

Expert Report – Derik Broekhoff

4 July 2022

1. Qualifications

My name is Derik Broekhoff. I am a Senior Scientist at the Stockholm Environment Institute ('SEI'). I am based in SEI's office in Seattle, United States. I joined in 2015 to work on climate change mitigation research. My areas of expertise include carbon markets and carbon offsets.

I have worked on energy and climate policy for more than 20 years, with an emphasis on greenhouse gas ('GHG') accounting, emissions trading, and carbon offsets. My research interests include the effective design and implementation of environmental market mechanisms, along with assessing and enabling climate mitigation policies that go beyond "carbon pricing". I have advised numerous state, national, and multi-national policy initiatives on carbon accounting and program design, including voluntary and regulatory offset programs and programs to reduce emissions from deforestation and degradation (REDD+).

Prior to joining SEI, I was vice president for policy at the Climate Action Reserve in Los Angeles, where I oversaw development of the Reserve's voluntary carbon offset program and its transition into California's regulatory cap-and-trade program.

Previously, I worked on the Greenhouse Gas Protocol Initiative at the World Resources Institute, where I also managed work on the design of emissions trading programs, registry systems, and standards for carbon offsets. While at WRI, I testified twice before the United States Congress as an expert on the design of standards and policies related to carbon offsets.

I have a master's degree in public policy (MPP) from the University of California at Berkeley, and a bachelor's degree in international relations from Stanford University.

My publications include:

- Broekhoff, D., Gillenwater, M., Colbert-Sangree, T., and Cage, P. (2019). "**Securing Climate Benefit: A Guide to Using Carbon Offsets.**" Stockholm Environment Institute & Greenhouse Gas Management Institute. This guide is for companies and organizations who aim to use offsets in voluntary GHG reduction strategies.
- Schneider, L., Duan, M., Stavins, R., Kizzier, K., Broekhoff, D., Jotzo, F., Winkler, H., Lazarus, M., Howard, A. and Hood, C. (2019). **Double counting and the Paris Agreement rulebook.** *Science* 366 (6462), pp. 180-183. This paper in *Science* identified three principles to guide the then upcoming UN negotiations on the rules for international carbon markets.
- Schneider, L., Michaelowa, A., Broekhoff, D., Espelage, A. and Siemons, A. (2019). **Lessons Learned from the First Round of Applications by Carbon-Offsetting Programs for Eligibility under CORSIA.** Öko-Institut / Perspectives / Stockholm Environment Institute. This study, conducted on behalf of the German government and the ClimateWorks Foundation, assessed the quality of applications submitted by carbon offset certification programs – including the Gold Standard – to the International Civil Aviation Organization (ICAO) for approval to issue

credits eligible for use under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

- La Hoz Theuer, S., Schneider, L. and Broekhoff, D. (2019). **When less is more: limits to international transfers under Article 6 of the Paris Agreement**. *Climate Policy*, 19(4). 401–13. This study assessed the environmental integrity risks of international carbon markets under Article 6 of the Paris Agreement and discussed possible international rules to address them.
- Bailis, R., Broekhoff, D. and Lee, C. M. (2016). **Supply and Sustainability of Carbon Offsets and Alternative Fuels for International Aviation**. Working Paper 2016-03. Stockholm Environment Institute, Stockholm. This paper examined the potential supply of carbon offsets and jet fuel alternatives available to help meet the international aviation sector’s emission reduction needs in 2020–2035, with a focus on which types of mitigation projects yield more robust offsetting claims.
- Broekhoff, D. and Zyla, K. (2008). **Outside the Cap: Opportunities and Limitations of Greenhouse Gas Offsets**. Climate and Energy Policy Series. World Resources Institute, Washington, DC. This paper likewise examined the degree to which different type of greenhouse gas mitigation activities (e.g., industrial gas destruction vs. tree planting) can provide reliable offsets, and argued that certain types of projects would be better supported through means other than selling offset credits because they cannot reliably support robust offsetting claims.
- Gillenwater, M., Broekhoff, D., Trexler, M., Hyman, J. and Fowler, R. (2007). **Policing the voluntary carbon market**. *Nature Reports Climate Change*, no. 0711. 85–87. This article examined requirements for effective carbon offsetting and argued that government regulation should be required to ensure the quality of voluntary carbon offsets.

