

The role of SAF and other fuel-related measures for contrails mitigation

Astrid Sonneveld
Neste

Eurocontrol Sustainable Skies Conference:
Contrails in Focus

November 2023

Driven by our purpose



We are

#1

Producer of Sustainable Aviation Fuel (SAF)

In 2022, our customers
reduced

>11 Mt

greenhouse gas emissions with
our renewable products

We are

5,244

dedicated professionals
committed to our purpose,
of which **25%** is working on
innovation

Neste is a global leader in renewable & circular solutions



Renewable Aviation

Over the life-cycle, Neste MY Sustainable Aviation Fuel has up to 80% smaller carbon footprint compared to fossil jet fuel.



Renewable Polymers and Chemicals

Neste RE is Neste's solution for the plastics and chemicals sectors to help them reduce crude oil dependency while also tackling climate change and plastic waste challenge.



Renewable Road Transportation

Comparing 100% fossil diesel, 100% Neste MY Renewable Diesel™ results on 75-95% lower greenhouse gas (GHG) emissions when evaluating the emissions over the fuels' life cycle.

Delivering on our promise of making SAF available



1.5 Mt/a

SAF capacity

Capacity in early 2024 with completed Singapore refinery expansion and ongoing investments in the Rotterdam refinery.

>70

Customers

Direct customers across the aviation supply chain, i.e. fuel suppliers, airlines, corporates and travel & cargo companies

21

Countries

Neste's SAF is used in a growing list of countries across Europe, Americas, Middle East and Asia-Pacific

>25

Key airports¹

Neste MY Sustainable Aviation Fuel is available either directly from Neste or via a channel partner at key aviation hubs around the world

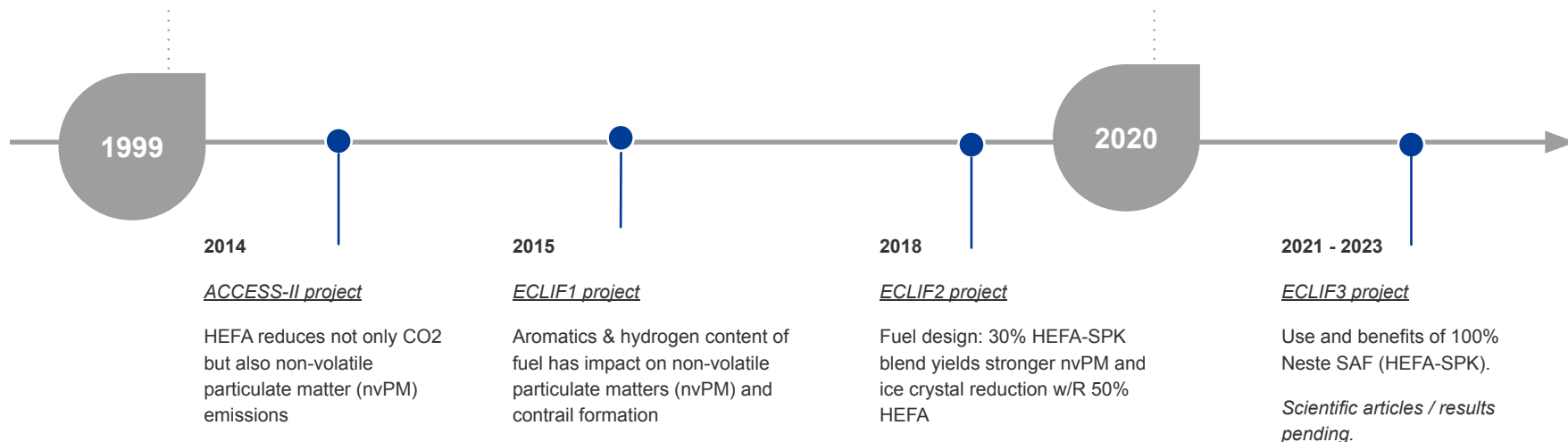
1) Including airports with over 1 million passengers where branded Neste MY Sustainable Aviation Fuel is available to airline customers, either directly from Neste or via a channel partner; Neste MY SAF is also available at several smaller and general aviation airports

