Climate Action Network (CAN) and International Coalition for Sustainable Aviation (ICSA)
Joint input to the Talanoa Dialogue

CONTRIBUTION OF THE GLOBAL AVIATION SECTOR TO ACHIEVING PARIS AGREEMENT CLIMATE OBJECTIVES

EXECUTIVE SUMMARY

The aviation sector is a top-ten global emitter whose emissions are expected to rise dramatically by mid-century. Under current scenarios, the aviation sector could emit 56 $GtCO_2$ over the period 2016-2050, or one-quarter of the remaining carbon budget.[1] It is critical that the global aviation sector contribute its fair share towards achieving a 1.5°C future. Aviation, therefore, needs to immediately start to reduce its in-sector emissions, then rapidly reduce its emissions and fully decarbonize toward the second half of this century. In addition to the sector's CO_2 emissions, aviation's non-CO_2 effects need to be addressed. Aviation emissions are 2.1% of the global share, but when non-CO_2 effects are included, aviation contributes an estimated 4.9% to the global warming problem. Hence, the global aviation sector must have both zero CO_2 emissions and zero non-CO_2 effects on the climate by the end of the century.

National governments, subnational governments, the aviation industry, international institutions, the private sector, and civil society must do more to harness viable technological and policy solutions to sharply reduce the sector's emissions by 2050 and fully decarbonize within the second half of the century. While current policy measures set by governments are a step forward to addressing aviation's runaway emissions, they are woefully insufficient to achieve necessary levels of deep decarbonization within the sector.

While many stakeholders have a role to play in the aviation industry's decarbonization, bold government action will, in the end, define whether the aviation sector is able to contribute its fair share to ensure a 1.5°C future. A methodical next step for governments—at the subnational, national, regional and international level—is to set long-term decarbonization pathways for aviation that are compatible with the Paris Agreement and a roadmap to adhere to these pathways. The elements of a roadmap for aviation's decarbonization include:

- Deploying near-term technology solutions (efficiency and operational measures and alternative fuels with lower lifecycle emissions than fossil jet fuel);
- Addressing non-CO_2 effects through mitigation measures;
- Investing in transformative, breakthrough clean aviation technologies;
- Strengthening the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA);
- Strengthening the ICAO CO_2 standard;
- Revisiting aviation subsidies;
- Developing new mobility solutions to support modal shift;
- Creating new business models for the aviation industry;
- Climate-proofing aviation against the effects of a changing climate; and
- Ensuring compatibility with the Paris Agreement.

[1] "Analysis: Aviation Could Consume a Quarter of 1.5C Carbon Budget by 2050." Carbon Brief, 8 August, 2016, https://www.carbonbrief.org/aviation-consume-quarter-carbon-budget.

WHERE ARE WE?

The aviation sector is a top-ten global emitter whose emissions are expected to rise dramatically by mid-century. Current policy measures and technologies are inadequate to fully decarbonize the sector by 2050. Parties, the aviation industry, international institutions, the private sector, subnational governments, and civil society must do more to harness viable technological and policy solutions in order to sharply reduce the sector's emissions by 2050 and fully decarbonize within the second half of the century. Failure to do so risks putting the goals of the Paris Agreement out of reach.

The aviation sector is a top-ten global emitter and for 4.9% of the warming impact on the Earth.[2] In 2015, aviation accounted for 2.1% of global CO_2 emissions, which is roughly equivalent to Germany's emissions from fuel combustion.[3] [4] Aviation's climate impact is not restricted to its CO_2 emissions—more than half of aviation's climate impact comes from non-CO_2 effects. Planes release other greenhouse gases and water vapor into the atmosphere, which create warming feedbacks. Taking these non-CO_2 effects into account, the aviation sector comprises 4.9% of historical radiative forcing. Compared with other modes of transportation, aviation has an outsized climate impact, accounting for 12% of global CO_2 emissions from transport.[5]

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The sector's emissions have already risen dramatically since 1990 and are expected to grow exponentially by mid-century. The international aviation sector's emissions rose 54% from 1990 to 2015 and are projected to increase as much as 4.3% annually over the next 20 years.[6] Demand far outpaces the sector's marginal efficiency improvements, and the sector's emissions continue to grow at a rate so fast that not addressing the problem poses a threat to the Paris Agreement targets. While the aviation sector is not easy to decarbonize in the near-term, there are solutions that must be bolstered and accelerated to reduce emissions in the short-term.