2. Introduction and summary of conclusions

I have been asked to provide my views on the questions of:

- Whether KLM may validly claim that the CO₂ emissions of passenger aviation are reliably compensated through the purchase and use of carbon credits from a reforestation project; and
- Under what conditions KLM might validly claim that a customer’s contribution to ‘Sustainable Aviation Fuel’ (SAF) purchases reduces the CO₂ emissions of passenger aviation.

The conclusions I have reached are, in summary:

- Use of carbon credits cannot reduce the impact of an emitting activity. Carbon credits are more accurately viewed as a contribution to mitigation activities (such as reforestation) that are supplementary to direct decarbonization efforts, not a compensatory measure. There are two reasons for this:
 - There is an emerging consensus that use of carbon credits is appropriate only in the context of a following a “mitigation hierarchy” that recognizes the need to comprehensively and directly reduce emissions in line with dwindling carbon budgets for climate goals such as 1.5C (where pathways meet ‘net zero’ in around 2050). Put

simply, climate goals require both reducing fossil fuel emissions and reforestation, so relying on one in place of the other is problematic.

- Determining whether mitigation meets essential criteria for “offsetting” emissions is subject to inherent uncertainties related to ‘additionality’ and quantification, and challenges with ‘permanence’ and ‘double claiming’. Because of this, it is best to treat carbon credits as a means of channeling investment into climate change mitigation activities, not as a failsafe way to compensate for a given source of emissions (Broekhoff et al. 2019).
- Accordingly, in my view, KLM may not validly claim that purchasing carbon credits from a reforestation project can truly compensate for, or reduce, the climate impacts of flying.
- To validly claim that a customer’s purchase of SAF reduces greenhouse gas emissions from flying, such purchases must directly result in increased use of SAF on the customer’s flight, beyond any quantity of SAF that would have been procured and used in the absence of such purchases. This question is directly analogous to the concept of additionality for carbon credits, and I address it in my discussion of additionality for carbon credits in this report.

In the remainder of this report, I will explain my views that:

- The use of carbon credits cannot compensate for emissions if those emissions deviate from Paris-aligned decarbonization trajectories;
- Inherent uncertainties in how carbon offsets are quantified make them unreliable in counterbalancing fossil fuel emissions on a tonne-for-tonne basis;
- Using carbon offsets based on biological sequestration suffers from a problem of permanence; and
- Carbon offsetting and compensation claims are not valid if they involve mitigation that is also counted by nation states in fulfillment of their pledges under the Paris Agreement.

3. Definitions

- A “carbon offset” broadly refers to a notional reduction in greenhouse gas emissions – or a removal of greenhouse gases from the atmosphere (e.g., through tree planting or other means) – that is used to compensate for greenhouse gas emissions that occur elsewhere (Broekhoff et al. 2019). Below, I use the term “mitigation” to refer to either a reduction in greenhouse gas emissions or removal of CO₂ from the atmosphere.
- “Compensate” in this context means to achieve an effect that is equivalent to avoiding (i.e., not emitting) the greenhouse gas emissions that are being offset.
- “Counterbalance,” in the sense I use it in this report, refers to causing emission reductions or removals to occur in an amount equal to the quantity of emissions being offset (denominated in tonnes of CO₂-equivalent).

