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Legal guardrails on states' dependence on carbon dioxide removal to meet climate targets

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ABSTRACT

This paper explores the international legal framework within which States' reliance on carbon dioxide removal in climate targets and emission reduction pathways is set and identifies guardrails on the extent of such reliance. While carbon dioxide removal is a vital component of the response to climate change, significant risks arise when States rely upon promises of future removals as a substitute for near-term emissions reductions. This paper focuses on the obligation of 'due diligence' that attaches to States in relation to their actions that cause and address climate harms. It identifies a standard against which the diligence (or lack thereof) exercised by States can be objectively measured. This standard, discussed at length in the International Court of Justice's Advisory Opinion on Climate Change, draws on several elements relevant to the governance of climate change, including precaution, scientific and technological information, and relevant rules and international standards, especially the normative pillars of the Paris Agreement. Although this standard applies to all actions and omissions by States in relation to climate harms, it assumes particular significance in relation to carbon dioxide removal, given the distinctive risks and uncertainties associated with it. We find that an application of this stringent standard of due diligence results first, in creating a pull towards a narrower range of global emission reduction pathways which minimize overshoot of the Paris Agreement's 1.5°C temperature goal, and second, in the emergence of indicative substantive and procedural guardrails which channel and constrain States' reliance on carbon dioxide removal to meet their climate targets. These findings underscore the need for States to pursue deep emissions reductions alongside transparent, feasible, and coherent strategies for carbon dioxide removal.

Key policy insights

- States have to adhere to a stringent standard of due diligence in relation to their actions that cause and address climate harms, including their use of carbon dioxide removal to meet climate targets.
- Application of this standard requires States to minimize the magnitude and duration of any overshoot of the Paris Agreement's temperature goal and put in place substantive and procedural guardrails on the nature and extent of their use of carbon dioxide removal to meet climate targets.

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- This in turn underscores the need for demanding near term emissions reductions, and greater transparency, feasibility and coherence in plans for reliance on carbon dioxide removal.

1. Introduction

As global temperatures rose to record levels in 2024 (World Meteorological Organization, 2025) and the Paris Agreement's 1.5°C temperature goal appears to be rapidly slipping out of reach, it is crucial to determine whether States' climate targets and pledges meet their legal obligations. In so doing, States' progress against their targets, and whether their action is consistent with the pace and level of stringency to meet the Paris Agreement's temperature goal, must be carefully assessed. This paper builds on the findings of Stuart-Smith et al. (2025) and focuses on a significant and necessary, yet under-researched element of States' plans to meet their climate targets – the reliance on carbon dioxide removal (CDR).

Stuart-Smith et al. (2025) analysed the role of CDR within States' mitigation strategies. It found that a combination of widespread transparency gaps and indications of heavy CDR reliance jeopardize the goals of the Paris Agreement. Yet, the international legal framework governing the use of CDR to meet climate targets is poorly understood and applied, including by States that appear guided by unbridled 'national determination' in their approach to CDR. This paper explores elements of the international legal framework governing climate change to ask if guardrails on the nature and extent of reliance on CDR are discernible in the legal framework and if so, what these might be. We use the term guardrails to signal standards of behaviour anchored in the legal framework that reduce the risk of adverse outcomes.

This paper unfolds as follows. Section 2 summarizes the distinctive risks associated with CDR reliance. Section 3 outlines elements of the relevant international legal framework, especially the duty and standard of due diligence. Section 4 scrutinizes the extent to which global emission reduction pathways with varying degrees of reliance on CDR are aligned with this legal framework. Section 5 distils legal guardrails which channel and constrain States' use of CDR to meet their climate targets. Section 6 concludes.

2. The risks of CDR reliance

CDR deployment is necessary to balance residual emissions and achieve net-zero CO₂ or greenhouse gas (GHG) emissions (IPCC, 2023c, C.11). High levels of emissions globally have reduced the remaining carbon budget for a 50% probability of limiting warming to 1.5°C to just 130 GtCO₂ at the start of 2025 (Forster et al., 2025), pointing towards global warming surpassing 1.5°C. CDR will therefore be required to if temperatures are to subsequently return to 1.5°C. However, the nature and extent of CDR deployment substantially alters the risks associated with possible mitigation pathways.

All mitigation strategies carry risks. Efforts to reduce emissions may not succeed, or they may have negative environmental and socioeconomic impacts (Ampah et al., 2024). However, reliance on CDR creates distinctive risks which merit legal scrutiny. The negative impacts of CDR vary depending on the removal and storage methods used as well as the location and scale of deployment (IPCC, 2023c, C.11.2). 'Conventional' forms of CDR such as afforestation and reforestation generate different risks and co-benefits than 'novel' forms such as bioenergy carbon capture and storage (BECCS) and direct air carbon capture and storage (DACCS). The implications of their varying characteristics for the guardrails applicable to States' mitigation strategies are addressed in Section 5. Despite their differences, greater reliance on the deployment of any of these CDR methods to meet climate targets increases risks of overshooting the 1.5°C temperature goal by a greater margin.

In its Sixth Assessment Report, the IPCC identifies a range of global emission reduction pathways that limit warming to 1.5°C above pre-industrial levels by the end of the century (IPCC, 2023c, Table 3.1). A subset of these pathways, categorized as C1, limit warming to 1.5°C above pre-industrial levels in 2100 with 'no or limited overshoot.' In practice, this means that the pathways' central global warming estimate temporarily exceeds 1.5°C by no more than 0.1°C (IPCC, 2023c, Table 3.1). A second category of pathways, C2, return to 1.5°C after higher overshoot, while C3–C8 fail to return to 1.5°C over the course of the century.

