Sensitive Intervention Points for Achieving Climate Neutrality

Summary Report of the Climate Neutrality Forum

Hosted University of Oxford, Mercator Research Institute on Global Commons and Climate Change, and RFF-CMCC European Institute on Economics and the Environment

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*This report is a working document and includes notes and research presented by hundreds of academics and experts at the Carbon Neutrality Forum in search of Sensitive Intervention Points for Achieving Climate Neutrality and represents the wide set of policy perspectives and considerations. As such not all views are necessarily shared commonly by authors, contributors and sponsors but the report instead summarizes insights across many themes.
Executive Summary

Summary Report of the Climate Neutrality Forum

The first Climate Neutrality Forum (CNF) took place in 2021 bringing together over 1,000 academics and climate policy experts in a multi-hub hybrid in-person and virtual meeting held in Berlin, Oxford, and Milan, on 8-9 September 2021, followed by six weekly webinars in the lead up to 26th Conference of Parties meeting of the UN Framework Convention on Climate Change (COP26). The forum explored challenges and key policy interventions for achieving climate neutrality. The CNF was informed by the work of the Intergovernmental Panel on Climate Change (IPCC) during its 6th Assessment Cycle in particular the IPCC Special Report on Warming of 1.5°C (SR1.5) and the IPCC Working Group I report on Scientific Understanding of Climate Change which was published in August 2021. Climate neutrality is considered to mean a cessation of further warming of the Earth’s climate system by atmospheric greenhouse gases. It is aligned with, and informed by, the Paris Agreement temperature goal to hold “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”. The forum sought Sensitive Intervention Points for achieving Climate Neutrality: Solutions which transform a system or take advantage of an amplification dynamics in part of the system that is at or near a tipping point or state of ‘criticality’ (Hepburn et al., 2020). These were evaluated on: Timing, to halve emissions by 2030, and again by 2040, and accelerate removals along the way; Impact, to reduce or remove GHG emissions by at least 1Gt in this time frame; Practicality, politically, technologically, and economically; Risk, potential unintended consequences and trade-offs.
Sensitive Intervention Points

FOR EQUITY AND A JUST TRANSITION, climate neutral strategies should explicitly outline their impacts on a wide range of stakeholders and equity considerations outlined. Revenue raising mechanisms such as Border Carbon Adjustment Mechanisms should devote funds to international climate finance to help close international finance gaps. Debt restructuring is also needed as developing countries weather climate catastrophe, increasing financial stress.

FOR RAPID EMISSIONS REDUCTIONS, climate neutral strategies should implement policy instruments that allow society to capitalize on the under-estimated savings potential of clean energy technology with declining cost-curves as well as higher carbon pricing paired with ambitious Carbon Border Adjustment Mechanisms to avoid carbon leakage.

FOR FINAL 20% HARD TO ABATE SECTORS, climate neutrality demands more than a shift to low-carbon road transport and renewable electricity generation. This will require public investment and policies to de-risk investment in carbon neutral fuel alternatives and infrastructure, such as, for example Contracts for Differences (CfDs) for shipping hydrogen. Experts warned that policies failing to differentiate between zero carbon versus net zero solutions (such as green and blue hydrogen), may waste public resources by confusing the technology and investment landscape and delaying the transition, and that an over-reliance on blue-hydrogen may lead to carbon lock-in.

FOR NATURE LANDUSE AND AGRICULTURE, Climate Neutrality demands radical agricultural subsidy reform. The global cost per year of the damage to nature from harmful subsidies is estimated between $4 to $6 trillion (The Dasgupta Review, 2021). Policies are also needed to scale monitoring verification and reporting for soil carbon sequestration. The world’s arable soils are estimated to sequester on average 5 billion tonnes CO2e per (Dunne, 2020). Nature-based solutions must support local communities to ensure integrity (Martin et al., 2021).

FOR GREENHOUSE GAS REMOVAL (GGR), standardization and regulations are key priorities. Climate Neutral strategies must include policies for scaling greenhouse gas removal. The IPCC SR 1.5 assessed that 100 to 1000 billion tonnes of carbon dioxide removal will be needed until 2100 (absent unprecedented development in technology and human behaviour). Policies to scale GGR include investment incentives and public financing, e.g. national Feed-In-Tariffs and a European Removal fund supported by the ETS. Policies are also needed requiring the heaviest emitters to drawdown hard-to-abate emissions such as a Carbon Take Back Obligation.

FOR CLIMATE FINANCE, a range of interventions are needed to achieve climate neutrality, green supportive factors, such as “green loan guarantees” and “targeted public private partnerships” to scale decarbonization solutions, as well as “dirty penalizing factors” such as “capital adjustment” (an extension of Basel rules), and “risk adjustments”. Experts emphasized that financial institutions must move beyond an era of transparency and climate-risk management and focus more on climate outcomes.
The Climate Neutrality Forum

Introduction

The first Climate Neutrality Forum (CNF) took place September to November 2021. It was designed to explore key features of and challenges in achieving climate neutrality. Planning for the CNF was informed by the IPCC SR1.5 and it was anticipated that the that IPCC Working group I report would be published shortly before it took place providing further scientific insights.

Identifying Sensitive Intervention Points

The focus of the CNF was on key challenge topics with the objective of identifying Sensitive Intervention Points within these topics (Equity and Justice, Rapid Emissions Reductions, Final 20% Hard-to-Decarbonize Sectors, Nature Land use and Agriculture, Greenhouse Gas Removal, and Finance and Policy). Sensitive Intervention Points (referred to as simply ‘Interventions’ in this report) are strategic solutions designed to enable transformative change to rapidly reduce GHG emissions or increase carbon sequestration. Sensitive intervention points are strategic actions that can lead to disproportionate effects, by taking advantage of positive feedback loops or amplification dynamics in part of the system that is at or near a state of ‘criticality’ (Farmer et al., 2019). This report is focused on the outputs from these considerations at the CNF and in a subsequent webinar series. The importance of the framing issues around physical sciences, formulation of climate ambition and scenarios were largely in the background. These were highlighted during the high-level opening and closing sessions and are included here as context for the CNF, and in the conclusions.

Climate neutrality

Climate neutrality is considered to mean a cessation of further warming of the Earth’s climate system by atmospheric greenhouse gases. It is aligned with, and informed by, the Paris Agreement temperature goal to hold “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”. It avoids further interpretation of that goal. Climate neutrality therefore serves to frame important issues such as the reliance on the vitality of natural systems to provide sinks for greenhouse gases. The ocean and unmanaged terrestrial carbon dioxide sinks are particularly important for this. It also provides a framing for various formulations of climate protection ambition such as carbon neutrality, net-zero greenhouse gases, etc. that have been widely adopted.

Context

The first CNF kicked off on the 8-9 September 2021, about eight weeks ahead of the delayed UNFCCC COP26 meeting in Glasgow. The opening session from the University of Oxford Hub heard the latest findings from the IPCC which highlighted the scientific imperative of reaching net zero carbon dioxide emissions in order to
stabilise the climate system\textsuperscript{1}. The need for high ambition in the period to 2030 to reach an emissions pivot point in 2050 was central to the Fit for 55 proposals outlined by the Commission, and this forum examined some ways for the commission to build on this ambition. Major steps forward since the IPCC AR5, including the Paris Agreement and open adoption of climate neutrality goals by governments and other non-state actors in were highlighted. The emergence of legal actions as a tool to imbed ambition was also noted. The need for European ambition to be accelerated and matched by other regions and the centrality of the international process and COP26 for this were outlined. Mechanisms for closing the gaps in climate finance were highlighted as well as the need to support investments in fundamental sciences i.e. Earth systems sciences as well as in scenarios.

What are Sensitive Intervention Points for Achieving Climate Neutrality?

Sensitive Intervention Points (SIPs) For Achieving Climate Neutrality - The need for non-linear systemic climate action

“Conventional approaches to mitigating climate change are not working. Despite the actions pledged under the 2015 Paris Agreement, actual progress is falling well short. Given limited time and resources, traditional efforts such as the climate stabilization wedge approach are unlikely to be effective on their own. Physical science has shown how complex adaptive systems can cross critical thresholds (“tipping points”), such that a relatively small change can trigger a larger change that becomes irreversible, where nonlinear feedback effects act as amplifiers. We propose to examine how to exploit similar sensitive intervention points (SIPs) and amplification mechanisms in socioeconomic, technological, and political systems to advance climate change mitigation. [Sensitive Intervention Points include] research and policies in which a relatively modest but well-timed intervention can generate outsized impacts and accelerate progress towards a post-carbon world. These can happen through either ‘kicks’ or ‘shifts’. Kicks push something at the verge of tipping in the system at just the right moment, while shifts change the underlying dynamics of the system.” (Farmer et al., 2019).

Sensitive Intervention Points also help to evaluate climate policy through new models more equipped to the current economic system, than conventional economics, which has considerably under-estimated the pace, costs, opportunities and scale of the transition to renewable energy for example (Ives, 2021). New analytic models can help us to predict better timed and cost-effective sensitive interventions to drive breakthroughs needed to achieve Climate Neutrality.

Such agent-based models and thinking are increasingly being used in policy (Turrell, 2021).

What Sensitive Intervention Points for achieving Climate Neutrality are NOT:

- **Sensitive Intervention Points are not an end-goal but a mechanism.** A Sensitive Intervention Point is not a solution but a mechanism designed to drive the scaled adoption of climate solutions. Sensitive
Intervention Points are distinct from a tipping point, breakthrough, or system change. Sensitive Intervention Points are clearly-defined, *agent-based mechanisms* (in this report mostly policies), that facilitate a breakthrough or tipping point in the socio-economic system. From here these will be referred to as Interventions. For example, tipping points in the restoration of nature and biodiversity net gain both represent valuable goals which in and of themselves are not sensitive intervention points, however, a national, regulated, bio-diversity net gain target might be the Intervention to deliver on such a goal.

- **Sensitive Intervention Points are not reforms with minimal impact.** Many important reforms or changes in behaviour across society are needed to achieve climate neutrality, but each on their own would not be considered a sensitive intervention point for doing so at the global or regional scale. A Sensitive Intervention Point must offer either a *kick* to the current state of a system which is primed for change, or a shift, which changes the underlying system dynamic, two (Farmer et al, 2019). There are many valuable reforms that fail to do either. For example, the US EPA’s increase in regulation of methane leaks is needed to rapidly reducing emissions. However, this reform alone is unlikely to fundamentally *shift* the underlying dynamics of the fossil fuel economy or *kick* the energy system towards a tipping point. There’s an important place in the Climate Neutral Policy landscape for quick-win interventions, and indeed a programme which aggregates and advocates many such reforms may add up to a Sensitive Intervention Point. On their own, however, such reforms would not be considered a Sensitive Intervention Point for achieving Climate Neutrality.

- **Sensitive Intervention Points are not policies developed through cost-benefit analysis which may be easily reversed.** Many climate interventions rely on cost-benefit analysis, or lowest-resistance options with a high degree of risk of reversal. For example, a carbon market driven by traditional market forces, such as a buyers’ market of lowest cost offsets, is likely to lead to the lowest quality offsets dominating the market. This results in the rapid reversal of the intended benefits of the offset through the expiry of sinks. Unregulated investment to scale carbon removal would not provide a Sensitive Intervention Point on its own, but the development and application of widely agreed standards for climate neutral sinks / credits, could be accompanied with an influx in investment to create a point for a sensitive intervention.
Criterion for discussing Sensitive Intervention Points

During the forum we used the following to discuss Interventions:

<table>
<thead>
<tr>
<th>Timing</th>
<th>Is this SIP required to:</th>
</tr>
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<tbody>
<tr>
<td>• Halve GHG emissions by 2030</td>
<td></td>
</tr>
<tr>
<td>• Start this decade in order to halve GHG emissions again by 2040</td>
<td></td>
</tr>
<tr>
<td>• Start this decade in order to remove GHG from the atmosphere by 2050</td>
<td></td>
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<table>
<thead>
<tr>
<th>Impact</th>
<th>Will this SIP:</th>
</tr>
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<tbody>
<tr>
<td>• Reduce GHG emissions by at least 1GT by 2020; or</td>
<td></td>
</tr>
<tr>
<td>• Reduce GHG emissions by at least 1GT/y by 2040</td>
<td></td>
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</tbody>
</table>

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<thead>
<tr>
<th>Practicality</th>
<th>Is the actor or group capable of taking this action; how effective will resistance be; and how robust and ready is the system and the technology? Think –</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Politically</td>
<td></td>
</tr>
<tr>
<td>• Economically</td>
<td></td>
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<tr>
<td>• Technically</td>
<td></td>
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<tr>
<th>Risks</th>
<th>What is the level of risk associated with this SIP. Think –</th>
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<tbody>
<tr>
<td>• Reversibility – how easily could it be reversed, and the benefits lost or worse</td>
<td></td>
</tr>
<tr>
<td>• Trade-offs – doing this SIP harms other better options.</td>
<td></td>
</tr>
<tr>
<td>• Unintended consequences – that would substantially offset the benefit of this SIP</td>
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Sensitive Intervention Points Policies for Climate Neutrality:

Throughout the Climate Neutrality Forum, we identified possible Sensitive Intervention Points which participants felt meet the criteria. These are outlined below. An appendix includes more discussion on additional interventions discussed in the forum not covered in detail in this report.

