Climate Catalyst

SASHA
Skies and Seas Hydrogen-fuels Accelerator Coalition

Environment, equity and just transition for emerging aviation fuels

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About the SASHA Coalition

The SASHA Coalition brings together key players from the shipping and aviation industries. They advocate for policies to support the use of green hydrogen (and, where needed, direct air capture) to decarbonise these sectors to reach net-zero by 2050 and create green jobs in the UK and EU.

Disclaimer

This paper is co-authored by Opportunity Green on behalf of the SASHA Coalition, as the Coalition secretariat, but it in no way represents the views of the members of the SASHA Coalition.

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Current state of play for just transition in aviation

The aviation sector is significantly off track on its decarbonisation pathway[1] and without action, is expected to consume a quarter of the entire 1.5°C carbon budget by 2050[2]. Urgent action is required to address the sector's climate impacts. This must happen in an equitable and environmentally just way.

Just transition combines the need for climate action with the consideration of social inclusion, through an economy-wide process which aligns to a sustainable future with the creation of decent work and quality jobs, net-zero emissions and thriving communities[3].

Ensuring a just transition when confronting climate change means that any climate action undertaken is done so with respect for labour and human rights, prevents existing inequalities and environmental damage from worsening, and maximises the socioeconomic benefits for marginalised groups affected by decarbonising sectors. Some have suggested a starting point is ensuring historically privileged sectors that have avoided equitable taxation—such as oil and gas, shipping and aviation—begin by paying their fair share. In the UK alone, taxing the use of kerosene at the same rate that car users pay for their fuel could generate around £6.7 billion annually[4]. This is just one consideration of how net-zero aviation (a commitment the International Air Transport Association (IATA) has to reach by 2050[5]) could be delivered in an equitable way.

The aviation sector directly employs over 11 million people globally[6]. This is set to rise as predictions show global air traffic doubling by 2040 in the absence of necessary action to curb growth in line with climate targets[7]. The sector's workforce will not only be people who must implement much of the change required for aviation to reach net-zero, but they will also be the ones who will live through the change. As such, they are a vital stakeholder in ensuring a just and equitable transition[8]. Several roadmaps for achieving net-zero aviation depend on the level of demand for flying being addressed. Some estimates show that without demand management, we would see a 1.7°C global temperature rise even if sector-wide decarbonisation is reached by 2050[9]. This is likely to have an impact on the workforce, who must be engaged to help shape a just transition. Workers need access to training, reskilling, and strong social protection measures to mitigate the risks of them paying the price of the sector's transition[10], especially with trends moving towards higher skill requirements to operate emerging technologies.

Airports rely on lower skilled, and lower paid workers, and Black, Asian and Minority Ethnic groups, as well as younger people, are expected to be disproportionately affected[11] by the sector's transition. In the US, a recent study also concluded that "socially vulnerable groups, including across race/ethnicity, education, and income" were the most likely to be exposed to environmental pollutants from aircraft (such as noise)[12]. But, alongside these risks, there could also be important opportunities for the sector's workforce to evolve, including more support for disadvantaged communities. Potential solutions and opportunities could include more employment of lower skilled, lower

paid workers, resulting in more secure work, but the transition could also bring employment opportunities across the fuel production supply chain (in areas with favourable geographical context) for skilled jobs in communities outside of major cities. In the UK, for example, this is evident in the proliferation of SAF projects in Teesside in the northeast of England[13]. This also has the potential to improve gender and minority equality across the supply chain[14], such as through closer collaboration between the aviation industry and education providers to ensure the correct training is being provided and targeted towards groups currently under-represented in the sector[15].

The equity and environmental challenges of aviation

The environmental impacts of the aviation sector's transition are just as pertinent as the implications for its workforce. A report from 2024 showed that 20 airports generated the equivalent amount of carbon dioxide (CO_2) emissions as 58 coal plants in 2019[16] (the latest year for which data were available), contributing to climate change impacts and significant air pollution. This presents serious health implications, particularly for disadvantaged groups that often live in the areas surrounding airports, making them more vulnerable to the health effects caused by frequent air travel—an activity predominantly associated with the more privileged portion of the global population.

From an equity standpoint, for many, aviation is a crucial enabler of global connectivity and economic growth. Yet, if the aviation sector were a country, it would rank in the top 10 greenhouse gas emitters globally[17]. And the benefits of aviation are concentrated on a relative few. Eighty per cent of the global population has never stepped foot on a plane[18] and just one per cent of the world's population is responsible for over 50 per cent of all passenger emissions[19]. Crucially, aviation provides connectivity for climate vulnerable countries such as small island states—and therefore equitable decarbonisation of these services is the only way to ensure a just transition.

It is also important to consider the role of tourism in our global economy when assessing the environmental impacts of aviation. Ecotourism as a sector has an annual growth rate of 20-34 per cent[20], and while this is problematic for addressing ever-increasing

aviation emissions and demand, ecotourism does support conservation efforts alongside job creation and local economic development. This is especially true for countries that are maintaining their unique ecosystems through this type of tourism, such as Costa Rica and Tanzania.

