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## Research Article

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**Corresponding author:**Dominic Lenzi; Email: [d.s.lenzi@utwente.nl](mailto:d.s.lenzi@utwente.nl)**Abstract**

**Non-Technical Summary.** Climate stabilization requires scaling-up technologies to capture and store carbon. Carbon removal could be very profitable, and some of the agents best placed to benefit are ‘carbon majors’, i.e. fossil fuel companies. We argue that in ordinary circumstances only agents without significant historical climate responsibilities would be entitled to the full benefits from carbon removal. Under non-ideal conditions, carbon majors might be entitled to benefit, provided that no other agent could remove similar quantities of carbon at similar costs. This burden of proof is only likely to be met in countries with poor governance capacities.

**Technical Summary.** Climate stabilization requires scaling up technologies to capture and store carbon. Some of the agents best placed to profit from carbon removal are ‘carbon majors’, especially fossil fuel companies. Yet incentivizing carbon majors to undertake carbon removal poses an ethical dilemma: carbon majors have made significant historical contributions to climate change and have significantly benefitted from such contributions without being made to compensate for resulting climate harm. This is why it seems unfair to reward them with additional economic benefits. However, carbon majors possess the technological skills and infrastructure to upscale carbon removal efficiently. We argue that in ordinary circumstances, only agents without significant climate responsibilities would be morally entitled to fully benefit from carbon removal. Yet under non-ideal conditions, it might be permissible to reward carbon majors if no other agent were capable of removing as much carbon at similar costs and on similar timeframes. We believe this argument faces an imposing burden of proof that is only likely to be met in countries with poor governance capacities. In more favorable circumstances, including those of most OECD countries, rewarding carbon majors without having them pay for their historical climate responsibilities remains impermissible.

**Social Media Summary.** Rewarding carbon majors to undertake carbon dioxide removal is unjust due to their historical climate responsibilities. Where possible, governments should empower other agents to remove CO<sub>2</sub>.

**1. Introduction**

In May 2021 in the case *Milieudefensie* (the Dutch branch of Friends of the Earth) vs Royal Dutch Shell, the District Court of the Hague found that the multinational corporation must reduce its CO<sub>2</sub> emissions by net 45% by 2030 (relative to its 2019 emissions) (Nollkaemper, 2021). Royal Dutch Shell is a ‘carbon major’, with emissions and complicity in producing emissions exceeding those of most countries. The term ‘carbon major’ refers to major producers of hydrocarbons, including coal, oil, and gas. A 2017 report by the Climate Accountability Institute (Griffin, 2017) found that 100 extant carbon majors have been linked to 71% of global GHG emissions since 1988. Stating that Shell’s current policy and climate targets were violating a ‘due standard of care’, the court further noted that the corporation has significant historical responsibility for climate change (Giabardo, 2021). While this may signal greater legal accountability for carbon majors, the urgency of decarbonization also raises the uncomfortable prospect of rewarding carbon majors for removing atmospheric carbon if these agents are best placed to do so.

Given decades of climate policy failure, limiting warming to ‘well below’ 2 °C above pre-industrial levels in line with the Paris Agreement is likely to require large-scale use of carbon dioxide removal (CDR) technologies (IPCC 2022). Energy analysts have begun to speculate about a future market in captured and stored carbon to rival existing energy markets (Vivid Economics, 2020). We refer to this as the *carbon removal market*. Some of this speculation concerns revenues that might be drawn from using carbon capture and sequestration (CCS) technology, which is a component of several CDR methods, such as direct air capture (DACCS) and bioenergy with CCS (BECCS). Such a market would likely be backed by public financing and favorable regulatory conditions. And at present, carbon majors look set to be leading beneficiaries. Shell is involved in one of the European Union’s major carbon storage projects (the Northern Lights Project) (European Commission, 2021) while ExxonMobil is

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asking the US Congress for subsidies to kick-start its carbon removal business (Lefebvre, 2021). In May 2021, Shell and ExxonMobile were granted \$2.4 billion in subsidies by the Dutch government for carbon sequestration and storage projects (Meijer, 2021).

