CAAFI Environment Team: Developing Tools & Means to Address Environmental Issues

January 28, 2014

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COMMERCIAL AVIATION
ALTERNATIVE FUELS INITIATIVE

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.

GHG Life Cycle Analysis: Focus & Achievements to Date

* Confirmed We Know the Steps and How to Apply Them to Aviation (building on "Framework & Guidance for Estimating Greenhouse Gas Footprints of Aviation Fuels")
  * Strong basis established for how the U.S. federal government can use existing tools and methodologies for confirming compliance with Section 526 of the Energy Independence & Security Act (EISA) and how commercial aviation stakeholders can demonstrate life cycle benefit

* Integrated Jet Fuel into the Argonne National Labs' GREET Model

GHG LCA: Ongoing Work

* Continue to Use GREET to Examine Additional Pathways
* **TODAY: Review Progress in Our Project to Compare GHG LCA Results from Different Models/Tools**

For now, accepted country-based tools are fine; but eventually will need mutual recognition for proper crediting of environmental benefit (alternative fuel for international flights)

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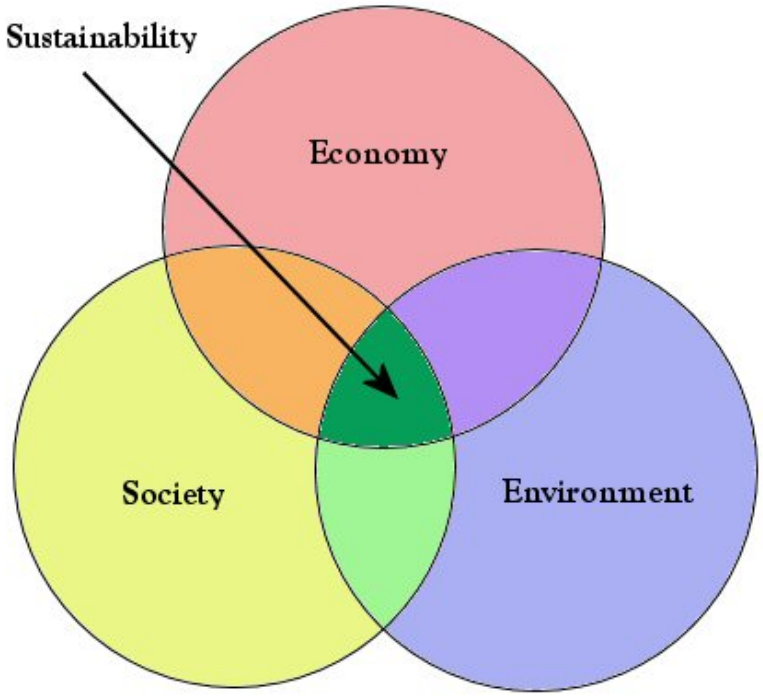
Sustainability: Focus of Environment Team to Date



Environmental Aspects of Sustainability

- Reduce air emissions
- Ensure compliance with requirements
- Do not induce environmental harm

Note: The Team recognizes that there are other aspects of "sustainability" besides environment

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Sustainability: Focus & Achievements to Date

- Developed Sustainability "Impact Matrix" and Guidance
  - Identified 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
- **TODAY: We Will Review These Products and Seek Your Input on them and Next Steps**

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Goals for Today

* Inform the Team on Progress
* Input on Sustainability Impact Matrix and Guidance and Environmental Progression Tool
  * What else should the Team do in this area?
* Input on the LCA Project
* Identify/Confirm Environment Team Focus and Actions for 2014