- The term “carbon” in this context is used as a shorthand for any of a number of greenhouse gases that contribute to global warming; carbon dioxide is the most important of such gases in terms of human contribution to climate change.
- The act of “offsetting” emissions typically refers to enabling a carbon offset to happen.
- “Carbon credits” are transferable instrument certified by governments or independent certification bodies to represent an emission reduction of one metric tonne of CO₂, or an equivalent amount of other greenhouse gases. The purchaser of an offset credit can “retire” it to claim the underlying reduction. Purchase of carbon credits is the primary means through which most actors seek to offset their emissions.

4. Use of carbon credits cannot compensate for emissions if those emissions deviate from Paris-aligned decarbonization trajectories

The international community has recognized long-term temperature stabilization as the primary objective of climate change mitigation efforts (Paris Agreement, Articles 2(1)(a) and 4(1)). Stabilizing global temperature requires limiting cumulative net emissions of carbon dioxide (CO₂) (Allen et al. 2009; Archer et al. 2009; Ciais et al. 2014; Eby et al. 2009; Mackey et al. 2013; Matthews et al. 2009; Matthews and Caldeira 2008), a fact that underpins the notion of a global “carbon budget.” That is, human-caused greenhouse gas emissions – and emissions of CO₂ in particular – must ultimately cease if we wish to keep the long-term increase in global average temperature below a certain threshold, such as the Paris Agreement’s target of “well below 2°C above pre-industrial levels.” The remaining budget for achieving this target is rapidly dwindling (IPCC 2021).

In principle, there are multiple trajectories or “pathways” the world could follow to both reduce CO₂ emissions and increase the removal of CO₂ from the atmosphere, such that cumulative net emissions will remain at or below a safe long-term carbon budget. For example, the Intergovernmental Panel on Climate Change (IPCC) identified four illustrative pathways for achieving net zero global emissions by the middle of the century that, if followed, would limit warming to 1.5°C (Figure 1) (IPCC 2018).

Breakdown of contributions to global net CO₂ emissions in four illustrative model pathways

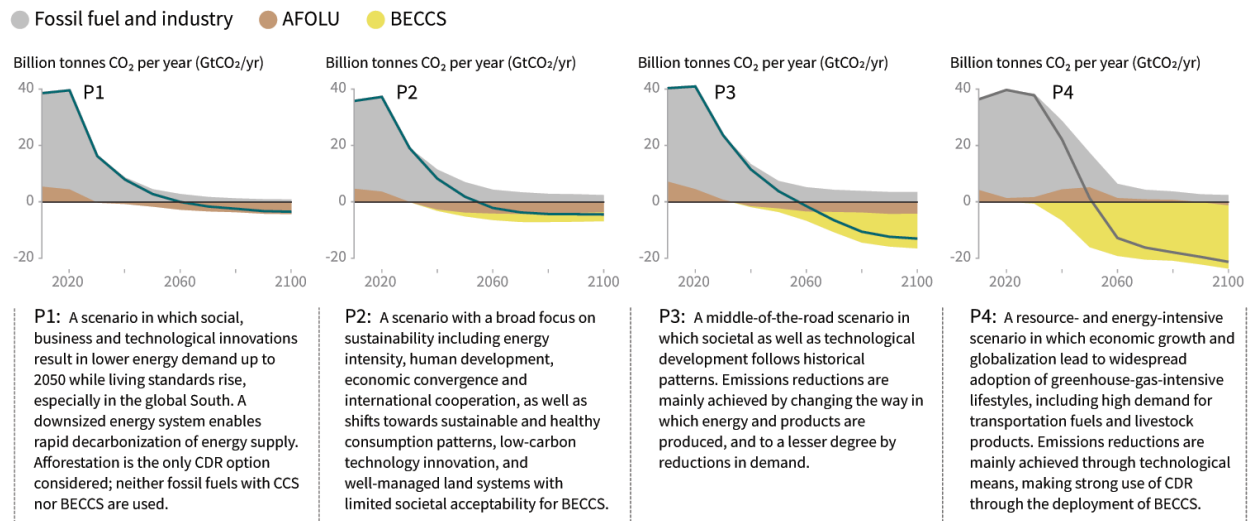


Figure 1. Illustrative pathways for limiting net cumulative emissions to keep global warming below 1.5°C (IPCC 2018)