Not only are some ecosystems being indirectly impacted—some positively but predominantly negatively—by the activities of the aviation sector and its users, decarbonisation poses its own significant risks. The production of alternative fuels brings potential biodiversity implications due to the land required to produce feedstocks for both biofuels and e-fuels. Powering half of all EU flights with e-fuels in 2050 would require eight million hectares of land. However, that pales in comparison to how much land would be required to power the same number of flights with biofuels: some 33 million hectares, or an area the size of Finland[21]. It is important that aviation's transition away from fossil fuels accounts for the twin crises of climate change and biodiversity loss, and that steps are taken to mitigate land use changes and intensification, which bring risk of habitat destruction, biodiversity loss and ecosystem degradation[22].

The role of alternative aviation fuels

The sector has faced increased scrutiny for its environmental impact in recent years, which has primarily driven action in the search for small efficiency gains and the shift from conventional kerosene to alternative fuels. These fuels—commonly referred to as sustainable aviation fuels, or SAFs—vary significantly in terms of lifecycle emissions[23]. Many SAFs face not only technical and economic challenges, but raise crucial questions of justice and social equity on the transition away from fossil-fuelled flight. Such alternative fuels also dominate the debate and narrative about how to begin to reduce emissions from aviation, at the expense of other solution pathways such as zero-emission flight solutions that would remove carbon emissions entirely (through the use of battery-electric or hydrogen aircraft and operations).

SAFs can be categorised according to the feedstock from which they are made. Broadly, there are two types: **biofuels**, produced from biomass feedstocks, and **e-fuels**, made from synthetic, power-based processes. It is estimated that 85 per cent of the SAF facilities coming online in the next few years will use Hydrotreated Esters and Fatty Acids (HEFA) production technologies, which rely on waste oils and fats[24]. This one

category of waste-based biofuel alone faces numerous concerns from an environment, equity and just transition perspective. It is highly susceptible to fraud risk, whereby environmentally damaging, low-cost plant oils like palm oil—known to drive land use change and biodiversity loss—are passed off as waste oils[25]. Furthermore, with wider sustainability efforts reducing waste, this feedstock may not be able to fulfil demand for SAFs; and, additionally, should be prioritised for use in sectors lacking alternatives, such as heavy road transport.

In some instances, policymakers have acknowledged these risks. The UK Government, for example, has applied a HEFA cap in its SAF Mandate due to enter into force in 2025[26]. But, the international nature of the sector—where each country and region is setting its own standards, regulations, and monitoring and traceability measures related to the environmental and social integrity of SAFs—poses a significant challenge for making flying truly sustainable. For example, while the UK is setting a HEFA cap, we are seeing more and more commitments from other jurisdictions to produce SAFs from low-integrity feedstocks. Indonesia and China both focus on supplying "waste" feedstocks (mostly used cooking oils, HEFA or palm-oil), which will not only serve their own ever-growing domestic markets, but also generate large supplies of SAF to export. Some countries have looked to mitigate the risks of over-supply of fuel products with low environmental credibility, such the UK, which has adopted an exclusion of Chinese biodiesel[27].

Unlike waste- or bio-based aviation fuels, e-fuels are expected to be much easier to scale because their main input is renewable energy, and could result in lifecycle emissions reductions of 75-98 per cent[28]. The highest integrity e-fuel is made from green hydrogen produced with renewable energy (that should be additional) and responsibly sourced CO_2 (such as via direct air capture (DAC), biogenic or where suitable in terms lifecycle emissions, industrial point source carbon). Other transition solutions such as zero-emission aircraft and operations will also utilise renewable energy and hydrogen as fuel sources, without the need for sourcing CO_2.

Though e-fuels are energy-intensive to produce, the cost of renewable energy will continue to come down alongside the availability of hydrogen, allowing the use of e-fuels to deliver huge carbon emissions savings. It is also important to note that some carbon capture technologies are considered "bridging" technologies, allowing for emissions abatement in the short term while longer-term energy transitions are pursued. As such, the sources of CO_2 to produce e-fuels should be considered on a case-by-case basis to yield the most sustainable outcomes.

The future of aviation fuels as it is unfolding today presents numerous potential risks from an environment, equity and just transition perspective. In this briefing, we will be exploring different issues under these themes, offering considerations and possible solutions, and outlining insights and recommendations relevant to policy and private sector actors working on the aviation fuels transition.

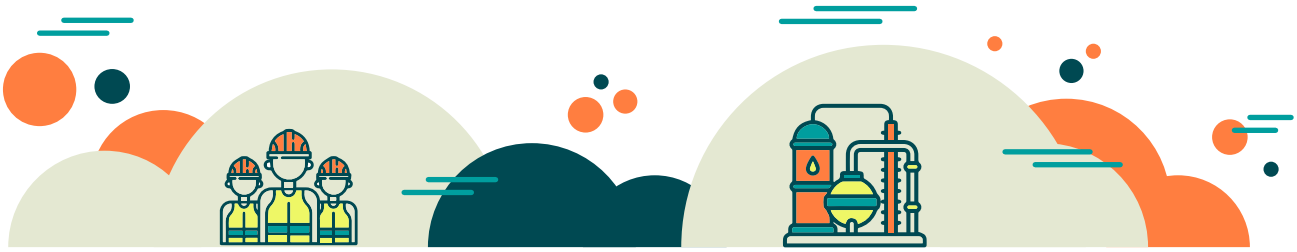
Just Transition issues in the aviation fuel transition

