Sustainable Aviation Fuel and its impact

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Aviation is the 2\textsuperscript{nd} largest source of transport emissions

- \textgreater{} 3\%: Aviation industry responsible for 2-3\% of global GHG emissions today.
- Double: Global air travel is expected to double in the next 15 years.
- CO\textsubscript{2}: Stakeholders are committed to lowering their carbon and emissions footprint.
The CO$_2$ effect

300 Gt CO$_2$ Budget, you do the math!

300gt CO$_2$  Global CO$_2$ emission budget (1.5 degree target) from Jan. 2021

40gt CO$_2$  Current global level of CO$_2$ emissions per year

Source: IPCC (2018) Special Report on Global Warming of 1.5°C$, October 2018
The climate effect
Non-CO₂ Emissions – Short term mitigation possible

Large short term mitigation potential from avoiding contrails and CiC

Source: Dahlmann, Schumann, et al.
What does “hard to abate” mean?

Departing flights & CO₂ emissions (2020)

Flight distances:
- > 4000 km
- 1500 – 4000 km
- 500 - 1500 km
- 0 - 500 km

Share of annual total:
- 6.2% create 51.9% of CO₂
- 30.6% create 4.3% of CO₂
- 19.6%
- 43.6%

Source: EUROCONTROL
What can we, as an industry, do together?

Neste is the #1 producer of Renewable Diesel & Sustainable Aviation Fuel made from wastes and residues.

In 2020, our customers reduced 10.0 Mt, aiming for 20.0 Mt in 2030 greenhouse gas emissions with our renewable products.

Creating a healthier planet for our children.
Our climate commitments

Handprint
Neste to reduce customers’ greenhouse gas emissions with its renewable and circular solutions by at least 20 million tons CO$_2$e annually by 2030

Footprint
Neste to reach carbon neutral production* by 2035

2000x this effort is needed

* Scope 1 & 2
Available drop-in solution

- Compatible with existing jet engines and fuel supply infrastructure
- Commercially available and in use
- Used in blends up to 50%

Greenhouse gas emission reduction

- In neat form, reducing GHG emissions up to 80% compared to fossil fuels over the lifecycle
- Produced 100% from renewable wastes and residues raw materials
- Direct in-sector emission reduction, unlike offsets

Reduction of non-CO₂ effects

- Burns clean, reducing local emissions
- Additional climate benefits through reduced particulate emissions (non-CO₂ effects of aviation may have equal or higher climate impact than carbon emissions¹)

¹ EASA Final Report: Updated analysis of the non-CO₂ climate impacts of aviation and potential policy measures pursuant to the EU Emissions Trading System Directive Article 30(4), November 2020
SAF supply chain from raw materials to airplane

Source: EUROCONTROL
Near term SAF capacity is almost all HEFA, dependent on lipid feedstocks.

Demand certainty for SAF can drive new investments for additional capacity in addition to pipeline in place.

Wide feedstock acceptance is critical for ensuring that ambitious SAF scale up targets are achievable (in Mt)

- Lipids in REDII Annex IX, Part A (POME, CTO): 2.7 Mt
- Lipids in REDII Annex IX, Part B (AF Cat 1 & 2, UCO): 10.3 Mt
- Other industrial wastes and residues (AF Cat 3, Acid oils, etc.): 29.2 Mt
- Oil trees on degraded land (85): 85 Mt
- Oil Cover crops (70): 70 Mt in 2030

Sources: Neste estimates, World Economic Forum estimates
Neste’s SAF capacity will grow to 1.5 million tonnes in 2023
And will continue to expand with new technologies

1. Up to 10% of global jet fuel use (35 Mton)

2. Potential exceeds global jet fuel use

3. Technical potential “unlimited”

Technologies close to commercialization
(municipal solid waste, lignocellulosic, etc.)

