Policy Brief:
Sustainable Aviation Fuels (SAF) as Alternatives to Fossil-Based Jet Fuel

Introduction

The aviation industry is heavily dependent on fossil fuels and accounts for about five percent of global greenhouse gas emissions that contribute to climate change (Lai et al, 2022a; Grewe et al, 2021). Possible solutions to reduce the aviation sector's carbon footprint include replacing fossil jet fuel with Sustainable Aviation Fuels (SAF), electric aircrafts and green hydrogen. However, currently electric aircrafts only exist for very small planes, such as electric two-seaters. Hydrogen-based aircrafts are undergoing research and development (R&D), but will most likely only become commercially available in a decade from now or later. On the contrary, SAF are already available today and are commercially used as a drop-in fuel at many airports around the world (Urban et al, 2024).

This policy brief outlines the environmental impacts of SAF, based on research findings from the Sustainable Energy Transformations in Aviation (SETA) project funded by the Swedish Energy Agency.

Sustainable Aviation Fuels (SAF)

The large majority of SAF produced today are advanced biofuels based on hydro-processed esters and fatty acids (HEFA). HEFA fuels are bio-waste products from the food processing and animal husbandry industry, such as used vegetable / plant oils and animal fat wastes. Currently up to 50% of SAF can be blended with conventional jet fuel without modifications to engines. SAF also uses existing airport and refueling infrastructure, unlike electric aviation that requires charging infrastructure.

In the future other SAF types may be used more regularly too, such as electrofuels, which are synthetic fuels generated from electricity, water and carbon dioxide (CO_2) and other types of advanced biofuels such as based on lignocellulosic feedstock from forest waste products (Lai et al, 2022b).

The environmental impacts of Sustainable Aviation Fuels

Some Life Cycle Assessment (LCA) studies suggest that advanced biofuels-based SAF can reduce greenhouse gas (GHG) emissions by up to 80-90% compared to conventional fossil-based jet fuel (Prussi et al, 2021; Lai et al, 2022a). This reduction varies depending on the specific feedstock used, highlighting the importance of choosing sustainable sources. Lai et al (2022b) studied wider environmental impacts across the lifecycle of SAF, beyond GHG emissions. Their analysis found that particularly the use of electrofuels results in other environmental impacts such as mineral depletion, land use changes, freshwater ecotoxicity and human toxicity. Hence burden-shifting can be observed, for example from reduced global warming impacts to other environmental impacts such as mineral depletion as the production of electrofuels requires large-scale electric generation infrastructure.

Market overview
At airports like Stockholm Arlanda, Frankfurt, Amsterdam Schiphol, San Francisco International, Los Angeles International and Singapore Changi Airport customers can currently choose bio-based SAF tickets when travelling with certain airlines. Some airlines offer customers the option to purchase a SAF-based ticket for an additional fee, which is based on 50% blending of SAF. Other airlines may offer tickets with lower percentages of SAF paired with carbon offsetting for an additional fee.
Some companies and organisations offer their employees the option to purchase SAF-based flight tickets for their business trips. At the same time, some employers encourage using other travel options, such as trains for shorter distances and encourage digital meetings where possible. Choosing more sustainable travel options can enhance corporate responsibility and employee engagement in environmental initiatives.

Conclusion
Sustainable Aviation Fuels represent a critical step towards reducing dependency on fossil fuels and reducing CO_2 emissions from aviation. As a transitional solution until electric flights and green hydrogen-based flights become commercially viable, SAF can significantly reduce greenhouse gas emissions and contribute to circular economy approaches by turning waste products into fuels[1]. By adopting SAF, airlines, airports, fuel producers and customers can contribute to reduced climate impacts of aviation. Yet, some types of SAF, such as electrofuels, could results in other environmental impacts such as mineral depletion and land use changes.

Did you know that:

- You could reduce your travel emissions by flying on used cooking oil? Sustainable Aviation fuels (SAF) can reduce greenhouse gas (GHG) emissions by up to 80-90% compared to conventional fossil-based jet fuel (Prussi et al, 2021; Lai et al, 2022a). Currently used biofuels are often bio-waste products from the food processing and animal husbandry industry, such as used vegetable / plant oils and animal fat wastes.
- SAF are available at several airports across the world, including at major airports like Stockholm Arlanda Airport (ARN), San Francisco International Airport (SFO), Los Angeles International Airport (LAX), Frankfurt Airport (FRA), Amsterdam Airport Schiphol (AMS), Changi Airport (SIN) and Narita International Airport (NRT). Some airlines offer the option to buy SAF-based tickets for an additional fee.

Find out more about our research on Sustainable Energy Transformations in Aviation (SETA) here:

https://liu.se/en/research/graduate-school-in-energy-systems/energiomstallning-for-en-mer-hallbar-flygindustri

https://www.kth.se/indek/side/current-projects/seta-sustainable-energy-transformations-in-aviation-1.1017817

[1] For example through the use of hydro-processed esters and fatty acids (HEFA).

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Read more about our publications:

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Urban, F. and Nordensvärd, J., 2023. Handbook on Climate Change and Technology. Edward Elgar Publishing, London. Chapter on energy transitions in aviation, co-authored by Aneta Kulanovic. https://www.e-elgar.com/shop/gbp/handbook-on-climate-change-and-technology-9781800882102.html