Sustainability Overview

January 28, 2014

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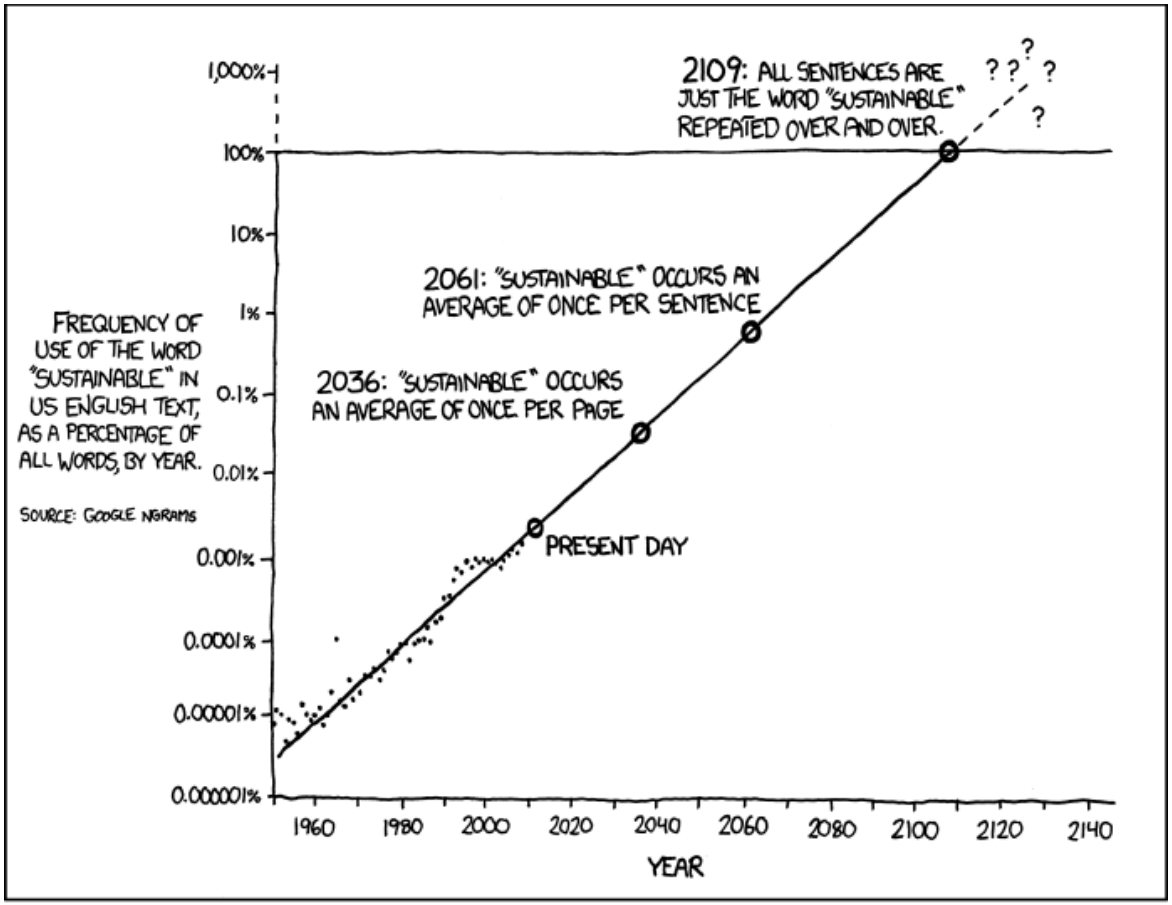
Dr. Kristin C. Lewis
Kirsten van Fossen
Nancy Young
Dr. Jim Hileman

Sustainability to date



THE WORD "SUSTAINABLE" IS UNSUSTAINABLE.

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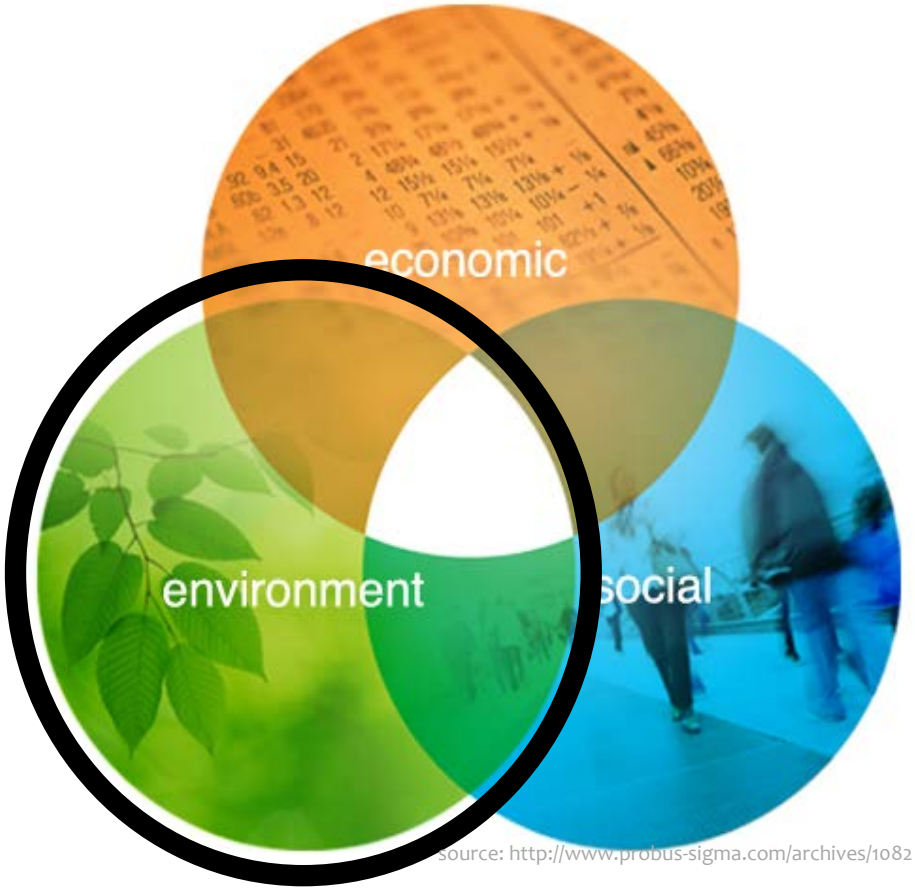
3 Subareas of Sustainability



