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The Political Logic of Net Zero

Authors

Kathleen A. Mar,
Charlotte Unger, Stefan Schäfer,
Mark G. Lawrence

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The promise of future technologies for abatement and removal of CO_2 is being used to justify inaction on reducing fossil fuels, even though this is incompatible with limiting warming to 1.5°C or 2°C.

by **Kathleen A. Mar, Charlotte Unger, Stefan Schäfer, Mark G. Lawrence**

The premise of "net zero" seems to imply significant freedom in choosing a balance between greenhouse gas (GHG) emissions reductions and active CO_2 removal. The reality, however, is that there are severe constraints. Achieving "net zero" requires deep reductions in CO_2 and other GHG emissions, which in turn means nearly completely phasing out fossil fuels. Technologies for Carbon Dioxide Removal (CDR) and Carbon Capture, Usage, and Storage (CCUS) will likely play some role in eventually achieving net zero, but they will not be able to compensate for continued fossil fuel use anywhere near current levels.

Key messages

- Technologies for Carbon Capture, Usage and Storage (CCUS) and Carbon Dioxide Removal (CDR) only represent climate solutions in as much as they go hand in hand with deep emissions reductions.
- The (future) availability of CCUS and CDR technologies does not mean we can delay or avoid phasing out fossil fuels if we are to have a chance of limiting global warming to 1.5°C or even 2°C.
- Likewise, the expansion of renewable energy technologies will be nowhere near adequate for meeting agreed-upon climate targets unless fossil fuels are simultaneously ramped down. Up until now, renewables have been largely in addition to, rather than substituting for fossil fuels.
- Achieving our climate and broader sustainable development goals will require transformations that go beyond energy systems and reevaluate the structures and institutions behind our patterns of consumption, mobility, and food production, among others.

Net zero: the bigger picture

Despite the growing understanding of the already disastrous impacts of climate change, there is not yet a political consensus on the need to phase down — let alone phase out — fossil energy sources. This should be cause for serious concern. At this juncture, the dominant arguments for continuing fossil fuel production and consumption are no longer about casting doubt on the reality of climate change or its anthropogenic nature, but rather claims that the problem — typically framed as greenhouse gas (GHG) emissions — can be managed by (future) technologies, without having to give up fossil fuels as an energy source. One category is Carbon Capture, Utilization, and Storage technologies (CCUS). CCUS can be used to "abate" (in the sense of reduce) CO_2 emissions from fossil fuel and other energy-intensive industrial emissions; here CO_2 is separated from the emissions stream and then either used as a raw material for industrial products (CCU), or stored, typically in deep geological formations (CCS). Another suite of relevant technologies is Carbon Dioxide Removal (CDR), which refers to approaches for removing CO_2 from the ambient atmosphere (some of which rely on CCS). The political significance attached to — and divisions associated with — these technologies is well-illustrated by a recent statement of the G20 Energy Transitions Ministers:

> *"[T]he importance of making efforts towards phase down of unabated fossil fuels…was emphasized by some [G20] members while others had different views on the matter that abatement and removal technologies will address such concerns."*
> [Chair's Summary of the G20 Energy Transitions Ministers' Meeting, Goa, India, July 2023]

CCUS and CDR technologies, while still unproven at scale, are indeed likely to play a role in future efforts to limit global warming [**1–3**]. But it is extremely problematic that the (future) availability of these technologies is being used by some as a convenient excuse to keep extracting and burning fossil fuels, when this is in no way compatible with limiting global warming to 1.5°C or 2°C [**4 ,5**].

The narrative that "abatement and removal technologies" can absolve us from the need to phase out fossil fuels plays into the fundamental idea behind "net zero": that some non-negligible amount of future emissions will be offset by anthropogenic removals of CO_2 from the atmosphere. The promised ability to cancel out emissions as an alternative to eliminating them at their source is alluring, especially for actors who have a large interest in continued fossil fuel extraction and use, or who see opportunities in developing new industrial frontiers through the expansion of CDR. Yet while the premise of "net zero" sounds like it offers significant freedom in choosing a balance between emissions reductions and CO_2 removals, the reality is that the solution space is severely constrained. There are substantial limitations to large-scale expansion of CDR even under an assumption of rapid technological progress and broad public support, neither of which should be considered a given. CO_2 removal on a scale that could compensate for continued fossil fuel use at or above current levels (i.e., exceeding 40 $GtCO_2$ per year) — and on a timescale fast enough that would prevent significant irreversible climatic changes — is extremely unlikely to be realized. For this reason, CDR only represents a climate "solution" in as much as it goes hand in hand with deep emissions reductions — and these can only be achieved by moving away from fossil fuels. Already over five years ago a substantial and rapidly-developed future role for CO_2 removal was envisioned in an IPCC special report: scenarios consistent with limiting warming to 1.5°C assume GHG emissions reductions of ca. 80% and the removal of ca. 10 $GtCO_2$ per year, both by 2050 [**4**]. The feasibility of scaling up CDR at this pace and to this extent is debatable [**1, 2**]; for reference, currently registered CDR projects remove an estimated 0.2 $GtCO_2$ per year [**6**]. But even with potentially overoptimistic assumptions about CDR development, model scenarios are only able to meet the Paris target by combining the application of CDR with a phasing down of fossil fuels.