Not all pathways are equal, however, in terms of their costs, risks, uncertainties, and relative reliance on land-based carbon sequestration in the agriculture, forest, and land use sectors (AFOLU), or on unproven technologies, such as bioenergy carbon capture and storage (BECCS) – as highlighted in Figure 1. A primary goal of climate policy is to follow as closely as possible a low-risk, low-cost, and equitable pathway to net zero global emissions, as expressed in Article 4.1 of the Paris Agreement (which calls for peaking emissions “as soon as possible,” and balancing global emissions with removals “on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty”).

Any actions to offset, or compensate for, greenhouse gas emissions need to be considered in the context international goals to equitably and cost-effectively keep emissions within a safe global carbon budget. In this context, any failure to avoid discretionary emissions today, or failure to reduce emissions that could be cost-effectively reduced, leads to a greater challenge for limiting cumulative net emissions in the future. Purchasing carbon credits, by the same token, should make it easier in the future to limit cumulative emissions. In this sense, carbon credits are claimed to be “compensation” for emissions.

However, offsetting cannot compensate for the *opportunity cost* of not having avoided or reduced the emissions in the first place. That is, if it would be preferable to simply avoid (not offset) the emissions in a scenario where the world followed an efficient and equitable approach to eliminating emissions, the act of offsetting cannot make up for this forgone opportunity. Instead, the act of offsetting merely sets the world on a slightly less worse path, but one that still deviates from what is optimal.

This is the fundamental premise behind an emerging consensus that purchasing carbon credits should only be pursued in the context of a “mitigation hierarchy.” As explained by the Science-Based Targets initiative, following a mitigation hierarchy means, as a first priority, reducing or avoiding one’s own emissions in line with an optimal or “science-based” pathway, and only after this seeking to offset those emissions (SBTi 2021). This principle has been universally endorsed in recent guidance and initiatives related to carbon offsetting, including the Voluntary Carbon Market Integrity Initiative (VCMI 2021), the UN Race to Zero campaign (Race to Zero 2021), the Oxford Principles for Net Zero Aligned Carbon Offsetting (Allen et al. 2020), and others (Broekhoff et al. 2019; Dugast 2020; New Climate Institute and

Data-Driven EnviroLab 2020; Schallert et al. 2020). To use offsets for emissions instead of reducing or avoiding them is inconsistent with this emerging consensus.

The failure of some actors to follow a mitigation hierarchy is already posing challenges for global mitigation efforts. According to one study, for example, a small handful of companies has pledged to offset their emissions with more removals than could plausibly be achieved at global scale (Greenpeace UK 2021) – an outcome that could pose dire climate risks and undermine sustainable development goals (Dooley and Kartha 2018).

The risk of undermining long-term mitigation goals is particularly acute if carbon credits are sold by companies to “compensate” for an activity where optimal mitigation pathways require consumer behavioural change. One such activity is aviation, where identified pathways refer to the need for demand management, or limits on flying (International Energy Agency 2021, pp.84–85; Transport & Environment 2022). Aviation emissions are especially impactful, since their total net effect is enhanced through a variety of non-CO₂ radiative forcing processes that occur at high altitudes (Lee et al. 2020).

To be clear, there could still be *some* room for aviation-related greenhouse gas emissions under an optimal global pathway for achieving long-term temperature goals. The point is that if a consumer decides to fly, it would be misleading to suggest that purchasing carbon credits is *equivalent in its impact* to not flying when considered against such a pathway. Purchasing carbon credits can still help to advance global mitigation efforts, but cannot make up for the opportunity cost of flying if traveling by air was avoidable. The purchase of carbon credits should instead be viewed as *supplementary* climate action that may help to advance global mitigation efforts despite any decision to fly, not as “neutralizing” compensation for flying that somehow erases the opportunity cost. The impact of a flight is what it is; purchasing carbon credits does not reduce it.