Source: http://www.probus-sigma.com/archives/1082

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Stakeholder Role

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Rating Systems

CRITERIA AND INDICATORS
Government Regulations
International Standards
Other Requirements

INPUTS
Primary and Secondary Data
Audit Evidence
Supplier Reps. & Certs.

RATING SYSTEM OPERATOR
Company/Group of Companies
Industrial Sector or Trade Association
Government Agency
Independent/Other Organization

(Analysis/ Modeling)
(Conformity Assessment)

OUTPUTS
LCA Study

Supplier Certification

Supplier's Declaration of Conformity

Product Label

Sustainability Product Declaration

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Measurement Comparison

to

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Local Context

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Emissions

Indicator Group

Metric

mass/unit energy
or
mass/unit operation

Possible thresholds

Permitted levels or comparison with accepted standard petroleum baseline

---

Baseline

Minimization of total acceptable for given economic operator, based on local context

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Withdrawal/consumption

Indicator

Metric

volume/unit energy
or
volume/unit operation

Possible thresholds

Local water permits, comparison with standard petroleum or other alternative fuels

Baseline

Sustainable renewable water available to operator considering source

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Land Use

Indicator Group

Metric

area/unit energy
or
soil impact/area

Possible thresholds

Minimization, comparison with other fuels

Baseline

Dependent on the initial condition of the land

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Biodiversity

Indicator

Metric

acres affected
or
Δspecies/facility?

Possible thresholds

Minimization, comparison with other fuels, zero impact on endangered / threatened species

Baseline

None

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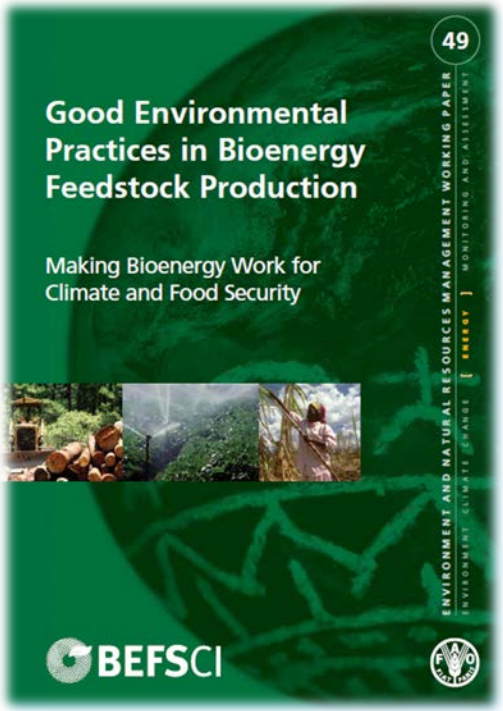
Best Practices



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Trade-offs

Impact Matrix

Indicator	Economic Operator				
	Feedstock Producer	Feedstock Processor	Fuel Producer	Fuel Blender/ Distributor	Fuel End User
Energy Use (Balance)	High	Medium	High	Low	High
Greenhouse Gases	High	Low	High	Low	High
Air quality	Medium	Low	High	Medium	High
Biodiversity	High	Medium	Medium	Low	Low
Land Use	High	Low	Medium	Low	Low
Water quality (Pollutants, Eutrophication)	High	Low	Medium	Low	Low
Freshwater use (Consumption)	High+	Low	High	Low	Low
Soil quality	High	Low	Low	Low	Low
	+ most likely related to irrigation for first generation biofuels, less likely for advanced biofuels				
Potential Impact Severity (color) →		Low	Medium	High	

