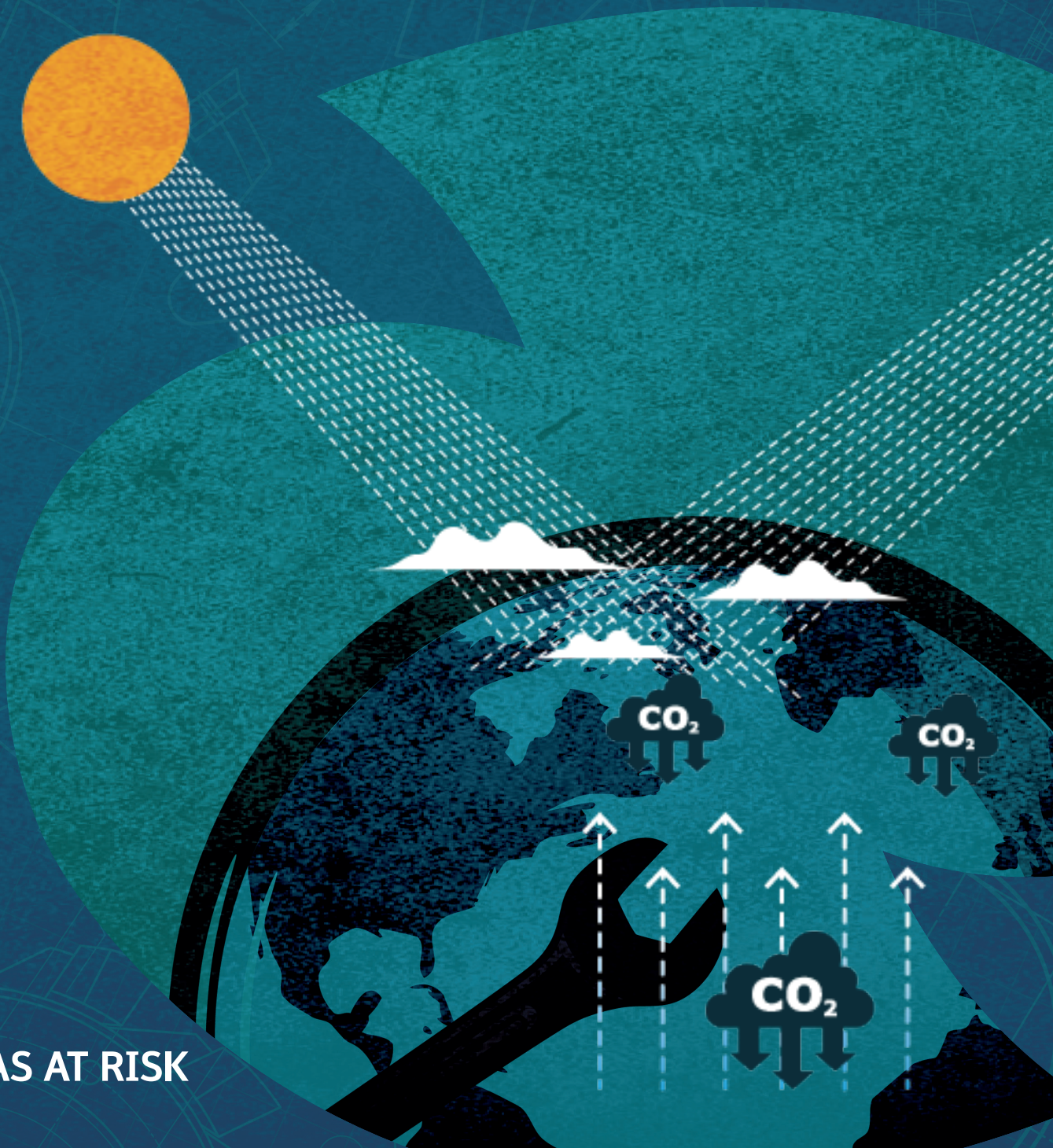
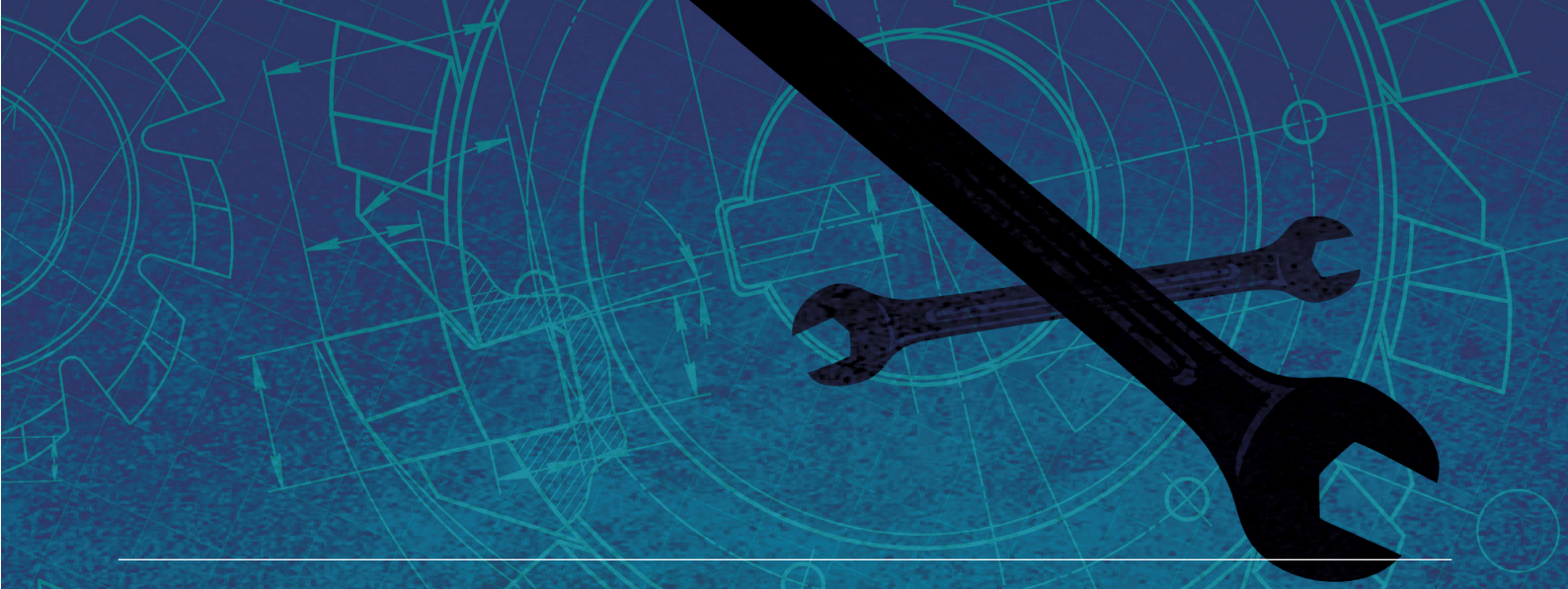
High risks and false friends: why Europe must say no to marine geo-engineering