Labour and human rights in fuel production

- We are increasingly seeing the health implications of aviation. Air pollution at airports is affecting both workers and surrounding communities, with growing evidence pointing to the harmful effects of fuel expulsion and airport operations contributing to long-term health risks for those exposed[29].
- Where the energy or feedstock required for production is being sourced from is a critical consideration for the scalability of alternative fuels. For example, the EU plans for half of its hydrogen to be imported by 2030[30], with cooperation agreements reached with countries such as Chile and Argentina[31], which are conscious of the negative effects mass production of energy exports such as hydrogen could have on the environment and communities.
- Another example is the human rights, or lack thereof, in emerging markets with predicted exponential growth of infrastructure for energy production. Many of the HEFA fuel sources are currently being imported from Asia. This creates a large degree of separation between the sources of these fuels and the inherent impacts on communities and subsequent human rights conditions in these regions. The race to increase volumes of alternative fuels for developed economies like the US and Europe could drive unintended consequences for communities in these other regions.
- Where green hydrogen or e-fuels are being imported to Europe, and cooperatives are being made with exporting nations, just transition principles should be vehemently upheld in the contractual agreements, including, for example, ensuring proper wages, worker safety and local community input. A recent example of a failed initiative was the Desertec project in the Sahara Desert[32]. The project, intended to generate solar and wind energy for Europe, did not consider the voices of the local people, exposing the shortfalls of the project to extract resources, grab land, and exploit labour from Global South nations.

Wealth implications

- With the existing fuel production infrastructure being dominated by large oil and gas refineries, we need to consider who gains from the development of an alternative fuels industry. It is unclear whether the sector will diversify to include smaller, joint renewable energy and



hydrogen production hubs, or if the oil and gas industry will continue to dominate the market. To truly see a just and equitable transition and to mitigate inaction from major oil and gas companies, we need more diversified fuel producers thriving in the market to meet the needed supply of high-integrity fuels (such as e-fuels and green hydrogen).

- The development and deployment of alternative fuels are currently highly capital-intensive, posing significant infrastructure and production costs. Directing private capital for fuel production into certain countries over others could potentially exacerbate global inequalities, as it is the wealthier nations and large corporations that are better positioned to invest in and benefit from these emerging technologies.
- The majority of oil and gas majors are based in wealthier nations, which further creates a disparity of wealth distribution as well as inherent inequalities. However, wealthier nations tend to have better sustainability criteria, which should help set the industry on a better trajectory than those of the less regulated activities occurring in other jurisdictions.

Community and workforce engagement

- Workers must be at the centre of plans to transition away from fossil fuels. Models such as Scotland's Just Transition Commission[33] could be adopted to engage workers to develop just transition plans for the sector and ensure a two-way community engagement process is established.
- Harnessing public support will be crucial to the uptake of a high-integrity alternative fuel industry. As the end-users, the flying public must be confident in transition technologies and solutions like e-fuels and zero-emission aircraft for them to take off. Studies show that 82 per cent of British people would be open to flying on a hydrogen-powered plane,[34] and using this positivity in line with other messaging that e-fuels are the highest integrity SAF option will be crucial to increasing confidence from the public.

Equity issues in the aviation fuel transition

Feedstock sources

- There are issues in the feedstock requirements of all the various alternative fuels, even for e-fuels, the highest-integrity SAF. Large amounts of renewable energy (for hydrogen production and carbon capture) are required to produce this fuel, which, if used for aviation, would be displaced from other sectors and parts of society that could benefit from renewable energy and fossil fuel free power sources, raising concerns about the fairness of resource distribution and access.
- Feedstock demand for SAFs drives competition for land and water resources, disproportionately affecting vulnerable communities, particularly in developing regions and where climate change is already impacting the availability of these natural resources. For example, water is not only required to grow biomass, but is a critical input for hydrogen production

via electrolysis. In a world where two billion people don't have access to safe drinking water[35], this creates challenges for balancing equity with climate action.

Food security

- The higher the demand for alternative fuels, the higher the risk of crops being directed to fuelling aviation and therefore more land needed for their creation. This is hugely problematic, as aviation is an already privileged sector, and much of the land availability will come from rural regions, where the demand for flying is lower.
- Fuels such as biofuels derived from corn will affect food security[36], using agricultural land for fuel feedstock rather than as a food source. Currently, these fuels are permitted in regions outside of Europe such as the United States but will particularly affect food security in some developing countries[37] where rapid growth in demand is causing the diversion of sizable percentages of food crops, normally intended for human consumption, to be used as biofuels.

Geographical considerations for feedstock distribution

- E-fuel production has the potential to bring a variety of opportunities to well-suited locations. However, this is limited to areas with favourable geographical features for significant renewable energy production. In such areas in the Global South, as was the case with the exploitation of oil and gas[38], there is a high risk of multinational energy companies and wealthier Western states neo-colonising renewables in developing nations. For example, importing cheap green hydrogen from resource-rich Morocco, Algeria and Egypt to the EU instead of allocating it to local needs could be a form of neocolonialism[39], which does not align with the goal of a just transition.

Just Transition & Equity considerations and solutions

1 **Integration of just transition principles in mandates for the aviation sector**

   - There is a necessity to embed just transition as we test and implement alternative fuels in the development stage. To support awareness of climate and just transition for transport and mobility[40], we need to see equity and just transition embedded in emerging policy mandates alongside airline transition plans from the outset.

