Environmental Defenders Office

22 March 2023

Rami Greiss
Executive General Manager
Consumer and Fair Trading Division
Australian Competition and Consumer Commission
23 Marcus Clarke St
CANBERRA ACT 2601

Via email: rami.greiss@accc.gov.au

Copied to: Richard Fleming, richard.fleming@accc.gov.au

Complaint about potential greenwashing by Etihad Airways PJSC

1. We act for Flight Free Australia. Flight Free Australia is a not-for-profit group of individuals dedicated to influencing public policy and raising awareness about the adverse climate impacts of the aviation industry and how to prevent them.

2. Our client requests that the Australian Competition and Consumer Commission (**ACCC**) investigate whether statements made by Etihad Airways PJSC (**Etihad**), a foreign corporation registered in Australia, about the environmental impact of their flights and their plan to achieve net zero emissions by 2050 are in breach of ss 18 and 29 of the *Australian Consumer Law* (**ACL**) (Schedule 2 of the *Competition and Consumer Act 2010* (Cth)).

3. Our client notes the ACCC's Compliance and Enforcement Priorities for 2022-2023, which include 'consumer and fair-trading issues in relation to environmental claims and sustainability'[1] and the impetus placed on this priority by Delia Rickard, the ACCC Deputy Chair, at the Sydney Morning Herald Sustainability Summit on 20 September 2022.[2] Our client is of the opinion that Etihad's behavior potentially represents a 'false and misleading sustainability claim [that] undermine[s] consumer trust in all green claims and reduce[s] confidence in the market' and therefore is referring it to the ACCC for investigation.[3]

4. Our client also considers that an investigation of Etihad's behavior is aligned with former aviation-related inquiries of the ACCC including the 'Airlines: Terms and conditions' report,[4] and the successful Flight Centre and Jetstar Federal Court cases.[5] The international pertinence of greenwashing in the aviation industry is evinced by the current KLM proceedings in the District Court of Amsterdam.[6]

[1] ACCC, 'Compliance & enforcement policy and priorities' (accessed on 20 January 2023).
[2] ACCC, 'Speech to Sydney Morning Herald Sustainability Summit' (accessed on 20 January 2023).
[3] Ibid.
[4] ACCC, 'Airlines need to comply with consumer law' (accessed on 20 January 2023).
[5] ACCC, 'Flight Centre ordered to pay $12.5 million in penalties' (accessed on 20 January 2023); ACCC, 'Jetstar to pay $1.95 million for false or misleading claims on refunds' (accessed on 20 January 2023).
[6] Reuters 'Dutch airline KLM sued over 'greenwashing' ads' (accessed on 20 January 2023).

Executive index

5. The complaint is structured as follows:

Statements made by Etihad

6. On 15 February 2022 at AAMI Park, during an A-League soccer game, the following Etihad advertisements were displayed on digital billboards throughout the stadium:

   a) 'Flying shouldn't cost the earth', displayed alongside the Etihad logo (**Statement A**); and

   b) 'Net zero emissions by 2050', displayed alongside the Etihad logo (**Statement B**),

   collectively, '**the Statements'**.

7. Photographs evidencing the Statements have been included in **Annexure A.**

8. Our client considers these advertisements are indicative of a sustained campaign by Etihad to market itself as the leading airline for sustainability. See, for example, Etihad's marketing regarding its "zero emissions" flights to COP27,[7] and its recent sustainability awards.[8]

Representations of the statements

9. Our client considers that Statement A represents that:

   a) flying can and does have a significant environmental impact; and

   b) unlike other airlines, flying with Etihad does not have a significant environmental impact.

   (**Environmental Impact Representation**.)

[7] Etihad, 'Etihad Airways and World Energy collaborate to demonstrate the future of Net Zero aviation with zero emissions flight to COP27' (accessed on 21 March 2023).
[8] Etihad, 'Etihad Airways ends the year with two prestigious sustainability awards' (accessed on 21 March 2023).

10. Statement B represents that:

    a) Etihad *intends* to achieve net zero emissions by 2050;[9]

    b) Etihad *expects* to achieve net zero emissions by 2050;[10] and

    c) Etihad had a *reasonable basis* for expecting to achieve net zero emissions by 2050.[11]

    (**Net Zero Representations**.)

11. For the reasons set out below, our client considers that the making of the Environmental Impact Representation and the Net Zero Representations may constitute misleading or deceptive conduct, and therefore potentially contravene ss 18 and 29 of the ACL.

Significance of aviation industry greenwashing

12. Consumers are demanding more sustainable and climate conscious practices from aviation companies and are increasingly prepared to pay more for them. This is evident in the results of recent 2022 consumer surveys, including:

    a) a survey undertaken by McKinsey & Company, which found emissions to be the top concern of aviation consumers, with 36% of survey respondents stating their intentions to fly less to minimise their environmental impact;[12] and

    b) the Oncarbon Travel Choices Consumer Survey, which found that 78% of travelers find travelling in a sustainable way rather or very important and that 72% of travelers would be willing to book a more sustainable flight option if they had such an option.[13]

13. The results of these surveys confirm that aviation consumers are highly influenced by climate change and emissions reductions considerations. It is therefore unsurprising that airline providers have sought to capitalise on such consumer preferences. Examples of this include the Qantas 'green tier' loyalty program[14] and, relevantly to this complaint, Etihad's 'Greenliner Programme'.[15]

14. The aviation sector has already contributed about 3.5% of anthropogenic global warming to date.[16] Due to forecast increases in aviation demand and other sectors' emissions reduction efforts, the aviation industry could potentially consume more than a quarter of the global

---

[9] *Awad v Twin Creek Properties Pty Ltd* [2011] NSWSC 923, 11 [29] at which Brereton J states that reasonable grounds involve that there be on the part of the representor first, an intention to perform the representation, and secondly, an ability to perform it.

[10] Ibid.

[11] *Campbell v Backoffice Investments Pty Ltd* (2009) 238 CLR 304, 321 [33] at which French CJ states that opinions carry with them the implied representation that the opinion is based on reasonable grounds, which may include that the representation was based on reasonable enquiry.

[12] McKinsey & Company 'Opportunity for industry leaders as new travelers take to the skies' (accessed on 20 January 2023), survey N = 5,500 air travelers from 13 countries.

[13] Oncarbon, 'Sustainable travel consumer attitudes, roadblocks, and opportunities' (accessed on 20 January 2023), survey disseminated using a stratified sample methodology to individuals in United Kingdom, Sweden and Netherlands. Representative sample of respondents N = 641.

[14] Qantas, 'Qantas frequent flyers to be rewarded for being sustainable' (accessed on 20 January 2023).

[15] Etihad, 'Net Zero Carbon Emissions' (accessed on 20 January 2023).