5. Inherent uncertainties in how carbon offsets are quantified make them unreliable in counterbalancing fossil fuel emissions on a tonne-for-tonne basis

Putting aside the question of whether carbon offsets can validly substitute for emission reductions needed to equitably and cost-effectively achieve long-term temperature goals, a separate question is whether they can reliably counterbalance emissions on a simple tonne-for-tonne basis. That is, if an actor purchases and retires a carbon credit, how confident can we be that this actually reduces greenhouse gas emissions in an amount equivalent to at least one tonne of CO₂, such that it will counterbalance one tonne of the actor’s own emissions?

A counterbalancing claim like this can only be valid if certain logical conditions are met. In particular, there must be a causal connection between using credits and lowering global greenhouse gas emissions. The “quality” of a carbon credit refers to the *level of confidence* one can have that using a credit actually lowers global emissions, compared to a scenario where the credits are not purchased or used (Broekhoff et al. 2019; Schneider and La Hoz Theuer 2019). For this basic logical requirement to be met, carbon credits must be associated with mitigation that meets the following five conditions (Broekhoff et al. 2019).

First, the mitigation **must be additional**. Mitigation is additional if it would not have occurred in the absence of demand for carbon credits. If mitigation would have happened anyway – i.e., without any prospect for the initiators of the mitigation to sell carbon credits – then it is not additional. “Additionality”

is the most essential criterion for carbon credit quality. If mitigation claimed as an offset is not additional, then purchasing carbon credits yields no change in global emissions. It would therefore be invalid to claim that the carbon credits have counterbalanced emissions.

Unfortunately, the determination of additionality is deceptively difficult and subject to inherent uncertainty. It requires comparison to a counterfactual scenario where demand for carbon credits is not present. While carbon credit certification programs take pains to try to ensure that credited mitigation is additional, their determinations are unavoidably prone to at least some subjectivity and error. Multiple studies have suggested that, for a wide range of mitigation activities certified as carbon offsets, additionality claims are not reliable (Alexeew et al. 2010; Cames et al. 2016; Haya 2009; Haya et al. 2020; Haya and Parekh 2011; Ruthner et al. 2011; Schneider 2009; Trexler 2019). Even for mitigation activities where uncertainty is lower – for example, capturing and destroying methane gas where there is no regulatory or financial incentive to do so – additionality cannot be fully guaranteed.

Note that additionality as a logical requirement applies to any kind of consequential mitigation claim, whether realized through carbon credit purchases or other means. Thus, when KLM suggests that customer purchases of ‘Sustainable Aviation Fuel’ (SAF) could directly reduce CO₂ emissions that result from flying, the validity of this claim rests on whether such purchases in fact result in increased use of SAF in an amount proportional to the customer’s imputed fuel consumption, beyond any quantity of SAF that would have been procured and used in the absence of such purchases. Without an explicit demonstration of this causal relationship, any suggestion that such purchases will reduce the emissions impact of a customer’s flight is not tenable. A valid demonstration of additionality would need to meet all the same requirements needed for standard carbon offsets, including the specification of a robust counterfactual scenario without customer purchases of SAF. An arrangement where KLM nominally allocates to paying customers some portion of the SAF it was already procuring, for example, would not pass this test.

Second, the mitigation **must not be overestimated**. If the actual effect of a mitigation activity on reducing or removing greenhouse gas emissions is overestimated, then its effect in counterbalancing emissions will also be overestimated. This is sometimes referred to as “over-crediting”: more credits are issued than the actual quantity of emission reductions or removals achieved. Overestimation can occur in several ways, including through inaccurate assessment of a mitigation activity’s *baseline* emissions, under-estimation of the activity’s *actual* emissions, and failing to account for an activity’s *indirect effects* on greenhouse gas emissions at other sources (sometimes called “leakage”) (Broekhoff et al. 2019). Again, uncertainty is inherent. A mitigation activity’s effects must be quantified against a counterfactual baseline, representing emissions or removals that would have occurred in the absence of a carbon credit transaction. This will always be inherently subjective, even where the baseline scenario appears to be straightforward.

