

# Marine Carbon Dioxide Removal

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# Marine carbon dioxide removal (mCDR) 101



*Priming ocean systems to capture and sequester CO<sub>2</sub> or using technology to extract CO<sub>2</sub> from seawater.*

# mCDR approaches



**Coastal blue carbon**



**Deep blue carbon**



# CDR options to achieve net zero



**34 minutes**



**24 seconds**



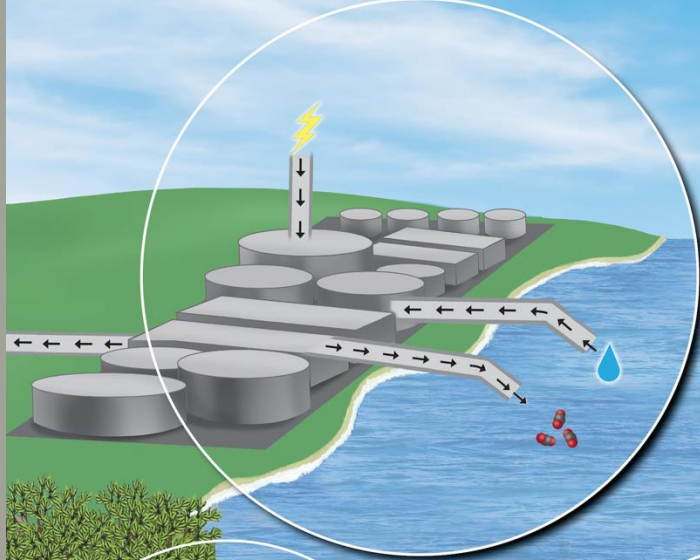
**8 seconds**



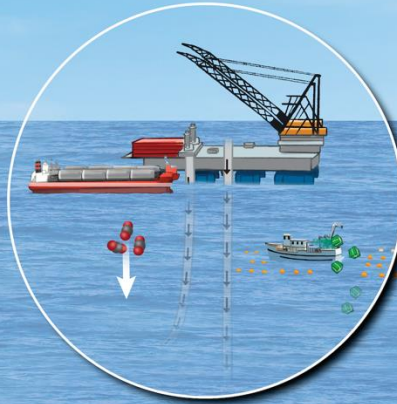
**3+ months**



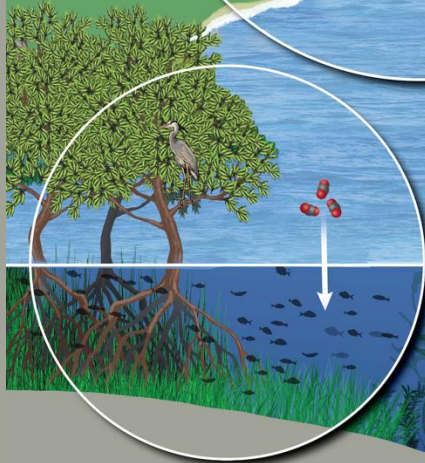
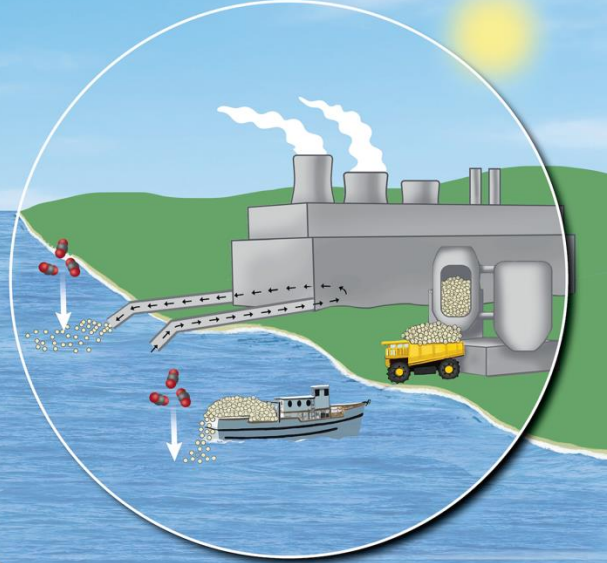
**ELECTROCHEMICAL OCEAN  
CARBON DIOXIDE REMOVAL**