<table>
<thead>
<tr>
<th>Discussion</th>
<th>Sensitive Intervention Points for Climate Neutral Strategies Detailed in this Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity and Just Transition</td>
<td>Climate and Nature Aligned Debt Restructuring (debt for nature swaps and debt for efficiency swaps) paired with international climate finance efforts through the IMF and the World Bank</td>
</tr>
<tr>
<td>Rapid Emissions Reduction</td>
<td>Policy instruments to incentivise investment in clean energy technology with declining costs AND Ambitious Carbon (&amp; Deforestation) Border Adjustment Mechanism, with ambition and equity measures such as international funding and new timelines</td>
</tr>
<tr>
<td>Final 20% Hard to Abate Sectors</td>
<td>Public interventions for targeted investment in clean energy and green (rather than blue) hydrogen infrastructure paired e.g. Contracts for Differences (CfDs)</td>
</tr>
<tr>
<td>Nature, Land-use, Agriculture</td>
<td>Redistribution of agricultural subsidies for climate, biodiversity and health aims AND Scaled up Monitoring Verification and Reporting (MRV) for soil carbon sequestration</td>
</tr>
<tr>
<td>Greenhouse Gas Removal</td>
<td>Standardized accounting for GHG Removals AND Carbon Take Back Obligation, with improved standards and separate measurement of removals</td>
</tr>
<tr>
<td>Climate Finance and Policy</td>
<td>Green Loan Guarantee Programmes</td>
</tr>
</tbody>
</table>
Understanding climate neutrality and net zero Greenhouse gas emissions

The Summary for Policymakers of the IPCC 6th Assessment Working Group I Report (AR6) states that “Achieving global net zero CO$_2$ emissions, with anthropogenic CO$_2$ emissions balanced by anthropogenic removals of CO$_2$, is a requirement for stabilizing CO$_2$-induced global surface temperature increase. This is different from achieving net zero GHG emissions, where metric-weighted anthropogenic GHG emissions equal metric-weighted anthropogenic GHG removals. For a given GHG emissions pathway, the pathways of individual GHGs determine the resulting climate response, whereas the choice of emissions metric used to calculate aggregated emissions and removals of different GHGs affects what point in time the aggregated GHGs are calculated to be net zero. Emissions pathways that reach and sustain net zero GHG emissions defined by the 100-year global warming potential (GWP$_{100}$) are projected to result in a decline in surface temperature after an earlier peak (high confidence).” The IPCC Special Report on a Global Warming of 1.5°C (SR1.5) stated “Reaching and sustaining net-zero global anthropogenic CO$_2$ emissions and declining net non-CO$_2$ radiative forcing [planetary energy imbalance resulting directly from human-induced changes] would halt anthropogenic global warming on multi-decadal timescales (high confidence).” [emphasis added]

Net Zero Carbon Dioxide

The IPCC is clear that reaching net-zero carbon dioxide (CO$_2$) emissions is essential to stabilising the climate system. This arises from the fact that every tonne of CO$_2$ emitted into the atmosphere increases global temperature by 0.45 (±0.18) trillionths of a degree Celsius (AR6 estimates), so current emissions of 40 billion tonnes of CO$_2$ per year are increasing global temperatures by almost 0.2°C per decade, augmented by other climate drivers. Limiting warming due to CO$_2$ alone to any specific temperature level, whether 1.5°C, 2°C or higher, implies a total “carbon budget”. When this budget is spent CO$_2$ emissions must reach net zero to halt further warming on multi-decadal timescales.

This issue was explored with the IPCC in the UNFCCC Structured Expert Dialogue (SED) for the first Periodic Review of the Long-term Global Goal. The Summary report for the SED was clear that reaching net-zero CO$_2$ emissions was required to halt the increase in global temperature because the net impact of other anthropogenic climate drivers was to add to CO$_2$-induced warming. That report also made it clear that carbon dioxide removals would be needed to offset any ongoing emissions of non-CO$_2$ greenhouse gases which could not be reduced to zero. These include methane and nitrous oxide linked to food production. These concepts are captured in the 2015 Paris Agreement as achievement of “a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century”. 

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Net Zero Greenhouse Gas emissions

There is no internationally agreed definition of what constitutes Net Zero greenhouse gas emissions because it depends on the choice of metric used to aggregate different gases. The IPCC notes “the choice of emissions metric depends on the purposes for which gases or forcing agents are being compared” and has highlighted the complexity of adopting an emissions metric to determine the scale of negative emissions that are required to compensate for ongoing emissions of non-CO$_2$ greenhouse gases. This can arise from three key factors

1. Different governments may, based on science, choose to adopt different metrics for determination of net-zero greenhouse gas emissions and the policies to achieve this.

2. The value of the metric adopted metric, e.g. GWP$_{100}$, may change following the publication of an IPCC Assessment Report.

3. The climate impact timescale highlighted by a particular metric may not be in line with the global policy goal to limit the increase in global temperature to well below 2°C or at, or close to, 1.5°C (The GWP$_{100}$, for example, indicates the warming impact of current methane emissions on global temperature in about 40 years’ time. If warming peaks sooner than this, GWP$_{100}$ would underestimate the impact of current methane emissions on peak temperatures; if later, the GWP$_{100}$ would overestimate current methane impact).

If differing emissions metrics are chosen by different governments, then the scale of effort and timing of achieving net-zero GHG emissions as well as its climate impacts may vary. Even if a single emissions metric is chosen its value may change with evolving science. This would impact the timing and scale of effort required to reach net-zero emissions encompassing all greenhouse gases although not the temperature outcome of any given emissions pathway.

The climate impacts of reaching net zero using different metrics, values or combinations of greenhouse gases may result in temperature neutrality, sustained cooling or continued warming. Achieving temperature neutrality (one possible definition of climate neutrality) would mean to halt or limit warming consistent with the Paris Agreement temperature goal. The AR6 WGI report suggests that use of GWP$_{100}$ to determine achievement of net-zero GHGs would result in sustained cooling due to the offsetting of ongoing emissions of short lived GHGs such as methane with carbon dioxide removals (CDR) which would in time overcompensate for the warming impact of those short-lived GHGs.

All these statements assume that warming is halted before Earth system responses are de-stabilized. The IPCC AR6 report shows that additional warming could occur even after carbon dioxide emissions reach net zero if earth system feedbacks result in a loss or reversal of natural terrestrial and ocean sinks of carbon dioxide, or the enhanced release of non-CO$_2$ GHGs such as methane. If this were to occur, further CDR would be required to keep the Paris Agreement temperature goal within reach.

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Recommendation

The concept of net zero GHG emissions and the implications of approaches adopted to achieve such an outcome, have not been fully explored or understood. It is recommended that the UNFCCC should explore this concept further order to provide greater clarity in the context of achievement of the Paris Agreement temperature goal. in order to provide greater clarity in the context of achievement of the Paris Agreement temperature goal.

Figure: Illustration of the distinction between net-zero CO₂ emissions and net-zero GHG emissions, here defined using the GWP₁₀₀ metric. In this representative mitigation scenario, net-zero CO₂ emissions is sufficient to halt further warming and is reached 15-20 years before net-zero GHG emissions is reached, by which time temperatures are declining. Ref. 3 refers to the IPCC SR1.5 report. Reproduced from Rogelj, J, O Geden, A Cowie and A Reisinger, Nature, 367:365-368 © Nature.
**Equity, Inclusion, and a Just Transition in Climate Neutral Strategies**

Measures to deliver equity, inclusion and a just transition should underpin climate neutral strategies to ensure that no sector, country, or stakeholder is left with undue burdens as result of the transition to Climate Neutrality. This session outlined several key stakeholder groups related to different forms of climate justice and equity. The broad challenge and recommendation from this session is to specifically address the impacts of climate neutral plans on stakeholders from the perspectives of each of these forms of equity, and to try to adjust policies which conflict with equity aims:

- **Intergenerational equity** was highlighted as a gap in current climate neutral strategies to address the undue distribution of costs to future generations because of current climate neutral policies.

- **A just transition for workers** at the local or national scale was acknowledged as a key pillar of robust climate neutral strategies. Strategies for Climate Neutrality were encouraged to invest in green adjacent job programmes, that is jobs which have transferable skills to those being lost in the transition (Mealy, 2021)

- **International equity** and national sovereignty were raised as key challenges to many of the current strategies and interventions put forward for achieving Climate Neutrality. There was broad acknowledgement that developing states, particularly in the Global South may need to reach climate neutrality at a later stage, and invest in adaptation, requiring developing countries to do more to support and compensate.

- **Environmental justice**, was raised requiring consideration in climate neutral strategies, particularly as defined as the fair treatment and meaningful involvement of all people regardless of race, colour, national origin, or income, with respect to the development, implementation and enforcement of environmental laws, regulations, and policies (USEPA, 2017).

- **An eco-centric lens** was regarded as a necessary. But ensure that the impacts on species, not just humans, are considered in policymaking.

- **Procedural equity** was raised and examines how different stakeholders are included in environmental decision-making at different levels and how they are affected by environmental change.

- **Distributive equity** involves efforts to remedy the uneven distribution of costs and benefits of environmental transitions (in both the physical and policy environment).

- **Compensatory equity** assesses who should be responsible for compensating for these uneven costs is one of the most difficult areas of discussion, but nonetheless critical, as it ultimately gets to the question of who and how we pay for climate mitigation, adaptation and loss and damage. Compensatory equity is a topic which is likely to remain high on the agenda for the next several Conferences of Parties.
“This year will be an opportunity for more equity to be injected into the race for net zero.”

– Lavanya Rajamani, Oxford’s professor of International Environmental Law is a veteran of Kyoto, Paris and COP: a negotiator, a drafter, a legal adviser.

A Rise in Climate Litigation

In the absence of greater efforts to address equity and justice concerns through policy, committers open themselves up to legal liability in their climate neutral strategies. Trends in climate litigation highlights the increasing number of climate litigation cases being brought forward across the globe. World-wide the cumulative number of climate change-related cases has more than doubled since 2015. Just over 800 cases were filed between 1986 and 2014, while over 1,000 cases have been brought in the last six years, with 37 ‘systemic mitigation’ cases against governments (Setzer and Higham, 2021). Governments are being called to make thorough, plans with equity embedded, and can’t afford to leave out, or leave for later efforts to address the equity concerns that arise as a result of, or a failure to rise to, the climate neutral transition.

Distributive equity in practice in a Climate Neutral Strategy – EU Proposed Social Climate Fund

Measures to embed equity into climate neutral strategies are increasingly acknowledged as a requirement for gaining the necessary public support to deliver on planned programmes. The EU’s Fit For 55 package addresses equity concerns about the new emissions trading system for Transport and Buildings by offering a new Social Climate Fund (EU Commission Fit for 55, 2021). “The size of the Social Climate Fund will correspond to a dedicated share of the revenues from the auctioning of emission allowances under the new system”. This aims to address the potential costs to citizens and consumers by providing funding to Member States to invest in reducing emissions in road transport and buildings, which should reduce costs for vulnerable households, small businesses, and transport users. These measures and investments need to principally benefit vulnerable households, micro-enterprises, or transport users. Pending the impact of those investments on reducing costs and emissions, the Fund will also be able to finance temporary direct income support for vulnerable households.

New Opportunities for Intervention for Equity in Climate Neutral Strategies

1. **International equity, especially considering global climate adaptation needs, remains a gap in many climate-neutral strategies.** While states are increasingly committing to funding (like the new EU Social Climate Fund) for domestic climate mitigation efforts, targets for international climate finance have fallen short and climate adaptation remains a key international challenge and an obvious gap in current climate neutral strategies, especially in the developed world. Despite adaptation being framed through international solidarity, concrete measures are often left to the responsibility of individual states, and financing is concessional with high interest rates (Hirsch et al., 2019). To address international and intergenerational Climate Equity, a new revenue stream is necessary for international adaptation financing. The vision of the Santiago Network is to catalyse the technical assistance of relevant
organizations, bodies, networks and experts, for the implementation of relevant approaches for averting, minimize and addressing L&D at the local, national and regional level, in developing countries that are particularly vulnerable to the adverse effects of climate change (Decision 2/CMA.2, para 43).

2. **More explicit consideration of all stakeholders is needed across climate neutral strategies.** Explicit equity considerations in climate policy often focus on a just transition for workers or domestic taxpayers. Incorporating gender, race, and generational lenses in policy and decision-making can increase the necessary emphasis also needed on the effects of policies on women, indigenous peoples, children, and groups on the frontline of the impacts of climate change. An eco-centric approach is also required to ensure a consideration of impact on biodiversity and non-human species.

3. **Climate neutral strategies must include the integration of equity at all levels, not just isolated interventions.** Some of the most powerful Interventions from the perspective of equity are not going to be found in single policies or programmes, but may involve tweaking existing interventions, or exploring the interlinkages between Interventions across sectors to ensure that equity and justice play a central part in all of them.

**Interventions discussed to improve equity in the climate neutral transition:**

- **Climate and Nature Aligned Debt Restructuring,** (e.g. debt for nature/ debt for efficiency swaps) paired with international climate finance through the IMF and the World Bank (for international equity).
- **Integrating procedural rights into NDCs** for through, for example citizens’ assemblies (for procedural equity).
- **Corporate requirements for reporting** on deforestation, indigenous rights (for environmental justice).
- **Integrating employment modelling into electricity system planning** (just transition for workers).
- **Integrating carbon dioxide removal quotas** into NDCs (distributive equity and international equity).
- **Policies and attribution science that open new roads for climate litigation** particularly for loss and damage (for compensatory justice).
- **Requirements for net zero committers** to justify their short-term emissions reductions in terms of intergenerational equity
- **Requirements to emissions offset purchasers** to take responsibility for long-term preservation of sinks (for intergenerational equity)
Equity: Climate and Nature Aligned Debt Restructuring

“This is not the time for nation-states to be forced to trade their people and futures for international debt repayments that have ballooned for reasons largely out of their control, putting action on our shared climate change and sustainable development goals on hold.” – Statement on Debt Relief for a Green and Inclusive Recovery, January 2021.

We face a ‘triple crisis’, characterised by climate change, biodiversity loss and a major debt crisis in the wake of Covid-19 (Steele & Patel, 2020). Climate-aligned debt restructuring mechanisms are key interventions for an equitable, global post-Covid ‘green recovery’.

Debt-for-nature swaps are perhaps the most well-known form of debt restructuring for environmental aims. The recent resurgence of interest in debt-for-nature swaps is partly an outcome of the ever more urgent need to halt emissions from deforestation (Cassimon et al., 2011). These increase financial resources available to recipient countries to invest in conservation by diverting resources from debt service payments to domestic spending. They are considered a ‘triple-win’ solution that simultaneously benefit the debtor country, NGO, and creditor country in financial and reputational terms (Cassimon et al., 2011; Yue et al., 2021). Many of the swaps that occurred in the 1980s and 90s, predominantly in Latin American countries, dealt with commercial (private) debt, in which a third-party organisation (usually an NGO) would purchase the commercial debt of a developing country at a discounted rate, in exchange for the debtor country committing to investments in conservation (Cassimon et al., 2011; Yue et al., 2021). Public (bilateral) swaps occur between debtor and creditor governments: the creditor government agrees to forgive a portion of debt owed by the debtor government, in exchange for the latter’s commitment to investing in local conservation efforts (Yue et al., 2021). A debt-for-nature swap in the Seychelles in 2016 (Yue et al., 2021), achieved 30% protection of its waters by March 2020, following restructuring of the $21.6 million debt owed to the UK, France, Belgium, and Italy, amongst others, through the Nature Conservancy (Yue et al., 2021).