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Environmental Progression

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Dr. Kristin C. Lewis
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Nancy Young

Motivation

* 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)

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Capture Supply Chain

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Capture Indicators

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FRL, FSRL & EP

Fuel Readiness Level	Feedstock Readiness Level	Env. Progression
Basic Principles	Basic Principles	Basic Principles
Concept Formulated	Concept Formulated	Concept Formulated
Proof of Concept	Proof of Concept	Proof of Concept
Preliminary Technical Evaluation	Preliminary Technical Evaluation	Preliminary Technical Evaluation
Process Validation	Production System Validation	Scale up Validation of Initial Assessments
Full-scale Technical Evaluation	Full-scale Production Initiation	Full-scale Feedstock Impact Evaluation
Certification/Fuel Approval	Feedstock Availability	Full-scale Fuel Producer Impact Evaluation
Commercialization	Commercialization	Commercialization
Production Capacity Established	Sustainable Feedstock Production Capacity Established	Sustainable Feedstock and Fuel Supply Established

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Assessing & Managing Risk

* Risk Assessment
  * Pro-active and iterative assessment of environmental impacts as information becomes available
    * Feedstock
    * Fuel Producer
    * Life Cycle
* Risk Management
  * Develop management plans, comply with regulations and standards, develop & implement best management practices
    * Feedstock
    * Fuel Producer

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Overview

Environmental Progression	Risk Assessment	Risk Management
Basic Principles	initial screening ↓ estimates, rigorous study ↓ comprehensive analysis	BMPs developed ↓ permitting ↓ reporting, continuous improvements
Concept Formulated		
Proof of Concept		
Preliminary Technical Evaluation		
Scale up Validation of Initial Assessments		
Full-scale Feedstock Impact Evaluation		
Full-scale Fuel Producer Impact Evaluation		
Commercialization		
Sustainable Feedstock and Fuel Supply Established		

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Risk Assessment

Environmental Progression
Basic Principles
Concept Formulated
Proof of Concept
Preliminary Technical Evaluation
Scale up Validation of Initial Assessments
Full-scale Feedstock Impact Evaluation
Full-scale Fuel Producer Impact Evaluation
Commercialization
Sustainable Feedstock and Fuel Supply Established

initial screening

comprehensive analysis

initial screening

comprehensive analysis

initial screening

comprehensive analysis

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Risk Management

Environmental Progression
Basic Principles
Concept Formulated
Proof of Concept
Preliminary Technical Evaluation
Scale up Validation of Initial Assessments
Full-scale Feedstock Impact Evaluation
Full-scale Fuel Producer Impact Evaluation
Commercialization
Sustainable Feedstock and Fuel Supply Established