The possibility of deploying CDR introduces flexibility in the composition of pathways which ultimately limit warming to 1.5°C. First, CDR can return the global temperature to a given level after temporarily overshooting it. Second, CDR can limit temperature increase to a given level while continuing to emit more GHGs, counterbalancing their warming impact by removing equivalent amounts of CO₂ from the atmosphere. While all C1 and C2 pathways rely on these flexibilities, the extent of this reliance varies widely between pathways. Greater reliance on either flexibility increases risks of overshooting the 1.5°C temperature goal and hence of associated impacts.

Pathways which overshoot 1.5°C substantially increase the likelihood of high-impact climate risks, some of which are irreversible (Möller et al., 2024; Schleussner et al., 2024). In addition to the deaths and economic losses caused by warming over 1.5°C, overshoot may also cause or exacerbate Earth system changes that are irreversible for centuries even if warming is reversed. This includes loss of polar and mountain ecosystems affected by habitat disappearance or the melting of ice sheets or glaciers, extinction of species and the loss of coral reefs (IPCC, 2023b). Overshoot emissions may also trigger tipping points that will amplify warming and cause catastrophic impacts. Every 0.1°C increase in peak temperature increases the risk of key tipping points being triggered (Möller et al., 2024; Wunderling et al., 2023) and there is compelling evidence that removing ‘overshoot emissions’ later will not immediately reverse global warming (Schleussner et al., 2024).

Even among the IPCC pathways projected to produce no or limited overshoot of the 1.5°C goal, the risks vary depending on how heavily they rely on CDR. Some planned CDR may not be delivered – for example due to technological challenges regarding the deployment of BECCS and DACCS or the re-release of carbon stored in forests (IPCC, 2023c, 3.4.6–3.4.7; Schleussner et al., 2024). Stuart-Smith et al. (2025) demonstrate that plausible CDR non-delivery levels would lead C1 pathways with higher CDR dependence to have increased peak warming and overshoot duration. These effects are more pronounced if the sensitivity of the climate system to cumulative CO₂ emissions is at the higher end of the IPCC’s uncertainty range (IPCC, 2023a; Stuart-Smith et al., 2025). Pathways with deeper and more rapid gross emission reductions minimize these risks.

Despite the clear need for a rigorous and cautious approach to CDR reliance, the Stuart-Smith et al. (2025) review of States’ nationally determined contributions and long-term strategies reveals heavy reliance on CDR and a lack of transparency regarding the extent of this reliance or how it will be achieved. The pressing need to understand legal constraints on States’ CDR strategies emerges in this context.

3. International legal framework

The international legal framework governing climate change includes the treaties comprising the UN climate regime – the 1992 Framework Convention on Climate Change (United Nations, 1992a), the 1997 Kyoto Protocol (UNFCCC, 1997) and the 2015 Paris Agreement (UNFCCC, 2016) – the customary international law principle of harm prevention (*Pulp Mills on the River Uruguay*, 2010), and a range of principles of international environmental law (United Nations, 1992b). Other widely ratified treaties, such as the core human rights instruments, also form an integral part of the wider legal framework. This international legal framework demarcates States’ duty of due diligence in relation to actions that cause and address climate change, including CDR.

3.1. The duty of due diligence

States have a duty of due diligence in relation to actions that cause and address climate harms. This duty can be sourced to the customary international law principle of harm prevention as well as core provisions of the Paris Agreement, between which there is dynamic interplay (*Advisory Opinion on Climate Change*, 2025, para. 313).

The principle of harm prevention imposes a responsibility on States ‘to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction’ (United Nations, 1992b, Principle 2). This principle is binding international law applicable to all States (*Certain Activities*, 2015; *Gabčíkovo-Nagymaros*, 1997; International Law Commission, 2001; *Nuclear Weapons*, 1996; *Pulp Mills*, 2010). It imposes on States an obligation of conduct, rather than of result, subject to the exercise of ‘due diligence’ (Brunnée, 2021). Although some States argued before the ICJ that this principle does not apply to harms to the ‘global commons’ (China, 2024, para 128; India, 2024, para 17; United States of

America, 2024, para 4.16), the ICJ extended this principle to ‘global environmental concerns’ and thus the ‘climate system’ (*Advisory Opinion on Climate Change*, 2025, para. 134).

The duty of due diligence can also be sourced to provisions of the Paris Agreement (Rajamani, 2024). The Paris Agreement requires Parties to submit NDCs at regular intervals, and pursue domestic mitigation measures (UNFCCC, 2016, Article 4.2). The obligation to pursue domestic measures is an obligation to exercise best efforts and is subject to due diligence requirements (*Advisory Opinion on Climate Change*, 2025, paras 250–253; Mayer, 2018; Rajamani, 2020). This raises the question of how the standard of diligence required of States is to be determined. Specifically, how do we assess if the nature and extent of States’ reliance on CDR is in keeping with the standard of due diligence required of them?

3.2. The standard of due diligence

The standard of due diligence required of States is context-specific and time dependent. In the *Seabed Mining Advisory Opinion*, the International Tribunal for the Law of the Sea (ITLOS) noted that due diligence is a ‘variable concept’ which may change in light of ‘new scientific or technological knowledge’ and/or in ‘the risks involved in the activity’ (Stephens & French, 2016; *Seabed Mining Advisory Opinion*, 2011, para 117). Although dynamic, the standard of due diligence is ‘objective’ and ‘stringent’ and can be ‘demanding’. It is objective in that it does not depend on the subjective will and judgment of States but on concrete benchmarks that guide, steer, and constrain the autonomy that States have in relation to their actions. Both the 2024 ITLOS and 2025 ICJ Advisory Opinions on climate change noted that the content and application of the obligation of due diligence should be determined ‘objectively’ under the circumstances (*Advisory Opinion on Climate Change*, 2025, para. 300; *ITLOS Advisory Opinion on Climate Change*, 2024, para. 257) and that the standard of due diligence for preventing significant harm to the climate system is ‘stringent’ (*Advisory Opinion on Climate Change*, 2025, para. 138; *ITLOS Advisory Opinion on Climate Change*, 2024, para. 241). The ICJ noted that ‘the higher the probability and the seriousness of possible harm, the more demanding the required standard of conduct’ and ITLOS that ‘an obligation of due diligence can be highly demanding’ (*Advisory Opinion on Climate Change*, 2025, para. 275; *ITLOS Advisory Opinion on Climate Change*, 2024, para. 257).