[16] D.S. Lee et al, 'The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018' (2021) 244 Atmospheric Environment 2; Our World in Data, 'Climate change and flying: what share if global CO2 emissions come from aviation?' (accessed on 20 January 2023).

carbon budget until 2050 (the maximum amount of carbon that can be emitted globally in order to stay below 1.5℃).[17]

15. For the reasons set out below, our client believes that attempts by aviation companies to market their services as 'sustainable' and 'net zero' are potentially misleading because such representations fail to engage with the reality that aviation is a significant contributor to global warming, and that current aviation emissions reduction initiatives are not technologically, practically, or economically feasible. Practices of this nature have the potential to impair consumer choice, undermine the integrity of the market by enabling unfair advantage vis a vis competitors, and compromise broader concerted efforts to meet the Paris Agreement goals to limit global warming to well below 2℃, preferably to 1.5℃ compared to pre-industrial levels. The consequences of greenwashing have been acknowledged by the United Nation's High-Level Expert Group on the Net Zero Emissions Commitments of Non-State Entities (**UN Expert Group**), who state that "[d]eceptive or misleading net zero claims by non-state actors not only erode confidence in net zero pledges overall, they undermine sovereign state commitments and understate the work required to achieve global net zero".[18]

Why the Environmental Impact Representation is potentially misleading or deceptive

16. Our client considers that the Environmental Impact Representation is likely misleading because flying with Etihad has a significant adverse environmental impact.

17. In its 2020-2021 Sustainability Report (**Sustainability Report**), Etihad disclosed that:

    a) it emitted a total of 4.31 million tonnes of carbon dioxide (**MtCO2**) in 2021;[19] and

    b) it forecasts an increase in *absolute* carbon dioxide (**CO2**) emissions to 5.47MtCO2 by 2026 due to 'commercial growth'.[20]

18. It seems that the above information in fact significantly understates Etihad's emissions. In particular, it excludes:

    a) non-CO2 emissions, such as NOx and contrails, which comprise 66% of aviation's climate impact.[21] Etihad's Sustainability Report acknowledges that 60% of aviation's climate impact is attributable to contrails, but does not quantify those emissions in its emissions disclosure;[22]

    b) aspects of Etihad's scope 3 emissions. The Sustainability Report includes scope 3 emissions associated with 'Waste to Landfill – Etihad Complex',[23] but does not include other scope 3 emissions relevant to airlines such as Etihad, including emissions involved in the manufacture of aircraft.

---

[17] CarbonBrief, 'Analysis: Aviation could consume a quarter of 1.5C carbon budget by 2050' (accessed on 20 January 2023).
[18] EN Expert Group, *Integrity Matters: Net zero commitments by businesses, financial institutions, cities and regions'* (Report, 8 November 2022), p 6. (**UN Recommendations**).
[19] Sustainability Report, p 6.
[20] Sustainability Report, p 15.
[21] D.S. Lee et al, 'The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018' (2021) 244 Atmospheric Environment 2; Our World in Data, 'Climate change and flying: what share if global CO2 emissions come from aviation?' (accessed on 20 January 2023).
[22] Sustainability Report, p 17.
[23] Sustainability Report, p 6.

19. The relationship between global warming and the emission of CO2 and other greenhouse gases is well-documented and unequivocal.

20. The impacts of global warming are already being felt.[24] Prominent examples include increased bleaching of Australia's Great Barrier Reef and other coral reefs,[25] increased and more intense heatwaves (such as the recent South-East Asian heatwave, which was 30 times more likely due to climate change),[26] and increased fire weather, with often serious consequences for Australia such as the 2019 bushfires.[27]

21. As noted above, the expansion plans of airlines such as Etihad means that the aviation industry could consume more than 25% of the global carbon budget until 2050.[28]

22. The Environmental Impact Representation is incongruous with Etihad's current and forecasted emissions, and the well-documented environmental impacts of such emissions. As such, our client considers that the Representation is likely to mislead consumers about the environmental impact of flying with Etihad.

Why the Net Zero Representations are potentially misleading or deceptive

23. Our client considers that the Net Zero Representations are likely misleading because Etihad did not:

    a) *intend* or *expect* to achieve net zero by 2050;[29] or

    b) have *reasonable grounds* to believe that it would achieve net zero by 2050.[30]

24. Further, our client considers that the Net Zero Representations are in 'the nature of a promise, forecast, prediction or other like statement about something that will only transpire in the future'.[31] They convey 'something about what may (or may not) happen'[32] and are consequently not 'capable of being proven true or false when made'.[33] They are therefore likely to be representations as to future matters for the purposes of s 4(1) of the ACL, requiring the existence of 'reasonable grounds' *at the time of making the representation.*[34]

Definition of 'net zero'

25. The term 'net zero' is derived from Art 4.1 of the Paris Agreement, and requires 'a state by which the greenhouse gases going into the atmosphere are reduced as close to zero as possible and

[24] IPCC, 'Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change' (2022).
[25] T P Hughes et al, 'Spatial and temporal patterns of mass bleaching of corals in the Anthropocene' (2022) 359 (6371) *Science* 80.
[26] M Zachariah et al, 'Climate change made devastating early heat in India and Pakistan 30 times more likely' (2022).
[27] IPCC, 'Regional Fact Sheet – Australasia' (2021).
[28] CarbonBrief, 'Analysis: Aviation could consume a quarter of 1.5C carbon budget by 2050' (accessed on 20 January 2023).
[29] *Awad v Twin Creek Properties Pty Ltd* [2011] NSWSC 923, 11 [29].
[30] *Campbell v Backoffice Investments Pty Ltd* (2009) 238 CLR 304, 321 [33].
[31] *Australian Competition and Consumer Commission v Woolworths Group Limited* (2020) 281 FCR 108, 145-146 [132] (the Court).
[32] *Samsung Electronics Australia Pty Ltd v LG Electronics Australia Pty Ltd* (2015) 113 IPR 11, 27 [84].
[33] *Australian Competition and Consumer Commission v Woolworths Group Limited* (2020) 281 FCR 108, 145-146 [132] (the Court).
[34] *Sykes v Reserve Bank of Australia* (1998) 158 ALR 710, 712 (Heerey J).

any residual emissions are balanced by permanent removals from the atmosphere by 2050'.[35] According to the UN Expert Group, in order to be consistent with this definition, corporate net zero targets must be consistent with Intergovernmental Panel on Climate Change (**IPCC**) or International Energy Agency (**IEA**) pathways that limit warming to 1.5℃, prioritise urgent and deep emissions reductions, and only use carbon credits for residual emissions.[36] Further, net zero targets must account for all greenhouse gas emissions, not just CO2.[37]

26. In the IEA's net zero by 2050 pathway, nearly 80% of emissions reductions in transport in 2050 'come from measures to reduce passenger aviation demand, with the remainder from road transport.'[38] The reduction in aviation demand is required because of the 'scarcity of commercially available options to eliminate all emissions' from aviation.[39]

Etihad's net zero target and plan

27. Etihad publicly announced its net zero target on 15 January 2020.

28. It is difficult to discern Etihad's plan to achieve net zero emissions from its latest Sustainability Report, website, or any other publicly available information.

