



CAAFI Readiness Tools

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On behalf of the CAAFI Administrative Leadership Team

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Communication / evaluation tools are a key CAAFI Priority

- * **Implement Frameworks & Share Best Practices** – CAAFI will continue to develop tools to evaluate the technical readiness of feedstocks and fuels, and commercial readiness of producers to identify prime targets of opportunity for sustainable near term supply.

-- CAAFI 2018 Look Ahead, Goals and Priorities (1/12/18)

What are CAAFI's Readiness Tools?

Adaptation of Technology Readiness Level to AJF-specific needs.

- * **Fuel Readiness Level** – technical and commercial maturity of AJF production processes.
- * **Feedstock Readiness Level** – technical and commercial maturity of feedstocks compatible with AJF production processes.
- * **Environmental Progression** – which sustainability evaluations should be performed and when during feedstock/process maturation.
- * **Commercial Engagement Readiness** – focus on facilitating interaction of commercially maturing entities with airlines.

Feedstock Readiness Level (FSRL)

* Response to R&D team need.

* Developed jointly by USDA/CAAFI (FAA/Volpe) at CAAFI's request (2012).

* Revised into checklist format under Farm2Fly 2.0 initiative (2014).

FEEDSTOCK READINESS LEVEL (FSRL) TOOL										
Fuel Readiness Level (FRL)		Feedstock Readiness Level (FSRL)			FSRL Components with Tailgate					
FRL Scale	Description	Fuel Analysis and Certification	Tailgate	Activity	Scale	Description	(1) Production	(2) Market	(3) Policy/Program Support and Regulatory Compliance	(4) Tailgate to Conversion Process
1	Basic Provisions	Feedstock and process have production capacity	Feedstock and process have production capacity	Feedstock Readiness Evaluation	1	Basic Provisions	Identify potential feedstocks for a possible conversion process	Identify current feedstocks, production, distribution and conversion process	Identify the ability to meet the production and conversion process	Identify the ability to meet the production and conversion process
					2	Process Readiness	Process a large range of potential feedstocks and convert to fuel feedstock	Identify feedstocks, use of feedstock	Identify the ability to meet the production and conversion process	Identify the ability to meet the production and conversion process
2	Process Readiness	Feedstock and process have production capacity	Feedstock and process have production capacity	Feedstock Readiness Evaluation	2	Process Readiness	Identify production capacity and feedstocks	Identify production capacity and feedstocks	Identify the ability to meet the production and conversion process	Identify the ability to meet the production and conversion process
					3	Market Readiness	Market a large range of potential feedstocks to a possible conversion process	Identify feedstocks, use of feedstock	Identify the ability to meet the production and conversion process	Identify the ability to meet the production and conversion process
3	Proof of Concept	Small fuel samples have been analyzed for conversion process	Small fuel samples have been analyzed for conversion process	Feedstock Readiness Evaluation	3	Proof of Concept	Develop a feedstock analysis process to determine feedstock suitability	Develop a feedstock analysis process to determine feedstock suitability	Develop a feedstock analysis process to determine feedstock suitability	Develop a feedstock analysis process to determine feedstock suitability
					4	Market Readiness	Market a large range of potential feedstocks to a possible conversion process	Identify feedstocks, use of feedstock	Identify the ability to meet the production and conversion process	Identify the ability to meet the production and conversion process
4	Feedstock Tailgate to Conversion	Feedstock Tailgate to Conversion	Feedstock Tailgate to Conversion	Feedstock Readiness Evaluation	4	Feedstock Tailgate to Conversion	Identify feedstocks, use of feedstock	Identify feedstocks, use of feedstock	Identify the ability to meet the production and conversion process	Identify the ability to meet the production and conversion process
					5	Market Readiness	Market a large range of potential feedstocks to a possible conversion process	Identify feedstocks, use of feedstock	Identify the ability to meet the production and conversion process	Identify the ability to meet the production and conversion process
5	Process Readiness	Feedstock and process have production capacity	Feedstock and process have production capacity	Feedstock Readiness Evaluation	5	Process Readiness	Process a large range of potential feedstocks and convert to fuel feedstock	Process a large range of potential feedstocks and convert to fuel feedstock	Process a large range of potential feedstocks and convert to fuel feedstock	Process a large range of potential feedstocks and convert to fuel feedstock
					6	Market Readiness	Market a large range of potential feedstocks to a possible conversion process	Identify feedstocks, use of feedstock	Identify the ability to meet the production and conversion process	Identify the ability to meet the production and conversion process
6	Feedstock Tailgate to Conversion	Feedstock Tailgate to Conversion	Feedstock Tailgate to Conversion	Feedstock Readiness Evaluation	6	Feedstock Tailgate to Conversion	Identify feedstocks, use of feedstock	Identify feedstocks, use of feedstock	Identify the ability to meet the production and conversion process	Identify the ability to meet the production and conversion process
					7	Market Readiness	Market a large range of potential feedstocks to a possible conversion process	Identify feedstocks, use of feedstock	Identify the ability to meet the production and conversion process	Identify the ability to meet the production and conversion process
7	Commercialization	Feedstock and process have production capacity	Feedstock and process have production capacity	Feedstock Readiness Evaluation	7	Commercialization	Develop a feedstock analysis process to determine feedstock suitability	Develop a feedstock analysis process to determine feedstock suitability	Develop a feedstock analysis process to determine feedstock suitability	Develop a feedstock analysis process to determine feedstock suitability
					8	Market Readiness	Market a large range of potential feedstocks to a possible conversion process	Identify feedstocks, use of feedstock	Identify the ability to meet the production and conversion process	Identify the ability to meet the production and conversion process
8	Feedstock Tailgate to Conversion	Feedstock Tailgate to Conversion	Feedstock Tailgate to Conversion	Feedstock Readiness Evaluation	8	Feedstock Tailgate to Conversion	Identify feedstocks, use of feedstock	Identify feedstocks, use of feedstock	Identify the ability to meet the production and conversion process	Identify the ability to meet the production and conversion process
					9	Market Readiness	Market a large range of potential feedstocks to a possible conversion process	Identify feedstocks, use of feedstock	Identify the ability to meet the production and conversion process	Identify the ability to meet the production and conversion process

