mCDR an emerging field and its actors

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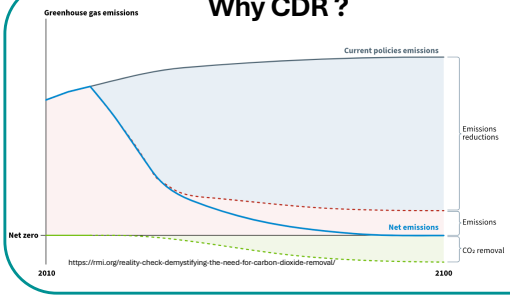
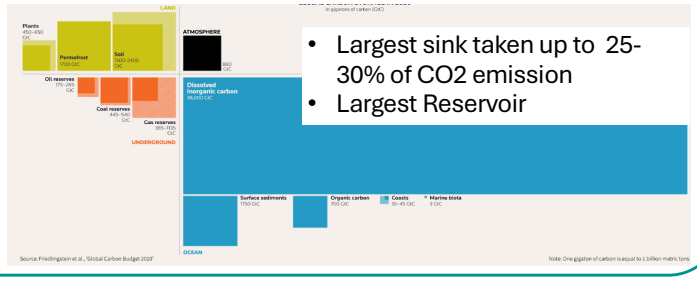
Marine Carbon Dioxide Removal (mCDR) refers to various techniques aimed at capturing and storing CO_2 from the atmosphere through ocean-based processes.

Why CDR ?



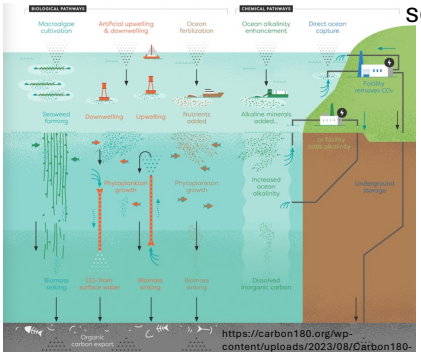
According to IPCC, CDR is needed in all scenarios pathway to limit global warming below 1.5°C to achieve net-zero emissions

Why the Ocean ?



- Largest sink taken up to 25-30% of CO2 emission
- Largest Reservoir

mCDR technology



https://carbon180.org/wp-content/uploads/2023/08/Carbon180-DependingOnTheOcean.pdf

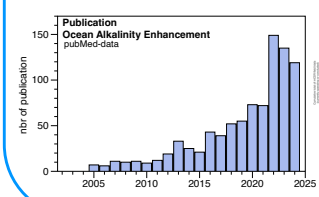
CDR Methods are evaluated on several success metrics

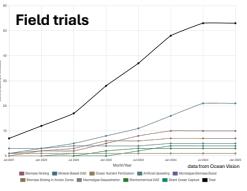
1. Technological readiness level
2. The sequestration efficiency "the additionality of the CO2 removed"
3. The durability of storage and risk of "leakage"
4. scalability
5. cost per ton of removal

CDR may have **environmental co-benefits and risks associated with their infrastructure or operation, which require equal consideration in evaluating their potential**

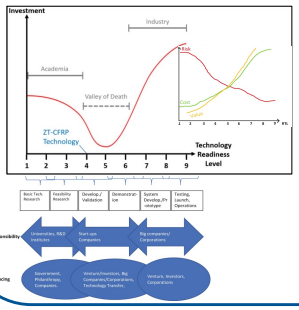
mCDR an emerging field

Agency	Program	Millions ($)
US Department of Energy's (DOE)	SEA-CO2	36
US NOAA		24
EU H2020	OceanNet	7
EU H2020	Ocean artUp	2.5
EU H2020	SeaO2 CDR	4.5
Germany federal ministry of education	CDRmare	27
UK Research and Innovation (UK RI)		43.1