29. Instead, a page titled 'Flying towards zero emissions' on Etihad's website[40] and its Sustainability Report detail a number of emissions reductions initiatives that Etihad intends to pursue. These initiatives include:

    a) the Etihad Greenliner Programme, which involves ecoFlight and ecoDemonstrator initiatives; and

    b) the Sustainable50 Programme, which involves using A350s as flying 'testbeds' for technological innovation and development.

30. From an analysis of these programs, the component sustainability initiatives which are relied upon by Etihad to achieve net zero emissions can be classified into the following overarching categories:

    a) development and implementation of Sustainable Aviation Fuels (**SAFs**);

    b) offsetting carbon emissions using credits and offset programs; and

    c) implementation of more efficient operational and engineering technologies.

Etihad does not intend or expect to achieve net zero emissions by 2050

31. Our client considers that Etihad does not intend or expect to achieve net zero emissions by 2050 because:

    a) Etihad in fact intends to *increase* its absolute CO2 emissions;

---

[35] UN Recommendations, p 15.
[36] Ibid, p 12; Science Based Targets Initiative, *Corporate Net-Zero Standard* (Report, October 2021) p 16 (**SBTI Standard**).
[37] UN Recommendations, p 12; SBTI Standard, p 17.
[38] IEA, *Net Zero by 2050 - A Roadmap for the Global Energy Sector* (Report, May 2021) p 69 (**IEA Report**).
[39] IEA Report, p 42.
[40] Etihad, 'Flying towards net zero emissions' (accessed on 20 January 2023).

b) Etihad's net zero target does not account for non-CO2 emissions that comprise the majority of the aviation industry's contribution to global warming;

c) Etihad's net zero target seemingly does not account for scope 3 emissions;

d) contrary to the UN Expert Group and the relevant IEA pathway for limiting warming to 1.5℃, Etihad intends to increase its number of flights; and

e) based on publicly available information, Etihad does not have a credible or feasible plan for how it will achieve net zero emissions by 2050.

32. In relation to Etihad's intention to increase its absolute CO2 emissions, Etihad claims that it achieved a 57% reduction in emissions in 2021, as compared to its 2019 emissions baseline.[41] Our client considers this claim is disingenuous, as it is premised on an emissions baseline that pre-dates the COVID-19 pandemic and associated aviation stoppages. Indeed, Etihad's Sustainability Report forecasts that its absolute emissions will increase from 4.22MtCO2 in 2021 to 5.47MtCO2 in 2026.[42] Etihad's forecasted growth in absolute CO2 emissions by over a million tonnes to 2026 is not in line with the absolute contraction required to keep global temperature increases to 1.5℃. It is difficult to discern an intention to achieve net zero emissions by 2050 in circumstances where Etihad is actively planning to increase short term absolute emissions.

33. The metrics for Etihad's absolute emissions reductions on page 15 of its Sustainability Report are in CO2 only and exclude scope 3 emissions. As stated above, the majority of the aviation industry's contribution to global warming (66%) is attributable to non-CO2 emissions such as NOx and contrails. The UN Expert Group has been clear that net zero targets must account for *all* greenhouse gas emissions.[43] While Etihad has initiatives to reduce its non-CO2 emissions, its net zero target does not account for these emissions.

34. Further, contrary to the IEA's pathway for the transport sector to limit warming to 1.5℃, there is no indication that Etihad intends to manage consumer demand or reduce actual fights as part of their net zero plan. Etihad's Sustainability Report forecasts that, despite its CO2 emissions *intensity* decreasing from 591 to 436 CO2/RTK(g) during 2021 to 2026, its *absolute* CO2 emissions are forecast to increase over the same period.[44] This disparity can only be attributable to an increase in the revenue tonne kilometers flown. That is, an increase in the number of Etihad flights.

35. In contrast to these concrete plans to increase its number of flights and absolute CO2 emissions, Etihad does not, based on publicly available information, have a credible plan to reduce its emissions to 'net zero' by 2050. Instead, it merely has a number of emissions reduction initiatives – for which it appears there is no modelling regarding the associated emissions reductions – that rely heavily on speculative innovation. For example, the Etihad website explains that it will achieve net zero emissions by 2050 by '*continuing to innovate* through EcoFlights, using sustainable fuels, reducing and recycling waste, *innovating* in fuel consumption and utilising electric ground transportation'[45] (emphasis added). The UN Expert Group emphasised the importance of 'comprehensive and actionable net zero plans which indicate actions that will be undertaken to meet all targets'.[46] Etihad's reliance on 'continued

[41] Sustainability Report, p 15.
[42] Sustainability Report, p 15.
[43] UN Recommendations, p 12; SBTI Standard, p 17.
[44] Sustainability Report, p 15.
[45] Etihad, 'Net Zero Carbon Emissions' (accessed on 20 January 2023).
[46] UN Recommendations, p 21.

innovation' is highly speculative and contrary to the 'transparent' and 'actionable' recommendations of the UN Expert Group. The innovation Etihad relies on is particularly concerning given the rate of improvement in fuel efficiency and engineering optimisation is progressively slowing down,[47] and that future innovation is not expected to match the projected increase in air traffic.[48]

Etihad does not have reasonable grounds to believe it will achieve net zero emissions by 2050

36. Our client considers that, in light of the above, Etihad does not have reasonable grounds to believe it will achieve net zero emissions by 2050.

37. Further, for the reasons stated below, the emissions reductions associated with the initiatives on which Etihad relies are, at best, uncertain.

Sustainable Aviation Fuels

38. SAFs are liquid hydrocarbon fuels that can be used in existing aircrafts in place of kerosene produced from fossil fuels. SAFs appear to be a major component of Etihad's net zero strategy and are said to contribute a significant portion of the emissions reductions associated with Etihad's 'Greenliner' and 'Sustainable50' programs (although these emissions reductions do not appear to have been modelled or quantified). Etihad's website states that it is 'leading the development of new sustainable fuels' which includes the creation of biofuels from saltwater tolerant plants and the conversion of Abu Dhabi's waste into fuel.[49]

39. While SAFs are a cleaner alternative to traditional fossil fuels, there are currently many limitations that prevent them from being 'net zero' and implemented at a commercial scale. In their 2019 update on Global Environmental Trends, the International Civil Aviation Organisation (**ICAO**) concluded that 'significant uncertainties exist in predicting the contribution of sustainable aviation fuels in the future'.[50]

40. The key limitations of SAFs are:

    a) *Limited emissions reduction potential:* While SAFs can reduce greenhouse gas emissions compared to traditional fossil fuels, they may not be able to fully decarbonise the aviation sector. Notably, SAFs do not eliminate the non-CO2 aviation biproducts (such as NOx and contrail cirrus) which contribute to approximately two thirds of the aviation industries global warming yield.[51] The decarbonisation potential of SAFs is further limited by the fact they cannot be used 'neat', but only in a blend with existing jet diesel.