The determination of the conduct required by due diligence requires an ‘assessment in concreto’ under the circumstances (*Advisory Opinion on Climate Change*, 2025, para. 137) and should consider ‘relevant factors’ (*ITLOS Advisory Opinion on Climate Change*, 2024, para. 257). Such conduct includes States taking, ‘appropriate and, if necessary, precautionary measures, which take account of scientific and technological information, as well as relevant rules and international standards, and which vary depending on each State’s respective capabilities’ (*Advisory Opinion on Climate Change*, 2025, para. 137). Each of these elements identified by the ICJ enrich the standard of due diligence with concrete content and are discussed below.

3.2.1. Precautionary measures

The need for precautionary measures is directly linked to the nature and extent of harm that would be suffered in the absence of due diligence. The ITLOS *Seabed Mining Advisory Opinion* found precaution to be ‘an integral part of the general obligation of due diligence’ (*Seabed Mining Advisory Opinion*, 2011, para 131). This approach is endorsed by the ICJ (*Advisory Opinion on Climate Change*, 2025, para. 294) and bolstered by the Framework Convention on Climate Change (United Nations, 1992b, Article 3.3). The standard for due diligence thus should be ‘appropriate and proportional to the degree of risk of the transboundary harm’ (International Law Commission, 2001, Article 3, para 11). There is robust scientific evidence of substantial risk of irreversible climate impacts when global average surface temperatures increase by more than 1.5°C, as outlined in section 2, suggesting a correspondingly stringent standard of due diligence. The underlying global warming trend stood at 1.3°C to 1.4°C in 2024 (with 2024 at 1.6°C as the hottest year on record) so crossing the 1.5°C threshold is imminent. Section 4 illustrates the legal effect of applying this stringent standard to emission reduction pathways that carry a considerable risk of overshoot.

In the context of CDR reliance, the ICJ’s guarded finding that, ‘when technologies pose further risks, States are expected to use them with prudence and caution’ is salient (*Advisory Opinion on Climate Change*, 2025, para. 286). In cases where CDR has been raised, national courts have also queried factoring the availability of CDR into targets (Neubauer, 2021, para 31; *Urgenda*, 2018, para 49; *Urgenda*, 2019, para 7.2.5), including in relation to specificity

and transparency of its use (*Friends of the Irish Environment*, 2020, para 128), and in some cases referencing the precautionary principle (*Neubauer*, 2021, para 229; *Urgenda*, 2018, para 49; *Urgenda*, 2019, para 7.2.5).

3.2.2. Scientific and technological information

The need for precaution is directly linked to the science underpinning the international climate change regime. The UNFCCC and the Paris Agreement stress the importance of being guided by the best available scientific knowledge (UNFCCC, 2016, preambular recital 4; United Nations, 1992b, preambular recital 15 and 16). The Paris Agreement also highlights the salience of ‘best available science’ in achieving net zero GHGs (UNFCCC, 2016, Article 4.1), and in the context of the Global Stocktake (UNFCCC, 2016, Article 14.1). Subsequent agreements between the Parties, including the 2021 Glasgow Climate Pact (UNFCCC, 2022, para 23) and the 2023 UAE Consensus (UNFCCC, 2024, paras 6, 28(d), 39, 55, 61 and 149) recognize that accelerated action in this critical decade needs to be based on the best available science. States have accordingly endorsed a response premised on the best available science, which the IPCC’s Sixth Assessment Report identifies as ‘deep, rapid, and sustained reductions in greenhouse gas emissions’ (IPCC, 2023d, B.1), a finding highlighted by the ICJ and incorporated into the standard of due diligence required of States (*Advisory Opinion on Climate Change*, 2025, paras 82, 254).

The reliance on best available science has procedural and substantive dimensions. States are to consider best available science when determining the stringency of their measures. This is a robust procedural requirement; the ICJ has interpreted States as needing to ‘actively pursue the scientific information necessary’ to make that determination (*Advisory Opinion on Climate Change*, 2025, para. 283). Substantively, States are also required to adopt mitigation measures that deliver ‘deep, rapid and sustained’ GHG reductions, as indicated by the IPCC and endorsed by the ICJ (*Advisory Opinion on Climate Change*, 2025, para. 282).

3.2.3. Relevant rules and international standards

The relevant rules and international standards that determine the standard of due diligence required of States can be sourced to treaties, such as the Paris Agreement, customary norms such as the harm prevention principle, and even non-binding norms such as decisions taken by Conferences of Parties (COP) under the Paris Agreement (*Advisory Opinion on Climate Change*, 2025, para. 287). The relevant standards in the Paris Agreement, and related COP decisions, include (but are not limited to) those discussed in the following sub-sections.

3.2.3.1. The Paris agreement’s temperature and net zero goals. The Paris Agreement identifies the global temperature goal as ‘holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels ...’ (UNFCCC, 2016, Article 2.1). To achieve this goal, the Paris Agreement requires a balance between GHG emissions by sources and removals by sinks – popularly characterized as ‘net zero’ GHG emissions – in the second half of this century (Fankhauser et al., 2022; Rajamani & Werksman, 2018; UNFCCC, 2016, Article 4.1).