Position statement



SEAS AT RISK



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SEAS AT RISK

Contents

1. Summary

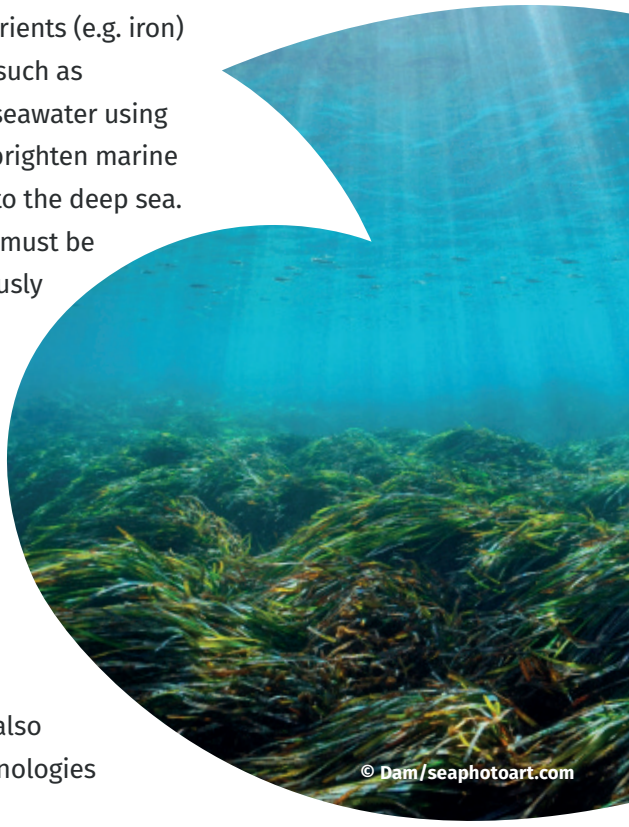
Marine geo-engineering (mGE) refers to large-scale interventions in the marine environment aimed at combatting the effects of climate change. While at surface level the intention sounds positive, in reality these high-risk "false friend" methods could cause vast and irreversible harm to marine biodiversity, disrupt livelihoods in coastal communities and delay the deep emission cuts that are necessary right now.[1] MGE is not a solution—it's a threat, a dangerous distraction from real climate action.

Europe must show leadership globally by prohibiting mGE in its seas, championing an international moratorium and focussing on restoring ocean health. Instead of investing in speculative techno-fixes, Europe should address the root causes of the climate crisis by phasing-out fossil fuels, halving energy demand, and transitioning to 100% renewables by 2040.

Climate change is here: floods, hurricanes and droughts are ravaging vast areas on all continents, and biodiversity is collapsing. Yet, efforts to cut greenhouse gas (GHG) emissions to zero remain sub-standard and nature is being depleted at an alarming rate.

Meanwhile, speculative geo-engineering practices like carbon dioxide removal (CDR) and solar radiation modification (SRM) are gaining traction. The Intergovernmental Panel on Climate Change (IPCC) gives mixed signals. It highlights the need for significant CO_2 removal alongside deep emission cuts to stay below the 1.5°C warming target, but warns of risks from non-natural CDR, rejects SRM, and advocates restoring ecosystems as a safer alternative. Recent research concludes that carbon removal is no solution if the world overshoots 1.5°C. Only stringent and much accelerated emission reductions can effectively limit climate risks.[2]

mGE methods include creating vast areas of algal blooms by adding nutrients (e.g. iron) to the ocean (ocean fertilisation), dumping huge quantities of minerals such as ground limestone (ocean alkalinity enhancement), extracting CO2 from seawater using electrochemical methods (direct ocean removal), spraying seawater to brighten marine clouds, and large-scale seaweed farming with sinking of the biomass into the deep sea. To result in a meaningful reduction of atmospheric CO2, these methods must be deployed on a massive scale (up to 10% of the ocean surface), continuously for decades or indefinitely and at high energy costs.
This risks irreversibly harming marine life, disrupting the food web, altering ocean chemistry and regional weather patterns, disturbing the ocean's CO2 balance, and exacerbating inequities (Figure 1). [3]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Internationally, a de-facto moratorium on geo-engineering exists under the Convention on Biological Diversity (CBD).
The London Protocol and Convention prohibit ocean fertilisation, with discussions underway to include additional mGE methods.
The Agreement on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction (BBNJ Treaty) also imposes prohibitive conditions. Despite these frameworks, various technologies are being tested, with millions invested in mGE research.

1 Center for International Environmental Law (CIEL) (2024). The Risks of Geoengineering: Accelerating Biodiversity Loss and Compounding Planetary Crises.
2 Schleussner, Carl-Friedrich, et al (2024), Overconfidence in climate overshoot | Nature
3 Joint Group of Experts on the Scientific Aspects of Marine Protection (GESAMP) (2019). High-level review of a wide range of proposed marine geoengineering techniques

The European Union adopts a precautionary stance on mGE, prioritising the restoration of ecosystems with a high CO2 absorbing capacity (e.g. tidal marshes, seagrass and kelp). The European Parliament has called for the implementation of an international moratorium on geo-engineering. However, some EU climate policies and regulations, such as the Carbon Removals and Carbon Farming Certification Regulation, risk paving the way for mGE. The Marine Strategy Framework Directive, aimed at achieving good environmental status for European seas, could help prevent mGE practices if better aligned with EU climate policies.

> *"We cannot solve our problems with the same thinking we used when we created them."*
>
> *(Albert Einstein)*

To address mGE's threats, Europe should:

Reduce GHG emissions to zero
halve energy demand (compared to 2020), phase out fossil fuels, and transition to 100% renewable energy by 2040.[4]

Restore the ocean and seas to good health by 2030
by implementing the Blue Manifesto roadmap.[5]

Enforce the international moratorium on geo-engineering
under the CBD, support efforts to regulate additional mGE technologies under the London Convention and Protocol, and ratify and implement the BBNJ Treaty.

Prohibit mGE in European seas
and exclude mGE technologies and practices from the CRCF Regulation and 2040 EU Climate Target. This ban should encompass research, testing and deployment of geo-engineering techniques.

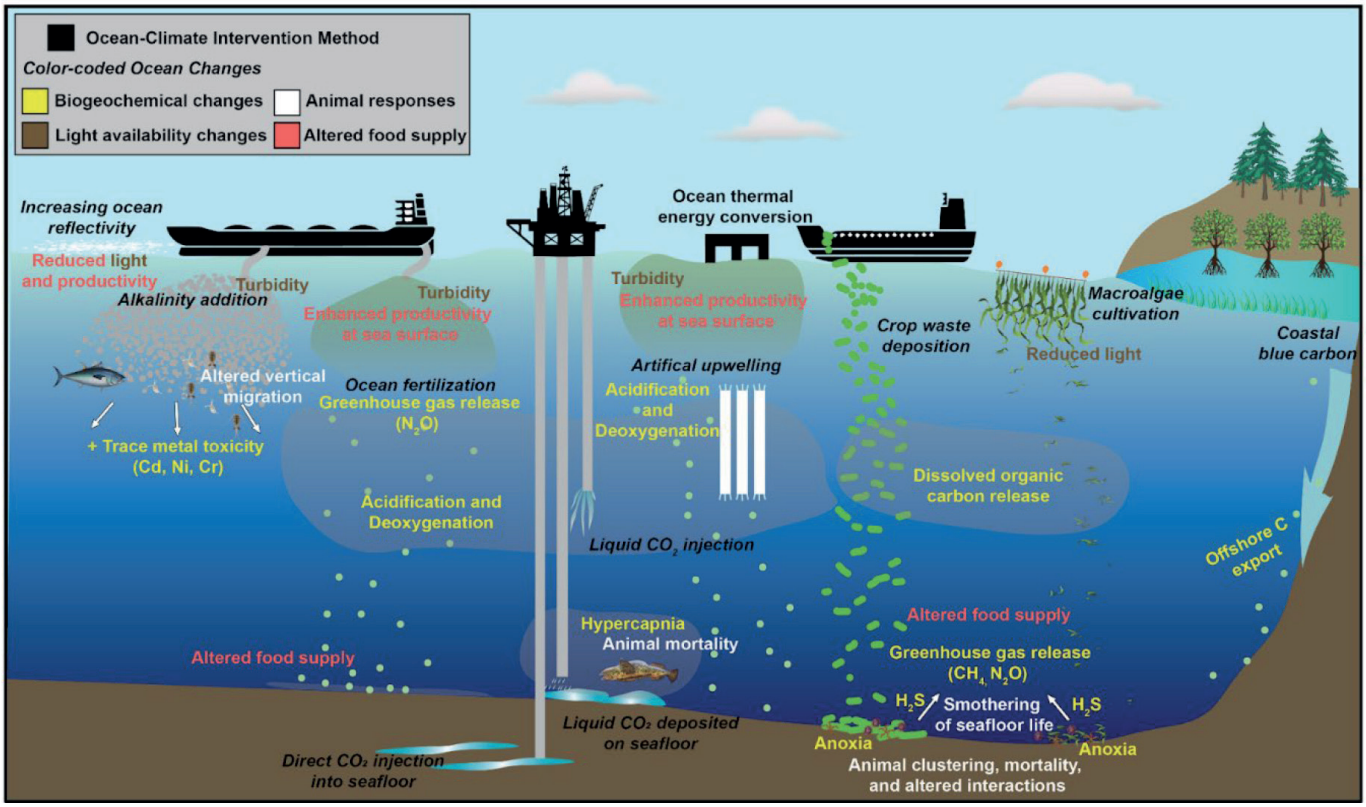
Redirect existing and future funds
intended for research into mGE towards efforts **to restore the ocean to health and make it climate resilient by 2030.**

