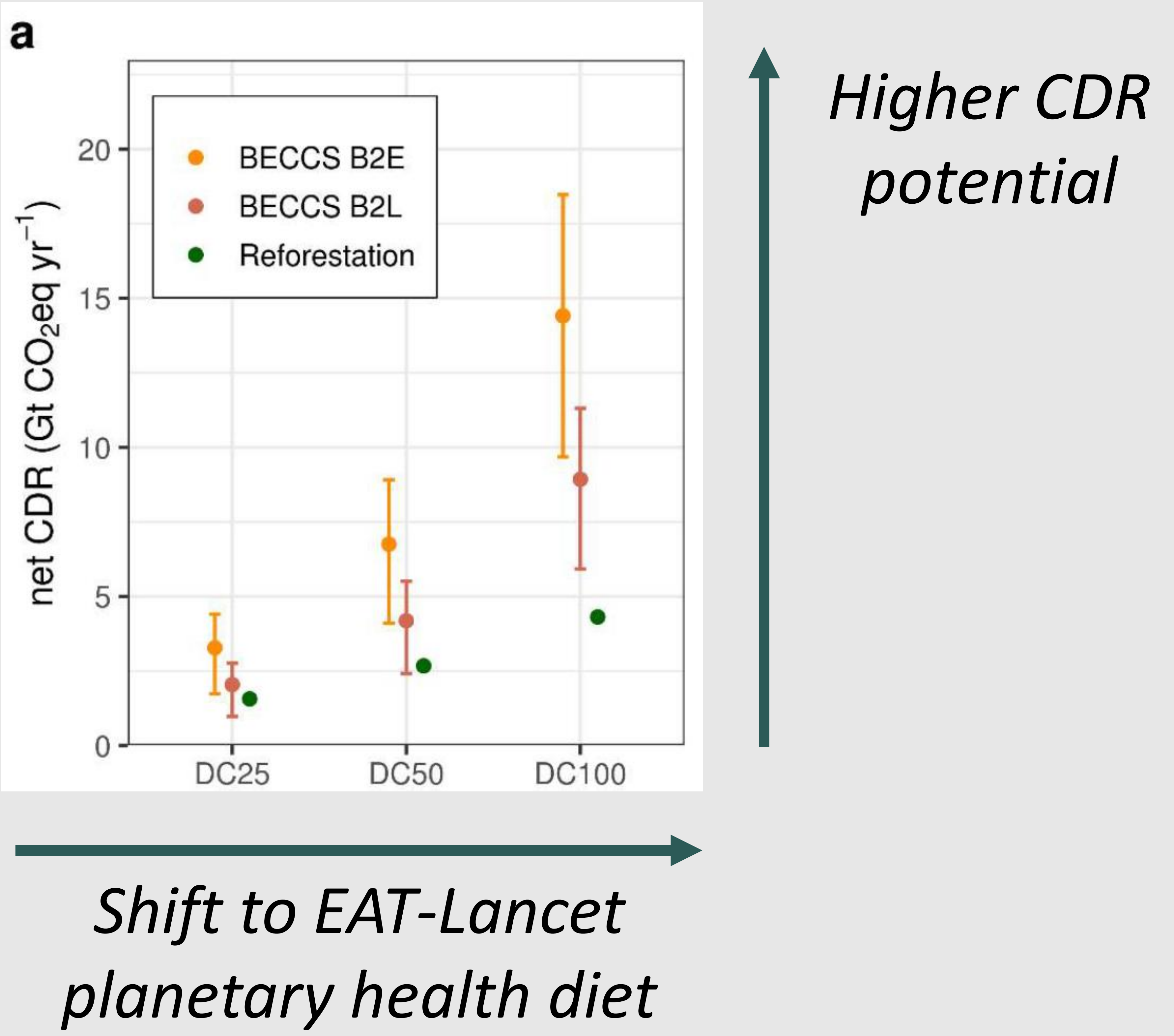
Supply-constrained approach

Biomass-dependent CDR potentials depend on large-scale dietary change.

Reforestation has lower CDR potential but higher potential co-benefits (e.g. enhancing biodiversity).



