Renewable Fuels For All Modes Of Transport

- D2 DIESEL
- HIGH OCTANE RACING FUEL
- GASOLINE
- COMMERCIAL JET FUEL Jet-A / Jet A-1
- MILITARY GRADE DIESEL F-76 Marine
JET FUEL
Basic Definitions

- **JET FUEL** “Standalone” hydrocarbon that can be used in turbine engines
- **BLENDSTOCK** Hydrocarbon product that can “only” be used as an additive to FUEL
- **DROP-IN FUEL** JET FUEL that is the result of “Blending” JET FUEL & BLENDSTOCK
- **REPLACEMENT JET FUEL** Alternatively produced JET FUEL requiring “no blending”
TRANSFORMING AN INDUSTRY
CREATING VALUE AT EACH STAGE

AGRICULTURE
Sugar Crops

FERMENTATION
Ethanol/Butanol

CATALYSIS
To Fuels

FARM RESIDUALS

FERMENTATION RESIDUALS

CATALYTIC RESIDUALS

• Electricity
• Fiberboard
• Carbon Fiber
• Animal Feed

• Animal Feed
• Omega Oils
• Human Food Proteins
• Chitosan Products

• Pure Water

• Gasoline
• Jet Fuel
• Diesel
• Heating Oil

The True BIO-REFINERY:
The New AgTech Business Model
FUNDAMENTALS & CHALLENGES
DEVELOPING AN ALTERNATIVE FUEL INDUSTRY

Industry Challenge

Scale & Cost

Feedstock
- 65% of the final fuel cost

Technology
- Biological vs. Chemicals (new vs. known)

Fuel Quality
- Blendstock Additive vs. Full Replacement Fuel

Fundamentals
“Required” To Achieve Scale & Cost
ALCOHOL TO JET (“ATJ – SKA”)

Synthetic Kerosine With Aromatics

ADDRESSING INDUSTRY CHALLENGES

- **Feedstock**
  - SUGARS
    - Most Abundant Feedstock In The World

- **Technology**
  - PETROCHEMICAL
    - Proven Chemical Process (No Magic Bugs)

- **Fuel Quality**
  - PREMIUM FULL REPLACEMENT FUEL
    - Eliminating Blending Logistic Challenges
THE IMPORTANCE OF A FULL FUEL SAFETY & COST

#1 Misconception ... No Need For A Fully Synthetic Fuel Now

“Industry is Too Large To Supply Enough Volume”

- 5 ASTM “Blendstock” specifications since 2009 (with varying blending limitations)
- Many additional blendstocks on the horizon
- Will require a global database of every drop
- Minimum 8% aromatics will require adjustments to blend from varying crude specs

DOWNSTREAM BLENDING LOGISTICS ARE UNDERESTIMATED
THE IMPORTANCE OF A FULL FUEL SAFETY & COST

Adopting a full replacement fuel will save billions $$$ by eliminating the downstream issues of:

- Blending
- Storage
- Transportation
- Accounting

DOWNSTREAM LOGISTICS COSTS ARE UNDERESTIMATED
In The News ....

OKLAHOMA: More Than 100 Fuel Retailers Affected by E30 Mix-Up

....more than 100 fuel retailers mistakenly received gasoline containing up to 30% ethanol instead of E10, creating chaos throughout the state but especially in the Tulsa and Oklahoma City metropolitan areas.....
FAA recognizes blending logistic challenges

The Continuous Lower Energy, Emissions and Noise (CLEEN) Program is a Federal Aviation Administration NextGen effort to accelerate development of environmentally promising aircraft technologies and sustainable alternative fuels. The CLEEN Program is managed by the FAA’s Office of Environment and Energy.

The report presented herein is a report deliverable submitted by Rolls Royce for a project conducted under the CLEEN Program to evaluate the feasibility of selected alternative fuels as viable drop-in replacements to petroleum jet fuel. This project was conducted under FAA other transaction agreement (OTA) DTFWA-10-C-00006. This is report number DOT/FAA/AEE/2015-02 by the FAA’s Office of Environment and Energy.