    b) *Limited availability:* Currently, SAFs are not widely available, making it difficult for airlines to incorporate them into their operations on a large scale. For example, Etihad's production of second-generation biofuel from Abu Dhabi's waste is severely constrained by the availability of waste which will likely be needed for other competing purposes, such as feeding a growing population whilst also decarbonising power, heating and agriculture.[52]

[47] ICAO, 'Trends in Emissions that Affect Climate Change' (accessed on 20 January 2023).
[48] Cabrera E & Melo de Sousa J, 'Use of Sustainable Fuels in Aviation – A Review' (2022) 15(7) *Energies* 3.
[49] Etihad, 'Sustainability' (accessed on 20 January 2023).
[50] ICAO, 'Trends in Emissions that Affect Climate Change' (accessed on 20 January 2023).
[51] D.S. Lee et al, 'The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018' (2021) 244 Atmospheric Environment 2.
[52] Stay Grounded, 'Biofuels Factsheet' (accessed on 20 January 2023).

c) *High cost:* SAFs are often more expensive than traditional fossil fuels, which can be a barrier for airlines looking to switch to more sustainable options.

d) *Infrastructure challenges:* The infrastructure needed to produce, distribute, and use SAFs is not yet fully developed, which can make it difficult for airlines to access these fuels at a commercial scale. This is relevant to Etihad's proposed generation of first-generation biofuel from saltwater tolerant plants. Use of first-generation biofuel can lead to very serious environmental impacts such as biodiversity loss and deforestation.[53]

e) *Compatibility issues*: Some types of SAFs may not be compatible with existing aircraft or airport infrastructure, which can limit their use.

41. In 'best case scenario' modelling, whereby 100% of international aviation jet fuel demand was met with SAFs in 2050, both ICAO and the International Air Transport Association (**IATA**) respectively determined that only a corresponding 63% and 65% reduction in CO2 emissions would be achieved.[54] In order to achieve this modelled scenario, the ICAO reasoned that 'extremely large capital investments' and 'substantial policy support' would be required to an extent 'significantly exceed[ing] historical precedent for other fuels, such as ethanol and biodiesel for road transportation'.[55]

42. Similar reticence towards SAFs appeared in a 2022 review of the use of sustainable fuels in aviation, which stated that:[56]

> *There are numerous barriers to the scale-up and expansion of the alternative fuels market, which can be classified in various categories - the lack of maturity of some, if not most, of the fuel pathways; unavailability of required feedstock quantities and, in the case of bio SAFs, sustainability problems associated with the increase in feedstock production; and not enough support from governments to accelerate and facilitate the fossil to renewable conversion.*

43. Such limitations of SAFs can be observed in the most recent ecoFlight undertaken by Etihad in October 2021, in which only '38% SAF was utilized on the flight' and the remaining emissions needed to be '100% carbon offset'.[57]

44. Lastly, beyond the technical limitations of SAFs outlined above, Etihad's intended use of SAFs is through a book and claim model. On their website, Etihad provides an example of what the book and claim model looks like in practice:

> *The NetZero flight will use conventional Jet-A1 fuel, and the SAF we purchase will be used on flights by other airlines out of LAX. That's because LAX has the infrastructure to take delivery of and distribute World Energy's SAF.*[58]

45. The expert report of Derik Broekhoff in the KLM case makes it clear that, in order to claim that a customer's purchase of SAF reduces greenhouse gas emissions from flying, it must be shown that the purchase directly leads to an increased use of SAF on the customer's flight, beyond the amount of SAF that would have been used without the purchase. Mr Broekhoff's expert report is contained at **Annexure B.** The book and claim system used by Etihad does not align with the

---

[53] Ibid.
[54] ICAO, 'Trends in Emissions that Affect Climate Change' (accessed on 20 January 2023); IATA, 'Net zero 2050: sustainable aviation fuels' (accessed on 20 January 2023).
[55] ICAO, 'Trends in Emissions that Affect Climate Change' (accessed on 20 January 2023).
[56] Cabrera E & Melo de Sousa J, 'Use of Sustainable Fuels in Aviation – A Review' (2022) 15(7) *Energies* 3, p 16.
[57] Sustainability Report, p 9.
[58] Etihad, 'Sustainable Flights' (accessed on 20 January 2023).

expert opinion of Mr Broekhoff, given that the SAFs purchased by Etihad are not used on Etihad flights.

Hydrogen

46. Etihad has expressed an intention to 'achieve hydrogen viability between 2025-2027 for full integration in 2030'.[59]

47. The potential of hydrogen fuel cells for the aviation industry is limited by their range. Currently, hydrogen fuel cell aircrafts are only being developed for short-range flights, and it is unlikely that hydrogen turbine aircrafts will be able to cover long distances.[60] This is because hydrogen has a lower energy by volume than conventional kerosene, which makes it difficult to store enough fuel for longer flights.[61] The properties of hydrogen also make it very difficult to store; it is highly flammable and requires highly pressurised tanks to contain it.[62] Further, use of hydrogen fuel in jet engines does not prevent the generation of harmful NOx and contrail cirrus which contribute significantly to the global warming effects of aviation.[63]

48. Hydrogen fuel in aviation is unproven, with many technical and safety aspects yet to be understood. Airbus has admitted that hydrogen will not be widely used in planes before 2050, stating that only regional 50-100 seaters would be ready for hydrogen in the 2030s, a small market with a small share of current CO2 emissions.[64] For these reasons, it is unlikely Etihad will be able to achieve 'full integration' of hydrogen by 2030.

Carbon credits and offsets

49. Carbon offsetting is a key component of Etihad's net zero emissions by 2050 efforts. In the Sustainability Report, Etihad states that it is committed to the Carbon Offset and Reduction Scheme for International Aviation (**CORSIA**) which 'pledges carbon neutral growth by airlines from 2020, with net emissions by 2050 reducing to *50 per cent* of 2005 levels'.[65]

50. We note that this commitment only concerns *growth* in airlines' emissions from 2020. That is, it treats airlines' 2019 emissions as a baseline, and only seeks to 'offset' emissions above and beyond that baseline. This means that airlines are allowed to continue emitting at 2019 levels completely unabated. In Etihad's case, its reported 2019 emissions were 9.11MtCO2, which is more than double its emissions in 2021 due to COVID-19-related travel disruptions.[66] The consequence is that Etihad's CORSIA commitment currently applies to zero of its emissions. As such, this commitment is clearly insufficient to support a claim that Etihad intends, expects or has reasonable grounds to believe it will achieve net zero emissions by 2050.

