NEGEM

Quantifying and Deploying Responsible Negative Emissions – Views and preliminary results from NEGEM project

June 5th, 2023
EUBCE NEGEM workshop

Kati Koponen
VTT Technical Research Centre of Finland

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

NEGEM Consortium

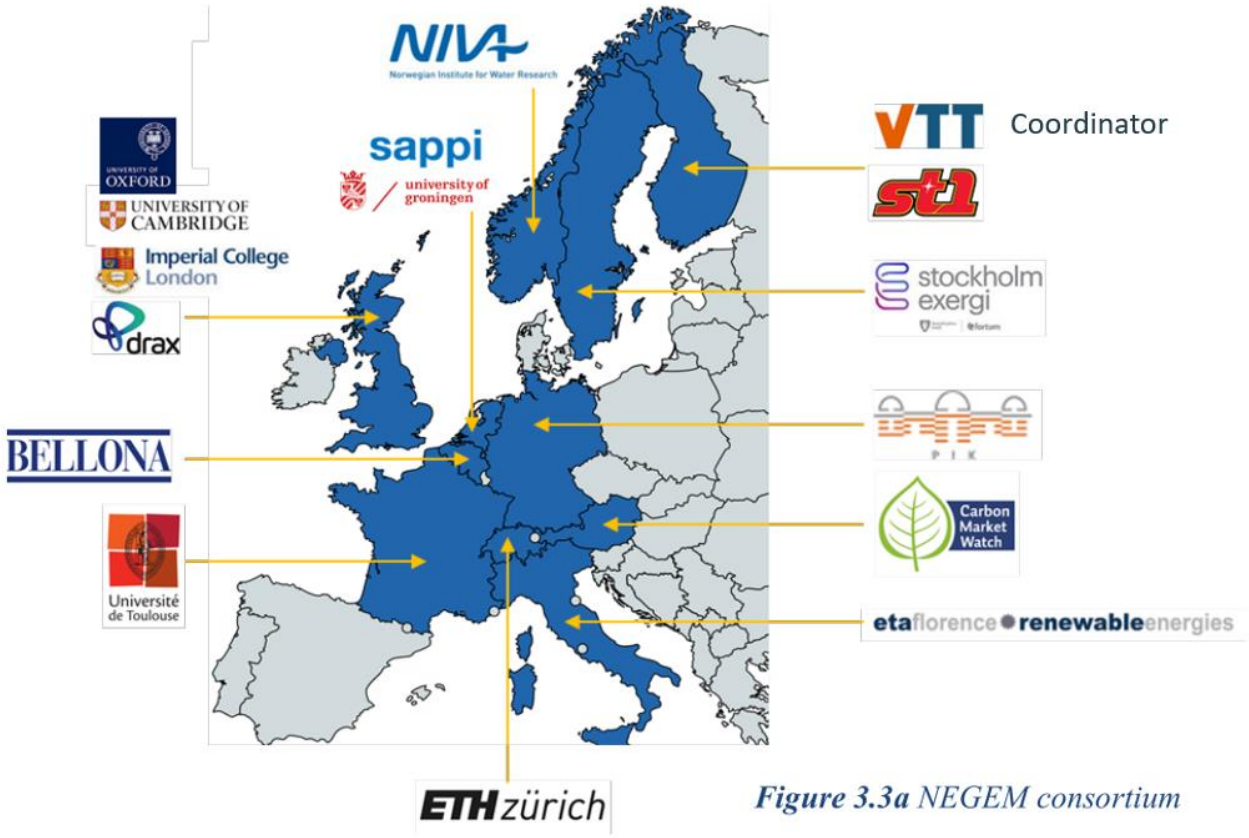


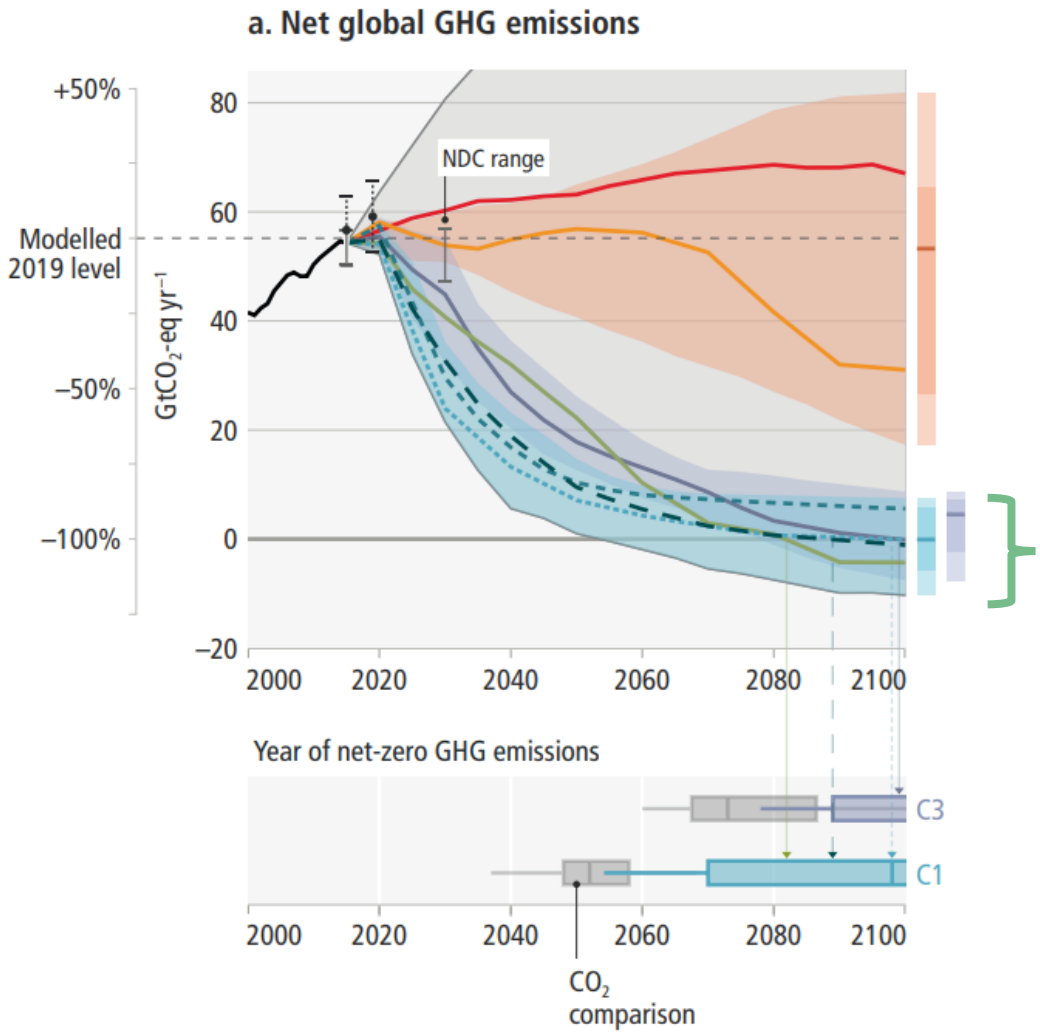
Figure 3.3a NEGEM consortium

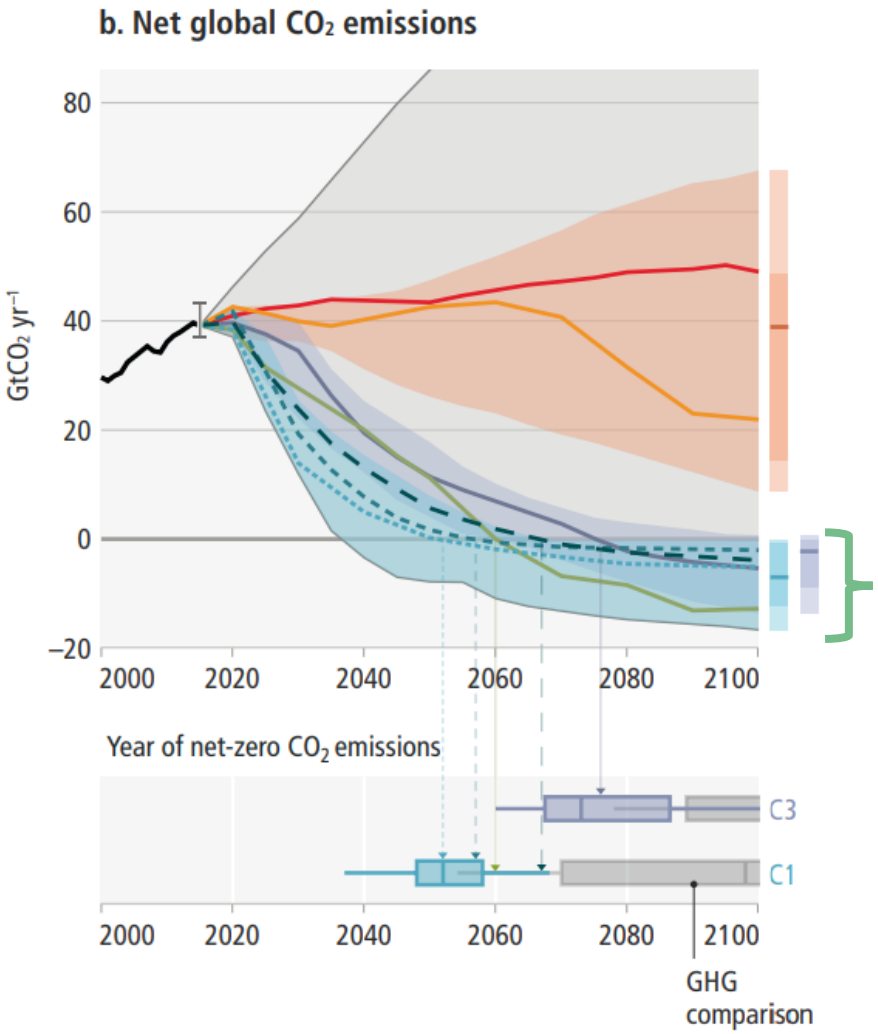
- 16 partners
- 11 countries
- 6 universities
