

R+D Team

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R+D Team mission statement

To identify, prioritize and communicate critical technology gaps that, if addressed, would potentially lead to cheaper, scalable, and more widely available production of aviation alternative fuels

Fuel Readiness Level

FRL	Description	Toll Gate	Fuel Quantity+
1	Basic Principles Observed and Reported	Feedstock /process <i>principles</i> identified.	
2	Technology Concept Formulated	Feedstock / <i>complete</i> process identified.	
3	Proof of Concept	Lab scale fuel sample produced from realistic production feedstock. Energy balance analysis executed for initial environmental assessment. Basic fuel properties validated.	0.13 US gallons (500 ml)
4.1 4.2	Preliminary Technical Evaluation	System performance and integration studies entry criteria/specification properties evaluated (MSDS/D1655/MIL 83133)	10 US gallons (37.8 litres)
5	Process Validation	Sequential scaling from laboratory to pilot plant	80 US gallons (302.8 litres) to 225,000 US gallons (851,718 litres)
6	Full-Scale Technical Evaluation	Fitness, fuel properties, rig testing, and engine testing *	80 US gallons (302.8 litres) to 225,000 US gallons (851,718 litres)
7	Fuel Approval	Fuel class/type listed in international fuel standards**	
8	Commercialization Validated	Business model validated for production airline/military purchase agreements – Facility specific GHG assessment conducted to internationally accepted independent methodology	
9	Production Capability Established	Full scale plant operational++	

