Since the last General Meeting...

- Off-year R&D Team workshop focusing on challenges and opportunities
- Developed white papers
- Developed position papers on R&D challenges and needs
- Developed updated team Mission Statement
- Established Seminars on Alternatives to Petroleum (Jet) – SOAP-Jet webinars
Critical R&D Challenges

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>White Paper Title</th>
<th>Date</th>
<th>Download</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate</td>
<td>Flexible economic and engineering models to evaluate proposed alternative fuel</td>
<td>TBD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>facilities and supply chains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate</td>
<td>Alternative fuels specification and testing</td>
<td>March 2013</td>
<td>![PDF]</td>
</tr>
<tr>
<td>Near-term</td>
<td>HEFA Feedstock Cost Reduction</td>
<td>March 2013</td>
<td>![PDF]</td>
</tr>
<tr>
<td>Near-term</td>
<td>Relative Economics of Sustainable Aviation Fuels, versus competing Biocommodities</td>
<td>March 2013</td>
<td>![PDF]</td>
</tr>
<tr>
<td></td>
<td>and uses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near-term</td>
<td>Development and streamlining of crosscutting technologies</td>
<td>TBD</td>
<td></td>
</tr>
<tr>
<td>Near-term</td>
<td>Diversity in biofuel feedstock production</td>
<td>March 2013</td>
<td>![PDF]</td>
</tr>
<tr>
<td>Near-term</td>
<td>Developing efficient and cost-effective use of wastes as feedstocks</td>
<td>March 2013</td>
<td>![PDF]</td>
</tr>
<tr>
<td>Mid- to long-term</td>
<td>Alternate methods of atmospheric CO2 capture</td>
<td>March 2013</td>
<td>![PDF]</td>
</tr>
<tr>
<td>Mid- to long-term</td>
<td>Approaches that Convert CO2 to Drop-In Jet Fuel</td>
<td>March 2013</td>
<td>![PDF]</td>
</tr>
</tbody>
</table>

Find chart at [http://www.caafi.org/information/rdchallenges.html](http://www.caafi.org/information/rdchallenges.html)
SOAP-Jet Webinars

- Intended to increase R&D team function as an information “node” for team members
- First series focusing on DOE CHASE grant recipients
- 2 seminars held so far
- 70-ish attendees at each
- Soliciting input on future topics from team
Breakout Discussion and Next Steps

* **White Papers**
  * Identified additional updates to add to existing papers
  * Identified potential authors/contributors to desired topics
    * Cross cutting technologies
    * Flexible economic and engineering models
    * Other papers suggested by team
  
* **Communications –**
  * Team to provide input on webinar topics
  * Request for LinkedIn page and community
  * Request to share resources and information via web links and discussion boards
Feedstock Readiness Level (FSRL)

- Discussed utility of tool – identified utility for purchasers and USDA – helps to stack/rank projects
- Discussed potential for case studies via integration of FSRL as requirement for NIFA CAP grant reporting
  - Provide case studies
  - Provide expansion opportunity for residues/non-crop feedstocks
  - Use as webinar topic
Certification-Qualification Breakout Session Overview

- ASTM D4054 Qualification Process Overview
- Pathway Status/Overview
  - Process Descriptions and ASTM Timelines for:

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Presenter/Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSHC</td>
<td>Fernando Garcia/Amyris</td>
</tr>
<tr>
<td>ATJ</td>
<td>Glenn Johnston/GEVO</td>
</tr>
<tr>
<td>CH</td>
<td>ARA/Ed Coppola</td>
</tr>
<tr>
<td>HDCJ</td>
<td>Jeff Trewella/KiOR</td>
</tr>
<tr>
<td>HDO-SK and HDO-SAK</td>
<td>Brice Dally/Virent</td>
</tr>
<tr>
<td>FT-SKA</td>
<td>Cliff Moses/Consultant</td>
</tr>
</tbody>
</table>
**ASTM D4054 Process**