- 3 RTOs
- 2 NGOs
- 5 industrial

H2020 Project
Duration: June 2020 - May 2024

First face to face meeting at VTT, Finland October 2022

Keeping global warming below 1.5-2°C requires drastic emission reductions -
In addition, carbon dioxide removals are needed to counterbalance residual emissions





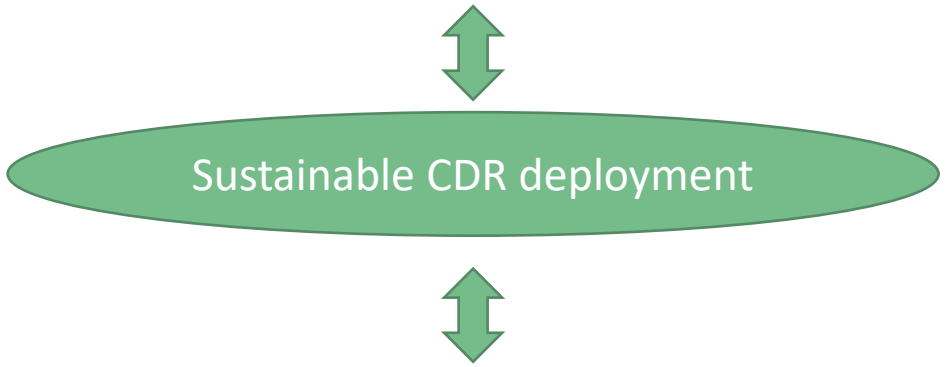
Limit warming to 1.5-2°C

Source: IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.
doi: 10.1017/9781009157926.001

