

Marine carbon dioxide removal

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*This advice is provided by third parties in response to **Query 10/26***

Query:

- 1. What are marine carbon dioxide removal (mCDR) technologies? Are they considered marine geoengineering?**
- 2. How do the Article 6 carbon market mechanisms (under 6.2 and 6.4, respectively) allow for mCDR to create tradeable emissions units? Please describe the steps a country needs to take if it wishes to use mCDR under article 6 of the Paris Agreement.**

Executive Summary:

Marine carbon dioxide removal (mCDR) comprises ocean-based techniques that remove CO₂ from the atmosphere and store it for extended periods including, but not limited to, ocean alkalinity enhancement, ocean fertilisation, seaweed cultivation and blue carbon ecosystem restoration.

Most mCDR techniques are generally considered forms of marine geoengineering because they involve deliberate interventions in marine systems to address climate change. Sub-seabed carbon capture and storage (CCS) is typically treated separately as a carbon storage activity rather than a marine geoengineering technique.

Article 6 of the Paris Agreement can accommodate mCDR activities, provided removals are scientifically measurable, verifiable, additional, durable and supported by robust monitoring, reporting and verification (MRV) systems.

Article 6.2 provides a flexible, decentralised route whereby countries can generate and trade Internationally Transferred Mitigation Outcomes (ITMOs) through bilateral or multilateral agreements. Countries can develop their own mCDR methodologies, subject to Paris Agreement accounting rules and corresponding adjustments to prevent double counting.

Article 6.4 establishes the UN-supervised Paris Agreement Crediting Mechanism, under which approved projects can generate Article 6.4 Emission Reductions (A6.4ERs). This route offers greater international standardisation but requires compliance with detailed UN methodologies and oversight procedures.

Advice:

Query 1. What are marine CDR technologies?

- 1 Marine Carbon Dioxide Removal (mCDR) refers to a range of techniques that use oceanic chemical, biological or ecological processes to remove carbon dioxide (CO₂) from the atmosphere and store it for extended periods. These approaches are intended to complement emissions-reduction efforts and, if deployed at sufficient scale, could contribute to gigaton-level carbon removal.¹ Commonly cited mCDR approaches include restoration of coastal and marine ecosystems, ocean fertilisation, ocean alkalinity enhancement, electrochemical processes, and seaweed cultivation.²
- 2 A key distinction should be drawn between carbon dioxide removal (CDR) and carbon capture and storage (CCS). CDR seeks to remove CO₂ that is already present in the atmosphere, whereas CCS captures CO₂ from industrial or energy-related point sources and stores it before it enters the atmosphere.³
- 3 In the Intergovernmental Panel on Climate Change (IPCC) SR1.5 glossary, CDR alongside solar radiation modification are generally discussed in the context of “geoengineering”, while CCS is included within mitigation pathways and industrial decarbonisation measures.⁴ The IPCC AR6 Working Group III has also stated that:⁵

‘Carbon Capture and Storage (CCS) and Carbon Capture and Utilisation (CCU) applied to fossil CO₂ do not count as removal technologies. CCS and CCU can only be part of CDR methods if the CO₂ is biogenic or directly captured from ambient air, and stored durably in geological reservoirs or products.’

Are mCDR technologies considered marine geoengineering?

- 4 Most mCDR technologies are generally regarded as forms of marine geoengineering, because they involve deliberate, large-scale interventions in ocean processes to address climate change.

¹ JN Cross and others, *Strategy for NOAA Carbon Dioxide Removal Research: A White Paper Documenting a Potential NOAA CDR Science Strategy as an Element of NOAA's Climate Interventions Portfolio* (NOAA Special Report, National Oceanic and Atmospheric Administration 2023) DOI: 10.25923/gzke-873e.

² GESAMP, High Level Review of a Wide Range of Proposed Marine Geoengineering Techniques (PW Boyd and CMG Vivian eds, Reports and Studies GESAMP No 98, 2019).