**TIER 1**
- Specification Properties

**TIER 2**
- Fit-For-Purpose Properties

**TIER 3**
- Component/Rig/APU Testing

**TIER 4**
- Engine/APU Testing

- ASTM Specification
- ASTM Balloting Process
- OEM Review & Approval
- ASTM Research Report
Catalytic Hydrothermolysis (CH) - Pathway

Biofuels ISOCONVERAION (BIC) Process = CH + Hydrotreating (Chevron Lummus Global)

Feed Stocks
- Triglycerides
- Plant oils
- Tallow
- Algal oils
- Fatty acids
- Water

Intermediate Products
- n-paraffins
- Iso paraffins
- Cycloparaffins
- Aromatics
- Olefins
- Organic acids

CH Conversion

Water

Hydrogen

Hydrogenation Fractionation

Jet Fuel
- “Drop-in”
- ASTM D1655 Equivalent
- w/o blending

D4054 Timeline

“HEFA SKA” Task Force Formed

1st Pilot production

2nd Pilot production

NRC Flight test on 100% ReadiJet

On-site OEM/TF meeting

Fit-for-Purpose testing

Start-up 100 bpd demo plant

3rd Pilot prod

PW 615 test

Ballot Research report

Ballot HEFA SKA spec

Submit Research Report

2011 2012 2013 2014 2015

“HEFA SKA” Task Force Formed

1st Pilot production

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Fit-for-Purpose testing

Start-up 100 bpd demo plant

3rd Pilot prod

PW 615 test

Ballot Research report

Ballot HEFA SKA spec

Submit Research Report

2011 2012 2013 2014 2015
Breakout Session Overview

* Concepts for Facilitating OEM Review of Alternative Fuel Property and Test Data
  * “OEM Review Panel”
* FAA R&D Initiatives
  * Possible Funding Sources for Support of ASTM Certification
* Round Table Discussion of D4054 Certification Process:
  * Challenges, Lessons Learned, Process Improvements
  * Fuel Producers and OEMS
  * Review of Survey Results
Key Issues and Recommendations

* Key Issue No. 1
  * Lack of management/coordination of ASTM D4054 Process for alternative fuel certification projects
    * creates conflicting demands for OEM resources to review data and perform tests
    * Makes business planning difficult for alt fuel producers due to uncertain schedule and costs

* Recommendation No. 1
  * Establish Single Focal Point as D4054 Facilitator
    * Track/Monitor D4054 Task Force Progress
    * Coordinate Data Review and Testing by OEMs
    * Establish Schedules and Prioritize Projects
    * Requires Funding
Key Issues and Recommendations

Key Issue No. 2

* Funding of OEM Support of Alternative Fuel D4054 Certification Projects
  * Component/Rig/Engine Testing & Research Report Review
  * D4054 Process Improvements
    * Advanced Analytical Methods in Lieu of Engine Testing
    * USAF Funding Support Drastically Reduced

Recommendation No. 2

* Recognition that OEMs Cannot Fund Entire Support Effort
* Consider D4054 Support in FAA R&D Programs
* Communicate Customer Support of D4054 Alternative Fuel Projects to OEM Management
  * Airlines & DOD
Key Issues and Recommendations

* **Key Issue No. 3**
  * ASTM D4054 Process too Lengthy and Costly
  * Extensive Fuel Property and Engine/Aircraft Testing
  * Repeating Same Tests Regardless of Compositional Similarities With Previous Fuel Approvals

* **Recommendation No. 3**
  * Establish Staged Gate Approach
  * Approve Smaller Blend Percentages (1% - 5%)
    * Reduce D4054 Certification Test Requirements
  * Increase Blend Percentage with Service & Production Experience
CAAFI Environment Team: Developing Tools & Means to Address Environmental Issues

January 29, 2014

Nancy Young and Jim Hileman
Co-Leads of CAAFI Environment Team
Refresher on the Environmental Imperative

* Overall Objectives for Alternative Fuel Deployment
  * Energy Security/Supply Reliability
  * Commodity Competitor to Petroleum
  * Environmental Benefit (our focus)

* Environmental Benefit
  * Life Cycle Greenhouse Gas (GHG) Emissions Improvements
  * Potential to Reduce Emissions with Air Quality Impact
  * Sustainability More Broadly: Do Not Induce Other Environmental Problems
    * Water use, land use, food-basket competition, etc.
Developed Sustainability “Impact Matrix” and Guidance