In this paper, we analyze the ethical implications of a carbon removal market in CDR, from which carbon majors stand to be leading beneficiaries. We will focus primarily on BECCS and DACCS, since these are the CDR techniques involving CCS that carbon majors possess the technical capabilities to undertake. We note that CCS can be used without achieving CDR, such as when it is fitted to existing fossil infrastructure to render it carbon neutral. However, we do not discuss CCS as a stand-alone technology nor the ethical implications of its use. We first introduce the dilemma of benefitting carbon majors by providing insights into the kind and scale of benefits that can be earned. Section 3 focuses on the first horn of the dilemma, arguing that benefitting from carbon removal is unjust under conditions applicable to carbon majors. Section 4 argues that the second horn of the dilemma may be resisted since it requires showing that it is necessary to allow carbon majors to benefit from CDR to secure a stable climate. As we show, this claim only appears plausible in circumstances that do not apply to most OECD countries. We conclude by suggesting ways to balance the need to incentivize carbon removal without canceling out historical climate responsibilities.

## 2. The dilemma of benefitting carbon majors

While the possibility of benefitting from emission reductions has long existed, the promise of benefitting from carbon dioxide removal has only emerged in the last few years. Carbon removal is increasingly prominent in national and private sector commitments to net zero emissions (Honegger *et al.*, 2017; Lenzi *et al.*, 2021). In most cases, carbon dioxide removal will be very costly (Fuss *et al.*, 2018). For example, bioenergy with carbon capture and storage (BECCS) is estimated to cost \$100–200 per ton of CO<sub>2</sub>, while direct air capture with carbon capture and storage (DACCS) is estimated at \$600–1000 per ton for early plants, with costs potentially falling to \$100–300 as more facilities are built (Fuss *et al.*, 2018, figures quoted in US dollars).

A carbon removal market could provide significant new revenues if appropriate state incentives and regulations were made available. A study by Vivid Economics (2020) estimated that such a market could present a trillion-dollar investment opportunity that may eventually rival the current oil and gas sector. This study estimates that ‘nature-based’ CDR, primarily afforestation and reforestation, could provide \$190 billion annually by 2050, while ‘avoided deforestation’ could provide as much as \$610 billion annually by 2050. BECCS and DACCS could provide as much as \$625 billion annually by 2050. In the US context, tax credits for biofuel generation may turn BECCS into a profit-generating opportunity (Ryan, 2018), whereas a regime to pay farmers to sequester carbon in soil is currently being considered (Colman *et al.*, 2021).

Some of the world’s largest corporations are already investing in CDR, and in CCS as a component of CDR strategies. For instance, Microsoft has announced a \$1 billion climate innovation fund to develop CDR and CCS technologies, aiming to become ‘carbon negative’ by 2030 and to remove all carbon directly or indirectly emitted since its foundation in 1975 (Smith, 2020). Large oil and gas companies are also investing in carbon dioxide

removal to reduce their carbon footprints. ExxonMobile has invested \$3 billion in CCS projects over the next five years, estimating that the market for carbon capture will be roughly \$2 trillion by 2040 (Eberhart, 2021). From these considerations, it appears that CDR is becoming an attractive investment for carbon majors.

Carbon majors already possess CCS infrastructure, which is necessary for prominent forms of CDR. At present, the technical capacities and the knowledge to do CCS, and thus CCS-dependent forms of CDR in the future, are largely limited to companies which produce fossil energy, i.e. carbon majors. This is due to large similarities in technology and infrastructure between oil extraction and carbon sequestration and storage (Hastings & Smith, 2020). As such, these companies seem to be key for the development and scaling up of prominent CDR techniques such as BECCS and DACCS. The EU ‘Northern Lights’ CCS project is a partnership with fossil fuel companies Equinor, Shell, and Total (Global CCS Institute, 2020). Likewise, the UK’s ‘Acorn’ CCS project is being carried out by Pale Blue Dot Energy, in partnership with Harbour Energy and Shell, and with funding from the EU and the UK (Pale Blue Dot Energy, 2021). We note that other authors (e.g. Moss, 2020) include cement producers under this category because they also contribute a large amount of yearly carbon emissions. However, the dilemma we discuss applies only to fossil fuel companies, because they already possess CCS infrastructure.