1. Fuel analysis and certification is a key component of the feedstock readiness process. It involves the analysis of the feedstock's chemical composition and the determination of its suitability for use in a specific conversion process. This process is critical to ensuring that the feedstock meets the requirements of the conversion process and that the resulting fuel meets the required specifications. The FSRL tool provides a structured approach to this process, ensuring that all relevant aspects are considered and documented.

2. The FSRL tool is a checklist format that provides a structured approach to the feedstock readiness process. It is designed to be used by a wide range of stakeholders, including feedstock producers, conversion process operators, and policy makers. The tool is intended to be used as a guide, rather than a strict checklist, and should be adapted to the specific needs of the user.

3. The FSRL tool is a checklist format that provides a structured approach to the feedstock readiness process. It is designed to be used by a wide range of stakeholders, including feedstock producers, conversion process operators, and policy makers. The tool is intended to be used as a guide, rather than a strict checklist, and should be adapted to the specific needs of the user.

FSRL Mirrors Development Phases

Level	Description	FSRL Component Tollgate Criteria			
1	Basic Principles	Preliminary Evaluation			
2	Concept Formulated				
3	Proof of Concept	Experimental Testing			
4	Preliminary Technical Evaluation				
5	Production System Validation	Production System Validation			
6	Full-Scale Production Initiation				
7	Feedstock Availability	Commercial Deployment			
8	Commercialization				
9	Production Capability Established				

FSRL Tool Components

		Feedstock Readiness Level (FSRL) Components				Fuel Readiness Level (FRL)
Feedstock Readiness Level #	FSRL Description	(1) PROD	(2) MARK	(3) POLY	(4) LINK	Conversion Process



FSRL uses FSRL desc **FSRL is described by four readiness components:**
Fuel Readiness (1) Production; (2) Market; (3) Policy; and (4) Linkage

*FSRL tool modeled after and designed to complement the
 CAAFI Fuel Readiness Level (FRL) tool.*

FSRL developed jointly by USDA/CAAFI (FAA/Volpe) at CAAFI's request



FSRL Checklist Structure

- * Instructions Sheet
- * Evaluation Overview
- * FSRL Checklist for Dedicated Crops and Woody Species
- * FSRL Checklist for Agricultural and Forest Residues
- * Summary Table

FSRL Checklist

- * Specific to feedstock, conversion process, region
- * Two checklist versions
 - * Dedicated crops and woody species
 - * Agricultural and forest residues
- * Summary table
 - * Includes current and anticipated FSRL status
 - * Provides opportunity to describe rationale for rating for each component



Formax, 1988

FSRL Repository

Goals:

- Benchmark feedstock readiness status.
- Clarify risks and barriers to feedstock development and availability.
- Provide a risk management tool for evaluating individual feedstocks.
- Comparison with FRL to identify R&D gaps.