Carbon capture technologies will likewise not provide the silver bullet that will allow us to perpetuate our fossil fuel economies. While fossil fuel producers are promoting CCS as means to a "low carbon" future for their industry, the reality looks different. To give one example, the United Arab Emirates (UAE), host of COP28, has set a target of using CCS to capture 0.005 $GtCO_2$ per year by 2030. But this represents only around 2% of their current emissions, and they have simultaneously announced plans to increase oil production and develop offshore gas infrastructure [**7**] — meaning they are on track to increase rather than decrease their emissions. Globally, the capacity of currently operational CCUS facilities is 0.045 $GtCO_2$ per year, or roughly 0.1% of current CO_2 emissions [**8**]. Even assuming that expansion of CCUS will help reduce fossil emissions, IPCC scenarios still require reductions in coal, oil and gas consumption of 95%, 60% and 45%, by 2050 respectively, to limit warming to 1.5°C [**5**].

Scaling up or phasing out?

Putting aside the limitations of *scaling up* technologies for carbon capture and carbon dioxide removal, it is *bringing down* anthropogenic emissions that is proving to be the more intractable issue. The sobering fact is that at present, global anthropogenic CO_2 emissions are 40 $GtCO_2$ per year — and they are still rising [**9**]. Even more alarming, all major oil and gas producing countries are still issuing permits for expanding oil and gas production [**7**]. Meanwhile, the latest IPCC scenarios that keep warming under 2.5°C are all characterized by global CO_2 and GHG emissions that peak by 2030; limiting warming to 1.5°C would require roughly halving CO_2 emissions by the end of the current decade [**5**].

As impending "deadlines" for meeting our climate goals are getting closer, the political stances on a fossil fuel phase out remain divergent. COP26 in Glasgow made history with a decision that for the first time explicitly targeted action against fossil fuels, calling on parties to "accelerat[e] efforts towards the phasedown of unabated coal power and phase-out of inefficient fossil fuel subsidies" after a fight over language in which a rhetorically stronger "phase out" of coal had been strived for. For COP28, the EU has announced its intention to push for a global pledge to phase out unabated fossil fuels (not just coal) ahead of 2050. There is, however, little expectation that this will prevail — especially considering the UAE's fossil fuel interests, reflected in the choice of the CEO of their state-owned oil company as COP28 president.

Rather than emphasizing a fossil fuel phase down, a central initiative of the COP28 presidency is to push for an agreement on tripling renewable energy capacity by 2030. This is a laudable goal, and if achieved it will be rightly seen as a success. But there is a problematic aspect: ramping up renewables will be nowhere near adequate for meeting agreed-upon climate targets if fossil fuels are not simultaneously ramped down and later phased out. While some economies have been able to displace some of their fossil energy use with renewables, the global picture is that renewables have been largely in addition to, rather than substituting for fossil fuels [**9, 10**]. And while this is certainly preferable to an even more rapid expansion of fossil fuels, it does not put us on track for meeting our established climate goals.

Imagining and developing new technologies has been the dominant approach to "solving" the climate crisis. And it is certainly the case that we need a wide range of technologies to help us mitigate climate change. But the pervasiveness of techno-optimism can also obstruct progress, as when faith in future technologies is used to justify inaction on fossil fuels. Given the huge financial interests and structural power at stake, it is no surprise that there is strong resistance to a fossil fuel phase-out. And considering the favourable policy and market environment in which the fossil fuel industry (still) operates, it is also no surprise that emissions reductions have not yet been achieved — the IMF reports, for instance, that fossil fuel subsidies in 2022 were higher than they have been in the past decade and a half [**11**], despite promises made in Glasgow.