51. More importantly, our client considers the use of offsets in the manner Etihad proposes – that is, offsets being used to compensate for continued emissions growth – is fundamentally inconsistent with the 'urgent and deep' emissions reductions required to achieve net zero

[59] Sustainability Report, pp 19, 20.
[60] Cabrera E & Melo de Sousa J, 'Use of Sustainable Fuels in Aviation – A Review' (2022) 15(7) *Energies* 3, p 15.
[61] Airbus, 'How to Store Liquid Hydrogen for Zero-Emission Flight' (accessed 20 January 2023).
[62] IATA, 'Fact Sheet 7: Liquid Hydrogen as A Potential Low-Carbon Fuel for Aviation' (accessed on 20 January 2023).
[63] Stay Grounded, 'Hydrogen Factsheet' (accessed on 20 January 2023).
[64] Euronews.next, 'Hydrogen planes won't take off until 2050, Airbus has admitted to the EU' (accessed on 20 January 2023).
[65] Sustainability Report, p 26.
[66] Sustainability Report, p 6.

emissions by 2050.[67] To the extent offsets can legitimately remove CO2 from the atmosphere, this removal is urgently needed to cool an already overheated planet. Australia has already warmed by 1.4℃,[68] and, in 2022 alone, the world experienced 10 climate-related disasters costing more than USD$3 billion each.[69] It is for this reason that existing standards for corporate net zero commitments prohibit offsets being counted towards emissions reductions.[70]

52. The offsetting initiatives that Etihad relies on are particularly problematic, given any removals achieved by ecosystem-based offsets are necessarily temporary.[71] For example, Etihad lists the following offset projects that it supports:

    a) Makame Savannah REDD Project: Tanzania Forestry.[72] This project is a conservation-based initiative which generates offsets by preventing the deforestation of a wildlife management area in the Makame Savannah Rift Valley.[73]

    b) Etihad Mangrove Forest (Jubail Island).[74] This project enables customers to 'adopt' existing mangrove trees surrounding Jubail island and in so doing 'conserve the trees to address the climate crisis and safeguard precious biodiversity'.[75]

53. The Sustainability Report also states that Etihad has 'aspirations to establish a mangrove forest in Abu Dhabi of up to 182,000 mangroves in 2022, with the ability to develop forests in destinations across our network'.[76] This program was launched in February 2022, and Etihad customers now have the option to plant and adopt a mangrove plant in the Etihad Mangrove Forest as a way of offsetting their emissions.[77] In relation to a similar ecosystem-based offset initiative used by KLM, Derik Broekhoff stated that airlines may 'not validly claim that purchasing carbon credits from a restoration project can truly compensate for, or reduce, the climate impacts of flying.'[78] Summarily, Mr Broekhoff stated the following:

    [O]ffsetting 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.[79]

54. Mr Broekhoff's full expert report is contained at **Annexure B.**

---

[67] UN Recommendations.
[68] Australian Government, *State of the Environment Report* (2021).
[69] Christian Aid, *Counting the Cost: A year of climate breakdown* (December 2022) p 5.
[70] UN Recommendations; SBTI Standard.
[71] Climate Social Science Network, *CCSN Position Paper: Net Zero, Carbon Removal and the Limitations of Carbon Offsetting* (2022) pp 7-8.
[72] Ibid.
[73] CarbonTanzania, 'Makame Savannah project' (accessed on 20 January 2023).
[74] Sustainability Report, p 27; Etihad, 'Etihad Mangrove Forest' (accessed on 20 January 2023).
[75] Mashable Middle East, 'Etihad Airways launches Etihad mangrove forest in Abu Dhabi with tree adoption initiative' (accessed on 20 January 2023).
[76] Etihad, 'Etihad Airways commits to adopt a mangrove tree for every guest who books Economy Space' (accessed on 20 January 2023).
[77] Sustainability Report, p 27; Etihad, 'Etihad Mangrove Forest' (accessed on 20 January 2023).
[78] Derik Broekhoff, 'Expert Report – Derik Broekhoff' (accessed on 20 January 2023) (**Broekhoff Report**).
[79] Broekhoff Report, p 5.

Aviation optimisation

55. Aviation optimisation refers to the use of various operational techniques and engineering technologies to improve the efficiency and effectiveness of the aviation industry. Optimisation is driven by the fuel efficiency of individual aircraft, operational efficiency (for example, the air traffic management system) and capacity utilisation of flights. Recent analysis that modelled the projected emissions reductions from optimisation projects against the forecasted growth of the aviation industry up to 2050 found that aviation CO2 emissions would increase by a factor of 1.3 to 2.[80] Or, in other words, the rate of CO2 emissions increase from the growth of the aviation industry exceeds the forecasted reductions from optimisation activities.

56. Etihad's net zero initiatives include the following optimisation initiatives:

    a) GE engine foam wash;[81]

    b) 'close coordination between airlines and air navigation service providers';[82]

    c) 'expeditated taxi time to reduce additional fuel burn';[83]

    d) implementation of 'continuous decent';[84] and

    e) implementation of new 'flight planning technology to identify flight paths that use less fuel'.[85]

57. Etihad only implements their optimisation initiatives on a select 'testbed of ecoFlights flights', which occur sporadically throughout the year.[86] Indeed, the 'Etihad Sustainable Flight', which is described as an 'all-encompassing ecoflight which saw a 72% reduction in absolute emissions compared to an equivalent flight in 2019', relied on the coordination of 'dozens of partners' to demonstrate the 'art of the possible' on a single -off flight. Etihad itself concedes:[87]

    > *While our ecoflight programme throughout 2020-2021 was successful in demonstrating opportunities for emissions reductions, the fact remains that many of these initiatives cannot be readily deployed today in regular commercial airline operations due to inherent industry limitations. Governments must support the industry in realizing the possibilities.*

Contrail management technology

58. Additionally, Etihad includes a detailed presentation of SATIVA contrail prevention technology in its Sustainability Report. Contrail avoidance can be achieved by making small adjustments to a flight's altitude in order to avoid flying through atmospheric conditions that are conducive to contrail formation.[88]

---

[80] Dray L et el, 'Cost and emissions pathways towards net-zero climate impacts in aviation' (2022) 12 *Nature Climate Change* 958.
[81] Sustainability Report, p 10.
[82] Sustainability Report, p 9.
[83] Sustainability Report, p 9.
[84] Sustainability Report, pp 9, 16.
[85] Sustainability Report, pp 9, 16.
[86] Sustainability Report, p 9.
[87] Sustainability Report, p 9.
[88] Dray L et el, 'Cost and emissions pathways towards net-zero climate impacts in aviation' (2022) 12 *Nature Climate Change* 958.

59. Etihad states that it will 'continue to work with SATIVA to continue in depth trials and development of the DECISIONX:NETZERO contrail prevention platform'.[89] This sustainability initiative is still embryonic and subject to further trial and testing. Currently, contrail avoidance technologies (such as SATIVA) are limited by:

    a) additional fuel burn increases involved in adjusting flight altitude (for example, implementation of the SATIVA software on the Etihad Sustainable flight caused a fuel burn increase of 100kgs);[90] and

    b) inaccurate weather prediction data and technology.[91]

Potential legal contraventions

60. Section 18 of the ACL states:

    A person must not, in trade or commerce, engage in conduct that is misleading or deceptive or is likely to mislead or deceive.