As the leading SAF producer, we have been monitoring and participating in research projects related to non-CO2 impacts

Timeline of SAF non-CO2 research

At the request of ICAO, the IPCC released a [special report on Aviation and the Global Atmosphere](#), highlighting “*contrail formation may increase cirrus cloudiness — all of which contribute to climate change.*”

EU Aviation Safety Agency (EASA) released their [Updated analysis of the non-CO2 climate impacts of aviation and potential policy measures](#), triggering both non-CO2 MRV (EU ETS) and jet fuel composition monitoring (ReFuelEU Aviation) obligations in subsequent years



A person's hand is pointing at a chalkboard diagram. The diagram shows a large, dark, irregular shape with a white outline, possibly representing a fuel-related measure or a contrail. The background is dark, and the lighting is focused on the hand and the diagram.

After many years of research on contrails, attention is increasingly shifting to mitigation measures.

SAF and other fuel-related measures are among the options considered.

The mitigation opportunity



Basics of hydrocarbon chemistry and non-CO2 emissions

Non-CO2 emissions depend on fuel composition, not feedstock.

SAFs tend to be paraffinic, conventional jet fuel contains aromatics.

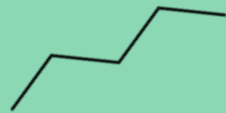
Paraffinic SAFs burn cleaner, reduce soot and ice crystal formation.

Sooting tendency of hydrocarbons

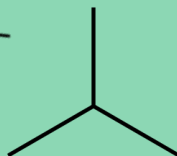
Conventional jet fuel species

Synthesized Paraffinic Kerosene (SPK)

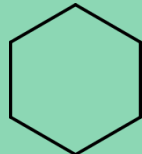
n-alkanes



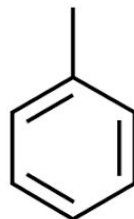
isoalkanes



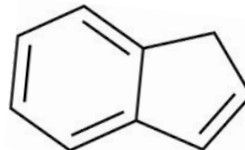
cycloalkanes



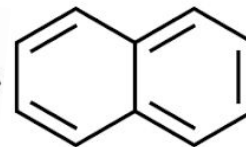
mono-aromatics



cyclo-aromatics



bi-aromatics



Sooting tendency

H:C ratio is a good indicator

Summary of SAF as a measure for mitigating contrails

Scientific evidence and Neste learnings

About soot emissions

- Reducing aromatic content in fuel reduces soot
- Lower amount of soot reduces amount of ice particles¹
- Neste SAF, i.e. the neat HEFA-SPK, reduces soot emissions by roughly ~50% compared to conventional jet fuel in cruise conditions

Implications for aviation non-CO2 climate impacts

- Properties and persistence of contrails are different for SPKs, resulting in lower radiative forcing compared to jet fuel

Next steps

- Validation of conversion of change in emissions to changes in climate impact (including radiative forcing)
- Validation of non-CO2 performance of SAFs that are not fully paraffinic

research areas where Neste seeks collaborations in the near future

¹ in sootrich conditions

An aerial photograph of a coastal road. The road is a two-lane highway with yellow center and white edge lines. It curves along a rocky coastline. On the left, the road meets a body of blue water. On the right, it runs parallel to a steep, rocky cliffside. A large waterfall cascades down the cliffside, creating white foam as it falls. The surrounding area is covered in green vegetation. The overall scene is rugged and scenic.

Implementation challenges

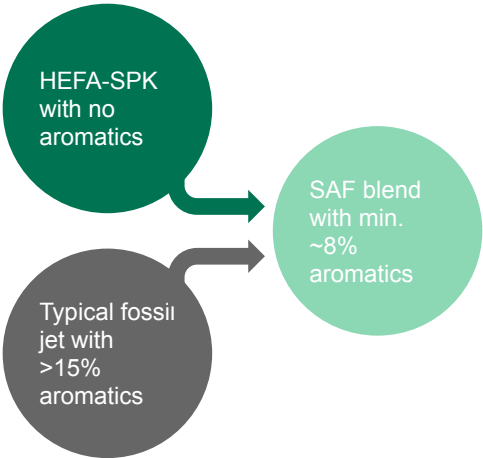
This material is confidential and intended for internal use only