Third, the mitigation **must be permanent**. One challenge with using carbon credits to counterbalance carbon emissions is that the effects of carbon emissions are very long-lived. Most of the carbon in a tonne of fossil CO₂ emitted today will – eventually – be removed from the atmosphere. However, around 25% remains in the atmosphere for hundreds to many thousands of years.

To counterbalance fossil fuel emissions, therefore, carbon credits must be associated with mitigation that is similarly permanent. If mitigation is “reversed” (i.e., carbon stored as a result of a mitigation activity is

subsequently emitted, so that no net reduction or removal occurs), then it no longer contributes to staying within a global carbon budget, and no longer serves a counterbalancing function. This is primarily a concern with mitigation activities that result in enhanced carbon storage in biospheric reservoirs (including trees, shrubs, soils, and other biological stores of carbon) such as the 'CO2OL Tropical Mix' reforestation initiative in Panama to which KLM customers may contribute. This is explained further below ('biological sequestration and the problem of permanence').

Fourth, the mitigation **must be exclusively claimed**. This requirement is straightforward. If two different actors lay claim to the same mitigation, the sum of their claims will exceed the actual mitigation achieved. Mitigation that is "double counted" (e.g., counted by another party towards the achievement of an emissions target) has no counterbalancing value, because in the absence of double counting, the other party can be expected to still achieve the same quantity of mitigation. Double counting can occur in mundane ways, e.g., if more than one credit is issued for the same tonne of mitigation ("double issuance"), or if a credit is used by more than one actor ("double use") (Schneider et al. 2015). A more challenging problem, however, is the risk that mitigation may be "double claimed" by national governments when accounting for progress towards their mitigation pledges under the Paris Agreement (Fearneough et al. 2020; Schneider, Duan, et al. 2019; Schneider, Broekhoff, et al. 2019). This is explained further below ('State climate action and the problem of double claiming').

Finally, mitigation activities **must avoid social and environmental harms**. Although this criterion is not directly related to the counterbalancing value of a carbon credit, it is essential for ensuring that purchase of carbon credits does not result in unintended and undesirable consequences. Unfortunately, there are multiple documented cases of carbon crediting projects resulting in adverse effects unrelated to climate change. Projects involving waste incineration and hydroelectricity production in developing countries, for example, have led to adverse local health impacts, environmental degradation, displacement of local populations, and social conflict (Dufrasne 2018; Haya 2007). Care must be taken in selecting the types of mitigation activities used to offset emissions.

One question that often arises is whether carbon crediting programs, like the Gold Standard, do a sufficient job in ensuring that all of the conditions above are met for the credits they issue. This is a contested debate, and one that is perhaps impossible to objectively resolve given the inherent uncertainties associated with key criteria such as additionality and the estimation of counterfactual baselines. The quality of a carbon credit is essentially a matter of confidence, not something that can be objectively measured and assessed. A key challenge for carbon crediting programs, therefore, is that they must make a binary decision about whether or not to issue credits for a mitigation activity, when in fact the quality of any given credit exists along a spectrum of relative confidence (Broekhoff et al. 2019; Trexler 2019). For communicating to consumers that greenhouse gas emissions from aviation are "compensated," it cannot be concluded that any given credit issued by a recognized program like the Gold Standard will provide sufficient confidence.

In light of these uncertainties, as well as the issues of deviating from safe decarbonization pathways identified in the prior section, it is best to treat carbon credits as a means of channeling investment into climate change mitigation activities, *above and beyond* efforts to avoid emissions from discretionary activities such as flying. They should not be viewed as a failsafe way to counterbalance or compensate

for emissions (Broekhoff et al. 2019).

