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PLAYING GOD WITH CLIMATE

The EU's geoengineering conundrum

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by

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The Earth is heating up – and fast. This year is set to become the warmest on record, with global surface temperatures exceeding 1.5°C each of the past 12 months[(1)]. In fact, the United Nations Secretary-General Antonio Guterres recently warned that the world is on track to reach a 'hellish' 3°C of global warming by the end of the century[(2)].

While CO_2 emissions reductions are well underway as part of the energy transition process this may prove insufficient to forestall the worst consequences of global warming. Therefore, geoengineering – a deliberate, large-scale intervention in the Earth's natural systems – has been increasingly floated as a potential solution to the climate crisis. So far, the EU has excluded certain geoengineering approaches from its climate agenda due to their controversial nature. However, as global temperatures continue to rise and societies become painfully aware of the sweltering future that awaits, the EU must take a more active role in the debate over whether geoengineering could provide deliverance from our climate woes.

Summary

- Despite accelerating energy transition efforts, the world is well on track to overshoot the warming targets of the Paris Agreement. This could potentially lead to cascading and irreversible climate impacts.
- Geoengineering is increasingly floated as one of the solutions that could forestall the worst consequences of global warming.
- While in recent years carbon dioxide removal (CDR) technologies have gone mainstream by gaining political and financial support, solar radiation management (SRM) approaches such as stratospheric aerosol injection, marine cloud brightening, and cirrus cloud thinning remain highly controversial.
- To prevent rogue SRM deployment and evaluate the potential of this technology as a climate fix of last resort, the EU needs to establish a code of practice for solar geoengineering experiments, support solar geoengineering research, and initiate international talks on solar radiation management governance.

GEOENGINEERING 101

Geoengineering refers to a set of approaches that manipulate the environment to mitigate the impacts of climate change. These approaches come in two forms: carbon dioxide removal (CDR) and solar radiation management (SRM). CDR extracts CO_2 from the atmosphere and stores it, while SRM cools the Earth by reflecting solar radiation.

While CDR and SRM fall under the same geoengineering umbrella, they differ significantly. CDR involves fewer uncertainties and risks, making it a viable tool, alongside energy transition efforts, for tackling climate change. However, the main drawback of CDR is its high cost and slow pace in reducing CO_2 emissions. Conversely, SRM offers a theoretically quick and inexpensive solution to rising temperatures but carries the risk of unintended consequences and does not reduce greenhouse gas emissions, thus failing to address the underlying cause of global warming.

CARBON DIOXIDE REMOVAL

CDR solutions can be grouped in two broad categories: nature and technology-based. Both remove CO_2 emissions from the atmosphere (or sequester them, to use the industry's parlance) and store them in different carbon sinks.

Forest management and soil carbon sequestration are some of the best-known nature-based CDR solutions. Planted trees absorb CO_2 during photosynthesis and store it as carbon in their trunks and roots. Meanwhile, soil carbon sequestration involves transferring CO_2 from the atmosphere into the soil primarily through plant residues, thereby 'locking away' the CO_2 in the form of organic carbon.

While easy to implement, these solutions are not without limitations. Chief among them is the temporary nature of carbon storage. Trees, for instance, store carbon only as long as they live, which can be up to a century or more, depending on the species. Once a tree dies and decomposes, the carbon it absorbed is released back into the atmosphere. Similarly, soil carbon is subject to decomposition by microbes, which eventually release the stored CO_2 back into the atmosphere.

