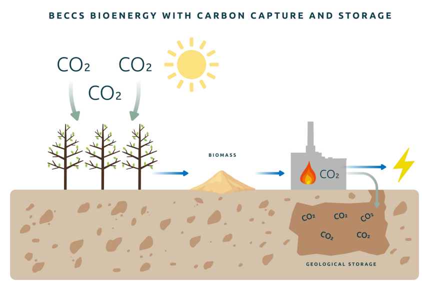
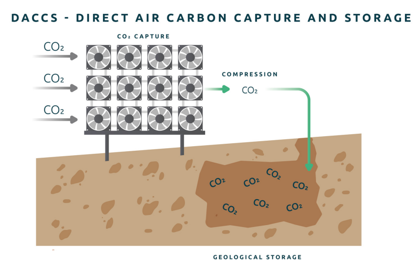
NEGEM Quantifying and Deploying Responsible Negative Emissions in Climate Resilient Pathways

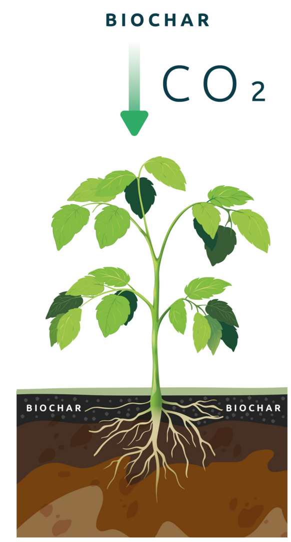
CARBON DIOXIDE REMOVALS

Regulation and accounting

In addition to drastic greenhouse gas (GHG) emission reductions, carbon dioxide removal (CDR) or "negative emissions" will be needed to ensure stabilization of climate to 1.5-2 °C warming (IPCC AR6).
CDR can be accomplished by technology or nature-based measures. Different CDR methods provide varying storage permanencies and vulnerabilities to reversals. Storage times vary from permanent geological carbon dioxide storage to short or medium term biomass/soil carbon storages.
Current global and EU climate regulations do not yet fully recognize the varying CDR measures and their specific features. The EU is currently working on policy initiatives and related legislative proposals in the field of **carbon removals**.







Main gaps in regulation and policy recommendations

Separate targets for reductions and removals

CDR is needed in addition to all possible mitigation measures, it cannot replace them. **Separate targets are needed** to avoid undermining urgent emission reduction.

Storage permanence

Regulations should recognize the question of storage permanence. **Only permanent removals can compensate for permanent climate impacts** of residual fossil emissions and non-carbon dioxide greenhouse gases.
Despite their low cost and potential co-benefits, nature-based carbon removal cannot effectively offset continued fossil fuel use, due to their high risk of reversal and potential for indirect carbon leakage.
Policy must be designed to honestly account for the opportunities and trade-offs of nature-based CDR solutions without undermining the case for investment in more permanent carbon storage solutions. **Separate policy instruments are needed for nature-based and permanent CDR.**

Only real removals should be counted

A removal process must actually deliver net-negative emissions. The net emissions of a CDR technology are the amount of carbon dioxide physically removed from atmosphere and permanently stored minus all greenhouse gas emissions created throughout the full value chain. **Only when more atmospheric carbon dioxide is permanently stored than greenhouse gases are emitted does the system result in real removals** (i.e., net removals). Systemic perspective is needed, as CDR methods impact many sectors (energy, forestry, agriculture).

Regulations should guarantee compliance of CDR with planetary boundaries

Large scale CDR measures can put pressures on several planetary boundaries, such as fresh water, land system change, and biosphere integrity.

Cross-border issues concerning carbon dioxide transport and storage need to be solved

Co-operation between EU Member States is needed for efficient CDR application.

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Key characteristics of selected CDR methods to be recognised in accounting

The accounting of CDR potential across the wide range of CDR methods can be complex, and several characteristics of the various CDR methods should be considered when planning for policy instruments.
In particular, the timing of associated emissions, and the monitorability of removals and storage can vary widely, as summarized below.

	CO_2		Emissions					Gap between extraction and storage	Ease of monitoring	Risk of leak
	extraction	storage	before extraction	during extraction	between extraction and storage	during storage	after storage			
BECCS	photosynthesis	geological	land use change, land preparation, harvesting	biomass decay, upkeep, ferilizers	harvest, transport processing, CO_2 compression, energy losses	energy use, injection losses	leakage (low risk)	yes, requires biomass transport, conversion, transport and injection	high	low
DACCS	chemical	geological	building and site preparation	fans, CO_2capture	CO_2 capture, compression, energy use, transport losses	energy use, injection losses	leakage (low risk)	yes, requires biomass transport, conversion, transport and injection	high	low
Afforestation	photosynthesis	standing biomass	land use change, land preparation	forest upkeep, biomass decay	n.a	Upkeep, biomass decay, monitoring	Release from wildfires, forests, deseases (high risk)	no	medium	high
Enhanced weathering	chemical	dissolved minerals that flow into soil and aquifers	mining, grinding, transport, spreading	n.a.	n.a	n.a.	n.a.	no, although speed of extraction is low	low	low,uncertain
Biochar	photosynthesis	char product of pyrolysis	land use change, land preparation, harvesting	biomass decay, upkeep, fertilizers	transport, processing, pyrolysis, repurposing	spreading, biochar decay	biochar decay	yes, requires biomass transport, conversion, transport and injection	low	medium

References

D2.2 Interactions and tradeoffs between nature-based and engineered climate solutions
D6.2 Principles for carbon negative accounting
D6.3 Global governance of NETPs global supply chains and coherent accounting

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