2 **Development of a clear framework and pathway for aviation workers supported by the industry**

   - Like other high-emitting sectors, such as energy production and heavy industries like steel, a clear framework and criteria is needed for equity and social considerations for existing aviation workers. This should be done in consultation with those impacted by the aviation sector's transition. The production and uptake of alternative fuels to meet decarbonisation targets[41], as well as implications for the workforce from demand reduction and new jobs creation, means there is a critical need for skills development or retraining to ensure a skilled workforce is maintained. Trade and workers unions are a key actor in developing such frameworks and roadmaps.

3 **Addressing the rampant health issues resulting from airports operations and fuel production**

- Without urgent measures to limit the growth of aviation, its climate impact is expected to grow exponentially in the coming decade. Evidence shows this could have considerable health implications on workers and communities local to airports. We must look at levers to limit pollutants from the sector, and mitigate their health impacts in the near and long term. This could include addressing emissions from ground operations, having flight caps to reduce the amount of pollution at each airport, commiting to no further airports being built, reducing consumer demand for air travel, and crucially, addressing the feedstocks of fuels which generate the pollutants in the first place.

4 **Assessment and support for taxation and pricing measures**

- Taxing CO_2 at an appropriate level and in an equitable way can begin to close the cost gap between traditional kerosene and alternative fuels[42], while at the same time generating revenue that can be reinvested into climate finance and just transition funds. Furthermore, a frequent flyer levy could raise substantial revenues for a similar purpose whilst targeting those in society who over consume flying at the expense of others.

Environmental issues in the aviation fuel transition

Land use change from biofuels

- Land clearing for fuel production is a huge concern given the forecasted volumes of biofuels needed to serve the sector's transition to net-zero[43]. This is particularly critical if biofuels continue to be prioritised and pursued over other types of alternative fuels. Biofuels have the largest environmental impact out of all the current alternative aviation fuels[44].
- The repurposing of existing land and shifting crop types to suit fuel feedstocks is also an issue for current land availability. The production of crops and by-products for energy use in the transport sector alone already requires 10 per cent and five per cent of arable land and four per cent and three per cent of agricultural land in the US and the EU respectively[45]. Expanding this volume into existing land contradicts and undermines other policies such as those aimed to restore nature and land, like the EU Nature Restoration Law. In the UK meanwhile, half of all farmland or more than double the land needed for the country's total renewable electricity supply would be needed to make enough aviation fuel to meet its ambitions for "jet zero", or net-zero flying[46].
- For e-fuel and necessary carbon capture sites, clearing land could

be required to build out the necessary infrastructure, if existing oil refineries sites are not utilised and repurposed.

Biodiversity

- Extensive biomass crop cultivation for fuel production brings with it a number of risks to biodiversity, from habitat loss and soil degradation to non-native species used to produce biomass potentially becoming invasive and altering local ecosystems.
- The EU's RED III regulation does put limitations on where feedstocks for alternative fuels can come from—for example, excluding the majority of virgin palm and soy derived feedstocks due to the association between oil palm plantations and deforestation in countries such as Indonesia and Malaysia and soy cultivation implications for deforestation and biodiversity in South America.
- Generating renewable electricity for e-fuels needs less land than harvesting biomass to produce biofuels. Its land requirements and associated biodiversity risks can be further limited by utilising urban spaces for electricity generation, which already have the lowest levels of biodiversity, and using dual function systems such as agrivoltaics[47].

Reliance on critical resources

- We are already facing increased risks of water scarcity, and food and energy insecurity due to the climate crisis. Alternative fuels require a large amount of these already at risk resources and their production processes are currently energy and resource intensive in their early development stages. For example, over 11,000 litres of water are required to create one litre of biodiesel from soybeans, while one litre of bioethanol from sugar beet demands around 1,200 litres of water. By comparison, the production of one kilogram of beef meat takes 15,400 litres of water[48]. This calls into question the use of such food crops for sectors like aviation, at a time when food security is a growing concern.
- E-fuels are also heavily reliant on critical resources, most notably large amounts of renewable energy, in an already demanding market looking for cheaper and more readily available renewable sources. If aviation growth is not managed, producing enough e-kerosene to supply 35 per cent of the EU's jet fuel demand in 2050 will require 534 TWh (assuming a mix of point source and DAC CO_2), or 19 per cent of the total electricity demand of the EU in 2022, and around 11 per cent of all projected renewable electricity generated in the EU in 2050[49].
- With all current options for alternative fuels being very dependent on resources that are in high demand and already overconsumed, we need transparent supply chains of these fuels and effective measurement in place, to ensure critical

resources are being distributed equitably —and not to privileged sectors over broader community access—as well as ensuring they are not causing further environmental harm.

Reliance on critical minerals

- Manufacturing the electrolysers and fuel cells needed to produce and use green hydrogen will require significant quantities of critical minerals. Today's dominant technologies require resources from all over the world, including zinc, copper and nickel (with Indonesia the world's nickel largest exporter[50]), but if newer electrolyser and fuel cell technologies are to be scaled, it is expected that they will require rarer minerals like yttrium and cobalt[51]. This is leading to significant equity issues in mineral-rich regions like Argentina as manufacturing nations buy up land[52]. This leaves green hydrogen production sensitive to the price of these resources. Human rights or labour violations are also common in critical mineral supply chains, and producers need to exercise scrutiny of supply chains limit this risk.
- Producers should consider circular economy models to improve and enhance value chains and minimise extraction where possible, which would help to reduce environmental harm, improve supply chains, utilise critical minerals effectively and present financial benefits.