In addition to being a major source of emissions, the aviation sector is uniquely exposed to climate impacts presently and increasingly in the future. Airlines are already experiencing climate impacts today. During the summer of 2017, extremely high temperatures grounded hundreds of flights in Arizona, USA since aircraft were not able to generate enough lift to take off in thinner air.[7] Higher temperatures and other climate effects, such as severe turbulence, extreme weather, and high-altitude icing, are only expected to increase flight disruptions over time.[8] In addition to more problems in the air, many airports are expected to be acutely impacted by climate change on the ground. From flooding and other extreme weather events, to sea level rise, to heat buckling runways, airports and airline workers are being exposed to climate impacts and these impacts are projected to increase. Given the unique exposure of airlines and airports to climate impacts, the aviation sector must act now to lessen the impact of climate change in the future, and must begin adapting to a changing climate.

Current policy measures are a step forward to addressing aviation's runaway emissions but are woefully insufficient to decarbonize the aviation sector by mid-century.

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[2] Lee, David S. et al. "Aviation and global climate change in the 21st century." *Atmospheric Environment*, vol. 43, 2009, pp. 3520–3537, http://elib.dlr.de/59761/1/lee.pdf.

[3] *Ibid*.

[4] "CO_2 emissions from fuel combustion." IEA Atlas of Energy, 2018, http://energyatlas.iea.org/#!/tellmap/1378539487.

[5] "Aviation." The International Council on Clean Transportation, 2018, https://www.theicct.org/aviation.

[6] Data from UNFCCC and IEA, 2016. Found in Grewe, Voker. "Climate Impact of Aviation CO_2 and non-CO_2 effects and examples for mitigation options." Transport & Environment, Aviation long-term decarbonisation workshop, 23 January 2018, https://www.transportenvironment.org/sites/te/files/Climate%20impact%20of%20aviation%20CO2%20and%20non-CO2%20effects_Volker%20Grewe.pdf.

[7] Wichter, Zach. "Too Hot to Fly? Climate Change May Take a Toll on Air Travel." *The New York Times,* 20 June 2017, https://www.nytimes.com/2017/06/20/business/flying-climate-change.html.

[8] Pearce, Fred. "Climate Change Spells Turbulent Times Ahead for Air Travel," 19 February 2018, *The Guardian,* https://www.theguardian.com/environment/2018/feb/19/climate-change-spells-turbulent-times-ahead-for-air-travel.

Current policy measures are a step forward to addressing aviation's runaway emissions, but are woefully insufficient to decarbonize the aviation sector by mid-century. These measures include the ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), the ICAO CO_2 emissions standard for new aircraft, and the European Union Emissions Trading System (EU ETS).

ICAO CARBON OFFSETTING AND REDUCTION SCHEME FOR INTERNATIONAL AVIATION (CORSIA)

CORSIA aims to achieve carbon-neutral growth from 2020 for international aviation. CORSIA is expected to cover 78% of the sector's CO_2 emissions above 2020 levels for the duration of the scheme, from 2021-2035.[9] This amounts to an estimated 21.6% of the sector's emissions over this period. Importantly, emissions reductions are subject to the quality of offsets and alternative fuels allowed in the scheme, the establishment of robust accounting within the Paris Agreement and effective enforcement by states. CORSIA is expected to generate demand for an estimated 2.5 Gigatonnes of reductions outside the international aviation sector.

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However, CORSIA's coverage is limited: the scheme does not currently address the roughly 10 Gigatonnes of CO_2 emissions up to the 2020 level that are expected over the 2021-2035 timeframe, and the scheme is planned to end in 2035, with no credible plans at the global level to address international aviation's emissions beyond this date. Further, CORSIA's goal of carbon-neutral growth from 2020 is not consistent with the temperature goals with the Paris Agreement, and a heavy dependence on offsetting will not be adequate for the sector long-term.

ICAO CO_2 EMISSIONS STANDARD

In addition to CORSIA, ICAO has agreed a CO_2 standard that would apply to new commercial and business aircraft delivered after January 1, 2028. While emissions performance standards are helpful tools promoting energy efficiency and lower CO_2 emissions from aircraft, analyses indicate that the ICAO CO_2 standard, as now designed, will have little or no impact beyond business as usual.[10] The CO_2 standard will need to be updated in the future, or, alternatively, strengthened in implementation by ICAO Member States, if it is to contribute to the decarbonization of the aviation sector.

EUROPEAN UNION EMISSIONS TRADING SYSTEM (EU ETS)

While CORSIA and the CO_2 standard are being developed at an international level, carbon pricing is evolving on a regional level. Flights within the EU have been covered by the EU ETS since 2012, with reforms to the scheme adopted in 2017 introducing a declining cap from 2021. Domestic aviation is included in New Zealand's emissions trading scheme. Other Parties, notably Canada and China, have indicated that they will bring their domestic sectors under carbon pricing.