If CDR is to be incentivized through market mechanisms, as many analysts suppose, the prospect of economic gains appears necessary. Since many CDR facilities, especially DACCS, are in the early stages of commercialization and face high costs (Fasihi *et al.*, 2019), a major concern is whether the gains received from a future carbon removal market will be sufficient to incentivize investments. However, it seems morally problematic that those who are best placed to profit from an emerging carbon removal market have profited significantly from the sale of vast quantities of fossil fuels, the key driver of anthropogenic climate change. While carbon majors do not bear the sole responsibility for the harm created by climate change, their supply of a primary driver of climate change, and their profits from doing so, appear to be morally relevant when considering future economic rewards from doing CDR.

Despite these facts about carbon majors and the distribution of capacities, not engaging in CDR likely leads to dangerous climate change given the reliance upon these technologies in most temperature stabilization pathways (IPCC, 2018, 2022). Since carbon majors already possess the necessary technology for future CDR implementation, it is likely that they could render these technologies viable within shorter timeframes and on larger scales than other agents. If so, carbon majors could be key to avoiding morally unacceptable climate harms and could contribute significantly to the global public good of a stable climate system in line with the Paris Agreement.

These considerations lead to what we call the ‘dilemma of benefitting carbon majors’. The first horn of this dilemma concerns the unfairness of allowing carbon majors to benefit from the carbon removal market. This seems compelling for two reasons: first carbon majors should be made to pay for their contribution to climate change and second, they should also be made to pay for any unjust benefits they have gained and continue to gain from such contributions. Thus, it appears fair that some or all of the revenue that carbon majors draw from carbon dioxide removal should be withheld. As we show in Section 3, this

**Table 1.** Different benefits, their benefit-generating action, and the criterion to assess injustice

	Category	Benefit	Action generating benefit	Criterion for assessing injustice
a	Benefitting from contributing to climate change	Economic gains from producing or using fossil energy	Selling or utilizing a key source of anthropogenic climate change	Proportional contribution to negative climate impacts, or benefit from supplying others' contributions
b	Benefitting from favorable changes in climatic conditions	Economic gains from favorable market conditions due to changing climatic conditions	Conducting business under favorable climatic conditions	Proportional benefits attributable to changes in climatic conditions
c	Benefitting from climate change mitigation policies (limited to the carbon removal market)	Economic gains from employing CDR	Implementation of CDR; providing technical knowledge or infrastructure for CDR	If reason for access to CDR technologies is benefit (a)

argument follows from formulations of the polluter pays principle that are interlinked with the beneficiary pays principle (Heyward, 2021).

However, this leads us to the second horn of the dilemma, which concerns the moral permissibility of providing economic incentives to achieve a desirable public good. Most plausible moral views hold that there is a moral imperative to limit climate change to 'well below' 2 °C, in line with the Paris Agreement. Given the necessity of not only reducing emissions but also removing atmospheric CO<sub>2</sub>, decreasing incentives to undertake CDR may reduce the likelihood of stabilizing the global climate. Yet carbon majors appear to be uniquely well-placed to undertake CDR if economic incentives were available. Because failing to stabilize the global climate would create very serious injustices, it seems permissible to reward the agents able to scale up CDR as rapidly as possible.

The prospect of a carbon removal market dominated by carbon majors thus raises questions about the fairness of benefits drawn from CDR. This situation appears to have the structure of a moral dilemma because choosing either option seems to mean choosing to do injustice: either allowing carbon majors to unfairly benefit to do as much CDR as is feasible or preventing such benefits yet undermining climate stabilization. To clarify this situation, we need to understand the conditions under which incentives for contributing to climate stabilization are morally justified. In the next section, we categorize the three unjust benefits of climate change and the carbon removal market and then turn to the challenges of morally justifying incentives to undertake CDR.

### 3. Benefitting from climate change and from a carbon removal market

This section deals with the first horn of the dilemma of benefitting carbon majors. It argues that benefitting from CDR is unjust under certain conditions and that such conditions apply to carbon majors.

First, a note about how we understand benefits. Benefits from the carbon removal market can be obtained by providing knowledge (e.g. of how carbon can be captured and stored) and infrastructure (e.g. for transport and storage of carbon). Benefits may be gained through the development and selling of CDR technology to remove, liquefy, and transport carbon; by providing infrastructure and technologies for capturing and transporting carbon; and by providing storage locations (Hastings & Smith, 2020). Most importantly, benefits will be gained through the

removal and storage of carbon on behalf of enterprises or states, e.g., through the purchase of carbon credits because they either voluntarily decided to reduce their carbon footprint or were legally obliged to do so.