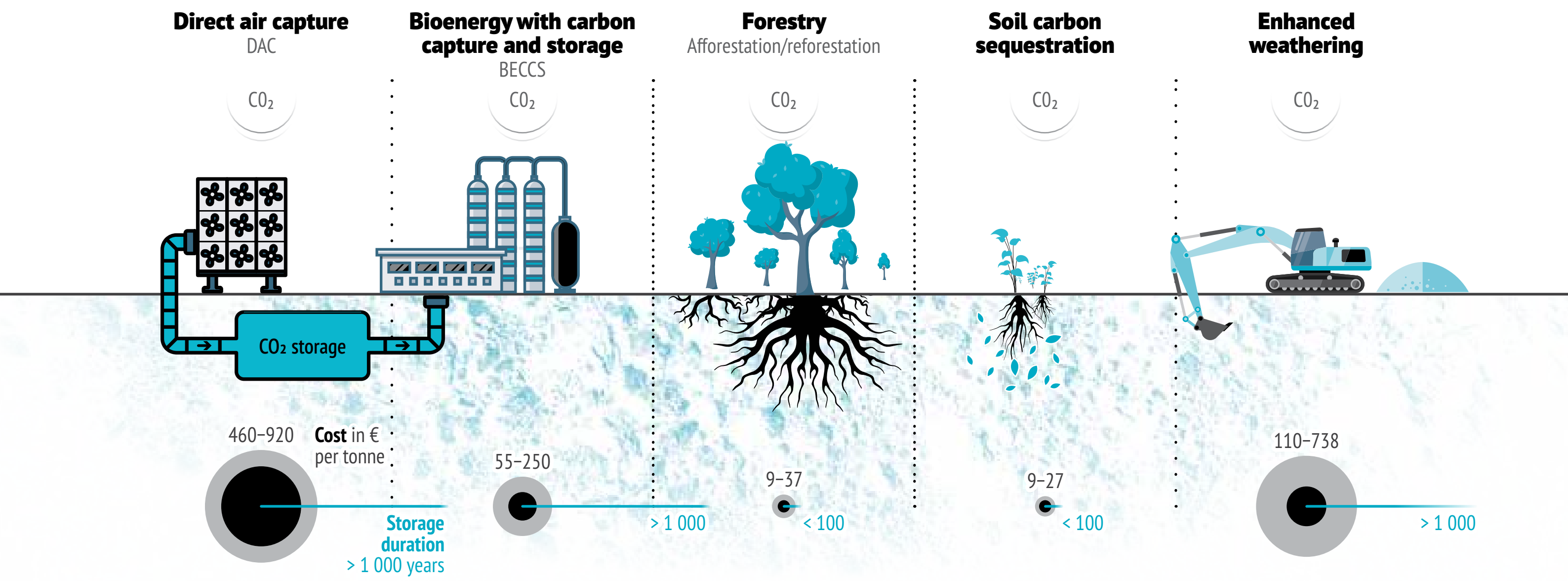
Direct air capture (DAC) and bioenergy with carbon capture and storage (BECCS) are among the best-known technology-based CDR solutions. DAC technology uses large fans to draw ambient air through a chemical substance that binds with the CO_2 molecules. The CO_2 is later separated from the chemical substance using heat, purified, and finally either stored underground or used for industrial purposes. Meanwhile, BECCS generally involves capturing and storing CO_2 that is produced during the process of generating energy using biomass. Because plants absorb CO_2 as they grow, this offers a way of removing CO_2 from the atmosphere.

Despite their great potential, both technologies face several hurdles. Due to immense low-carbon electricity demand, DAC offers a prohibitively expensive way of sequestering carbon. By contrast, BECCS struggles with issues of feedstock availability and biomass sustainability. Although investments and learning curves may reduce costs, developers will also have to deal with a lack of carbon handling and storage infrastructure.

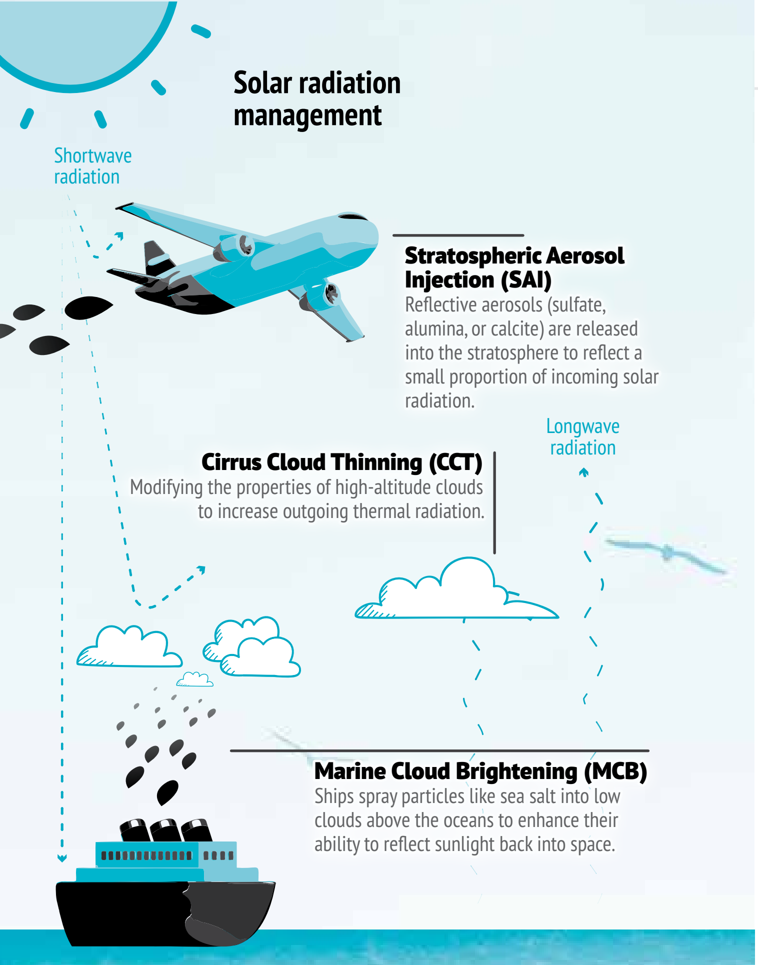
SOLAR RADIATION MANAGEMENT

Although never tested on a large scale, there is no shortage of ideas on how SRM could work. In principle,