Aviation policies should be guided by a long-term emissions reduction goal so that the policy goal is aligned with the sector's need for greater ambition. The aviation industry itself has set an aspirational target of 50% emissions reductions relative to 2005 levels by 2050[11], though is opposing measures such as carbon pricing and more effective CO_2 standards which would help deliver this goal.

Despite attempts to date, ICAO has failed to established a medium-term or long-term goal for the sector. Setting an ambitious long-term goal for the aviation sector would help guide supportive international, domestic, and regional policies to sharply reduce aviation's emissions by 2050 and decarbonize the aviation sector by the second half of the century.

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[9] "ICAO's market-based measure." Environmental Defense Fund, 2018, https://www.edf.org/climate/icaos-market-based-measure.
[10] "International Civil Aviation Organization's CO_2 Standard for New Aircraft." International Council on Clean Transportation, January 2017, https://www.theicct.org/sites/default/files/publications/ICCT-ICAO_policy-update_revised_jan2017.pdf
[11] "Fact Sheet: Climate Change & CORSIA." International Air Transport Association, December 2017, https://www.iata.org/pressroom/facts_figures/fact_sheets/Documents/fact-sheet-climate-change.pdf.

WHERE DO WE WANT TO GO?

If society is to avoid exceeding the 1.5°C temperature threshold called for in the Paris Agreement, that leaves a carbon budget between 200-350 $GtCO_2$ to cover the period 2016-2100.[12] The date by which we need to achieve a balance between anthropogenic emissions by sources and removals by sinks is therefore conditional on how quickly we reduce emissions—a delay in emission reductions brings forward the date by when this balance is required. It is therefore essential that all sectors sharply reduce their emissions by 2050 and then fully decarbonize within the second half of the century.

For aviation, under current scenarios it is envisaged that aviation could emit 56 $GtCO_2$ over the period 2016-2050, or in other terms, one-quarter of the remaining carbon budget over this period.[13] This points to how critical it is for aviation to contribute its fair share towards achievement of the 1.5°C. Aviation, therefore, not only needs to decarbonize towards the second half of this century, but needs to immediately and then rapidly reduce its in-sector emissions. In addition to CO_2, aviation's non-CO_2 effects need to be addressed. As mentioned earlier, these effects equal or even exceed the CO_2 effects, resulting in aviation contributing to an estimated 4.9% of global warming. Hence, the end result must be an aviation sector which is zero CO_2 and non-CO_2 effects on the climate by the end of this century.

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The Talanoa Dialogue is an important opportunity to revisit the precise pathway for aviation's decarbonization. The aviation industry set a long-term target in 2008 (50% emissions reductions from 2005 levels by 2050), which is has been the dominant global vision for aviation's decarbonization. However, in light of the Paris Agreement, the increased level of urgency to cut emissions, technology advancements, and other developments this vision and the assumptions behind it need revisiting. One assessment by Cames et al. in 2015 suggests that this vision could be incompatible with a 2°C future, let alone with a 1.5°C vision.[14]

HOW DO WE GET THERE?

While many stakeholders have a role to play in the aviation industry's decarbonization, bold government action will, in the end, define whether the aviation is able to contribute its fair share to ensure a 1.5°C future.

A methodical first step for governments—at the subnational, national, regional and international levels—is to set long-term decarbonization pathways for aviation that are compatible with the Paris Agreement and a roadmap to adhere to these pathways. If we are to achieve a 1.5°C future, the aviation sector must adhere to its fair share of the remaining global carbon budget, estimated at 200-350 $GtCO_2$.

A methodical first step for governments - at the subnational, national, regional and international level - is to set long-term decarbonization pathways for aviation that are compatible with the Paris Agreement and a roadmap to adhere to these pathways.

One available option for national governments in ICAO is to follow through on a long-term emissions reduction goal for international aviation that aligns with this 200-350 $GtCO_2$ carbon budget. Countries in ICAO have committed three times since 2010 to develop options for a long-term goal. This long-term goal would provide a

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[12] *Climate Change 2013: The Physical Science Basis*. "Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change." IPCC, 2013, http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf.

[13] "Analysis: Aviation Could Consume a Quarter of 1.5C Carbon Budget by 2050." Carbon Brief, 8 August, 2016, https://www.carbonbrief.org/aviation-consume-quarter-carbon-budget.