While the climate ethics literature has primarily focused on the negative impacts of climate change and the fair sharing of burdens for their minimization, prevention, and compensation (cf. Gardiner et al., 2010; Hayward, 2012; Page 2008; Wallimann-Helmer, 2019), potential benefits from contributing to emissions reduction have been comparatively neglected. Normative literature on benefitting and climate change focuses on the Beneficiary Pays Principle (BPP), which holds that those who benefit from climate change have proportionally greater responsibilities for climate action (Heyward, 2014; Page, 2012). The BPP is most often understood not to be independent from historical contributions and therefore draws some of its normative force from the Polluter Pays Principle (PPP) (Garcia-Portela, 2023; Heyward, 2014).

Nonetheless, previous discussions of the BPP only capture some of the concerns raised by the benefitting carbon major's dilemma. On the basis of an expanded understanding of the BPP, we argue that it would be just for agents without large historical climate responsibilities to benefit from removed and stored carbon. On the basis of the PPP, we argue that it would be unjust for agents with large historical responsibilities to benefit.

To justify these claims, we outline three categories for assessing benefits in the context of climate change (see Table 1): (a) benefits gained by contributing to climate change; (b) benefits gained due to favorable changes in climatic conditions; and (c) benefits gained from climate change mitigation policies. We include CDR under the broader category of climate change mitigation policies, following the IPCC's recent reclassification of it as a form of mitigation (Babiker et al., 2022). CDR had previously been classified as 'geoengineering' (Edenhofer et al., 2014, 60). Our discussion concerns benefit (c), although we focus on benefits derived from CDR. For each category, we suggest conditions under which benefitting would be unjust.

(a) *Unjustly benefitting from contributing to climate change:* Benefits obtained from contributing to climate change can be deemed unjust because these actions contribute to morally serious forms of harm (Butt, 2009; Goodin, 2013; Heyward, 2014). According to the PPP, there is a duty to support climate action in proportion to one's current or historical emissions (Caney, 2005; Meyer & Roser, 2010; Neumayer, 2000; Shue, 1999). Similarly, the BPP places greater responsibility upon those

who have benefitted more from actions that contributed to climate change, even if they did not directly cause the emissions (Page, 2012). Under both the PPP and the BPP, carbon majors carry unaddressed historical responsibilities deemed unjust and both principles identify duties to correct for this situation (García-Portela, 2023; Heyward, 2021; Wallimann-Helmer, 2019). Most importantly, investing in CDR may allow carbon majors to become 'carbon neutral' while continuing to contribute to climate change or to benefit from actions contributing to it. Benefit (a) is highly relevant in the assessment of carbon majors, since as we will see shortly, it is the reason they stand to benefit from CDR.

(b) *Unjustly benefitting from favorable market conditions*: some benefits are not gained directly from activities contributing to climate change, but from adapting to new climatic conditions. Examples include growing wine in areas where it could not previously be grown or selling more air conditioners. Such actions fall under benefitting from injustice because they only become possible due to unjust climate harms (Butt, 2009; Goodin, 2013; Heyward, 2014). Although these conditions were not intentionally brought about, they happen as a consequence of changing climatic conditions jointly produced by all emitting parties. Voluntarily benefitting from these injustices can be argued to be a reason for carrying responsibilities toward those treated unjustly (Pasternak, 2014). Under the BPP, actions may generate the obligation to compensate even if the actions are not consensual or voluntary (Atkins, 2018). Where 'losers' of climate change are compensated by polluters, the entitlement of the 'winners' to benefits from climate change may depend on whether they result from a course of action or maintaining one's economic activities (Mintz-Woo & Leroux, 2021). Nonetheless, culpability is necessary for these benefits to be unjust. Heyward (2014) distinguishes culpable from non-culpable beneficiaries on the basis of being partly or fully responsible for the injustice or having no role in its occurrence. Agents who share culpability are under strict duties of remedial justice to surrender any benefits. The culpability condition of benefit (b) is also highly relevant for carbon majors since these agents have voluntarily contributed to climate change through the extraction and sale of fossil fuels, through ongoing lobbying for weaker climate change mitigation policies, and even through the dissemination of misinformation (Oreskes & Conway, 2010).