Carbon dioxide removal options



Data: McKinsey, 'Carbon removals: How to scale a new gigaton industry', 2024



Data: Alliance for Just Deliberation on Solar Geoengineering, 'Solar Geoengineering', 2024

these proposals focus on increasing the reflectance of incoming solar radiation (a concept also known as the albedo effect), thereby reducing the warming impact of sunlight on the Earth's surface and lower atmosphere.

Stratospheric aerosol injection (SAI) is the most studied SRM method for planetary-scale global warming reduction. It involves injecting reflective aerosols (microscopic solid or liquid particles) into the stratosphere, which would reflect a portion of sunlight, mimicking the cooling effects of volcanic eruptions. For context, the 1991 eruption of Mount Pinatubo caused a temporary 0.5°C drop in global temperatures[3]. Therefore, SAI is considered one of the quickest and cheapest climate fixes, with effects felt within months and annual costs estimated in billions of euros, compared to the trillions needed for the global energy transition[4].

However, SAI is mired in controversy due to its scientific uncertainties. Studies suggest SAI could disrupt weather patterns, reduce precipitation, deplete the ozone layer, and cause acid rain[5]. There is also a risk of 'termination shock', where abruptly stopping SAI practices could suddenly cause a rapid rebound in temperatures, potentially wreaking havoc on the environment[6].

Marine cloud brightening (MCB) and cirrus cloud thinning (CCT) are two other approaches that could help cool the planet. MCB involves spraying seawater aerosols into marine clouds to brighten them, increasing sunlight reflection and reducing heat absorption. Meanwhile, CCT would work by making high-altitude cirrus clouds, which are made of ice crystals, less effective at trapping heat. Scientists would achieve this by injecting bismuth triiodide or silver-iodide particles into the clouds to form bigger ice crystals, which fall faster. This makes clouds thinner and less frequent, allowing more heat to escape.

Compared to SAI, MCB and CCT are less controversial. Although untested, early models suggest they may pose fewer environmental risks[7]. Moreover, although their deployment costs are unknown, scientists generally believe these techniques would likely be inexpensive for mitigating global warming, especially considering the costs of inaction[8]. Yet, given the lack of research into MCB and CCT, it is difficult to predict their effectiveness compared to SAI in reducing global temperatures.

THE EU AND GEOENGINEERING

The EU holds contrasting views on CDR and SRM. The Commission's long-term strategy to achieve climate neutrality by 2050 partially relies on technology-based CDR approaches like DAC or BECCS[9]. Meanwhile, initiatives like the Net-Zero Industry Act, which aims to support the scaling of clean technologies, have the goal for the EU to develop Co_2 storage capacity of at least 50 million tonnes per year by 2030[10]. More recently, in 2024, the EU released its Industrial Carbon Management Strategy, which aims to promote investments and support the development of a carbon management ecosystem[11].

Conversely, the EU is less enthusiastic about SRM. Brussels maintains that the only way to halt global warming is by bringing greenhouse gas emissions to net-zero[12]. Furthermore, it argues that SRM, in the current state of development, poses 'an unacceptable level of risk for humans and the environment'[13]. However, the EU also admits that as there is no clear scientific knowledge on the impact and consequences of such actions, a comprehensive review process is essential[14].

TIME FOR ACTION

While the EU has so far been reluctant to assume a greater role in the debate over SRM, it is time for this to change. The fact is that the world is on course to overshoot the Paris Agreement goals, meaning that it is imperative for the EU to act. It would be irrational to ignore a potential climate solution, even if the odds are low.

This view, however, is not universally shared. Since 2022, some 500 scientists have signed an appeal for a solar geoengineering non-use agreement, stipulating 'no public funding, no deployment, no patents, no experiments, and no support in international forums' [15]. This was partly driven by the concern that introducing SRM into policy debates would establish it as a viable climate policy option, disincentivising broader energy transition efforts.

While there are legitimate concerns about SRM, there is a clear need to understand the science behind it and the rules of international engagement. As global temperatures rise and frustration over the lack of climate progress grows, it is likely that individual actors will unilaterally proceed with SRM experiments and deployments without any international oversight or accountability. In fact, SRM has already piqued the interest of a growing number of billionaires, tech leaders and private foundations, including some driven by the ethos that neat engineering fixes are the solution for most of life's ills and that the private sector can be more effective in delivering solutions than governments [16].