Source: Werner et al. 2023, "Global assessment of NETP impacts utilising concepts of biosphere integrity" (D3.3)

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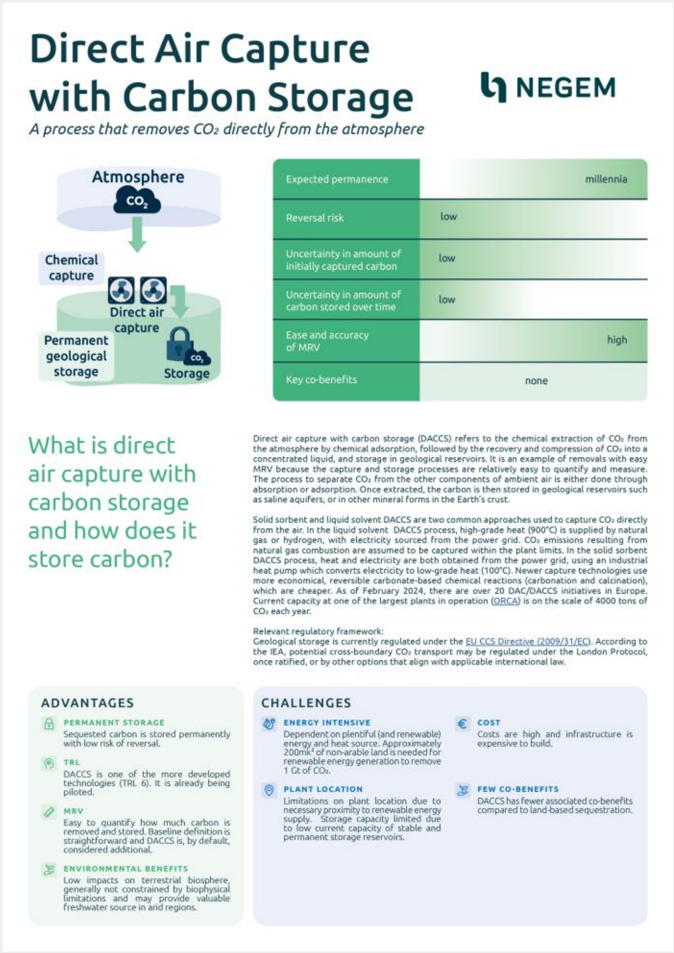
There is no silver bullet: all CDR methods have trade-offs

CDR handbook and factsheets



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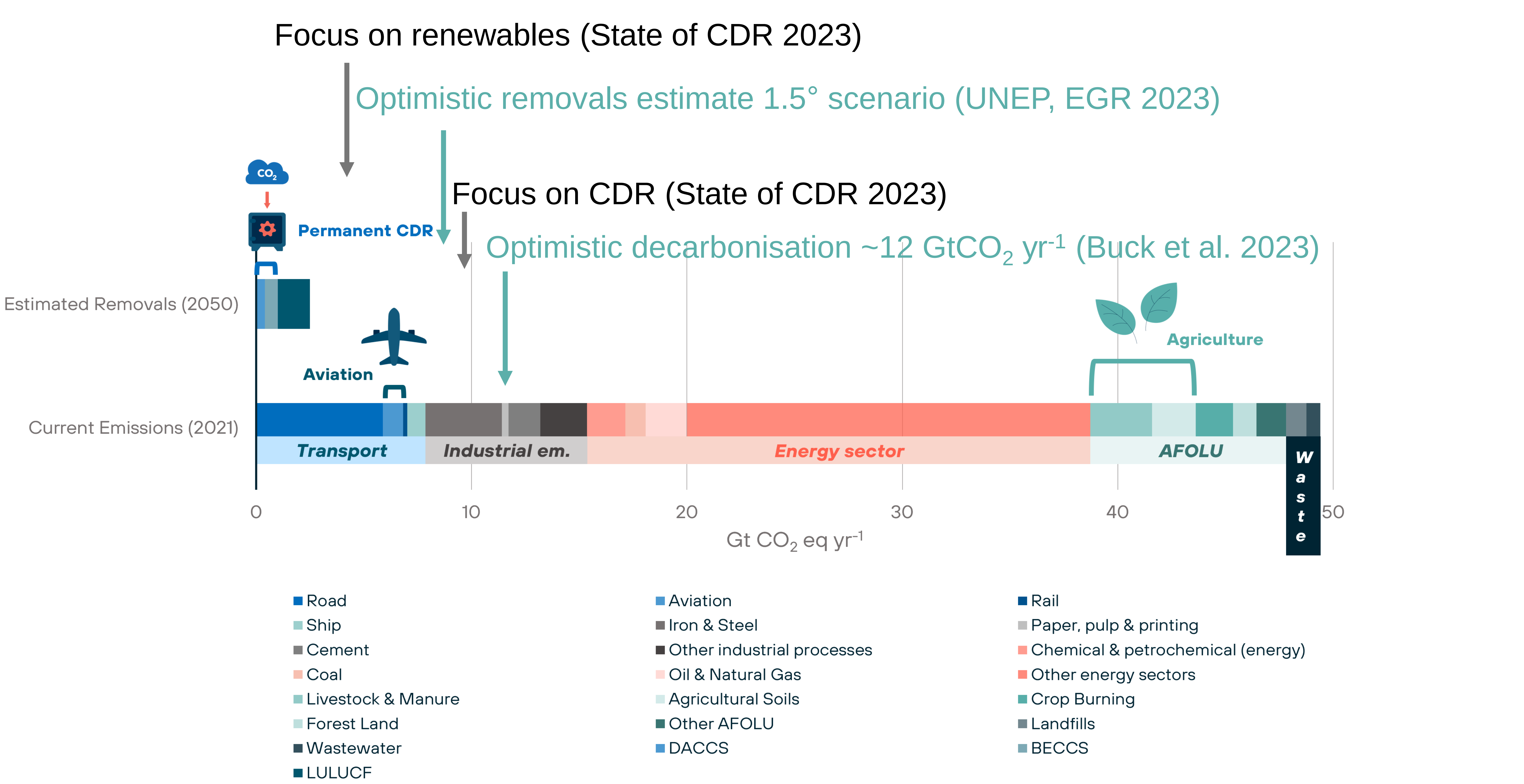
We need to manage expectations on the future role of CDR in climate policy.



