Increasing Supply and Demand for Sustainable Fuels

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Alternative fuels have made significant advancements in the last decade

<table>
<thead>
<tr>
<th>Time Period</th>
<th>LCA reduction</th>
<th>Key questions</th>
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</thead>
<tbody>
<tr>
<td>10 years ago</td>
<td>10%-20%</td>
<td><em>Will it hurt the engines?</em></td>
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<td><em>Will it affect aircraft performance?</em></td>
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<td><em>How do we certify this?</em></td>
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<td></td>
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<td><strong>Is it safe?</strong></td>
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<td>5 years ago</td>
<td>30%-40%</td>
<td><em>What policies are needed?</em></td>
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<td><em>How can the business case work?</em></td>
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<td><em>Why should we be first?</em></td>
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<td>Today</td>
<td>60%-80%</td>
<td><em>Where is the money to scale up?</em></td>
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<td><em>How do we engage our customers?</em></td>
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Airlines aren’t willing to pay a price premium, so we need to find creative pricing or value structures…

- Converted an unused refinery and using it for production
- Avoided costly startup expenses, so reduced need for cost recovery or to advance down the learning cove
- Cost/risk-sharing agreement with United

- Using municipal solid waste as feedstock, and receiving it at no cost
- Bringing in investors from across the value chain who receive different benefit streams
United to park dozens of jets
Chicago Tribune
June 4, 2008

United Airlines is expected to ground dozens of its least-fuel-efficient aircraft, including Boeing 747 jumbo jets, as part of a sweeping round of cuts intended to help the carrier conserve cash and survive as a stand-alone company in daunting times. United plans to retire the workhorses of its domestic fleet: 94 decades-old Boeing 737 jets. Doing so would eliminate more than 20 percent of the 460 aircraft in United's fleet.
Monetizing the air quality benefits of alternative fuels could help pay price premiums

Emissions reduction of ‘neat’ SPK\(^1\) alternative fuel vs. conventional jet fuel

<table>
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<tr>
<th>Emissions</th>
<th>CO(_2)</th>
<th>SO(_x)</th>
<th>PM</th>
<th>CO</th>
<th>UHC</th>
<th>NO(_x)</th>
</tr>
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<tbody>
<tr>
<td>Nearly 100(^{%})</td>
<td>60%-80(^{%})</td>
<td>50%-80(^{%})</td>
<td>9%-40(^{%})</td>
<td>20%-30(^{%})</td>
<td>At most 10(^{%})</td>
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1. Synthetic paraffinic kerosene, or ‘biojet’
It’s important to diversify risk across suppliers…

**United Airlines Flies First U.S. Commercial Advanced Biofuel Flight**
November 7, 2011

United Airlines announced that it is operating the first U.S. commercial flight powered by advanced biofuels. Today’s flight from Houston to Chicago makes United the first U.S. airline to fly passengers using a blend of sustainable, advanced biofuel and traditional petroleum-derived jet fuel.

Solazyme, working with Honeywell’s UOP process technology, developed the algae oil that was refined into jet fuel to power today’s commercial flight.

Also today, United is announcing it has signed a letter of intent with Solazyme to negotiate the purchase of 20 million gallons of jet fuel per year, derived exclusively from algae oil, for delivery as early as 2014.

**Solazyme Ditches Biofuels (and Name) in a World of Cheap Oil**
*Fortune*
March 16, 2016

A company that has been paving a path to make biofuels from algae oil over the past decade has finally given up on its biofuel ambitions in a world of ultra cheap petroleum-based oil.

Solazyme, now renamed as TerraVia, says it will no longer focus on its fuels and its industrial businesses, and instead will double down on selling its algae oil to the food and personal care industries, for use in products like cooking oil, protein powders and face lotion.
…determine how airports can best engage…

Oslo becomes the first airport to supply sustainable jet fuel
January 22, 2016

Port of Seattle Announces Partnership for Sustainable Aviation Fuels at Sea-Tac Airport
May 1, 2018

Genève Aéroport to offer sustainable and renewable solutions for aviation
September 13, 2017

SFO Announces Landmark Agreement for Use of Sustainable Aviation Fuels
September 5, 2018
...and understand how to appeal to customers

Which aircraft looks more fun to fly on?
We need to do more to partner beyond aviation

Aviation organizations

Beyond aviation

[Logos and images of various aviation and sustainability organizations]
Although volumes are small today, history suggests technology can scale up

Orbiting the Earth Projection: 1957 ✓ 1957

Traveling to the moon Projection: 1970 × 1969

Source: Kevin Kelly, *Was Moore’s Law Inevitable?*
2017 Eco-Airline of the Year