A new wave of debt restructuring proposals (such as ‘debt for efficiency swaps’) have emerged in response to the lessons of the last four decades seeking to overcome the challenges of traditional mechanisms such as debt-for-nature swaps (OECD, 2007). These are more international in scope and emphasise the importance of multi-stakeholder collaboration and coordination, including working with the IMF and World Bank (Volz et al., 2020). In a Statement released in January 2021, twenty-three former Central Bank Governors and Former Finance Ministers called the G20 to initiate a Debt Relief for a Green and Inclusive Recovery Initiative, to include large-scale bilateral, multilateral, and private sector debt relief. Other recent proposals include ‘climate-health-debt swaps’ (Westphal & Liu, 2020), and ‘debt-for-efficiency’ swaps (Cassimon et al., 2011). These new approaches are part of broader conversations around how best to integrate development and human rights principles into climate change policy and the Paris framework (Cassimon et al., 2011), which has seen a rapid rise in climate litigation cases (Setzer & Higham, 2021), and increasing calls for developed economies to meet their failed promises to provide $100bn per year in climate finance by 2020 (Timperley, 2021).
Impact and scale of Climate Aligned Debt Restructuring mechanisms: Since 2019, sovereign debt has increased across almost all geographic regions. In low- and middle-income countries, external debt reached $8.7 trillion in 2020, a rise of 5.6% on average since 2019, and the debt-to-GNI ratio rose from 37% to 42% (World Bank, 2021). In 2018, developing countries spent, on average, 10.3% of their government revenues on debt repayments (UNCTAD, 2020), limiting their economic stability and ability to invest in sustainable development (DRGR, 2021). In 2020, Fiji saw a 32% reduction in government funding for climate projects (Westphal & Liu, 2020). Debt restructuring is needed to break this vicious cycle of debt by relieving countries of some repayment obligations, so they can invest in conservation, adaptation, and mitigation (Westphal & Liu, 2020). Debt-for-nature swaps have directed $1.2 billion towards such projects between 1987 and 2015 (Yue et al., 2021). Recent calls for China to promote debt-for-nature swaps (Liu, 2021) is likely to increase the impact of this Intervention. Debt restructuring mechanisms must include middle-income countries. Of the 150 million people that the World Bank (2020) estimated would be pushed into extreme poverty by 2021, 8 of 10 are from middle income countries. The combination of development issues, high debt, and high emissions in many middle-income countries means that climate-aligned debt restructuring in these regions could have a significant impact. Debt restructuring will likely be required to fill funding gaps in order to meet world leaders’ new goal to end deforestation by 2030 (UK COP 26 Announcement). One estimate shows that even halving forest emissions could cost up to $35 billion per year (Angelsen et al., 2009). Conservation measures implemented through debt-for-nature swaps reduce emissions and maximise co-benefits, including biodiversity, local adaptation and development (Cassimon et al., 2011). As such, the full impact of debt restructuring mechanisms is difficult to quantify (Yue et al., 2021). However, it is essential that these co-benefits, are not forgotten as interventions are made. The recent wave of proposals for multi-stakeholder frameworks for debt restructuring will bring many actors to the table (Liu, 2021).

Risks related to Climate Aligned Debt Restructuring: The main risk of debt-for-nature swaps and similar mechanisms is the potential that they fail to deliver on developmental and conservation goals. These risks include high transaction costs, crowding out potentially more effective forms of aid, inflation of local currency which can reduce the real cash value of conservation funds, the gradual nature of debt relief funds (Cassimon et al., 2011; Yue et al., 2021). Additional risks come from greenwashing that hides poorly designed projects, weak monitoring and oversight, or debt-for-nature swaps simply acting as a substitute for conservation projects that would have been initiated by the government anyway (Cassimon et al., 2011; Liu, 2021). The design of conservation projects can also represent an equity risk if they conflict with existing environmental projects, involving resettlement of local communities or issues of land ownership, if they fail to involve local stakeholders, or if they undermine government policies by attaching certain conditions to debt relief (Yue et al., 2021; Cassimon et al., 2011). However, each of these risks can be mitigated by strengthening the institutions involved in the implementation of debt restructuring mechanisms. This should be a feasible option given the increasing traction of debt restructuring mechanisms amongst multilateral institutions such as the G20, and moves to involve the World Bank and IMF (Volz et al., 2020), who have the knowledge-sharing, regulatory, and monitoring capacities to promote a more coordinated effort. For example, Yue et al.’s (2021) recommendations for facilitating debt-for-nature swaps in the Belt and Road Initiative proposed stricter sustainability requirements for conservation projects and setting up an agency to manage such swaps.
Timing of Climate Aligned Debt Restructuring: Debt restructuring negotiations, which typically last 2-4 years (OECD, 2007), followed by the planning and implementation of conservation projects, mean that the environmental benefits of these mechanisms are far from immediate. Disagreements between the multiple stakeholders involved can cause further delay (Yue et al., 2021). Developmental benefits may also be slow to materialise given that debt relief savings are realised gradually, over several years or even decades (Cassimon et al., 2011). However, given the speed at which the Debt Service Suspension Initiative (DSSI) was adopted by G20 Finance Ministers in 2020, suspending bilateral debt payments for 73 low-income countries until July 2021 (Simmons et al., 2021), it is clear that when urgent measures are required, rapid action is possible. Given the risk that developing countries turn to exploiting natural resources in attempt to reduce their debt burden, the G20 has recognised that they will need to go further than debt suspension to avoid significant environmental harm (ibid.). This is a promising sign for further rapid action.

Practicality of Climate Aligned Debt Restructuring: It appears that the current moment – characterised by the Covid-19 debt crisis (World Bank, 2021), increasing attention towards climate finance, higher infrastructure spending (Yue et al., 2021), and the urgent need to halt emissions from deforestation (Cassimon et al., 2011) – represents a critical point for realising the potential of debt restructuring mechanisms. As more international bodies (including the IIED and UNCTAD) add their voice to the conversation around debt restructuring mechanisms, contributing knowledge, and financial and technical capacity, the practicality of such mechanisms is strengthened.

Data from Clements, Gupta and Liu (2021)
Recent calls for the involvement of additional stakeholders in facilitating debt restructuring mechanisms – from the private sector to the IMF and World Bank (Volz et al., 2020) – mean that negotiations may be more complex, though this does not make them less feasible. Other key actors – such as the WWF, The Nature Conservancy, and the US government – are already primed for action, given their significant experience implementing such mechanisms. One barrier to practicality could be the fact that debt restructuring mechanisms require debtor countries to commit to long-term financial investments in conservation programmes, which can be undermined by economic instability, mismanagement or corruption (Yue et al., 2021). However, given the size of debt in low- and middle-income countries, the benefits of debt restructuring alongside conservation measures should compensate for the perceived risk of committing to long-term investments, if the supporting institutions can also be strengthened.
Rapid Emissions Reductions for Climate Neutral Strategies

Since AR5, estimates of remaining carbon budgets have been improved by a new methodology first presented in SR1.5, updated evidence, and the integration of results from multiple lines of evidence. A comprehensive range of possible future air pollution controls in scenarios is used to consistently assess the effects of various assumptions on projections of climate and air pollution. A novel development is the ability to ascertain when climate responses to emissions reductions would become discernible above natural climate variability, including internal variability and responses to natural drivers. The IPCC SR 1.5°C report indicates that globally the world would have to curb its carbon emissions by at least 49% of 2017 levels by 2030 and then achieve carbon neutrality by 2050 to meet the ambitious 1.5°C temperature target (IPCC 2018). This reaffirmed with high confidence the AR5 finding that there is a near-linear relationship between cumulative anthropogenic CO2 emissions and global warming. Each 1000 GtCO2 of cumulative CO2 emissions is assessed to likely cause a 0.27°C to 0.63°C increase in global surface temperature with a best estimate of 0.45°C. Compared to AR5. AR6 estimates that for a 66% chance of limiting warming to 1.5°C, the world has a remaining carbon budget of 360GtCO2 – or nine years of current emissions, an increase from the SR15 carbon budget of 295GtCO2 (IPCC, 2021). Interventions for Rapid Emissions Reductions are the bedrock of any Climate Neutral strategy. The IPCC evaluates hundreds of pathways to bring down greenhouse gas emissions, however economic model calculations have shown that long-term planning with front-loading emissions reductions, is the most cost-effective way to reach a given temperature target (Fankhauser at al., 2021).

Properties of a Sensitive Intervention Point for Immediate Emissions Reduction

Take advantage of synergies in the energy system: Breakthroughs occur when a technology is required by multiple stakeholders and sectors, who all have an incentive to increase the quality and efficiency of a technology and bring down costs (Cesaro, et al., 2021). Cross-sector collaboration is required to take advantage of the positive feedback loop between upscaling deployment and cost reduction through ‘learning by doing’.

Capitalise on co-benefits: Highlighting the co-benefits of rapid emissions reduction, such as human health and mitigating air and water pollution, can reduce resistance and promote collaboration across sectors. a new report by the Grantham Research Institute on Climate Change and the Environment, Multiple benefits from climate change mitigation: Assessing the evidence, helps to dispel some of the gloomy arithmetic of climate change by providing evidence on the scale and range of ancillary benefits that derive from reducing emissions of CO2 and other greenhouse gases. And in contrast to the benefits of abating emissions, the largest of these ancillary – or co- – benefits are immediate and will occur with a high degree of confidence. The report looks at the full range of potential co-benefits from reducing emissions, including reduction in damages from local air pollution, and economy-wide benefits and costs associated with carbon taxation, impacts on competitiveness, green jobs, green innovation, energy efficiency, and dealing with short-lived climate pollutants. Assessing climate models to 2030 also enables us to take a longer-term perspective on the co-benefits from climate change mitigation.

Capitalise on the cost-saving potential of renewable energy: The bulk of emissions that we can reduce rapidly will come from a transition in the energy sector. There are three broad areas can support short-term
emissions reduction by 2030 in the energy sector: power generation, energy efficiency and electrification. The most effective and immediate set of interventions for reducing emissions will be policy instruments to incentivize investment in proven clean energy technology with declining cost curves. Globally, renewable energy costs have fallen much faster than anticipated. Recent research from the University of Oxford demonstrates that early pricing prediction models have consistently underestimated both how far the costs of renewable energy sources might fall, and the benefits of an accelerated switch to clean energy. They estimate future energy system costs and find that, compared to continuing with a fossil-fuel-based system, a rapid green energy transition will likely result in overall net savings of up to $20 trillion— even without accounting for climate damages or co-benefits of climate policy trillion on energy costs by switching to green power (Way et al., 2021). “The belief that the green energy transition will be expensive has been a major driver of the ineffective response to climate change for the last forty years.” Targeted interventions to support the switch to green power can capitalise on these cost-saving, and compliment more restrictive emissions reduction measures.

Top Interventions discussed for rapid reduce emissions reductions:

- Policy instruments to incentivise investment in clean energy technology with declining costs.
- A Carbon (and Deforestation) Border Adjustment Mechanism with an International Climate Fund.
Rapid Emissions Reductions: Policy instruments to incentivise investment in clean energy technology with consistently declining costs

A significant level of policy support has already been applied to a list of new clean technologies with consistently declining costs – with spectacular results. Since the beginning of Germany’s Energiewende in 2009, which sparked a trend in Feed-in-Tariffs and other subsidising support measures for solar PV, the costs of solar PV have declined almost 10-fold to be now regarded “the cheapest form of electricity in history” (IEA, 2020; Nemet 2019). When the UK government began its renewable obligations and contract-for-difference policy programmes to incentivise clean energy in the UK the cost of offshore wind electricity was some 3 times the cost baseload electricity in the UK. The latest strike prices of these contracts are now below baseload electricity costs. These examples show the power of supporting direct investment in such technologies that have shown consistent declining costs. These cost declines are expected to continue for both wind and solar, as they are with complimentary storage technologies including short- and medium-term batteries and electrolysers for hydrogen-based fuels. That is, provided investment in these technologies continues to the point where the economics more heavily favour these clean tech. With 88% of global emissions now covered by a net zero pledge the policy space is changing to allow global support for such technologies and with the new Breakthrough Agreement announced at COP26 the focus is now quite rightly being steered towards incentivising investment in clean energy technologies with consistently declining costs. Our recommendation based on extensive research (Net Zero Tracker, 2021; Ives, et al. 2021, Way et al. 2021) would be to primarily focus on four key technologies, namely solar PV, wind, batteries, and hydrogen electrolysers, which along with increased electrification provide sufficient flexibility and security to replace the entire global fossil-fuel-based energy system and ultimately eliminate the majority of anthropogenic emissions for a lower cost than would be required to maintain the current system (Way et al. 2021).

Practicality: Fossil fuel companies stand to make significant losses and have strong lobbying power. They have and will likely continue to use their influence to block this switch given sunk costs in current reserves. Subsidies to fossil fuels and other incumbents make cost-parity harder to reach. Current electricity transmission and distribution networks will need growth and enhancement to integrate higher electricity use and more variable sources e.g. storage and smart grids

Speed and Scale of Impact: Several social, political, technical, and economic hurdles still need to be overcome before such dynamics will continue of their own accord but this “tipping point” is very close in a number of large and powerful countries including India, China, and the US. Governments can subsidise production of most promising clean technologies. Pension funds and private investors are also capable of investing more and are seeing value in the steady long-term returns of clean technologies. Energy providers and corporations can also choose to invest in these technologies to reduce the carbon intensity of their operations. Based on current trends 8-10 Gt by 2030 could be reduced. The impact will be global, as cost and efficiency improvements for technologies will be shared but greatest gains will be made in countries that are deploying most of the technology. The economic dynamics will be compelling once we are well past price parity between the clean
and dirty energy providers, and the fossil fuel industry with all its power and wealth will struggle to stop this transition — it is difficult to unlearn what we know about solar, wind, and storage potential.