Research gap: Amount of carbon dioxide removal (CDR) in mitigation scenarios is demand based → The objective of NEGEM is to analyse the realistic potential

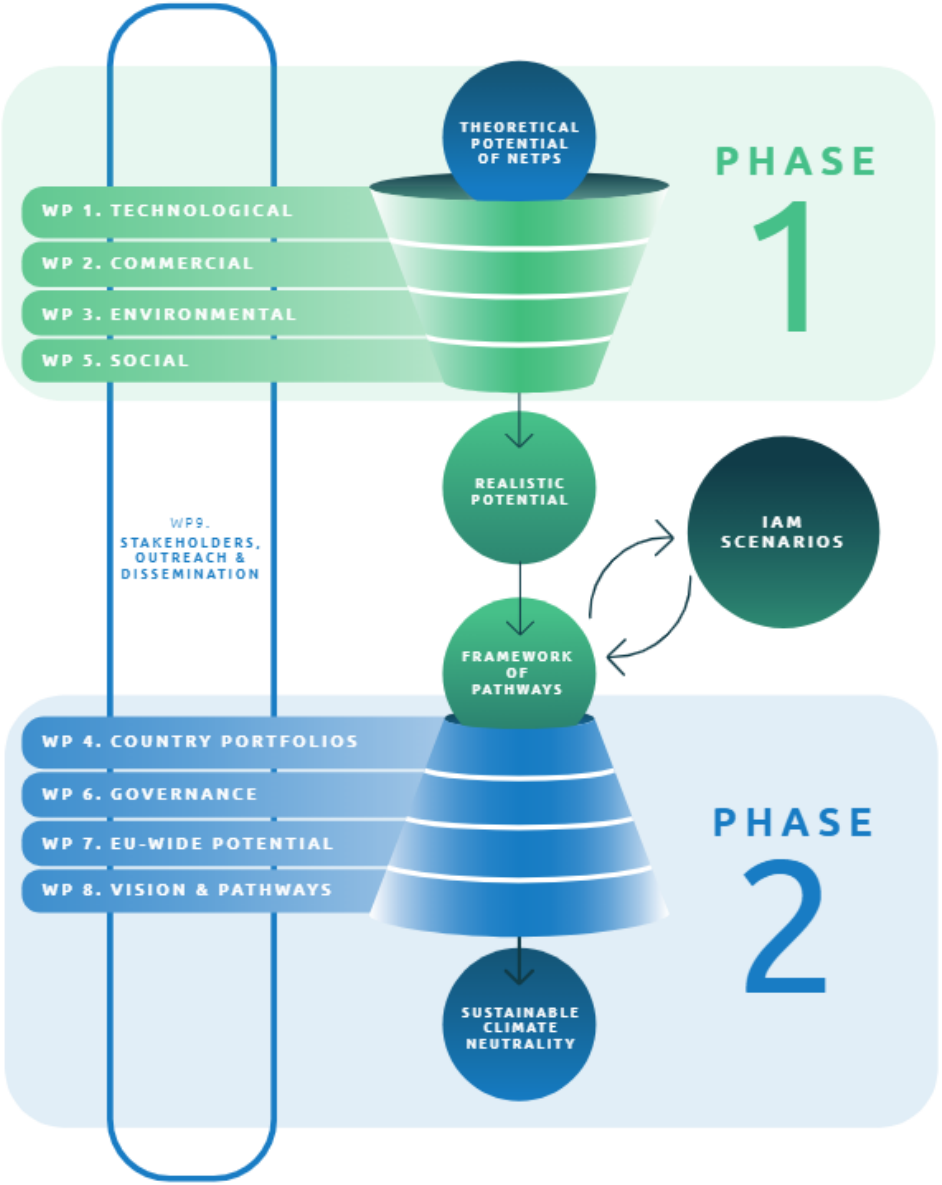
What is the realistic potential for CDR?

- Technological parameters
- Planetary and regional boundaries
- Costs, opportunities and risks
- Social acceptance, uptake and political feasibility