³ Ove Hoegh-Guldberg and others, *The Ocean as a Solution to Climate Change: Updated Opportunities for Action* (Special Report, World Resources Institute 2023) 93.

⁴ Intergovernmental Panel on Climate Change, Global Warming of 1.5°C: Annex I Glossary (IPCC 2018) 544 https://www.ipcc.ch/site/assets/uploads/sites/2/2022/06/SR15_AnnexI.pdf.

⁵ IPCC, Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change: Technical Summary (IPCC 2022) 114 [IPCC AR6 WGI Technical Summary.pdf](https://www.ipcc.ch/site/assets/uploads/sites/2/2022/06/SR15_AnnexI.pdf).

5 The UK Royal Society defines geoengineering as the deliberate large-scale manipulation of the planetary environment to counter anthropogenic climate change.⁶ Similarly, the London Convention and London Protocol describe marine geoengineering as deliberate ocean-based interventions designed to counteract climate change, including techniques such as ocean fertilisation and alkalinity enhancement.⁷

6 Applying those definitions:

Technology	Marine CDR?	Marine Geoengineering?
Ocean fertilisation	Yes	Yes
Ocean alkalinity enhancement	Yes	Yes
Ecosystem restoration/blue carbon projects	Generally, yes	Sometimes, depending on scale and definition
Sub-seabed CCS	Generally, no (because it stores captured CO ₂ rather than removing atmospheric CO ₂)	Generally treated separately from marine geoengineering

7 Notably, the London Convention/London Protocol regulatory framework distinguishes sub-seabed CCS from marine geoengineering techniques such as ocean fertilisation.⁸ While both are regulated marine climate interventions, CCS is generally treated as a carbon storage activity rather than a marine geoengineering or mCDR technique.

8 In its Advisory Opinion on climate change, the International Tribunal for the Law of the Sea underlines the importance of mangroves, tidal marshes and seagrass meadows as sinks and that the obligation to protect the marine environment under the UN Convention on the Law of the Sea (UNCLOS) thereby also mitigates greenhouse gas emissions by enhancing carbon sequestration.⁹

9 The Tribunal establishes that anthropogenic greenhouse gas emissions into the atmosphere constitute pollution of the marine environment.¹⁰ When it considers the duty not to transfer or transform under Article 195 of the UNCLOS, and use of technologies, the Tribunal mentions that marine geoengineering would be contrary to Article 195 if it has the consequence of transforming one type of pollution into another.

⁶ The Royal Society, *Geoengineering the Climate: Science, Governance and Uncertainty* (The Royal Society 2009) <https://royalsociety.org/-/media/policy/publications/2009/8693.pdf>.

⁷ London Protocol Contracting Parties, Resolution LP.4(8) on the Amendment to the London Protocol to Regulate the Placement of Matter for Ocean Fertilization and Other Marine Geoengineering Activities (adopted 18 October 2013) Annex, art 1(5bis).

⁸ 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (adopted 7 November 1996, entered into force 24 March 2006) 36 ILM 1 (1997) ('London Protocol'). annex 1 para 1.8.; International Maritime Organization, *Specific Guidelines for the Assessment of Carbon Dioxide Streams for Disposal into Sub-seabed Geological Formations* (2012) LC 34/15, annex 8 <https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/2012%20SPECIFIC%20GUIDELINES%20FOR%20THE%20ASSESSMENT%20OF%20CARBON%20DIOXIDE.pdf>.

⁹ International Tribunal for the Law of the Sea, *Request for an Advisory Opinion Submitted by the Commission of Small Island States on Climate Change and International Law*, Advisory Opinion (21 May 2024) para 390.

¹⁰ *ibid* paras 159-179.

The Tribunal also links marine geoengineering to Article 196 of UNCLOS, which requires States to take all measures necessary to prevent, reduce and control marine pollution resulting from the use of technologies under their jurisdiction or control.¹¹ Thus, if marine geoengineering does not result in marine pollution but helps in reducing pollution from carbon, it would not be contrary to Articles 195 and 196.