**Risks:** the learning-by-doing feedback dynamic leads to exponential change which can become problematic for regions that are unprepared for such a speed of change. There are implications for the financial sector — potential systemic risk if shares in fossil fuel companies decline suddenly. One explanation for recent higher coal, oil and gas prices is that shareholders of fossil fuel stocks are requiring a return of dividends rather than re-investment in growth, leading to shortages in energy production. The market is anticipating the transition and these prices rises are part of the unintended consequences. There will also likely be more jobs created by clean energy than lost in fossil fuels but there is still a transition and the potential for stranded assets and stranded locations. Electricity costs could fall dramatically leading to many co-benefits but also potentially a rebound in increased energy demand.
Rapid Emissions Reduction: Border Carbon Adjustment Mechanisms

**Carbon leakage** is a common challenge that arises with the introduction of domestic carbon pricing or stricter climate regulation. A Border Carbon Tax or Carbon Border Adjustment Mechanism (CBAM) was raised as a critical intervention to address this, and minimize the risk that companies will move carbon-intensive production processes to regions with lower environmental regulations. A CBAM could encourage non-domestic producers to green their production processes, by requiring companies importing goods from external producers to purchase CBAM certificates that correspond to the price that would have been paid had the goods been produced under the domestic carbon pricing rules. The European Commission’s proposal of a CBAM in July 2021, as part of the EU’s Fit for 55 package, sparked widespread conversation over the potential of this mechanism. Given the scale and pace of emissions reductions required, a CBAM in the EU alone is not enough (especially given the rise of South-South trade; see Meng et al., 2018). We propose the creation of a “Carbon Bloc”, in which major emitters unilaterally and simultaneously introduce CBAMs (Parr, 2021). To achieve the rapid emissions reductions required, CBAMs must also be combined with a suite of positive interventions, including targeted incentives for investing in clean energy. We also propose the integration of a Deforestation Border Adjustment Mechanism within the CBAM framework (See chart).

**Impact and scale of a Carbon Border Adjustment Mechanism:** Estimations of leakage rates, and the potential impacts of a CBAM on leakage rates and CO2 emissions in different sectors, vary widely, although it is generally agreed that CBAMs tend to reduce leakage rates and CO2 emissions. Emissions embedded in the EU’s imports have been rising, and currently represent 20% of the EU’s domestic CO2 emissions (European Parliament, 2019) Although it is unclear how much of this is a result of carbon leakage, this is predicted to increase in the EU as ETS allowances are reduced (Gore, 2021). A report published by UNCTAD (2021) found that a CBA of $44 per tonne CO2, applied to the imports of power and energy intensive industries in the EU, leads to a net decrease of 27 MtCO2 in emissions, a reduction of 0.1% of global CO2 emissions and 0.9% of
the EU’s emissions. In this case, the CBAM allowed the leakage rate to be reduced from 13.3% to 5.2%. A higher CBA of $88 per tonne CO2 reduces global CO2 emissions by 45 MtCO2. In general, introducing a carbon adjustment could decrease leakage rates by a third on average compared to uniform emission pricing only (Böhringer et al., 2012). However, others argue that carbon leakage is a myth (Carbon Market Watch, 2021).

With increasing global commitments to tackling climate change, there will be fewer and fewer countries to which emissions-intensive activities can be relocated, reducing the need for a CBAM (Carbon Market Watch, 2021). Focusing CBAM models on the most emissions-intensive industries is essential for immediate emissions reduction. These industries, such as steel and cement, despite having spent very little in low-carbon investments thus far, are in a strong position to contribute to clean research and innovation (Carbon Market Watch, 2021). A CBAM could initiate a global discussion on how best to decarbonise these high-emitting, harder-to-abate sectors and promote cooperative sectoral agreements (Stam & Moscovenko, 2020; IEEP, 2021). Some argue that in providing a mechanism for the heaviest emitting sectors to pay for their emissions, CBAMs exclude these sectors from the effort required to reach climate neutrality and will fail to deliver the necessary pace of decarbonisation (EEB, 2021). From a global perspective, border carbon instruments are insufficient on their own because carbon embodied in trade flows is typically less than 10% of countries’ total emissions (Gaspar & Parry, 2021). Even with a CBAM, there is still a risk of leakage. As demand for fossil fuels in regulated regions falls, the price of fossil fuels also falls, which increases fuel consumption and emissions in non-regulated regions (Cosbey et al., 2019). For these reasons, we argue that CBAMs must be implemented alongside targeted incentives for investing in low-cost clean energy both domestically and abroad.

Risks associated with a Carbon Border Adjustment Mechanism: Although the EU's proposed CBAM is not a first (see California; Pauer, 2018), the EU CBAM is significantly larger, with remaining uncertainties in design, impact and barriers (OECD, 2020). The proposal for a CBAM in the EU has proved controversial and has received critique for lacking ambition and consideration of equity (Killick et al., 2021; Gore, 2021). The Commission's CBAM proposal covers the scope 1 emissions of key emissions-intensive goods with high risk of leakage (iron and steel, cement, fertiliser, aluminium, and electricity generation). During the transition period (2023-2025), importers will be required to report the emissions embedded in their goods but will not have to pay a financial adjustment. Between 2026 and 2035, producers will lose 10% of their free allowances each year. So, by 2030, the allocation of free allowances to these sectors has only been reduced by 50%, which many argue is not ambitious enough (Gore, 2021), looking to the European Parliament’s (2019) proposal, which includes indirect emissions and does not include a transition period (Killick et al., 2021). The Commission will review the mechanism in 2025 for possible extension to other products and indirect emissions, an opportunity for a faster phase-out of free allowances with equity in mind (European Commission, 2021; IEEP, 2021). Equity risks are an outcome of CBAM increasing pressure on developing countries to reduce emissions. The EU’s proposal has been criticised by the BASIC countries for undermining the principle of ‘common but differentiated responsibilities and respective capabilities’ under the UNFCCC and the ‘nationally-determined’ spirit of the Paris Agreement (Mohan, 2021; Lowe, 2021; Gore, 2021). Low-income countries, heavily reliant on energy-intensive exports to the EU will also be affected by the introduction of the EU’s CBAM (Gore, 2021). Metal makes up 22% of Mozambique’s exports, 87% of which goes to the EU, and iron and steel constitutes 13% of Zimbabwe’s exports, 25% of which is sold to the EU (IEEP, 2021). While the EU’s CBAM seeks to “ensure a level playing field between EU and non-EU businesses” (European Commission, 2021), producers in climate vulnerable
countries are unlikely to be able to compete without the financial and technical support (Gore, 2021). The default value – in the case that producers can’t measure their emissions and there is no national comparable average data available –is 10% of the worst performing EU products, which may overstate emissions (Gore, 2021; IEEP, 2021). Following the EU’s CBAM announcement, Russia (Morgan, 2020) and China (Reuters, 2021) claimed the proposal violated WTO rules, despite the EU Commission’s affirmation that it was developed in compliance (European Commission, 2021). The CBAM also raises questions with the UNFCC Convention (1992) which states: “Measures taken to combat climate change, including unilateral ones, should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade.” CBAMs raise complex legal questions about embedded emissions. These risks may be mitigated by increasing traction and the fact that the CBAMs can be justified through other trade agreements, and additional CBAMs may force conventions on trade to be revisited. Trade issues are debatable in principle, but thus far no carbon adjustment mechanisms have been challenged for violating WTO rules (Orte Júlvez, 2021). GATT contains exemptions based on health and environmental reasons, and the WTO allows countries to introduce regulations to protect their people (Orte Júlvez, 2021). Equity and trade issues could risk undermining trust in multilateral decision-making (IEEP, 2021). However, there several ways to address equity issues and WTO-compatibility, including exemptions, and recycling of revenues (Gore, 2021). Although the EU’s current proposal ringfences revenues (which are expected to reach €9.1bn per year by 2030; Gore, 2021) for the EU budget, a commitment of a portion of revenues to climate finance in developing countries (which to date has failed to meet its $100 billion target; Timperley, 2021) would set strong precedent for equity in the design of future CBAMs. This is feasible given that a similar model – the Modernisation Fund – is used in the ETS to support lower-income Member States (Gore, 2021). Fit for 55 goes some way in addressing internal equity by through the Social Climate Fund. From an effective global emissions reduction perspective, the next step for the EU is to address the implications of Fit for 55 in terms of international equity.

Timing of a Border Carbon Adjustment Mechanism: The EU’s proposal for a CBAM is part of its Fit for 55 aim to reduce emissions by 55% by 2030 and reach climate neutrality by 2050. A CBAM sends a strong market signal for businesses to invest now to avoid progressive future tariffs. This fits the discounted cashflow/net present value method commonly used by companies in their decision-making (Parr, 2021). CBAMs are also unilateral, so take less time to implement than multilateral agreements. However, a CBAM alone will not incentivise decarbonisation at the speed required and must be complemented with targeted incentives for investing in clean energy.

Practicality of a Border Carbon Adjustment Mechanism: Major emitters have failed to reach a multilateral agreement on carbon pricing, or any multilateral agreement capable of limiting global warming to below 2.7°C by 2100. Country leaders fear that implementing a pricing system will weaken their competitiveness in the global economy (Orte Júlvez, 2021), but there is an incentive for countries to introduce a CBAM because it protects their domestic economy from competition by high-emission exporters in less regulated regions (Helm, Hepburn & Ruta, 2012). Governments are already well-equipped to legislate and impose tariffs (Parr, 2021). CBAMs are likely to meet resistance from certain high-emitting industries and exporting countries (Gore, 2021; Killick et al., 2021). However, positioned correctly, a CBAM can be a popular policy across the political divide, as recent polling in the US has shown (Moore Information Group Poll, 2021). And, in practice, once clear rules are

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established and the playing-field is level, businesses should adapt rapidly (Parr, 2021). The private sector has a key role to play in contributing to clean research and innovation (providing ~75% of investments in the EU), and is well positioned to do so (Carbon Market Watch, 2021). Certain energy-intensive industries are already supportive of a CBAM, such as fertiliser producers in the EU (IEEP, 2021). The US is unlikely to embrace an EU-led carbon club, and there are no current plans under the Biden Administration to explore carbon pricing (IEEP, 2021). However, several other countries are looking to implement a CBAM, including the UK (UK Parliament, 2021), Canada (Government of Canada, 2021) and Japan (European Commission, 2021). If successful, this will strengthen the viability of CBAM as an idea and increase the knowledge and support available, combined with assistance from the IMF and OECD, which have both shown support for carbon pricing mechanisms (European Commission, 2021).
Final 20%, Climate Neutral Strategies for Hard-to-Abate Sectors

The final 20% challenge: Achieving climate neutrality demands more than a shift to low-carbon road transport and renewable electricity generation. Governments have a key role to play in de-risking investment in harder-to-abate sectors to ensure these technologies are scaled and available over the coming decades to meet the goals of the Paris Agreement. To avoid an overreliance on carbon credits and offsetting, governments must ensure that corporate actors draft and adhere to credible decarbonisation pathways.

Cement, steel, plastics, trucking, shipping and aviation together represent 30% of current energy-related emissions; this could increase to 60% by mid-century if other sectors reduce their emissions rapidly (Mission Possible Partnership). Even so, the total cost of decarbonizing these harder-to-abate sectors would be less than 0.5% of global GDP by mid-century—and could be reduced even further by improving energy efficiency, making better use of carbon-intensive materials (e.g., through improvements in design, Lovins, 2021), increasing circularity in resource use, and limiting growth in demand for carbon-intensive transport (e.g., through greater logistics efficiency and modal shift). Notably, this would have only a minor impact on the price of consumer and industrial goods (Afionis, et al., 2017). Supply-side interventions to reduce carbon intensity and phase out fossil-fuels in the energy sector are also critical for the decarbonization these sectors.

Harder-to-abate sectors merit particular attention because under market-based mechanisms for emission reduction, rational actors seek out the cheapest abatement opportunities with the greatest technological readiness. This causes a simple market failure whereby critical decarbonisation technologies are side-lined until more straightforward mitigation measures (e.g., increasing efficiency in the built environment) are exhausted. But technology development takes time. Frontloading the work of decarbonising harder-to-abate sectors is essential to staying within global carbon budgets. Because of these urgencies and time lags, achieving net-zero emissions by 2050 will depend in part upon a certain amount of pump-priming to advance decarbonisation in these sectors. This will require significant investment from government, industry, and public-private partnerships, both in research and development and to scale net-zero solutions.

The global energy transition will be significantly mineral- and infrastructure-intensive (World Bank, 2019). In many ways, the capital costs of renewable energy infrastructure (e.g., solar panels, wind turbines, electric vehicles, transmission lines) are directly affected by the cost of their constituent parts and the expense of transporting materials across long distances. This puts many harder-to-abate sectors in the paradoxical position of being simultaneously part of the climate problem and essential to the climate solution. For that reason, it is critical to ensure an abundant and affordable supply of critical materials like steel and copper.

At the same time, the extractive industries that comprise the bulk of the harder-to-abate sector must be managed with an eye for impact that extends beyond greenhouse gas emissions. This is especially true where extraction and processing infringe upon the health and rights of human communities and ecosystems, a problem that runs rampant in extractive industries despite decades of advocacy by, and on behalf of, vulnerable communities. But extraction is possible without causing undue harm to local environments and while providing benefits to local communities. What’s more, following industry best practices in the extractive industry rarely adds a large cost.
burden; rather, most research suggests that responsible development of critical materials is largely a function of advance planning, corporate responsibility, and community engagement (Lezak et al., 2019).

**Recommendations for Policymakers for Harder-to-Abate Sectors**

**Low-Carbon Procurement:** In many harder-to-abate sectors, demand aggregation remains a major challenge in driving low-carbon technology. This is true in a wide range of sectors, from commodities (e.g., green steel) to transportation (e.g., electric aviation or synthetic fuel production). Many governments, with their large, coordinated purchasing power, are uniquely equipped to accelerate the scaling of low-carbon technologies by modifying their procurement protocols to favour climate-friendly products and services. For example, public agencies responsible for infrastructure like roads and bridges are ideally positioned to invest in low-carbon steel and cement. The same is true for public employees’ who travel for work, who should be obligated to consider carbon in their transportation choices. These measures can be efficiently deployed by using well-developed mechanisms, such as shadow carbon pricing, to tip the scales in favour of low-carbon goods and services, creating responsible demand for those that have not yet reached price parity with their high-carbon competitors.