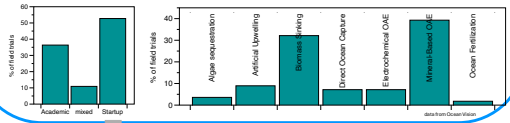


Technology Readiness Level



	Technological Readiness	Estimated Cost ($ / tCO₂ removal)	Scale Potential (Gt CO₂ / yr)	Duration of Storage (years)
Alkalinity Enhancement [2,14,17]	Low - Moderate	Low - Moderate ($25 - $160)	Moderate - High (1 - 15+)	High (>20,000)
Macroalgal Cultivation [2,3,14,15,16]	Moderate	Low - Moderate ($25 - $125)	Low (0.1 - 0.6)	Low - Moderate (10 - 100)
Direct Ocean Removal [14,17,18]	Low - Moderate	High ($400 - $600)	Moderate (1 - 10)	High, using geologic storage (> 1000 Years)
Ocean Fertilization [2,14,19]	Moderate	Low - Moderate ($50 - $125)	Low - Moderate (0.1 - 1+)	Low - Moderate (10 - 100)
Artificial Upwelling / Downwelling [4]	Low	Moderate ($100 - $150)	Low (0.1 - 1)	Low - Moderate (10 - 100)

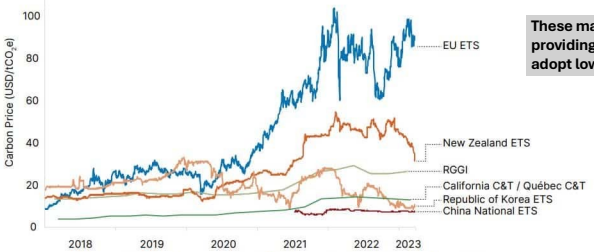
mCDR field trials



The carbon market

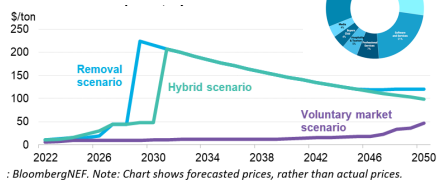
1.Compliance Market: Regulated by governments, this market requires companies to meet emission reduction targets, often within a cap-and-trade system. Companies that emit more than their allowance must buy credits, while those that emit less can sell excess credits.

2. Voluntary Market: allows companies, organizations, or individuals to buy carbon credits voluntarily to offset their emissions beyond regulatory requirements. These credits fund projects like reforestation, renewable energy, or emerging CDR



Data from World bank report , credit : https://carboncredits.com/carbon-pricing-understanding-the-economics-and-trends-of-fighting-climate-change/

These markets encourage emission reductions by providing financial incentives to develop and adopt low-carbon technologies



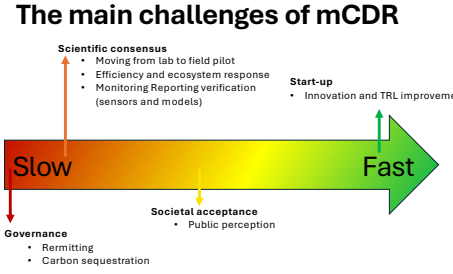
: BloombergNEF. Note: Chart shows forecasted prices, rather than actual prices.

CDR.fyi Top 10 Carbon Removal Purchasers

Ranked by total tonnage purchased

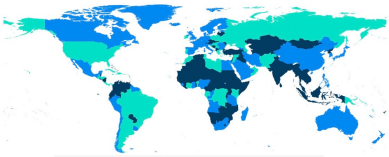
1	Microsoft	3,178,503
2	Airbus	400,000
3	Frontier Buyers	358,594
4	Amazon	250,000
5	NextGen	193,125
6	BCG	121,565
7	Shopify	87,516
8	JPMorgan Chase	63,822
9	Google	62,583
10	Boeing	62,000

The main challenges of mCDR



Example of Governance

On Marine Pollution by Dumping of Wastes

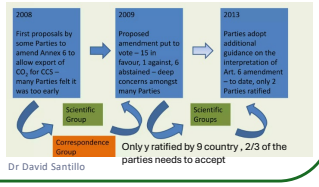


The London Protocol (LP) to the London Convention

Protocol parties | Convention parties | Non-parties

Map of Parties to the London Convention/Protocol (IMO, 2019).

- **1972** The London Convention allows all forms of marine dumping at the exception of blacklisted substances
- **1996-2006** The London Protocol allows 7 categories of waste to be dumped and prohibits all forms of marine dumping
  - **2009** amendment on CO2 flow stream for CCS
  - **2013** amendment for marine geoengineering (6 country)



Dr David Santillo