Best Management Practices developed

reporting, continuous improvements

Best Management Practices developed

reporting, continuous improvements

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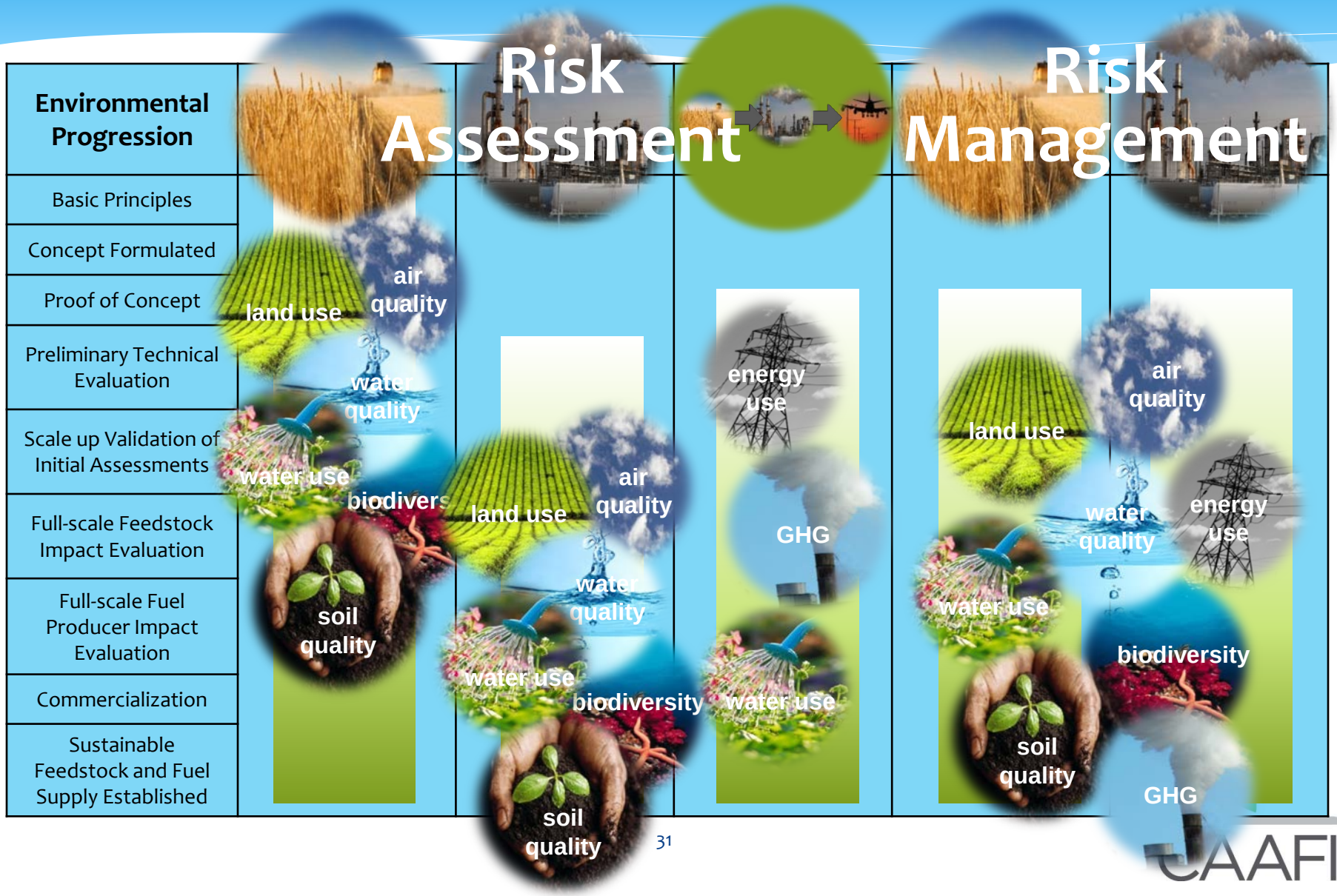
Environmental Progression



Review Scope

* Covers Feedstock, Fuel Production and Life Cycle
* Covers energy use, air quality, land use, GHG emissions, water use, water quality, biodiversity and soil quality

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Discussion

* How can we improve utility?
* Additions?
* Specific issues/concerns?

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Life Cycle GHG Emissions – Report out from Environment Team Workshop

January 28, 2014

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COMMERCIAL AVIATION ALTERNATIVE FUELS INITIATIVE

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Refresher on the Environmental Imperative

* Overall Objectives for Alternative Fuel Deployment
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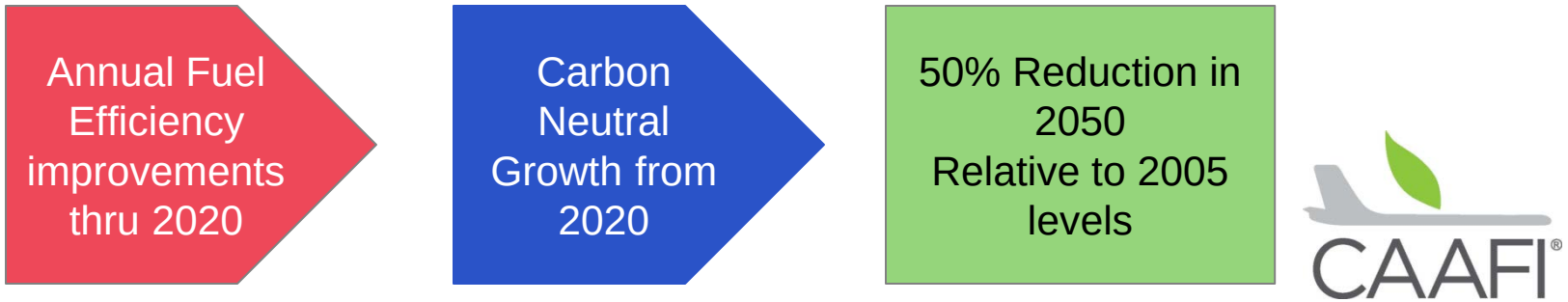
  * **Environmental Benefit (our focus)**

* Environmental Benefit
  * **Potential Life Cycle Greenhouse Gas (GHG) Emissions Improvements (our focus here)**
  * 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.