Potential users:

- Policy makers and R&D funding organizations identifying gaps that require additional R&D funding or incentives;
- Fuel purchasers (e.g., airlines) looking to evaluate proposals for fuel procurement;
- Fuel producers looking to identify feedstock options.

* Resides on USDA National Ag Library Ag Data Commons-
<https://data.nal.usda.gov/farm-2-fly>



FSRL Repository

- * Includes:
 - Checklist and Report Template
 - Summary table of FSRL evaluations in repository.
 - Link to publication.
 - Full FSRL evaluations.
- * USDA Biomass Research Center researchers provided initial evaluations.
- * Additional evaluations have been submitted by feedstock producers, CAP grant PIs, and others.

Feedstock Readiness Level (FSRL) Evaluations

The Feedstock Readiness Level (FSRL) evaluations repository is a catalog and archive of assessments of bioenergy feedstock development. The FSRL is a communication tool for evaluating production, market, and policy maturity of feedstocks for a particular use, specifically, alternative fuel production technologies. These evaluations are performed for a specific feedstock-conversion process combination and for a particular region. FSRL evaluations complement evaluations of Fuel Readiness Level (FRL) and environmental progress.

The evaluations are intended to be used for two purposes: first, to enable stakeholders to identify gaps where further research, development or investment may be needed to facilitate readiness of a particular feedstock for a given conversion process, and second, to allow parties interested in developing alternative fuel facilities to understand what feedstocks may be available in the near term in a particular region.

A tabular summary of the existing evaluations can be found in the Resources section below, within which you can link to individual reports. Individual reports are also listed below in Evaluations and/or can be accessed via the search function or by filtering for tags listed at left.

Filter by Ag Data Commons keywords

Bioenergy (37)
Plants & Crops (37)

Filter by Program

Farm2Fly (38)
Life Cycle Assessment - LCA (1)

Filter by User-supplied tags

alternative fuels (36)
aviation (36)
feedstocks (36)
fuel production (36)
panicum virgatum (10)
switchgrass (10)
canola (8)
brassica napus (7)
napier grass (7)
poplar (7)
sweet sorghum (7)
wheat straw (7)

Browse Feedstock Readiness Level Resources

Summary of FSRL Evaluations in the Repository - a table of available evaluations and results, with links to the original submissions (these can be found under "Evaluations" below).

FSRL Checklist and Report Template - This document provides the FSRL checklist and report template for performing a feedstock evaluation, as well as examples of a complete checklist and report to show what is expected. Instructions for performing an evaluation are located in the first sheet of the template. A completed FSRL evaluation can be submitted to info@caafi.org, and we will contact you for more information.

A Feedstock Readiness Level Tool to Complement the Aviation Industry Fuel Readiness Level Tool - This is a peer-reviewed publication on the FSRL tool.

Alternative Jet Fuel Readiness Level Tools for Alternative Jet Fuel - The Commercial Aviation Alternative Fuels Initiative (CAAFI) website has the original FSRL and other fuel readiness tools for understanding and evaluating alternative jet fuel maturity.