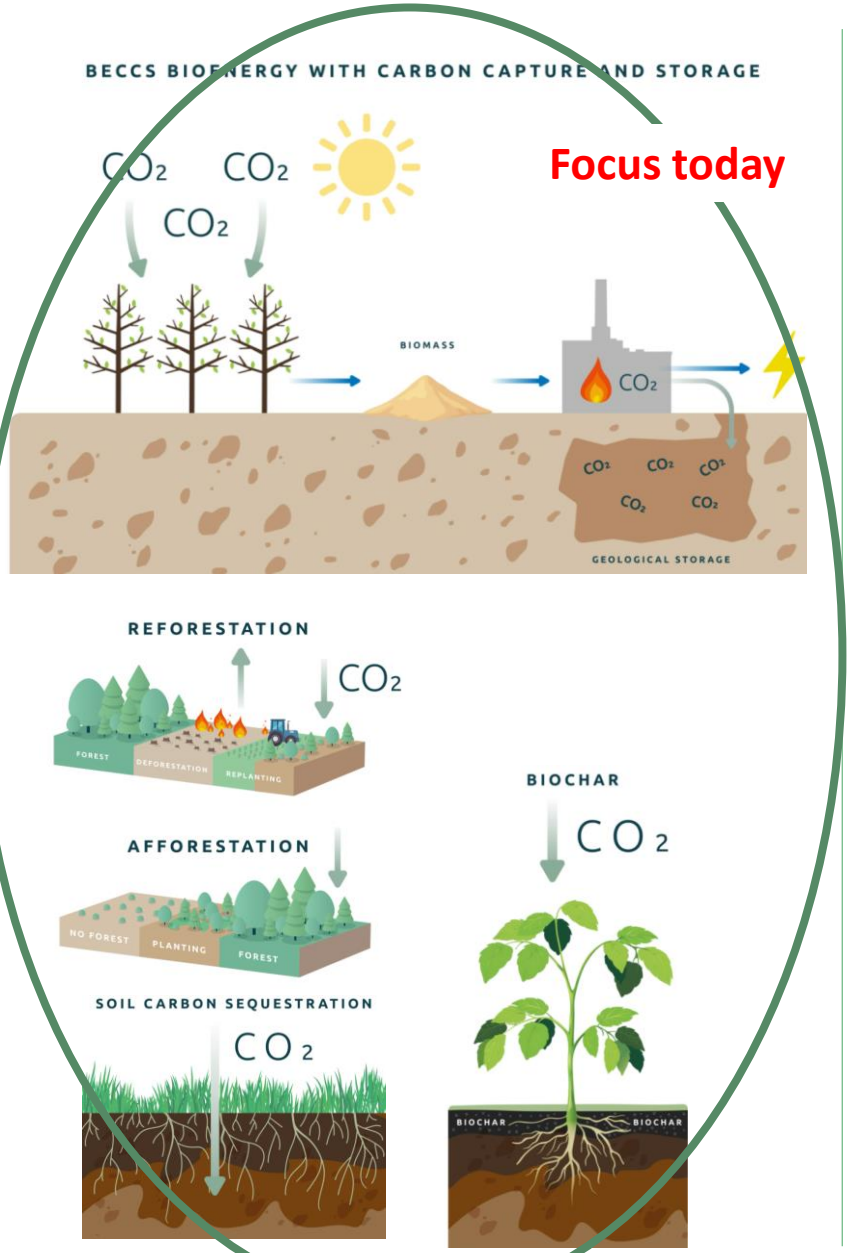


How do we meet the realistic potential for CDR?

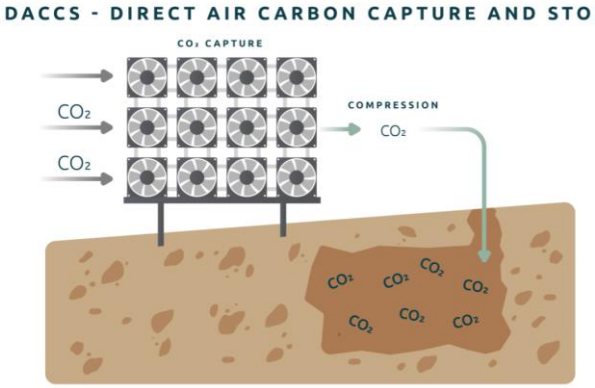
- Country portfolios, EU-wide potentials
- Enabling governance frameworks

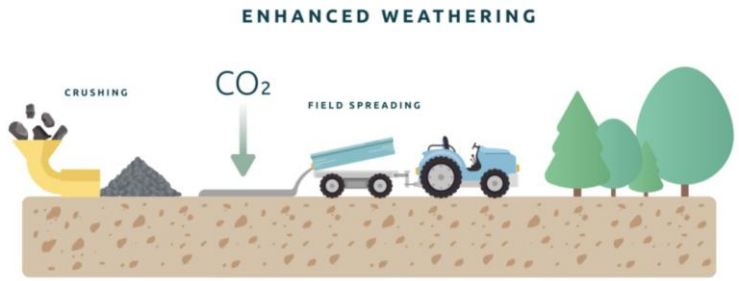


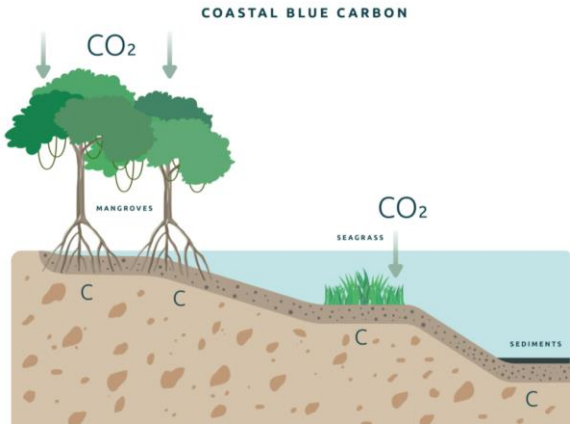
Carbon dioxide removal (CDR) can be done in many ways



