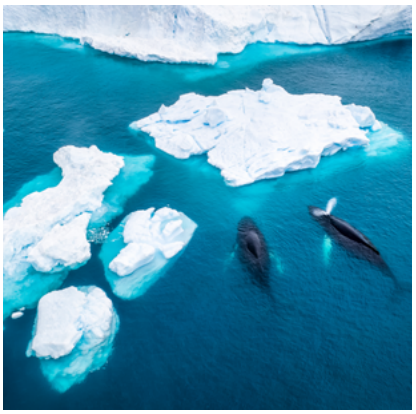
AGENDA FOR A **PROGRESSIVE POLITICAL ECONOMY OF CARBON REMOVAL**



Agenda for a Progressive Political Economy of Carbon Removal

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Executive Summary

Large amounts of carbon dioxide will need to be removed and durably stored to meet climate targets. Even the lowest estimates suggest that large new industries will need to be created to produce these removals. As both private and public investments begin to fill this gap, the foundations of an emerging carbon removal industry are now being laid via policy decisions that will shape the field to come.

In this report, we look to the possible versions of a future with carbon removal, imagining its best forms, its worst forms, and its most likely forms. As we take stock of the path that the sector is currently on, we worry that carbon removal might result in harms and injustices—or simply fail to be effective. On the other hand, we can also envision a future in which carbon removal serves as a tool for progressive principles like real climate action, justice, labor and economic rights, democratic participation, and wealth redistribution.

We are confident that a just and effective configuration of a future carbon removal industry *is* possible. This report aims to chart a path to such a future. The report is global in scope, although much of the discussion focuses on Global North contexts, in part given the early-stage nature of the sector.

A first group of recommendations centers on **(1) incentivizing carbon removal for the right reasons and at the right scale.** We recommend:

- Rethinking how we incentivize and account for carbon removal to ensure that it does not delay emissions reductions;
- Transparently linking removals to what is truly 'hard-to-abate', as defined via participatory processes; and
- Producing bottom-up, interdisciplinary, inclusively developed estimates of carbon removal's full potential scale.

A second group of recommendations focuses on **(2) moving beyond both markets and private ownership as models for deploying carbon removal.** We recommend:

- Rejecting offset models for carbon removal;
- Funding and conducting carbon removal via strategic, government-led industrial policy;
- Developing and incentivizing collective ownership models for carbon removal; and
- Treating intellectual property as a public good and supporting technology sharing.

A third group of recommendations centers on **(3) making carbon removal a tool for procedural, distributive, and reparative justice.** We recommend:

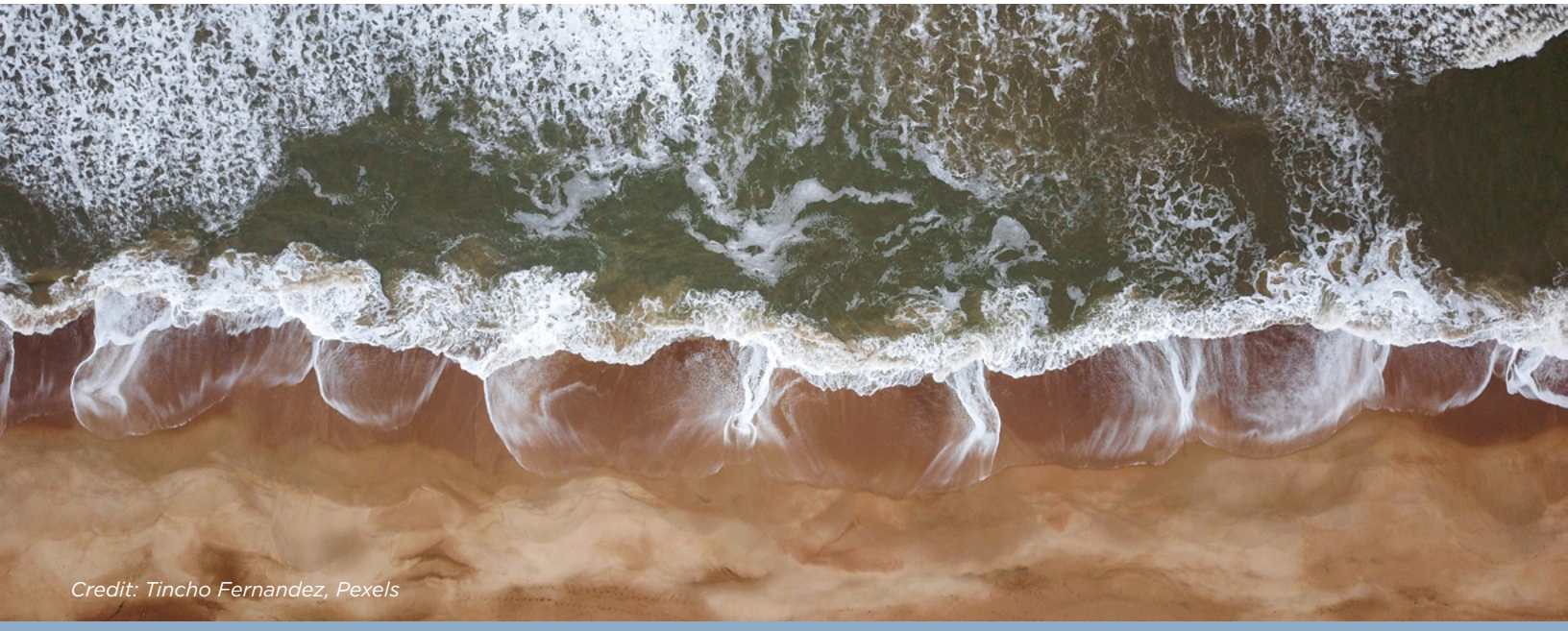
- Ensuring that community, environmental justice, Indigenous and labor groups participate substantively in decision-making on carbon removal;

- Explicitly shifting the burden of costs and risks off Indigenous, marginalized, and vulnerable groups, and the Global South; and

- Using carbon removal as a tool to work towards remedying legacies of colonialism and extractivism.

In addition to specific suggestions relevant to each of these points, we also introduce four 'bold policy ideas' that national governments, international institutions, and large philanthropic funders might pursue and support. These are novel ideas that integrate many of the priorities discussed above and that we think should be explored further and considered at various policy scales. One idea is **a global reparations fund,** which would offer an important mechanism to fund carbon removal and remedy past harms. Other ideas to be considered at the national level are **pooled approaches to removals,** which might address the problems with offset models for incentivizing and accounting for removals. **National carbon removal administrations** would support the production of carbon removal as a public good, and **independent, publicly funded engagement bodies** would work to ensure that carbon removal (both public and private) aligns with the priorities of public and community groups.

This report also outlines key future research, policy development, and movement building priorities needed to advance the progressive vision laid out here. The report is intended to serve as a starting point for funders, researchers, academics, activists, organizers, project developers, and policymakers who are interested in working towards a comprehensive progressive and justice-oriented program for carbon removal.



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Introducing a progressive agenda for carbon removal

The science is increasingly clear: large amounts of carbon dioxide will need to be removed and durably stored in order to meet global climate targets[1]. Technologies promising durable removal are rapidly moving from laboratories to commercial settings, particularly in the US. Large investments in carbon removal aim to get technologies off the ground, such as the US Department of Energy's $1.2 billion investment in infrastructure development[2] and Frontier Climate's $1+ billion advance market commitment[3]. These efforts are just the beginning: while scholars and models disagree on exact numbers, there is agreement that removing large amounts of CO_2 by midcentury, more than a gigatonne per year, will be necessary to avoid the worst impacts of climate change[1,4,5]. To put that in context, current emissions levels are on the order of 50 metric gigatons of CO_2e per year[6]. To meet the scale of carbon removal needed and to do so on a timeline consistent with the Paris Agreement, research and deployment need to be advanced now[7].

What is carbon removal? Why do we focus on long-duration carbon removal?

'Carbon removal' encompasses a variety of technologies and approaches to removing and durably storing carbon dioxide from the atmosphere. In this report, we focus discussion on a set of novel approaches considered 'long-duration' in that they have the potential to store CO_2 for hundreds to thousands of years. Amongst others, these approaches include *direct air capture* (DAC) with carbon storage (in total, DACCS, which involves using machines to capture and store CO_2), *biomass carbon removal and storage* (BiCRS, which involves using biomass to remove CO_2 and storing it in the ground or in long-lived products), *ocean alkalinity enhancement* (adding alkaline substances to seawater or the ocean to absorb and drawdown CO_2), and *biomass sinking* (sinking biomass to the ocean floor to store CO_2). These techniques are new, and are not yet being implemented at scale; to date, minimal research has explored the wide-ranging social and justice considerations that these might raise[8,9,] especially given the scale of deployment likely required.

In this report, we leave aside the shorter-duration approaches often deemed 'nature-based', such as those involving afforestation and forest restoration, and restoration and management of wetlands and seagrass meadows. While nature-based approaches[10] are critical to pursue, this is largely as a means of generating important non-carbon benefits such as biodiversity protection, food security, or

coastal erosion prevention rather than carbon removal at the scales needed. Such 'nature-based' approaches to carbon removal cannot compensate for geological carbon emissions from fossil fuels, and when relied upon to meet national targets, can introduce issues such as competition with land for agriculture[11–15].

The policy decisions made today will lay the groundwork for a potential large-scale carbon removal industry to come. Path dependency effects mean that these early decisions—about funding, governance, risk management, and decision-making—could get locked in, limiting future approaches to the paths carved out today. Thus, we are obligated to think preemptively with an eye to the landscape several decades into the future. This prompts us to take on the challenge of envisioning a future world with carbon removal, imagining a wide range of possibilities, both equitable and exploitative.