Beyond obscuring the need to phase out fossil fuels, the dominant focus on technological solutions to the climate crisis seems to come at the expense of reflection and action on everything else we need to change to transition to a sustainable society that not only avoids catastrophic climate change, but supports the achievement of a wide range of the UN Sustainable Development Goals: our consumption patterns, our mobility behaviour, and our institutions and governance structures, to name a few. In addition to resolute action to phase out fossil fuels, deep and sustained emissions reductions will require — and can in turn support — society-wide transformations that go beyond energy systems towards reimagining the ways we live, work, produce, consume, and ultimately relate to one another in society.

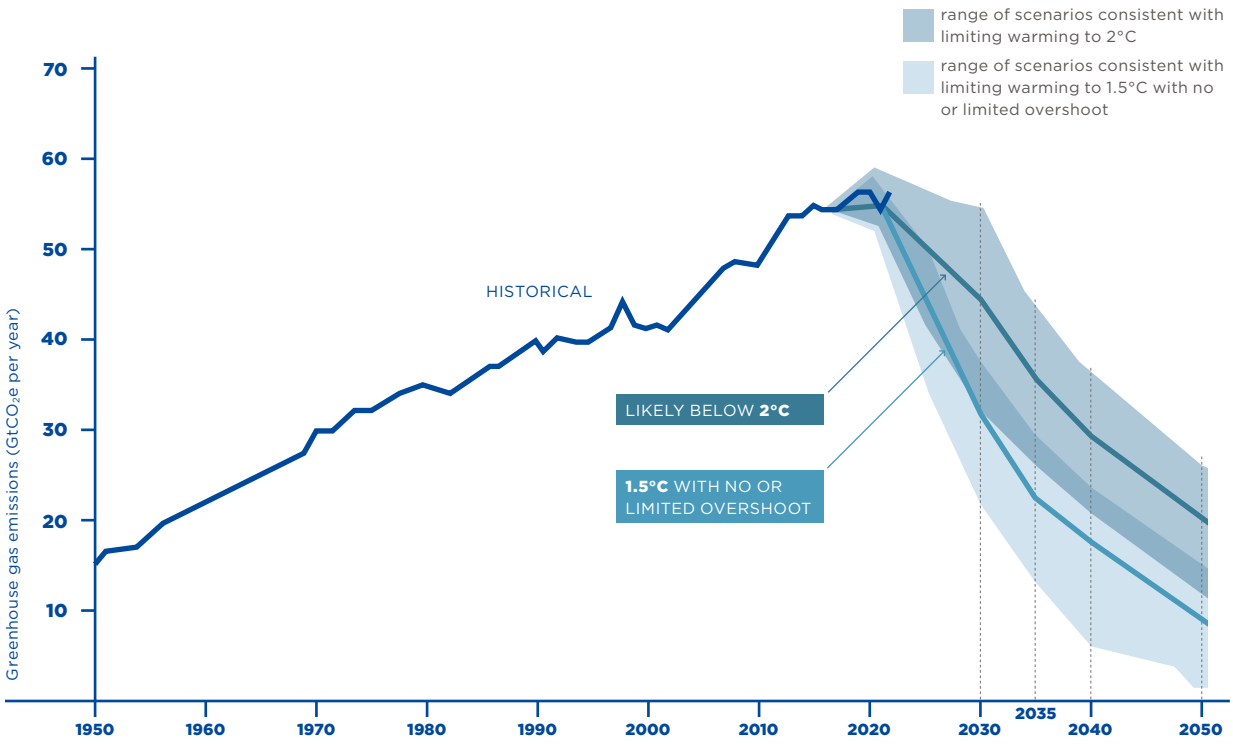
Current levels of anthropogenic CO_2 emissions, removals and capture: A reality check

40

$GtCO_2$ per year
Global anthropogenic CO_2 emissions [9]