Prohibit ocean carbon storage
in the water column and on the seabed and halt storage in sub-seabed geological formations until there is proof of no environmental harm.

4 Climate Action Network Europe (2024). Energy Compass for the new policy cycle 2024-2029.
5 Seas At Risk (2024). Blue Manifesto: the roadmap to a healthy ocean in 2030

The ocean, Earth's largest natural carbon sink, is a vital ally in combating climate change. Restoring its health must be central to European climate policies.

Figure 1: Examples of mGE methods, with their corresponding impacts



Source: Deep Ocean Stewardship Initiative DOSI (2023), Marine Carbon Dioxide Removal: Ocean Impacts and Policy Needs

2. Marine geo-engineering: methods and risks

Geo-engineering refers to a range of deliberate, large or planetary scale interventions in the marine environment designed to counteract the effects of anthropogenic climate change. This includes practices to reduce atmospheric carbon dioxide (CO2) levels (**carbon dioxide removal, CDR**) or modify the reflection of solar radiation (**solar radiation modification, SRM**). Geo-engineering is a long-standing 'fringe' idea, but recent decades have seen it grown in attention and research budgets (see Box 1).

This paper outlines the steps the EU, its 27 Member States, the United Kingdom (UK) and Norway (i.e. the countries of Seas At Risk's membership) should take to prevent these highly speculative and risky marine geo-engineering (mGE) practices.

MGE methods that are currently investigated include both CDR and SRM. Examples are the creation of vast areas of algal blooms by adding nutrients (e.g. iron) to the ocean (ocean fertilisation), dumping of minerals such as ground limestone in the ocean (ocean alkalinity enhancement), extracting CO2 from the seawater using electrochemical methods (direct ocean capture), spraying seawater to brighten clouds (marine cloud brightening), and industrial macro-algae/seaweed farming and sinking of the harvested biomass into the deep sea.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Studies on the risks of mGE all conclude that the technologies are not well developed, the risks are significant, and there is only a poor understanding of how they will interact with the diverse marine ecosystems that underpin global biodiversity, food chains and human livelihoods.

To achieve a reduction of CO2 that is meaningful from a climate perspective (i.e. gigatonnes per year), these technologies will need to be deployed at a massive scale, risking irreversible widespread damage to marine life, changing ocean chemistry and weather patterns, and exacerbating existing inequities (see Table 1 and Figure 1). To have any long-term effect, mGE will have to be undertaken continuously over decades, or even permanently.

Methods like fertilisation, alkalinisation or seaweed farming would need to cover up to 10% of the ocean surface to be effective.[6] Approximately 2.5 billion tonnes of ground limestone would need to be dumped into the ocean to remove 1 Gtonne of CO_2 from the atmosphere (35.8 Gtonnes CO2 were emitted globally in 2023).[7]

6 HOME Alliance (2024), Briefing on Marine Geoengineering
7 Alkalinity enhancement – an approach in its infancy « World Ocean Review 2024

MGE also poses a security threat if one country uses it as a military weapon to alter the climate of another state intentionally. Significantly, **mGE risks undermining crucial efforts to reduce emissions, with fossil fuel companies turning to these technologies to keep drilling for oil and gas.**

Given the ecological, social and ethical risks, mGE also conflicts with the UN Sustainable Development Goals 1 (no poverty), 10 (reduced inequalities), 14 (life below water) and 16 (peace, justice, and strong institutions).

This creates a clear case for a strong application of the precautionary principle by implementing a moratorium – if not a complete prohibition – on mGE.

Box 1: Geo-engineering: how a 19th century 'fringe' idea became mainstream in the 21st century

Humans have been geo-engineering our planet since the industrial revolution. As early as the 19th century, scientists pointed out that an increase in CO2 concentrations would lead to an increase in global temperatures, with others considering methods to generate rain on command during periods of drought. Geo-engineering was quickly linked to the military sphere: in the runup to World War II, and during the Cold War, Russia and the United States (US) conducted hundreds of cloud-seeding experiments to try and alter the weather. Following public outrage about these experiments during the Vietnam War (1967-1972), the United Nations General Assembly (UNGA) banned weather warfare and other hostile uses of climate manipulation in 1976. Since the establishment of the United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC) in the 1990s, geo-engineering has increasingly become part of international negotiations on climate change. Countries such as China, the US and Russia are stepping up their research and geoengineering experiments are on the rise. What used to be 'fringe science' is now firmly the mainstream.

Source: McCormick, T. (2013). Geoengineering: A short history.

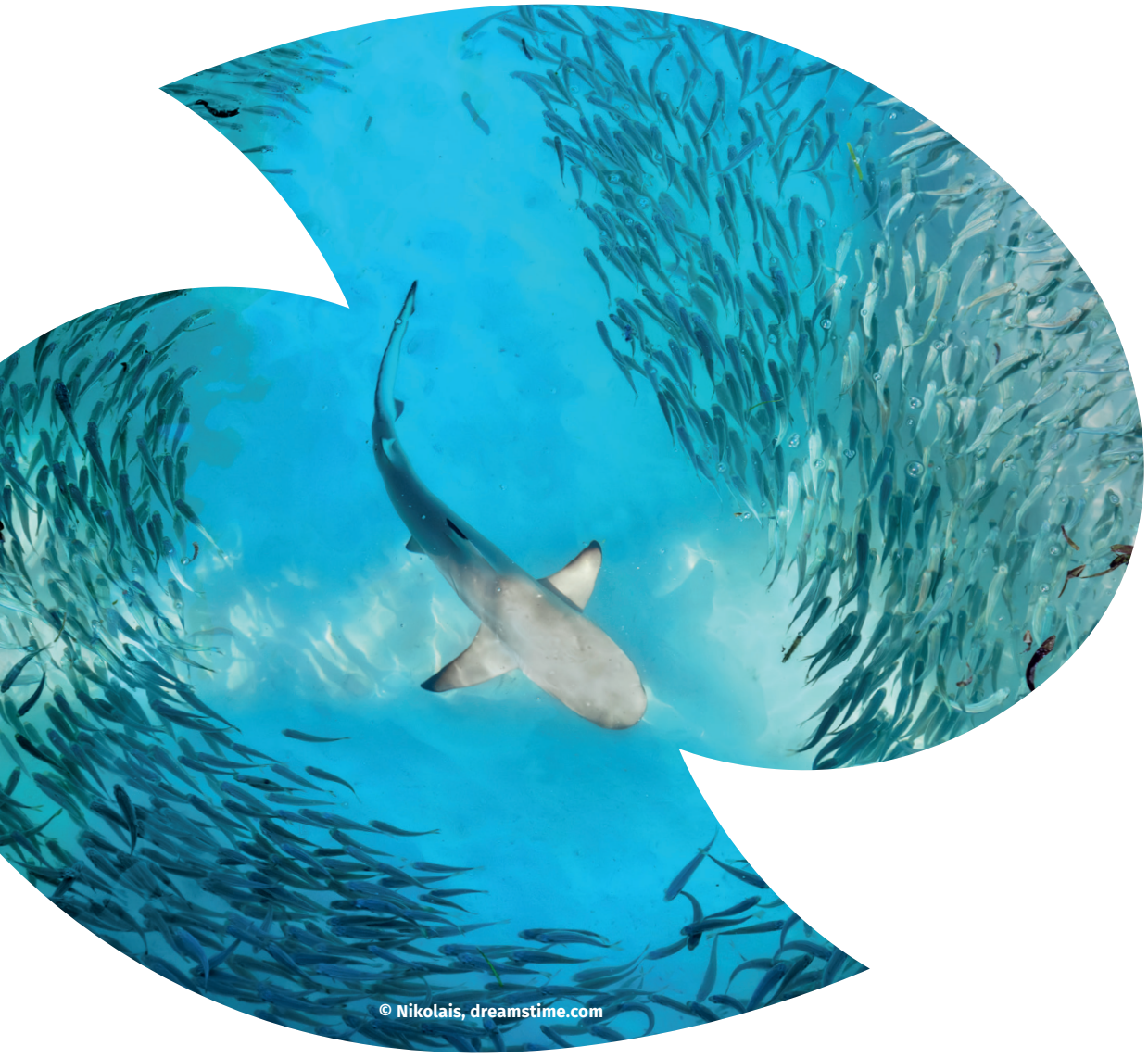
Box 2: The alarming rise of geoengineering experiments