61. The Statements are also likely to raise concerns about potential breaches of s 29 of the ACL. Section 29 relevantly states:

    (1) A person must not, in trade or commerce, in connection with the supply or possible supply of goods or services or in connection with the promotion by any means of the supply or use of goods or services:

        (b) make a false or misleading representation that services are of a particular standard, quality, value or grade;

        …

        (g) make a false or misleading representation that goods or services have sponsorship, approval, performance characteristics, accessories, uses or benefits; or

        (h) make a false or misleading representation that the person making the representation has a sponsorship, approval or affiliation.

62. When determining whether conduct is misleading or deceptive the central question is whether the impugned conduct, viewed as a whole, has a sufficient tendency to lead a person exposed to the conduct into error.[92] In making this assessment it is unnecessary to prove that the conduct in question actually deceived or misled anyone.[93] Additionally, if the conduct in question is directed to the public (or a section of the public), the Court will consider the likely effect on an ordinary and reasonable person in the relevant class to whom the conduct is directed.[94]

---

[89] Sustainability Report, p 17.
[90] Sustainability Report, p 9.
[91] Teoh, R et al, 'Mitigating the climate forcing of aircraft contrails by small-scale diversions and technology adoption' (2020) *54(5) Environmental Science & Technology* 2942-2943.
[92] *Australian Competition and Consumer Commission v TPG Internet Pty Ltd* (2020) 278 FCR 450, 458 (the Court).
[93] *Taco Co of Australia Inc v Taco Bell Pty Ltd* (1982) 42 ALR 177, 202 (Deane and Fitzgerald JJ).
[94] *Campomar Sociedad, Limitada v Nike International Ltd* (2000) 202 CLR 45, 85 (the Court).

63. The relevant class to whom Etihad's Statements are directed are members of the public who are concerned about climate change and are seeking to travel domestically or internationally via airplane.

64. For the above reasons, our client considers that the Environmental Impact Representation and Net Zero Representations are likely to mislead the relevant class of persons. The misleading potential of the Representations is exacerbated by the fact the Statements were made during brief advertisements at a soccer game with no contextual information about Etihad's emissions or net zero plan, meaning the relevant class of persons would have to 'find their way to the truth' in this regard.[95]

65. Further, the Statements were made 'in trade or commerce' because they were 'promotional activities in relation to, or for the purposes of, the supply of goods or services' to actual or potential Etihad customers.[96] As explained above, aviation companies' attempts to mitigate the environmental impact of flying are now a material consideration for many consumers.

Request to investigate

66. For the reasons set out above, and given the ongoing nature of Etihad's conduct, our client requests the ACCC investigate the concerns raised by our client and take such compliance action as is deemed appropriate.

67. In particular, given the current prominence of net zero plans in the aviation industry, our client requests that the ACCC communicates the importance of companies such as Etihad considering and disclosing the implications of their environmental impacts and emissions trajectories more transparently in future statements and reports.

68. We look to your response to the matters raised above. Please contact us by email to Zoe Bush at zoe.bush@edo.org.au.

Yours faithfully

Environmental Defenders Office

Zoe Bush

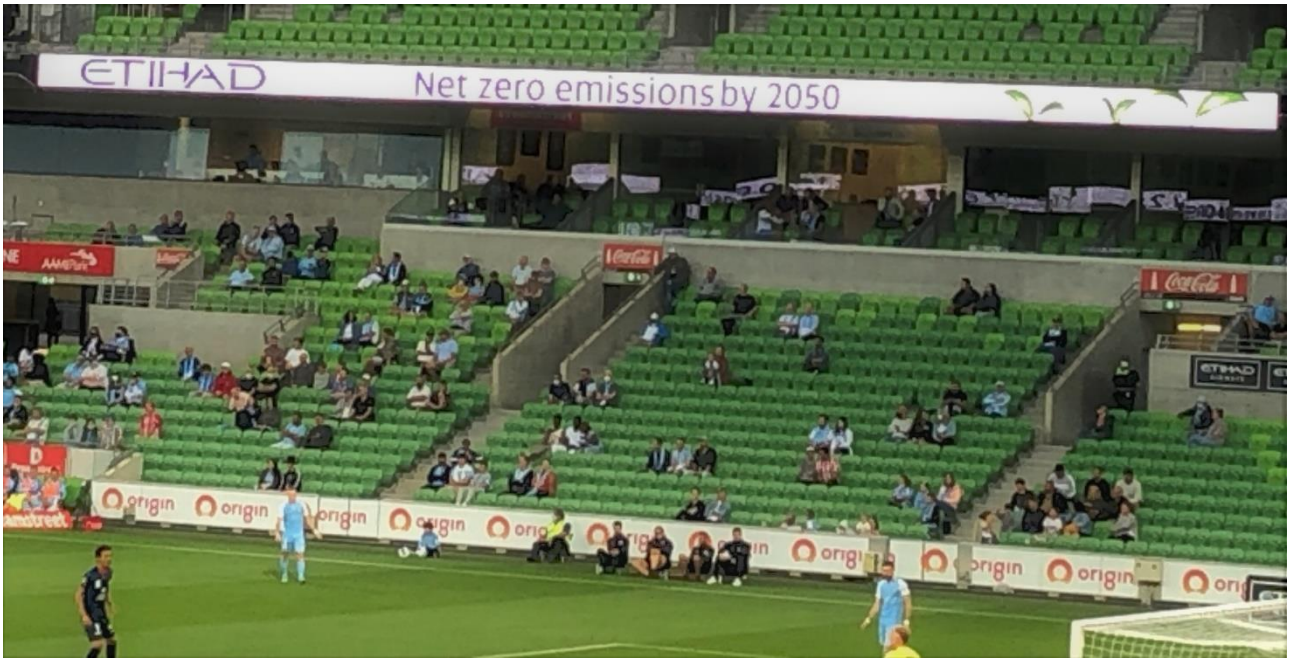
Senior Solicitor

Safe Climate (Corporate)

[95] *ACCC v TPG Internet Pty Ltd* (2013) 250 CLR 640, 656-657 [54] (French CJ, Crennan, Bell and Keane JJ).
[96] *Concrete Constructions (NSW) Pty Ltd v Nelson* (1990) 169 CLR 594, 603-604 (Mason CJ, Deane, Dawson and Gaudron JJ).

Annexure A

Photographs of Etihad Advertisements dated 15 February 2022



Annexure B

Expert Report of Derik Broekhoff dated 4 July 2022

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 CO_2 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 CO_2 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 CO_2 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 CO_2-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 CO_2, 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 (CO_2) (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 CO_2 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 CO_2 emissions and increase the removal of CO_2 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).

