tCDR – A Climate Policy Wager?
Terrestrial CO₂ Removal: Potentials and tradeoffs in the SDG context

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Overview

• The Challenge
• The role of negative emissions in mitigation pathways
• The Coal Question
• Moral Hazard, Hedging and CDR
• Policy Options
Emissions are rising.

Source: Peters et al. (2017)
NETs used to compensate for atmospheric overshoot and residual emissions

Fuss et al (under review)
NETs comprise a wealth of different methods

Afforestation and reforestation
Additional trees are planted, capturing CO₂ from the atmosphere as they grow. The CO₂ is then stored in living biomass.

Bioenergy with carbon capture and sequestration (BECCS)
Plants turn CO₂ into biomass, which is then combusted in power plants, a process that is ideally CO₂ neutral. If CCS is applied in addition, CO₂ is removed from the atmosphere.

Biochar and soil carbon sequestration (SCS)
Biochar is created via the pyrolysis of biomass, making it resistant to decomposition; it is then added to soil to store the embedded CO₂. SCS enhances soil carbon by increasing inputs or reducing losses.

Enhanced weathering
Minerals that naturally absorb CO₂ are crushed and spread on fields or the ocean; this increases their surface area so that CO₂ is absorbed more rapidly.

Ocean fertilization
Iron or other nutrients are applied to the ocean, stimulating phytoplankton growth and increasing CO₂ absorption. When the plankton die, they sink to the deep ocean and permanently sequester carbon.

Direct air capture (DAC)
Chemicals are used to absorb CO₂ directly from the atmosphere, which is then stored in geological reservoirs.

Minx et al. (2017)
NETs play a distinct role in 1.5°C scenarios: on geophysical requirements and economic attractiveness

Characteristics of 1.5°C scenarios

- Fully decarbonized world economy by 2050 (sharp emissions reductions)
- Sustained period of deep negative emissions thereafter
- Up to 15Gt of NETs deployment in 2050
- Rate of near-term upscaling substantially higher

While 1.5°C fundamentally depend on negative emissions, this is not the case for 2°C scenarios

Fuss et al. (under review)
Role of NETs varies in 2°C scenarios –
NETs can still be limited in many cases

Important distinctions for 2°C scenarios:

- Full tech, immediate action scenarios feature large-scale NETs deployment
- There are scenarios without or limited NETs deployment
- Low energy demand pathway provide additional flexibility for NETs deployment
- NDC trajectory poses similar challenges in 2030 like 1.5°C world today

Fuss et al. (under review)
How much NETs do we really need to meet the climate goals?

Minx et al. (under review)
The 2°C budget does not leave any leeway.

Cheap and abundant coal is the driver of a „re-carbonisation“ of the energy system in some parts of the world.

*All budgets are subject to considerable uncertainty, see Edenhofer et al. (2017)*
Need for land...

- 5 billion hectares (approximately 40% of the land surface) is under agricultural use (potentially increasing in the future).
- Additional land-use pressure to be expected from land based CDR options.

Based on Popp et al. 2016; GEC
There are different ways how NETs can be used, but not all are equally well understood

Late century NETs

No overshoot

Rapid decarbonization

Minimize NETs

Obersteiner et al. (2018)
Potential externalities of land-based CDR:

- Loss of natural land - affecting e.g. biodiversity,
- greenhouse gas emissions from land use and agricultural production,
- nitrogen pollution,
- water withdrawals for irrigation - affecting e.g. sweet water ecosystems,
- food security
Dedicated sustainability can overcompensate additional risks of 1.5°C scenarios
Closing the innovation gap

A The scale-up challenge
Integrated assessment scenarios assume a rapid upscaling of NETs, starting in 2030, and growing to ~5 Gt CO₂/year by the mid-century. As with any other niche technology that reaches wide-scale adoption, basic research and demonstration must be in place, as well as a set of mutually reinforcing political and institutional conditions that generate demand. To align with integrated assessment scenarios for 2°C, these conditions must be in place within 15 years.

B The current focus of research
Although the NETs research to date is quite mature for research and development, there is very little work on the crucial demand factors ...
Results from integrated assessment models show that while NETs play a key role in the second half of the 21st century for 1.5°C and 2°C scenarios, the major period of new NETs deployment is between 2030 and 2050.

Given that the broader innovation literature consistently finds long time periods involved in scaling up and deploying novel technologies, there is an urgency to develop NETs that is largely unappreciated.

This challenge is exacerbated by the thousands to millions of actors that potentially need to adopt these technologies for them to achieve the planetary scale.
Closing the innovation gap (II)

• This urgency is neither reflected in the Paris Agreement NDCs nor in most of the literature we review here.

• If NETs are to be deployed at the levels required to meet 1.5°C and 2°C targets, then important post-R&D issues will need to be addressed in the literature, including incentives for early deployment, niche markets, scale-up, demand, and—particularly if deployment is to be hastened—public acceptance.
A pre-condition for short-term mitigation in order to limit NETs is carbon-pricing.
Conclusion

• (t)CDR is an important part of the technology mix for 1.5°C, but not necessarily so for 2°C.
• (t)CDR is only a reasonable hedging strategy for committed policy makers.
• However, there is a risk of moral hazard.
• Short-term entry points and carbon pricing are essential to limit (t)CDR
• If NETs should be available at any larger scale, the innovation gap needs to be bridged.
• Other dedicated policies are needed for sustainable pathways.