Aviation's Commitment to Continued and Verifiable GHG Emissions Improvement

* Strong Record on Fuel Efficiency & Emissions Savings
  * Globally, aviation accounts for 2% of man-made CO_2
  * U.S. aviation = 2% of the U.S. GHG inventory, while accounting for 5% of GDP
    * U.S. airlines improved their fuel efficiency ~120% between 1978 and 2012 (saved 3.4 billion metric tons of CO_2)
* The Aviation Industry Has Committed to Aggressive CO_2 Emissions Targets Going Forward
  * Premised on government investment and airline ability to invest so technology, operations & infrastructure improvements flourish
  * FAA aspirational goal - carbon neutral growth by 2020 compared to 2005



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Regulatory Focus on Continued & Verifiable Aviation GHG Emissions Improvement

* State-Specific & Regional Regulatory Initiatives
  * 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
  * Working on a potential global market-based measure

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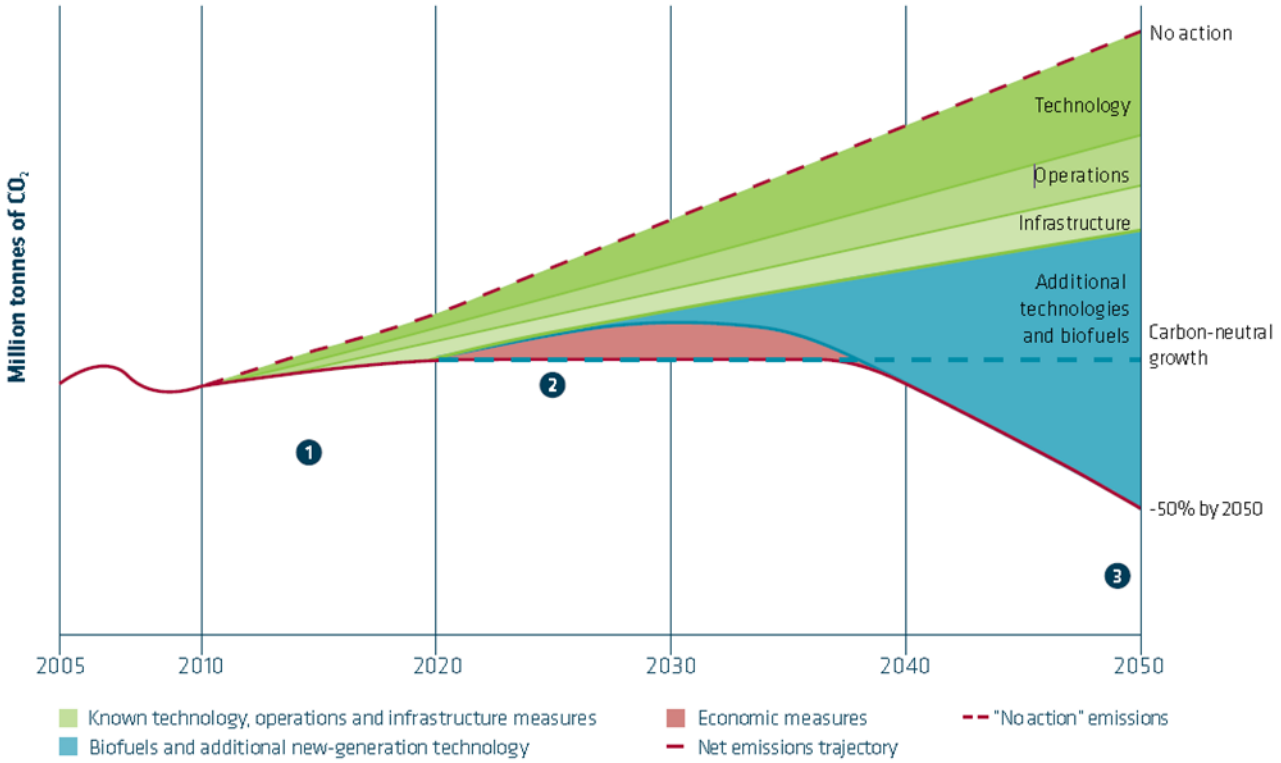
How Do We Meet Our Targets? Technology, Alt Fuels, Operations & Infrastructure