Query 2: How do the Article 6 carbon market mechanisms (under 6.2 and 6.4, respectively) allow for mCDR to create tradeable emissions units?

- 10 Article 6¹² provides the framework for international cooperation on climate mitigation. It allows countries to work together to achieve their Nationally Determined Contributions (NDCs), while promoting sustainable development, environmental integrity, and the mobilisation of climate finance. It creates pathways for transferring mitigation outcomes between countries and for both market and non-market forms of cooperation.¹³
- 11 Article 6.2 establishes the rules for countries to transfer mitigation outcomes between one another, known as Internationally Transferred Mitigation Outcomes (ITMOs). It is a largely decentralised system where participating countries agree their own cooperative arrangements, provided they follow agreed accounting and reporting requirements. A key objective is to avoid double counting through the use of corresponding adjustments.¹⁴
- 12 Article 6.4 creates a centralised UN-supervised carbon market mechanism, often referred to as the Paris Agreement Crediting Mechanism.¹⁵ It is overseen by the Article 6.4 Supervisory Body and generates high-integrity carbon credits from approved mitigation activities. It is intended to succeed and improve upon the Kyoto Protocol's Clean Development Mechanism (CDM).¹⁶
- 13 The key difference between 6.2 and 6.4 for mCDR is that the mechanism under Article 6.2 is faster and more flexible. Countries can agree on their own accounting framework and methodologies, subject to Paris accounting rules. Article 6.4 is more standardised and overseen by the UN. It generates internationally recognised credits but requires approved methodologies and compliance with detailed UN rules.
- 14 If a country wants to use mCDR under Article 6 of the Paris Agreement,¹⁷ it must first ensure that the mCDR activity can generate a recognised mitigation outcome (a verified quantity of CO₂ removed) and then route those outcomes through either the Article 6.2 bilateral trading system or the Article 6.4 UN crediting mechanism. Article 6 does not currently have a

¹¹ *ibid* para 231.

¹² See Annex 1 of this Note.

¹³ United Nations Framework Convention on Climate Change (UNFCCC), 'Article 6 of the Paris Agreement' (UNFCCC) <https://unfccc.int/process-and-meetings/the-paris-agreement/article6>.

¹⁴ UNFCCC, 'Article 6.2' (UNFCCC) <https://unfccc.int/process-and-meetings/the-paris-agreement/article-6/article-62>; Lambert Schneider, Afrianto Perdanah and Thomas Day, *Double Counting and the Paris Agreement* (Climate Focus Client Brief II, Version 2.0, January 2016) <https://climatefocus.com/wp-content/uploads/2022/06/20160105-v.2.0-Double-Counting-and-Paris-Agreement-FIN.pdf.pdf>.

¹⁵ United Nations Framework Convention on Climate Change (UNFCCC), 'Paris Agreement Crediting Mechanism' (UNFCCC) <https://unfccc.int/process-and-meetings/the-paris-agreement/article-64-mechanism>.

¹⁶ UNFCCC, 'FAQs on Transitioning CDM Activities to the Article 6.4 Mechanism' (UNFCCC) https://unfccc.int/process-and-meetings/the-paris-agreement/article-6/article-64-pacm/CDM_transition/faqs.

¹⁷ Paris Agreement (adopted 12 December 2015, entered into force 4 November 2016) UNTS No 54113.

dedicated mCDR methodology, but the framework is designed to accommodate removals, including potentially ocean-based removals, provided they meet the required standards.

- 15 It is more likely that most early mCDR deployments are expected to emerge first through Article 6.2 cooperative agreements because dedicated UN-approved mCDR methodologies under Article 6.4 are still developing.¹⁸
- 16 For a marine CDR project (e.g. ocean alkalinity enhancement), the general process a country might follow is:
 - 16.1 Develop a scientifically accepted methodology for quantifying durable CO₂ removal.
 - 16.2 Establish MRV and environmental safeguards.
 - 16.3 Obtain government approval.
 - 16.4 Verify the quantity of net atmospheric CO₂ removed.
 - 16.5 Generate ITMOs directly under Article 6.2 or A6.4ER credits under Article 6.4.
 - 16.6 Transfer those units internationally with corresponding adjustments if another country claims them.