6. Biological sequestration and the problem of permanence

A large segment of the voluntary carbon market today is focused on supporting mitigation activities such as reducing deforestation, tree planting, and other activities that effectively seek to enhance the storage of carbon in biospheric reservoirs (compared to what proponents claim would occur without those activities). These kinds of activities are often referred to under the umbrella of “nature-based climate solutions” (“NCS”). The 'CO2OL Tropical Mix' reforestation initiative in Panama to which KLM ask customers to contribute is an example of this type of activity.

Such activities are an essential part of comprehensive efforts to address climate change globally. However, as *offsets* to greenhouse gas emissions from the combustion of fossil fuels, they pose serious risks. The fundamental issue is that NCS mitigation cannot reliably balance out fossil carbon emissions over the long run and at large scales. This is readily apparent from Figure 1, where AFOLU-based removals are plainly not capable of replacing the need for reduction of fossil fuel emissions.

Substituting NCS mitigation for fossil fuel reductions means, in essence, shifting carbon from highly stable geologic reservoirs (such as oil deposits) to more precarious terrestrial ones (such as forests), which may release carbon to the atmosphere due to natural and/or anthropogenic disturbances – including disturbances induced by climate change itself (Smith et al. 2014).

Already, there are examples of forests associated with carbon crediting projects being destroyed by catastrophic fires, including projects funded by BP and Microsoft affected by the increasingly prevalent wildfires in the American West (Hodgson 2021). Such impacts are leading credit buyers to re-evaluate the risks of such projects. While some carbon offset programs, such as the Gold Standard, maintain insurance mechanisms to address carbon losses (essentially, “buffer reserves” of credits that are issued but not circulated), there are questions about whether they are sufficiently robust (Hodgson 2021) and it is doubtful that such mechanisms can be effective over indefinite time periods (Schneider, Michaelowa, et al. 2019). Furthermore, in the case of the Gold Standard, the obligation to compensate for “reversals” (i.e., carbon losses) may extend for as little as 20 years – far short of what is needed to fully counterbalance carbon emissions.

The fragility of biospheric carbon reservoirs has led some scientists to object to *any* use of NCS to offset fossil carbon emissions (Mackey et al. 2013; Becken and Mackey 2017). As a general rule, it is prudent to treat carbon credits for NCS as *helpful complements* to actions that reduce and avoid emission from fossil fuels, but not as substitutes or compensation for them (Mackey et al. 2013; McLaren et al. 2019). Again, this is illustrated in Figure 1, where AFOLU-based carbon dioxide removal is – in every pathway – complementary to fossil fuel emission reductions and other measures, not a substitute for them.

7. State climate action and the problem of double claiming

One under-recognized challenge affecting the entire market for carbon offsets today is how offsetting can

be reconciled with mitigation pledges that all countries have made under the Paris Agreement. In short, mitigation that countries have already pledged to achieve cannot credibly be used to compensate for an entity's emissions. This would represent a form of double counting called "double claiming" (Schneider et al. 2015; Schneider, Broekhoff, et al. 2019). The presumption must be that, in the absence of any carbon credit transactions, countries will make good on their pledges and achieve mitigation that would otherwise be enabled through carbon credits.

The possibility of double claiming has long been recognized as a challenge for emissions trading in a world with universal climate action pledges (Schneider et al. 2015). At the State level, the Paris Agreement formally recognizes this challenge and calls on countries to avoid double claiming through the application of "corresponding adjustments" (UNFCCC 2015, para.36) – essentially a form of bookkeeping to ensure that no two countries can count the same mitigation towards achievement of their pledges (called Nationally Determined Contributions, or "NDCs").