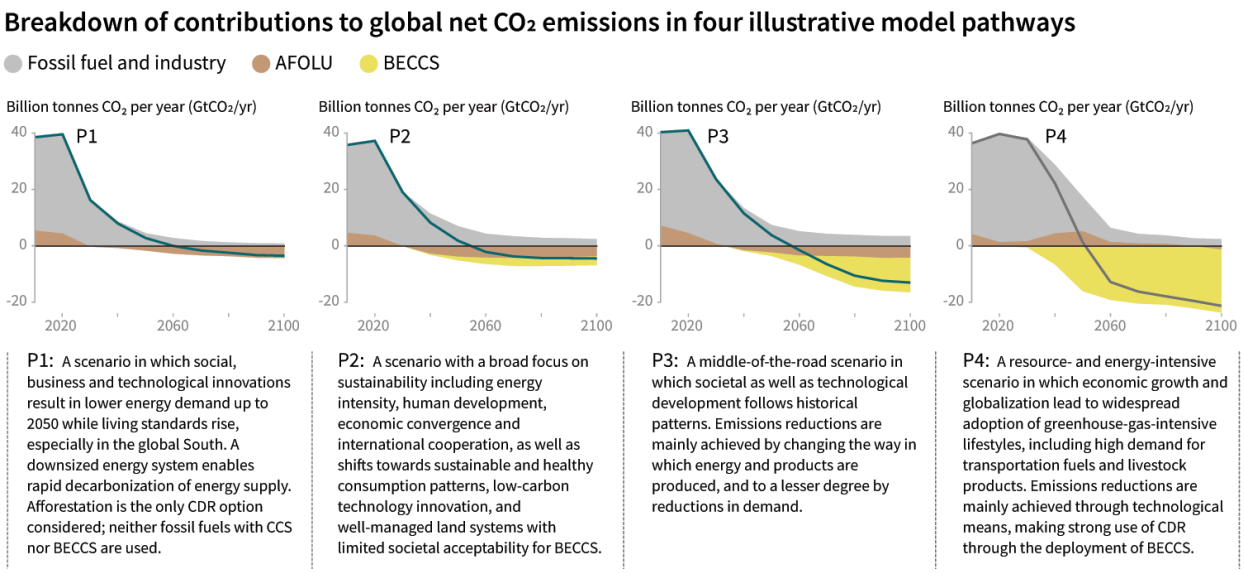


Figure 1. Illustrative pathways for limiting net cumulative emissions to keep global warming below 1.5°C (IPCC 2018)

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-CO_2 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 CO_2, 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 CO_2 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 CO_2 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 (Fearnehough 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

Alexeew, J., Bergset, L., Meyer, K., Petersen, J., Schneider, L. and Unger, C. (2010). An analysis of the relationship between the additionality of CDM projects and their contribution to sustainable development. *International Environmental Agreements: Politics, Law and Economics*, 10(3). 233–48. DOI: 10.1007/s10784-010-9121-y

Allen, M., Axelsson, K., Caldecott, B., Hale, T., Hepburn, C., et al. (2020). *The Oxford Principles for Net Zero Aligned Carbon Offsetting*. University of Oxford. https://www.smithschool.ox.ac.uk/publications/reports/Oxford-Offsetting-Principles-2020.pdf

Allen, M. R., Frame, D. J., Huntingford, C., Jones, C. D., Lowe, J. A., Meinshausen, M. and Meinshausen, N. (2009). Warming caused by cumulative carbon emissions towards the trillionth tonne. *Nature*, 458(7242). 1163–66. DOI: 10.1038/nature08019

Archer, D., Eby, M., Brovkin, V., Ridgwell, A., Cao, L., et al. (2009). Atmospheric Lifetime of Fossil Fuel Carbon Dioxide. *Annual Review of Earth and Planetary Sciences*, 37(1). 117–34. DOI: 10.1146/annurev.earth.031208.100206

Becken, S. and Mackey, B. (2017). What role for offsetting aviation greenhouse gas emissions in a deep-cut carbon world? *Journal of Air Transport Management*, 63. 71–83. DOI: 10.1016/j.jairtraman.2017.05.009

Broekhoff, D., Gillenwater, M., Colbert-Sangree, T. and Cage, P. (2019). *Securing Climate Benefit: A Guide to Using Carbon Offsets*. Stockholm Environment Institute and Greenhouse Gas Management Institute. http://www.offsetguide.org/pdf-download/

Cames, M., Harthan, R. O., Fussler, J., Lazarus, M., Lee, C. M., Erickson, P. and Spalding-Fecher, R. (2016). *How Additional Is the Clean Development Mechanism? Analysis of the Application of Current Tools and Proposed Alternatives*. CLIMA.B.3/SERI2013/0026r. Prepared for DG Clima by Oko-Institut, INFRAS, Stockholm Environment Institute (SEI), Berlin. https://ec.europa.eu/clima/sites/clima/files/ets/docs/clean_dev_mechanism_en.pdf

Ciais, P., Sabine, C., Bala, G., Bopp, L., Brovkin, V., et al. (2014). Carbon and Other Biogeochemical Cycles. In *Climate Change 2013: The Physical Science Basis: Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*.. Cambridge University Press, New York

Dooley, K. and Kartha, S. (2018). Land-based negative emissions: risks for climate mitigation and impacts on sustainable development. *International Environmental Agreements: Politics, Law and Economics*, 18(1). 79–98. DOI: 10.1007/s10784-017-9382-9

Dufrasne, G. (2018). *The Clean Development Mechanism: Local Impacts of a Global System*. Carbon Market Watch. https://carbonmarketwatch.org/wp-content/uploads/2018/10/CMW-THE-CLEAN-DEVELOPMENT-MECHANISM-LOCAL-IMPACTS-OF-A-GLOBAL-SYSTEM-FINAL-SPREAD-WEB.pdf

Dugast, C. (2020). *Net Zero Initiative: A Framework for Collective Carbon Neutrality*. Carbone 4. https://www.carbone4.com/wp-content/uploads/2020/04/Carbone-4-NZI-Guidelines-april-2020-1.pdf

Eby, M., Zickfeld, K., Montenegro, A., Archer, D., Meissner, K. J. and Weaver, A. J. (2009). Lifetime of anthropogenic climate change: Time-scales of CO2and temperature perturbations. *IOP Conference Series: Earth and Environmental Science*, 6(4). 042015. DOI: 10.1088/1755-1307/6/4/042015

Fearnehough, H., Kachi, A., Mooldijk, S., Warnecke, C. and Schneider, L. (2020). *Future Role for Voluntary Carbon Markets in the Paris Era*. Umweltbundesamt. https://www.umweltbundesamt.de/en/publikationen/future-role-for-voluntary-carbon-markets-in-the

Gold Standard (2021). *Treatment of Double Counting and Corresponding Adjustments in Voluntary Carbon Markets*. Gold Standard. https://www.goldstandard.org/sites/default/files/documents/gs_guidance_correspondingadjustments_feb2021.pdf

Greenpeace UK (2021). *Net Expectations: Assessing the Role of Carbon Dioxide Removal in Companies' Climate Plans*. Greenpeace UK. https://www.greenpeace.org.uk/wp-content/uploads/2021/01/Net-Expectations-Greenpeace-CDR-briefing.pdf

Haya, B. (2007). *Failed Mechanism: How the CDM Is Subsidizing Hydro Developers and Harming the Kyoto Protocol*. International Rivers, Berkeley, CA.