MAPPING OUT THE INDUSTRY COMMITMENTS

❶ improve fleet fuel efficiency by 1.5% per year from now until 2020

❷ cap net emissions from 2020 through carbon neutral growth

❸ by 2050, net aviation carbon emissions will be half of what they were in 2005



(Schematic, indicative diagram only)

Source: Air Transport Action Group (ATAG) "A sustainable flightpath towards reducing emissions" (2012). http://atag.org/component/downloads/downloads/203.html

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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

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Jan 2014 Environment Team Workshop
Goal and Process

- 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 yield more harmonized results
- Process:
  - Briefings explored how life cycle GHG emissions varied with different tools and purposes
  - Group discussion is feeding into an LCA Issue Matrix spreadsheet
    - Captured key elements leading to differences in LC GHG emissions for the varied fuel pathways under consideration by the alternative jet fuel community.
    - Worked through four areas: Baseline, Data Source, Accounting, and System Boundaries
    - The spreadsheet is a tool to help us identify what is leading to variations in results (filling in all of the blanks is not the goal)

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Jan 2014 Environment Team Workshop

Agenda

Topic	Speaker
Opening Remarks (Overview of Issues and Review of Workshop Objectives)	Nancy Young (A4A) and Jim Hileman (FAA)
A comparison of LC GHG accounting for alternative fuels in the US and EU	Robert Malina (MIT) and Michael Wang (ANL)
Review of EPA/OTAQ Biofuel LCA Work for the RFS Program	Vince Camobreco (EPA)
Case Studies on Variability in LC GHG Emissions of Biofuels	David Shonnard (Michigan Tech)
ICAO CAEP Alternative Fuels Task Force: Scope of Work & Experiences from Spain in LCA	Cesar Velarde (SENASA)
RSB GHG Calculator	Mireille Faist (Quantis)
Group Discussion on LCA Issue Matrix	CAAFI Leadership

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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		Fuel Pathways													
		Soybean HEFA (good for comparison)	Rapeseed HEFA (relatively large N2O)	Jatropha HEFA	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) Alcohol To Jet
Elements	***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?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

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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

Elements	Fuel Pathways														
	Soybean HEFA (good for comparison)	Rapeseed HEFA (relatively large N2O)	Jatropha HEFA	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) Alcohol To Jet
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														
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System Boundary (attributional versus consequential analysis)														
Direct land use change														
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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?														

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**

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LCA Issue Matrix

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Elements														
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)														
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Is a waste still a waste if you don't waste it?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

Feedstock-to-Fuel Pathways

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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)

Jan 2014 Environment Team Workshop

LCA Issue Matrix

Elements	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														
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	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?														

Seeking answer to each Question for each Element and Fuel Pathway YES | MAYBE | NO

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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	Fuel Pathways														
Elements	Soybean HEFA (good for comparison)	Rapeseed HEFA (relatively large N2O)	Jatropha HEFA	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) Alcohol To Jet
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)														
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Oil-Meal system co-product allocation														
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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?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

Will use YES | MAYBE | NO answers to identify elements that lead to variations in LC GHG emissions results

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"Element" Categories

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)

Workshop outputs are covered in following slides

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Baseline for Comparison
What is the Question you are Answering?

* Are you considering the average barrel or marginal barrel of petroleum-based conventional fuel?
* Time when baseline is defined (e.g., is it based on a fixed point in time such as 2005 for EPA RFS2 versus a target in the future with a % reduction of emissions relative to a fixed year)
* Geographical basis of petroleum baseline - is production of concern company-specific, region, domestic-national or international?
* All issues below need to be addressed for the petroleum baseline (this includes transportation, refining product allocation, etc.)
* What is included in the baseline (e.g., conventional petroleum-based fuel, unconventional petroleum-based fuel, etc.)?
* Is LC value of alt fuel relative to a threshold or an absolute lc value?
* Production scale for the alt fuel being considered - facility-specific value (pilot scale, first of a kind facility, or n^{th} plant) versus industry-wide average value
* Note: Need to ensure that analysis is based on petroleum-baed jet fuel instead of "petroleum-based diesel fuel as a surrogate for jet"
* Need to communicate uncertainty in baseline definition – in reality, it is not a point value