In response to the Special Report on Global Warming of 1.5°C by the IPCC, which found discernible differences in impacts between 1.5°C and 2°C (IPCC, 2018, I.5), the Glasgow Climate Pact shifted the emphasis in the Paris Agreement’s temperature goal from ‘well below 2°C’ to 1.5°C (UNFCCC, 2022, paras 21 and 22). This shift in emphasis was confirmed in subsequent decisions of the Parties (UNFCCC, 2023, 2024, 2025). The Glasgow Climate Pact also recognized that limiting global warming to 1.5°C requires ‘reducing global carbon dioxide emissions [...] to net zero around mid-century’ (UNFCCC, 2022, para 22).

These consensus-based decisions represent subsequent agreement of the Parties in relation to the interpretation of the treaty (Vienna Convention on the Law of Treaties, 1969, Article 31.3(a)), and generate a normative expectation that Parties’ actions will be aligned with these goals. On this basis, the ICJ identified 1.5°C as the Parties’ ‘agreed primary temperature goal’ and the ‘scientifically based consensus target’ for States (*Advisory Opinion on Climate Change*, 2025, para. 224). The normative weight of 1.5°C has also been recognized by national, regional, and international courts (*ITLOS Advisory Opinion on Climate Change*, 2024, para. 222; *Klimaatzaak v. Kingdom of Belgium and Others*, 2023, para. 191; *Klimaseniorinnen*, 2024, para. 106).

3.2.3.2. The normative expectation of highest possible ambition from States. The standard of due diligence is also influenced by the normative expectation in the Paris Agreement that Parties’ NDCs are to reflect their

'highest possible ambition' (UNFCCC, 2016, Article 4.3). Although the term 'highest possible ambition' is not defined, there is a strong normative expectation that Parties will do their utmost to address climate harms (Rajamani, 2020, 2024; Voigt, 2023) which shapes the due diligence standard (Voigt, 2023; Voigt & Ferreira, 2016). The ICJ interprets this provision to mean that the content of Parties' NDCs must 'be capable of making an adequate contribution to the achievement of the temperature goal' (*Advisory Opinion on Climate Change*, 2025, para. 242). The Parties themselves have recognized the need for NDCs to align with the temperature goal (UNFCCC, 2022, para. 29, 2024, para. 39). Rules requiring Parties to provide information on how their contribution is 'fair and ambitious', and addresses 'progression' and 'highest possible ambition' (UNFCCC, 2019a, Annex I, para 6) bolster this position and instil transparency and accountability in Parties' delivery of highest possible ambition. The strong normative expectation of 'highest possible ambition' weighs in favour of current verifiable actions, given that this expectation is attached to NDCs or short – and medium-term contributions, which are subject to ex-ante and ex-post transparency requirements (UNFCCC, 2016, Article 4.8 and 13; UNFCCC, 2019a, 2019b).

As noted above, whether a State's mitigation efforts reflect its highest possible ambition depends in part on whether they make an 'adequate contribution' to the Paris Agreement's temperature goal. The global ambition of the temperature goal can be expressed by estimating a remaining carbon budget (Rogelj et al., 2019) and subsequently translated into national level expectations through an analysis of each State's 'fair share' (*Klimaseniorinnen*, 2024, para. 571; Pelz, Ganti, Pachauri, et al., 2025; Rajamani et al., 2021). Although the ICJ does not explicitly address States' fair shares in addressing climate harms, it interprets the customary duty to cooperate as requiring States to 'co-operate to achieve concrete emission reduction targets or a methodology for determining contributions of individual States, including with respect to the fulfilment of any collective temperature goal' (*Advisory Opinion on Climate Change*, 2025, para. 305). Fair share methodologies are being canvassed in national and regional courts and will likely emerge over time to fill this gap (Mead et al., 2024, pp. 95–97; Sabin Center Climate Litigation Database, 2021a, 2021b, 2024). For States that have overconsumed their fair share of the global budget and are responsible for overshoot, pursuing deepest possible near-term emissions reductions in line with a State's highest possible ambition (Schönfeld & Rogelj, 2025; Voigt et al., 2025) becomes the only way to minimize further entrenching unfairness (Pelz, Ganti, Pachauri, et al., 2025). These ambitious near-term reductions also pave the way to return to their fair shares later through the pursuit of net negative emissions (Li et al., 2025; Pelz, Ganti, Lamboll, et al., 2025).

3.2.3.3. The central importance of transparency. Transparency is another relevant factor informing the standard of due diligence. Transparency is a cross-cutting feature of international environmental law (United Nations, 1992b, Principle 10), and climate change law (UNFCCC, 2016, Articles 12 and 13; UNFCCC 2019a, 2019b; United Nations, 1992a, Article 12). The harm prevention principle has also been interpreted as requiring States to cooperate and exchange information on potential environmental harm (*MOX Plant*, 2001, para 82 and 84). Transparency has strong substantive dimensions. The obligation to report on domestic mitigation measures encourages States to devise and disclose concrete, measurable plans. Transparency can also lead to greater accountability and stronger regulation over time. It enables non-state actors to hold States to their expressed intentions and plans. The European Court of Human Rights has stressed the importance of providing information on mitigation measures to enable the public to assess associated risks (*Klimaseniorinnen*, 2024, para 554(a) and 539(d)).

The ICJ's interpretation of the harm prevention principle, and the attached duty of diligence, also requires States to notify and consult with each other 'when an activity significantly affects collective efforts to address harm to the climate system' (*Advisory Opinion on Climate Change*, 2025, para. 299). As the nature and extent of a States' CDR reliance has significant implications for collective efforts to address harm to the climate system, full transparency, and consequent notification and consultation is necessary.