How do we ensure that a carbon removal industry does not exacerbate impacts to the most vulnerable, prove to be a waste of time and money, or indeed worsen climate change? Building a carbon removal industry requires addressing critically important questions: How will the benefits and burdens be allocated? Who will have a say over these? Who should fund the research needed to get this industry off the ground? Who, if anyone, should profit from it?

There are reasons to be concerned about the shape this industry is taking. In one of the largest investments and transactions for carbon removal to date, the oil and gas company Occidental Petroleum (Oxy) was awarded up to $600 million of US Department of Energy funding to lead development of a DAC hub in South Texas[2]. Oxy also announced in August 2023 that it will be purchasing the DAC company Carbon Engineering[16]. It is not outlandish to imagine that fossil fuel producers view carbon removal as a way to continue existing; as Oxy CEO Vicki Hollub explained[17], DAC could give the industry "a license to continue to operate" for "60, 70, 80 years." Considering both the great lengths to which fossil fuel producers have gone to deny climate change, and their history of exploitative practices[18], there are preferable alternatives to a fossil-led carbon removal industry.

Unsurprisingly, many people on the environmental and climate left are skeptical of carbon removal along these lines. It does not help that climate left politics often simplifies matters by treating some technologies as 'good' and others as 'bad'[19]. It makes sense that critical environmentalists might view carbon removal as 'sophisticated greenwashing', given what we know about people's intuitive tendencies to prefer what seems more 'natural'[20]. But as social science scholars of technology have long argued, technologies akin to carbon removal are best understood not in isolation, but instead in the context of how we implement them. Carbon removal is not just a technological innovation but also a system of institutions, legal and regulatory structures, infrastructure, and economics and finance. How a carbon removal approach is implemented—whether for better or worse—is thus not *just* a function of technical specifics, but of the broader system in which it operates.

We are confident that a 'just' and 'effective' configuration of a carbon removal industry is possible. This report aims to envision a path to implementing carbon removal that is both these things.

The report serves as a starting point for researchers, academics, activists, organizers, funders, developers, and policymakers who are interested in developing a comprehensive progressive- and justice-oriented program for carbon removal, particularly one that meaningfully addresses the concerns of progressive leaning groups. This agenda will also be useful to members of the broader carbon removal community who recognize that long-term speed and scale will require cultivating political support and avoiding polarization and conflict. This is an ambitious agenda—one that is oriented around the vision that we want to see, rather than the limits of what seems more 'realistic' or politically feasible. **We are hopeful that, even if the ideas shared here seem overly ambitious at first blush, their ambition may help catalyze action in ways that open new possibilities of the 'practical'.**

In the sections below we sketch elements of a progressive agenda for carbon removal, developing the initial arguments for each of its components, in the hope that future analysis can deepen and develop concrete proposals for the concepts laid out here. The report aims to build on other related efforts to both imagine progressive approaches to carbon removal[21–23] and map policy options for its effective scaling[24]. This agenda deviates from these important efforts, by offering a more comprehensive perspective (going beyond the US context, and beyond DAC as a technology) and by introducing novel policy ideas to the carbon removal conversation.

Origins of this report

The report builds on a collaborative three-day workshop convened by the Institute for Responsible Carbon Removal (formerly the Institute for Carbon Removal Law and Policy) at American University in Washington DC. Participants, who joined primarily from policy and academic institutions, have been researching, working, and reflecting on different aspects of progressive approaches to carbon removal. It is worth noting that all participants are based in the Global North; as such, this agenda represents the views of a somewhat narrow group of thinkers. Our hope is that this agenda will be taken up, expanded, and adapted by others who come from and represent a much wider array of groups with an interest in a progressive agenda, such as environmental justice groups, Indigenous people, labor organizations, and communities from the Global South.

Defining 'progressive'

The term 'progressive' can mean many things, from 'left of center' to 'socialist' and more. Rather than pick a precise term to root this report in a more specific political orientation, we hope to build the work here on a set of shared principles. The report orients around the following principles and associated goals, outlining how carbon removal policy and research might better support and realize them.

Principle	Goal for carbon removal
Real climate action	Timely and substantive action on carbon removal occurs to address climate change in line with the Paris Agreement There is a commitment to tackling the root causes of climate change
Environmental & social justice	The harms and benefits of carbon removal do not fall disproportionately on marginalized groups and there is meaningful involvement of all people in decision making on carbon removal Carbon removal approaches offering localized social and ecological benefits are prioritized
Reparative global justice	Redress, via reparations, decolonization, and sustainable development, occurs for the harms of colonialism and extractivism in the Global South
Labor and economic rights	People's rights to quality employment and economic opportunity are protected and supported in the process of developing carbon removal
Democratic governance and participation	People participate meaningfully in governing carbon removal

Imagining carbon removal futures?

Carbon removal is, inherently, a multi-generational project. We may plan to construct widely beneficial carbon removal policies, but government programs can be rolled back from one generation to the next. What is needed is thus both curiosity—to ask questions about what might happen in both near and distant futures—and imagination—to envision alternative futures that might now seem improbable but may pose far better options than the status quo. During the workshop that led to this report, we explored different ways that carbon removal might evolve in the future: both how it could go well and how it could lead to harmful, unintended consequences. Andrew Dana Hudson, a climate fiction writer and workshop participant, synthesizes some of these potential futures in the box below. The kinds of scenarios described below offered useful perspectives on the problems with—and possible alternatives to—the future we are on track for.

Speculative scenarios for a world with(out) carbon removal

by Andrew Dana Hudson

Throughout this report, we share a series of 'what if' scenarios that imagine possible futures involving carbon removal. Some imagine the implications of possible policy regimes, while others throw in "black swan" disruptions or windfalls. These diverging scenarios are meant to provoke ideas and spark reflection around the diverse social and political realities that need to be anticipated to design effective carbon removal policy. Consider these examples:

- **Abandoned commitments find new, messier life:** In 2048, a budget crisis has caused political winds to shift. The well-developed carbon removal industry is falling out of favor, leaving DAC facilities unfunded. Seeing this opportunity, civil society groups begin to buy up carbon removal infrastructure at pennies on the dollar. They are able to keep much of it running, thanks to a herculean volunteer effort. Still, the question remains how long the carbon removal project can continue without help from the public purse.

- **A long-buried resource:** Millennia from now, unexplained decreases in the sun's luminosity send researchers—including historians and archeologists—searching for CO_2 locked in forgotten geologic reservoirs. Global Cold is setting in, and future atmospheric managers are hoping to release stored carbon to "fluff up the world's greenhouse blanket." Did the heroic engineers of old leave accurate enough records to find their buried work?

We invite you to consider these "what if" scenarios as you read the rest of the report. How do they make you think differently (or not) about the policies needed to create a successful world with carbon removal?

A progressive agenda for carbon removal

In this section, we lay out three broad suggestions for what a 'progressive approach to carbon removal' involves. (1) First, it incentivizes carbon removal only for justifiable reasons and scales; (2) it moves both governance and implementation beyond markets and private ownership; and (3) it makes carbon removal a tool for justice. These are not 'exclusive' conditions: a progressive approach to carbon removal will include more and other aspects, but we argue that these are 'necessary if not sufficient' conditions.

Incentivize carbon removal for the right reasons and at the right scales

Doing carbon removal for the right reasons and scales means several things. First, carbon removal should not be done as a means to allow for ongoing emissions—rather, it should be done to compensate for justifiable and hard-to-abate emissions, as a means to sustainable and ethical decarbonization. To make this possible, work is needed to inclusively define which ongoing emissions are truly 'necessary' and transparently link these to specific removals. Given that carbon removal is in fact a limited resource (more on this below), better estimates of the full potential scale of ethical, sustainable removals are needed to better define when and where to do carbon removal.

Ensure carbon removal does not delay emissions reductions

In recent years, over 150 nation states have adopted 'net-zero' targets, typically 'by 2050'[25], reflecting the Paris Climate Agreement's call for achieving a balance between anthropogenic sources and removals of greenhouse gases in the second half of this century. Net zero is the climate policy framework in which these commitments have emerged. 'Net zero' means that any greenhouse gases emitted to the atmosphere are correspondingly balanced by removal out of the atmosphere[26].[1] Under this framework, not only do human-generated carbon removals become essential to counterbalance any residual greenhouse gas emissions, but there is a baked-in assumption that one ton of CO_2 is exchangeable for any other ton of CO_2: indeed, this 'ton is a ton' notion might be seen as net zero's "central premise"[28].

[1] Anthropogenic warming is caused by CO_2 but also other greenhouse gases (GHGs). The non-CO_2 GHGs tend to have shorter lifetimes than CO_2 but cause greater warming per unit. This means that near term cuts in non-CO_2 emissions (or removals via techniques such as methane destruction) can bring disproportionate short-term benefits, but in the long-term removing CO_2 is the main way in which atmospheric GHG concentrations can be reduced[27].

There are several problems with this notion that a 'ton is a ton'. The first is with claims about physical equivalence[28,29]. A ton of carbon emitted cannot be assumed to be balanced by any ton sequestered, due to issues of non-additionality, impermanence, and leakage. As we have seen with the increasingly intense wildfires of recent years, carbon stored in trees is only stored until a (climate-driven) blaze hits. Complexities in carbon cycles mean that lands and oceans may respond in ways that are not always predictable. The second issue pertains to different social and environmental impacts across a ton emitted vs. a ton removed[11,28,30]. The equivalency of any two given tons also obscures impacts that vary depending on where those emissions or sequestrations occur. For the communities that bear the environmental and health burdens associated with industrial pollution, removing emissions elsewhere is not the same as reducing these at their source. There are important differences across time and space, socio-economic and environmental impacts, and levels of risk involved. As Shelley Welton explains, a net zero approach also imposes equivalencies across the many different choices required to transition to a decarbonized world—it equates differences across value-laden decisions on how to work, live, and structure our communities. Net zero cannot tell us anything about how to prioritize the various means of reducing or removing carbon from the standpoint of moral or value-based judgements. Instead, a net zero framework treats these differences as interchangeable.