NESTE

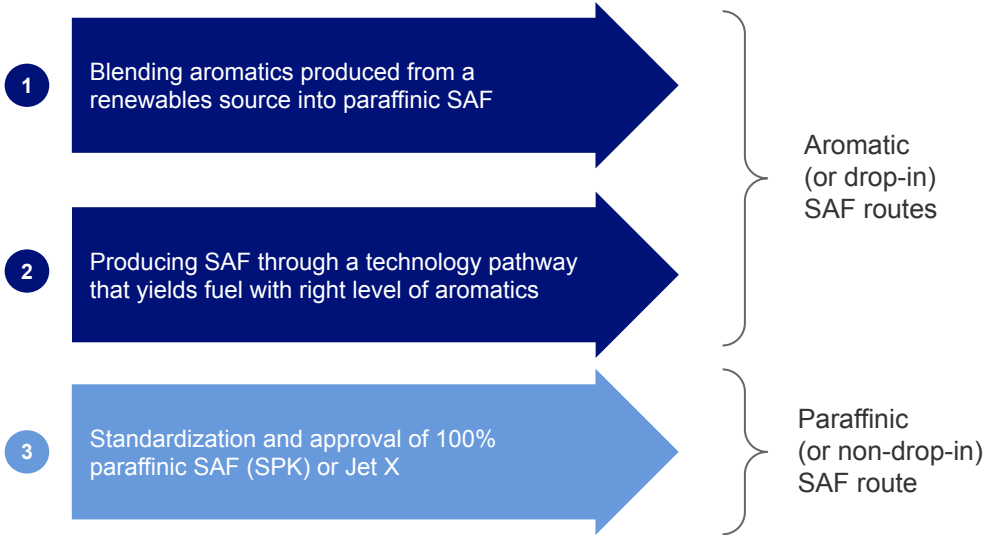
Three different routes to 100% SAF exist, each with their own timelines, uncertainties and collaborations required

Overview of paraffinic and aromatic routes to reaching higher blends and 100% SAF

Today - Blends of max. 50% SAF



Future - 100% SAF



The dilemma of aromatics in the route to 100% SAF

Aromatics play an important role not just in contrail formation, but as well in ensuring aircraft and infrastructure compatibility

For certain elastomer types, a certain amount of aromatic compounds is required to ensure seal swell and prevent from leakage. Also, aromatics play a role in ensuring the jet fuel meets the required density and viscosity. These attributes are important to ensure aircraft safety.

Aromatics tend to burn slower, leading to more incomplete combustion products ('nvPM'), contributing to contrail formation.

Aircraft nvPM emissions are dependent on the content and type of aromatics in the jet fuel. Not all aromatics are equal. Naphthalene in particular is a compound of concern.

Compatibility

100% SAF with right level of aromatics is a drop-in fuel, requiring little to no changes and aircraft and fuel distribution infrastructure



Non-CO2 impacts

100% SAF without aromatics is typically better from a non-CO2 climate impact point of view

Summary of implementation challenges of SAF as a measure for mitigating contrails

Neste learnings

- If the intention is to mitigate contrails through lowering of aromatics content in conventional jet fuel alongside the planned increase of the share of SAF in the aviation fuel mix, **fuel-related (policy) measures will need to be accompanied by changes in fuel specifications.**
- Today, SAF is typically delivered as blended fuel to comingled storage, triggering questions regarding traceability and allocation as part of non-CO2 MRV.

Next steps

- Work with OEMs on compatibility of future aircraft with jet fuel containing low-aromatic (<8%) or 100% SPK.
- Explore options for traceability and allocation of non-CO2 benefits of SAF to specific airlines and/or flights.

research areas where Neste seeks collaborations in the near future

A person's hand is pointing at a chalkboard. On the chalkboard, there is a large blue arrow pointing to the right. The background is dark, and the text is overlaid on the image.

Overall aviation climate impact reduction is the goal: CO₂ and non-CO₂ can and should be tackled in parallel.

Fuel-related policies measures and fuel specifications need to develop in sync.