Please describe the steps a country needs to take if it wishes to use mCDR under article 6 of the Paris Agreement.

Article 6.2: Bilateral or Cooperative Approaches

- 17 Article 6.2 allows countries to transfer Internationally Transferred Mitigation Outcomes (ITMOs) to other countries. The removals can come from projects that reduce emissions or remove CO₂ from the atmosphere. The steps for a country using mCDR under Article 6.2 are as follows:
- 18 **Step One: Establish the legal basis**
 The host country must decide that mCDR activities are eligible under its domestic carbon market and climate policy framework and ensure consistency with its NDC. Decision 2/CMA.3 of the Conference of the Parties identifies that ITMOs can arise from emission reductions and removals when internationally transferred.¹⁹ ITMOs shall:²⁰
 - 18.1 Be real, verified and additional;
 - 18.2 Represent emission reductions or removals (including mitigation co-benefits from adaptation actions or economic diversification plans);
 - 18.3 Be internationally transferred between participating Parties;
 - 18.4 Be measured in tCO₂e (or another approved non-GHG metric consistent with the participating Parties' NDCs);
 - 18.5 Originate from the Article 6.2 cooperative approach;
 - 18.6 Be authorised by the host Party for use towards an NDC or another recognised international mitigation purpose;

¹⁸ Plymouth Marine Laboratory and others, mCDR Consensus Statement (May 2026) https://pml.ac.uk/wp-content/uploads/2026/05/eNGO_mCDR-consensus-statement_2026_Final.pdf

¹⁹ Conference of the Parties Serving as the Meeting of the Parties to the Paris (CMA), 'Decision 2/CMA.3: Guidance on Cooperative Approaches Referred to in Article 6, Paragraph 2, of the Paris Agreement' in UN Doc FCCC/PA/CMA/2021/10/Add.1 (published 8 March 2022) Annex ('Decision 2/CMA.3').

²⁰ *ibid*, annex para 1.

- 18.7 Be generated from mitigation occurring from 2021 onwards; and
- 18.8 Include eligible Article 6.4 emission reductions/removals where these have been authorised for transfer and use.

19 **Step Two: Create or approve an mCDR methodology**

Because Article 6.2 is decentralized, participating countries have significant flexibility in designing methodologies, provided transparency and accounting rules are met. The country needs a robust methodology defining:²¹

- 19.1 how CO₂ removal is quantified,
- 19.2 monitoring, reporting and verification (MRV),
- 19.3 permanence requirements,
- 19.4 leakage accounting,
- 19.5 environmental safeguards.

20 **Step Three: Measure and verify removals**

The mCDR project must demonstrate scientifically verified net removals, such as through ocean alkalinity enhancement, biomass sinking, or another approved approach. The measurement, reporting and verification (MRV) of internationally transferred mitigation outcomes (ITMOs) under Article 6.2 is governed principally by the UNFCCC decisions adopted by the CMA. These decisions embed ITMO accounting within the Paris Agreement's broader transparency framework, combining Party reporting, registry tracking, technical expert review, and consistency checks to ensure the environmental integrity and credibility of international carbon market transactions.²²

21 **Step Four: Authorise the mitigation outcomes²³**

Authorisation is the formal approval by a participating Party for the use of internationally transferred mitigation outcomes (ITMOs) under a cooperative approach. It identifies three possible authorisation components: (i) the cooperative approach itself, (ii) the ITMOs, and (iii) participating entities.²⁴ The authorisation should specify key details such as the parties/entities covered, permitted uses, duration, first transfer arrangements, relevant registries, sectors and methodologies. Any changes to authorisation must avoid double counting and generally cannot affect ITMOs that have already been first transferred.