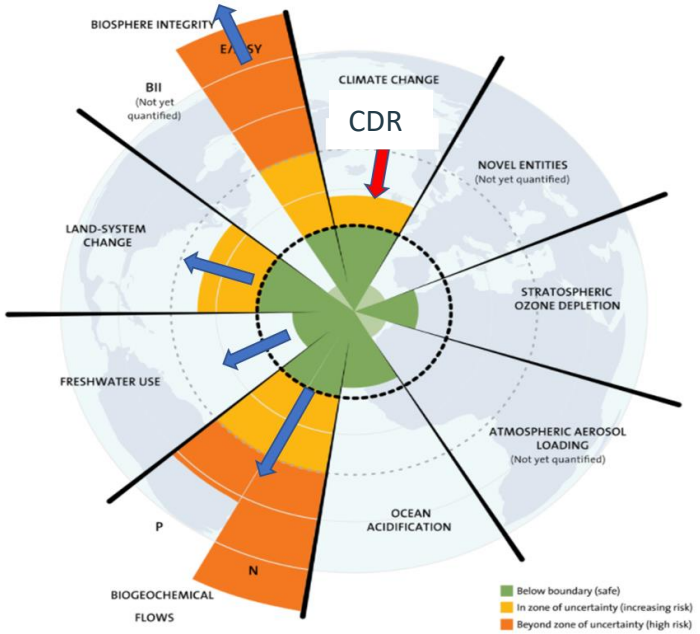
Focus today





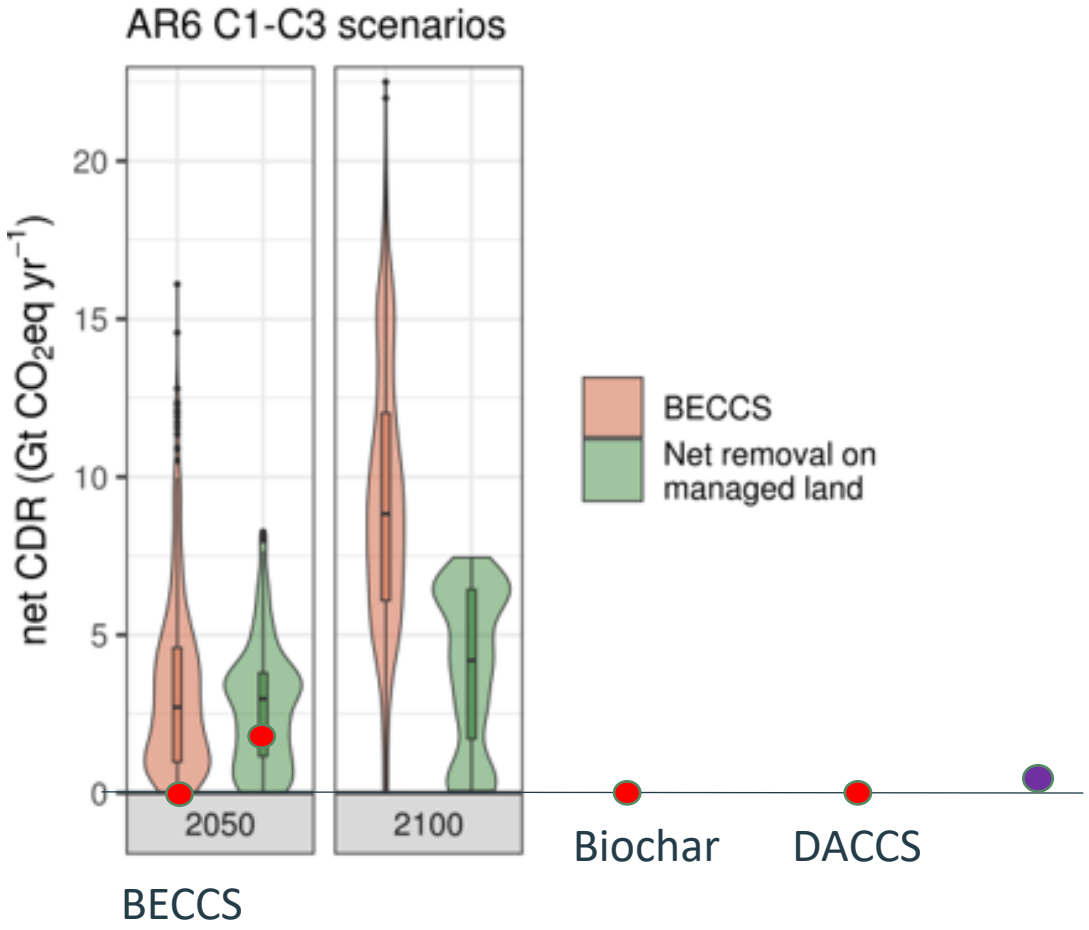


CDR needed to ensure the planetary boundary for climate



CDR measures may put pressure on other planetary / regional boundaries

Biomass-based carbon dioxide removals in IPCC AR6 scenarios in 2050 and 2100 vs. current CDR deployment



- **Current CDR approximately:**
  - BECCS 1.8 **$MtCO_2$/yr**
  - Traditional land management 2 $GtCO_2$/yr
  - Biochar 0.5 **$MtCO_2$/yr**
  - DACCS 0.01 **$MtCO_2$/yr** (1 **$MtCO_2$/yr** in construction)

Size of the voluntary carbon market 2020: ~100 $MtCO_2$

Figure adapted from NEGEM deliverable 3.7

Sources:

- Smith, S. et al. (2023). The State of Carbon Dioxide Removal - 1st Edition. doi:10.17605/OSF.IO/W3B4Z
- IEA. 2022b. Direct Air Capture, IEA, Paris. Available: https://www.iea.org/reports/direct-air-capture
- McKinsey 2021: https://www.mckinsey.com/capabilities/sustainability/our-insights/a-blueprint-for-scaling-voluntary-carbon-markets-to-meet-the-climate-challenge

Some key questions on biomass-based CDR

- How much land we have available for CDR & biomass production considering possible trade-offs with
  - Food production, and planetary boundaries e.g. for water and biosphere integrity

- How to do BECCS right?
  - Conversion to energy only with high efficiencies, e.g. CHP plants
  - Use of residues, cascading principle, bio-CCS: existing point-sources of biogenic CO_2, future biorefineries

- Potential of biochar and it's co-benefits?

- Nature-based carbon removals (re-/afforestation, soil carbon sequestration) can provide co-benefits but have also challenges
  - Risk of CO_2 release, long time frames for forest growth
  - Non-GHG impacts on climate, e.g. albedo

- Social licence to operate for different CDR solutions?
  - Acceptance of storing CO_2 on/off-shore
  - Acceptance of BECCS
  - Landscape impacts of reforestation, etc.