3.3. Common but differentiated responsibilities and respective capabilities

The standard of due diligence required of States is mediated by the principle of common but differentiated responsibilities and respective capabilities (CBDRRC) (*Advisory Opinion on Climate Change*, 2025, paras 137, 247), a cross-cutting feature of the UN climate regime (UNFCCC, 1997, Article 10, 2016, para. 2.2, 4.2, 4.19;

United Nations, 1992b, Article 3.1). In practice this means the standard of due diligence applicable to a State will depend on its specific situation, subject to the expectation that developed States must satisfy a ‘more demanding standard of conduct’ (*Advisory Opinion on Climate Change*, 2025, para. 292). There is also an expectation that the applicable standard of due diligence will reflect an ‘equitable distribution of burdens’, as the ICJ underscores in the context of the duty to cooperate (*Advisory Opinion on Climate Change*, 2025, para. 306). While these elements of the CBDRRRC principle add precision and nuance to the determination and application of the standard of due diligence to a particular State, they do not detract from the fact that the standard is objective, stringent and demanding.

To conclude Section 3, the elements that influence the standard of due diligence – precaution, scientific and technological information, and relevant rules and international standards – present a compelling legal case for a stringent and demanding standard of due diligence for States in their actions that cause and address climate harms. Sections 4 and 5 address the application of this standard to States’ reliance on CDR.

4. Due diligence and global emission reduction pathways

As discussed in Section 2, the possibility of CDR deployment introduces flexibility in the composition of global emission reduction pathways which ultimately limit warming to 1.5°C above pre-industrial levels. This section argues that the international legal framework imposes constraints on the extent to which States can rely on this flexibility.

Emission reduction pathways are not aligned with the Paris Agreement’s temperature goal merely because they *eventually* return to 1.5°C through CDR deployment, without regard for the extent to which they initially overshoot it. The Parties have recognized that ‘limiting global warming to 1.5°C with no or limited overshoot requires deep, rapid and sustained reductions in global greenhouse gas emissions’ (UNFCCC, 2024, para. 27) and resolved ‘to pursue efforts... to limit both the magnitude and duration of any temperature overshoot...’ (UNFCCC, 2025, para. 7). The 1.5°C goal is intended to promote the UNFCCC objective of stabilizing GHG concentrations in the atmosphere ‘at a level that would prevent dangerous anthropogenic interference with the climate system’ (*Advisory Opinion on Climate Change*, 2025, para. 225; United Nations, 1992b, Article 2). That temperatures above the Paris threshold would be ‘dangerous’ is acknowledged in the final clause of Article 2.1(a) of the Paris Agreement, which indicates that achieving the temperature goal would ‘significantly reduce the risks and impacts of climate change’.

The best available science demonstrates that even a temporary exceedance of the 1.5°C threshold would lead to dangerous interference with the climate system. The IPCC concluded that ‘[o]vershoot entails adverse impacts, some irreversible, and additional risks for human and natural systems, all growing with the magnitude and duration of overshoot’ (IPCC, 2023d, para. B.7). Even such a temporary exceedance therefore represents a failure of collective efforts to fulfil the objective of the UNFCCC. In combination with the ICJ’s recognition of the need for an ‘equitable distribution of burdens’ (*Advisory Opinion on Climate Change*, 2025, paras 305–306), this failure could provide the basis for efforts to allocate responsibility for overshoot and identify corresponding ‘carbon drawdown obligations’ (Pelz, Ganti, Lamboll, et al., 2025).

Read in light of the UNFCCC’s objective and the best available science, aligning with the Paris Agreement’s temperature goal not only requires States to do their part in returning to 1.5°C after any exceedance; it also requires them to minimize the magnitude and duration of this overshoot. In conjunction with the expectation that the temperature goal is to be achieved by reaching net zero GHG emissions ‘in the second half of this century’ (UNFCCC, 2016, Article 4.1), this entails that within the IPCC’s Sixth Assessment Report the ‘C1a’ pathways are most closely aligned with the international legal framework. These ‘no or limited overshoot’ pathways achieve net zero GHGs in the second half of the century and limit overshoot to a maximum of about 0.1°C (IPCC, 2023c, Table 3.1). C1a pathways may no longer be achievable as they are premised on strong GHG reductions between 2020 and 2030, a period thus far marked by ‘global inaction’ and ‘lock-in’ (United Nations Environment Programme, 2025, p. 39). Studies that account for continued high emissions since 2020 find that it remains possible to limit peak warming to 1.7°C and subsequently reduce temperatures back below 1.5°C (Climate Analytics & PIK, 2025).

Even emission reduction pathways projected to produce minimal overshoot of the 1.5°C goal may nevertheless run serious overshoot-related risks. As discussed in Section 2, pathways which rely more heavily on CDR will

have higher peak warming and overshoot duration if some planned removals are not delivered (Stuart-Smith et al., 2025). This risk grows further if the global warming resulting from cumulative carbon dioxide emissions is higher than the IPCC's central estimate (IPCC, 2023a; Stuart-Smith et al., 2025). The standard of due diligence, and the precaution implicit in it, entails that States must take these risks into account. This standard should be 'appropriate and proportional to the degree of risk of the transboundary harm' (International Law Commission, 2001, Article 3, para 11). The 'degree of risk' of transboundary harm is a function of the likelihood that the harm will occur, and the magnitude of the likely harm should it occur. Given the magnitude of the likely harm, pathways which minimize overshoot and are robust to under-delivery of assumed CDR or higher-than-expected climate sensitivity are more closely aligned with the international legal framework.