HEFA¹ (waste and residue oils and fats as raw materials)

Neste SAF scale up
- Current: 100 kton/a in Porvoo
- 2023: 1 Mton/a in Singapore (under construction)
- 2023: 450 kton/a in Rotterdam (feasibility study on-going)
- SAF capacity included in future renewable refineries

Source: WorldSource: Neste estimates. 1 HEFA = Hydroprocessed Esters and Fatty Acids
SAF will remain more expensive than fossil jet fuel, prices will come down as technologies mature

Development of production costs of SAF and comparison to fossil jet fuel
Impact on fares - your call

The influence on ticket prices is moderate:

<table>
<thead>
<tr>
<th>SAF blend:</th>
<th>5%</th>
<th>14%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helsinki - Singapore</td>
<td>+ €12</td>
<td>+ €33</td>
<td>+ €71</td>
</tr>
<tr>
<td>Helsinki - Munich</td>
<td>+ €3</td>
<td>+ €9</td>
<td>+ €20</td>
</tr>
<tr>
<td>Helsinki - Stockholm</td>
<td>+ €1</td>
<td>+ €4</td>
<td>+ €8</td>
</tr>
</tbody>
</table>
**Conclusions**

**Availability**
HEFA based SAF is commercially immediately available. Eligibility of all sustainable feedstocks is crucial.

**Climate**
For the climate, biofuels are most effective when used in aviation due to the reduction of also the non-CO2 effects.

**Contribute**
Ticket price increase is reasonable. Aviation will continue to contribute to connectivity and productivity.

**Urgency to act**
SAF will remain more expensive than fossil fuel, making regulatory measures necessary.
SAF potential

- SAF technical feasibility proven
- Reducing both CO₂ and non-CO₂ climate effects
- Production capacity existing and ramping up
- Sustainable feedstocks available
Sufficient bio-feedstock potential for substituting fossil jet fuel

Power-to-liquids will bring unlimited additional potential as the technology matures.

Immediately available HEFA technology based on zero ILUC lipids can replace 20% of jet fuel.

In mid 2020’s, Gasification+synthesis and ATJ technologies will mature. Together with HEFA, they have the potential of substituting all fossil jet fuel.

Estimated SAF potential 490 Mt in total in 2030.

Up to 120% of estimated global jet fuel demand of 410 Mt in 2030.

Practical feedstock availability in 2030, Mt/year:

- Power-to-Liquids (CO2): Unlimited
- Waste & residue lipids
- Oil trees on degraded land
- Oil-cover crops
- CategCellulosic cover crops
- Agriculture residues
- Forestry residues
- Wood-processing waste
- Municipal solid waste

Starting around 2030, industrial volumes of PtL can become available.

### Regulatory treatment and availability of the HEFA feedstocks

<table>
<thead>
<tr>
<th>Category</th>
<th>RED II (Availability: WEF and Neste estimates)</th>
<th>CORSIA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 Waste and residue lipids</strong></td>
<td>Annex IX Part A 2.7 Mt/a</td>
<td>Partly specifically included. None are excluded and individual LCA values allowed since zero ILUC</td>
</tr>
<tr>
<td></td>
<td>Annex IX Part B 10.3 Mt/a</td>
<td>Specifically included. Zero ILUC assigned</td>
</tr>
<tr>
<td><strong>2 Oil trees on degraded land</strong></td>
<td>Not included in any category, but similar with “Low ILUC Risk Biofuels” definition RED II Art. 2(37)</td>
<td>Included in the “Low land use change (LUC) risk practices” category. Zero ILUC assigned. (Temporary rules, to be updated)</td>
</tr>
<tr>
<td><strong>3 Oil Cover Crops</strong></td>
<td>Included in the “Intermediate Crops” definition RED II Art. 2(40)</td>
<td>Included in the “Low land use change (LUC) risk practices” category. Zero ILUC assigned. (Temporary rules, to be updated)</td>
</tr>
</tbody>
</table>

- **Category**: (Ref. to Figure 1 above)
- **RED II**: (Availability: WEF and Neste estimates)
- **CORSIA**: Partly specifically included. None are excluded and individual LCA values allowed since zero ILUC
- **Partly specifically included. None are excluded and individual LCA values allowed since zero ILUC**
- **Specifically included. Zero ILUC assigned**
- **Included in the “Low land use change (LUC) risk practices” category. Zero ILUC assigned. (Temporary rules, to be updated)**
- **Outside of Annex IX 29.2 Mt/a**