Data Sources (1 of 2)

* Emission factors (e.g., grid electricity)
* Emissions factor from key inputs (e.g., fertilizer production (especially N), hydrogen, catalysts)
* Differences in farming practices
* Process efficiencies
* N2O emissions factor
* Note: Inclusion of black carbon as a climate factor (note that it is not included in accounting for RED, RFS2) – from fuel combustion perspective, there is a similar to other non-Co2 impacts – for ground sources, there is now bc information from IPCC
* Emissions factor time scale (GWP 30, 100, 500 years) and discounting
* Transportation logistics (truck, pipeline, rail, barge) and distances - note this could be important for some feedstock-to-fuel pathways
* Variation in local laws, regulations, etc.
* Scope of eligibility under framework (e.g., RFS certifies a pathway from feedstock to fuel while RED is certified according to company providing feedstock and fuel)

Data Sources (2 of 2)

- Time frame for determining data inputs (is it averaged over a day, growing season, year, several years?) -- often LCA are based on long-term average values (several growing seasons, years, etc.)
- Time window for normalizing long term emissions (discrepancy between RED (20 yrs) and RFS2 (30 yrs) timescales – this is DIFFERENT from GWP time factors)
- NOTE: some data ARE different as they are representative of different regions - need to find a way to identify those elements that are choices as opposed to being representative of the system
- NOTE: we need accurate data and to understand any factors that are being applied to the data (e.g., EC introduced a factor for the JRC WTW values to make data points more conservative with the hope that it would encourage producers to provide more accurate values)
- NOTE: It is important to consider uncertainty and variability in data inputs

Allocation

* Oil-Meal system co-product allocation / displacement of other comparable products in the broader economy (HEFA, Green Diesel)
* Corn stover, starch, oil system co-product / displacement while accounting for DGS use
* Lignocellulosic system co-product allocation / displacement of other comparable products in the broader economy
* Refinery/Facility energy co-product allocation / displacement of other comparable products in the broader economy (liquid fuels, electricity, heat, steam)
* Handling of co-products that are plastics and chemicals (bio-plastics, biochemicals and petroleum equivalents)
* Is a waste still a waste if you don't waste it? (is a co-product or feedstock a waste stream with zero GHG, a co-product with some GHG value that is accounted for in another LC system, or is it a feedstock to this LC system?) (there are regulatory requirements for how to handle wastes and this reality needs to be taken into account by the LCA practitioner)
* NOTE: Is everything within the system a "co-product"? If so, how do we allocate emissions to all of these co-products of the fuel and related systems?

System Boundary (in a loose sense, this is a question of attributional versus consequential analysis)

* Direct land use change (this is always domestic)
* Indirect (induced) land use change (this can be either domestic or international)
* Soil carbon data
* Time window for allocating land use change emissions (need consistency with other time windows – see data sources)
* Inclusion of the creation of infrastructure (e.g., refinery) (note that this is generally thought to be small but could be larger for algae PBR)
* Co-product displacement - this is tied to elements relating to allocation within "Accounting" topic area
* Including consequences of large-scale alt fuel production that could displace production of other energy sources or products in the broader market (beyond LUC)
* Alternative use question - Including consequences of not using wastes, (e.g., tallow being used for other purposes, waste gases being vented, agricultural residue being pulled from the field, forest residue not being pulled from the forest)
* NOTE: it is critical to communicate uncertainty regarding indirect effects (from a consequential analysis) as they have large uncertainty

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Goal and Process (revisited)

- 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 yield more harmonized results**
- Process:
  - Briefings explored how life cycle GHG emissions varied with different tools and purposes
  - Group discussion is feeding into an LCA Issue Matrix spreadsheet
    - Captured key elements leading to differences in LC GHG emissions for the varied fuel pathways under consideration by the alternative jet fuel community.
    - Worked through four areas: Baseline, Data Source, Accounting, and System Boundaries
    - The spreadsheet is a tool to help us identify what is leading to variations in results (filling in all of the blanks is not the goal)

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Questions for the Group

* Have we missed any major "Elements"?
* Do you have recommendations for how we construct the "YES | MAYBE | NO" questions to be answered for each element and fuel pathway?
* Do you have recommendations for how we further develop this LCA Issue Matrix? (online survey, additional face-to-face meetings, etc.)
* Do you have thoughts on "**actions that could be taken to better understand differences in LC GHG results**"?
* What should the CAAFI Environment Team do next?

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