- Identified indicators (areas of concern) and relevant metrics for reflecting potential impact
- Overview of existing regulatory and voluntary sustainability regimes
- “Impact Matrix” defines the potential impact risk and metrics along the alternative fuel supply chain

Developed Environmental Progression

- Puts “environmental readiness” on a scale with feedstock readiness and fuel readiness
Capture Indicators

- energy use
- air quality
- land use
- GHG
- water use
- water quality
- biodiversity
- soil quality
## Impact Matrix
### Assessing Potential for Environmental Impact

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Feedstock Producer</th>
<th>Feedstock Processor</th>
<th>Fuel Producer</th>
<th>Fuel Blender/Distributor</th>
<th>Fuel End User</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Use (Balance)</strong></td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td><strong>Greenhouse Gases</strong></td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td><strong>Air quality</strong></td>
<td>Medium</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td><strong>Biodiversity</strong></td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Land Use</strong></td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Water quality (Pollutants, Eutrophication)</strong></td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Freshwater use (Consumption)</strong></td>
<td>High$^*$</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Soil quality</strong></td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

*Most likely related to irrigation for first generation biofuels, less likely for advanced biofuels*
What environmental analyses might be expected and/or required for alternative jet fuel production?

When in pathway development can/should analyses be performed?

NOT prescriptive of outcomes (no thresholds)

Aligned Environmental Progression with Fuel Readiness Level and Feedstock Readiness Level
## Environmental Progression

<table>
<thead>
<tr>
<th>Environmental Progression</th>
<th>Risk Assessment</th>
<th>Risk Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Principles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concept Formulated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proof of Concept</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preliminary Technical Evaluation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scale up Validation of Initial Assessments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-scale Feedstock Impact Evaluation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-scale Fuel Producer Impact Evaluation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercialization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sustainable Feedstock and Fuel Supply Established</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Risk Assessment
- initial screening
- estimates, rigorous study
- comprehensive analysis

### Risk Management
- Best management practices developed
- permitting
- reporting, continuous improvements
Confirmed We Know the Steps and How to Apply Them to Aviation (building on “Framework & Guidance for Estimating Greenhouse Gas Footprints of Aviation Fuels”)  

Integrated Jet Fuel into the Argonne National Labs’ GREET Model  

Initial comparison of LC GHG results using different tools and under different regulations
Industry Commitments to CO2 reduction

State-Specific & Regional Initiatives
* e.g., FAA goal for carbon neutral growth
* e.g., European Union Emissions Trading Scheme
* e.g., U.S. requirement for federal/military procurement of fuels
  * Can only procure alternative fuels with lifecycle emissions better than or equal to conventional fuels (EISA Section 526)

States Are Working on a Global Agreement for Addressing Aviation GHG Emissions through the International Civil Aviation Organization (ICAO)
* Includes carbon neutral growth from 2020 goal
* ICAO CAEP Alternative Fuels Task Force
* Working on a potential global market-based measure
How Do We Meet Our Targets?  
Technology, Alt Fuels, Operations & Infrastructure

MAPPING OUT THE INDUSTRY COMMITMENTS

1. Improve fleet fuel efficiency by 1.5% per year from now until 2020
2. Cap net emissions from 2020 through carbon neutral growth
3. By 2050, net aviation carbon emissions will be half of what they were in 2005

Aviation Has a Unique Need for Future Acceptance of GHG LCA Results Across Borders

- Obviously, Aircraft Are Mobile Sources that Cross Borders
- System of CO2 Monitoring, Reporting & Verification needed for Global Aviation CO2 Programs
- GHG LCA Results Will be a Key Part of any Global Scheme
- Need Means for “Mutual Recognition” Among States and Perhaps, Ultimately, Harmonization
- Key Starting Point: Understand the Differences Between LCA Regulatory Approaches and Tools
Examine variations in life cycle greenhouse gas (GHG) emissions due to:

- Using different Life Cycle Analysis (LCA) methods, tools, and data
- Meeting varied purposes and regulatory regimes