Moral hazard and 'mitigation deterrence' issues—that is, the extent to which carbon removal might deter or delay other mitigation efforts—are key risks associated with pursuing carbon removal in a net zero context, raising risks of doing carbon removal for the wrong reasons and at a problematic scale[31]. Carbon removal could create moral hazard and mitigation deterrence issues if it facilitates corporates in using removals to 'offset' their continued emissions, for example, or if it buys fossil producers license to continue operating.

To support real climate action, carbon removal must be deployed in a way that does not substitute for ongoing, planned, or accelerated emission reductions. Previous research has suggested a range of approaches to minimize deterrence effects whilst supporting robust development of carbon removal. These include restricting and regulating carbon markets; developing a clear, separate carbon removal strategy with dedicated support mechanisms incentivizing permanent storage rather than carbon utilization; active measures to reduce the power of fossil fuel interests and incumbents; enhanced political and corporate accountability around removal promises – with effective standards open to scrutiny by investors, media, NGOs and publics; enhanced monitoring and verification systems to strengthen the reliability of carbon removal; and separation of targets and accounting of carbon removal and emissions reduction[32]. We discuss several of these below.

Maintaining separate targets for emission reductions and carbon removal is one important approach to help ensure that carbon removal deployment does not reduce ambition around emission reductions[30,33]. Leading private-sector standards require separate emission reduction and removal targets (e.g., the Science-based Targets Initiative). The European Climate Law has (at least for now) adopted this approach[34]. Such a commitment arguably already

applies to provisions under the Paris Agreement, as countries are required to put forward increasingly ambitious and specific nationally determined contributions and long-term strategies, which one could interpret to require separating emissions reduction and removal targets—potentially even sector-by-sector[35,36]. Yet only one G20 country (France) has thus far created separate targets for emissions reductions and removals. Although several countries now have explicit targets for carbon removal or some forms of carbon removal, it generally remains unclear the extent to which these are formally additional to existing emission reduction goals. Wherever net-zero accounting is used in the public or private sector, emissions reductions and carbon removal should be separately and transparently reported, and ambition around each should be guided by separate targets designed to maximize emissions reductions and avoid over reliance on carbon removal[37].

The role of fossil fuel producers in carbon removal projects must also be strictly limited. Carbon removal should be introduced to counterbalance unavoidable or 'residual' emissions from agriculture, and to enable future drawdown of atmospheric greenhouse gas concentrations—not prop up fossil industry. To operationalize this, government and private funders could commit to only financing projects where fossil fuel producers do not play an ownership or lead role. For example, Heirloom, a carbon removal company, has recently made commitments of this nature, promising that they will not grant equity to oil and gas companies, or name any oil and gas industry representatives to its board[38]. They also have promised that they will not use any CO_2 removed via their technology for enhanced oil recovery.

One worrying possibility is future large-scale buyouts in which fossil fuel producers acquire a range of carbon removal start-ups and businesses. This is relevant even for carbon removal start-ups today that do not envision themselves as having anything to do with fossil fuel production. Early-stage carbon removal companies and projects might formulate stances on whom they will allow themselves to be acquired by, and adopt 'poison-pill' measures to guard against their possible acquisition by fossil producers.

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Disentangling carbon removal from fossil fuels

Implementing actor	Examples of commitments & policy ideas to avoid mitigation deterrence risks
National governments	National governments should create separate targets and accounting for emissions reductions and removals. This is particularly important in the short and medium terms; longer term targets might be kept open-ended until there is more clarity on future balances between emissions reductions and carbon removal[39]. They should make commitments to avoid financing projects that are owned or led by fossil fuel producers. Not least, they should also seek to provide dedicated public infrastructures to support carbon removal (see next section).
Emissions trading schemes (e.g., European Union, California)	Existing emissions trading systems (whether voluntary or compliance) should not integrate removals; rather, efforts to incentivize removals should only be done via creation of separate 'removals trading schemes'[40]. Participating entities might be assigned quotas for (durable) removals based on historical, current and/or future emissions.
Financial institutions, investors, verifiers	Those involved in funding and verifying carbon removal should ensure that there is a clear separation between removals and emission reductions in standards and accounting towards verification of corporate net zero policies.
Companies, including start-ups	Private companies should make commitments to limit the influence of fossil fuel producers in owning, controlling, or benefiting from their activities.

Another important contribution to managing mitigation deterrence is a planned phase-out of fossil fuel production, which is increasingly recognized as necessary by 2050[41]. While the phase-out is in progress, putting fossil fuel production into public ownership—such as by means of a majority buyout, regulation[42] or quantitative easing[43]—could help reduce the risk of mitigation deterrence. It is worth noting here that transferring ownership of fossil fuels to the public sector is not a panacea, but it may open up important options for contesting the industry[42,44,45].

It is important to note, though, that managing the influence of the fossil fuel industry is not the only important priority for minimizing mitigation deterrence risks with carbon removal. More broadly, disentangling carbon removal from offset approaches will be essential to addressing mitigation deterrence issues. Making carbon into tradeable 'offsets' might add flexibility for corporates and countries trying to meet emissions reduction targets, but it might not actually reduce or eliminate emissions[29]. As Danny Cullenward and colleagues write, "carbon offsets are primarily used to justify ongoing emissions, rather than reduce them."[29] This is because carbon offsets make sense for meeting moderate climate targets, but not to drastically cut emissions, as is—and will only continue to be—needed. As we elaborate later in this report, to address the mitigation deterrence challenge, the carbon removal sector must also move away from offset models for managing removals.

Transparently link removals to what is truly 'hard-to-abate'

Carbon removal does not have unlimited potential for deployment—rather, it should be thought of as 'precious' and a scarce option, due to resource limitations, particularly around space, energy, and physical materials[46]. Carbon removal will be expensive and resource-intensive, taking dollars from other important investments needed for decarbonization and renewables that might otherwise be used to substitute for fossil fuels. In other words, there is likely only so much carbon removal that we can do, within sustainable resource constraints, and without introducing justice and equity implications or trade-offs with other important decarbonization priorities.

Because carbon removal is a scarce resource, we need to think carefully about what we do carbon removal for.

Our current understanding is limited on what the upper bounds of 'total possible carbon removal' might be, but the limited nature of possible deployment necessitates that we make decisions about what to do carbon removal for: do we do it to compensate for "luxury" emissions[46], or emissions from production of staple food crops?

While residuals are often justified on the basis of technical difficulty (e.g., 'it is too difficult to decarbonize this technology'), also important are cultural, economic, and other social reasons for determining which ongoing emissions might be deemed crucial[47]. We argue that we should prioritize carbon removal for the compensation of *truly necessary* residual emissions over non-necessary residuals. But what constitutes a truly necessary residual emission[48]? Some such distinctions are clear, but many are not. What is considered 'necessary' is not objective, but should be understood as value-based—for example, it might vary with cultural values around meat consumption, aviation and long-distance travel[4]. Yet currently, models underpinning calculations of residuals 'bake in' certain presumptions of necessity, taking them as givens, rather than value-laden judgments likely influenced by industry interests. These presumptions of necessity are increasingly relevant, as corporate-driven voluntary markets are beginning to include carbon removals into their systems and purchasers are determining which residuals warrant offsetting[49].

Efforts are needed to bring reflexivity and clarity to what constitutes 'hard-to-abate'—and in doing so, to ensure that justice considerations are prioritized in the evaluation of these classes of emissions. In other words, we need 'rules of legitimacy'[49] for calculating residuals. To be truly 'legitimate', these rules need to be developed not in isolation by a few decisionmakers, but in a democratic manner where different social groups can participate. In other words, we need broad public deliberation over what kinds of activities warrant taking the (relatively) small amount of carbon removal resources that are available to us. While it is important to generate agreement on what counts as legitimate, it is also important that this process is not dictated from an elite policy vantage point, but that it emerges from a broad-based effort to explore what resonates as legitimate with a diverse range of groups and people.

One option for creating transparency and legitimacy might be to develop a UN-led process and national-level oversight bodies by which 'legitimate' corporate or country buyers of carbon removal could register as such, based on established criteria. Such criteria might be inclusion in a sector/process that has been given legal exemption from abatement, or if a company has a robust plan in place for a just transition[49]. Aggregate allotments of residual amounts made by such oversight bodies would vary depending on geography and over time: it might be ethically important, for example, to allow Global South countries and actors to assume higher residuals[49,50]. In this way, countries and corporations might acquire removals in a way that is in line with the type of residuals they can 'legitimately' claim.

In another possible (and potentially compatible) approach, oversight of residuals might be more centralized. Instead of permitting individual companies to purchase removals, companies might be required to contribute to a national fund. This centralized fund would then support the provision of removals. In essence, this approach functions to pool carbon removal funding, centralizing it and taking decision-making out of the hands of corporate actors, so that corporates are funding—but not overseeing—carbon removal.

A note on historical emissions: it would also be possible to deploy carbon removal to draw down legacy emissions. This may, indeed, be an important reason to do carbon removal,

particularly as opposed to carbon removal done to facilitate the ongoing use of fossil fuels. However, we are wary of recommending that carbon removal be prioritized for this purpose. The reason for this, again, goes back to the limited nature of carbon removal as a resource. It might be preferable, for example, to prioritize carbon removal as a means to avoid harsh socio-environmental impacts or draconian restrictions (e.g., on flying) that might otherwise occur to reduce some types of emissions. As we will describe in more detail in the following section, what is really needed is a justice-oriented, participatory decision-making system for navigating the tradeoffs that carbon removal inevitably raises—rather than a prescriptive list of what carbon removal 'should' and 'shouldn't' be used for.

What if...?