An interactive world map on geoengineering prepared by the ETC Group and the Heinrich Boell Foundation sheds light on the alarming expansion of geoengineering research and experimentation, including CDR and SRM.

An analysis by the Center for International Environmental Law (CIEL) shows that since 1971, at least 598 outdoor geoengineering experiments have been proposed, over 90% since 2004, and more than half between 2019 and 2023. There were more than four times as many marine CDR removal technology field experiments (OAE, artificial upwelling, etc.) proposed in the 2019-2023 period compared to 2014-2018[8].

Start-ups are emerging (e.g. Tide, Project Vesta) that are funded by large philanthropic organisations such as Ocean Visions. Often, the potential of marine CDR is vastly exaggerated to attract investments, and these partnerships have inadequate governance.

In 2024, the Hands-Off Mother Earth (HOME!) Alliance issued a statement signed by over 100 organisations, calling on governments to prevent outdoor mGE experiments from taking place[9].



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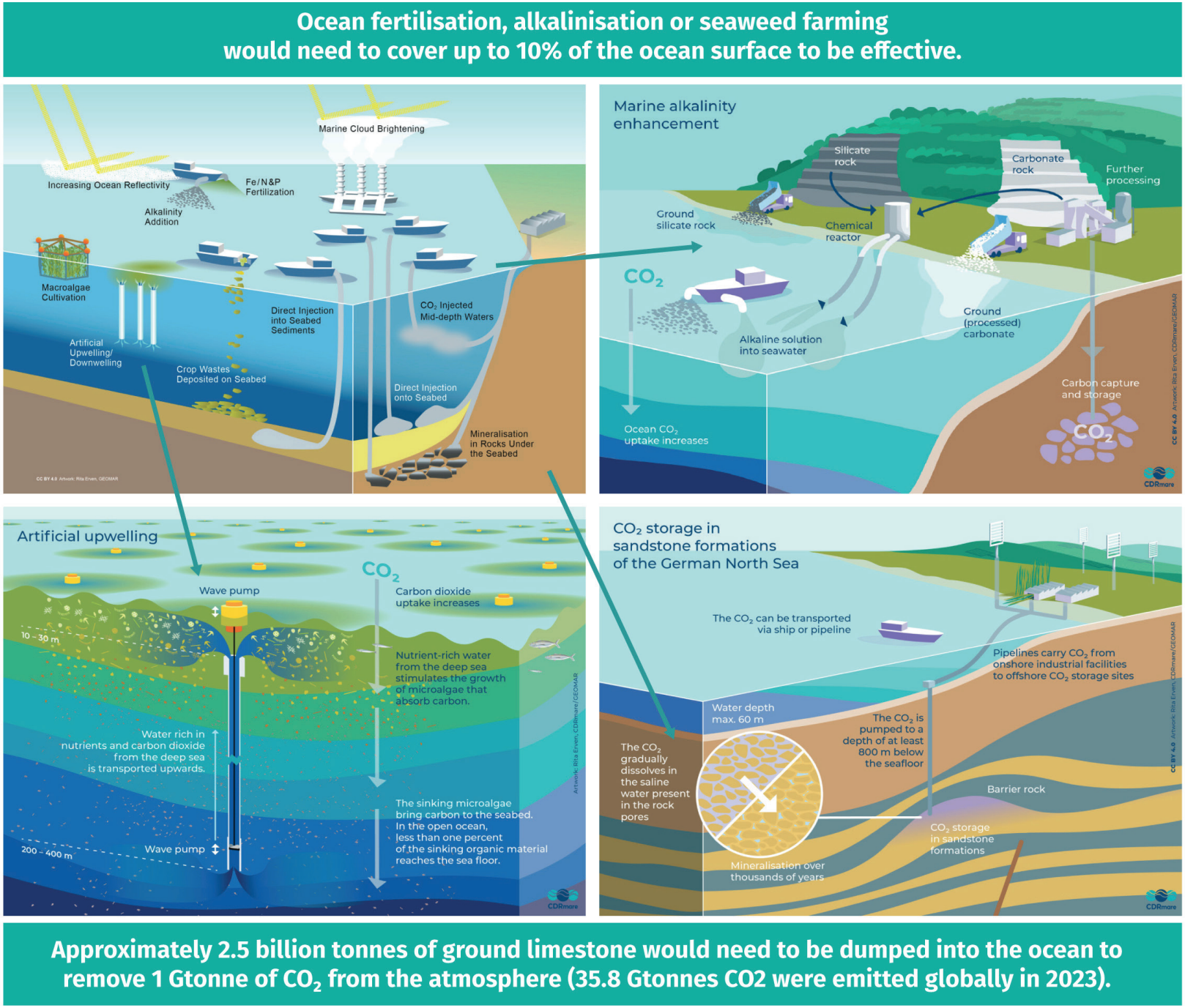
8 Center for International Environmental Law (CIEL) (2024). The Risks of Geoengineering: Accelerating Biodiversity Loss and Compounding Planetary Crises.
9 Geoengineering Monitor (2024). HOME! Alliance Statement on Marine Geoengineering Experiments.