To address this, the EU should adopt a three-pronged approach:

- Establish a code of practice for SRM experiments. The good news is that the EU does not have to reinvent the wheel. The national scientific academies of partners such as the United Kingdom and the United States have already made significant progress in this area. The task would be to build on their and others' findings and develop a unified approach that could gain broader support from the international scientific community.
- Support scientific research into SRM approaches. Currently, there is little understanding of how different SRM methods work. This gap creates fertile ground for speculation and makes it difficult, if not impossible, to have meaningful conversations about their potential utility or lack thereof. Most data on SRM approaches comes from computer models, which, while useful, cannot completely replace practical field experiments.
- Initiate high-level international discussions on SRM governance. It is crucial to comprehensively assess the risks and uncertainties of major climate interventions while ensuring this process is inclusive. There is a risk that certain SRM approaches might have unequal global consequences, benefiting some while disadvantaging others, thereby encouraging the use of these technologies for geopolitical purposes.

In the end, it is important to stress that climate fixes, whether in the form of CDR or the more controversial SRM, cannot substitute for cutting emissions. However, as emissions grow and temperatures continue to break records, it is crucial to know if there is a plan B, C or even F on the table. This is not about playing God but ensuring that if the time comes, we will not need to pray for one.

References

(1) Mooney, A., 'World in line for hottest year as 1.5C limit breached for 12 months in a row', *Financial Times*, 10 July 2024 (ft.com/content/31e565e9-e08a-42c7-90e6-6ccdc3dc47e0).

(2) Carrington, D., 'World facing "hellish" 3C of climate heating, UN warns before Cop28', *The Guardian*, 20 November 2023 (theguardian.com/environment/2023/nov/20/world-facing-hellish-3c-of-climate-heating-un-warns-before-cop28).

(3) Voosen, P., 'Massive volcanoes could cool Earth more in a warming world', *Science*, 19 August 2021, (science.org/content/article/massive-volcanoes-could-cool-earth-more-warming-world).

(4) Tracy, S., et. al., 'Stratospheric aerosol injection may impact global systems and human health outcomes', *Elementa*, Vol.10, 21 December 2022 (online.ucpress.edu/elementa/article/10/1/00047/195026/Stratospheric-aerosol-injection-may-impact-global).

(5) Ibid.

(6) Parker, A. and Irvine, P, 'The risk of termination shock from solar geoengineering', *Earth's Future*, Vol. 6, Issue 3, March 2018 (agupubs.onlinelibrary.wiley.com/doi/10.1002/2017EF000735).

(7) Storelvmo, T., et. al., 'Cirrus cloud seeding: a climate engineering mechanism with reduced side effects?', *Philosophical Transactions of the Royal Society*, 28 December 2014 (royalsocietypublishing.org/doi/10.1098/rsta.2014.0116).; Li, M., et. al., 'Marine cloud brightening provides a glimmer of hope for climate change', Duke University (bassconnections.duke.edu/about/news/marine-cloud-brightening-provides-glimmer-hope-climate-change).

(8) 'Preliminary results for salt aerosol production intended for marine cloud brightening, using effervescent spray atomization', *Philosophical Transactions of the Royal Society*, 28 December 2014 (royalsocietypublishing.org/doi/10.1098/rsta.2014.0055); Muri, H., et. al., 'The climatic effects of modifying cirrus clouds in a climate engineering framework', *Journal of Geophysical Research: Atmospheres*, 20 March 2014 (agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2013JD021063).

(9) European Commission, 'About Industrial Carbon Management' (climate.ec.europa.eu/eu-action/industrial-carbon-management_en).

(10) European Commission, 'Questions and Answers on the Net-Zero Industry Act', 27 May 2024 (ec.europa.eu/commission/presscorner/detail/en/QANDA_24_2310).

(11) European Commission, 'Questions and Answers on the EU Industrial Carbon Management Strategy', 6 February 2024 (ec.europa.eu/commission/presscorner/detail/en/qanda_24_586).

(12) European Commission, 'Questions and Answers on a new outlook on the climate and security nexus', 28 June 2023 (ec.europa.eu/commission/presscorner/detail/en/qanda_23_3525).

(13) Ibid.

(14) Ibid.

(15) Kerry, J., et al., 'Not such a bright idea: cooling the Earth by reflecting sunlight back to space is a dangerous distraction', *The Conversation*, 1 March 2024 (theconversation.com/not-such-a-bright-idea-cooling-the-earth-by-reflecting-sunlight-back-to-space-is-a-dangerous-distraction-223353).

(16) De la Garza, A., 'Why billionaires are obsessed with blocking out the sun', *Time*, 24 February 2023 (time.com/6258126/solar-geoengineering-billionaries-george-soros/).

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