22 **Step Five: Apply corresponding adjustments**

A participating Party must state in its initial report which method it will use to apply corresponding adjustments (CAs) and apply that method consistently throughout the NDC implementation period.²⁵

- 23 A participating Party must choose and consistently apply a method for making corresponding adjustments to account for ITMOs and avoid double counting. For single-year NDCs, Parties

²¹ *ibid*, annex para 18(d). See also United Nations Framework Convention on Climate Change (UNFCCC) Secretariat, *Article 6.2 Reference Manual for the Accounting, Reporting and Review of Cooperative Approaches* (Version 3, April 2025) https://unfccc.int/sites/default/files/resource/Article_6.2_Reference_Manual.pdf

²² CMA, Decision 2/CMA.3 Annex (n 16); CMA, Guidance on Cooperative Approaches Referred to in Article 6, Paragraph 2, of the Paris Agreement UN Doc FCCC/PA/CMA/2022/10/Add.2, Decision 6/CMA.4 (published 17 March 2023); CMA, Matters Relating to Cooperative Approaches Referred to in Article 6, Paragraph 2, of the Paris Agreement UN Doc FCCC/PA/CMA/2024/L.15 (23 November 2024).

²³ UN Doc FCCC/PA/CMA/2024/L.15 (*ibid*), paras 2-10.

²⁴ *ibid*.

²⁵ CMA, Decision 2/CMA.3 Annex (n 16), para 7.

may either (i) use an indicative multi-year emissions trajectory or budget and apply annual adjustments based on actual ITMOs transferred or used, or (ii) apply annual adjustments based on the average amount of ITMOs over the NDC period.²⁶ For multi-year NDCs, Parties must establish a multi-year emissions trajectory or budget and apply annual and cumulative adjustments based on actual ITMO transfers and use.²⁷ The chosen method must be transparent, accurate and consistent with NDC implementation, ensure environmental integrity, and prevent any increase in net emissions across participating Parties.

24 Step Six: Transfer and use the ITMOs

Once authorized and recorded, ITMOs may be internationally transferred and used by the acquiring Party towards achievement of its nationally determined contribution (NDC) or, where authorized, for other international mitigation purposes. Participating Parties must maintain arrangements for tracking and recording ITMOs, including through national or international registries.²⁸

Article 6.4: UN-Centralised Crediting Mechanism

25 Article 6.4 creates a UN-supervised carbon market known as the Paris Agreement Crediting Mechanism (PACM). This mechanism can issue credits for both emission reductions and removals. The steps for a country using mCDR under Article 6.4 are:

26 Step One: Host-country participation

The country must participate in Article 6.4 and designate the national authority responsible for approvals and authorisations.²⁹

27 Step Two: Develop or adopt an approved removal methodology

The project developer must use an approved Article 6.4 methodology or submit a new methodology for review by the Supervisory Body. The UNFCCC has adopted standards governing removals and methodology development.³⁰

28 For mCDR, this is currently the key challenge because specific ocean-removal methodologies are still emerging.

29 Step Three: Register the activity

The mCDR project is submitted to the Article 6.4 Supervisory Body and must demonstrate:³¹

- 29.1 additionality,
- 29.2 sustainable development benefits,
- 29.3 robust MRV,
- 29.4 management of reversal risks,
- 29.5 environmental and social safeguards.

²⁶ *ibid*, para 7(a).

²⁷ *ibid*, para 7(b).

²⁸ *ibid*, paras 1(d), 1(f), 19, 29-30.

²⁹ Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA), Rules, Modalities and Procedures for the Mechanism Established by Article 6, Paragraph 4, of the Paris Agreement (Decision 3/CMA.3, FCCC/PA/CMA/2021/10/Add.1, 13 November 2021) Annex ('Decision 3/CMA.3 Annex').

³⁰ Decision 3/CMA.3 mandates the Supervisory Body to develop and approve methodologies for Article 6.4 activities; Article 6.4 Supervisory Body, *Standard: Requirements for Activities Involving Removals under the Article 6.4 Mechanism* (Version 01.0, 9 October 2024) para 10 ('Removals Standard').