(c) *Unjustly benefitting from climate change mitigation policies*: Some benefits are not gained as the result of climate change, but specifically due to climate change mitigation policies. Such policies involve CDR which, in contrast to most economic activities, do not produce additional emissions. Instead, carbon removal is their product, and their wider aim is to reduce the concentration of CO<sub>2</sub> in the atmosphere. These are benefits made from climate change mitigation policies that set up, regulate, and incentivize investments in the carbon removal market. This market is based on governments creating conditions to bring about the public good of a stable global climate. Because the benefits from the carbon removal market are largely drawn from public funds and are aimed at a public good, it is difficult to maintain that their distribution is not a matter of justice. Further, not all agents benefit from this market for the same reasons. While the primary good traded is captured carbon, we saw that benefits can be obtained by making available storage space, infrastructure, knowledge, and technology in exchange for payment.

As such, the reasons for access to CDR become a principal criterion for determining whether a benefit counts as an injustice. Some CDR businesses possess these capacities independently of past contributions to climate change, such as the Swiss company Climeworks (founded in 2009) (Climeworks, 2022). It could be argued that such agents are entitled to their gains since they lack historical responsibility and since these agents are directly contributing to climate change mitigation (Mintz-Woo & Leroux, 2021). Carbon majors, by contrast, possess these capacities precisely because of their past contributions to climate change (see benefit (a)). They gained the capacity to profit from the carbon removal market by extracting, transporting, and selling fossil fuels, and because CDR infrastructure turns out to be similar to the infrastructure needed to extract fossil fuels. Pipelines built for transporting fossil fuel and gas will be essential for reducing the costs of transporting liquified carbon. By extracting fossil fuels, carbon majors have also gained empty reservoirs that can serve as storage sites for liquified carbon (Bui et al., 2018).

Therefore, it would be unjust for carbon majors to be allowed to benefit from a carbon removal market in CDR due to their unaddressed historical climate responsibilities, as well as their continuous contributions to climate change. Since this carbon removal market only becomes profitable given the existence of climate change, it is a benefit built atop the prior injustice of benefitting from and contributing to climate change. Thus, the first horn of our dilemma remains compelling: carbon majors ought not to be permitted to benefit from CDR.

Yet this result runs into the second horn of the dilemma: preventing carbon majors from revenues gained from the carbon removal market implies that less CDR will be done. Given this concern, the next section explores a non-ideal argument for permitting what we have argued to be a clear injustice, namely, providing economic incentives for carbon majors to undertake CDR.

#### 4. Justice and incentivizing carbon removal

Discussions of benefitting from climate change have seldom considered the importance of incentives, yet incentives can matter greatly for achieving climate justice (Mintz-Woo & Leroux, 2021). Ignoring economic incentives to invest in carbon removal may undermine the economic case for some agents to invest in this business (Ko et al., 2021). Nonetheless, ignoring the history of carbon majors when designing incentives would undermine any attempt at fairly distributing responsibilities for climate action, and could even be self-defeating.

We argue that under non-ideal conditions, economic incentives for carbon majors to undertake CDR would be morally permissible *if and only if* no other agents were capable of removing as much carbon at roughly similar costs, and on roughly similar timeframes, and in accordance with existing demands of justice. Even given this condition, carbon majors may only benefit from the carbon removal market if they address their existing historical climate responsibilities. We will shortly explain what these conditions require.

There are different views about the morality of incentives to comply with justice. As Mintz-Woo and Leroux note (2021), consequentialists generally regard incentives to maximize the good as morally legitimate, if not compulsory. They favor incentives to decarbonize the global economy, internalizing all harmful impacts of climate change. By contrast, Rawls' 'difference principle', which holds that inequalities are permitted so long as this benefits the worst off, allows for the incentivization of those capable of

producing more – but only to the extent that this benefits the worst off (Rawls, 1971). A Rawlsian view would mean that carbon majors would be entitled to incentives from the carbon removal market only if these benefitted the worst off, i.e. those most vulnerable to the negative impacts of climate change. It is safe to assume that a stabilized climate would benefit the worst off. However, in his prominent critique of the Rawlsian position, Cohen (2008) objected that those capable of producing more are not justified in working less hard unless they are paid more. This appears somewhat analogous to the case of carbon majors, who like Cohen's talented rich, would be unjustly demanding an incentive if they invested less in CDR unless they received public subsidies.