Figure 2: Examples of mGE methods



Cc Artwork: Rita Erven, GEOMAR

Table 1: mGE methods and practices and associated risks

		Method	Risks and impacts
Carbon Dioxide Removal	**Ocean fertilisation**	Depositing iron or nutrients in the ocean to stimulate massive blooms of phytoplankton growth to increase absorption of CO2 from the air through photosynthesis. Once dead, the phytoplankton sinks to the sea floor, sequestering the CO_2.	Releases harmful gases like methane and nitrous oxide, potentially worsening global warming, triggering harmful algal blooms, disrupting marine food chains, and creating deoxygenated 'dead zones' in the ocean. Deploying iron fertilisation in one part of the ocean may also affect nutrients elsewhere. Most carbon absorbed is later re-released, limiting long-term sequestration.
	Industrial seaweed/ macro-algae farming & sinking	Seaweed absorbs and stores CO2, in biomass, for example. Methods include using seaweed to create materials such as biochar or bioplastics, or gathering/compressing seaweed biomass and sinking it into the deep sea.	Large-scale mono-cultivation can disrupt ecosystems, deplete nutrients for phytoplankton, and release harmful gases. Sinking organic matter may cause oxygen depletion, harming marine life. The massive scale of cultivation required (up to 10-20% of ocean surface is suggested) would significantly disrupt marine ecosystems and affect the livelihoods of coastal communities.
	Ocean alkalinity enhancement (OAE)	Increasing ocean alkalinity by adding crushed lime or silicate minerals to the ocean or using electrochemical methods to absorb CO2. Massive amounts of alkaline rock would need to be dumped for any significant CO2 removal: 5-26 gigatons each year to maintain ocean surface pH.	Risks releasing toxic trace elements and altering ecosystems, and is inefficient and energy intensive. Billions of tonnes of limestone or other minerals and rocks would be needed, which would cause vast impacts from terrestrial mining, processing, and transport. Trace elements such as cadmium, nickel, and chromium could negatively impact deep-sea organisms. Increased pH would have harmful short-term impacts on marine life in surface water. Particles sinking into deeper waters could alter microbial communities and affect the food supply for deep-sea life.
	Direct Ocean Removal (DOR)	Aims to extract CO2 from the seawater using electrochemistry. This reduces the CO2 concentration in seawater, prompting the ocean to absorb more CO2 from the atmosphere. The extracted CO2 must be stored somewhere, geological storage on land on under the seabed has been proposed.	DOR at scale would require massive amounts of seawater and renewable energy, and the process of large quantities of seawater would have significant negative impacts on foundational marine life such as plankton and fish larvae.
	Ocean carbon storage	Injection of liquid CO2 into mid-deep water on the seabed, a few hundred metres into deep sea sediments or into disused natural gas or oil fields. Another method is mineralisation in rocks under the seabed.	Dissolution of CO2 in the ocean alters ocean chemistry, with likely impacts on deep ocean ecosystems, including the possibility of mortality of seafloor life. The areas where mid-depth injection would take place are largely unexplored. Storage in old oil or gas fields could harm deep-sea ecosystems, cause noise pollution, and increase seismic risks. The permanence of these techniques has yet to be proven and potential leaks could cause bottom-up ocean acidification at a depth where marine life is less resilient to pH disruption.

Table 1: mGE methods and practices and associated risks

		Method	Risks and impacts
Carbon Dioxide Removal	**Artificial upwelling**	Pumping nutrient-rich waters from the deep ocean to the surface to increase biological productivity.	Enhanced biological production at the scale required for climatic benefits is likely to lead to enhanced remineralisation of organic material in the water column, significantly depleting mid-water oxygen levels and increasing methane and nitrous oxide release. It would also disrupt marine species habitats, change species composition, and alter ocean circulation patterns.
Solar Radiation Modification	**Marine cloud brightening**	Injecting sea salt into clouds that form above the ocean to increase reflectivity, potentially reducing global temperatures	Highly unpredictable and could lead to changes in regional weather patterns, uneven cooling, and extreme weather events. Additional salt loads returning to the ocean surface will slow air-sea gas exchange – thus CO2 uptake by oceans – reducing light and temperature levels and affecting ocean circulation. On land, increased salt deposition could corrode coastal infrastructure, pollute waterways, and harm agricultural productivity. Large-scale seawater pumping and filtration will ingest and kill significant numbers of marine organisms.
	Ocean reflectivity enhancement	Using microbubbles or foam to increase ocean surface reflectivity and reduce heat absorption. Methods include using ships equipped with special nozzles to produce microbubbles, or using chemicals (possibly surfactants that are toxic to marine life) to stabilise the bubbles.	Could disrupt marine ecosystems by reducing the sunlight that phytoplankton need for photosynthesis. It could also hinder gas exchange, leading to lower oxygen levels in the water, affecting marine biodiversity and productivity

Sources: CIEL (2024). The risks of geoengineering: accelerating biodiversity loss and compounding planetary crises. *Joint Group of Experts on the Scientific Aspects of Marine Protection (GESAMP) (2019).* High-level review of a wide range of proposed marine geoengineering techniques. *HOME Alliance (2024),* Briefing on Marine Geoengineering*; Friends of the Earth,* What is Marine Geoengineering?

3. International governance

The 1992 **UNFCCC** addressed the need to reduce greenhouse gas (GHG) emissions and removal by both natural sinks and removal of CO2 by technology. The ensuing **Paris Agreement** (2015) aims to keep global temperature rise this century well below 2ºC above pre-industrial levels and to pursue efforts to limit that increase to 1.5ºC. It recognises that achieving net-zero emissions by the second half of the century – and allowing the Earth's surface to cool – will require complementing drastic emission reductions with the removal of CO2 from the atmosphere. [10]

The Paris Agreement encourages innovation, technology development, and cooperative mechanisms that can accommodate CDR, including natural solutions and technological methods. The precautionary principle embedded in both frameworks stresses the need for careful evaluation of these methods to avoid risks to the environment and society. Both the UNFCCC and the Paris Agreement emphasise that climate actions should not harm ecosystems or biodiversity. Significantly, however, neither the UNFCCC nor the Paris Agreement explicitly mentions mCDR projects.

The Paris Agreement also provides for the establishment of market mechanisms to give countries opportunities to invest in CDR projects through carbon trading or international cooperation, enabling CDR projects to be financed through carbon credits. At COP29 in November 2024, countries agreed rules to implement this provision, but the rules for carbon removal remain insufficient.[11]

Box 3: IPCC's mixed signals about carbon dioxide removal

The IPCC provides scientific assessments to guide the UNFCCC and the Paris Agreement. The 2023 IPCC report warned that overshooting 1.5ºC increase of global average temperature entails adverse and potentially irreversible impacts, with additional risks for human and natural systems growing alongside the magnitude and duration of overshoot.

The IPCC acknowledges that, in addition to drastic emission cuts, significant amounts of CO2 removal from the atmosphere will be needed by the second half of the century to balance residual emissions from hard-to-abate sectors (e.g. heavy industry) and to achieve net negative emissions to allow the Earth's surface to cool. Protecting and restoring natural ecosystems, such as forests, wetlands, and grasslands, is recommended by IPCC as a low-risk, high-benefit strategy for CDR. It points to the huge risks and uncertainties of large-scale deployment of non-natural CDR measures and rejects SRM as a valid solution. It also warns that reliance on such practices is delaying the deep emission cuts that are necessary right now.

Recent research doubts that temperature decline after overshoot is feasible and concludes that mitigation of climate risks can only be achieved effectively by rapid reduction of emissions to net-zero, before 1.5C is reached.

Source: IPCC (2023). Sixth Assessment Report. Schleussner, Carl-Friedrich, et al (2024), Overconfidence in climate overshoot | Nature.

10 UNFCCC (n.d.). The Paris Agreement.
11 Carbon Market Watch (2024). COP29: Complex Article 6 rules pave way to unruly carbon markets.

In 2008, the **Convention for Biological Diversity** (CBD) called for a moratorium on ocean fertilisation. In 2010, it broadened its de facto moratorium to include all climate-related geoengineering activities 'until there is an adequate scientific basis on which to justify such activities[12, 13]. It urged countries to avoid deploying geo-engineering activities until comprehensive risk assessments were conducted. At the 2024 Biodiversity COP16, the parties reaffirmed their commitment to this decision[14].