[14] Cames, Martin et al. "Emission Reduction Targets for International Aviation and Shipping." European Union, November 2015, http://www.europarl.europa.eu/RegData/etudes/STUD/2015/569964/IPOL_STU(2015)569964_EN.pdf.

unifying understanding of where the sector needs to go and would stimulate additional technological, policy, and financing innovation. The exercise of setting long-term decarbonization pathways cannot be limited to ICAO, as ICAO only deals with international aviation emissions. Countries, particularly developed countries, must begin setting ambitious goals for the reduction of domestic aviation emissions too as they represent approximately 40% of global aviation activity.

Aviation decarbonization pathways must also take into account the other half of aviation's climate pollution problem, non-CO_2 effects, and should prioritize transitioning away from offsetting at the earliest practicable date. Once a government sets a sufficiently ambitious long-term pathway, there must be an accompanying roadmap in place to achieve the pathway, which defines actions for the near-term, medium-term, and long-term and policies to enable these actions.

A ROADMAP FOR DECARBONIZATION

The elements of such a decarbonization roadmap are discussed below:

DEPLOYING NEAR-TERM TECHNOLOGY SOLUTIONS

The aviation industry needs to deploy available clean aviation technology, lower-carbon fuels, and operational efficiency improvements more rapidly in the near-term.

EFFICIENCY AND OPERATIONAL MEASURES

First and foremost, the industry needs to prioritize energy efficiency and operational measures. Research on airlines' fuel efficiency has identified gaps in the efficiency of carriers ranging from 50% to as high as 85% for international and US domestic flights, respectively. [15] Governments should set policies to enhance the transparency of airline environmental performance metrics, especially fuel efficiency, and make this information available at the point of ticket purchase, so that consumers can make informed choices about their travel footprint. In the near-term, airlines must phase out older, less efficient aircraft at a faster rate than at present, and should retrofit existing aircraft with wingtips, electric taxiing systems, and other efficiency technologies to improve environmental performance. Governments should implement technology-forcing efficiency standards for existing and new aircraft to incentivize aircraft phase-out and retrofits, and to promote the development of new efficiency technologies in order to achieve substantial efficiency gains.

ALTERNATIVE FUELS

Sustainable alternative fuels have a role to play in reducing the sector's emissions. Some second-generation biofuels, derived from plant and animal wastes and residues, demonstrate potential to substantially reduce emissions on a lifecycle basis while avoiding significant competition with food and land availability. One example of a successful deployment of biofuels in the aviation sector is the partnership between United Airlines and AltAir in California.[16] Governments should implement supportive policies that promote a level playing field for truly sustainable alternative jet fuels. If governments choose to promote alternative jet fuels, the incentives provided should take into account both CO_2 and non-CO_2 climate impacts to maximize the environmental benefit of limited feedstocks. However, due to the challenges to sustainably and economically scaling production, biofuels are expected to have a marginal contribution to reducing the sector's emissions overall.

NON-CO_2 EFFECTS MITIGATION MEASURES

The aviation industry must begin addressing non-CO_2 climate effects as soon as possible. Industry and governments should invest in scientific research related to non-CO_2 effects and should advance measures to address non-CO_2 in the near-term, such as avoiding flight paths in climate-sensitive areas and developing operational requirements and engine standards to manage short-lived climate pollutants that are deemed significant.

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[15] The discrepancies in international airline fuel efficiency are attributed to freight share, passenger load factor, aircraft fuel burn, and seating density. Sources: Kwan, Irene et al. "Transatlantic airline fuel efficiency ranking, 2014." The International Council on Clean Transportation, November 2015, https://www.theicct.org/sites/default/files/publications/ICCT_transatlantic-airline-ranking-2014_0.pdf, and Olmer, Naya et al. "U.S. domestic airline fuel efficiency ranking, 2015–2016." The International Council on Clean Transportation, December 2017, https://www.theicct.org/sites/default/files/publications/US-Airline-Ranking-2015-16_ICCT-White-Paper_14122017_vF.pdf.

[16] AltAir uses inedible waste oils and fats to create alternative fuels, which reduce emissions 65-85% on a lifecycle basis compared to conventional jet fuel. Source: Kharina, Anastasia et al. "Alternative jet fuels: Case study of commercial-scale deployment." The International Council on Clean Transportation, 24 October 2017, https://www.theicct.org/sites/default/files/publications/United-LAX-Case-Study_ICCT-Working-Paper_23102017_vF.pdf.