Farm 2 Fly Datasets

38 datasets

Search... Date changed Descending Apply Reset

Feedstock Readiness Level (FSRL) evaluation: Sorghum bicolor (sweet sorghum), Alcohol-to-Jet, Southeast, Sept. 2016

Feedstock readiness level evaluations are performed for a specific feedstock-conversion

Current evaluations

* Oilseeds

Feedstock	Scientific name	Region
Carinata	<i>Brassica carinata</i>	Northwest
Canola	<i>Brassica napus</i>	Southeast, Northwest
Industrial rapeseed	<i>Brassica napus</i>	Northwest
Camelina	<i>Camelina sativa</i>	Northwest
Pongamia	<i>Millettia pinnata</i>	Southeast

* Sugars

Feedstock	Scientific name	Region
Energy cane/ Sugar cane	<i>Saccharum officinarum</i>	South, Southeast, Hawaii
Energy beet	<i>Beta vulgaris</i>	Southeast
Sweet sorghum	<i>Sorghum bicolor</i>	Southeast

* Lignocellulosics

Feedstock	Scientific name	Region
Big bluestem	<i>Andropogon gerardii</i>	Central East
Eucalyptus	<i>Eucalyptus grandis</i>	Hawaii
Juniper	<i>Juniperus spp.</i>	Northwest
Giant miscanthus	<i>Miscanthus x giganteus</i>	Southeast
Switchgrass	<i>Panicum virgatum</i>	Central East, Northwest, Southeast
Herbaceous Perennial Grasses	<i>P. virgatum, A. gerardii,</i> <i>Sorghastrum nutans</i>	Central East
Napiergrass	<i>Pennisetum purpureum</i>	Southeast
Banagrass	<i>Pennisetum purpureum x</i> <i>glaucum</i>	Hawaii
Poplar	<i>Populus spp.</i>	Northwest
Sweet sorghum	<i>Sorghum bicolor</i>	Central East
Wheatgrass	<i>Thinopyrum intermedium</i>	Northwest
Wheat straw	<i>Triticum aestivum</i>	Central East, Northwest
Corn stover	<i>Zea mays</i>	Central East

Request for Evaluations

Please contact us if you would like help performing or sharing an evaluation:

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CAAFI Readiness Level Frameworks

- * **Pathway to SAJF**
- * **Feedstock (FSRL)**
- * **Technology (FRL)**
- * **Guidance for Selling Alternative Fuels to Airlines**
- * **Environmental Progression**

Commercial Engagement Readiness Level

New CAAFI Readiness Level Framework

* What:

- * Creation of a mechanism to enable a structured means of assisting, reviewing & measuring progress of potential producers by CAAFI Business Team and cognizant airlines' members via a Commercialization Council (CC)

* Why:

- * The industry has suffered some false starts, and we want to avoid those going forward
 - * Industry is interested in clearly communicating expectations, and ensuring producer has a viable commercialization plan
- * As opportunities now expand, this approach lowers workload of producer, buyer, and supporting entities by reducing/eliminating redundancy

* When:

- * 1Q'19 rollout

* How:

- * CAAFI Business Team works with producers – mutually voluntary process
- * Biannual Commercialization Committee meetings – virtual or in-person, where progress would be reviewed/reported using a standard agenda

Risk assessment demands of airlines to enable any serious engagement

“Eight Buckets of Risk” – from Guidance document

1. Construction – what is cost and time to complete?
2. Technology – what if the technology does not work, or fails to yield the promised production?
3. Feedstock – will it be available at any cost, let alone at the presumed cost?
4. Policy – if the project’s viability depends on government policy/assistance, will that policy remain constant throughout the facility’s economic life?
5. Financial – how will the economic assumptions (e.g., cost of debt and equity, cost of production, selling price of all of the fuel products) been realized?
 - * How is the producer thinking about achieving petroleum parity
6. Engineering – is the engineering and design of the plant appropriate?
7. Management – what experience does management have and what happens if it proves inadequate for the task?
8. Scalability – is the project able to scale up and generate meaningful quantities of fuel and co-products?

Commercial Engagement Readiness Level

New CAAFI Readiness Level Framework

Three phases

Preparatory work for introduction to airlines

- * Addressing “bucket of risk” from Airline Guidance document
- * Assist in preparation for successful first meetings
- * Hold joint Committee meeting for joint airline presentation

Execution of engagement by/with individual airlines

- * Producer sufficiently defines business case elements as required by airlines to begin to develop offtake agreements
- * Producer and airlines agree to enter into detailed offtake

Commercialization progress tracking

- * Monitoring of Commercialization Activity in Progress
- * Helping to close gaps
- * Identifying when additional/expanded offtakes might be warranted