Goal:

- Identify elements that lead to variations in LC GHG emissions results
- Develop actions that could be taken to improve our understanding

Process:

- Briefings explored how life cycle GHG emissions varied with different tools and purposes
- Group discussion led to creation of an LCA Issue Matrix spreadsheet (that is still under development)
# Jan 2014 Environment Team Workshop

## LCA Issue Matrix

<table>
<thead>
<tr>
<th>Does the “element” contribute to differences in LC GHG emissions results for this “fuel pathway”?</th>
<th>Fuel Pathways</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>MAYBE</td>
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</table>

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<th>Does the “element” impact a “fuel pathway’s” qualification under a reduced LC GHG emissions policy (e.g., RFS2)?</th>
<th></th>
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<td>MAYBE</td>
</tr>
</tbody>
</table>

### Baseline for Comparison

<table>
<thead>
<tr>
<th>Item</th>
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<th>Jatropha HEFA</th>
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<th>Ag waste F-T</th>
<th>Energy grass F-T</th>
<th>Natural Gas F-T</th>
<th>Sugar cane</th>
<th>Alcohol To Jet</th>
<th>Sugar cane bagasse HDCJ (pyrolysis)</th>
<th>Waste gas (CO)</th>
<th>Alcohol To Jet</th>
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</thead>
</table>

### Data Sources

<table>
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</table>

### Accounting

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<th>Soybean HEFA</th>
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### System Boundary (attributional versus consequential analysis)

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</table>
### Jan 2014 Environment Team Workshop

#### LCA Issue Matrix

**Does the “element” contribute to differences in LC GHG emissions results for this “fuel pathway”?**
- YES | MAYBE | NO

**Does the “element” impact a “fuel pathway’s” qualification under a reduced LC GHG emissions policy (e.g., RFS2)?**
- YES | MAYBE | NO

<table>
<thead>
<tr>
<th><strong>Baseline for Comparison</strong></th>
<th><strong>Fuel Pathways</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average barrel or marginal barrel of conv fuel</td>
<td>Soybean HEFA</td>
</tr>
</tbody>
</table>

**Emission factors (e.g., grid electricity)**
- ?

**Process efficiencies**
- ?

**N2O emissions factor**
- ?

**Emissions factor time scale (GWP 30, 100, 500 years)**
- ?

**Time window for normalizing long term emissions**
- ?

**Transportation logistics**
- ?

**Data sources**
- Emission factors (e.g., grid electricity)
- Process efficiencies
- Differences in farming practices
- N2O emissions factor
- Emissions factor time scale (GWP 30, 100, 500 years)
- Time window for normalizing long term emissions
- Transportation logistics

**Elements**
- Oil-Meal system co-product allocation
- Lignin-cellulosic system co-product allocation
- Refinery/Facility energy co-product allocation (liquid fuels, electricity, heat, steam)

**Accounting**
- Oil-Meal system co-product allocation
- Lignin-cellulosic system co-product allocation
- Refinery/Facility energy co-product allocation (liquid fuels, electricity, heat, steam)

**System Boundary (attributional versus consequential analysis)**
- Direct land use change
- Indirect land use change
- Time window for emissions allocation (from LUC)
- Inclusion of building infrastructure (i.e., refinery)
- Including consequences of alt fuel production
- Displacement by alt fuel co-products
- Is a waste still a waste if you don’t waste it?

---

**“Elements” that could lead to variations in LC GHG emissions results**

**Workshop focused on identifying these “elements” (preliminary list shown here)**
# LCA Issue Matrix

**Data sources**
- Emission factors (e.g., grid electricity)
- Process efficiencies
- Differences in farming practices
- N2O emissions factor
- Emissions factor time scale (GWP 30, 100, 500 years)
- Time window for normalizing long term emissions
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- Displacement by alt fuel co-products
- Is a waste still a waste if you don't waste it?

**Baseline for Comparison**
- Average barrel or marginal barrel of conv fuel
- Geographical basis of baseline (domestic or international)
- Is LC value relative to a threshold or an absolute LC value?