In addition to the UNFCCC and CBD, other international instruments related to the governance of mGE include[15] :

- The 1996 Protocol to the London Convention (**London Protocol**), its amendment in 2013 (yet to be ratified) and a 2008 Resolution of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (**London Convention**): These prohibit ocean fertilisation for purposes other than legitimate scientific research. Efforts are underway to expand the London Protocol to include techniques such as marine cloud brightening and OAE[16].
- The 1982 **UN Convention on the Law of the Sea (UNCLOS)** was signed by 117 states and establishes rules to enable equitable and efficient utilisation of ocean resources and to protect and preserve the marine environment. While UNCLOS does not regulate ocean CDR, it defines jurisdictional boundaries, determining which countries oversee such activities. Its provisions on marine environmental protection may shape national regulations, as many ocean CDR methods involve introducing materials (e.g. nutrients in ocean fertilisation, alkaline substances in OAE) that could cause marine pollution.
- The 2023 **Biodiversity Beyond National Jurisdiction (BBNJ) Agreement** was adopted to supplement UNCLOS requirements, and includes the requirement to protect 30% of the ocean by 2030. It aims to ensure the conservation and sustainable use of marine biological diversity of the high seas and the deep sea and sets out rules for area-based management and EIAs. The BBNJ Agreement has significant potential to implement a moratorium on ocean CDR in areas beyond national jurisdiction, but whether that potential is realised will depend on countries' willingness and ability to implement it effectively. For the Agreement to enter into force, it must be ratified by at least 60 countries, which could take several years.
- A landmark **Advisory Opinion of the International Tribunal on the Law of the Sea (ITLOS)** clarifies States' obligations to protect the marine environment from climate change. mGE conflicts with UNCLOS when it simply transforms one type of pollution into another, making it incompatible with States' obligations to protect marine biodiversity for the purposes of climate change mitigation and adaptation.[17]
- The **OSPAR Commission** oversees the protection of the marine environment of the North-East Atlantic and has taken a cautious and proactive stance on mGE. OSPAR's focus includes ocean fertilisation and other geo-engineering techniques that might form part of climate change mitigation efforts. In 2007, OSPAR banned ocean fertilisation within its jurisdiction, except for legitimate scientific research. In 2013, OSPAR amended Annex V to the OSPAR Convention to include mGE activities and to impose a permit system and stringent EIAs for any geo-engineering activities.

12 Keane, K. (2020). 'Geo-engineering the climate: A preliminary examination of international governance challenges and opportunities'. Trinity College Law Review, 23(1), 56-86.
13 CBD (2010). Tenth meeting of the Conference of the Parties to the Convention on Biological Diversity, 18-29 October 2010.
14 CIEL (2024). UN Biodiversity Conference reaffirms geoengineering moratorium but falls short on fossil fuel phaseout.
15 Webb, R.W. (2024). International governance of ocean-based carbon dioxide removal: recent developments and future directions. Sabin Center for Climate Change Law. Columbia Law School.
16 Lyons, LBL Y., Santillo, D. and Cantonini, F. (2024). 'Legitimate Scientific Research: Objective Scientific Assessment of Marine Geoengineering Activities under the London Convention and London Protocol.' International Journal of Marine and Coastal Law, 39(3).
17 ITLOS (2024). Request for an advisory opinion submitted by the commission of small island states on climate change and international law. Case 31.

4. EU policy framework

The EU pursues a precautionary and regulatory approach to mGE, focusing on preventing harmful interventions in the ocean.

At EU level, CDR has entered the EU climate policy scene through multiple policy doors (see Annex 1)[18], such as the European Green Deal, the EU Climate Law and the Fit for 55 Package. The Commission's 2040 Climate Target Plan (to reduce net emissions by 90% by 2040 relative to 1990) and its Industrial Carbon Management Strategy rely heavily on carbon capture and carbon removal, but do not address the effectiveness of these technologies. The EU Emissions Trading System (ETS) does not include carbon removal directly, but could indirectly allow revenues to be used for removal initiatives.

The EU is committed to protecting and restoring marine ecosystems and promoting nature-based solutions to combat climate change. Announced by European Commission President Ursula von der Leyen as part of the 2024-2029 programme. the Ocean Pact is a key opportunity to step-up efforts to restore the ocean to health and prohibit harmful activities such as mGE and oil and gas drilling. The Blue Manifesto lists 50 measures for the EU to include in the Ocean Pact[19].

Two key EU policy instruments are central to mGE[20].

- **The Marine Strategy Framework Directive (MSFD)** aims to protect the marine environment across Europe and restore European seas to good environmental status. It provides the framework for the ecosystem-based management of human activities at sea, and requires countries to put in place targets and measures to reduce environmental impacts. The objectives on biodiversity, food webs, contaminants, seafloor integrity, hydrographical conditions and introduction of energy are all relevant to mGE. In order to prevent the roll-out of false climate solutions such as mGE, a better alignment between the MSFD and EU climate policies is a prerequisite.
- **The Carbon Removal and Carbon Farming (CRCF)** Certification Regulation[21] establishes a voluntary EU governance certification system for carbon removal, carbon farming and carbon storage in products across Europe. It aims to avoid greenwashing by applying and enforcing the EU quality framework criteria consistently. The Regulation focuses on rules for quantifying carbon removal and long-term storage of carbon, with minimum sustainability requirements that reconcile the objectives of climate change mitigation and the protection and restoration of biodiversity and ecosystems. The Commission intends to look into detailed certification for mCDR methodologies in 2025.

The European Commission and European Parliament have repeatedly called for prioritising emissions reductions over CDR, stressing the importance of conserving biodiversity and enhancing natural sinks and reservoirs.

18 Carbon Market Watch (2023). Poor framing: The role of negative emissions technologies in existing climate policy frameworks.
19 Seas At Risk (2024). Blue Manifesto.
20 M., Geden, O. and Schenuit, F. (2023). Into the Blue: The role of the ocean in climate policy. SWP Berlin.
21 Regulation of the European Parliament and of the Council establishing a Union certification framework for permanent carbon removals, carbon farming and carbonstorage in products, (EU) 2024/3012

In 2023, the European Commission published its Communication 'A new outlook on the climate and security nexus: Addressing the impact of climate change and environmental degradation on peace, security and defence.[22]
It highlights the poorly understood consequences and risks of these technologies, notes the existing legal and governance gaps, and states that it will be guided by the precautionary principle in comprehensively assessing any such climate interventions.

The EU Scientific Advice Mechanism, responding to a request from the European Commission, advises maintaining a focus on emissions reductions and establishing an EU moratorium on SRM technologies. However, the recommendation to review this position every five years and to support certain outdoor experiments sends mixed signals regarding the commitment to preventing the use of solar geoengineering[23].

The EU is proactively promoting carbon capture and storage (CCS), as the basis for many CO2 removal techniques (see Annex 2). The safety and permanent nature of ocean carbon storage have recently come under scrutiny, with two experiments in Norwegian waters proven to be failing[24].

The European Parliament has raised concerns about geoengineering and called for international governance to address its risks[25]. Its 2021 Resolution on the climate crisis emphasises the need for caution in deploying geoengineering technologies and strong international oversight, especially for mGE. In 2023, the Parliament passed a resolution calling on the Commission and the Member States to initiate a non-use agreement on SRM at international level, given the absence of a full global consensus on its acceptability[26].

Europe is a strong actor in the international ocean governance scene. The 27 EU Member States, the UK and Norway are signatories to the London Protocol and the London Convention, and, together with the EU, are Parties to the CBD and UNCLOS. The EU and Member States have signed the BBNJ Treaty and intend to ratify that Treaty[27], as have the UK and Norway[28]. The EU and European countries are thus in a key position to champion a strong precautionary approach and put ocean health at the forefront.