³¹ 'Decision 3/CMA.3 (n 26), ch V (Activity Cycle) and ch V.B (Methodologies). Removals Standard, paras 10-17, 18-25, 40-57 and section 4.8.

30 Step Four: Quantify and monitor removals

Removals must be continuously monitored and independently verified according to Article 6.4 removal standards. Requirements include accounting for reversals, leakage and long-term monitoring.³²

31 Step Five: Issuance of Article 6.4 credits

Once verified, the mechanism issues Article 6.4 Emission Reductions (A6.4ERs) representing tonnes of CO₂ removed.³³

32 Step Six: Authorisation and export

The host country may:³⁴

- 32.1 keep the credits for its own NDC,
- 32.2 authorise them for international transfer,
- 32.3 convert them into ITMOs for use by another country.

If exported, corresponding adjustments are required.

³² Removals Standard, ss 4.1-4.7, especially paras 11-28 and 40-57.

³³ Decision 3/CMA.3 Annex (n 26), ch V (Activity Cycle).

³⁴ *ibid*, provisions relating to authorisation and use of A6.4ERs.

Annex I:

Paris Agreement (adopted 12 December 2015, entered into force 4 November 2016) (2016) ATS 24 art 6.

Article 6

1. Parties recognize that some Parties choose to pursue voluntary cooperation in the implementation of their nationally determined contributions to allow for higher ambition in their mitigation and adaptation actions and to promote sustainable development and environmental integrity.
2. Parties shall, where engaging on a voluntary basis in cooperative approaches that involve the use of internationally transferred mitigation outcomes towards nationally determined contributions, promote sustainable development and ensure environmental integrity and transparency, including in governance, and shall apply robust accounting to ensure, inter alia, the avoidance of double counting, consistent with guidance adopted by the Conference of the Parties serving as the meeting of the Parties to this Agreement.
3. The use of internationally transferred mitigation outcomes to achieve nationally determined contributions under this Agreement shall be voluntary and authorized by participating Parties.
4. A mechanism to contribute to the mitigation of greenhouse gas emissions and support sustainable development is hereby established under the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Agreement for use by Parties on a voluntary basis. It shall be supervised by a body designated by the Conference of the Parties serving as the meeting of the Parties to this Agreement, and shall aim:
 - a. To promote the mitigation of greenhouse gas emissions while fostering sustainable development;
 - b. To incentivize and facilitate participation in the mitigation of greenhouse gas emissions by public and private entities authorized by a Party;
 - c. To contribute to the reduction of emission levels in the host Party, which will benefit from mitigation activities resulting in emission reductions that can also be used by another Party to fulfil its nationally determined contribution; and
 - d. To deliver an overall mitigation in global emissions.
5. Emission reductions resulting from the mechanism referred to in paragraph 4 of this Article shall not be used to demonstrate achievement of the host Party's nationally determined contribution if used by another Party to demonstrate achievement of its nationally determined contribution.
6. The Conference of the Parties serving as the meeting of the Parties to this Agreement shall ensure that a share of the proceeds from activities under the mechanism referred to in paragraph 4 of this Article is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.
7. The Conference of the Parties serving as the meeting of the Parties to this Agreement shall adopt rules, modalities and procedures for the mechanism referred to in paragraph 4 of this Article at its first session.

8. Parties recognize the importance of integrated, holistic and balanced non-market approaches being available to Parties to assist in the implementation of their nationally determined contributions, in the context of sustainable development and poverty eradication, in a coordinated and effective manner, including through, inter alia, mitigation, adaptation, finance, technology transfer and capacity-building, as appropriate. These approaches shall aim to:
 - a. Promote mitigation and adaptation ambition;
 - b. Enhance public and private sector participation in the implementation of nationally determined contributions; and
 - c. Enable opportunities for coordination across instruments and relevant institutional arrangements.
9. A framework for non-market approaches to sustainable development is hereby defined to promote the non-market approaches referred to in paragraph 8 of this Article.