Nonetheless, this critique comes from ideal theory and thus appears to be inapplicable to the dilemma of carbon majors. This dilemma is more plausibly viewed under the lens of non-ideal justice. A situation falls under non-ideal justice when two conditions of ideal justice are absent, namely full compliance with principles of political morality and favorable external conditions (Rawls, 2001). Climate ethics generally seems to be especially apt for non-ideal analysis, because there remains little compliance with demands of climate justice, and because climate policy is fraught with unfavorable political and economic circumstances (Heyward & Roser, 2016).

Non-ideal justice allows consideration of actions that would be impermissible under ideal justice, in the interests of making a just future situation more likely (Stemplowska & Swift, 2012). From a non-ideal view, one might make the following argument: carbon dioxide removal has become essential for avoiding dangerous climate change. The urgency of avoiding dangerous climate change is such that as much carbon removal should be done as is possible without severe adverse side-effects. Carbon majors are also among the agents most capable of speedily scaling up carbon removal. Thus, carbon majors should be allowed economic gains from doing so, despite this being unjust (see Section 3). As a result, the incentivization of carbon majors is morally permitted if it could be reasonably shown that such incentives were necessary to avoid dangerous climate change. This would be so even if such incentives involve sufficient injustice to render them impermissible under ideal justice. If so, it seems morally permissible for carbon majors to benefit from CDR to the extent that this is actually required to avoid dangerous climate change.

However, this argument is unlikely to succeed in most contexts where CDR is being contemplated. It requires demonstrating that no other agents are capable of doing as much CDR as carbon majors, as rapidly, and at similar costs. There are serious challenges facing any attempt to bear out this claim. These stem from the conditions of non-ideal justice of most relevance to climate change, namely epistemic uncertainty, moral uncertainty, and technological constraints (Heyward & Roser, 2016). First, there is epistemic uncertainty about whether the involvement of carbon majors would, in fact, allow for more rapid upscaling of CDR, and whether large-scale implementation of CDR is feasible at all. There is moral uncertainty about the conditions under which implementing CDR would be permissible (Lenzi, 2021). There is also technical uncertainty about the viability of redeploying existing fossil fuel infrastructure for carbon removal and about the technical viability of CDR techniques. Further, there is epistemic and moral uncertainty about the likely costs, side effects, and threats to justice posed by CDR (Lenzi, 2018; Schübel & Wallimann-Helmer, 2021; Wallimann-Helmer, 2021). Due to such uncertainties, it is difficult to demonstrate that carbon

majors are indeed the agents who could undertake CDR most efficiently, or that they could do so without causing further injustice.

Whether alternative courses of action are available is also likely to depend upon the governance capacities of individual countries. One approach for assessing governance capacity is the World Bank's worldwide governance indicators, which include indicators for voice and accountability, political stability and the absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption (World Bank, 2022). Among these indicators, regulatory quality, rule of law, and control of corruption appear most directly relevant to the implementation and monitoring of carbon removal infrastructure. Countries that score poorly on regulatory quality, rule of law, and controlling corruption may face severe challenges in incentivizing carbon removal using state capacities, such as expropriating private capital infrastructure under the public domain, establishing publicly owned corporations to undertake carbon removal, or supporting private corporations without historical climate responsibilities to undertake carbon removal. It appears easier to justify incentivizing carbon majors to undertake carbon removal under conditions where these alternatives are unlikely to succeed.

Yet according to these World Bank indicators, few if any OECD countries could reasonably claim that they lack the governance capacities to undertake CDR themselves, or to incentivize carbon removal from actors without significant historical responsibilities. Appealing to the urgency of climate stabilization does not justify rewarding carbon majors so long as there are alternative agents who might do this effectively in due time, and certainly does not permit carbon majors to unilaterally dictate the economic gains they are entitled to as the condition for scaling up carbon removal.

The difficulties with showing the necessity of incentivizing carbon majors also turn on epistemically dubious and potentially unverifiable judgments of political feasibility. The ambiguity surrounding feasibility judgments exacerbates the challenge of showing why incentivizing carbon majors is genuinely necessary. Extra caution is required since claims about what is economically or politically infeasible can be disguised statements of willingness, knowledge, or even strategic attempts to secure advantage (Schuppert & Seidel, 2017; Schuppert & Wallimann-Helmer, 2014; Wallimann-Helmer, 2022). For example, carbon majors may exclude smaller players from entering the market, which could lead to path dependencies for them to undertake CDR. There is also the danger of carbon majors pursuing emitting activities in some countries while benefitting from incentives and state subsidies to undertake CDR in other countries. To make feasibility assessments more credible in the future, it is essential to create opportunities for democratic participation in determinations of feasible and fair policy proposals to decarbonize (Honegger et al., 2017; Lenzi & Kowarsch, 2021; Wallimann-Helmer, 2018, 2021).

