



WWF

CLIMATE
& ENERGY

POSITION
PAPER

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CARBON DIOXIDE REMOVAL, INCLUDING CARBON SEQUESTRATION IN NATURAL SYSTEMS

Position Summary

1. Most current scenarios that keep global warming within the Paris Agreement's 1.5°C limit rely on removing large amounts of carbon dioxide from the atmosphere using a mix of land-based carbon sinks and technological removal approaches, in addition to accelerated action to cut emissions.
2. Immediate efforts must **prioritise cutting greenhouse gas emissions rapidly and deeply**, as less emissions entering the atmosphere means there is less need for carbon dioxide removal later in the century. Relying on carbon dioxide removal to any significant extent is a high-risk approach given uncertainties to its deliverability at scale. Thus:
 - Carbon dioxide removal must not delay or replace efforts to cut greenhouse gas emissions.
 - Pathways that rapidly cut emissions and minimise the need for carbon dioxide removal must be prioritised.
3. However, **some carbon dioxide removal is likely needed** to limit global temperature rise to 1.5°C, both to cancel out hard-to-mitigate residual emissions and/or to reduce atmospheric carbon dioxide concentration in the event of temperature overshoot scenarios.
4. **There are a range of approaches** that could, in principle, be used to remove carbon dioxide from the atmosphere at very large scale, but all carry risks and their social acceptability can differ depending on the context.
 - All carbon dioxide removal approaches have potential trade-offs and/or scale limitations and no single approach will be the full removal solution in the most 1.5°C scenarios.
 - We should prioritise those approaches which remove carbon dioxide from the atmosphere and permanently sequester it in natural systems – particularly those which have proven benefits for people and nature as well as climate.
 - The reliability, costs and benefits, impacts, and risks of many approaches are not well-understood. Further research and development will help to ascertain whether they can be part of the climate solution, and their tradeoffs if so.
5. To the extent that carbon dioxide removal approaches are implemented, they should adhere to strict environmental and social safeguards in order to minimise negative consequences.

Position Statement

6. **Rapid and deep cuts to greenhouse gas emissions is the top priority in climate change mitigation** as it is better to prevent emissions getting into the atmosphere in the first place than it is to remove them later. Any chance of achieving the Paris Agreement's 1.5°C or well below 2°C global warming limit requires an immediate and ongoing increase in emissions reduction.
7. Relying on carbon dioxide removal to any significant extent is a high risk approach given uncertainties to its deliverability at scale, so **carbon dioxide removal must not delay or replace efforts to cut greenhouse gas emissions**. The feasibility, effectiveness and social acceptance of large-scale use of carbon dioxide removal is uncertain, therefore carbon dioxide removal must be about lowering the risks associated with higher global temperatures and not about enabling continued or additional burning of fossil fuels.
8. **More rapid and deeper emissions cuts in the short-term reduces the need for riskier carbon dioxide removal in the longer term**. Therefore, **pathways that minimise the need for large-scale carbon dioxide removal must be prioritised**.
9. However, alongside rapid and deep greenhouse gas emissions cuts, **some removal of carbon dioxide from the atmosphere will likely be needed to limit global temperature rise to 1.5°C / well below 2°C**, both for overshoot and non-overshoot scenarios¹.
 - a. To achieve net-zero, or net-negative, emissions, **carbon dioxide removal will be needed to cancel out residual emissions in hard-to-mitigate sectors** such as aviation and agriculture.
 - b. To reduce atmospheric carbon dioxide concentration in the event of temperature overshoot scenarios **carbon dioxide removal would be needed to pay back the carbon budget when it becomes overdrawn**.
10. **A range of approaches would be required to remove carbon dioxide at large scale**, as each potential approach has scale limitations, constraints and trade-offs – for example with land use, water and biodiversity. The costs and benefits of each potential carbon dioxide removal approach, and their different institutional and economic contexts and geographies, need to be carefully considered.
11. WWF considers that the following carbon dioxide removal approaches are among those which would **increase carbon sequestration in natural systems and have other benefits which together outweigh the costs**. Such approaches should be prioritised provided they adhere to strict environmental and social safeguards and consider storage permanence – i.e. they have benefits for nature, people and climate:
 - a. **Enhancement of forest carbon stocks** through:
 - i. **Restoration** of ecological functioning of degraded forest landscapes – comprising peatlands, mangroves, coastal wetlands/ecosystems or low productive land – by promoting multifunctional landscapes, including reforestation and afforestation.
 - ii. **Natural regeneration of forests**, assisted or otherwise.