**Carbon Border Adjustment Mechanisms:** Many harder-to-abate sectors produce goods, especially commodities, that are traded on global markets, often travelling intercontinentally several times from extraction to final sale (e.g., Australia is a major producer of iron ore, which is then shipped to China to be processed into steel). Because of this movement, taxing carbon within a jurisdiction (e.g., nationally), has limited efficacy in commodity markets, as it decreases the competitiveness of local producers, while giving a market advantage to producers operating in other jurisdictions without carbon pricing. This complex problem can be elegantly addressed by carbon border adjustment mechanisms. Tariffs are levied on imports of certain goods produced in regions with no or low carbon prices. When the tariff levied on imports is matched with a domestic carbon price, it can level the playing field between domestic and foreign producers of goods. It can also prevent so-called “carbon leakage,” when domestic production shifts overseas to avoid carbon pricing. In 2021, the European Union adopted a proposal for a carbon border adjustment mechanism, which will become fully operational in 2026. The EU’s plan will cover several harder-to-abate sectors, including the production of cement, steel, fertiliser, and aluminium. Similar trade-based policies will be critical for increasing the competitive advantage of low-carbon production in heavy industry. For more information on carbon border adjustment mechanisms, see the preceding pages. Some have suggested, however that Article 26 of the ETS, should be reformed which leaves industrial greenhouse gas emissions self-regulated by the market rather than by the IED.

**Supporting hydrogen technologies:** Hydrogen is likely to play a key role in the deep decarbonisation of several harder-to-abate sectors, particularly in steel production, shipping, and electricity generation. Even so, the technological readiness of many hydrogen-based climate solutions requires further scaling. Targeted investment in these technologies will be critical to addressing readiness gaps and helping cornerstone industries transition rapidly into a low-carbon future. For more on hydrogen technology, see the immediately following pages.

**Ensuring long-term decarbonisation planning:** Harder-to-abate sectors are often characterised by long-lived capital assets (smelting facilities, aircraft, and mines all have routine service lives in excess of 30 years).
so, industry-standard accounting practices, which heavily discount future profits and losses, result in firms under-accounting for carbon risk. For that reason, it is common to find instances of firms investing in new capital assets that could continue to emit greenhouse gasses into the second half of this century. Governments can, and should, require credible decarbonisation plans as part of the permitting and approval processes for corporations wishing to build these assets. Such plans would dovetail with existing environmental impact assessment requirements and help overcome corporate decisions based on short-term thinking and technological inertia.

**Top Interventions discussed for climate neutrality in hard-to-abate sectors:**

- **Interventions and investment for clean energy and green hydrogen infrastructure** for heavy industry and transport, paired with de-risking mechanisms for private investment, such as Contracts for Differences (CfDs), see next section.

- **Digitally-native, DLT-based emissions accounting:** Current emissions tracking protocols rely heavily on industry averages. The ability to separate commodity markets into high- and low-carbon sections will require asset-level reporting and data transfer. Ideally, this system would employ digital ledger technology (DLT) to ensure traceability and accountability along complex, vertically-integrated supply chains (Kaplan and Ramanna, 2021).

- **Differentiated commodity markets:** Presently, a tonne of copper produced using 100% renewable electricity in Chile sells for the same price on the London Metals Exchange as a tonne of copper produced using coal power elsewhere. If uniform commodity markets can be separated on the basis of embodied carbon, with low-carbon goods fetching a higher price than their high-carbon counterparts, responsible producers will be able to fetch a premium return and recoup the capital costs of decarbonization.

- **Consumption-based carbon accounting requirements for key actors, large corporations and governments.**

- **Inclusion of aviation and shipping emissions in greenhouse gas inventories.**

- **Investment in research into design efficiency to reduce material intensity of production.**

- **Aggressively reducing methane emissions from natural gas production.**
Final 20%: Climate Neutral Infrastructure Investment, Green Hydrogen & Ammonia

International political negotiations and national policy for climate change mitigation are increasingly focussed on the mobilisation and scale up of investments in clean energy infrastructure (Jones, A.W., 2015). Energy efficiency, renewable power, and direct electrification can reduce emissions from electricity production and a portion of transportation; but the last 15-20 percent or so of the economy, comprising aviation, shipping, long-distance trucking and concrete and steel manufacturing, is difficult to decarbonize because these sectors require high energy density fuel or intense heat. Zero carbon, and net zero carbon fuels could meet these needs, and arguably should be reserved for heavy industry: Philipp Niessen, director for industry and innovation at ECF says that “there is a push from heavy industry to get green hydrogen into road transport so private car owners bear some of the early costs, but we believe it will be a scarce resource and it makes more sense to grow demand in sectors such as heavy industry where there is no decarbonization alternative.” (van Renssen, S., 2020.)

Timing and The Role of Hydrogen: As a clean energy carrier hydrogen offers a range of benefits for simultaneously decarbonizing the transport, residential, commercial, and industrial sectors. Hydrogen is shown to have synergies with other low-carbon alternatives, and can enable a more cost-effective transition to decarbonized and cleaner energy systems (Elam, C.C., 2003). Hydrogen produced via low-carbon (or zero carbon) technologies such as electrolysis coupled with a decarbonized power mix offers a new approach to flexibility provision, and makes it possible to link the different energy sectors together, thanks to the hydrogen versatility. Hydrogen offers benefits in the supply chain for power-to-gas, power-to-power and gas-to-gas supply pathways and can be used for both chemical purposes and energy applications. While industry players have already started the market introduction of hydrogen fuel cell systems, including fuel cell electric vehicles and micro-combined heat and power devices, the use of hydrogen at grid scale requires the challenges of clean hydrogen production, bulk storage and distribution to be resolved. Ultimately, greater government support, in partnership with industry and academia, is still needed to realize hydrogen’s potential across all economic sectors and in particular the heavy industry. The International Energy Agency published a landmark report on the future of hydrogen which identifies four strategic intervention points to make use of the current momentum and scale hydrogen:

1. Leverage existing industrial ports to turn them into hubs for lower cost, low-carbon hydrogen;
2. Leverage existing gas infrastructure for hydrogen supply;
3. Support transport fleets, freight and corridors to increase the competitiveness of fuel-cell vehicles; and
4. Establish shipping routes to kick-start international hydrogen trade (IEA, 2019).

Risk associated with Technology-Neutral Alternative Fuel Investment (trade-offs): The introduction of technology-neutral policies may stretch limited public resources. In key harder-to-abate sectors, such as shipping, a choice may need to be made between investment in infrastructure for zero carbon fuel (such as...
green hydrogen and green ammonia made with renewable energy) and net zero carbon fuel (such as blue hydrogen made with natural gas and carbon capture and storage).

“Technology neutrality between carbon- and non-carbon-based fuels is likely to raise costs and slow the growth of both. This suggests that a choice should be made between carbon and non-carbon-based fuels for the shipping sector, rather than committing public resources to both. Neutrality between hydrogen and ammonia is more justifiable, although ammonia is more likely to be the ultimate winner for practical reasons and appears to be the only viable option for long-distance, deep-sea ships.” (Clark et al., 2021).

Figure B1.1: Carbon-based vs non-carbon-based fuels. Note that production of hydrogen-based fuels from methane will likely require offsets on top of Carbon Capture and Storage (CCS) to ensure carbon neutrality. Adapted from ETH Zurich (2019) Towards net zero – comparison of zero-carbon.

Impact Potential of Investment in Green Hydrogen: Green hydrogen could supply up to 25% of the world’s energy needs by 2050 and become a US$10 trillion addressable market by 2050, according to Goldman Sachs (Dincer, I., 2012). Unlike carbon-based synfuels, hydrogen does not emit any CO2 when combusted to generate power. Green hydrogen production from water (through electrolysis powered by renewable electricity) uses commercially mature technologies that have been proven at scale. The one-step production process makes it less energy-intensive to produce than synfuels or ammonia and gives it a cost advantage over ammonia and synfuels on an energy content basis. Each MWh of energy stored as hydrogen requires around 16% less input energy than ammonia, and 60-70% less than e-methanol. The rapidly declining costs of clean and renewable energy for making green hydrogen point towards green hydrogen as a strong choice for many sectors. A number of countries have recently published national hydrogen strategies, including Australia, Chile, Germany, the EU, Japan, New Zealand, Portugal, Spain and South Korea. However, there is not wide agreement on the development of infrastructure for zero carbon fuel such as green hydrogen. However, Green hydrogen, specifically currently accounts for less than 1 percent of total annual hydrogen production.

Practicality of scaling Green Hydrogen Infrastructure: Policy support for green hydrogen infrastructure may come through as a range of instruments and regulations including the direct provision of early-stage R&D and
Capex support as subsidies or tax credits for developers and capital providers. The main practicality concern in betting on green hydrogen is that electrolyzers needed to develop it are not yet at scale and costs are high. In a report published last year (using data from 2018), the International Energy Agency put the cost of green hydrogen at $3 to $7.50 per kilo, compared to $0.90 to $3.20 for production using steam methane reformation (Lipman et al., 2004; Olfa et al., 2019).

**Contracts for Differences policies** may help to counteract risks associated with costs to help close the gap between an incumbent and new technology system “without unduly distorting the market and do so at limited cost to government” (Clark et al., 2021). A contract for difference (CFD) is a contract between a buyer and a seller that stipulates that the buyer must pay the seller the difference between the current value of an asset and its value at contract time. This could be a strong solution for clean energy investment and hydrogen. CFDs allow traders and investors an opportunity to profit from price movement without owning the underlying assets. The value of a CFD contract does not consider the asset's underlying value: only the price change between the trade entry and exit. (Bunn D., Yusupov T., 2015).

**German case study:** In its request for changes to grid development plans, the German Federal Network Agency (BNetzA) argued that converting existing natural gas infrastructure to transport hydrogen is generally much cheaper than building a new network from scratch, a prime case study for the development, increased investment and government support for clean energy and hydrogen infrastructure. German gas grid operators said in 2020 that an initial hydrogen grid could be established at “justifiable cost” of 660 million euros, largely by converting current pipelines (Aamelong, 2020). But while they would have liked to see a new integrated planning of the gas and hydrogen network, the German government decided in February 2021 that the existing gas pipeline network and the new hydrogen infrastructure would be regulated separately (Appun, 2020). The economy and energy ministry (BMWi) in charge of the bill said this was necessary to avoid cross-financing between fossil gas and hydrogen networks, which would be in violation of EU law. One prime way hydrogen has also been used in the steel industry in Germany is the switch from carbon to hydrogen in blast furnaces. Using hydrogen rather than carbon as the reducing agent in producing iron and as the furnace fuel, in a process called hydrogen direct reduction. The oxygen in the iron ore combines with the hydrogen to produce water (instead of with carbon to produce CO2), eliminating the CO2 emissions from this part of the process. The “sponge iron” product is then processed in an electric arc furnace to produce steel. Since the arc furnace runs on electricity, this part of the process can be readily decarbonized as well. Regarding hydrogen production, the governmental role is crucial in order to decrease the electrolysis costs and further improve the profitability of hydrogen systems. Implementing a multi-sectorial approach seems essential to benefit from the versatility of hydrogen as a chemical component and an energy carrier, thus enhancing the margins and gain in profitability. Hydrogen production via electrolysis can also participate to the provision of flexibility to the electricity grid. This would help hydrogen systems further increase their revenues than systems engaging in only hydrogen markets. Tax exemptions can also be part of the solution to lower the costs and ease the early market penetration. Overall, different options can be considered in order to surpass the economic barriers: both industrial and political efforts need to be achieved to lower the costs and prepare a suitable market penetration environment.
Nature, Land Use and Agriculture for Climate Neutrality

The Agriculture, Forestry and Other Land Use (AFOLU) sector is a significant source of emissions while also holding important potential for it to act as a carbon sink and remove greenhouse gasses from the atmosphere. The AFOLU sector is responsible for a quarter of anthropogenic greenhouse gas emissions, with estimates ranging from 23-27%, or about 20 Gt CO2e annually according to one estimate (UNFCCC, 2021; McKinsey, 2020). Agriculture particularly is responsible for 45% of global methane emissions and 80% of nitrous oxide emissions (McKinsey, 2020). Crucially, climate change affects the AFOLU sector, with agriculture being the most vulnerable sector to climatic change, and mitigation actions have the potential for win-win solutions for climate adaptation.

To bring AFOLU emissions down to reach Climate Neutrality by 2050, changes in land use and management are needed. Nature-based solutions (NbS), that is, solutions that harness nature to achieve societal goals, can play a powerful role in climate change mitigation. A 2021 study has estimated that nature-based solutions have the mitigation potential 10 Gt CO2 per year: 4 Gt CO2 yr⁻¹ from the protection of existing carbon sinks (e.g. avoided deforestation); 4 Gt CO2 yr⁻¹ from improving management of existing agricultural, grazing and timber-producing lands; and 2 Gt CO2 yr⁻¹ from ecosystem restoration such as reforestation (Girardin et al., 2021) (see figure below). Together this has the potential to shave off 0.1 to 0.3°C of warming in 1.5 °C and 2 °C scenarios, respectively. This is significant when the difference in climate impacts between these two scenarios is considered. Moreover, nature-based solutions are projected to keep cooling the planet after peak temperature has been reached, suppressing warming by 0.4 °C by 2100 (Girardin et al., 2021), though, uncertainty in permanence must be considered.

To limit global temperature rise, we must slash emissions and invest now to protect, manage and restore ecosystems and land for the future. Nature based solutions, protecting and restoring ecosystems, and better
management of working lands have a real but limited impact on bringing down our peak warming by mid-century. They can play an important role in cooling our global temperatures up to the end of the century and beyond. This means we need to invest in nature-based solutions for the long term, in projects that are ecologically sound, socially equitable, and designed to provide multiple benefits over a century or more—not in place of other emissions reductions measures (Girardin et al., 2021).

A frequently discussed concern is that companies rely on short-term biological offsets to balance longer-term carbon emissions to achieve their climate neutral goals. Experts caution against focussing on carbon as the main metric of success for nature-based solutions without considering biodiversity, human rights, and climate adaptation, raising serious moral hazard and resulting in large scale afforestation projects to offset continued emissions from the fossil fuel industry. At its worst, it can lead to deforestation of old-growth forests to make space for large-scale, fast growing reforestation projects resulting in biodiversity loss and serious unintended consequences. A better alternative to offsetting, "insetting" refers to investments made by companies in projects/ interventions along their supply chains that reduce GHG emissions, enhance carbon storage, support or enhance biodiversity and generate positive impacts for communities. These projects provide measurable benefits to companies, including achieving Corporate Social Responsibility goals and future-proofing value chains.