https://www.researchgate.net/publication/254412849_Failed_Mechanism_How_the_CDM_is_Subsidizing_Hydro_Developers_and_Harming_the_Kyoto_Protocol

Haya, B. (2009). *Measuring Emissions Against an Alternative Future: Fundamental Flaws in the Structure of the Kyoto Protocol's Clean Development Mechanism*. University of California, Berkeley

Haya, B., Cullenward, D., Strong, A. L., Grubert, E., Heilmayr, R., Sivas, D. A. and Wara, M. (2020). Managing uncertainty in carbon offsets: insights from California's standardized approach. *Climate Policy*, 20(9). 1112–26. DOI: 10.1080/14693062.2020.1781035

Haya, B. and Parekh, P. (2011). *Hydropower in the CDM: Examining Additionality and Criteria for Sustainability*. ERG-11-01. Energy and Resources Group, University of California Berkeley, Berkeley, CA. http://erg.berkeley.edu/working_paper/index.shtml

Hodgson, C. (2021). US forest fires threaten carbon offsets as company-linked trees burn. *Financial Times*, 3 August 2021. https://www.ft.com/content/3f89c759-eb9a-4dfb-b768-d4af1ec5aa23

International Energy Agency (2021). *Net Zero by 2050 - A Roadmap for the Global Energy Sector*. International Energy Agency. https://www.iea.org/reports/net-zero-by-2050

IPCC (2018). *Global Warming of 1.5°C: An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*. Masson-Delmotte, V., Zhai, P., Pörtner, H.-O., Roberts, D., Skea, J., et al. (eds). Intergovernmental Panel on Climate Change, Geneva, Switzerland. http://www.ipcc.ch/report/sr15/

IPCC (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge

Lee, D. S., Fahey, D. W., Skowron, A., Allen, M. R., Burkhardt, U., et al. (2020). The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018. *Atmospheric Environment*. 117834. DOI: 10.1016/j.atmosenv.2020.117834

Mackey, B., Prentice, I. C., Steffen, W., House, J. I., Lindenmayer, D., Keith, H. and Berry, S. (2013). Untangling the confusion around land carbon science and climate change mitigation policy. *Nature Climate Change*, 3(6). 552–57. DOI: 10.1038/nclimate1804

Matthews, H. D. and Caldeira, K. (2008). Stabilizing climate requires near-zero emissions. *Geophysical Research Letters*, 35(4). DOI: 10.1029/2007GL032388

Matthews, H. D., Gillett, N. P., Stott, P. A. and Zickfeld, K. (2009). The proportionality of global warming to cumulative carbon emissions. *Nature*, 459(7248). 829–32. DOI: 10.1038/nature08047

McLaren, D. P., Tyfield, D. P., Willis, R., Szerszynski, B. and Markusson, N. O. (2019). Beyond "Net-Zero": A Case for Separate Targets for Emissions Reduction and Negative Emissions. *Frontiers in Climate*, 1. DOI: 10.3389/fclim.2019.00004

New Climate Institute and Data-Driven EnviroLab (2020). *Navigating the Nuances of Net-Zero Targets*. New Climate Institute. https://newclimate.org/2020/10/22/navigating-the-nuances-of-net-zero-targets/

Race to Zero (2021). Starting Line and Leadership Practices 2.0. , June 2021. https://racetozero.unfccc.int/wp-content/uploads/2021/04/Race-to-Zero-Criteria-2.0.pdf

Ruthner, L., Johnson, M., Chatterjee, B., Lazarus, M., Fujiwara, N., Egenhofer, C., du Monceau, T. and Brohe, A. (2011). *Study on the Integrity of the Clean Development Mechanism (CDM)*. AEA Technology for the EU Commission

SBTi (2021). *Beyond Value Chain Mitigation FAQ, Version 1.0*. Science Based Targets initiative. https://sciencebasedtargets.org/resources/files/Beyond-Value-Chain-Mitigation-FAQ.pdf

Schallert, B., Stevenson, M., Weber, C., Farsan, A., Nielsen, J., Ponce de León, P. and Collins, N. (2020). *Beyond Science-Based Targets: A Blueprint for Corporate Action on Climate and Nature*. World Wildlife Fund. https://wwf.panda.org/discover/our_focus/climate_and_energy_practice/blog/?1172766/Blueprint-Corporate-Action-Climate-Nature

Schneider, L. (2009). Assessing the additionality of CDM projects: practical experiences and lessons learned. *Climate Policy*, 9(3). 242–54. DOI: 10.3763/cpol.2008.0533

Schneider, L., Broekhoff, D., Mealey, T. and Soparkar, I. (2019). Avoiding Double Counting for CORSIA. *Carbon Mechanisms Review*, no. 3. 19–25.

Schneider, L., Duan, M., Stavins, R., Kizzier, K., Broekhoff, D., et al. (2019). Double counting and the Paris Agreement rulebook. *Science*, 366(6462). 180–83. DOI: 10.1126/science.aay8750

Schneider, L., Kollmuss, A. and Lazarus, M. (2015). Addressing the risk of double counting emission reductions under the UNFCCC. *Climatic Change*, 131(4). 473–86. DOI: 10.1007/s10584-015-1398-y

Schneider, L. and La Hoz Theuer, S. (2019). Environmental integrity of international carbon market mechanisms under the Paris Agreement. *Climate Policy*, 19(3). 386–400. DOI: 10.1080/14693062.2018.1521332

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. https://www.carbon-mechanisms.de/fileadmin/media/dokumente/Publikationen/Studie/2019_O__ko-Institut_CORSIA_Lessons.pdf

Smith, P., Bustamente, M., Ahammad, H., Clark, H., Dong, H., et al. (2014). Chapter 11: Agriculture, Forestry and Other Land Use (AFOLU). In *Climate Change 2014: Mitigation of Climate Change: Working Group III Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change and Edenhofer, O. (eds). Cambridge University Press, New York, NY

Transport & Environment (2022). *Roadmap to Climate Neutral Aviation in Europe*. Transport & Environment. https://www.transportenvironment.org/discover/2050roadmap/

Trexler, M. C. (2019). *Fixing Carbon Offsets: Today's Carbon Offset Standards Undermine the Environmental Integrity of Carbon Markets; We Can Do (Much!) Better*. The Climatographers. https://climatographer.com/wp-content/uploads/2019/10/2019-Trexler_Fixing-Carbon-Offsets.pdf

UNFCCC (2015). *Decision 1/CP.21: Adoption of the Paris Agreement*. United Nations Framework Convention on Climate Change, Bonn, Germany. http://unfccc.int/resource/docs/2015/cop21/eng/10a01.pdf

VCMI (2021). *Aligning Voluntary Carbon Markets with the 1.5˚C Paris Agreement Ambition*. Voluntary Carbon Markets Integrity Initiative. https://vcmintegrity.org/wp-content/uploads/2021/07/VCMI-Consultation-Report.pdf