Table 2 – Candidate Fuels Selected for Rig Testing

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Fuel Type and Description</th>
<th>Aromatic content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline blends</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jet A-1 (baseline)</td>
<td>100% Conventional</td>
</tr>
<tr>
<td></td>
<td>HEFA / Jet A-1</td>
<td>50/50 Blend (ASTM D7566)</td>
</tr>
<tr>
<td></td>
<td>HEFA / Jet A-1</td>
<td>75/25 Blend</td>
</tr>
<tr>
<td></td>
<td>100% HEFA</td>
<td>100% HEFA</td>
</tr>
<tr>
<td>Novel fuels</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alcohol to Jet 1</td>
<td>Novel Single Process No1</td>
</tr>
<tr>
<td></td>
<td>Catalytic Hydrothermolysis</td>
<td>Novel Single Process No2</td>
</tr>
<tr>
<td></td>
<td>GIL + Sugar Bio-forming</td>
<td>Novel Blend No 1</td>
</tr>
<tr>
<td></td>
<td>Cellulose - Aromatic + SPK</td>
<td>Novel Blend No2</td>
</tr>
</tbody>
</table>
Byogy Fuel Testing Results From FAA CLEEN

**BLENDED 50-50**

- JET (Petroleum) 50%
- HEFA (Plant Oils) 50%

**100% FUEL**

- BYOGY NEAT

---

Hydrocarbon Type Ratio Analysis

Byogy Can Adjust Aromatics 0% to 30%+

Cyclo-Paraffins are favorable in a fuel

n-Paraffins are not favorable in a fuel
BYOGY FUEL TESTING
Proves PREMIUM Full Replacement Fuel

BYOGY’s ATJ-SKA Testing:
- FAA CLEEN Program
- USAF
- SASOL
- PRIVATE

All testing validated a “premium full replacement aviation fuel”

✅ Better Fuel Burn Efficiency (“SFC”) (greater miles per gallon)
✅ Reduce GHG by >80%
✅ Delivers lower engine maintenance costs (negligible n-paraffins)
✅ Has lower freeze temperature (opening up new flight space)
✅ Can adjust aromatics to any level (to adapt to local crude oil specs)
ASTM: Alcohol To Jet – Advanced Testing

ALCOHOL-TO-JET (ATJ) SPECIFICATIONS

**ATJ CORE APPROVED**

**ATJ – SPK-1 Iso-Butanol (30% max)**

**ATJ AMENDMENT #1**

**ATJ – SPK-2 Ethanol & n-Butanol (50% max)**

**ATJ AMENDMENT #2**

**Or New Annex**

**ATJ – SKA-1**

Ethanol & Butanol (50% max)

**ATJ SKA – 100% FULL FUEL**

Mil-Spec & ADVANCED TESTING PROGRAM

**ATJ – SKA ADVANCED TESTING TO DEVELOP A SPECIFICATION FOR UP TO 100%**

(Subsequent and/or parallel processing to be introduced at ASTM to achieve higher blends than 50% once sufficient “experience” data is collected)

**MIL-SPEC & ATJ-SKA 2**

100% Circa 2019/21

ALL DATES SHOWN HEREON ARE ESTIMATES AND SUBJECT TO PROCESS AND APPROVAL BY THE ASTM AND/OR MILITARY CONSTITUENTS
Byogy Commercializes at Every Level Of ATJ

<table>
<thead>
<tr>
<th>ATJ ASTM MILESTONE</th>
<th>PROJECTED(^1) TIMEFRAME</th>
<th>FEEDSTOCK</th>
<th>AROMATICS</th>
<th>BLEND Max</th>
<th>BYOGY APPLICABILITY (Commercial Viability)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPK - 1</td>
<td>2015</td>
<td>Iso- Butanol</td>
<td>NO</td>
<td>30%</td>
<td>✓</td>
</tr>
<tr>
<td>SPK - 2</td>
<td>2016/17</td>
<td>Ethanol N-Butanol Mixed Alcohol</td>
<td>NO</td>
<td>50%</td>
<td>✓</td>
</tr>
<tr>
<td>SKA - 1</td>
<td>2017/18</td>
<td>Ethanol, Butanol</td>
<td>YES</td>
<td>50%</td>
<td>✓</td>
</tr>
<tr>
<td>SKA – 2</td>
<td>~ 2018-2020</td>
<td>Ethanol, Butanol</td>
<td>YES</td>
<td>100%</td>
<td>✓</td>
</tr>
</tbody>
</table>

\(^1\) Best estimation based on Byogy ASTM participation – subject to ASTM process