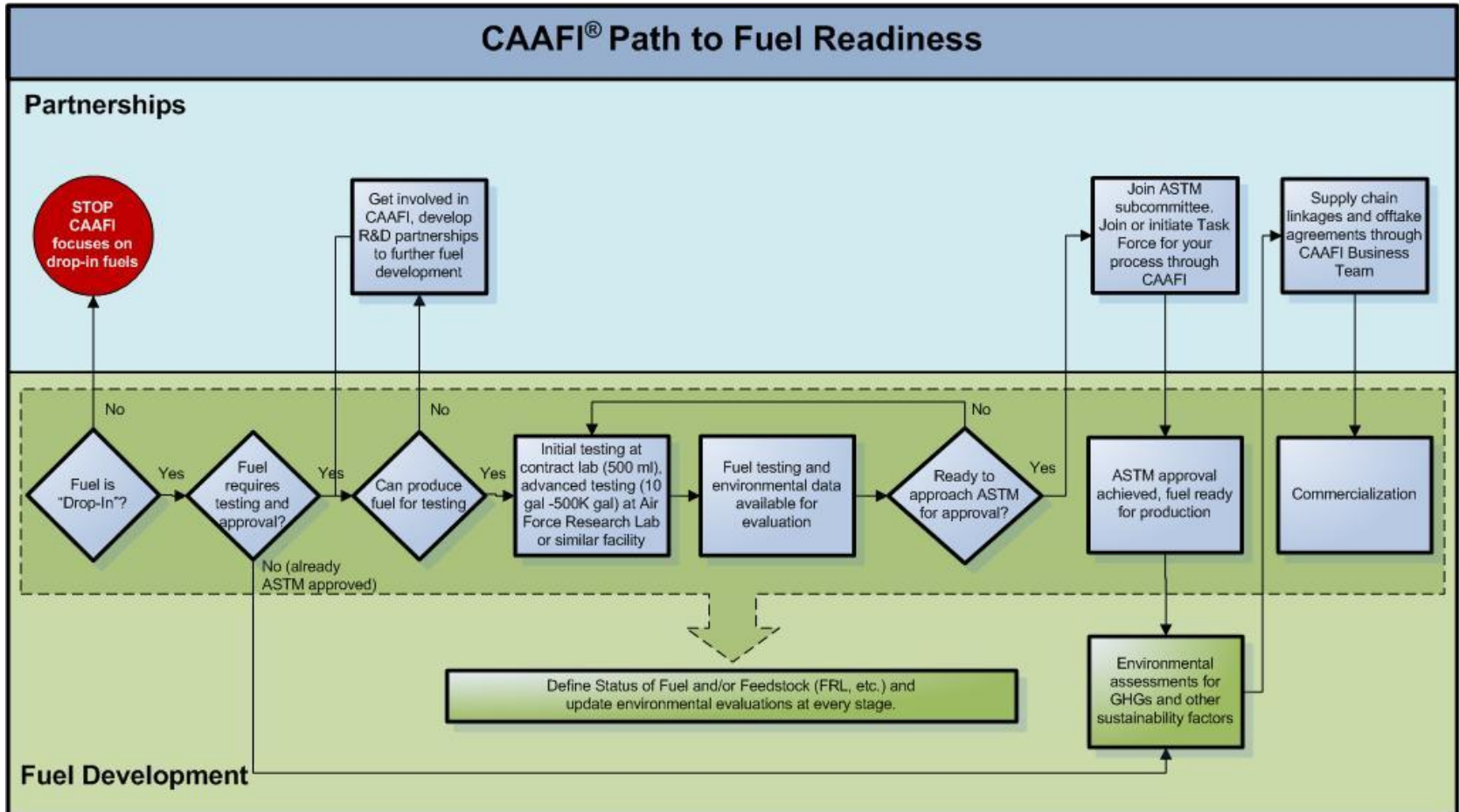
Feedstock Readiness Level

FEEDSTOCK READINESS LEVEL (FSRL) TOOL										
<p>The Feedstock Readiness Level (FSRL) Tool and companion Commercial Aviation Alternative Fuels Initiative (CAAIFI) Feedstock Readiness Level (FSRL) Tool. The FSRL Tool provides a means of tracking progress of non-feedstocks towards established production in the commercial sector that are listed in commercial scale feedstock production - towards the creation of a complete supply chain. The FSRL Tool is comprised of four components: (1) Production, (2) Market, (3) Policy - Program Support and Regulatory Compliance, and (4) Linkage to Conversion Process. The FSRL Tool components are to parallel with the FSRL tool components, including the readiness of the individual economic process technology that will be utilized including the testing and certification readiness. The approach provides an integrated way to determine the critical requirements of feedstocks and conversion technologies needed in being additional feedstocks into commercial production and use.</p>										
Feedstock Readiness Level (FSRL)			Feedstock Readiness Level (FSRL)				FSRL Components with Tutorials			
FSRL State	Description	Feed Testing and Certification	Activity	State	Description	(1) Production	(2) Market	(3) Policy - Program Support and Regulatory Compliance	(4) Linkage to Conversion Process	
1	Raw Feedstock	Feedstock and process feed principles identified	Production in Feedstocks to Feedstocks	1	Raw Feedstock	Identify potential feedstocks for a specific conversion technology	Identify current feedstock suppliers, feedstocks, suppliers, users, and markets	Identify regulatory requirements for a new feedstock?	Identify potential conversion technology to utilize feedstock	
2	Concept Feedstock	Feedstock and process process identified		2.1	Identify feedstock	Identify feedstock market availability	Identify feedstock market availability	Identify feedstock market availability	Identify feedstock market availability	Identify feedstock market availability
				2.2	Concept Feedstock	Identify production system components	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology
				2.3	Concept Feedstock	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology
3	Proof of Concept	Small feedstock available from pilot plant program identified	3.1	Proof of Concept	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	
			3.2	Proof of Concept	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	
4.1	Preliminary Feedstock Evaluation	System performance and integration studies	Feedstock Utilization in Feedstocks	4.1.1	Preliminary Feedstock Evaluation	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology
				4.1.2	Preliminary Feedstock Evaluation	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology
				4.1.3	Preliminary Feedstock Evaluation	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology
4.2	Process Validation	Laboratory production development	Feedstock Utilization in Feedstocks	4.2.1	Laboratory production development	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology
				4.2.2	Laboratory production development	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology
				4.2.3	Laboratory production development	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology
				4.2.4	Laboratory production development	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology
4.3	Full Scale Feedstock Evaluation	Commercial production development	Feedstock Utilization in Feedstocks	4.3.1	Commercial production development	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology
				4.3.2	Commercial production development	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology
				4.3.3	Commercial production development	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology
				4.3.4	Commercial production development	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology	Identify potential conversion technology
5	Commercialization	Commercial production development	Commercial production development	Commercial production development	Commercial production development	Commercial production development	Commercial production development	Commercial production development	Commercial production development	
6	Production Capacity Development	Production capacity development	Production capacity development	Production capacity development	Production capacity development	Production capacity development	Production capacity development	Production capacity development	Production capacity development	

- ## Readiness components
- Production
 - Market
 - Policy/Regulatory
 - Linkage to conversion



Path to Fuel Readiness



Technology gap identification

- **Concept proposed through membership input at 2011 Annual Meeting**
- **Solicited technology gaps/challenges from membership through mid-2012**
- **R+D team chairs “rolled-up” suggestions and drafted white papers**
- **Additional input gathered from gap proposers**
- **Drafts reviewed, revised, prioritized at R+D Team meeting, Dec 2012**
- **White papers in final review with R+D team membership**
- **Distribution Q2, 2012**