Emissions data from "Our World in Data", modified from Paul et al. 2023, "Who should use NETPs?" (D6.5)

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Recommendations for climate policy frameworks

Adopt a robust definition for CDR (4 principles).

Create separate targets and governance frameworks for emission reductions, permanent CDR and land-based sequestration. CDR must be **supplementary** to fast and deep emissions reduction.

Limit dependence on CDR, based on a supply-driven approach and to match residual emissions.

Accurately and comprehensively account for real removals and consider variable timescales of carbon removals.

Adopt a holistic perspective on Earth system stability, respecting Planetary Boundaries. Policies integrate climate stabilisation and biosphere stewardship to account for their equally fundamental role in supporting Earth system resilience.

Principles should be included in the **EU 2040 target** and **NDC** for international replication.

See more in "*CDR Handbook for Policymakers*".

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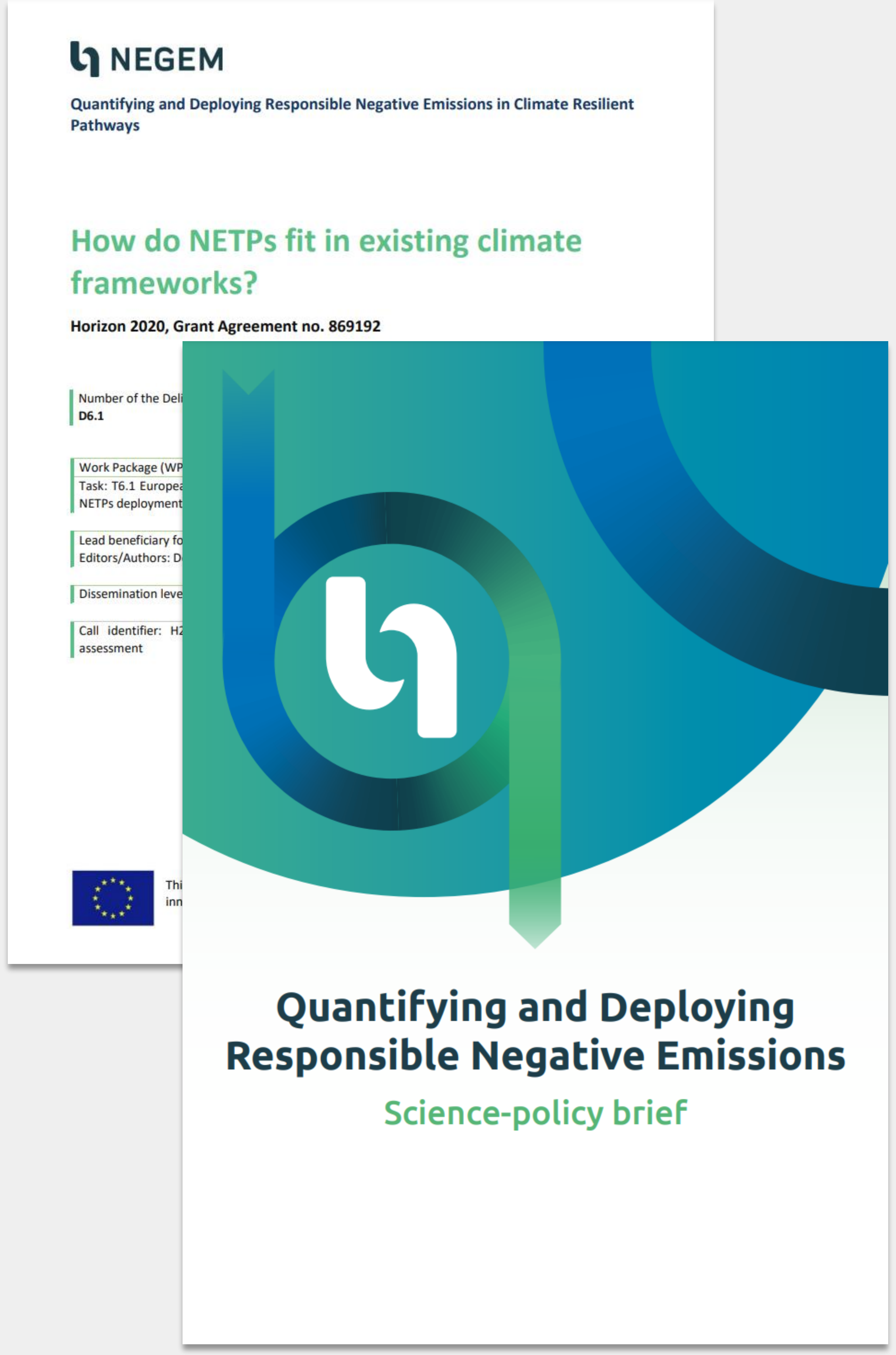
How should CDR be integrated into climate policy?

