Understanding carbon dioxide removal (CDR) for net zero

Opportunities, risks and benefits

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Outline

- CDR for net-zero CO₂ and for net-zero GHG
- Differentiated use of CDR in mitigation strategies
- Interactions with SDGs and other goals
- What happens after net-zero?
What is CDR?

Anthropogenic activities removing CO$_2$ from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products.

It includes existing and potential anthropogenic enhancement of biological or geochemical sinks and direct air capture and storage, but excludes natural CO$_2$ uptake not directly caused by human activities.

SR15 (2018) glossary; emphasis mine
Net-zero emissions and global temperature

Illustrated for pathways with low/no overshoot of 1.5°C; scenarios from Rogelj et al (2018), data from Huppmann et al (2019)
Net-zero GHG calculated using GWP100
Net-zero emissions and global temperature

**net-zero CO2 ≈ time of peak temperature**

**net-zero GHG ≈ temperature starts declining**

In 1.5°C scenarios, net-zero CO₂ occurs almost two decades before net-zero GHG
(≈ 2050 vs 2067)

In 2°C scenarios, net-zero CO₂ occurs roughly three decades before net-zero GHG
(≈ 2070 vs 2100)

Illustrated for pathways with low/no overshoot of 1.5°C; scenarios from Rogelj et al (2018), data from Huppmann et al (2019)

Net-zero GHG calculated using GWP100
CDR is necessary for net-zero CO$_2$ emissions

Illustrated for pathways with low/no overshoot of 1.5°C; scenarios from Rogelj et al (2018), data from Huppmann et al (2019)
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All mitigation pathways rely on CDR

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CDR is necessary for net-zero CO$_2$ emissions

All mitigation pathways rely on CDR

- to achieve net-zero CO$_2$ (compensate for residual CO$_2$)

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**CDR is necessary for net-zero CO₂ emissions**

All mitigation pathways rely on CDR

- to achieve net-zero CO₂ (*compensate for residual CO₂*)
- to achieve net-negative CO₂ emissions afterwards (*compensate for hard-to-abate residual non-CO₂ emissions, to achieve net-zero GHG*)

Illustrated for pathways with low/no overshoot of 1.5°C; scenarios from Rogelj et al (2018), data from Huppmann et al (2019)
CDR is necessary for net-zero GHG emissions

All mitigation pathways rely on CDR

- to achieve net-zero GHG (requires greater amount of CDR)
- to achieve net-negative GHG emissions afterwards

(to achieve a faster rate of temperature decline)

Illustrated for pathways with low/no overshoot of 1.5°C; scenarios from Rogelj et al (2018), data from Huppmann et al (2019)
**Strategies for net-zero differ in their reliance on CDR**

- timing and scale of abatement of gross emissions
- rate of decline after the temperature peak
- mix of CDR technologies (AFOLU, BECCS, DAC, other ...)

Illustrative pathways from IPCC SR15: Rogelj et al (2018)
Strategies for net-zero differ in their reliance on CDR

- depends on the temperature goal
- lower temperature targets imply
  ✓ earlier, and
  ✓ more CDR
- … but with significant variations
Interaction of CDR with ecosystem services

All CDR options rely on one or several of the following:

• Land
• Water
• Energy
• Marine net primary production
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Implementation of CDR

Asymmetries:
- Maturity
- Permanence
- Effectiveness
- Cost and potentials
- Actors and governance
Global assessments provide limited guidance, as interactions depend on local context and both mode and scale of implementation.
What happens after net-zero is reached?

- the higher residual (gross) emissions, the more continued CDR is required to maintain net-zero.
- risk of saturation and reversal
- global/national net-zero implies some actors have to be sustained net-negative while others are still net-positive

Which actors have targets for sustained net-negative emissions, and by what date?
Conclusions

• CDR is absolutely necessary for net-zero …
• … but timing and scale differs for net-zero CO₂ or net-zero GHG
• Reliance on CDR grows with every tonne of emission
• All CDR options have limits and potential for negative side-effects that grow with the scale of implementation
• Choices around how much CDR, when, and what need to become core parts of climate policy to reduce over-reliance and forced trade-offs
• Investments in R&D, pilots, up-scaling, institutions, governance, embedding in development plans do not match our reliance on CDR

Thank you! andy.reisinger@mfe.govt.nz