→ **NEGEM has approached these questions with various modelling tools & social analysis**

Side-effects and trade-offs:

NEGEM LCA for a full set of CDR methods:

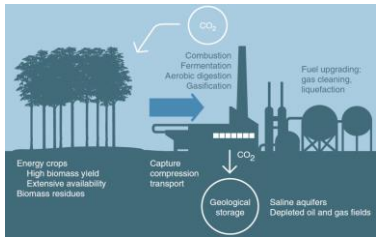
Afforestation, reforestation, HWP, biochar (BC)

Harvested wood products (HWP): oriented strand board production (OSB), glulam production (GLU)

Marine NETPs

Marine: macroalgae farming and sinking (AL), ocean liming (OL), coastal enhanced weathering (CEW)

BECCS

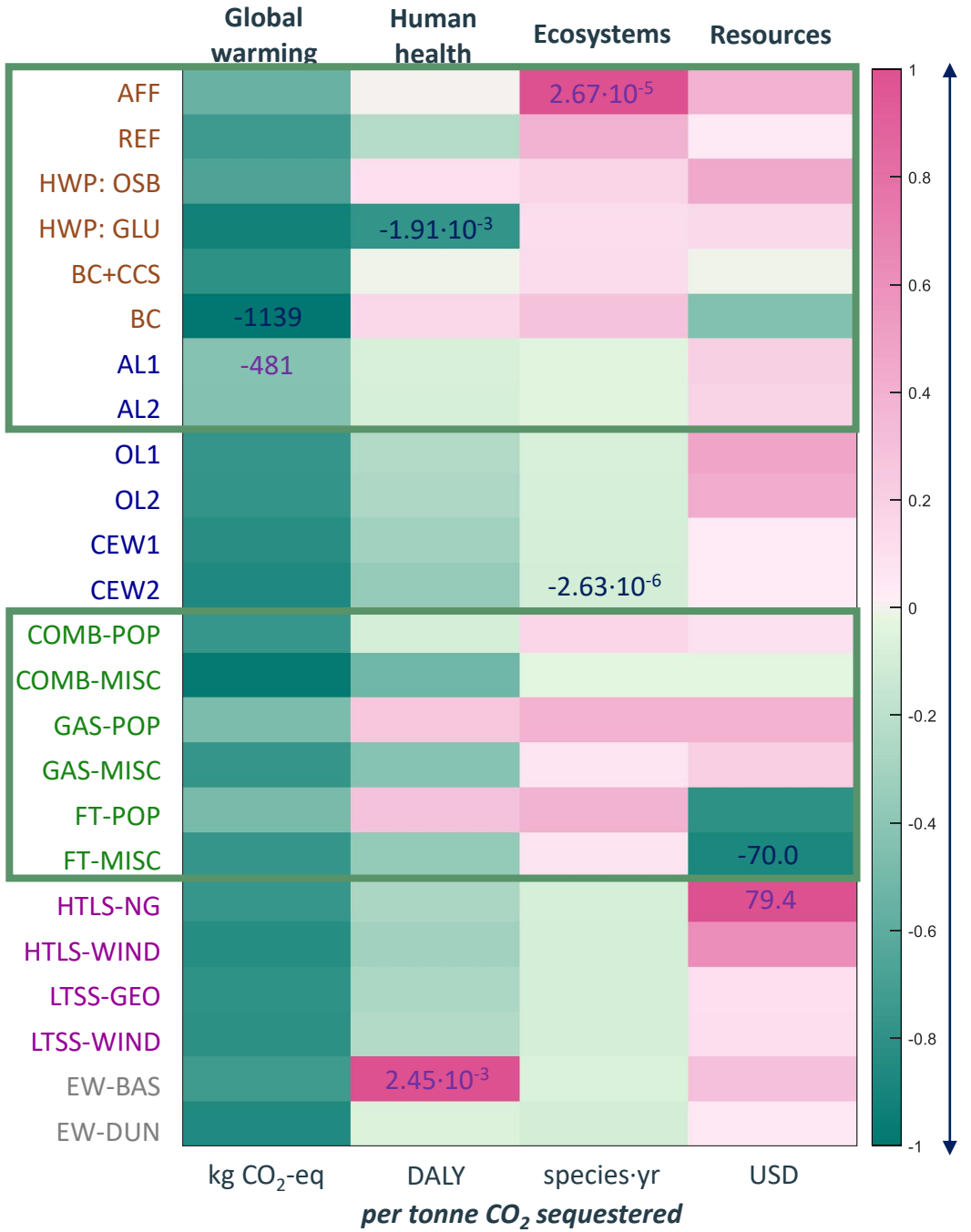


BECCS: combustion for elect. (COMB), gasification for hydrogen (GAS), Fischer-Tropsch to syncrude (FT)

DACCS

DACCS: High Temperature Liquid Sorbent powered by natural gas or wind (HTLS-NG or HTLS-WIND), Low Temperature Solid Sorbent using geothermal or wind energy (LTSS-GEO or LTSS-WIND)

Enhanced weathering (basalt or dunite)



Net additional impacts

Net prevented impacts

ETH zürich

More results:

Cobo et al. 2023. Sustainable scale-up of negative emissions technologies and practices: where to focus
DOI 10.1088/1748-9326/acacb3

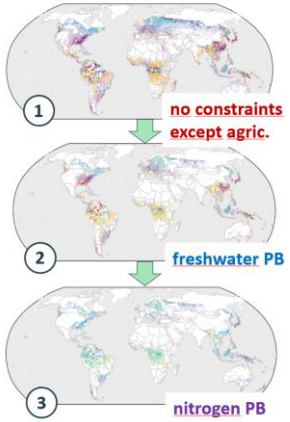
Cobo et al. 2022. Human and planetary health implications of negative emissions technologies
https://www.nature.com/articles/s41467-022-30136-7