Commercial Engagement Readiness Level

New CAAFI Readiness Level Framework

Readiness Levels

1. Pre-engagement (R&D, Cert/Qual, ALT, airline) with interests confirmed
2. Initiation of Framework collaboration
3. Preparation for airline engagement
4. Committee Engagement, presentation, feedback
5. Individual airline follow-up - progress on buckets
6. Transition to direct negotiation & execution of offtake
7. Commercialization in progress
8. Groundbreaking
9. Routine commercial production established

Exit Criteria

1. Producer agrees to CERL Framework
2. Buckets-of-Risk strategy identified
3. FRL 5, FSRL 3, CC agreement on progress
4. Presentation to CC, feedback provided
5. Producer and airline agree to progress to formal documentation
6. First airline offtake agreement executed
7. Financial Close
8. Construction complete
9. Offtake and use communicated

More detail to follow

CAAFI will:

- * **Convene Commercialization Council in Q1**
 - * Define agreed overall approach
 - * Agree Entry, Work Elements, and Exit criteria
 - * Operating mechanics, ground-rules, operating rhythm
- * **Publish framework**
- * **Perform initial industry assessment and agree on candidate evaluation order**
- * **Contact selected producers for detailed engagement**
- * **Execute process**

CAAFI.org Website Tour

December 6, 2018



Peter Herzig
CAAFI / Volpe / U.S. DOT

What's available?



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Featured Program: Farm 2 Fly 2.0 Feedstock Readiness Level Repository

This joint initiative between USDA, US Department of Transportation, Department of Energy, and the aviation industry focuses on assessing and maturing feedstocks and developing supply chains for alternative jet fuel production.

The [Farm to Fly 2.0 \(F2F2\) Feedstock Readiness](#) page is live on the National Agricultural Library page. We would welcome evaluations from CAAFI members.

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Quick Links

[CRC Aviation Fuel Properties Handbook](#)

[IATA Aviation Fuel Supply Model Agreement](#)

[CAAFI D4054 User's Guide](#)

[CAAFI Environmental Readiness](#)

[FAA's Alternative Jet Fuel R&D page](#)

[Guidance for Selling Alternative Fuels to Airlines](#)

[Fuel Readiness Tool](#)

Recent News

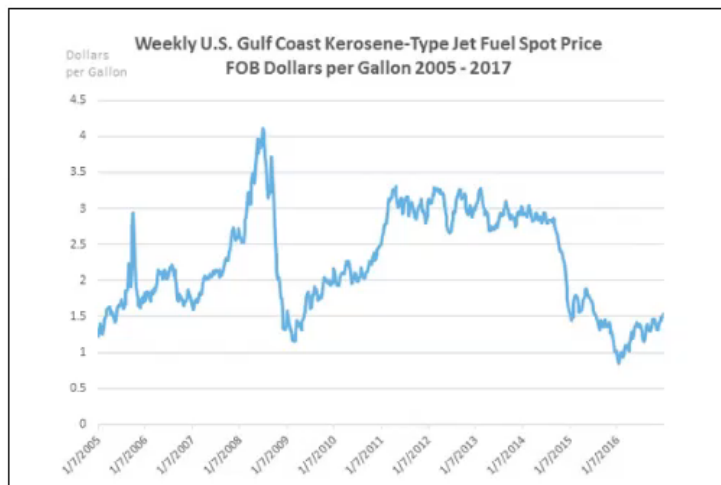
Mass production of alternative jet fuel and biodiesel from algae and waste oil to begin in Japan

Business Aviation Organizations Reaffirm Commitment to Sustainable Alternative Jet Fuel

Phillips 66 and Renewable Energy Group Announce Plans for West Coast Renewable Diesel Facility

SAS and 10 other Nordic-based companies commit to AJF use as part of aligning their business strategies with the UN Sustainable Development Goals





Enabling significant SAJF supply should help address the extreme price fluctuations of crude and jet fuel that have proven detrimental to the industry.



Quick Links

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- [Phillips 66 and Renewable Energy Group Announce Plans for West Coast Renewable Diesel Facility](#)
- [SAS and 10 other Nordic-based companies commit to AJF use as part of aligning their business strategies with the UN Sustainable Development Goals](#)
- [World Energy Paramount announces decision to invest in expanding renewable fuel production capacity more than six times current production levels](#)

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Thank you!

We welcome your input as we are continually updating the website

Contact: Peter.Herzig@dot.gov





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