Stranded assets of existing fuel infrastructure

- Existing infrastructure and the land it occupies is a key consideration for the transition. Current fuel facilities should be utilised, retrofitted and transitioned for new fuel production or equivalent technologies in the first instance and where possible, rather than closing facilities within their usable lifetime without an alternative purpose. Failure to do so could result in job losses, financial implications and creation of brownfield sites alongside other environmental and societal issues.
- Decommissioning a site can occur for a number of reasons, such as ceasing production of coal plants or oil and gas refineries, but can happen for renewable energy providers too[53]. Regardless, this will come with a huge cost implication, often which the taxpayers have to shoulder.
- For the development of emerging fuel technologies, there is a risk of future stranded assets if investments and expansions are made into the wrong solutions. Diversifying the types of technologies and solutions would help mitigate further stranded assets in the future while we explore various technology pathways for the sector.

Demand reduction

- Demand reduction plays an important role in tackling the environmental issues of the aviation sector as well as justice and equity disparities within the sector. Reduced overall demand, through improved operational efficiency measures, minimised business and luxury travel or incentives to utilise alternative transport, will reduce the sector's reliance on critical resources and minerals, while reducing its overall CO_2 and non-CO_2 impacts.
- Projected demand increases and efforts to pursue airport expansion is resulting in increased land clearing, further environmental damage and biodiversity loss. Some positive actions have been taken to avoid the risks from airport expansion in places like Portugal, where a legal case was won to deny the building of a new airport on the grounds of its expected impact to a biodiverse wetland near the proposed site[54].

Environmental considerations & solutions

1 **Greater understanding of the full spectrum of alternative fuel environmental impacts**

- Amongst the two categories of alternative aviation fuels—those of biological origin, and those of non-biological origin—there are substantially differing degrees of sustainability[55]. The initial benefits of certain fuels can potentially overshadow grave impacts which are often not realised until the fuels are on the market. Investors, policymakers and the industry more broadly would benefit from a deeper understanding of the various types of SAFs currently in development and their environmental impacts. For example, waste-based fuels may seem like a win-win solution, as they divert waste from the landfill. However, the large volume of waste that would be needed to meet SAF supply stands in contrast with the aims of circularity initiatives to reduce waste. As such, these fuels should be reserved for applications in which there are fewer alternatives to decarbonise (such as heavy road transport), or in geographies where there is less access to cleaner alternative fuel feedstocks such as renewable energy and green hydrogen.

2 **Transparent corporate disclosure of diversified fuel sources, highlighting the utilisation of various feedstocks and their varying sustainability criteria**

- To effectively limit the environmental impacts of SAFs, the industry and key supply chain actors must strive for greater transparency in how SAFs are made, taking a localised approach, whereby feedstocks are prioritised according to what is most sustainable (e.g. renewable energy-based fuels in Scandinavia and HEFA fuels in Asia). This level of consideration, and not simply prioritising cost, will curb the environmental impacts we are already seeing from SAF production and its importation and exportation issues.
- Airlines should be required to specify what types of alternative fuels (SAFs) they are purchasing and using through voluntary and mandatory reporting, making this level of detail available to consumers and financiers to increase awareness and mitigate greenwashing.

3 **Consider the potential for retrofitting existing sites with new technologies such as renewable energy generation and hydrogen production to support the scaling of e-fuels**

- Refineries and energy providers could explore retrofitting existing oil and gas infrastructure, such as industrial clusters and hubs, with facilities for the production of renewable energy and green hydrogen. This would have the added benefit of mitigating emissions from the transport of e-fuel feedstocks.

4 **Policymakers should ensure environmental and biodiversity criteria are prioritised and call on project developers to undertake community engagement**

- Policymakers should take into account the possible environmental impacts of alternative fuels—for

example, land conversion for biofuel production—and ensure certain environmental criteria are met for new fuel projects before they reach Final Investment Decision (FID). Establishing such a set of metrics would guide project developers and investors in the initial scoping of these new technology projects.

5 **Investors should undertake robust nature stewardship with aviation companies to address the environmental harm caused by fuel production**

- In their corporate engagement processes, investors should work with their investee companies to address explicit and implicit biodiversity impacts from feedstock production, such as direct and indirect land use change from crop-based fuels. Investors should collaborate to identify and fund solutions to climate and nature impacts from the scaling of feedstocks for alternative fuels.

The role of policy & regulation

Corporates and investors lack clarity in the reporting requirements for aviation emissions, particularly when it comes to fuels. The term "SAF" is being used as the main umbrella classification for alternative fuels without the level of specificity that would be needed to reflect how they can vary in their environmental and equity impacts. This is evident in key reporting frameworks such as GHG Protocol, Science Based Targets initiative (SBTi), and Task Force on Climate-related Financial Disclosure (TCFD), where aviation reporting currently doesn't require adequate level of detail, such as determining whether a company is procuring a certain proportion of biofuels over e-fuels.