Assessing which global emission reduction pathways are more or less aligned with the international legal framework does not in itself specify the duties of individual States. As noted above, the ICJ recognizes the need for an 'equitable distribution of burdens' between States, in accordance with the principle of CBDRRRC (*Advisory Opinion on Climate Change*, 2025, paras 305–306). In the context of the rapidly depleting carbon budget for remaining below 1.5°C (Forster et al., 2025), identifying the action required of each State requires an evaluation of their highest possible mitigation ambition (Schönfeld & Rogelj, 2025; Voigt et al., 2025) and the allocation of responsibility for net-negative emissions to reverse temperature overshoot (Li et al., 2025; Pelz, Ganti, Lamboll, et al., 2025).

In any case, two key national-level implications can be drawn from the analysis of global pathways. First, States' mitigation efforts are not aligned with the Paris Agreement's temperature goal merely because these are consistent with pathways which ultimately limit warming to 1.5°C, if these pathways fail to minimize the magnitude and duration of overshoot. Second, given the risks of overshoot associated with CDR non-delivery, States must be both cautious in the extent of their reliance on CDR, and diligent in implementing feasible strategies to ensure CDR delivery. These implications of the Paris Agreement's temperature goal overlap with and support the legal guardrails discussed below.

5. Distilling guardrails on CDR use in line with the standard of due diligence

The legal framework outlined in Section 3 allows us to distil a set of guardrails which channel and constrain States' reliance on CDR. While these guardrails are rooted in explicit requirements established by the UNFCCC, the Paris Agreement, and related COP decisions, they also draw upon the wider elements informing States' duty of due diligence. The substantive guardrails provide standards of conduct for States, while the procedural guardrails indicate information for States to disclose. As there is an interpretational range to some of the relevant rules and international standards, these guardrails are stated at a relatively high level of abstraction. They nevertheless indicate the standard of conduct consistent with States' duties under international law and provide guidance for the clarification of explicit CDR-related requirements within the international rule-making process.

These guardrails are relevant not only to States' NDCs, but also to their longer-term mitigation plans. Article 4.19 of the Paris Agreement urges Parties to formulate long-term low GHG emission development strategies (LT-LEDS), while the UAE Consensus encouraged Parties to align their NDCs with these LT-LEDS (UNFCCC, 2024, para 40). However, absent explicit requirements relating to the content of LT-LEDS States are not providing a clear picture of their longer-term mitigation plans. This is especially true of CDR, because States often rely on it more heavily closer to the point of their net zero targets (Stuart-Smith et al., 2025). Nevertheless, there are explicit longer-term requirements which provide support for some of the guardrails discussed below. Biennial Transparency Reports (BTRs) submitted under Paris Article 13.7(b) are required to include indicative projections of future trends in GHG emissions and removals over 15 years, with flexibility for developing country Parties depending on their capacities (UNFCCC, 2019b, para 3 and Annex I para 95–101).

The long-term applicability of guardrails beyond these explicit requirements can be sourced to the Paris Agreement, and the standard of due diligence. The requirement that States 'provide the information necessary for clarity, transparency and understanding' in communicating their NDCs (UNFCCC, 2016, Article 4.8) can only be satisfied if they are placed coherently within the context of longer-term plans. One key determinant of the short-term emission reductions necessary to enable the achievement of States' net-zero targets is the extent of projected future CDR deployment. When States do not disclose clear plans for future CDR the

assumptions underlying their NDCs are also left unexplained. This vital interdependence of long-term and short-term planning is underscored by the ICJ's conclusion that NDCs 'must, when taken together, be capable of achieving the temperature goal and the purposes of the [Paris] Agreement.' (*Advisory Opinion on Climate Change*, 2025, para. 270). This depends on how Parties' current NDCs fit into longer-term mitigation strategies.

Finally, the need for rigorous long-term planning is supported by the principle of intergenerational equity, referenced in the Paris Agreement's preamble. The ICJ found that States need to consider 'the interests of future generations and the long-term implications of conduct' when planning and implementing policies and measures (*Advisory Opinion on Climate Change*, 2025, paras 155–157). This perspective should inform assessments of cost-effectiveness. States may rely on CDR because removals are perceived as less costly than emissions reductions. Cost-effectiveness considerations are relevant to the evaluation of States' conduct (*Advisory Opinion on Climate Change*, 2025, para. 286). However, States are not acting diligently if they do not account for the long-term costs and risks of CDR reliance – including those associated with maintaining geological or land-based carbon storage in perpetuity.

5.1. Substantive guardrails

5.1.1. Prioritizing emissions reductions over removals

The Paris Agreement repeatedly emphasizes emissions reductions rather than removals. In Article 4.1 Parties are to 'undertake rapid reductions' and in Article 4.4 developed countries are to lead by undertaking 'economy-wide absolute emissions reduction targets' and developing countries are encouraged to move towards 'economy-wide emissions reduction or limitation targets.' In doing so, Article 4.4 underscores the importance of emissions reductions in States' mitigation efforts (Craik, 2024, p. 353).

Read in context, these provisions are directed at gross, rather than net, emissions reductions. These provisions refer only to 'emissions', whereas others refer to 'emissions and removals' or 'mitigation' (Honegger et al., 2021, p. 333). Removals are addressed separately in Article 5.1, which urges action to conserve and enhance GHG sinks. Although removals fall within Article 4.2's 'domestic mitigation measures' (Honegger et al., 2021, p. 330), their distinct treatment in Article 5.1 confirms that Article 4 is primarily focussed on measures to reduce gross emissions.