Modelling tools used in NEGEM

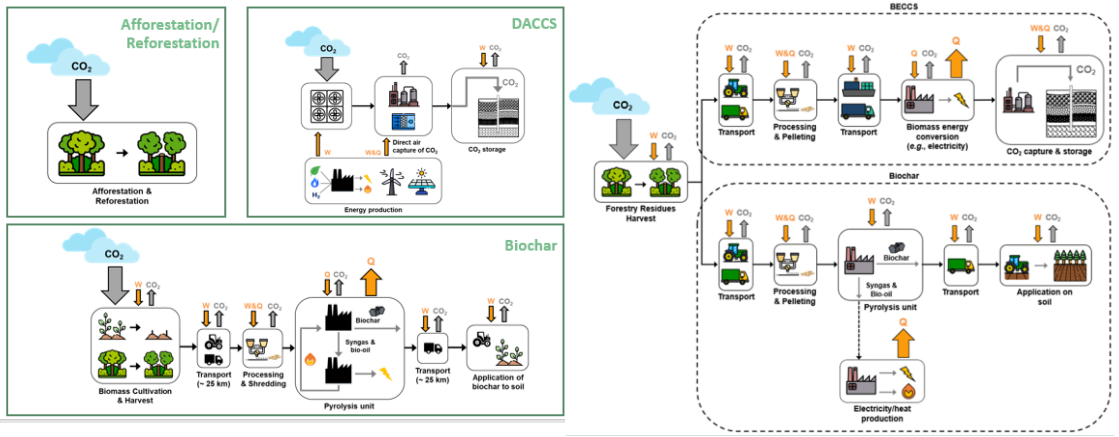
Supply-constrained analysis of CDR potentials within planetary boundaries

LPJmL

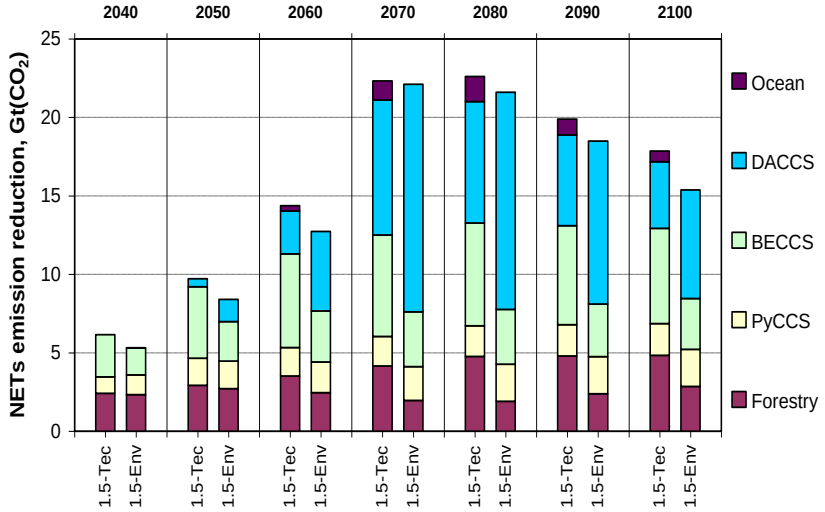
Biosphere Model



MONET-EU tool for cost-optimisation & CDR efficiencies



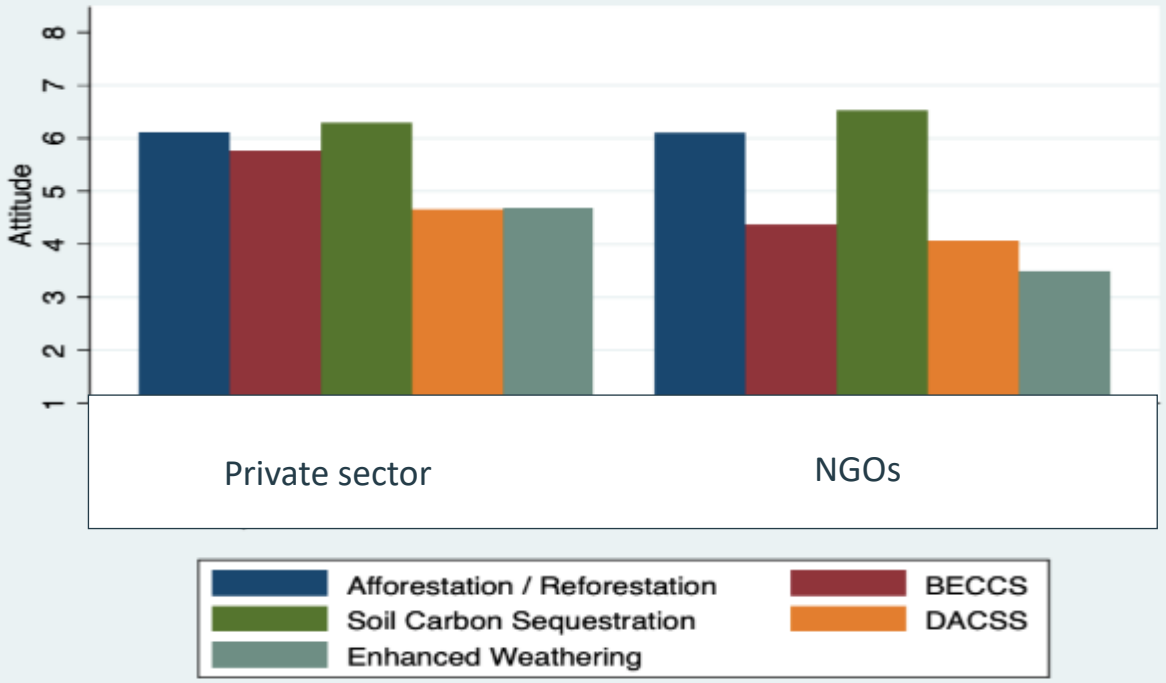
Modelling of NEGEM scenarios with varying storylines by TIMES-VTT (global & EU)



