Why does aviation need green hydrogen to decarbonise?

Green hydrogen will have an important role to play in aviation's transition away from fossil fuels. This factsheet explains how this is the case, and why a focus on green hydrogen for aviation will drive European innovation and complement the EU's targets enshrined in the European Green Deal.

Background

- Aviation is a high-emitting sector, which currently accounts for 3% of global emissions (with additional non-CO_2 impacts). In the EU in 2017, direct emissions from aviation even accounted for 3.8% of total CO_2 emissions. In latest figures from 2018, the aviation sector created 14.4% of the emissions from transport, making it the second biggest source of transport greenhouse gas emissions after road transport.
- Aviation emissions in Europe increased by an average of 5% year-on-year between 2013 and 2019. While dropping dramatically during the pandemic, aviation emissions have since returned to their pre-pandemic levels and are projected to grow further. The increased climate ambition of the aviation sector will be crucial for the EU to reach its climate objectives under the Paris Agreement and make the European Green Deal a reality.
- Lowering emissions through improvements to fuel efficiency, among other factors, will be crucial. But ultimately, we need alternatives to the fossil jet fuel used today.
- But not all alternatives are made equally. Decisions must be taken now to ensure investment is targeted towards the alternatives with the greatest potential to lower emissions and drive growth.

Click to read our policy recommendations

SASHA Coalition

The options available

Broadly speaking, the main alternatives to fossil jet fuel available to the aviation industry are:

1. Direct electrification
2. Use of gaseous or liquid hydrogen propulsion aircraft or
3. Producing jet fuel from renewable sources, through a range of fuels commonly referred to as 'sustainable aviation fuels' (SAFs).

Green hydrogen will play a role in all pathways to producing alternative fuels for the aviation industry (other than for direct electrification).

But do all the alternatives offer the potential to provide a secure supply of low-emission fuel for the sector?

Let's look at the options...

Direct electrification

- Without the need to use renewable electricity to produce alternative fuels, direct electrification offers the most efficient alternative available to the aviation industry.
- When considering the non-CO_2 effects of aviation, electric aircraft would not produce exhaust products and therefore no contrail effect (a key driver of non-CO_2 climate impacts). To ensure the lowest possible lifecycle emissions, it is important that renewable electricity is used to charge the batteries powering electric aircraft.
- Strides are being taken towards developing electric aircraft. However, a significant amount of research and development is still required to develop batteries that are capable of storing enough energy to power an aeroplane.

Green hydrogen propulsion

- Green hydrogen has great potential to be used as a fuel itself, whether that be via combustion or using fuel cell technology.
- Crucially, when green hydrogen is combusted it does not release CO_2 emissions (further research is needed to fully understand the non-CO_2 impacts of hydrogen aircraft). To maximise emission reductions, it's important that green hydrogen – made using renewable electricity – is used to produce any hydrogen used in the aviation sector.
- The vast majority of hydrogen used today is produced using fossil fuels, and scaling green hydrogen production is not challenge-free, being energy- and water-intensive. Big changes will also be needed to both the aircraft and airports to facilitate this transition: new storage and transportation infrastructure will be required, and hydrogen-powered aircraft will need alternative engines and fuel storage.
- It is likely that, at least initially, hydrogen-powered aircraft will be best suited to commuter to medium-range flights, with market leaders suggesting hydrogen propulsion aircraft could be operating this decade.

Click to read our policy recommendations

SASHA Coalition

‘Sustainable aviation fuels’ (SAFs)

- The term SAF is a catch-all phrase, and in many cases a misnomer due to the limited emission reductions from some production pathways.
- Simply put, there are two main types of SAF: biofuels, produced using biomass, and e-fuels, made from a source of hydrogen and a source of carbon.
- Unlike hydrogen aircraft, which do not emit carbon, SAFs emit the same amount of carbon as traditional jet fuel, so their ability to lower emissions is entirely based on the full lifecycle emissions of the fuel and the feedstock used to produce it. They will, however, require far fewer modifications to aircraft and airports than using hydrogen directly due to their chemical similarity to jet fuel.
- For biofuels, first generation crop-based biofuels (produced using crops grown specifically to be used as a fuel) and used cooking oils and animal fats will be available in such limited quantities that they don’t present a long-term, viable route to producing alternative fuels for the aviation sector. Crop-based fuels also come with additional land use impacts, while used oils and fats have competing, existing uses.
- E-fuels, on the other hand, can be produced using green hydrogen and carbon captured via direct air capture (DAC). As long as a renewable source of electricity is used, this makes them close to carbon neutral.
- Like green hydrogen propulsion, producing e-fuels in the quantities needed will require significant amounts of renewable electricity. Work to scale supply from across the supply chain therefore needs to start now if e-fuels are to be scaled at the pace required.
- E-fuels therefore present the best option to sustainably produce aviation fuel in the long-term.

Image courtesy of Cranfield Aerospace. Over the last two years, Cranfield Aerospace has developed a zero-emissions, hydrogen fuel-powered propulsion system for a range of aerial platforms.

Click to read our policy recommendations

SASHA Coalition

What is the current policy landscape?

- ReFuel EU Aviation includes a headline target of 6% Sustainable Aviation Fuel (SAF) in 2030, but only 1.2% of that is synthetic fuels (including green hydrogen-derived). This will rise to a target of 70% SAF by 2050, of which 35% must be synthetic fuels.
- The legislation is projected to reduce aircraft CO_2 emissions by around two-thirds by 2050 compared to a 'no action' scenario, and provide climate and air quality benefits by reducing non-CO_2 emissions.
- This agreement is an important step towards the implementation of the Commission's 'Fit for 55' legislative package, and will help achieve the EU's climate ambitions under the European Green Deal.
- However, the EU has recognised that biofuel policy in the past created perverse incentives which drove deforestation. ReFuel EU Aviation risks creating the same issues by driving huge uptake of certain biofuels in aviation. Green hydrogen fuels can prevent this and create jobs across the EU. Our research shows that the current legislation creates a Green Hydrogen Gap which to be filled requires the EU to ensure that any update to aviation legislation supports green hydrogen fuels in aviation.

What we need from policymakers

Underpinning aviation's decarbonisation trajectory is a huge demand for green hydrogen. For aviation to have access to the fuels it needs and at the pace needed, supply needs to start being scaled up now. Regulations will be key to sending the demand signal that producers need to start scaling supply.

Here are our policy recommendations:

1. We need policy coherence across the Commission on aviation decarbonisation – ensuring that transport stakeholders are involved in decision making on future uses of green hydrogen (and DAC).
2. Hydrogen strategies must also recognise that the hydrogen used in decarbonising aviation, along with other hard-to-electrify sectors, must be *green*.
3. The targets set by ReFuel EU Aviation should be revised to better support green hydrogen fuels over other alternatives fuels with less potential to lower emissions. The fuels with the greatest emission reduction potential must continue to be incentivised over others when putting in place additional mechanisms to drive the supply and uptake of alternative fuels for the sector.

Want to know more?
Click here to read our Regulation Roadmap for green hydrogen.

SASHA Coalition

This factsheet draws on information and statistics included in the Green Hydrogen Gap report and supporting research conducted by Arup.