Meanwhile, varying regulatory landscapes for aviation decarbonisation globally have resulted in a number of different feedstock pathways being pursued for the sector. Lobbying and policy advocacy is taking place to influence governmental positions via emerging regulations, causing uncertainty and a lack of accountability for stakeholders working across multiple jurisdictions. International bodies like the International Air Transport Association (IATA) and the International Civil Aviation Organisation's (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) only briefly mention just transition or equity impacts when providing guidance on SAF uptake. There is an absence of clear, consistent guidance from aviation industry bodies on the standards and baselines the industry should follow for addressing equity and environmental implications of fuel production.

Policy levers for key actors

International standards bodies should establish criteria for the production of alternative fuels

- Supply chain actors and standards bodies, such as the British Standards Institute or the International Organisation for Standardisation, can design and implement a set of criteria for any new fuel production, either at existing or new sites, and as an aid for the phase out of conventional jet fuel.

Policymakers should align objectives for climate and nature action

- It is often the case that environment agencies and departments are tasked with biodiversity and land use issues, and must respond to proposals from energy, transport or other departments that may cause impacts to the environment. We see this in many jurisdictions; at the EU level within the Commission, DG CLIMA are tasked with climate policy, DG ENER with energy policy and DG ENV with environmental policy though all three areas are critically interlinked. An example of potential conflicting objectives can be seen via the EU's Nature Restoration Law requiring at least 20 per cent of EU land and seas to be restored for nature. However, there are aspirations to also grow the EU's manufacturing base for "green" industries via the Net Zero Industry Act, requiring land, energy and feedstocks for products including SAFs. These tensions between policy areas could drive further land use change and environmental degradation overseas in countries where nature and climate policy are less regulated or progressed.

Governments should enable joint planning and dialogue between different parts of the sector[56]

- As well as maintaining targets and commitments under emerging mandates and regulations, governments can be a catalyst for collaboration and joint planning for mechanisms like private-public partnerships (such as the EU's Clean Hydrogen Joint Undertaking, which supports hydrogen research and innovation in the bloc[57]), revenue certainty mechanisms, and specific government policies with a lens on aggregating and increasing opportunities in affected communities to help unlock institutional capital.
- Governments also have an important role to play in taking a holistic approach to ensuring a just and equitable transition. Education and skills, biodiversity, and health must all be central considerations when developing wider aviation decarbonisation strategies and relevant policy frameworks.

Investors should engage proactively in the development and implementation of government policies to support their investment decisions

- Engaging in open consultations and policy advocacy opportunities would ensure policies align and support investors' investment decisions, reducing risk and leading to positive outcomes for investment returns and impacted communities.

Just transition, equity and environmental considerations should be embedded into regional mandates

- Key actors working on aviation can advocate for some form of these elements to be included in their respective regional mandates, such as the Net Zero Industry Act (NZIA) and RefuelEU in Europe, and other regional mandates to ensure consistency of reporting and guidance.

Airlines should voluntarily report on their just transition, environmental and equity considerations via reporting frameworks

- Airlines and other aviation supply chain companies should utilise corporate reporting frameworks such as SBTI, TCFD, and initiatives such as the Climate Action 100+, to credibly share their activities to support a just and equitable transition for the sector. For example, the CA100+ Net Zero Company Benchmark measures the top high emitting companies via an annual assessment, with a metric on just transition[58]. For a company to achieve this, it would need to meet a set of criteria, including explicitly stating its commitment to just transition principles and defining what it means when referring to just transition. The latter criterion involves detailing a plan for retaining, retraining or compensating workers, and ensuring that any new projects associated with the company's decarbonisation efforts are developed in consultation with affected communities and seek their consent. None of the top five emitting airlines engaged in the initiative currently meet a single criterion for the just transition metric.

Financial mechanisms like private-public partnerships can be prioritised to reduce risk

- One of the challenges for institutional investors to support smaller and local businesses is their limited scalability, especially when projects involve the adoption of new technology and innovation that have not reached commercialisation. There is an opportunity to create mechanisms that attract investment capital through, for example, the aggregation of relatively small investment opportunities associated with low carbon technology (e.g. how the Sustainable Aviation Buyers Alliance (SABA) initiative is aggregating demand for aviation fuels) or nature-based solutions. This may require the involvement of multiple investors with different risk/return profiles such as philanthropists, impact investors, government and institutional investors. Local governments and financiers will play a pivotal role in developing and promoting these mechanisms[59].

Case study: Just transition, environment & equity in CORSIA eligible fuels

Environmental standards and eligibility criteria for alternative aviation fuels vary from country to country, which can pose challenges for a sector that is international by nature. Lifecycle assessments (LCAs) are the most common methodology for analysing the emission savings from different types of SAF. At the international level, the International Civil Aviation Organisation's (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) is a global market-based measure established to address carbon emissions from international aviation. It aims to achieve "carbon-neutral growth" by requiring airlines to offset their emissions through the purchase of carbon credits[60]. During the period 2021-35, and based on expected participation, the scheme is estimated to offset around 80 per cent of the emissions above 2020 levels. To be eligible for CORSIA, SAF must achieve GHG emissions reductions of at least 10 per cent compared to the baseline emissions values for aviation fuel on a lifecycle basis, which analyses "core lifecycle assessment" and "induced land-use change" emissions[61].