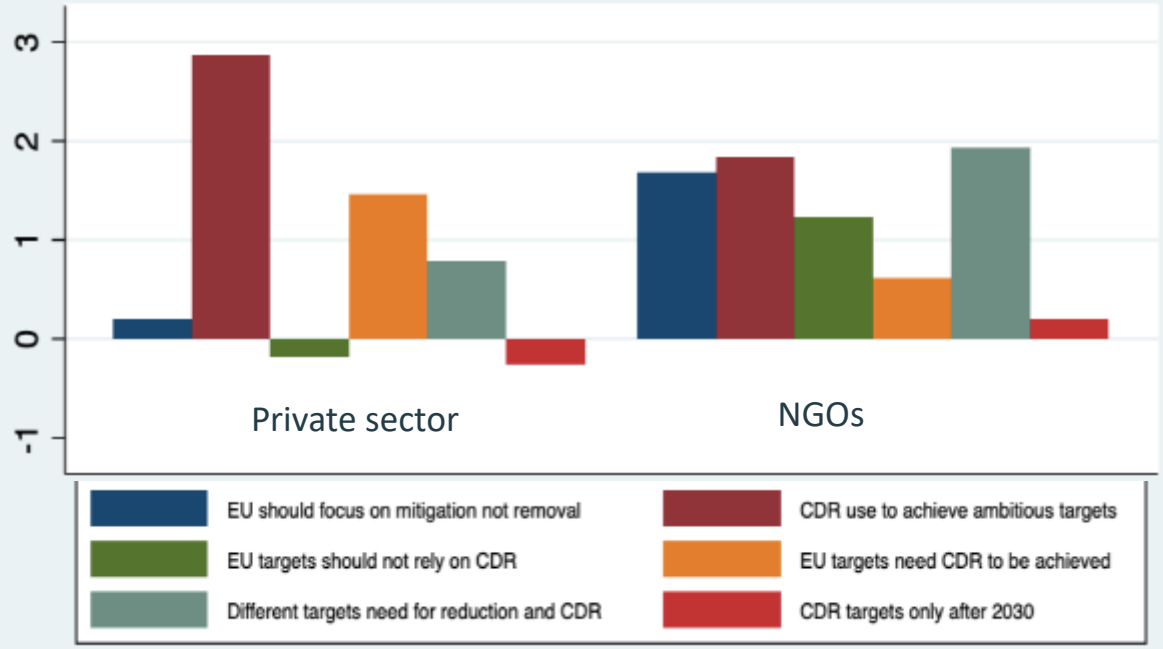
LCA data, Socio-political constraints, Market mechanisms & Expert elicitation

Social licence to operate: Stakeholder Perceptions

NETPs Attitude by Stakeholder Group



Policy attitudes



- NGOs have most favourable attitudes towards nature based solutions
- Private sector more in favour of also technological solutions

- Private sector sees the role of CDR more necessary to achieve EU climate targets
- NGOs more in favour of separate targets for emission reduction and removals

UNIVERSITY OF CAMBRIDGE

Source: NEGEM Deliverable 5.2 "Stakeholder Perceptions of NETPs" https://www.negemproject.eu/wp-content/uploads/2021/12/D-5.3-Stakeholder-views-on-NETP-governance.pdf

The final matched sample 86 respondents: 46 representatives of NGOs, and 40 representatives of the private sector

NEGEM conclusions on biomass-based CDR

- Biomass-based CDR methods have trade-offs → A portfolio of CDR methods needed to reduce the risks
  - NEGEM work continues for EU Member State portfolios
  - Co-operation between EU Members States is needed regarding biomass and CO_2 storage resources
- Global large-scale implementation of BECCS (as foreseen in IPCC scenarios) will require transformation of agricultural sector to free land for bioenergy-crops
  - In addition, new land management & cropping methods can provide solutions
  - BECCS from residues, and from biogenic CO_2 point-source emissions e.g., from pulp & paper industry and biorefineries
- It is important to understand the characteristics of different CDR methods to create efficient regulation
  - Nature based vs. technical solutions → Permanence of storage is a key question
- Nature based solutions can provide several co-benefits including positive impacts on biodiversity and soils
  - Need for instruments that allow taking advantage of the significant opportunities for nature-based climate solutions without undermining the case for investment in more permanent carbon storage solutions.

References:

NEGEM Deliverable 2.2 “Interactions and trade-offs between nature-based and engineered climate change solutions” https://www.negemproject.eu/wp-content/uploads/2021/11/D-2.2-Interactions-and-trade-offs-between-nature-based-and-engineered-climate-solutions.pdf

NEGEM Deliverable 3.2. “Global NETP biochemical potential and impact analysis constrained by interacting planetary boundaries”

https://www.negemproject.eu/wp-content/uploads/2023/05/D-3.2-Global-NETP-biogeochemical-potential.pdf

NEGEM deliverable 3.8 “Comparative life-cycle sustainability assessment of NETPs” https://www.negemproject.eu/wp-content/uploads/2023/04/D3.8-Comparative-sustainability-assessment-of-NETPs.pdf

NEGEM Deliverable 5.2 “Stakeholder Perceptions of NETPs” https://www.negemproject.eu/wp-content/uploads/2021/12/D-5.3-Stakeholder-views-on-NETP-governance.pdf

NEGEM Deliverable 8.6 “Quantitative assessments of NEGEM scenarios with TIMES-VTT, preliminary results” https://www.negemproject.eu/wp-content/uploads/2023/05/D8.6-Quantitative-assessments-of-NEGEM-scenarios-with-TIMES-VTT-preliminary-results.pdf

All NEGEM results: https://www.negemproject.eu/results/

Learn more at NEGEM website

https://www.negemproject.eu/

Coordinator contact: kati.koponen@vtt.fi