At the UNFCCC meeting in Glasgow in November 2021 (COP26), formal rules were agreed for how and when corresponding adjustments must be applied. The rules explicitly recognize that countries may authorize carbon credits for use in offsetting international aviation emissions (under the Carbon Offsetting and Reduction Scheme for International Aviation, or CORSIA) as well as for voluntary offsetting purposes. As explained in this report, in my view the premise of these schemes should be questioned. However, they do clarify that when such authorization occurs, the country hosting a mitigation activity effectively agrees to apply an "adjustment" to the ledger it uses to track progress towards achievement of its NDC, to reflect that the aviation industry (or another credit buyer) has used the mitigation activity to offset its emissions.

Actors such as KLM who use carbon credits for the purpose of offsetting emissions must obtain an authorization to ensure that mitigation associated with those credits is not counted by any national government in the fulfillment of its mitigation pledge. The Gold Standard, which certifies the CO2OL Tropical Mix reforestation initiative, explicitly recognizes this requirement, although systems for obtaining authorization and implementing appropriate accounting measures have yet to be established (Gold Standard 2021). For current mitigation projects, such as the CO2OL Tropical Mix initiative, the main risk is that national governments have not yet had time to consider whether they are willing to authorize mitigation for voluntary use, and therefore relinquish any claim to the mitigation when accounting for progress in achieving their NDCs. As a necessary, though not sufficient, condition for carbon credits from the CO2OL initiative to counterbalance emissions from air travel, the government of Panama would need to provide an explicit authorization.

8. Conclusion

The use of carbon credits can be an effective means for channeling investment into climate change mitigation and for accelerating efforts to address climate change. As a means to compensate for greenhouse gas emissions, however, carbon credits are an imperfect and unreliable solution, for the reasons I have cited above.

Of chief concern is that, over the long term, offsetting is not a viable greenhouse gas mitigation strategy. As the world economy decarbonizes, opportunities for additional mitigation that could compensate for remaining emissions will dwindle. To avoid both higher overall mitigation costs and a greater risk of

exceeding the long-term temperature targets expressed in the Paris Agreement, the world must focus on rapidly reducing emissions, and reserve scarce and uncertain capacity for *removing* carbon from the atmosphere for balancing out truly hard-to-abate and unavoidable emissions that may continue to occur later in the century. Any greenhouse gas emissions that can be easily avoided today, or that should be avoided under an efficient, equitable, and low-risk transition to net zero global emissions – such as the P1 pathway in Figure 1, and the pathways described in similar analyses by the International Energy Agency and others (International Energy Agency 2021; Transport & Environment 2022) – should be avoided. Allowing such emissions to occur and then offsetting them still pushes the world closer to a higher-cost and higher-risk emissions trajectory. From the standpoint of global mitigation pathways, offsetting is not a means for turning an otherwise incompatible emission into a compatible one.

Furthermore, even from the perspective of counterbalancing emissions on a tonne-for-tonne basis (i.e., ignoring any consequences for achieving global mitigation pathways), offsetting is too often an imperfect and unreliable exercise. This is chiefly because offsetting mitigation must meet certain logical requirements – including additionality and avoidance of over-quantification – that are subject to inherent uncertainties related to counterfactuals. Furthermore, tonne-for-tonne offsetting is only valid if it involves mitigation that is truly permanent and that is not counted by any national government towards the achievement of mitigation pledges under the Paris Agreement. Tree planting efforts like the CO2OL Tropical Mix reforestation initiative, though certainly valuable, face unavoidable risks with regard to permanence, and today face significant uncertainties with respect to the willingness of governments (such as Panama) to authorize the mitigation for voluntary offsetting purposes.

For all of these reasons, I believe it would be misleading for KLM to suggest to its customers that purchasing offsets can truly compensate for, or reduce the impact of, flying. Any option to use carbon credits should be presented as a potentially useful way to help accelerate climate action. Carbon credits should not be presented as a way to make up for, or compensate, aviation emissions that are not consistent with safe and equitable climate goals.

9. References

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