- **Supplement emissions reduction**, which remains critical
  - Lower net emissions in the near term
  - Counterbalance residual for climate neutrality
  - Reach net negative
- If used to replace or slow decarbonisation, it creates **mitigation deterrence**
  - Current reality in many policy frameworks
  - Inclusion of CDR in offsetting mechanisms
- CDR is **not equivalent** to emissions reductions
  - Cannot undo the damage of emissions
  - Potential risks and impacts associated



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European Climate Law – CDR in EU climate targets

Current state of play

Net 55% reductions by 2030

- ~52% emission reductions
- LULUCF contribution capped at -225MtCO_2e
- LULUCF target is -310MtCO_2e
- De facto target of ~57% net reductions

Climate neutrality by 2050

- Balance between GHG emissions and CO_2 removal
- Aim for net-negative thereafter

Communication on 2040 target

- Net 90% emission reductions

Recommendations

Clarify definition of 'climate neutrality'

- Recognise CO_2 neutrality comes before GHG neutrality
- Identify residual GHG emissions
- Minimise dependence on CDR
- Ensure CO_2 is counterbalanced only with permanent CDR
- Identify counterbalancing options for non-CO_2 emissions

Set out separate pathways for carbon removal

- Ambitious target for emission reductions
  - Approx 95% of effort
- Restoration of the land sink for its own merits
  - Sequestration as a co-benefit
- Realistic target for permanent CDR
  - Strong signal which doesn't undermine reductions

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Carbon Removal (Carbon Farming and Carbon Storage in Products) Certification Framework

Current state of play

Adopted

Separate categories of activities

- Carbon Farming
- Carbon Storage in Products
- **Permanent Carbon Removal**

Expert Group on Carbon Removals

- Technical Assessment Papers on DACCS/BioCCS
- Exploratory work on biochar

Geared specifically towards carbon crediting

- Unclear role in climate policy

Recommendations

Clarify the different roles of the different activities

- Only permanent CDR can be used for counterbalancing
- Temporary carbon sequestration as a co-benefit

Ensure methodologies accurately quantify net carbon flows

- All emissions resulting from an activity should be included
- Electricity for DACCS should be additional

Ensure methodologies can be used beyond carbon crediting

- Primary aim of methodologies should be to count net carbon flows
- Improve national GHG inventories and activity-based incentives/subsidies
- Carbon crediting approach should not be priority

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EU Emission Trading System

Current state of play

Commission to explore options by July 2026

By 31 July 2026, the Commission shall report to the European Parliament and to the Council on the following, accompanied, where appropriate, by a legislative proposal and impact assessment:

(a) how negative emissions resulting from greenhouse gases that are removed from the atmosphere and safely and permanently stored could be accounted for and how these negative emissions could be covered by emissions trading, if appropriate, including a clear scope and strict criteria and safeguards to ensure that such removals are not offsetting necessary emissions reductions in accordance with Union climate targets as laid down in Regulation (EU) 2021/1119;

Recommendations

Don't rush it!

Consider physical and social credibility issues

- Respect resource constraints and limits to CDR deployment potential
- Ensure accurate climate outcomes
- Avoid fungibility between reductions and removals
- Ensure climate neutrality is met at Union-level, not only at level of individual operators

Pooling and use of portion of ETS revenues may be better

Explore full suite of financing options for CDR

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