INVESTMENTS IN TRANSFORMATIVE, BREAKTHROUGH CLEAN AVIATION TECHNOLOGIES

Greater investments towards developing transformative, low-carbon alternative fuels and airframe designs will be necessary, but they should be invested in alongside the deployment of existing clean aviation technologies. In the long-run, there is an upper limit to the amount to the land available for biofuel production due to competing land use needs. Other more viable, non-bio-based alternative fuels include power-to-liquid (PtL) fuels sourced from renewable electricity. The water and land requirements associated with PtL are small compared to crop-based biofuels. Greater investment and opportunities are needed to bring the cost of PtL down. Hydrogen and/or hybrid electric propulsion systems could be viable for short-distance flights. The funds for such investment can be raised through increased taxation, ideally through carbon pricing.[17]

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STRENGTHENING CORSIA

As of now, CORSIA only covers 21.6% of international aviation emissions over the period 2021-2035; however, governments in ICAO could decide to use CORSIA to step up ambition during the first review. One concrete way to increase the ambition of CORSIA is to change the carbon-neutral growth target such that an CORSIA is delivering an absolute net emissions reduction. Another way is by converting CORSIA from offsetting system, which will only become increasingly incompatible with the 1.5°C target over time, toward a market-based measure that would generate revenue that could be used for developing new technologies that would lead to greater aviation-sector reductions. However, before the ambition of CORSIA can be greatly improved as part of its review mechanism, the countries must complete the CORSIA Rulebook so it is fully operational and functioning properly beginning in 2021.

STRENGTHENING THE ICAO CO_2 STANDARD

The ICAO CO_2 standard adopted in 2016 has been rendered ineffective due to low stringency for new aircraft designs and a cut-off delay for the production of current aircraft until 2028. This is especially problematic given the long operational lifetime of aircraft, which can be 20-30 years. During ICAO's next rulemaking cycle, 2019-2022, countries should agree to greatly increase the stringency of this standard and make cut-off date for the production of current aircraft earlier than what it is currently in the existing ICAO CO_2 standard. In the interim, countries should strengthen the ICAO CO_2 standard through national implementation. This can be done by, for example, ensuring publicly accessible information on the efficiency of aircraft in order to support policies which incentivize newer and more efficiency aircraft.

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REVISITING AVIATION SUBSIDIES

Demand for air travel is exceeding efficiency gains leading to an overall growth in emissions from the sector. So long as efficiency gains remain low, governments need to examine whether the growth in demand brings economic or social benefits which justify the resulting increase in emissions. One policy approach to moderate demand for air travel could be to phase out direct and indirect subsidies, such as subsidies for airport expansion or fuel and sales tax exemptions.

NEW MOBILITY SOLUTIONS TO SUPPORT A MODAL SHIFT

Increasingly, we need mobility solutions that allow people to connect with one another without traveling in a carbon-intensive way. These would include new disruptive transport technologies and business models for

[17] Jon Strand. "Fear of Flying (or Sailing)? Pricing International Aviation and Maritime Emissions." The World Bank, January 6, 2015, http://blogs.worldbank.org/developmenttalk/fear-flying-or-sailing-pricing-international-aviation-and-maritime-emissions.

delivering transport services and virtual connection options that reduce the need to fly, such as videoconferencing.

NEW BUSINESS MODELS FOR THE AVIATION INDUSTRY

The aviation industry needs to adapt to a changing business climate. Airlines should consider investing in and/or diversifying into other mobility options and services. JetBlue and Boeing, for example, have developed venture capital arms that have a mandate to invest in breakthrough clean aviation technologies. Fuel suppliers should look diversifying their fuel sources to those that are less carbon intensive.

CLIMATE-PROOFING AVIATION AGAINST THE EFFECTS OF A CHANGING CLIMATE

The aviation industry needs to adapt to a changing climate. The aviation industry must make its infrastructure and operations more resilient to effects of climate change. This includes designing aircraft and flight patterns that can cope with increasing air temperatures and turbulence.

COMPATIBILITY WITH THE PARIS AGREEMENT

Beyond a Paris-compatible target, the sector must ensure that any actions undertaken are in line with the principles of the Paris Agreement, specifically as they relate to the Article 4, Article 13 and Article 6.

Article 4 stipulates that countries should move towards economy-wide Nationally Determined Contributions (NDCs) led by developed countries that set the pace on ambition. This means that national and subnational governments should set policies that tackle emissions from international aviation.

Article 13 lays out the principles of the Transparency Framework, which is to provide a clear understanding of climate change action in light of the 1.5°C warming limit. As aviation emissions will need to be considered in reviews of progress towards the global climate target, clarity, transparency and understanding of aviation's impact under the Paris Agreement will be crucial for a scientific understanding of aviation's growing climate impact.

Article 6 lays out rules for cooperative approaches and houses a new market mechanism that may be eligible for use under CORSIA. As emission reductions will be trading hands between states and airlines, the rules for proper reporting and accounting of these units is essential to ensuring that they are not counted twice undermining the ability to meet the Paris temperature goals.

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