22 Joint Communication to the European Parliament and the Council: A new outlook on the climate and security nexus: Addressing the impact of climate change and environmental degradation on peace, security and defence, JOIN(2023) 19 final.
23 Scientific Advice Mechanism to the European Union (2024), Solar Radiation Modification
24 Institute for Energy Economics and Financial Analysis (2023). Norway's carbon capture and storage projects augur geological risks in global aspirations to bury carbon dioxide.
25 European Parliament (2021). Carbon dioxide removal: Nature-based and technological solutions. Think Tank.
26 European Parliament resolution of 21 November 2023 on the UN Climate Change Conference 2023 in Dubai, United Arab Emirates (COP28).
27 European Commission, Directorate-General for Maritime Affairs and Fisheries (2024). The EU is ready to ratify the High Seas Treaty.
28 High Seas Treaty, Signature and Ratification Progress Table.

Box 4: Blue carbon: Nature based methods to remove carbon

So-called blue carbon is gaining attention in EU climate policy. This refers to carbon captured and stored in marine and coastal ecosystems, such as mangroves, tidal marshes, seagrass meadows, marine sediments and kelp. The deep ocean, whales and fish stocks also have a role in enhancing carbon sequestration and climate mitigation via the biological carbon pump.

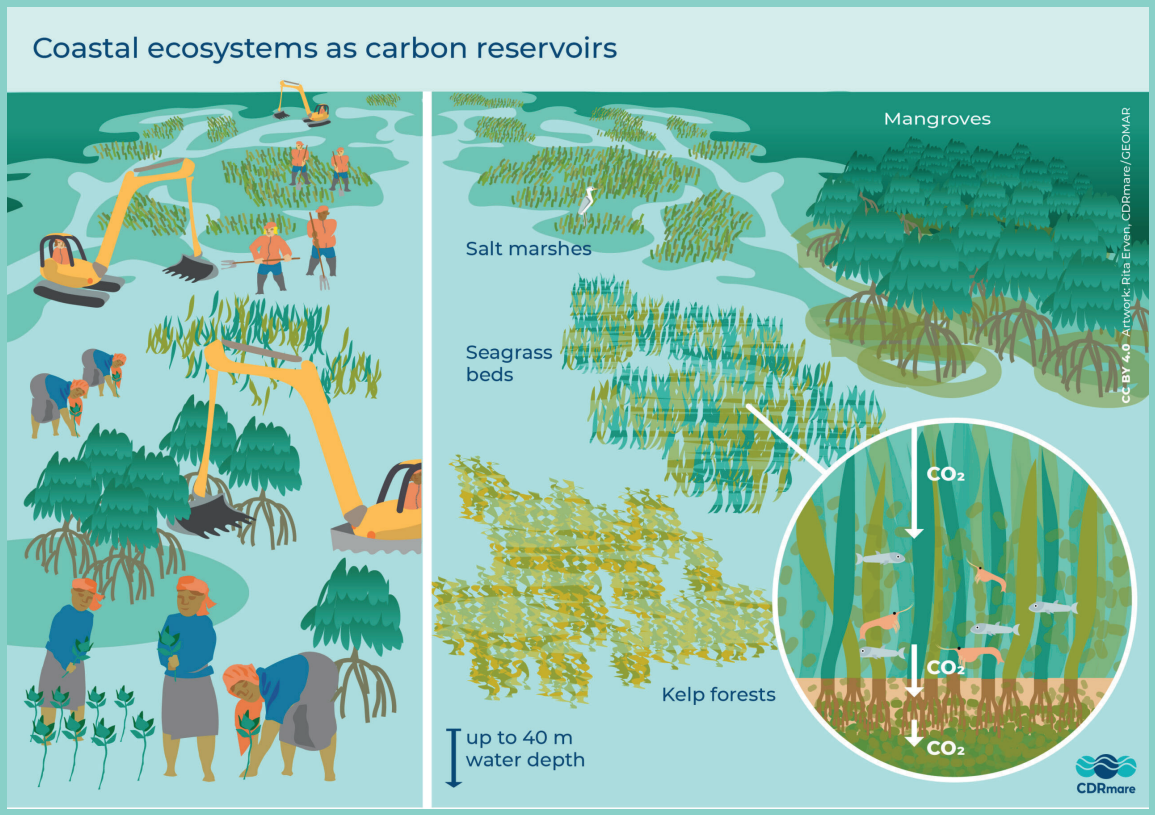
Blue carbon is a form of nature-based CO2 removal. As such, its use is promoted under the EU Nature Restoration Law, which advocates the use of natural carbon sinks. This could be complemented by establishing marine protected areas (MPAs) focusing on blue carbon locations.

The IPCC recommends integrating blue carbon strategies into nationmal climate plans, such as Nationally Determined Contributions (NDCs). It also highlights the co-benefits of blue carbon, such as enhancing biodiversity and marine habitats, protecting coastal areas from storm surges and erosion, and supporting livelihoods dependent on fisheries and ecotourism.

However, there are scientific doubts (including in the IPCC) about the permanence of CO2 sequestration in blue carbon, as the extra carbon would likely be returned to the atmosphere on decadal timescales. There is also a risk of greenwashing: several countries are already cheating to achieve net zero with passive land sinks, and blue carbon accounting could be similarly misused.

The European Environment Agency (EEA) concludes that 'Measures to stimulate and/or safeguard carbon storage in the marine environment need urgent attention, since only a limited number of marine habitats have been considered to date'. These measures, however, can take decades to take effect, thus realising only a limited amount of carbon sequestration within the timeframe of the policy implementation process.

The new Ocean and Fisheries Commissioner has been tasked with exploring the 'feasibility of European blue carbon reserves and other ways to help build a new business model for coastal communities'.



Cc Artwork: Rita Erven, GEOMAR

Sources: European Marine Board (2023). Blue carbon: Challenges and opportunities to mitigate the climate and biodiversity crises; IPCC (2019). Changing ocean, marine ecosystems and dependent communities; European Environment Agency (2022). Carbon stocks and sequestration in terrestrial and marine ecosystems: a lever for nature restoration?. Von der Leyen, U. (2024), Mission letter to Costas Kadis, Commissioner Designate for Fisheries and Oceans.

5. Growing opposition to marine geo-engineering

In 2022, more than 60 senior climate scientists and governance scholars from around the world launched a global initiative calling for an International Non-Use Agreement on Solar Geoengineering (including marine cloud brightening). More than 500 scientists now support this call for a Non-Use Agreement[29].

Large coalitions of civil society organisations, such as Climate Action Network International (CAN) -International)[30], the Hands Off Mother Earth Alliance[31] the Deep Sea Conservation Coalition[32], are advocating for a complete prohibition or strict moratorium on mGE. They argue that such interventions could have severe ecological consequences and harmful impacts on communities and are sceptical about their ability to address climate change meaningfully. These groups are influential in pushing for precautionary measures and halting large-scale geoengineering projects.

Indigenous groups and environmental justice movements, such as the Indigenous Environmental Network (IEN), also express strong opposition to geoengineering, arguing that mGE poses a direct threat to traditional livelihoods and the environmental balance in oceans and coastal areas.

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"The role of geo-engineering should, in a world of responsibility, in a world of scientifically enlightened decision-making and ecological understanding, it should be zero.
There is no role for geo-engineering. Because what is geo-engineering but extending the engineering paradigm?"

- (Vandana Shiva)

29 Solar Geo-Engineering (2022). Non-Use Agreement.
30 CAN International (2024), Position on Marine Geoengineering - Climate Action Network
31 Hands off Mother Earth Alliance
32 Deep Sea Conservation Coalition (n.d.). DSCC position statement on marine carbon capture, removal and storage.docx.

6. Europe to champion real and strong climate action, reject false solutions

Seas At Risk's position is grounded in the precautionary principle, in alignment with existing EU and international environmental laws and governance frameworks. It reflects the urgent need to protect marine ecosystems from potentially catastrophic experimentation and to restore the ocean to health by 2030 so it can continue its natural function as an important climate regulator and carbon sink.