Conspicuous carbon credit consumption: It is 2041, and carbon removal credits are a trendy luxury item that the wealthier classes are using to flaunt their wealth. Pundits frequently discuss how much the mega-wealthy should be lauded for 'reversing' their egregious personal emissions. Others argue that they should be condemned for not cutting those emissions in the first place.

The end of an era: It is 2090, a generation after the ocean alkalinity enhancement and DAC booms helped the world reach Net Zero without unpopular changes to air travel habits or diet. Now, many of these industrial facilities are reaching the end of their life and require massive (and costly) investments to be upgraded. Trying to avoid these huge investments, governments have begun to discuss cracking down on the world's significant 'residual' emissions. Governments are debating: Does it make sense to continue paying to keep the carbon removal sector going, or would it be better to invest that money in next-gen carbon-free infrastructure, like green super-steel and mantle trains?

Rethink estimates of the scale of responsible deployment of carbon removal

Currently, estimates of future carbon removal at both international and national levels tend to be top-down. They begin from a perspective of, 'how much carbon removal will be needed?'[51]. Approaches to quantify 'needed carbon removal' generally begin with temperature targets or residual emissions targets[4], and they tend to optimize for lowest cost[52].

These approaches fail to ask at what scale carbon removal may realistically be done *well*. They fail to acknowledge the practical realities of operating with a likely limited amount of possible carbon removal, due to physical and financial resource constraints, and are inattentive to the social and environmental impacts and tradeoffs that might arise—especially when pushing beyond these resource constraints. For example, we have a limited amount of renewable energy at present—and carbon removal with high energy needs will displace renewables

that could have substituted for fossil fuels. Existing top-down approaches also fail to attend to questions of equity[53]—such as, which regions have most contributed to historic emissions[52]? Which should be asked to dedicate resources to carbon removal? As many scholars have demonstrated, integrated assessment models—on which many of these estimates might be based—are laden with assumptions that exclude key social considerations, making predictions less just and also less socially accurate[54–57].

We thus argue that more rigorously justifiable projections are needed on the scale of carbon removal that could be responsibly deployed. Neutral or independent decision-making bodies[58] have a key role to play in leading such projections, minimizing the vested interests or incentives at play. These estimates must include physical parameters for the viable deployment of carbon removal, accounting for the biophysical and economic limits on deployment. But they must include more than just physical criteria and should also include social parameters to guide estimates of potential. This could be done, for example, by integrating existing social and governance data into estimates.

It might also be done (perhaps more ambitiously) by linking assessment with qualitative engagement work and quantitative social science research on public perceptions. A range of public groups—from workers to environmental justice groups to local communities—might be brought into discussions, providing input on if, and where, specific carbon removal approaches might be socially viable. It is worth emphasizing that this type of analysis will not be straightforward or easy, and it will involve many assumptions and value-based decisions. But this kind of analysis would provide a more scrutable understanding of carbon removal potential, one that is less locked into the expert domain, and more 'opened up'[59] to broader public participation and deliberation.

It is worth noting that such assessments would not inherently recommend 'less' carbon removal: less carbon removal implies greater degrees of emissions cuts, and emissions cuts also can have social and cultural downsides. Carbon removal, too, could have important co-benefits. Rather, the kind of analysis described here will be attentive to where certain types of carbon removal might not confidently be done without important social and justice-related concerns. This analysis might, for example, highlight the specific locations where carbon removal might *not* be feasible without adverse impacts to disadvantaged and vulnerable populations. Such an improved understanding of 'total possible carbon removal' may also head off issues of moral hazard and the use of carbon removal for the wrong purposes, by more explicitly clarifying that only a limited amount of carbon removal will be ethical or viable from a resource perspective.

What if...?

Inadequate infrastructure results in green land-grabs: In the 2050s, some of the more durable carbon removal approaches have promised much but failed to deliver. DAC plants have shown themselves to be budget-busting energy gluttons, using up large amounts of renewables capacity. CO_2 is also leaking from hastily built pipelines and some underground reservoirs. Social pushback due to insufficient public engagement has hindered the integration of new infrastructure at wastewater treatment facilities, making it difficult to build infrastructure to conduct ocean alkalinity enhancement. Instead, key politicians are touting large afforestation projects as alternative ways of meeting removals targets—despite the pressure these would put on agricultural systems and the risks they may spell for food security.

Credit: Chun han, iStock

Move beyond markets and private ownership

In today's common political-economic context, market logics are pervasive: prevailing assumptions are that markets are the best way of distributing goods and resources, and that they should be indefinitely expanded, and their continual growth pursued. We see this in the widespread assumption that climate and environmental goals are best addressed by turning environmental goods and services into tradeable units and bringing them into markets. Too often, the default policy assumption is that markets are inevitable—and that innovation can only occur via market forces.

Such a default to markets can be seen in the emerging carbon removal sector, in part via offset markets, as discussed in the previous section. The early movers in carbon removal like Microsoft, Stripe, Shopify, and Frontier are making investments in carbon removal largely via the frame of 'purchases'—i.e., in a manner that assumes that carbon removal credits will be traded in existing or new carbon markets (voluntary or compliance) will eventually arise in which carbon removal credits will be bought and sold.[61]

We also see the assumption that only markets can drive innovation in the carbon removal sector (e.g., in McKinsey's 2023 report on scaling carbon removal[60]). In this view, government's primary role is often understood as enabling private sector innovation and competition. This is also evident, for example, in the August 2023 DAC Hub funding announcements by the US Department of Energy, which provide finance for private development of key network infrastructure. Such arrangements, if not carefully designed, can end up placing tax dollars in the hands of corporates with questionable records and raising mitigation deterrence issues—as has been the case with the DAC Hubs.

There are other problems with relying on market-based approaches and private capital to drive innovation, particularly when supported by innovation prizes and venture capital. As demonstrated in the wider environmental technology sector[61], the demands of early-stage investors seeking profitable exit drive companies to direct their ambitions to less environmentally transformative but more commercial applications (such as sale of offsets, or carbon utilization, for example through use of captured carbon for enhanced oil recovery). Investors also bring in business managers, often displacing or demoting the technical experts in a process Jesse Goldstein dubs 'killing the inventor'.

In sum, there are limits to what a market-based approach for carbon removal can offer—both for scaling the industry, and for doing that scaling in a way that aligns with progressive values. Our goal here is not to claim that there is any one institution or actor that is better (e.g., the government). Rather, we assert that there are a range of many different political economic arrangements besides market approaches that might lead to more optimal outcomes, and that these should be considered and explored. In the following section, we build on this case against offset markets specifically before turning to the exploration of what some of these alternative economic arrangements might be, and how they might be harnessed to responsibly scale carbon removal.

Reject offset models

As already discussed earlier in this report, offset market approaches are—we argue—by no means the best way to generate investment in carbon removal. Indeed, looking to existing carbon offset markets offers a sobering perspective on if and how carbon removal should aim to follow in this direction.

These markets have aimed to certify emissions reductions (or, avoided emissions) in compensation for emissions elsewhere[62]. Numerous scholars and studies have shown how offset markets have led to profiteering, land-grabbing, and human rights violations, including involving Indigenous peoples[63]. Markets tend to incentivize driving costs downward, with negative impacts to quality of offsets[64]. Offsets tend not to be accurate depictions of truly avoided or removed emissions. Emissions are often over or double-counted, or the emissions savings would have happened anyways[65]; in fact, Joe Romm asserts that offset markets have caused massive *increases* in emissions as a result of these issues (in the case of the Clean Development Mechanism, a United Nations-run carbon offset scheme, this is at the scale of an extra 6 Gt CO_2 produced since 2006).[65]

Critics of offset markets as a model for carbon removal propose various ways to reform and improve offset market approaches. Adding removals into *existing* markets would clearly be a recipe for mitigation deterrence, as discussed above; but it is not clear that even a separate carbon removal offset market could be designed to avoid these problems that have plagued voluntary and non-voluntary offset markets. Fundamentally, offsets were designed to add flexibility to meeting emissions reduction targets, making them more politically and economically achievable—rather than to actually reduce or eliminate emissions[29]. Offset approaches have, in sum, proven themselves to be 'incompatible'[29] with effective and responsible decarbonization.

At a minimum, we should move away from voluntary offsetting claims made by individual, corporate or institutional buyers as they purchase removals to compensate for other emissions elsewhere[66]. But what might an alternative approach look like? There is an undercurrent within the carbon removal sector that recognizes the misaligned incentives involved in presenting purchases as offsets or tradeable entities. This perspective seeks to present pre-purchases and offtakes as 'climate contributions'[67]. This perspective acknowledges the problematic incentives with offset approaches, given that they are premised on compensatory claims wherein removals 'compensate' for emissions. Contribution approaches offer an alternative, where incentives support innovation and scaling by filling knowledge gaps, without making claims of offsetting or neutrality[68]. The non-profit Terraset offers an example in this vein, pooling philanthropic donations to purchase carbon removal collectively without the generation of credits or offsets. In the absence of making corresponding adjustments to nationally determined contributions, such an approach is the only way to remedy the double-counting issue noted above[29,69]. We applaud such steps towards shifting incentives.

Ultimately, however, we are skeptical whether such approaches can be sufficient. Emphasizing 'contributions to knowledge' over 'compensation for emissions' is an improvement, but how might that scale up to meaningfully support removals at scale? A 'pooled' approach to removals might be one option for doing this. National governments could create pools of removals from a portfolio of verified sustainable providers, funded by levies, or contributions from corporate actors with certified 'legitimate residuals' (building on the discussion in the previous section). Such an approach might offer a compelling alternative to the offset model, generating removals in a non-compensatory fashion.

What if...?