**Accounting**
- Oil-Meal system co-product allocation
- Lignin-cellulosic system co-product allocation
- Refinery/Facility energy co-product allocation (liquid fuels, electricity, heat, steam)

<table>
<thead>
<tr>
<th>Feedstock-to-Fuel Pathways</th>
<th>Soybean HEFA (good for comparison)</th>
<th>Rapeseed HEFA (relatively large N2O)</th>
<th>Jatropha HEFA</th>
<th>Camelina HEFA (rotation crop)</th>
<th>Tallow/FOG HEFA (waste product)</th>
<th>Algae HEFA</th>
<th>Forestry waste F-T</th>
<th>Forestry waste HDCJ (pyrolysis)</th>
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<td>Does the &quot;element&quot; contribute to differences in LC GHG emissions results for this &quot;fuel pathway&quot;?</td>
<td>YES</td>
<td>MAYBE</td>
<td>NO</td>
<td></td>
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<tr>
<td>Does the &quot;element&quot; impact a &quot;fuel pathway's&quot; qualification under a reduced LC GHG emissions policy (e.g., RFS2)?</td>
<td>YES</td>
<td>MAYBE</td>
<td>NO</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Does the "element" contribute to differences in LC GHG emissions results for this "fuel pathway"?**
- YES
- MAYBE
- NO
## Questions of Interest:

- **Does the "element" contribute to differences in LC GHG emissions results for this "fuel pathway"?**
- **Does the "element" impact a "fuel pathway's" qualification under a reduced LC GHG emissions policy (e.g., RFS2)?**
- Following workshop input, we will refine questions to better reflect different purposes for conducting life cycle GHG analysis

### Baseline for Comparison

- Average barrel or marginal barrel of conv fuel
  - Geographical basis of baseline (domestic or international)
  - Is LC value relative to a threshold or an absolute LC value?

### Data sources

- Emission factors (e.g., grid electricity)
- Process efficiencies
- Differences in farming practices
- N2O emissions factor
- Emissions factor time scale (GWP 30, 100, 500 years)
- Time window for normalizing long term emissions
- Transportation logistics

### Elements

- Oil-Meal system co-product allocation
- Lignin/cellulosic system co-product allocation
- Refinery/Facility energy co-product allocation (liquid fuels, electricity, heat, steam)

### System Boundary (attributional versus consequential analysis)

- Direct land use change
- Indirect land use change
- Time window for emissions allocation (from LUC)
- Inclusion of building infrastructure (i.e., refinery)
- Including consequences of alt fuel production
- Displacement by alt fuel co-products
- Is a waste still a waste if you don’t waste it?

---

**Does the "element" contribute to differences in LC GHG emissions results for this "fuel pathway"?**

**YES | MAYBE | NO**

**Does the "element" impact a "fuel pathway's" qualification under a reduced LC GHG emissions policy (e.g., RFS2)?**

**YES | MAYBE | NO**

---

**Fuel Pathways**

| Soybean HEFA (good for comparison) | Rapeseed HEFA | Jatropha HEFA | Camelina HEFA (rotation crop) | Tallow/FOG HEFA (waste product) | Algae HEFA | Forestry waste F-T | Forestry waste HDCl (pyrolysis) | Ag waste F-T | Energy grass F-T | Natural Gas F-T | Sugar cane | Alcohol To Jet | Sugar cane bagasse HDCl (pyrolysis) | Waste gas (CO) |
|-----------------------------------|--------------|--------------|-------------------------------|--------------------------------|------------|-------------------|-------------------------------|-------------|----------------|----------------|-----------|------------|-----------------------------|----------------|---------------|
# LCA Issue Matrix

## Seeking answer to each Question for each Element and Fuel Pathway

**YES | MAYBE | NO**

### Baseline for Comparison
- Average barrel or marginal barrel of conv fuel
- Geographical basis of baseline (domestic or international)
- Is LC value relative to a threshold or an absolute lc value?