To address mGE's threats, Europe should:

Reduce GHG emissions to zero
halve energy demand (compared to 2020), phase out fossil fuels, and transition to 100% renewable energy by 2040.[33]

Restore the ocean and seas to good health by 2030
by implementing the Blue Manifesto roadmap.[34]

Enforce the international moratorium on geo-engineering
under the CBD, support efforts to regulate additional mGE technologies under the London Convention and Protocol, and ratify and implement the BBNJ Treaty.

Prohibit mGE in European seas
and exclude mGE technologies and practices from the CRCF Regulation and 2040 EU Climate Target. This ban should encompass research, testing and deployment of geo-engineering techniques.

Redirect existing and future funds
intended for research into mGE towards efforts **to restore the ocean to health and make it climate resilient by 2030.**

Prohibit ocean carbon storage
in the water column and on the seabed and halt storage in sub-seabed geological formations until there is proof of no environmental harm.

33 Climate Action Network Europe (2024). Energy Compass for the new policy cycle 2024-2029.
34 Seas At Risk (2024). Blue Manifesto: the roadmap to a healthy ocean in 2030

7. Annex 1:
EU regulatory frameworks relevant for marine geo-engineering

No EU-wide policies specifically promote large-scale mGE. However, several relate directly or indirectly to mGE[35],[36].

Climate and environment policies

- The MSFD (2008) provides a legal framework for the protection of the marine environment across Europe, promoting the sustainable use of seas and ensuring that human activities are conducted sustainably. The MSFD is currently being revised, presenting an opportunity to make a closer link to climate policy.
- The European Green Deal (2019) sets out the EU's goal to achieve climate neutrality by 2050, emphasising the need for negative emissions technologies. While CDR is not specifically promoted, it is an important tool for balancing residual emissions that cannot be fully eliminated. The European Green Deal Communication does not mention the ocean's carbon-absorbing potential.
- The Fit for 55 package (2021) is a comprehensive set of legislative proposals to reduce GHG emissions by at least 55% by 2030. It does not include geo-engineering, but gives scope for expanding and enhancing carbon sinks (such as afforestation), and carbon capture, utilisation, and storage (CCUS).
- The ETS does not include carbon removal within its scope, but revenue from the system can be used to fund CDR initiatives.
- The EU Climate Law (2021) enshrines the 2050 climate neutrality target in law, encouraging the use of technologies like CCS and CDR. It mandates that the EU must reduce net GHG emissions by at least 55% by 2030, leaving room for CDR technologies to help bridge the gap.
- The Effort Sharing Regulation (ESR, 2018 and 2023) aims to reduce emissions from all sectors not covered by the main ETS (also known as ETS1 which covers industry, electricity and heat generation, and intra-EU aviation and international shipping).
- Communication (2021) on Sustainable Carbon Cycles stresses the importance of enabling a business model that rewards land managers for carbon sequestration in full respect of ecological principles (carbon farming), and creating an EU internal market for CCUS through innovative technologies.
- The 2022 joint Communication by the Commission and the EU High Representative on the EU's international ocean governance agenda emphasised that before the EU advances any new mCDR approaches, there must be an adequate scientific basis to justify such activities, with the associated risk and impacts appropriately considered.
- The 2022 Communication 'Towards a Strong and Sustainable EU Algae Sector' highlighted the role of macro-algae (seaweed) cultivation in climate change mitigation through carbon sequestration and set out targeted actions to upscale algae cultivation throughout the EU.
- The 2022 revision of the Land Use, Land-Use Change and Forestry Regulation (LULUCF) includes the possible consideration of accounting for CO2 removal in marine ecosystems in the future.

35 Böttcher, M., Geden, O. and Schenuit, F. (2023). Into the Blue: The role of the ocean in climate policy. SWP Berlin.
36 Carbon Market Watch (2023). Poor framing: The role of negative emissions technologies in existing climate policy frameworks.

- In February 2024, the European Commission published a Communication on a 2040 climate target for the EU. This recommends reducing the EU's net GHG emissions by 90% by 2040.
  The EU Climate Law is expected to be amended to reflect this target. The plan relies heavily on carbon capture and carbon removal at scale, but does not examine the effectiveness of such technologies.
- The EU Industrial Carbon Management Strategy (2024) seeks to develop technologies (and the associated regulatory and investment framework) to capture, store, transport and use CO2 emissions from industrial facilities, as well as to remove CO2 from the atmosphere.
- The CRCF Regulation (2024) sets out a framework of rules for certifying carbon removal processes as measurable, verifiable, and contributing to the EU's climate neutrality goals. It has the potential to link to marine-based CO2 removal methods. The Commission will develop delegated acts for certification methodologies, including screening marine methods in 2025. By 2026, the Commission must assess the possibility of including permanent carbon removal in the ETS.
- The Nature Restoration Law (2024) sets a legally binding target to restore at least 20% of degraded EU land and sea areas by 2030. Carbon removal is promoted, particularly restoration of damaged terrestrial and aquatic ecosystems crucial for storing CO2, such as peatlands, forests, grasslands, marshlands, heathland and scrub, and coastal wetlands.
- The European Ocean Pact forms part of the European Commission's 2024-2029 programme. It represents a step in the right direction for ocean protection and an opportunity to phase out or ban harmful activities.

Research and innovation

- CDR is supported by EU-funded research initiatives under Horizon Europe and previous programmes (e.g. Horizon 2020). Projects related to mGE include OceanNETs (Ocean-based Negative Emission Technologies - analysing the feasibility, risks, and co-benefits of ocean-based negative emission technologies for stabilising the climate) and SEAO2-CDR - Strategies for the evaluation and assessment of ocean-based CDR.
- The LIFE Programme finances environmental and climate action projects, including blue carbon projects that focus on conserving and restoring marine and coastal ecosystems to enhance their capacity to store carbon.
- The EU Innovation Fund, created as part of the ETS, finances large-scale demonstration projects in CCS, CDR, and other innovative low-carbon technologies. It supports the development and deployment of large-scale CCS facilities in sectors such as cement, steel, and chemicals.

8. Annex 2

EU policies that advance climate capture and storage (CCS) technologies

Many land-based and marine CDRs rely on storage of CO2 in or under the ocean. Several policies and regulations are relevant here.

- ETS: CCS is supported under the ETS, which is the EU's key tool for reducing industrial GHG emissions. The system allows for the inclusion of CCS installations, providing financial incentives for industries to adopt CCS to meet emissions reduction targets.
- The CCS Directive (2009/31/EC) establishes a legal framework for the safe selection of storage sites and regulates storage permits.
- Under the ETS Directive (2003/87/EC), any CO_2 captured and stored through CCS is not counted as an emission, providing a significant economic benefit for companies.
- The Trans-European Energy Network (TEN-E) Regulation provides a legal framework for identifying and funding cross-border infrastructure projects, including CO_2 transportation networks needed for CCS projects. It enables the identification of Projects of Common Interest (PCIs) that promote the development of CCS infrastructure across the Member States.
- The Strategic Energy Technology (SET) Plan includes specific targets for CCS deployment and promotes cooperation between Member States to develop carbon capture infrastructure and improve storage solutions. The goal is to make CCS commercially viable by 2030 by funding pilot projects and research across Europe.
- The Net Zero Industry Act (2023) scales up the manufacturing of clean technologies in the EU and addresses technologies that will make a significant contribution to decarbonisation. Its list of net zero technologies includes carbon capture and transport technologies (but not CRD).
- The Institute for Energy Economics and Financial Analysis (IEEFA) 2024 analysis found that the EU's carbon capture plans rely on theoretical and unproven technical solutions, risk distracting from the rapid emission cuts required, and could require €140 billion from the public purse[37].

37 Institute for Energy Economics and Financial Analysis (2023). Norway's carbon capture and storage projects augur geological risks in global aspirations to bury carbon dioxide.

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