The standard of due diligence also reinforces the prioritization of emissions reductions. Given uncertainties regarding the feasibility of large-scale novel or conventional CDR deployment, and concerns about the permanence of removals, States acting in accordance with the best available science cannot rely on CDR as a substitute for rapid and deep emissions reductions. In *Neubauer*, the German Federal Constitutional Court raised concerns regarding the 'economic viability', 'technical feasibility', 'social impacts' and 'emerging ecological risks' of CDR (*Neubauer*, 2021, para 33). In combination with the precautionary principle, these concerns led the Court to conclude that '[t]he main onus is therefore on measures to reduce greenhouse gas emissions' (*Neubauer*, 2021, para 197 and 229).

While the due diligence steer to prioritize emissions reductions does not provide precise answers about an appropriate balance between reductions and removals globally, or for individual States, it necessitates asking hard questions about essential (and non-essential) activities. Technological difficulties in abating emissions from animal agriculture and aviation mean these industries feature prominently in estimates of the residual emissions that remain at (and beyond) States' net-zero targets (Buck et al., 2023; Edelenbosch et al., 2024; Luderer et al., 2018). Given the need to prioritize emissions reductions and uncertainties about the availability of large-scale CDR, significant demand-side reductions in these activities should be considered (Lund et al., 2023).

5.1.2. Pursuing feasible and coherent strategies for emissions reductions and removals

The ICJ held that the obligation to 'pursue domestic mitigation measures' under Paris Article 4.2 requires States to 'pursue measures that are reasonably capable of achieving the NDCs set by them.' (*Advisory Opinion on Climate Change*, 2025, para. 253). The Court also found that the duty to prevent significant harm to the environment requires States to implement 'appropriate rules and measures', including 'regulatory mitigation

mechanisms that are designed to achieve deep, rapid and sustained reductions of GHG emissions.’ (*Advisory Opinion on Climate Change*, 2025, para. 282). Since this customary obligation applies to ‘the prevention of significant harm to the climate system’ generally (*Advisory Opinion on Climate Change*, 2025, para. 282), it extends beyond NDCs to encompass long-term mitigation strategies. It is not enough for States to set short-term or long-term targets; they must also put in place feasible and coherent plans for achieving them.

This guardrail has three key implications for CDR. First, States should ensure their CDR plans become achievable. This cautions against relying on novel CDR options such as BECCS or DACCS without actively enabling their deployment through technological development, the construction of CO₂ transport infrastructure, and the identification of suitable storage sites. Similarly, States should not depend on implausible projections of conventional removals. For example, New Zealand’s latest mitigation plan assumes that an additional 325,000 hectares of afforestation will take place on top of already high estimates. This assumption was added ‘to produce the emissions removals needed to offset the estimate emissions projected to be outstanding in 2050’ (New Zealand Ministry for the Environment, 2024, p. 88), leading the Climate Change Commission to caution that it ‘may overestimate the potential carbon removals that can be achieved or the land available.’ (New Zealand Climate Change Commission, 2025, p. 131).

Second, States should address potential trade-offs arising from CDR. Reliance on DACCS may compete with the energy demands of decarbonization, while biomass sourcing for BECCS may impact land-based sinks (IPCC, 2023c, Table TS.7). Recognizing these concerns, the UK’s 2023 Biomass Strategy takes a ‘precautionary approach’ where bioenergy crops are restricted to abandoned land. However, this restriction makes the UK heavily dependent on biomass imports, potentially jeopardizing its net-zero target given uncertain international supplies (Department for Energy Security & Net Zero, 2023, p. 68, 73).

Third, States should avoid relying heavily on non-permanent land-based sinks to compensate for ongoing GHG emissions with long atmospheric life-spans, as this non-equivalence may jeopardize sustained achievement of net-zero emissions (Brunner et al., 2024; European Scientific Advisory Board on Climate Change, 2025).

5.1.3. Minimizing the adverse effects of CDR

Due diligence requires States to minimize the harms created by climate change as well as by efforts to address climate change. The ICJ warns that where technologies to mitigate climate harms pose risks, they should be approached with ‘prudence and caution.’ (*Advisory Opinion on Climate Change*, 2025, para. 286). Similarly, UNFCCC Article 4.1 (f) requires Parties to minimize adverse effects of their mitigation and adaptation measures, while the Paris Agreement’s preamble urges them to take their human rights obligations into account when taking climate action.

The potential adverse effects of CDR (Deprez et al., 2024; Prütz et al., 2024) are sometimes acknowledged in States’ long-term strategies but seldom addressed. For example, Canada’s LT-LEDS relies significantly on BECCS, but admits that its modelling ‘does not account for the environmental or food security concerns that could potentially arise due to increased production of feedstock.’ (Environment and Climate Change Canada, 2022, p. 60).

5.1.4. Prioritizing domestic action over international emissions reductions and removals

Voluntary cooperation within Paris Article 6 is premised on Parties pursuing such cooperation ‘to allow for higher ambition in their mitigation and adaptation actions and to promote sustainable development and environmental integrity’ (UNFCCC, 2016, Article 6.1). Accordingly, reliance on international credits should enable greater overall mitigation efforts, rather than compensating for domestic efforts which fall short of the ‘highest possible ambition’ required by the due diligence standard. This aligns with the operational rules for Article 6.2, which require participation to contribute to the implementation of NDCs, LT-LEDS and the Paris Agreement’s long-term goals (UNFCCC, 2021, Annex, para 4). Where international cooperation is used to justify less ambitious domestic mitigation efforts it displaces action from one location to another, without enhancing overall ambition. Relying on removals abroad to meet national climate targets carries distinctive risks relating to integrity and permanence, particularly if carbon market governance is weak (Fyson et al., 2020).