### Data sources
- Emission factors (e.g., grid electricity)
- Process efficiencies
- Differences in farming practices
- N2O emissions factor
- Emissions factor time scale (GWP 30, 100, 500 years)
- Time window for normalizing long term emissions
- Transportation logistics

### Accounting
- Oil-Meal system co-product allocation
- Lignincellulosic system co-product allocation
- Refinery/Facility energy co-product allocation (liquid fuels, electricity, heat, steam)

### System Boundary (attributional versus consequential analysis)
- Direct land use change
- Indirect land use change
- Time window for emissions allocation (from LUC)
- Inclusion of building infrastructure (i.e., refinery)
- Including consequences of alt fuel production
- Displacement by alt fuel co-products
- Is a waste still a waste if you don’t waste it?

---

**Fuel Pathways**

<table>
<thead>
<tr>
<th>Soybean HEFA (good for comparison)</th>
<th>Rapeseed HEFA (relatively large N2O)</th>
<th>Jatropha HEFA (rotation crop)</th>
<th>Tallow/FOG HEFA (waste product)</th>
<th>Algae HEFA</th>
<th>Forestry waste F-T</th>
<th>Forestry waste HDCJ (pyrolysis)</th>
<th>Ag waste F-T</th>
<th>Energy grass F-T</th>
<th>Natural Gas F-T</th>
<th>Sugar cane</th>
<th>Alcohol To Jet</th>
<th>Sugar cane bagasse HDCJ (pyrolysis)</th>
<th>Waste gas (CO)</th>
</tr>
</thead>
</table>
### Jan 2014 Environment Team Workshop

**LCA Issue Matrix**

| Does the “element” contribute to differences in LC GHG emissions results for this “fuel pathway”? | YES | MAYBE | NO |
| Does the “element” impact a “fuel pathway’s” qualification under a reduced LC GHG emissions policy (e.g., RFS2)? | YES | MAYBE | NO |

#### Baseline for Comparison

- **Average barrel or marginal barrel of conv fuel**
- **Geographical basis of baseline (domestic or international)**
- **Is LC value relative to a threshold or an absolute lc value?**

#### Data sources

- Emission factors (e.g., grid electricity)
- Process efficiencies
- Differences in farming practices
- N2O emissions factor
- Emissions factor time scale (GWP 30, 100, 500 years)
- Time window for normalizing long term emissions
- Transportation logistics

#### Elements

- Oil-Meal system co-product allocation
- Lignincellulosic system co-product allocation
- Refinery/Facility energy co-product allocation (liquid fuels, electricity, heat, steam)

#### Accounting

- System Boundary (attributional versus consequential analysis)
  - Direct land use change
  - Indirect land use change
  - Time window for emissions allocation (from LUC)
  - Inclusion of building infrastructure (i.e., refinery)
  - Including consequences of alt fuel production
  - Displacement by alt fuel co-products
  - Is a waste still a waste if you don’t waste it?

#### Fuel Pathways

- Soybean HEFA (good for comparison)
- Rapeseed HEFA (relatively large N2O)
- Jatropha HEFA (rotation crop)
- Camelina HEFA (rotation crop)
- Tallow/FOG HEFA (waste product)
- Algae HEFA
- Forestry waste F-T
- Forestry waste HDCJ (pyrolysis)
- Ag waste F-T
- Energy grass F-T
- Natural Gas F-T
- Sugar cane Alcohol To Jet
- Sugar cane bagasse HDCJ (pyrolysis)
- Waste gas (CO)
- Waste gas (CO)

### Will use

**YES | MAYBE | NO**

**answers to identify and prioritize elements that lead to variations in LC GHG emissions results**
Workshop discussion focused on four categories of “elements” that could lead to LC GHG variation:

- Baseline for Comparison / What is the Question you are Answering?
- Data sources
- Allocation
- System Boundary (in a loose sense, this is a question of attributional versus consequential analysis)
Sustainability guidance and impact matrix are living documents and we continue to seek input on how to improve their utility.

Complete LCA Impact Matrix and solicit input from experts to answer the questions such that we create a prioritized list of “elements” to be addressed.

Conduct a 1.5 day CAAFI Environment Team meeting in early 2015.
FUELING SOLUTIONS FOR SECURE & SUSTAINABLE AVIATION