¹ A 1.5°C "overshoot" scenario is one in where the global temperature rise exceeds the 1.5°C limit for a number of years before returning to below 1.5°C by the end of the century. Non-overshoot scenarios always remain below the temperature limit.

- b. **Enhancement of soil carbon** through:
 - iii. **Carbon sequestration in agricultural soils**, which also enhances soil health and productivity.
 - iv. **Soil sequestration using sustainable production of biochar.**
- 12. WWF considers that for the following approaches **the balance between costs and benefits and the unknown risks, is not yet clear**. Further research and development is needed to ascertain whether these potential carbon dioxide removal approaches can be part of the climate solution, as such, **they should neither be ruled out nor actively supported**.
 - a. **Afforestation** at scale on non-degraded land, which may not compensate the opportunity costs of land conversion, and may produce negative social impacts;
 - b. **Bioenergy with carbon capture and storage (BECCS)** is land-intensive and limited in spatial suitability but could, in appropriate circumstances and with adequate safeguards, provide carbon dioxide removal;
 - c. **Direct air capture and storage** is expensive and energy intensive but has large potential and fewer and less severe land-competition impacts; and
 - d. **Enhanced weathering of minerals on land** requires large volumes of materials implying negative impacts from mining and transport but could permanently store a sizable amount of carbon dioxide.
- 13. Based on current evidence WWF considers a number of proposed carbon dioxide removal approaches are **not suitable for use at this time** since, at present, **the ecological and social uncertainties far outweigh the known benefits**. Examples include but aren't limited to:
 - a. **large-scale ocean fertilisation** as it has a high potential for unintended and damaging side effects for ocean ecosystems; and
 - b. **Enhanced weathering of minerals added to the oceans** appear to have environmental and other costs that outweigh the potential climate benefits.
- 14. To the extent that carbon dioxide removal approaches are implemented, they should adhere to strict environmental and social safeguards in order to minimise negative consequences. These consequences could include land and water resource conflict with food production or impacts on local people's livelihoods.
- 15. Cancelling out the hard-to-mitigate residual emissions will need all the removals available so those sinks already in existence must also be protected – while not an additional carbon dioxide removal opportunity, we should also ensure the future of forests that are currently significant net sinks of carbon dioxide. We should also continue good practice to avoid emissions through protection of forests of high biodiversity and carbon value, especially primary forests; and responsible management of forests. Many land-based conservation techniques which halt deforestation or prevent degradation and conversion of natural ecosystems have biodiversity and social benefits and are also cost-effective approaches to cut greenhouse gas emissions.

Prioritise: benefits outweigh the costs.

- **Enhancement of forest carbon stocks** through:
 - **Restoration** of ecological functioning of degraded forest landscapes – comprising peatlands, mangroves, coastal wetlands/ecosystems or low productive land – by promoting multifunctional landscapes, including reforestation and afforestation.
 - **Natural regeneration of forests**, assisted or otherwise.
- **Enhancement of soil carbon** through:
 - **Carbon sequestration in agricultural soils**, which also enhances soil health and productivity.
 - **Soil sequestration using sustainable production of biochar**.


Further research and development is needed to ascertain whether these approaches can be part of the climate solution: balance between costs and benefits, and the unknown risks is not yet clear.

- **Afforestation** at scale on non-degraded land, which may not compensate the opportunity costs of land conversion, and may produce negative social impacts;
- **Bioenergy with carbon capture and storage (BECCS)** is land-intensive and limited in spatial suitability but could, in appropriate circumstances and with adequate safeguards, provide carbon dioxide removal;
- **Direct air capture and storage** is expensive and energy intensive but has large potential and fewer and less severe land-competition impacts; and
- **Enhanced weathering of minerals on land** requires large volumes of materials implying negative impacts from mining and transport but could permanently store a sizable amount of carbon dioxide.

Not suitable for use at this time since: the ecological and social uncertainties far outweigh the known benefits.

- **large-scale ocean fertilisation** as it has a high potential for unintended and damaging side effects for ocean ecosystems; and
- **Enhanced weathering of minerals added to the oceans** appear to have environmental and other costs that outweigh the potential climate benefits.

Table 1: Summary of WWF's position on Carbon Dioxide Removal, including Carbon Sequestration in Natural Systems

	<p>Why we are here To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.</p> <hr/> <p>panda.org/climateandenergy</p>
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