ICAO has published a methodology for assessing the lifecycle GHG emission factors of SAFs, which establishes over 80 values, representing 22 different feedstocks from across six conversion technologies. To be considered a "CORSIA Eligible Fuel", it must meet a set of principles for "carbon reduction", "environment" and "socio-economic" sustainability themes[62], such as:

- Fuels should not be made from biomass obtained from land with high carbon stock.
- Production should maintain or enhance soil health.
- Production should maintain biodiversity, conversation value, and ecosystems.
- Production should respect land rights, both indigenous and customary ones.
- Production should contribute to localised socio-economic development.

However, individual countries and regions are pursuing their own rules and sustainability criteria for assessing and approving these fuels, which has given rise to tensions. For example, in early 2024, a legal challenge was mounted by US biofuel groups against the sustainability criteria within the EU's Renewable Energy Directive due to their implications for the exclusion of "food and food crops" feedstock in meeting the ReFuelEU aviation initiative. Additionally, an advert for Virgin Atlantic's first transatlantic flight using "100 per cent sustainable aviation fuel"[63] was banned by the UK Advertising Standards Agency for misleading consumers. The SAF in question was produced using industrial cornstarch and animal fats unsuitable for human consumption—predominantly HEFA—which are an acceptable "sustainable" fuel under UK policy when capped.

Case study: Prioritising equitable community engagement and related benefits in the development of US clean hydrogen hubs

Green hydrogen is an appealing and promising solution to achieve decarbonisation for key hard-to-abate or heavy industry sectors, including aviation. With most regions of the world looking at how to increase hydrogen infrastructure supply as quickly as possible, we are already seeing the benefits of some projects that are set in motion and generating positive results for decarbonisation, and other social and environmental impacts, in hard-to-abate sectors.

The US Government has set a clear vision for the development of a hydrogen market, with the goal of scaling production to 10 million tons per year by 2030[64]. This goal will be supported by financial incentives in the Infrastructure Investment and Jobs Act (also known as the Bipartisan Infrastructure Law) and the Inflation Reduction Act (IRA). This commitment encompasses the development of seven regional clean hydrogen hubs, promising the creation of local jobs and outlining additional funding pathways, with the central focus of balancing the needs of local communities and accounting for historic and persistent inequality that has taken place in growth and development projects to date.

New federal funding packages associated with the programme have paired access to financial incentives with new requirements, such as the Office of Environment's (under the Department of Energy) Clean Energy Demonstrations. They mandate that all potential funding recipients create and implement a community benefits plan to present their two-way community engagement, adhering to the government's Justice40 requirements[65]. Essentially, developers must set goals for diversity, inclusion, equity and accessibility while demonstrating the creation of local, high quality jobs. This requirement ensures public support and shared prosperity while reducing project risk, and fosters support for first-of-a-kind (FOAK) clean energy technologies.

For these protocols to truly yield successful engagement, policymakers and developers must take a proactive approach to establishing a transparent and equitable process of involvement, creating accessible content that enables an equitable, two-way engagement process.

Policy priorities that underpin this within the Justice40 legislation for disadvantaged communities specifically include:

- Decrease energy burden.
- Decrease environmental exposure and burdens.
- Increase clean energy jobs, job pipeline, and job training for individuals from these communities.
- Increase clean energy enterprise creation and contracting from minority and disadvantaged businesses.
- Increase energy democracy.
- Increase access to low-cost capital.
- Increase parity in clean energy technology access and adoption.
- Increase reliability, resilience, and infrastructure.

The application of these principles within aviation and alternative fuels in particular, would ensure a more holistic approach to the sector's decarbonisation that prioritises justice and environmental considerations, with workers and communities embedded in the process.

Overarching insights and recommendations for investors, aviation companies and project developers

There are various complex levers and strategies required for the aviation sector to decarbonise globally. But all of them must have the lens of environment, equity, and just transition as a foundation to ensure the transformation of the sector serves people and the planet.

To apply and implement these considerations meaningfully—and ensure full transparency and rigour while doing so—institutional investors, aviation companies and other key aviation stakeholders are invited to consider the following insights to support the sector's transition:

Increasing knowledge and capacity

- With the above information as a starting point, the private sector can continue to build their knowledge and expertise on what legitimate just transition, environment and equity considerations mean for the aviation sector, using existing examples from parallel sectors as a guide and sharing their learnings with other stakeholders in the process.

Stakeholder engagement

- Consulting affected communities and workers from the outset of new fuel project development is crucial. Engaging early with community stakeholders, and analysing local context when assessing investment opportunities in communities that are involved in transition, will provide institutional investors with greater oversight of certainty that their investments are truly just and equitable.

Supply chain transparency

- Displacement of emissions and adverse impacts in marginalised geographies is a huge risk, particularly due to the international nature of aviation and fuel feedstock production. There has been a huge amount of greenwashing through offsetting schemes and false claims about solution pathways such as the dominant types of bio-based SAFs. Investors can collaborate with stakeholders to mobilise capital and investments towards the highest integrity, certifiably "sustainable" alternative fuels, while requiring transparency as to how these investments include just transition, environment and equity considerations to be eligible.