White papers on gap identification

Critical enablers requiring immediate development:

- 1) Flexible economic and engineering
- 2) Detailed analyses of fuel chemistry effects on fuel properties

R&D with near- and mid-term return on investment:

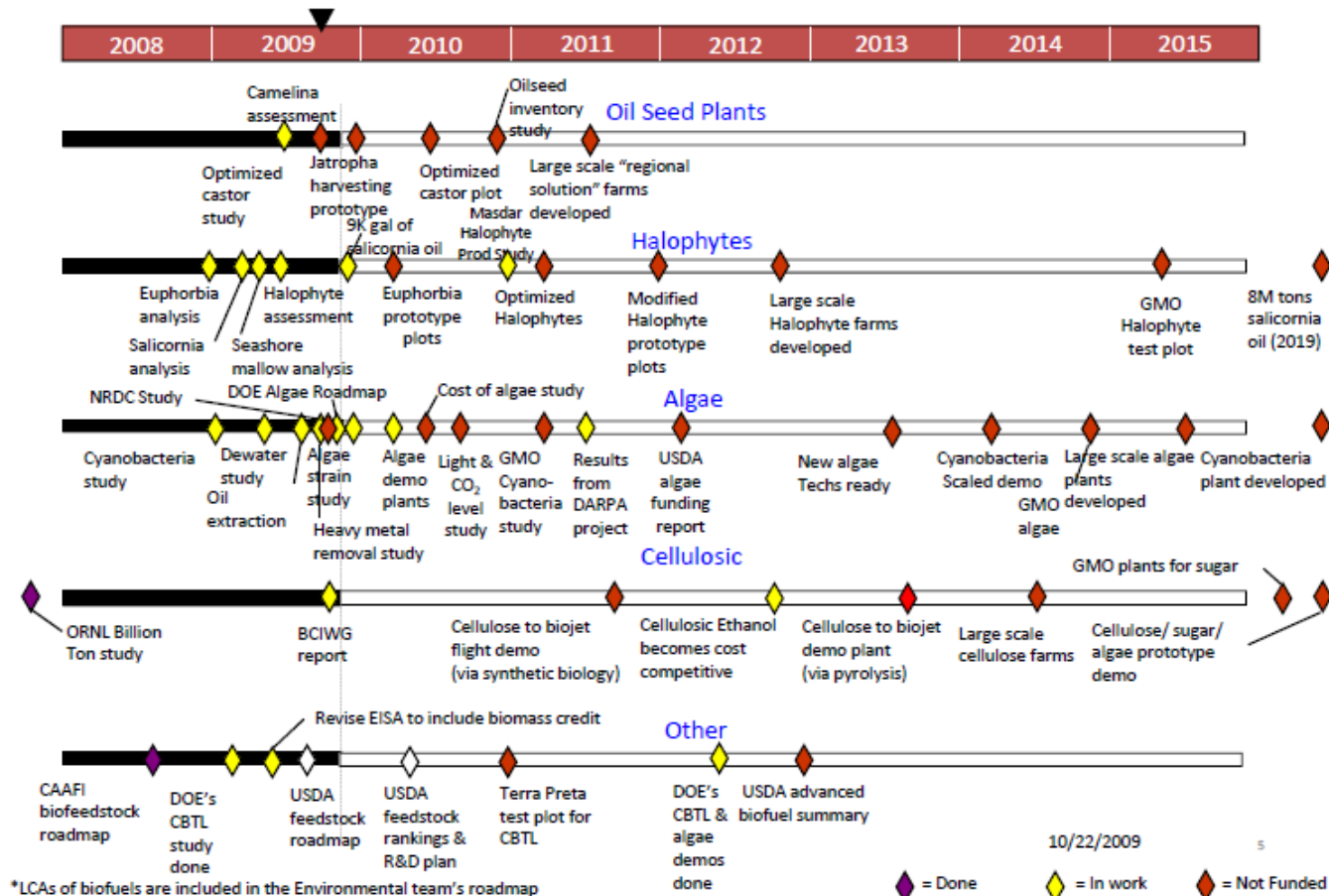
- 3) HEFA Feedstock cost reduction
- 4) Development of crosscutting
- 5) Feedstock production systems that incorporate diversity
- 6) Waste as feedstocks for alternative fuels

Sustained R&D on high benefit, low readiness level processes:

- 7) Direct collection and conversion of atmospheric CO₂ to fuels

Refinement of Roadmap Tools

Level 3 Research and Development (1 of 6) Feedstock



*LCAs of biofuels are included in the Environmental team's roadmap

Thank you

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On behalf of

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