Properties of strong Interventions in Nature, Land-use, and Agriculture:

To be contribute meaningfully to Climate Neutrality, Interventions in nature and land-use must adhere to guidelines:

1) NbS must not be used as a substitute for rapid emissions reductions, as without drastic GHG reductions and a phase-out of fossil fuels, nature-based solutions become overwhelmed.

2) NbS must focus on a diverse array of ecosystems, including aquatic systems and grasslands, not only on forests and tree planting, which has received the majority of attention thus far.

3) NbS must support or enhance biodiversity, and natural climate solutions must not come at the expense of biodiversity as biodiversity is what underpins the provisioning of ecosystem services.

4) NbS must support and respect communities and indigenous people in developing solutions for long-lasting impacts with minimized trade-offs (Seddon et al., 2021). Dawson et al. (2021) have shown that initiatives are much more successful in their conservation, environmental and climate mitigation goals, when local communities and indigenous peoples are actively involved in the design, implementation and monitoring of projects. Initiatives which lack this often fail.

Thus, Interventions which do not work closely with local communities and indigenous peoples, do not account for biodiversity and diverse ecosystems, and tend to rely too heavily on nature-based solutions to provide carbon credits without decarbonizing as much as possible first, are Interventions which should not be supported or encouraged.

Governments around the world are also publishing targets and strategies for achieving climate neutrality in their AFOLU sectors, as part of their Nationally Determined Contributions (NDCs) and climate neutral strategies. In its Fit for 55 legislative package, the EU has a LULUCF target for carbon removal of 225 Mt CO2e between
2021-2025, which increases to 310 Mt CO2e between 2026 and 2030, and aims to reach climate neutrality by 2035 in the combined land use, forestry and agriculture sector. In order to achieve these aims, coordinated efforts by governments are needed to fill in gaps and the policy interventions proposed here can help accomplish these targets.

Interventions proposed and discussed to achieve Climate Neutrality in Nature, Land-use and Agriculture:

- Ambitious reform and repurposing of agricultural subsidy regimes
- Investing in and scaling up monitoring, reporting and verification (MRV) for soil carbon sequestration
- Advanced purchasing commitments complying with high standards for NbS carbon credits
- Capital controls on tropical deforestation
- Landscape-based approaches to generating sustainable commodities
- Separate LULUCF & non-LULUCF targets in NDCs and other emissions accounting
- Indigenous land titling and transfer of material power and leadership to indigenous peoples

In this report, we discuss the first two in detail, while further elaboration on the rest can be found in the appendix. The Interventions which were determined to hold the most potential to support Climate Neutrality goals are the reform of agricultural subsidies and scaling up MRV for soil carbon sequestration. While we present these separately, clear links can be made between the Interventions. A portion of repurposed agricultural subsidies should be invested in scaling up soil carbon MRV, as part of new subsidy regime objectives to support climate mitigation research, development and implementation.
Nature & Agriculture: Reform Subsidies for Climate, Biodiversity and Health

An ambitious overturn of agricultural subsidies worldwide is crucial to Climate Neutrality. The UNDP and UNEP consider this intervention ‘A multi-billion-dollar opportunity’, demonstrating that almost 90% of global agricultural subsidies support activities considered ‘harmful’, to human health, biodiversity and the climate (FAO et al., 2021). Global agricultural subsidies amount to around $540 billion USD annually, having almost doubled in the past decade, and, without reform, are on track to rise to $1.8 trillion annually by 2030 (FAO et al., 2021; Locke, 2021). Out of this, $470 billion (87%) are considered ‘harmful’ activities, including worsening climate change. Of the total sum of global annual agricultural subsidies, only 5% goes to environmental conservation objectives (World Bank Group, 2020). Currently, the true cost of food production is masked by subsidies and externalised costs to health and the environment. The hidden costs of the food system are estimated at $12 trillion annually, more than the value of food produced itself (FOLU, 2019; Carrington, 2021). The Dasgupta Review (2021) has estimated the total global cost per year of the damage to nature from harmful subsidies at $4 to $6 trillion. The public provides an estimated $1 million USD per minute in tax dollars towards global agricultural subsidies, supporting activities such as the excess use of fertiliser and expanding cattle production (Carrington, 2019). In the EU, where 10% of greenhouse gas emissions are from the agricultural sector, €387 billion euros will be spent on agricultural subsidies between 2021 and 2027, $67 billion per year, as part of its Common Agricultural Policy (CAP), representing one-third of the EU’s total budget. Despite reforms to green CAP payments, auditors found that between 2014 and 2020, the $100 billion labelled for green farming practices in the CAP had not been successful in significantly reducing emissions from EU agriculture (Abnet, 2021). Calls for sweeping agricultural subsidy reform to combat climate change and biodiversity loss are widespread and intensifying, including from the UN, and the World Bank, the Aichi Targets, and Local farmers competing against subsidized imports.

Impact and Scale: Notwithstanding the immense potential of agricultural subsidy reform to redirect $500 billion from supporting harmful activities to climate-friendly ones, reforms may fall flat on delivering the scale of change required if policies are not ambitious enough, as cautious tweaks to subsidies rarely lead to transformative system change (Meadows, 1999; Searchinger et al., 2020). The agricultural subsidy regime must change its primary purpose to supporting positive societal goals, such as climate mitigation. In the UK, the new agricultural subsidy regime consists primarily of the Environmental Land Management (ELM) scheme, the main goal of which is ‘public money for public goods’ to farmers and land managers, with environmental objectives at the centre of the scheme (DEFRA, 2020). While too early to make conclusions, this is an example of an agricultural policy which has shifted the goals of the system.

Risks. Public backlash due to real or perceived higher food prices is a major risk in the redistribution of agricultural subsidies. Past food price increases have historically led to social unrest. Examples from Ecuador in 2019 and France in 2018 illustrate cases of backlash to fossil fuel subsidy removals with increased prices leading to mass protests, forcing governments to reverse policies (FAO et al., 2021). These cases highlight the need for inclusive consultation, transparency, public communication, gradual subsidy phase-outs, and parallel fiscal policies which reduce trade-offs. In Indonesia, fuel subsidy reforms which proved successful were linked...
to a social assistance scheme to reduce the inequitable effects on poor households (FAO et al., 2021). Risks to farmers and their livelihoods are also key considerations. It is vital that agricultural subsidies are not merely removed but redirected with support systems. However, subsidy reform could also help the most impoverished farmers. The head of the UNDP, Achim Steiner, has stated that redirecting global agricultural subsidies could reduce inequality by boosting the livelihoods of 500 million smallholders (Carrington, 2021). Nevertheless, there will be winners and losers in such reforms, requiring compensation for the losers. Moreover, country context must be considered (for more risk mitigation measures see FAO et al., 2021).

**Timing:** Measures should be gradually phased in/out, bi-partisan support must be built and negotiated, policies need to be passed through government and stakeholders must be consulted. However, this Intervention does not rely on untested technology. If nations were motivated enough, they could begin the process immediately, delivering results in the next decade.

**Practicality:** Political resistance to subsidy reform, from the public, from farmers, and from industry lobbyists, is considerable. In the USA, notorious for its industry lobbying power, pushback from special interest actors continue to undermine subsidy reform efforts, with over $300 million spent on lobbying by big food corporations in the past decade (Maplight, 2021). Strong governance and movement pressure is needed to resist lobbying and pass reforms through the political process. Crucially, short-term negative consequences of the reforms must be mitigated through complementary policies such as cash transfer schemes, directed at poor and vulnerable households and farmers. Lastly, nations must engage in diplomacy and work together to deliver policy coherence across borders, as global food systems and markets are interlinked (FAO et al., 2021).
Nature & Agriculture: Scale Monitoring, Verification & Reporting for Soil Carbon

Soil is the largest terrestrial carbon sink, storing more carbon than all the Earth’s trees combined. The world’s soils contain more than double the amount of carbon that is found in the atmosphere, but they are losing their carbon content to unsustainable agricultural practices and other disturbances (BEIS, 2021). Maximum potential soil carbon sequestration estimates are 0.9 to 1.85 billion tonnes of carbon per year, the equivalent of 3.3 to 6.7 billion tonnes CO2e annually, or 15% of global emissions (Zomer et al., 2017). Groups such as the 4 per 1000 initiative and others estimate its potential as being much higher. Increasing soil carbon content typically has multiple co-benefits, such as increasing soil fertility and soil quality, increasing its water holding capacity, making it more resilient to both floods and droughts and less prone to soil erosion (Schwart, 2014). Practices which increase soil carbon levels are well-known. They include cover cropping, crop rotations, reduced tilling or no-till, the retention and addition of crop residues in fields combined with direct seeding, mulching, the use of perennial crops, agroforestry, silvopasture, and multi-paddock rotational adaptive management grazing. However, there is still need for more research to quantify the outcomes of practices under different climatic conditions, management regimes and soil types (Zomer et al., 2017).

Despite the potential of soil carbon sequestration, the technologies and procedures for the monitoring, reporting and verification (MRV) of soil carbon on large scales are still emergent, and not one is yet agreed as a common standard (Smith et al., 2019). This impedes the ability for farmers and land managers to receive accurate and reliable payments in the form of carbon credits. There is high demand for such voluntary credits, but supply lags due to lack of MRV and soil carbon makes up a tiny fraction of carbon markets. Public support for climate mitigation efforts on agricultural lands and particularly in soils will not be sufficient – a blend of public and private finance is required to incentivise soil carbon sequestration at relevant scales (Oldfield et al., 2021). However, for private finance to become available, soil carbon credits must be of high-quality and provide high certainty, requiring more MRV. Both the UK and the EU have set out intentions to facilitate the blending of public and private finance for incentivising carbon sequestration in the agriculture and land-use sector, gesturing to the Australian ETS model as an example (Verschuuren, 2017). Despite concerns over the commodification of nature, private capital can help fill the financing gap for carbon sequestration payments, which would be beneficial if governments implement systems to avoid double accounting (Orman, 2019).

Currently, there is much uncertainty around issues of additionality, leakage, reversals and permanence related to soil carbon (BEIS, 2021). Estimates of soil carbon changes are obtained through soil sampling, modelling, or a hybrid combination of the two. Yet, modelling in this area is still inaccurate, with different models leading to widely different results, and extensive soil sampling is laborious and prohibitively expensive. Because soil carbon amounts may vary significantly in a field or across a landscape, a very high number of samples must be taken to obtain accurate results (Oldfield et al., 2021). There exist two different types of possible payment mechanisms with regards to soil carbon and agricultural incentives more generally: payments by practices and payments by results. While practice-based payments pay farmers for implementing a sustainable practice, such as cover cropping, result-based payments rely on measurements of actual outcomes. (Smith et al., 2019;
Oldfield et al., 2021) The use of Payments-By-Results (PBR) is both a potential threat and opportunity, and most stakeholders agree that a hybrid approach will be necessary, combining it with the traditional payments for the implementation of sustainable practices and income foregone approach. Full reliance on PBR would carry too much risk for farmers, since carbon sequestration can take many years to yield noticeable results and many influencing factors such as soil type, climate and natural disasters are out of their control (Lyon, 2019). Nevertheless, those in favour of PBR say that it is an efficient way to accurately reward farmers for the environmental outcomes they produce, no matter how they choose to achieve those results or the costs involved, giving the farmer more flexibility and autonomy and encouraging the proliferation of best practices. Of course, successful PBR is dependent on proper MRV, which can be burdensome and expensive, and must take into account the risks around the permanence of the carbon sequestered (Sustainable Soils Alliance, 2020). Research and technological development in this area is still emerging, keeping MRV costs high for the moment (Orman, 2019). Whole farm carbon audit tools reliant on modelling, such as the Farm Carbon Calculator, are becoming available to farmers, but the results they yield are not standardised and often inconsistent. The research behind the use of proxies estimating the amount of carbon sequestered based on the practices being employed is incomplete, which makes a Payment-By-Results (PBR) method more attractive in some situations. With more reliable MRV, soil carbon credits would be of higher quality and could therefore be sold at a higher price, strengthening the economic incentives for farmers and land managers. Investments must be made into MRV to accelerate the cost curve of soil carbon MRV in order to get over the financial hurdle of sampling and measuring that can otherwise make MRV inaccessible to farmers. For more details on current and proposed methods for MRV, as well as on a proposed global soil MRV platform, see the paper by Smith et al., 2019 and the report by Oldfield et al., 2021.

Impact of scaling MRV of Soil Carbon: The potential impact of increasing soil carbon sequestration in the world’s arable soils is large, estimated at an average 5 billion tonnes CO2e per year (Dunne, 2020). Investing in and scaling up soil carbon MRV would unlock this potential, allowing for soil carbon credits to be sold at a higher price due to higher levels of confidence, incentivizing the implementation of practices which increase levels of soil carbon (Badgery et al., 2020). However, high levels of uncertainty currently exist in estimates of total global soil carbon removal potential, as well as in estimates of how much carbon is likely to be sequestered using different types of practices and land management approaches. More research is needed to gain more accurate estimates on the potential scale and impact of this intervention. Moreover, in order to reach its full potential, soil carbon would have to be increased on all arable land worldwide, meaning that the majority farmers and land managers would need to implement soil carbon enhancing practices (Oldfield et al., 2021). Clearly, agricultural extension services and education for farmers will be required alongside better MRV for this intervention to reach the impact described.