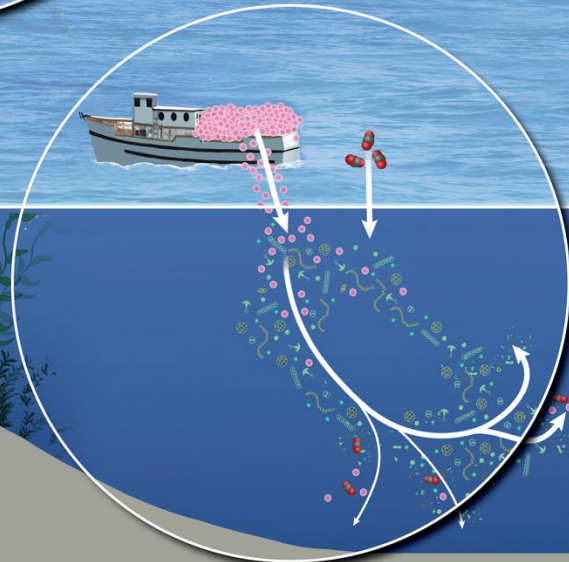
**DEEP SEA  
STORAGE**



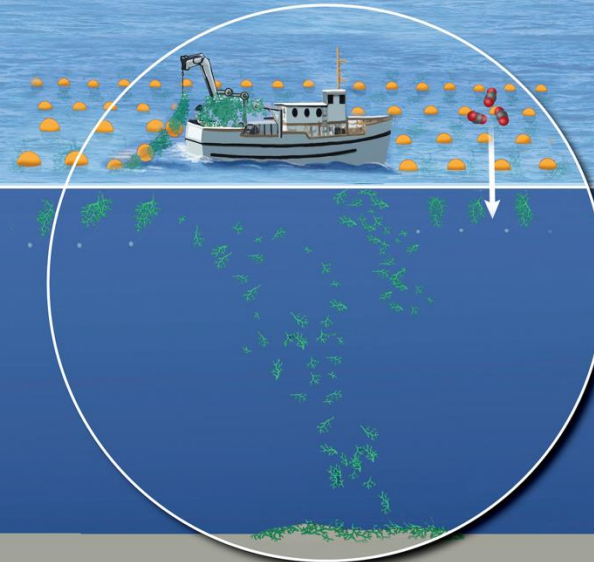
**OCEAN ALKALINITY  
ENHANCEMENT**



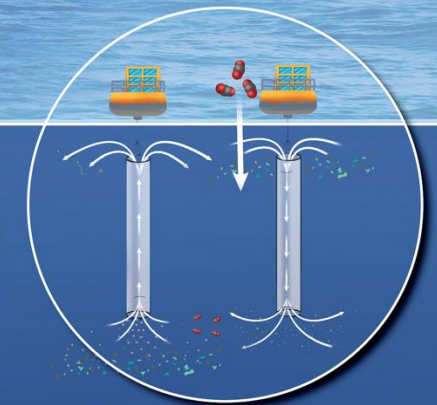
**RESTORING LIVING  
BLUE CARBON**



**MICROALGAE  
CULTIVATION**



**MACROALGAE  
CULTIVATION AND CARBON  
SEQUESTRATION**



**ARTIFICIAL  
UPWELLING AND  
DOWNWELLING**



# What is the state of play?

## Global mCDR removal opportunity

Conservative estimate:  
1 GT/year CO<sub>2</sub>

Optimistic estimate:  
multi-GT/year CO<sub>2</sub>

Durability 100 to >1000 years





# What is the state of play?

## Technology readiness levels:

Lab and small-scale field pilots

## State of deployment

Small-scale pilot @ coastal sites  
(~100 ton/year CO<sub>2</sub> removal, 2023)

Larger project aiming @ 1,000-  
(10,000 tonnes/year CO<sub>2</sub>, 2024)



# What is the state of play?

## Policies and regulations

- London Convention and London Protocol (open ocean)
  - Exception "for legitimate scientific research"
- Initial standards for mCDR in voluntary markets (Isometric)
- Some MRV conducted by individual projects
- Recent advances – documents in EU and US



\*Ocean Visions Field Trial Database  
[oceanvisions.org/mcdr-field-trials](https://oceanvisions.org/mcdr-field-trials)