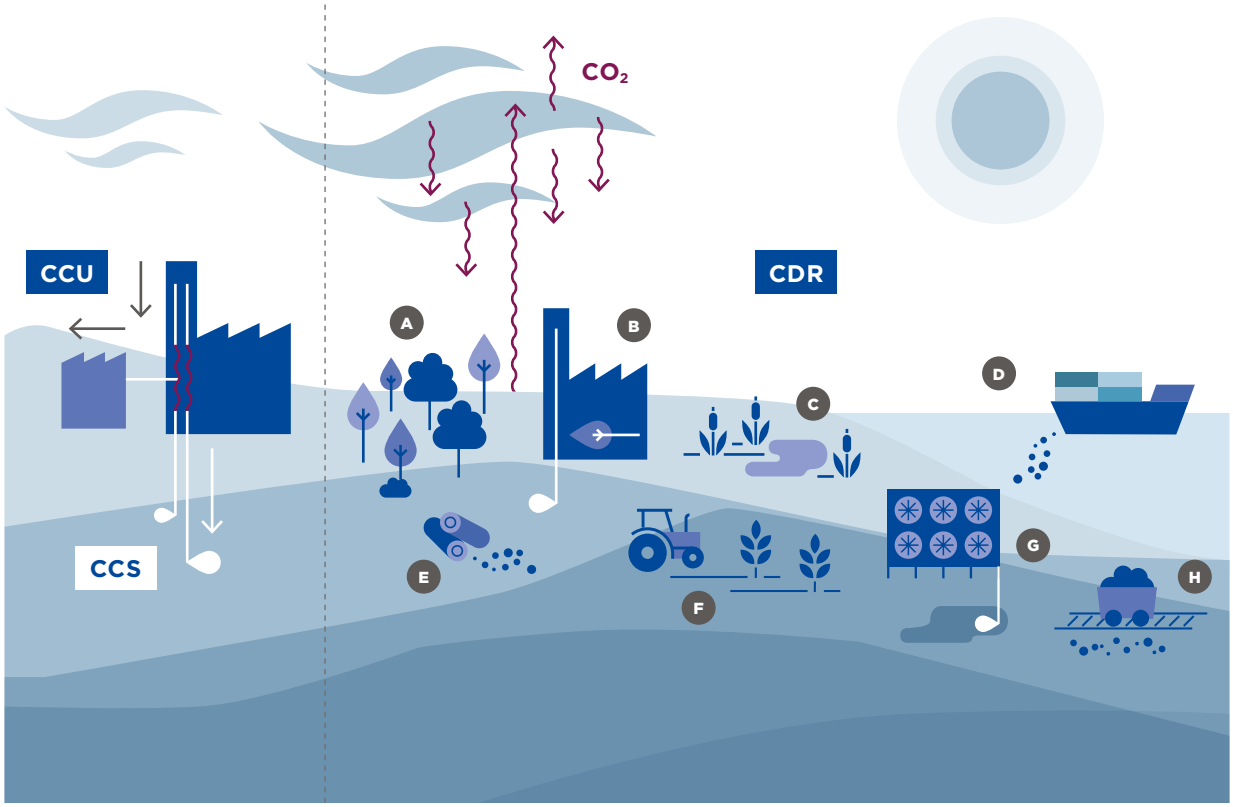
- **2** $GtCO_2$ per year **in CDR via managed land use** [6]
- **0.2** $GtCO_2$ per year **in CDR considering registered projects only** [6]
- **0.045** $GtCO_2$ per year **captured from energy and industrial processes for CCUS** [8]

Can we reverse the trend in emissions? Historical emissions and pathways compatible with limiting warming to 1.5°C or 2°C



Historical and projected GHG emissions, adapted from [12]. All pathways that limit warming to 1.5°C or 2°C are characterized by emissions peaking by 2030 with a sharp decline thereafter. Note that this figure shows total GHG emissions, whereas our text has focused on CO_2 emissions for clarity of comparison, since CO_2 is currently the only GHG for which we have removal technologies.

Methods for CO_2 Capture, Utilization, and Storage (CCUS) and Carbon Dioxide Removal (CDR)



A Large-scale afforestation / **B** Bioenergy with carbon capture and storage (BECCS) / **C** Peat- and wetland restoration / **D** Ocean alkinisation / **E** Biochar production and burial / **F** Soil carbon sequestration / **G** Direct air CO_2 capture and storage (DACCS) / **H** Enhanced weathering

Schematic showing CCU, CCS and CDR, adapted from [1]. Left: Depictions of CCU and CCS, in which CO_2 from process emissions are diverted and either used as a raw material (CCU) or stored underground (CCS). Right: Various proposed approaches for CDR, which remove CO_2 from the ambient atmosphere.

THE AUTHORS

This RIFS Policy Brief was prepared by Dr Kathleen A. Mar (Research Group Lead, Climate Action in National and International Processes (ClimAct)), Dr Charlotte Unger (Senior Research Associate, ClimAct), Stefan Schäfer (Research Group Lead, Planetary Geopolitics and Geoengineering) and Prof. Dr Mark Lawrence (Scientific Director).

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Research Institute for Sustainability (RIFS) — Helmholtz Centre Potsdam
Berliner Straße 130
14467 Potsdam
Tel: +49 (0) 331-28822-300
media@rifs-potsdam.de
www.rifs-potsdam.de

ViSdP:
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