Risks associated with scaling MRV of Soil Carbon: Numerous risks and sources of uncertainty can be identified when relying on soil carbon sequestration as a natural carbon removal strategy. The first of these is the issue of permanence, a concern with all nature-based solutions to climate change mitigation. Not only can a change in agricultural practices (such as tilling) reverse the gains in soil carbon, but climate change itself is warming soils, increasing microbial activity and resulting in increased carbon off-gassing. This is not entirely
different from the better-known permanence challenges associated with planted forests, which can be deforested and are, in some areas, also vulnerable to the effects of a warming climate. Responses to these challenges are threefold. First, considering this, it is even more important to rapidly scale up and deploy MRV of soil carbon in the present in order to obtain a baseline measurement and better track and model the changes that are caused by warming temperatures. Second, mechanisms can be put in place that account for shorter timescales of permanence in the sale of carbon credits, using the metric carbon-tonne-years and issuing permanence warranties. Third, increased empirical, experimental and modeling research on the way soil carbon behaves with changes in management practices and climate change forecasts will help to reduce uncertainty and better inform future estimates (Smith et al., 2019). A second set of challenges is the lack of standardization of soil carbon calculators for farmers, land managers and researchers to use. In the UK, there are already around 50 different soil carbon calculators, which are all based on models that use different assumptions and different sources of evidence for churning out their estimates based on factors such as climate, crop type and practices used. This lack of standardization makes soil carbon measurements and therefore potential credits difficult, if not impossible, to accurately compare. Soil carbon accounting must be standardized within and across countries. Governments of the EU should commission a study to determine which method is most accurate and champion the winning model, making it the government-accredited standard. Furthermore, payments for soil carbon sequestration share potential risks as other payments for ecosystem services and broader nature-based solutions – those of the commodification of nature, excessive bureaucratization, potential land grabs, and the imposition of neoliberal and neo-colonial forces on local communities. Safeguards and standards must be employed to mitigate these risks, beginning with the four guidelines for nature-based solutions outlines above, which includes designing, implementing and monitoring Interventions with indigenous peoples and local communities (Oldfield et al., 2021).

**Timing to scale MRV of Soil Carbon:** While the techniques to increase soil carbon sequestration are well ready to be deployed, having been used, in fact, for thousands of years, the science behind the MRV of soil carbon must be further funded and developed. This Intervention can be rolled out starting today, but more research soil science and soil carbon dynamics is needed to underpin developments in MRV.

**Practicality of scaling MRV of Soil Carbon:** Despite high potential for significant impact, paying farmers to sequester soil carbon remains an uncertain approach to climate change mitigation due to reversal risk and the uncertainties of accurately detecting carbon stock change over time. Current research and MRV advances will help address these challenges by providing the evidence needed for outcomes to match expectations. Public support from governments is needed not only in the research and development of MRV mechanisms, but also in offering to pay farmers for the costs of MRV, including soil sampling, in order to make MRV processes accessible to farmers today, while driving down cost curves. As previously mentioned, the practicality of this Intervention also depends on the ability of governments to provide increased agricultural extension support, providing education to farmers about the benefits of soil carbon sequestration, the practices which can enhance it, and the MRV methods required to help them receive financial compensation. Further specific recommendations can be found in Oldfield et al., 2021.
Greenhouse Gas Removal for Climate Neutrality

To stabilise global temperatures, we need to achieve Climate Neutrality while avoiding biogeophysical effects of human activity that, for example, affect surface albedo – counteracting any remaining emissions of greenhouse gases into the atmosphere with an equivalent amount of **Greenhouse Gas Removal (GGR)**. None of the pathways reaching the 1.5°C target manages to do so without removing at least some of the CO2 previously emitted from the atmosphere again (IPCC SR1.5 2018). While residual emissions might still be somewhat reduced, thereby minimizing the dependence on GGR, there is an urgent need invest in Research and Development to scale Greenhouse Gas Removal in order for it to be available when it is needed: In most 1.5°C and 2°C scenarios, CO2 removal technologies already achieve significant scales by 2050 with up to 20% of today's emissions being removed through bioenergy coupled with Carbon Capture and Storage and up to 25% through reforestation and agricultural measures (IPCC SR1.5 2018). Current estimates are that between 100-1,000 billion tonnes of CO2 will need to be removed from the atmosphere during the course of the century (SR 1.5, 2020). There is a need to demonstrate whether proposed GGR techniques are effective and socially acceptable at a significant scale (Minx et al., 2017; Fuss, S. et al. 2018; Nemet, G.F. et al., 2018). This will require resources to research and develop proposed techniques, along with detailed consideration of the regulatory frameworks that need to be put in place to appropriately incentivise deployment. The range of proposed GGR techniques includes biological approaches, such as afforestation, investment in marine ecosystems or soil sequestration, and engineered approaches, such as enhancing the rate at which certain minerals weather and devices that directly capture CO2 from the air. To assess how effective such techniques could be, it is necessary to understand how long-lasting the storage of CO2 away from the atmosphere is, and to determine the social acceptability of deploying such techniques at scale. Of great concern is also that the prospect of removal could disincentivise short term abatement requiring a better understanding of the (unwanted) interactions with mitigation.

**Proposed properties of a good intervention for Scaling GGR**

1) Public incentives needed to **rapidly** scale GRR whilst maintaining state control and **safety** measures. Time is not abundant which introduces short interim period once we have had time to develop policy responsibility. We need to be able to pull the handbrake if there are negative impacts.

2) Holistic Interventions must avoid the moral hazard of sending a signal that removals are equal to reductions so that wealthy actors don’t just purchase removals instead of reducing emissions.

3) More credit must be given to more permanent, high-integrity solutions and any market for removals must be designed to the aims of achieving a real net zero balance (pairing sources with sinks on matching time-scales).

**Interventions for responsibly scaling carbon removals were discussed:**

- **Public procurement and incentives** are needed through, e.g.: **A region-wide auction system** (such as an EU-Auction) and public procurement for early GGR projects; **Feed-in-Tariffs** in which governments commit to buying removals at a set price scheduled to drop; a **European Removals fund to be integrated into the ETS**.

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- **Standardising removal accounting**: Presently, corporates assume that a tonne of removal in current markets equates to a tonne of emissions when often it does not. Parties underestimate the volume and cost of net zero alignment and a buyers’ market drives standards down. Standardised removal accounting must improve permanence and, like-for-like carbon accounting (sinks balanced with sources on matching timescales) (Seymour, 2020).

- **Setting a separate target for removals** in national policy and corporate pledges could offer better understanding of the removal gap to drive more funding towards the space, produce better sequencing of policy/action, and instigate negotiations as to what emissions should be considered residual. Separate targets also reduce moral hazard issues and require like-for-like matching. This requires significant political capital and without global consistency may bring about leakage/international equity concerns, requiring a global removal stocktake to review transboundary effects.

- **Court-mandated decarbonisation (carbon takeback)** were proposed in conjunction with rising climate litigation against oil and gas companies. Royal Dutch Shell has recently appealed a landmark case in Netherlands asking them to reduce its global net carbon emissions by 45% by 2030 compared to 2019 levels. Participants suggested that if the courts were made aware of the possibilities of Carbon Capture and Storage and mandated a decarbonisation effort through carbon-take back it would be harder for a company to appeal.
Greenhouse Gas Removal: Carbon Takeback Obligation

A Carbon Takeback Obligation (CTBO), requiring extractors and importers of fossil fuels to recapture and geologically store a progressively rising fraction of the CO$_2$ generated by their activities and products, is explored as a supply-side mitigation policy for achieving Net-Zero (Jenkins, S., Mitchell-Larson, E., Haszeldine, S. and Allen, M., 2021). Climate change mitigation designed to reach Net Zero CO$_2$ emissions by the middle of the 21st century requires the annual storage of billions of tonnes of CO$_2$ using CCS, BECCS and DACCS, according to the ambitious mitigation scenarios designed by leading Integrated Assessment Models. Enabling permanent storage to be rapid, controlled, and low cost requires substantial policy innovation. Investment in carbon capture and storage technologies at the scale required to deliver decarbonisation targets has, to date, been dependent on state subsidies. Continuing along this path risks failing to adequately invest in Geological Carbon Storage (GCS) capacity, and therefore ultimately increases the carbon price paid by citizens to drive emissions down to Net Zero. A Carbon Takeback Obligation provides an alternative solution, creating a long-sighted investment environment for the fossil fuel industry to develop the GCS industry at the required scale. Costs of GCS are passed to the consumers of fossil fuels only in the prices they pay for these fuels, and are capped at the cost of direct air capture technologies, thus reducing the risk of prohibitively high carbon prices in the middle of the 21st century. The full cost of implementing a global CTBO is comparable to the cost of mitigation in conventional scenarios driven by high global carbon prices and, because it is an upstream regulation acting only on the suppliers of fossil fuels, may be politically more acceptable than demand-reduction measures. A CTBO combined with demand-side mitigation policy provides the lowest risk pathway to net-zero emissions by 2050, ensuring early emission reductions, a rapid scale-up of permanent CO$_2$ storage and unilateral, controllable, price discovery.

Figure: Key interactions for a carbon takeback obligation. CO$_2$ is recaptured and stored, through a mixture of CCS at industrial point sources and direct air capture. Regulation and verification of storage is only required between government and the fossil fuel industry, with costs of storage passed onto consumers of fossil fuels.
A European Context: There is currently a gap in the Fit for 55 package as it relates to the management of harder-to-abate and fossil fuel sectors. While the package contains major new components to cover emissions trading for buildings and transport, the package still leaves many fundamental political choices to be addressed in negotiations by the Council and European Parliament. These include choices the free allocation volumes to industry, and whether and how the Carbon Border Adjustment Mechanism will come into effect. One major political choice, however, seems to be to extend carbon pricing to new sectors, and to sectors that directly impact citizens: fuels in road transport and the heating of buildings. The Commission also proposes a separate emissions trading system for these sectors rather than inclusion in the ‘main ETS’ (Kambli, R.P.N., 2021). So far, EU climate policy has predominantly focused on the decarbonisation of the electricity and industrial sectors, notably through the ETS and binding targets for renewable energy and energy efficiency. Consequently, emissions from the electricity sector have fallen fast. However, emissions from the industrial sector have decreased more slowly and emissions from the building sector have not decreased significantly, while transport sector emissions have even increased steadily (Quadrelli, R. and Peterson, S., 2007.)

Impact and Scale of a Carbon Takeback Obligation: To incentivise development and growth of long-term CO₂ storage, extractors and importers of fossil fuels are required to permanently store a percentage of the CO₂ generated by the products they sell. Over time this stored fraction rises to reach 100%, such that the CTBO requires the fossil fuel industry to achieve Net Zero for all the embedded CO₂ emissions in its products. Based on current projections, the CTBO’s stored fraction could start at ~1% in 2023 before increasing to 10% in 2030 and reaching 100% by 2050 (Jenkins, S et al., 2021). Companies need not be obliged to complete the CO₂ storage themselves. We envisage the growth of a CO₂ storage market, based around tradable certificates of geological carbon storage, significantly reducing costs for consumers, and meaning verification of safe and long-term storage can be achieved. Initially, CO₂ for storage could come from factories, refineries and cement plants – point sources where it is easier to capture a fraction of the CO₂ in the flue gases. Once these have been tapped, getting to 100% storage would mean going further, and recapturing CO₂ directly from the atmosphere. A CTBO demands 100% recapture and storage for the carbon embedded in the fossil fuels extracted at the time of Net Zero – acting like an intensity target. If CO₂ storage proves harder to achieve than first envisaged, or the costs associated are higher than expected, then the tolerated level of negative emissions goes down and the market moves to decarbonise further as happens if a carbon price is raised.

Practicality of Implementing a Carbon Takeback Obligation: The public already intuitively holds fossil fuel companies responsible for climate change, and some (such as BP, Shell) are beginning to accept that conclusion as well. A Carbon Takeback Obligation makes that responsibility official and equitable, updating our social contract with the fossil fuel sector and making them part of the solution, rather than the source of the problem. Engaging with the fossil fuel industry means we can leverage their considerable expertise and capital, and by deploying a CTBO, which sponsors the growth of the safe capture and geological storage of CO₂, results in wider economic benefits too. Growth of a CO₂ storage marketplace, based around tradable certificates of storage, significantly reduces costs for consumers (Lee, K., Fyson, C. and Schleussner, C.F., 2021). Including CDR in an ETS with a zero cap might also achieve this aim.

A case example: Carbon Takeback in the UK: If incorporated into the UK’s Nationally Determined Contribution to the UNFCCC, Carbon Takeback would represent a dramatic increase in ambition as the first
climate policy directly linked to achieving Net Zero. This would have minimal impact on UK competitiveness: obliging industry to store up to 10% of extracted and imported fuels by 2030 would add less to the cost of carbon-based products than the current UK carbon floor price. This policy is the simplest and most efficient way of getting a fleet of initial CO₂ storage projects built, allowing us to validate costs and reduce them through learning. The UK already plans to sequester ~10 MtCO₂/year by 2030 at a series of industrial hubs (e.g. Teesside). This would constitute about 2.5% of fossil fuel extraction and imports, a welcome first step, but well short of the 10% required for a smooth transition to 100% storage, or net zero emissions, by 2050. Instituting Carbon Takeback gets us the rest of the way, and deploys the expertise of the fossil fuel industry to get us there. Happily, we can reuse existing infrastructure – pipelines connecting Britain’s North Sea coast to depleted oil and gas fields are instantly transformed from a £24 billion decommissioning liability to a valuable asset. These depleted fields contain enough storage space for at least 200 years of UK emissions. All of this enables a just transition, including thousands of new jobs, a new offshore industry, and exportable skills (Zakkour et al., 2021).

**Risks Associated with Implementing a Carbon Takeback Obligation:** The costs of geological storage (£40-100/tCO₂depending on source) are high but can be spread over the full volume of fossil fuels sold. For example, sequestering 10% of emissions adds just £0.70-£1.80 to the cost of a barrel of oil, less than current carbon prices. Costs decline over time as more projects are built to satisfy the CTBO (Jenkins, S et al., 2021). Another risk is brown-flight, or the concern that heavy-emitting sectors will leave a jurisdiction made less competitive through the application of mitigation policy. This concern is somewhat addressed as a CTBO ramps up ambition across the 21st century, meaning industry can adapt to regulation and costs over an extended period. All mitigation policy comes with attached costs, and the CTBO remains cheaper per unit CO₂ produced than policies of equivalent ambition using carbon pricing alone. This risk can be further abated by the introduction of a CBAM. Another possible risk associated with a CTBO is the moral hazard concern in the justification of ongoing emissions if the harms of ongoing emissions are seen as ‘neutralized’ through a Carbon Takeback. Addressing this requires a CTBO to have strict verification and regulation procedures to ensure that the stated storage is achieved to high standards. A CTBO is designed to help finance this process, and the needed R&D for removals reserved for the most difficult to abate sectors, while passing on costs onto the extractors and importers of fossil fuels. A CTBO combined with modest demand-side mitigation policy provides a low risk pathway to net-zero emissions by 2050, ensuring early emission reductions, a rapid scale-up of permanent CO₂ storage and unilateral, controllable, price discovery.
Climate Finance and Policy for Climate Neutrality

Global climate finance remains far below the levels needed to reach the goals of the Paris Agreement. By 2050, an estimated $1.6-3.8 trillion in new climate investment is required for the supply side of the global energy system (CPI, 2021). As of 2020, $632 billion has been committed. Furthermore, UNEP’s Gap Report estimates Global funding would need to increase to $300 billion a year to respond to escalating climate risks. It is also vital that this funding is tracked and utilization is measured to ensure it is reaching vulnerable communities (Global Center on Adaptation, 2020). Furthermore, high-emissions investment continues to flow in key sectors, which are curbing the impact of new finance in climate mitigation and adaptation. To close these gaps, current investment trends need to significantly shift towards low emissions and climate-resilient development (Campiglio, 2016).