5.2. Procedural guardrails

5.2.1. Distinguishing clearly between emissions reductions and removals within targets

Parties are required to ‘strive to include all categories of anthropogenic emissions and removals ...’ in their NDCs (UNFCCC, 2019a, Annex II, para 3(b)). The rules relating to BTRs require that ‘emission projections shall be provided with and without’ the land-use, land use change and forestry (LULUCF) sector (UNFCCC, 2019b, Annex I, para 100). In practice many NDCs and LT-LEDS only provide net emissions targets and not the respective contributions of gross emissions and removals. Stuart-Smith et al. (2025) found that 31% of countries with net-zero targets failed to provide any estimate of their gross emissions in the target year – including China, Denmark, India, Ireland, Japan and New Zealand. Failure to set separate targets for emissions reductions and removals creates ambiguity about how much of each is planned, undermining the prioritization of emissions reductions.

5.2.2. Disaggregating emissions by sector and by gas

Parties are required to provide information on the ‘sectors, gases, [and] categories’ covered by their NDCs (UNFCCC, 2019a, Annex I, para 3(b)). BTRs must provide ‘projections on a sectoral basis and by gas, as well as for the national total.’ (UNFCCC, 2019b, Annex I, para 98). Transparency on the composition of future GHG emissions is essential for integrity of mitigation targets and feasibility of CDR strategies. Disaggregation of gases enables assessment of whether the duration of the warming effect of emissions is equivalent to the permanence of removals included in targets. Since some sectors and activities are harder to decarbonize than others, sectoral disaggregation is necessary to assess the ambition of planned emission reductions and hence the appropriateness of the corresponding reliance on removals.

5.2.3. Disaggregating removals by type

NDCs are required to provide information on the sectors and ‘pools’ covered (UNFCCC, 2019a, Annex I, para 3(b)). States should distinguish removals that store carbon in the active carbon cycle (such as afforestation) from those that remove carbon quasi-permanently (such as geological storage). This disaggregation enables assessments of the comparability between emissions and removals.

Due diligence also supports a more granular disaggregation of planned removals. BECCS and DACCS both store carbon geologically, but raise different technological, social and economic challenges. While requirements for NDCs and BTRs do not yet address the need for such disaggregation, the European Commission encourages Member States to provide separate projections for LULUCF, BECCS, and DACCS in their National Energy and Climate Plans (European Commission, 2022, p. 36).

5.2.4. Specifying methodologies and assumptions underlying strategies

NDCs must provide information on the ‘assumptions and methodological approaches used for accounting for anthropogenic GHG emissions and removals’, including those that are ‘sector-, category-, or activity – specific.’ (UNFCCC, 2019a, Annex I, para 5). This explicitly includes approaches used to account for natural disturbances, harvested wood products, and the age-class structure in forests (UNFCCC, 2019a, Annex I, para 5). Similarly, BTRs are required to describe ‘the methodology used to develop the projections’, including ‘key underlying assumptions and parameters used for projections’ and ‘assumptions on policies and measures’ (UNFCCC, 2019b, Annex I, para 96).

Unless the assumptions and methodologies underlying CDR strategies are made explicit, it is impossible to assess whether they are feasible and coherent. This includes, for example, assumptions about the type and source of biomass feedstocks for BECCS; the expected energy demands of DACCS; and the effects of carbon saturation and natural disturbances on the LULUCF sink.

The importance of disclosing these methodologies and assumptions is bolstered by Article 12 of the Paris Agreement, which underscores the salience of public awareness, participation, and access to information. As the ICJ stressed, the ability of mitigation measures to contribute to the prevention of significant harm depends on the sharing of information, which can also help to minimize the risk that such measures generate harms of their own (*Advisory Opinion on Climate Change*, 2025, para. 285).

5.2.5. Specifying reliance on international emissions reductions and removals

Parties are required to provide information on their intended use of Article 6 mechanisms in their NDCs (UNFCCC, 2019a, Annex I, para 5(g)). They are not, however, explicitly required to quantify the expected contribution of international credits to their targets. Stuart-Smith et al. (2025) found that States rarely quantify the expected extent of this reliance. For example, Canada, New Zealand, and Singapore rely on international credits to achieve their net-zero targets without placing any limits on their contribution.

While the due diligence standard does not impose precise limits on the use of international credits, preventing inappropriate reliance from materializing requires Parties to be explicit about this use. Unless States are explicit about the extent of their reliance it is impossible to determine the level of domestic mitigation action implied by their targets, undermining the implementation of appropriate measures required under Article 4.2 of the Paris Agreement and the broader duty of due diligence.

6. Conclusion

In an uncertain and volatile international order, characterized by unbridled national interest and faltering diplomatic efforts, some States are gambling on the future deployment of novel and conventional CDR to meet their climate targets in the absence of steep near-term emission reductions. While CDR is essential for meeting the Paris Agreement's 1.5°C temperature goal, greater reliance on removals to reverse avoidable magnitudes of overshoot and to balance ongoing emissions that are higher than the lowest, unavoidable levels increases the risk of potentially irreversible climate impacts.

Building on the ICJ's recent Advisory Opinion, this article identifies the standard of due diligence attaching to States' action on climate change and applies this standard in the context of CDR reliance. We find that the objective and stringent standard of due diligence requires minimization of the magnitude and duration of any overshoot of the 1.5°C goal. It also provides guardrails on the nature and extent of CDR deployment by States to meet their climate targets. In line with these guardrails, States should ensure that their CDR strategies are feasible and coherent, and that they do not undermine the ambition of near-term emissions reductions by displacing responsibility into the future. States should also minimize the adverse effects of CDR deployment, prioritize domestic action over removals abroad, and provide clear information about their plans for deploying different forms of CDR.

There are strong indications that States are currently falling short of these standards, particularly within long-term strategies (Stuart-Smith et al., 2025). Our findings emphasize that stringent near-term emissions reductions and feasible CDR strategies are not only ethical imperatives – they are legal requirements.

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