No one likes a nag: In 2032, governments have effectively outsourced carbon removal to private offset markets. Governments are making sweeping claims about their impact (although the results are so far dubious). Having no better options, mainstream activists are turning to the public, using pressure campaigns and ads that demand that 'everyone pays' for their carbon footprint. The result of this rhetoric of individual responsibility is a general turn of public opinion against the climate movement, which is increasingly perceived as 'scolding' the public for their inaction.

The big big short: In the 2040s, offsets are a hit, leading to highly financialized carbon market full of shorts, securities, and derivatives. Pretty soon traders realize it makes more sense to bet *against* the planet. Hedge fund bonuses soar—until markets start to collapse into crypto-style rug-pulls and fraud. Meanwhile, the weather is getting worse...

Create strategic, government-led industrial policy to innovate on carbon removal

As some scholars have compellingly argued, markets alone are not best suited to lead rapid large-scale industrial transformation[70]. They often need significant inputs from government to jumpstart important technological innovation: in energy markets, low-carbon technologies have needed dedicated subsidies to become competitive with established incumbents. Given the scale of research development and demonstration needed to get carbon removal off the ground, such government input is likely to be required[71]—but moreover, what is needed is not just subsidies but a coordinated, national-scale effort to create a carbon removal industry[64]. Indeed, the kind of massive economic transition involved in something like carbon removal has, according to Christian Parenti, "always require[d] state coordination and subsidy, if not outright nationalization"[20]. Furthermore, there is a strong case to be made that carbon removal

should be understood as a public good or service[19,46], something that should be provided for the benefit of society *rather than* as a commodity for private industry to profit from.

This kind of government role in funding—and planning—a large economic transition has precedents in much infrastructure development. While there may be no truly comparable historical example of either public or private sectors having accomplished the type of massive scale-up required for a carbon removal sector[72], the closest public comparators might be the World War II mobilization. This was shorter in duration, had a lower physical footprint, and may have benefitted from a common enemy and existential threat that was not politically polarized[72]. Other precedents include the New Deal era's Civil Works Administration, Public Works Administration, the Works Progress Administration, and others[19]. Today, models of public provision exist via extensive systems of public utility models for electricity and water provision in the United States, which provide these services and goods for the benefit of society rather than as a means for corporate profit[73]. Even private sector-led economic transitions have built on decades of public investment and ownership, such as the information technology scale-up (which also benefited from a lower physical footprint and high financial returns. Across clean energy transitions, the fastest (e.g., in France, Norway, Uruguay, Costa Rica, and China) have all involved high degrees of public investment in—and crucially, ownership of—clean energy production[72].

It is worth emphasizing that the approach we propose here differs from what we have seen with the recent DAC Hub investments in the US. As Emily Grubert and Shuchi Talati have pointed out, the US DAC Hub investments required a 50% cost share, making it difficult for other institutions besides for-profit institutions[46] to participate. Instituting funding requirements that are more amenable to not-for-profit applicants is thus one place to start.

Taking this a step even further, the model we propose and advocate for here is one in which public entities lead the development, direct the operation, and maintain ownership of carbon removal facilities and associated infrastructures. In the current model that is unfolding in the US (where much current carbon removal investment is happening), the government foots the bill, but removals are produced by private companies. US government carbon removal support is largely via grants, production subsidies, and tax breaks like 45Q and California Low Carbon Fuel Standard (LCFS) for DAC companies[74]. As a result, on the current path we are on, carbon removal might potentially end up a boon to corporates, or worse, a government-funded prolonging of harmful industries (as indicated by Occidental's role in recent DAC developments).[2]

Moreover, however, the current model still leans towards a model of commercial innovation epitomized by Silicon Valley[75] in which technological innovation is driven by angel investors, venture capitalists, and innovation prizes, triggering a proliferation of start-ups. Most of these are destined to fail, with incentives to profit favoring not those that can develop the most socially valuable carbon removal techniques, but rather those that can quickly develop a viable commercial business model to allow the early-stage investors to take their profit through a trade sale or initial public offering[61]. Such companies likely face incentive structures that encourage them to prioritize market development over technological improvement. This model will face significant challenges in meeting the medium and long-term goals of developing carbon removal projects that are socially beneficial and doing so at a substantial scale.

What is a potential path to public provision of carbon removal in the US? One approach might take advantage of the Inflation Reduction Act's 'direct pay' provision, by which public and nonprofit entities can receive tax credits as direct cash payments, despite having no tax liability[76,77]. For example, this year New York passed a publicly funded renewable energy program, the "Build Public Renewables Act" (BPRA) using this provision[8]. The 'direct pay' approach might be a pathway for municipal governments to create publicly owned carbon removal projects. More ambitiously, creating "Carbon Removal Administrations"—in the US and elsewhere—could create institutions to take on the mandate of removing carbon in accordance with national commitments. These could also be set up as regional bodies, conducting research tailored to local areas, but collaborating on broader research priorities such as around monitoring, reporting and verification (MRV)[79] (although MRV would likely need to be outsourced to ensure the right internal incentives[29]). It is worth noting that this approach makes most sense for carbon removal approaches that involve building and maintaining infrastructure, rather than changing rules and regulations, as may be the case with, for example, enhanced weathering.

Develop and incentivize collective ownership models for carbon removal

Another compelling path forward is exploring a range of ownership models and arrangements that might place governance and decision-making in the hands of people. Some of the ownership models we discuss here might be best suited to smaller-scale operations, if it proves difficult to apply collectively and cooperatively run approaches to more capital-intensive technologies. But there are, likely, alternative ownership structures worth exploring for many types of carbon removal.

One such ownership model involves a partial government equity stake in a publicly traded company[80]. This has historically been more common in Europe, where it has been applied to support public infrastructure and governance—as opposed to the US and the UK, where it

has been used more for bailouts (such as with General Motors[81]). Cooperatives are another model[80]. For carbon removal, these might include producer coops (e.g., Ocean Spray, Ace Hardware), or worker coops (such as Mondragon Corporation in Spain, which is a network of worker cooperatives[82]). Employee Stock Ownership Programs give workers equity stakes and therefore ownership, allowing workers to provide some input into strategy[83]. Other approaches that legally mandate worker involvement in corporate decision-making, such as 'co-determination' (a model with a history in Germany), might be considered as well[80,84].

Governments (both federal and local) and private sector funders might incentivize, prioritize, or preferentially consider programs that introduce this kind of ownership structure. This could be in the form of both formal commitments (e.g., legislation to fund carbon removal), and informally via programs dedicated to funding more collective and collaborative ownership and management structures. Hub-type approaches that focus on long-term capacity building for Global South-led research and development are needed, rather than extractivist, Global North-led implementation of carbon removal in the Global South that risks reproducing settler-colonial relationships and accompanying harms.

Community-led models of carbon removal: Two examples

The following are two early examples of carbon removal projects or initiatives that represent alternative structures managing and owning carbon removal.

The **CALDAC application** to the US Department of Energy's DAC hub funding that offers the first example of community-designed, community-owned large-scale carbon removal[85]. Such an approach might serve as a model for other projects to emulate in centered community design and ownership in siting and other project decisions.

The **4 Corners Carbon Coalition** is a partnership of four local governments in the US (Boulder County, Colorado; Flagstaff, Arizona; Santa Fe, New Mexico; and Salt Lake City, Utah) that allows municipalities to pool resources towards carbon removal projects in their communities[86]. This kind of local government-led approach to carbon removal procurement has the potential to ensure that local priorities, planning capacity, and engagement efforts are centered in carbon removal projects.

What if...?

We put our faith in workers: In 2029, the unprecedented project of building an entire new industry from scratch—on top of new anti-capitalist populism—has led to an unprecedented challenge to neoliberalism in the US. The government is only funding public- or employee-owned carbon removal firms, who are tasked with the monumental task of repairing the climate. It's the first trial of a new American economic model, and many economists are cynical, worrying that it will cause an entire generation to turn their trust back to the market. In response, an air of all-hands-on-deck dedication pervades the industry, injecting it with extra momentum.

Sinking surplus electrons: By 2035, the rapid proliferation of cheap-but-intermittent solar and wind has led to big energy gluts during peak generation hours, particularly the sunny middle of the day. Policymakers are suggesting carbon removal procurement programs as a "buyer of last resort" to soak up these excess electrons. However, the challenge is determining which financing models might support building DAC plants that only run a few hours a day. Once that's sorted, a long-awaited renaissance for the carbon removal sector begins to bloom.

Credit: Mark Stebnicki, Pexels

Treat intellectual property as a public good and incentivize technology sharing

Management and regulation of intellectual property (IP) is a central (and under-discussed) issue for carbon removal. Terrestrial/agriculture, DAC-based, and ocean-based approaches all raise important IP considerations, in terms of the technologies and systems required to both do effective carbon removal and effectively monitor/measure, report, and verify these removals. Protection of IP relevant to carbon removal can be in the form patents on inventions, copyright for software, and trade secrets for commercially valuable information such as production processes[87]. Private sector firms often rely on practices of non-disclosure to guard intellectual property, preventing broader sharing of knowledge. Climate technology tends to be privately owned, meaning that others—such as those in the Global South, but also non-corporate groups in the North—cannot easily access or benefit from it[36,88]. Openly sharing these technologies is also an important piece of global reparative justice, as discussed below.

IP regimes for climate-related technologies at the international and national levels are, in theory, designed to provide a balance between incentivizing innovation and the provision of technology and information necessary to the public good of addressing climate change[87,89]. This is a tenuous balance, with polarized views on how to best strike it. Given past and ongoing debates on climate technology more broadly, there is good reason to ask whether the existing international IP regime is currently able to support both (1) rapid scaling of quality removals, and (2) integration of a diverse set of countries in participating in and benefiting from deploying carbon removal, especially given that carbon removal initiatives are predominantly located in the Global North at present.