Global Climate Finance Gap:

Investment required to keep warming within a 1.5°C scenario: The graph above shows the global climate finance gap and the estimated annual investment needed by 2050 in the energy system alone. To meet our climate objectives by 2030 annual climate finance must increase by 588% to $4.35 trillion (CPI, 2021). More targeted investment is thus needed to fill financing gaps (Fankhauser et al., 2015). Financing needs are defined as the additional investment required for achieving climate neutrality and adapting to the worst impacts of climate change coupled with the ability of investors to mobilize the required funds (Haites, 2013). In accordance with the UNFCCC’s principle of Common but Differentiated Responsibilities and Respective Capabilities, the Paris Agreement reiterates that developed countries shall provide financial resources to assist developing
countries with respect to both mitigation and adaptation and should continue to take the lead in mobilizing climate finance from a wide variety of sources (UNFCCC, 2021). Access to such funding boosts capacity-building and supports technology development and transfer. This in turn helps countries transition to clean energy and invest in reducing climate risks, or leapfrog in their development to green technologies, avoiding the fossil fuel phase all together. However, developing countries are falling through the cracks of a major financing gap which is being continually deepened by a lack of commitment to and continued postponement of reaching the annual $100 billion climate finance target. This hinders developing countries’ abilities for mitigation and adaptation and exacerbates carbon lock-ins and further reliance on costly fossil fuel infrastructure (Barder and Talbot, 2015).

**Green Finance and Recovery Spending in the Global Pandemic**: “A modest fraction of worldwide COVID-19 economic stimulus package funds—which have surpassed USD 12 trillion to date—could help put the world on track to Paris Agreement goals for the climate” (Andrijevic, et al. 2020). Despite global economic setbacks from the ongoing pandemic, COVID-19 recovery spending poses a significant window of opportunity for governments to meaningfully spend on environmental and social issues in five core green policy areas: green energy, green transport, green building upgrades and energy efficiency, natural capital, and green R&D. Studies show that well-designed green spending can counter the environmental crises of climate change, pollution, and biodiversity loss, while also delivering significant social benefits. In response to COVID-19, we find that the fifty largest economies announced $14.6 trillion in fiscal spending in 2020, of which $1.9 trillion (13%) was for long-term economic recovery. In 2020, only 18% of recovery spending and 2.5% of total spending had positive green characteristics (UNEP Green Recovery Report, 2021). As nations continue addressing the health consequences of the pandemic, policymakers must urgently support teams to develop and implement sustainable and equitable recovery policies.

**Global Fossil Fuel Financing in the Banking Sector**: Several studies discuss the potential role of monetary policies and macro-financial regulation: modifying the incentives and constraints that banks face when deciding their lending strategy—through, for instance, a differentiation of reserve requirements according to the destination of ending—may fruitfully expand credit creation directed towards low-carbon sectors. This seems to be especially feasible in emerging economies, where the central banking framework usually allows for a stronger public control on credit allocation and a wider range of monetary policy instruments than the sole interest rate (Campiglio, 2016).
Five years following the Paris Agreement, the sixty largest commercial and investment banks collectively financed $3.8 trillion in fossil fuel companies (Banking on Climate Chaos, 2021). Most of this facilitates the expansion of fossil fuel extraction and infrastructure and 39% went to one-hundred key companies with contested fossil fuel expansion plans. Bank financing in the first half of 2021 was the highest of any half-year since the adoption of the Paris Agreement, as large energy companies took on cheap debt at the start of the pandemic.

Interventions for Climate Neutral Finance: Efforts under the Paris Agreement are guided by its aim of making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development. Assessing progress in provision and mobilization of support is also part of the global stocktake under the Agreement. The Paris Agreement also places emphasis on the transparency and enhanced predictability of financial support. To give developing nations a fair chance at climate action while they work to close the adaptation gap, a suite of policies is needed to restructure debt. These might include “debt for nature swaps” discussed earlier in this report (Hansen, 1989), “catastrophe clauses in development loans” (Stiglitz and Rashid, 2020).

A range of green financial interventions are needed to achieve Climate Neutrality: Both green supportive factors, such as “green loan guarantees” and “targeted public private partnerships” to scale decarbonization solutions, as well as “dirty penalizing factors” such as “capital adjustment” (an extension of Basel rules), and “risk adjustments”. Experts emphasized that financial institutions must move beyond an era of transparency and climate-risk management and focus more on climate outcomes. While climate-risk management may incidentally or indirectly contribute to alignment with climate outcomes, reporting lacks standardization, and more specific or targeted measures were called on to align with the goals of the Paris Agreement (Ameli et al., 2020). One risk to interventions which restrict fossil fuel financing is brown flight to other regions which has proven to driving fossil fuel prices down which could lead to an increase in procurement and emissions in developing regions. To address this, measures such as border carbon adjustments might be paired with financial instruments that penalize fossil fuel development (Helm et al., 2012).

Interventions for facilitating Climate Neutrality through Finance discussed:

- Green Loan Guarantee Program (GLGP) and Green Loan Guarantee Program Facility (GLGPF) (See below)
- Climate Risk Adjusted Collateral Haircuts: central banks apply a haircut (reduction of the face value of an asset) to collateral they accept for liquidity and monetary policy operations based on
the associated climate risk. This action would increase (decrease) the cost of capital for brown (green) investment.

- **Increasing Climate Aligned Capital Requirements:** central banks hold higher capital for loans to fossil fuel projects.
- **Green Bonds:** Bonds earmarked for projects with environmental and/or climate benefits.
- **Green Quantitative Easing:** Targeted purchases of sustainable assets by central banks. This can be done either as a separate program to quantitative easing or as a tilting of the asset portfolio held by central banks.
- **Green Targeted Re-financing Operations:** A program by which central banks release inexpensive long-term credit to financial institutions earmarked for sustainable loans.
- **Obligatory Climate Risk Disclosure:** Governments require financial institutions and corporations to divulge their exposure to transitional and physical climate risks to their investors.
Climate Finance: Green Loan Guarantee Programme & Facility

Green Loan Guarantee Programmes (GLGP) and Green Loan Guarantee Facilities (GLGPF) can be set up in tandem by governments and central banks to reduce the green cost of capital along two dimensions; (1) reducing the default premium on green loans and (2) reducing the liquidity premium. A high liquidity premium can be a serious issue as it adds increased cost to the large amounts of upfront capital necessary to set up green energy generation or other mitigation measures. Research has shown that the high capital intensity of green technology (Hirth and Steckel, 2016; Best, 2017) implies a relatively low return on capital for renewables as profits need to be distributed over a very large capital base (Yanovski and Lessmann, 2021). Under a GLGP, the government would provide the guarantee to banks that they will cover a certain percentage of the nominal value of a loan plus the accrued interest, provided the loan meets a greenness criteria. For example, with a 90% green loan guarantee, in case of a default with a recovery rate of 50%, the government would pay the bank the difference between the recovery rate and the guarantee, i.e. 40% of the nominal loan nominal value plus the accrued interest. Because of the government’s green loan guarantee, banks can reduce the premium required to cover the probability of default and hence a component of the green cost of capital can be reduced. Under the GLGPF, commercial banks would be allowed to borrow against the green loans from the central bank, which would eliminate liquidity concerns and, thereby, the liquidity premium associated with the green loans. While similar adjustments to the cost of capital could be achieved with an investment subsidy program, the GLGP and GLGPF instruments are, theoretically, considerably less costly in terms of public expenditures and amount of additional public debt needed, as they leverage commercial bank and central bank funds: rather than paying for the entire investment subsidy, the government only pays in case of default, while under GLGPF the liquidity is provided by the central bank (Pizzutilo and Calò, 2015). Moreover, rather than governments having to painstakingly evaluate green projects, banks can use their considerable know-how and infrastructure to pick good projects (OECD, 2020). In a comprehensive assessment of nine climate financial policies, Bhandary et al. (2021) find GLGP programs to be highly effective in mobilising green investment whilst being economically efficient. Applying a globally consistent methodology to identify a loan as “green” can help banks and financial institutions track the green share of their lending portfolio vis-à-vis their sustainability goals, redirect capital flows to meet targets, and even consider divesting in assets seen as vulnerable to climate events. GLGP-aligned loans also help regulators apply universally accepted eligibility criteria for incentives such as grants or tax rebates, allowing small-sized projects that require smaller investments to access cheaper financing. Banks and financial institutions can also package such loans into Covered Green Bonds (Wulandari et al., 2018).

Impact and scale: GLGPs and GLGPFs decrease the green cost of capital and encourage financial institutions to increase their green lending and subsequently build up knowledge of the business sector, further decreasing the green cost of capital. Due to their ability to generate effective leverage, guarantee schemes can be an efficient way to scale up private investment. Increased learning from increased exposure to green projects, as a result of GLGPs, is likely to disseminate between financial institutions reducing perceived risk and increasing investment. Effective leverage is demonstrated in the few rigorous evaluations of general credit guarantee schemes. For example, the European Banking Authority (2020) published an overview of 47 public guarantee schemes.
schemes (43 from EU Member States and 4 from EEA members). Furthermore, the IMF policy tracker shows that most countries, including, the United States, Germany, the United Kingdom and Belgium put in place various types of government loan guarantees for the nominal value of loans provided by banks to businesses and households (IMF, 2021).

Risks associated with the implementation of a GLGP: A major concern is how to prevent excessive risk taking by banks who may issue riskier loans or not bother to attempt to recover parts of defaulted loans. However, evidence from past loan guarantee programs has shown these issues do not present themselves in reality and rather have reduced default rates and increased the sales and assets of affected firms (Brault and Signore, 2020). Precautionary measures in programme structures can incentivise financial institutions to perform due diligence in loan creation and not put an undue burden on government guarantees. These include: lower default coverage, penalty based incentives systems, and reward-based incentive systems.

Timing: The present economic system is primed for GLGP's as part of green recovery spending. COVID-19 governmental loans have demonstrated a model for this type of spending that will help the economy transition to a post-carbon system with significant cost-savings, which will help the economy recover in a stable way from the COVID-19 recession (Green Recovery Report, 2021).

Practicality: The program requires a taxonomy to determine what a green investment. Currently, the EU has a strong taxonomy developed that could be to evaluate loans for GLGPs. The EU taxonomy is a classification system, establishing a list of environmentally sustainable economic activities. It can play a key role in helping the EU scale up sustainable investment and implement the European green deal. The EU taxonomy provides companies, investors, and policymakers with appropriate definitions for which economic activities can be considered environmentally sustainable. In this way, it helps create security for investors, protect private investors from greenwashing, help companies to become more climate-friendly, mitigate market fragmentation and help shift investments where they are most needed. UNEP FI's report “Testing the application of the EU Taxonomy to core banking products” suggests that the Taxonomy is currently too technical for SMEs to adopt and requires significant simplification. Nuances for the SME segment need to be addressed and alternatively we need guidelines for the use of third-party certification (UNEP, 2021). However, part of the Green investment fund for the Green New Deal can go towards covering the defaults.

GLGPs in practice: While still early days, labelled Green Loan issuance amounted to about $60 billion in 2018. In the ASEAN region, ING issued the first GLGP-compliant Green Loan to finance a portfolio of rooftop solar projects developed and owned by Sunseap Commercial Assets Pte. Ltd., the largest clean energy solutions provider in Singapore (Hussain, 2020). Green credits such as loans to projects offering energy savings or emission reductions now make up approximately 10% of the portfolios of China’s top 21 banks thanks to mandatory Green Credit Guidelines issued by the China Banking Regulatory Commission and the People’s Bank of China (CPI, 2020). The Government of Malaysia’s Green Technology Financing Scheme (GTFS) has resulted in the participation of 28 banks and financial institutions in 319 projects (approximately $875 million in
loans) as of July 2018. The Scheme offers borrowers a 2% rebate on the total interest charged by banks for eligible green projects as well as a guarantee of 60% of the total approved loan. Loan guarantees ($35.7 billion in loans) have been used extensively by the U.S. Department of Energy over the past 10 years with losses of only 2.3% of 2020 they have created a new Renewable Energy and Energy Projects Loan Guarantees Program that will allocate $4.5 billion in guarantees to energy projects that utilise innovative technology to reduce, avoid, or sequester greenhouse gas emissions (Hansen, 2021). Over the past year there have been additional commitments by Sweden and Korea in 2021 to renewable large scale industrial loan guarantees (IEA, 2021).

**Recommendation for policymakers for Green Loan Guarantee Programmes**

- Design the loan guarantee schemes, such as eligibility criteria, risk sharing provisions, and the pricing
- Identify the best institution to run the guarantee scheme – e.g. ministry, a public finance institution or an appropriate private sector entity.
- Organise a coordinated facility with central banks to provide liquidity relief to financial institutions.
- Reach out to green SMES to apply and start issuing loan guarantees to accelerate the green recovery.
- Scale up successful green loan guarantee schemes
- Companies should invest in sustainable practices and technologies within and beyond direct operations, and demand that local decision-makers prioritise sustainability in recovery schemes and funds.
- Private and public sector leaders need to work together to build back better and expedite the decision on whether to set-up a loan guarantee scheme. GLGP’s are a proven way to keep up the momentum and ambition for a sustainable COVID-19 recovery (Stadelman, 2020).

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Many characteristics of green market segments act as barriers for lenders, but the barriers can also affect borrowers—that is, the demand side: unfamiliar technologies or adverse regulatory or legal frameworks can dissuade project owners.