Prospects and challenges for low carbon aviation fuels

Greener by Design Conference
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E4tech perspective: Strategy – Energy - Sustainability

- International consulting firm, offices in UK and Switzerland
- Focus on sustainable energy – ahead of the curve
- 22 years old this year, always independent
- Deep expertise in technology, business and strategy, market assessment, techno-economic modelling, policy support...
- A spectrum of clients from start-ups to global corporations
Contents

- Current status of sustainable aviation fuel (SAF) production
- Future prospects for SAF production
- Challenges to scaling up SAF production
HEFA is the most commercial SAF technology, whilst several others are being developed

<table>
<thead>
<tr>
<th>Fuel Name</th>
<th>Date certified</th>
<th>Maximum blend level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fischer-Tropsch - Synthetic paraffinic kerosene (FT-SPK)</td>
<td>2009</td>
<td>50%</td>
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<tr>
<td>Fischer-Tropsch - Synthetic paraffinic kerosene with added aromatics (FT-SPK/A)</td>
<td>2015</td>
<td>50%</td>
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<tr>
<td>Hydroprocessed Esters &amp; Fatty Acids (HEFA) - Synthetic paraffinic kerosene (SPK)</td>
<td>2011</td>
<td>50%</td>
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<td>Synthetic Iso-Paraffinic fuels (SIP)</td>
<td>2014</td>
<td>10%</td>
</tr>
<tr>
<td>Alcohol to jet</td>
<td>2016 (updated 2018 to include more feedstocks and higher blend %)</td>
<td>50%</td>
</tr>
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</table>
Currently low volumes of SAF are produced, but several large plants are planned or under construction

- Currently there is 5Mtonnes/year of dedicated hydroprocessing and co-processing capacity globally, and substantial capacity likely to be added in the next few years. However most of this is used to produce renewable fuel for the road transport sector.

- Production capacity of other technologies is substantially lower, but several large plants are planned

- This is still substantially less than global kerosene use (300 Mtonnes/year)
Policy is beginning to be implemented that will bridge the price gap between SAF and kerosene

**International policy:**

• CORSIA aims to stabilise net CO$_2$ emissions from international civil aviation at 2020 levels.

**National / regional policy:**

• Several regions including the UK, the Netherlands and California, allow renewable fuel supplied in the aviation sector to contribute towards renewable fuel blending mandates, although the aviation sector is not obligated to supply renewable fuel.

• An obligation to supply renewable fuel into the aviation sector will be introduced by Norway from January 2020 and is being considered by other European Member States.
Short-medium term prospects for SAF globally

• In the short term most SAF will be supplied from HEFA

• Hydro-processing facilities need a relatively small modification in order to increase the amount of jet fuel they produce

• However for existing SAF plants this production would be at the expense of road transport fuel production, so the price incentives must be in place for them to do this.

• Some dedicated HEFA production facilities are now operating / under construction:
  • World Energy, California, 128 ktonnes/year production capacity
  • Neste, Singapore, ~700 ktonnes/year production capacity

• Bottom-up modelling of biofuel plant build-rates suggests that global SAF production capacity could reach between 15 and 31 Mtonnes/year by 2035.

• UK currently has supportive policy environment for SAF
Long term prospects for SAF

- Longer term, HEFA production capacity is likely to be limited by the availability of sustainable feedstock, therefore other routes from different forms of biomass or renewable electricity will be required.

- Projections indicate global SAF production capacity could get to between 63 and 131 Mtonnes/year in 2050 - between 22% and 45% of global kerosene use in 2050 according to the IEA 2DS scenario.

\[\text{Global SAF production capacity projections to 2050}\]

- Aviation Optimised, Fast Growth, Bottom-up
- Aviation Optimised, Slow Growth, Bottom-up
- Road Optimised, Fast Growth, Bottom-up
- Road Optimised, Slow Growth, Bottom-up

E4tech analysis: Bottom-up analysis to 2035 based on operating and planned plants, and plant build-rates; dashed lines from 2035 to 2050 indicate scale-up at CAGR of 15%
Sufficient feedstock is available to produce 130Mtonnes of SAF globally in 2050.

Using the total global resource of UCO and tallow, and all vegetable oil crops currently used for FAME production, to produce HEFA, limits global HEFA production at 43Mtonnes/year.

**Global feedstock available for energy in 2050**

- **Biomass feedstock (Mtonnes / year)**
  - Agricultural Residues + Energy Crops: 5,737
  - Forestry Residues: 759
  - MSW: 999
  - Waste Oils/Fats + Conventional oil crops: 43
  - Conventional sugar crops: 574

- **Renewable Electricity (PWh / year)**: 417

*E4tech analysis, based on range of sources.*

1. Data for agricultural and forestry residues and energy crops refers to technical potential accounting for competing non-energy uses; Data for MSW refers to quantity collected; Waste oils/fats are comprised of UCO (data refers to quantity collected) and tallow (data refers to total arising); Data for sugar and oil crops refers to amount used for biofuels today; Data for renewable electricity refers to technical potential.
Challenges to achieving SAF production at this scale

• Scale-up and development of production technologies which are not currently commercialised

• Establishment of supply chains for large volumes of sustainable feedstocks

• SAF is currently substantially more expensive than fossil kerosene, and will likely continue to be into the future, therefore long-term and stable policy is required to bridge the price gap

• Access to finance to build large-scale plants