Although a common logic is that private rights are needed to create innovation, it is also arguable that more open sharing of carbon removal IP would generate more coordination, faster innovation, and more efficient deployment, particularly if combined with systems to ensure that carbon removal is prioritized regardless of its ability to generate profits (as discussed above). Unwieldy IP regimes can hinder innovation, preventing straightforward access to new innovations. From a justice perspective, open sharing of intellectual property is also essential—so that those who have disproportionately contributed to climate change and benefited from economic development do not prevent others from also benefiting from and participating in approaches to address climate change. Beyond technology in the form of hardware or patents, or even software, key needs are also the knowledge and capacity to adapt technology to local contexts[90]. This adaptation is not a small challenge, given as noted above that carbon removal research has thus far been centered in the Global North[9]. Translating research to the Global South may not always be optimal, straightforward, or risk-free. Public sector licensing and collaborative patent licensing models, such as pools and clearinghouses, might improve innovation, via greater transparency, affordability, and less friction from 'patent thickets'[91,92]. These could facilitate carbon removal suppliers' use of IP, particularly IP developed in the Global North.

It is also essential that efforts are taken to help facilitate innovation in the Global South[93]. One approach might be for Global North suppliers of carbon removal methods and techniques to offer preferential terms for technology licenses to developing-world suppliers[94]. In a public utility or managed pool approach, removal operators could be required to provide such licensing if they are to participate in the domestic scheme. Another approach might be to set up a hub for fostering collaborative research and development partnerships and co-creation strategies[36]; this might be done, for example, by leveraging the UNFCCC's Technology Mechanism's Climate Technology Center and Network (CTCN). Other multilateral fora like Mission Innovation and the Clean Energy Ministerial might be options for implementing a hub like this[36].[2] Such a hub-type approach to technology transfer might be suited to facilitating not just transfer of technology, but also building capacity and knowledge on carbon removal in the Global South.

What if...?

Carbon accounting cover-ups: In 2061, researchers have just realized that the US federal procurement program has been over-crediting certain forms of carbon removal by a factor of two, due to loose and inconsistent verification rules embedded in the decade-old UN carbon removal treaty. The government sweeps this under the rug, thinking that it will be too expensive to make up the removals that are missing. Similarly, mis-accountings at privately managed carbon storage sites are hushed up. Around the world, on-paper progress on climate repair is failing to result in expected temperature reductions.

Technological success, financial complications: In 2044, carbon removal technologies have been scaled and proven, but debate rages at the COP over who should pay for it and how to handle intellectual property. Nations and corporations disavow their past emissions as the products of bygone regimes or even the liability of political entities that no longer exist. Governments and companies hide the wealth that might be mandated to fund carbon removal, making use of cryptocurrencies and shell companies. Forensic accountants must race against the planetary clock to unlock funding streams for carbon removal giga-projects.

[2] Mission Innovation is an initiative led by a set of 20+ countries and the European Union to spur research, development, and demonstration of affordable clean energy. The Clean Energy Ministerial is a global forum to promote policies and programs for clean energy technology, led by key economies.

Make carbon removal a tool for justice

There are three 'dimensions' of justice that we think are useful for imagining a more just approach to carbon removal. Here, we discuss priorities for making carbon removal more aligned with each of these dimensions. They include *procedural justice* (involving groups in decision-making on issues that affect them), *distributive justice* (ensuring that no group bears a disproportionate share of impacts or gains an unfair share of benefits), and *reparative justice* (repairing past harms, and redressing historical and systemic injustices). Many aspects of these dimensions have in fact been already touched on in previous sections of this report.

Procedural justice: Ensure that community, Indigenous and labor groups participate substantively in decision-making

An element of a 'just' approach to carbon removal requires setting aside urgency-driven narratives of 'carbon removal at all costs.' Carbon removal research is urgently needed—but rushing carbon removal deployment is a recipe for harming those that are most vulnerable. The right conditions need to be in place for carbon removal to align with a progressive future, and processes of deliberation, discussion, and consent-seeking are needed to establish if and how these conditions can be created. We believe that adequate climate action on carbon removal is possible without the politics of emergency, i.e., through participation in such deliberative and democratic processes. Indeed, such processes are required. To make carbon removal aligned with procedural justice, the proponents of carbon removal projects—public or private—must meaningfully involve potentially affected groups and communities in making decisions[22,95]. For engagement to work, it needs to help groups shape if, where, and how projects happen—and it must occur early[96]. Given that most of the public is completely unaware of carbon removal technologies, and do not yet have the tools to grapple meaningfully with decisions about them[33], engagement must involve processes of two-way dialogue and learning—where groups learn about carbon removal and shape understandings of project risks and benefits via their own experience and localized knowledge. In other words, engagement needs to move beyond 'consultation' to instead use a co-design approach, where communities actively participate in shaping options, alternatives, benefits, and decisions.

At present, engagement on new infrastructure and resource extraction projects tends to follow a 'decide, announce, defend' model, in which communities have little opportunity to have a say in new projects that affect them[97]. This status quo approach to engagement means that projects are decided behind closed doors, and engagement is limited to announcing these plans and defending them against opposition. This model is, clearly, at odds with procedural justice, but it is commonplace in engagement on energy, infrastructure, oil and gas, mining, and other sectors. Carbon removal is, thus far, no exception; even though 'engagement' has been recognized by the US Department of Energy as a critical component of funding criteria

for its DAC Hubs, communities around recently announced projects in Louisiana and Texas are calling the quality and timeline of engagement into question[98]. Community groups cite resentments about responding to pre-selected locations, rather than playing an active role in the siting process.

For engagement to be more than just performative, broader and more substantive participation is needed. Furthermore, there need to be changes in who leads engagement activities. In the emerging carbon removal sector, engagement is largely absent, and at best, primarily consists of individual project efforts with circumscribed engagement[3,58]. This disjointed approach has several downsides: First, it tends to bake-in a responsive dynamic, in which communities are likely to arrive at the table too late to set their own priorities. Second, communities are not likely to be given the full range of possible options via this approach—instead, the developer's given technology or approach is centered, despite that there might be other approaches, technologies, or configurations of benefits that could be preferable to communities. This approach likely will make engagement on the provision of shared infrastructure—such as pipelines—more challenging. Communities may also be hesitant to trust developer-led efforts, even if facilitated by third parties.

How can we best ensure that engagement is done well? Independent institutions—not developers—need to lead engagement efforts in order to ensure that engagement builds trust, that it is conducted in resourced and rigorous ways, and that it facilitates the coordination and knowledge-sharing needed for a nascent carbon removal sector[58]. Both private and public funders can ensure that developers' engagement approaches are not just evaluated but also prioritized in funding decisions. But this alone will likely be insufficient if engagement is solely developer-led. Large-scale, independent, publicly funded engagement programs are needed on carbon removal (not to mention on decarbonization more broadly[101]) at national and regional levels. Such programs should take a comprehensive and expansive perspective, deploying resources and relevant expertise to help communities look across technology options, locations, and political economic configurations to assess if, how, and where carbon removal might make sense for them. They should also involve communities in national and even international planning of future allocations of carbon removals and emissions reduction budgets.

A final point: efforts to improve engagement and participation are incomplete without attention to consent. Central here is that Indigenous sovereignty is respected—meaning that free, prior and informed consent is sought, and that projects never move forward without this[102]. This is also crucial for Global North-led endeavors operating in Global South contexts, and projects involving environmental justice communities, or those who have been historically harmed by fossil fuel production and other industrial activities. Consent is not just about 'yes or no' once a project is decided—it should be a process of iteration as technological concepts move from lab or bench to pilot studies or field trials and beyond.

[3] Some exceptions exist amongst academic projects, such as the European Commission-funded OceanNETs project[99] or the Canadian Solid Carbon project[100].

Research is needed to establish what constitutes 'consent' in the context of different stages of carbon removal projects, emphasizing approaches like direct referenda, citizen juries, and citizens assemblies, which place decision-making in the hands of communities[103]. Also needed is greater clarity on what constitutes 'consent-based siting'[104], which is often discussed around the development of nuclear waste facilities, but has been critiqued as not specific enough to generate clear rules of play[105]. At a minimum, all communities (particularly Indigenous, environmental justice and Global South) should have the 'right to refuse' carbon removal projects[106].

Improving procedural justice via dedicated engagement with Indigenous communities

The NGO Global Ocean Health's *"Building Tribal Leadership in Carbon Removal"* initiative has launched an Intertribal Working Group to explore options for cooperative economic development and environmental restoration for US Tribes and Indigenous Communities via carbon removal, and to ensure that they "lead in both the practice and governance of carbon removal"[107]. Such efforts to engage historically marginalized rightsholders and others are important contributions to exploring if and how carbon removal might support the priorities of these groups.

What if...?

Weather control accusations: In the 2030s, DAC plants spring up around the country, thanks to libertine permitting reform. But these facilities are soon the targets of protest and sabotage. Community resentment over lack of engagement combines with social media mania, resulting in rampant conspiracy theories. These conspiracy theories allege that DAC plants are in fact *causing* the climate impacts that increasingly batter the globe.

Too late, but not too little: During the crucial transition decades, carbon removal industry proved too difficult and contentious to get off the ground—particularly due to lack of buy-in from labor leaders and community groups. As a result, it has been relegated to the margins. However, with the world careening toward 3C warming in the 2040s, the underdeveloped carbon removal sector begins to become revitalized by a new generation of activists demanding massive moonshot removals.

Distributive justice: Do not place the burden of costs and risks onto Indigenous, marginalized, or vulnerable groups, or the Global South

Carbon removal 'done well' does not just remove and store carbon—it also avoids harms, provides numerous co-benefits, and allocates these gains to disadvantaged groups in equitable ways. Benefits could range from economic, like quality jobs, to ecological, like enhanced ecosystem functioning. To achieve these, it is critical to ensure that potential ecological, social, and political impacts of carbon removal projects are, first, better understood and, second, prioritized in policy and governance mechanisms. In other words, we need to remember that it is "not all about the carbon"[23]. Done well, carbon removal avoids other harms that would otherwise arise or continue, such as the particulate pollution associated with fossil fuels. In sum, only optimizing for the 'carbon' in 'carbon removal' risks incurring harms and missing important key benefits.