Thus, the non-ideal argument may justify incentivizing carbon majors to undertake CDR in certain circumstances. Yet the burden of proof is very demanding and fraught with technical, epistemic, and moral uncertainties, including questions of feasibility. We have suggested that this burden of proof is likely to be met only in countries with poor regulatory and governance capacities. However, in most contexts where CDR is being contemplated, such as OECD nations, it remains impermissible to incentivize carbon majors to undertake CDR, at least until they address their historical climate responsibilities.

## 5. Managing the dilemma of benefitting carbon majors

We have argued that even where rewarding carbon majors turns out to be morally permissible, this does not cancel their historical climate responsibilities. For this reason, governments are justified in imposing additional burdens upon carbon majors, irrespective of whether they claim benefits from a market in carbon removal. In principle, any economic gains from the carbon removal market can be treated separately from obligations to redress historical responsibilities for emissions, since the fact of benefitting is insufficient to show that an injustice has occurred – at least when this benefit occurs as a result of climate change mitigation. However, if, as in the case of carbon majors, agents stand to benefit from CDR due to their past and current contributions to and benefits from climate change, then any benefits from these technologies remain unjust, at least until such historical responsibilities are met. These benefits are only possible due to the existence of climate change, which is a very serious injustice.

This indirect connection between climate harms and benefits from the carbon removal market shows why any future beneficiaries must account for the fact that they are also benefitting from an injustice. In practice, this can be achieved via well-known means of climate policy. One possibility would be lowering revenues through taxes, which would be redistributed to the victims of climate change. Compensation could also be paid by providing technology and know-how for climate adaptation, or by developing CDR infrastructure and technology for other agents to profit from the carbon removal market. However, most actors capable of developing CDR technologies also benefit from past emissions indirectly. Their technological innovation would not have been possible if past generations had not enjoyed the benefits of carbon emissions. This especially holds true for businesses of industrialized countries that have contributed proportionally more to climate change.

Historical contributions to climate change are especially morally relevant in the case of carbon majors. While it may seem expedient to incentivize them to invest in CDR, their historical responsibilities cannot be ignored. Taxing away gains from trading in carbon removal in higher proportion might be one way to account for their historical responsibilities. Because this poses the risk of rendering carbon removal less attractive for carbon majors, it might be justifiable to allow carbon majors similar revenues from carbon removal to other market actors, but only where no other agents are available and where governance capacities are poor. Conversely, carbon majors could be obliged to make available part of their infrastructure or storage space free of charge. Where there is already a legal requirement to become carbon neutral, as in the case of Shell, removing more carbon than is currently produced or providing infrastructure and storage space for other parties without revenue might be a way of paying court-imposed fines.

Such policy measures demand caution. If carbon majors do not foresee sufficient profits from investing in CDR, they may abandon this business model. Yet it remains to be seen whether this would be ruinous for the project of climate stabilization, or simply hard luck for carbon majors. One additional challenge for policymakers is that carbon majors are (partly) state-owned in many cases. This is one of the reasons why our solution to the dilemma may be problematic or challenging for policymakers: they would have to move away from (partly) state-owned carbon majors toward smaller corporations to carry out CDR. Investigating different layers of institutional capacity and

feasibility is also likely to resolve what otherwise appears to be a serious dilemma of choosing between two kinds of injustice.

## 6. Conclusion

The dilemma of rewarding carbon majors is based on the historical responsibilities of carbon majors, on account of which they now stand to benefit from a future market in CDR. Historical responsibilities make it unjust to permit carbon majors to benefit unconditionally from climate change mitigation policies, such as policies incentivizing carbon dioxide removal. However, there may be circumstances under which carbon majors can indeed be incentivized to undertake CDR. We have argued that such circumstances are unlikely to be found in OECD nations because they require that no other agent could achieve carbon removal at approximately the same rate as carbon majors. This is very difficult to demonstrate, and any legitimate attempt to do so must be transparent about its assumptions of feasibility.

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