Consistent, credible disclosure

- There is a need for more consistent and streamlined reporting across the board to understand climate and nature impacts and emissions in the aviation sector. Investors can encourage consultation inputs and advocate for just transition and environmental factors within voluntary or mandatory reporting frameworks, such as SBTi, GHG Protocol and more, to result in greater disclosure on the critical measures to decarbonise, as well as to better reflect their risks and returns.

Policy advocacy

- Advocacy plays an important role in promoting transparent, effective policy responses that support aviation decarbonisation, while emphasising the need for a just and equitable transition. Stakeholders can form partnerships to identify emerging policy priorities through direct engagement and consultation, while also mobilising efforts to strengthen existing mandates to ensure their longevity. Additionally, these partnerships can identify opportunities that align investor and policymaker objectives with the principles of a just transition.

Investor and corporate engagement

- Investors should ensure oversight and clear disclosure of their aviation- or fuel supply chain-specific portfolio companies. Deepening disclosure to reveal what types of "sustainable aviation fuels" companies are investing in, with specific attention and prioritisation in engagements focusing on just transition, environment and equity factors, will generate responsible returns whilst mitigating risks, such as transition or stranded asset risk.

To find out more about Climate Catalyst's aviation programme, please get in touch with Madeleine Hill at madeleine@climatecatalyst.org**.**

To find out more about Opportunity Green's SASHA Coalition, please get in touch with Nuala Doyle at nuala@opportunitygreen.org**.**

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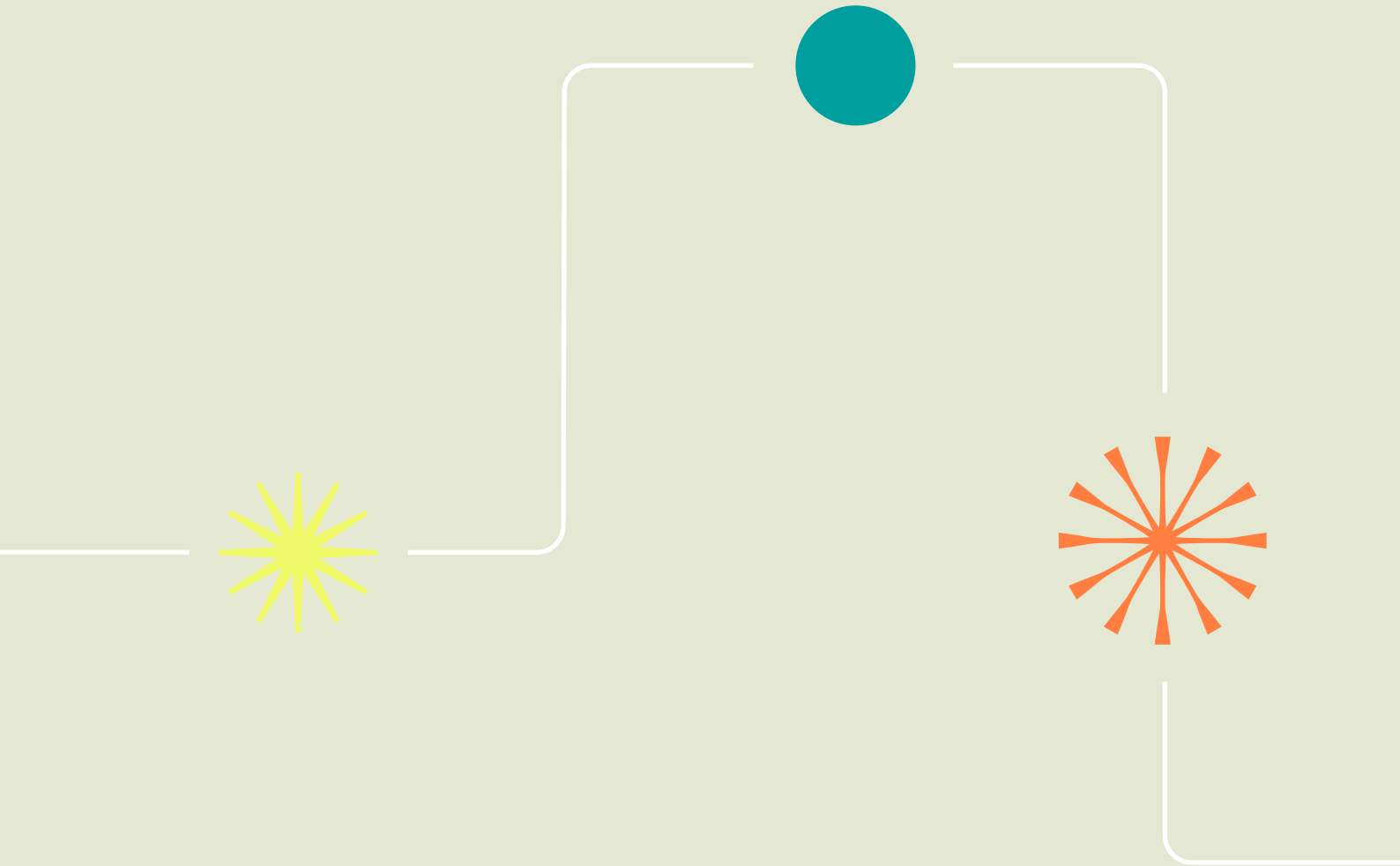

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