Instead, research is needed that examines the full spectrum of social and environmental risks and benefits of carbon removal—in its various potential configurations, both technological and political, economic, and social—in comprehensive and interdisciplinary ways. At present, very little such research exists, with much attention focused on techno-economic feasibility[9]. What is also needed are feasibility assessments that account not just for techno-economics but also social and ecological considerations. Social science research that accompanies early-stage field trials and demonstration projects will also help advance this interdisciplinary understanding, taking advantage of these experiments as opportunities to ground more theoretical research on public views and priorities in situated contexts[108].

Cumulative impacts are a particularly critical piece of the research needed[96,108]. As carbon removal scales, there may be smaller impacts that become significant via accumulated effects of multiple projects, and initial projects will likely open the door to other projects in the region. Integrated planning and environmental-social assessment efforts are needed that pre-empt these complex impacts—rather than leaving them to be dealt with after-the-fact. This pro-active management of cumulative and other impacts needs to be addressed via planning and impact management tools used in other sectors, but in the rapid pace and large scale at which it may grow, carbon removal may pose a challenge to these existing methods[104]. Funding for regional and local planning efforts is needed to allocate these efforts the resources they require.

In addition to assessing potential impacts, it will also be important that that communities are involved in determining the benefits of projects. These may be formalized via community benefit agreements, project labor agreements, community workforce agreements and others[109]. While community benefit plans are widely discussed in the context of the US DAC Hubs, it is worth noting that these are not legally binding[110]. Moreover, although applicants to the US Department of Energy's DAC Hubs Program (excepting for desk-based work) were required to submit community benefit plans on their plans to engage and provide benefits to communities, these have not been made public, and moreover, many groups were not consulted with or meaningfully allowed to contribute to the development of these plans[111].

Funding of carbon removal should mandate that benefit arrangements with communities, workers and others be legally binding, enforceable, and transparent. In managing both impacts and benefits, funding should also support communities in producing key 'metrics' to hold developers (public, private or otherwise) accountable via legally enforceable mechanisms[109]. Metrics might be on ecological, labor, noise pollution, or myriad other criteria determined to be of importance to communities in question.

What if...?

Sins of the past: Long awaited climate repair finance comes in the unexpected form of the 2050 Global Reparations Treaty. After decades of shifting political winds, growing outrage at a variety of historical injustices, and a wave of impactful strikes, the old colonial powers agree to foot the bill for cleaning up some of the world's past emissions. Some say it's killing two birds with one stone, while others complain that the RNG countries—Rich 'N Guilty—are getting a free pass spending their reparations dollars on something they'd need to pay for anyway.

Thermostat tug-of-war: The carbon removal tech to reduce global temperatures is ready and built, but nations of different latitudes can't agree on where to set drawdown targets. Operations are started and stopped, facilities are turned on and off, as a geopolitical struggle for climate control unfolds.

Global reparative justice: Work towards remedying legacies of colonialism and extractivism

A central aspect of reparative justice is ensuring that those who have suffered from historical emissions receive reparation from those who produced the bulk of historical emissions. Those who have contributed the most to climate change must in fact bear responsibility for funding carbon removal—this responsibility should not be outsourced elsewhere[22]. 'Carbon take-back obligations' are a prominent suggestion for how to enforce 'producer responsibility' amongst fossil fuel companies[112], but one risk that we envision is that they might help maintain the political power of the fossil lobby—and become a license to continue extraction and pollution. Part of the reason to avoid market-based approaches (as discussed above), such as via emissions trading regimes, is that they can result in this kind of outsourcing of responsibility[65].

Otherwise known as 'climate reparations', one framing of such enforcement of responsibility applies to all of those who have caused harm—that is, countries, fossil fuel producers, and other emitters and disproportionate users of energy and resources[113]. As Olufemi Táíwò has argued, the Global North owes reparations to the Global South—not in the form of loans that

generate debt (such as those commonly provided by international development financial institutions), but instead, as unconditional cash and capital transfers.[113] Ongoing debates over how to compensate for the unavoidable 'Loss and Damage' arising from climate impacts in the Global South may provide an opportunity to institutionalize Northern obligations to support carbon removal as a form of climate reparation, alongside financial transfers. An outstanding question that bears further consideration (and political deliberation) is: how should responsibility be allocated—on the basis of historical emissions, ability to pay for removals, or something else[36,52,114]?

Where the money comes from matters, but also important is that decision-making power around this funding is placed in the hands of people and communities. One option for this might involve setting up a global fund that private corporations pay into, based on some calculation of past harms done. A global Tobin tax on financial transactions could be an option for funding such an initiative[115]. Given the magnitude of expenditures needed to fund carbon removal in the coming century—as much as a third of government spending in advanced economies, by some measures[116]—this kind of fund might offer an important mechanism to offset otherwise burdensome fiscal needs.

In addition to repairing, rather than exacerbating, past and ongoing harms of colonialism, it is crucial that carbon removal addresses harms from extractive industries. In reflecting on the complicated incentives wrapped up with fossil fuel producers leading research on DAC technologies, Kate Aronoff asks, "If this technology is so needed, why leave it up to companies that have spent decades lying about this problem and misleading the public?"[117]. A reparative justice approach to carbon removal ensures the dismantling of historical structures that have caused harm—beginning with fossil fuel producers. Many of the recommendations above, in the section on mitigation deterrence, are relevant here.

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Four bold policy ideas for a progressive approach to carbon removal

Below we offer four novel, ambitious policy ideas that national governments, international institutions, and large funders might pursue and facilitate. These ideas holistically integrate the principles and priorities discussed throughout the report.

Carbon removal administrations

Chartering national "Carbon Removal Administrations" would be a means to public implementation of carbon removal. These administrations would take on mandates of removing a certain amount of carbon annually, in accordance with a national commitment; compliance with these commitments might come into effect following a period in which research (rather than removals) would be the goal, to incentivize knowledge development. These administrations might be akin to the US Department of Energy's Office of Environmental Management (in charge of the world's largest environmental cleanup operation)[118]. Administrations could be set up to have regional sub-administrations that conduct research tailored to local areas, but also collaborate on broader research priorities such as around monitoring, reporting, and verification[78] (although MRV would likely need to be outsourced to ensure the right internal incentives[29]). Such administrations could also establish subsidiary projects with strong rules of play, such as around collective ownership. They could be funded via a mix of taxes on and fees from carbon emitters.

Structuring provision of carbon removal via such public institutions could support many of the goals discussed in this report. First and foremost, these administrations would create removals for the public good rather than private profit. They could generate research on types of carbon removal that the private sector is not inclined to fund. Second, such administrations could be established to support a contribution model rather than compensation model of removals, reducing mitigation deterrence, overcounting and other risks of offset approaches. If paired with transfer of ownership of fossil fuel production, they might leverage fossil industry expertise and skills for types of carbon removal that involve geological storage. Finally, they could support sectoral planning, creating coordination and strategy needed to move the sector forward as a whole, and they could support participatory and democratic decision making, by linking with independent engagement bodies (discussed below).

Although DACCS has dominated much of the (US) government spending on carbon removal thus far, such carbon removal administrations could oversee research and deployment of potentially important ocean-based approaches, like alkalinity enhancement and biomass sinking. In fact, public-driven carbon removal is arguably vital to consider for ocean contexts,

given the difficult jurisdictional challenges that these often bring[119]. It is worth noting, however, that a 'carbon removal administration' approach might be less applicable to terrestrial carbon removal approaches that rely on changing of rules and regulations, rather than building of extensive new infrastructures (such as may be the case with enhanced weathering).

Pooled approaches to removals

The creation of 'pools' of removals, by national agencies, might be a compelling alternative to offset models for incentivizing and accounting for carbon removal. Such an approach would involve first developing portfolios of verified sustainable payers. These payers would be corporate actors producing what have been designated as 'legitimate removals', as defined by collaborative and inclusive processes of societal deliberation over what should count as 'legitimate'. Examples of potential criteria for 'legitimacy' might be that a company is in a sector that has been given legal exemption from abatement, or has a robust plan in place for a just transition[49]. Agencies might allocate fluctuating residuals amounts, varying on geography and over time. In this way, countries and corporations might acquire removals in a way that is in line with the type of residuals they can 'legitimately' claim.

Rather than asking these corporates with legitimate removals to offset these at the company level, however, the national agency would instead develop a sum total of removals to be accounted for the national level, in line with national removals commitments. To generate these removals, the agency would not 'purchase' carbon removals (which, as we have seen, often involves going for the cheapest option), but instead would invest more thoughtfully in removal approaches. This might, for example, in the nearest term involve investing in key research needed to de-risk early-stage but promising technological approaches.

This approach would ensure that 'the polluter pays,' but insulate the process from the outsize political influence otherwise wielded by corporate interests, and avoid the issues raised by existing offset approaches. Such an approach would also create a more reliable and publicly guided source of finance for driving new removals. Not least, it would help avoid the conflation of removals and emissions reductions, as it would prevent corporates from buying cheap carbon removal credits as a means to avoiding meaningful emissions reductions.

Independent, publicly funded engagement bodies

An option for conducting robust engagement on carbon removal would be to create a public entity to lead this engagement work[58]. This kind of a public entity might be an arm of a 'Carbon Removal Administration' of the kind discussed above, or it might be its own separate entity, perhaps modelled off independent public participation bodies in France, Quebec and elsewhere[120]. Such entities would undertake the kind of rich, deliberative, detailed

engagement needed for public groups to meaningfully make sense of the options for carbon removal in their local areas. They would rigorously communicate the latest state-of-knowledge on carbon removal to these groups, providing a counter point to groups touting non-fact-based information. They would also generate knowledge on how public groups view different carbon removal options, and the risks, benefits, and trade-offs they involve.