# What is the state of play?

## Community responses:

No awareness



Not in my backyard

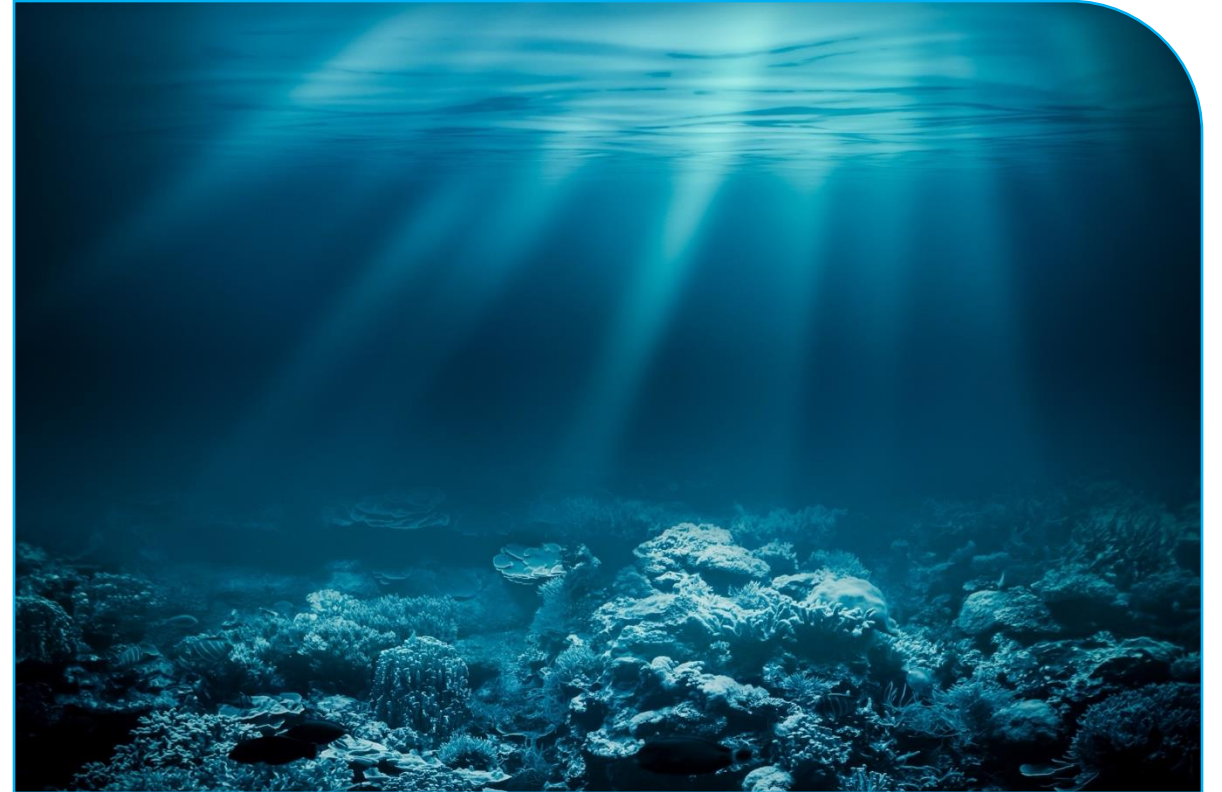


Awareness and acceptance



# Considerations for scale-up

- Changing scale of Oceanography
- Resolve process uncertainties for large-scale, low-impact, durable deployment
- Develop governance, standard and protocol frameworks
- Establish ocean baseline and MRV infrastructure





# Considerations for scaling

## **System dependencies:**

Policy & regulatory framework

## **Unintended consequences:**

Unknown ecological impacts

## **Example:**

Environmental justice



# Considerations for scaling

## Enablers + game changers:

- Ocean Carbon Observatory (international facility to enable measurement of the ocean baseline)
- Funding for commercial pilot projects to align with well-funded ocean research







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# Considerations for scaling

**System dependencies:**  
Policy & regulatory framework





# What is the state of play?

## Funding landscape

- Philanthropy:  
~\$400M
- Government:  
~\$200M – but some research  
focused
- Investment:  
~\$150M ++
- AMC/Offtake Agreements:  
~\$30M



# Considerations for scaling

## Open questions + uncertainties

- How much energy?
- Carbon footprint?
- How to observe the baseline + carbon uptake?