Such entities would establish regional and sector insights on if, where, and how carbon removal projects should be deployed and how these projects can be oriented to the public's and key groups' priorities. They would identify the conditions under which carbon removal projects could be deployed with public buy-in, and locations where widespread rejection might make that difficult. They would build capacity amongst and lay the groundwork for communities to meaningfully engage with private sector carbon removal initiatives, placing them on a more level playing field with these project proponents. They might also advise or oversee efforts to establish public oversight of carbon removal projects, such as via citizen advisory committees. Such government-driven integration of public engagement has, for example, proven useful to supporting a 'just transition', such as in the case of Germany's transition away from coal[121–123]. Such a body might also be suited to lead interdisciplinary research on social and environmental risks and benefits of different carbon removal projects, from field-level trials to larger deployments. They would also be well poised to develop planning efforts to manage the cumulative impacts associated with rapid scaling of carbon removal approaches.

It would also be important for this kind of deliberative, participatory engagement to be conducted with workers. Many new jobs will need to be created for carbon removal to work, and potential workers will have important insights into the kind of jobs, technologies, and projects that they would want to see[124]. A worker-led envisioning of carbon removal might emulate the Lucas Plan, which was an effort by workers at the Lucas Aerospace Shop in the UK in 1976 to propose new products and types of work[125–127]. When faced with large potential layoffs, Lucas workers came up with a wide range of new ideas for products, systems, and equipment that they could produce. An independent engagement body might facilitate the kind of worker-led initiative needed to best understand the types of jobs and employment that future workers want, and the ways to best to support them in that transition.

A global reparations fund

While the other ideas posed here might be implemented at the national level, this last idea is relevant in the international sphere. A global reparations fund is a concept that involves requiring private corporations to pay into an international fund according to a calculation of harms that they have caused (e.g., contribution to climate change, pollution, other social and environmental harms). This fund would pay for carbon removal in efforts to generate carbon removals as a reparative public good. One option for operationalizing the collection of funds for this might be via a global Tobin tax[4] on financial transactions[115]. Debt-free transfers of cash and capital might also be an option.

Given the magnitude of expenditures needed to fund carbon removal in the coming century—as much as a third of government spending in advanced economies, by some measures[116]—this kind of fund might offer an important complementary mechanism to offset otherwise burdensome fiscal needs. The fund would be linked with robust and participatory oversight to ensure that the carbon removal generated via this fund would be done only where it is wanted by local groups (especially in the Global South) and where it can offer them robust ecological and social benefits in addition to broader climatic ones. The fund could also be linked with research and development hubs for building capacity on carbon removal implementation in the Global South and could be facilitated by public sector licensing models and clearinghouses to help the Global South make use of IP to set up their own carbon removal projects and initiatives.

[4] Tobin taxes have been proposed as a way to supplement multilateral aid flows via a currency transaction tax. Rajan, R. S. (2002). Tobin Tax Revisited: A Global Tax for Global Purposes? Economic and Political Weekly, 37(11), 1024–1026.)

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Future needs for research, policy development, and movement building

What policy development work, research, and movement building are needed to advance the agenda laid out in this report? Here, we highlight key priorities.

Policy development priorities

These are brief concepts that legal experts and policy developers (e.g., at think tanks, policy institutes, advocacy groups, or elsewhere) could elaborate into specific proposals:

1. **Possible structures and mechanisms for pooled funds for carbon removal.** A pooled fund might offer a way to take carbon removal out of the hands of corporates and fossil fuel producers, avoid the issues with offset models, and manage transparency around residuals. Legal and policy experts should scope the national arrangements and governance structures that might support such models.

2. **Possible structures and mechanisms for reparations funds.** Such funds might allocate carbon removal on a needs-based, rather than compensatory, basis. Legal and policy experts and others experienced in establishing similar funding structures should develop options for structuring and financing such funds.

3. **A draft mandate for chartering national carbon removal administrations.** Such institutions would not only fund carbon removal, but also ensure that it is done at the right scales and as a public good rather than as a for-profit activity. Drawing on similar examples and contexts, legal and policy experts might map out what such an institution might look like.

4. **Fiscal and monetary policy options for funding publicly procured carbon removal.** Even if funded in part by fossil fuel producers, government-led carbon removal program will be costly, and further research is needed that explores ways to fund this that do not place undue burden on already resource-strapped groups. Some work already exists on funding mechanisms generally[128], but much more research is needed that explores public funding specifically. While monetary policy is less discussed as a vehicle for growing carbon removal (or decarbonization more generally), it also requires attention[129]. Both policy experts and economists can contribute here.

5. **A proposal for an international intellectual property, technology and capacity sharing hub.** Such a hub would facilitate the Global South in meaningfully participating in carbon removal. Research on intellectual property regimes that might be usefully applied to this context is needed.

Research priorities

These are projects that interdisciplinary academic researchers might be best suited to undertake:

1. **Interdisciplinary research on the total possible amount of carbon removal.** Teams of researchers from diverse disciplines (engineering, geology, biogeochemistry, social science, etc.) are needed to develop bottom-up estimates of the reasonable, ethical, and sustainable maximum potential for carbon removal. Understanding these 'upper limits' can help guide prioritization of what carbon removal should be best used for (i.e., what types of residual emissions) at the national and international levels.

2. **Research on what residual emissions people understand to be 'truly essential'.** Determining what types of emissions are 'hard-to-abate' should not be a top-down decision made by elite policymakers. Rather, 'rules of legitimacy' should be driven by participatory processes, following principles of procedural justice. Doing so would also draw upon localized knowledge and cultural values that otherwise would be excluded from expert determination of 'hard-to-abate'. Social science scholarship could facilitate engagement that seeks input from a diverse array of communities and groups on the kinds of emissions that should truly be deemed 'residual'.

3. **Analysis on types of alternative ownership structures best suited to different types of carbon removal.** A DAC facility is a different type of economic structure than a coastal alkalinity enhancement facility; agricultural approaches require still other structures. Political science and economics research is needed to explore which types of carbon removal technologies might be best suited to different ownership structures. Economists and political scientists might also produce recommendations on how best to incentivize these structures across different technology types. These recommendations might help funders (governments, philanthropy) to set up policies that offer priority to projects with such collective structures.

4. **Options and recommendations for confirming community 'consent' to carbon removal projects (or lack thereof).** Social science research is needed to illuminate what might constitute community consent to carbon removal projects (particularly as they evolve from research to deployment). This is particularly the case in contexts like coastal areas and the High Seas, where issues of consent become even murkier. Social science research on this might, for example, outline different scenarios in which consent is sought, and offer recommendations for ethical 'best practices' around when consent can be understood to have been provided (or not).

Movement-building priorities

These are priorities that progressively oriented activist groups, non-profits, philanthropies, or others might take on to support climate, environmental justice, and labor-related activist and organizing efforts as they relate to carbon removal:

1. **Collective conversation on a progressive agenda and political strategy on carbon removal.** The agenda laid out here has, as we have noted above, been produced by a small group of largely academic and policy people. Broader discussion and collaboration are needed to explore if and how climate, environmental justice, labor, and other groups might want to take up this agenda or a related one. Non-profits, philanthropy, and others might play a role in supporting these groups in further developing an agenda and accompanying political strategy, one that places carbon removal within a comprehensive package of action for climate justice that is appealing across various political groups and geographic contexts.

2. **Scope labor groups relevant to carbon removal.** Labor groups might be a source of potential positive momentum on carbon removal. Yet there is minimal knowledge at present on which labor groups might take an interest in it, particularly across the range of technological approaches and economic sectors. Scoping work, again by NGOs, philanthropy, academics, or others, could map relevant groups across types of carbon removal, paving the way for future collaboration and strategy development between labor groups and climate activists to shape the emerging field of carbon removal.

Conclusion

In this report, we have laid out an agenda that might support a progressive vision of carbon removal, and mapped research, policy and organizing work to support it. We have also proposed four 'bold ideas' that national governments, international institutions, and large funders might pursue.

Some of the ideas presented in this report may seem unrealistic or impractical. That may in fact be the case. Our goal here has not been to imagine what is most likely to happen, but rather to take a step back and consider what carbon removal *could* look like in the future—for better or for worse. We drew on these reflections to sketch out a vision for how to align carbon removal with progressive values and generate a vision of it that might be tenable to the political groups that may otherwise oppose it. Much more work is needed on this front, above all work with people in the Global South, Indigenous and environmental justice communities, and others who might be vulnerable both to climate change and unjustly implemented carbon removal. We hope this report serves as a useful resource on that path.

We feel it cannot be repeated too often: doing large-scale carbon removal is useless without urgent and large emissions reductions[130]. Carbon removal must happen alongside—and never instead of—urgent action on emissions reductions. Finally, we note that many of the proposals offered here may also include useful insights for making emissions cuts themselves more progressive. Integrating progressive values into decarbonization and the climate transition, more generally, is a notable and urgent goal.

Credit: Tom Fisk, Pexels

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Institute for Responsible Carbon Removal

Carbon removal involves the drawdown and durable storage of atmospheric CO_2 emissions, increasingly recognized as necessary to meet climate targets. At the Institute, we believe that significant amounts of carbon removal will be needed in the coming decades—but that scaling carbon removal responsibly will require more than demonstrating techno-economic feasibility. Instead, 'responsible' scaling of carbon removal means addressing other aspects of what might make carbon removal approaches better or worse for society. Our mission is to build ways of doing carbon removal that are responsible, democratic, just & equitable.

Agenda for a Progressive Political Economy of Carbon Removal

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