

# FEEDSTOCK READINESS LEVEL (FSRL) TOOL

The *Feedstock Readiness Level (FSRL) Tool* and companion Commercial Aviation Alternative Fuels Initiative® (CAAIFI®) *Fuel Readiness Level (FRL) Tool*. The FSRL Tool provides a means of tracking progress of new feedstocks towards established production in the commercial sector that are linked to commercial-scale biofuels 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 four FSRL Tool components are in parallel with the FRL tool components, including the readiness of the biofuel conversion process technology that will be utilized including fuel testing and certification readiness. This approach provides an integrated way to demonstrate the mutual requirements of feedstocks and conversion technologies needed to bring advanced biofuels into commercial production and use.

Fuel Readiness Level (FRL)				Feedstock Readiness Level (FSRL)			FSRL Components with Tollgates			
FRL Scale	Description	Fuel Testing and Certification	Tollgate	Activity	Scale	Description	(1) Production	(2) Market	(3) Policy - Program Support and Regulatory Compliance	(4) Linkage to Conversion Process
1	Basic Principles		Feedstock and process basic principles identified	Preliminary Feedstock Evaluation	1	Basic Principles	Identify potential feedstock for a specific conversion technology	Identify current feedstock producers, feedstocks and coproduct users, and wastes	Identify regulatory requirements to producing a new feedstock	Identify potential conversion technology to utilize feedstock
					2.1	Concept Formulated	Estimate likely range of production environments and competing land uses	Assess feedstock market alternatives	Evaluate feedstock for compliance with regulatory requirements for likely production environments	Test feedstock quality for specific conversion technology
2.2	Identify production system components	Identify potential coproducts	Estimate production impacts on multiple resources concerns							
2.3	Develop enterprise budget for potential feedstock	Identify waste disposal requirements	Formulate a plan including best practices to address regulatory requirements							
2.4	Identify possible consequences of expanded production, articulate responses to trade-offs	Identify harvest method, post-harvest collection, transportation, and storage logistic options	Comply with any feedstock pre-importation regulations							
3	Proof of Concept		Small fuel sample available from lab - basic fuel properties validated	Feedstock Experimental Testing	3.1	Proof of Concept	Screen candidate genetic resources for feedstock yield	Estimate feedstock production costs	Determine potential for societal resistance to use of the candidate feedstock	Test feedstock in conversion process at the experimental bench-scale
4.1	Preliminary Technical Evaluation	Preliminary Specification of Properties	System performance and integration studies		3.2	Screen candidate genetic resources for biofuel conversion potential	Evaluate current and alternative future scenarios for establishing a feedstock sector - feasibility study	Formulate a plan to address societal concerns		
					4.1	Perform coordinated regional feedstock trials to determine potential for yield improvement and dependability of feedstock supply	Identify biorefiners for targeted feedstock market development and link feedstock producers to feedstock brokers to supply biorefineries	Identify Federal, state, or other special incentive programs	Performance estimated for feedstock through a conversion process	
					4.2	Compare performance of candidate feedstock with alternative feedstock choices	Identify specific alternatives for reducing production and supply uncertainties (i.e., contracts and loan guarantees)	Develop conservation plan to address resource concerns for a feedstock production system	Determine conversion efficiency and unique effects on fuel properties	
4.2			Entry criteria/specification properties evaluated		4.3	Implement agricultural extension and education programs to promote feedstock production	Implement education programs to establish interest in production and demand for feedstock purchase	Draft NEPA (EA or EIS) and other required permitting documents	Co-product production and utilization performance estimated	
5.1	Process Validation		Laboratory production development	Pre-commercial Feedstock Assessment	5.1	Production System Validation	Define range of adaptation for feedstock and identify production uncertainties	Develop and refine post-harvest logistics and storage	NEPA documents, conservation plan, and other required permit applications submitted	Pilot-scale testing
5.2			Conduct on-farm, field-scale production cost trials and assess production impacts on resource concerns		Assess maximum market potential for feedstock and coproducts		NEPA documents, conservation plan, and other required permit applications approved			
5.3			Scalability of production demonstrated		Establish partial budget costs and returns		Evaluate waste disposal and other costs	Prepare and submit service program applications	Scaled-commercial testing	
5.4			Pilot plant capability enabled		Establish price points for feedstock market competitiveness with competing land uses		Develop feedstock offtake options and pathways to realizing market potential	Service program applications approved and payments received		
6.1	Full-Scale Technical Evaluation	Component/Rig Testing OEM Review and Approval	Fit-for-Purpose Properties - ASTM Balloting Process	Full-Scale Production Initiation	6.1	Full-Scale Production Initiation	Establish source material nurseries and begin feedstock production scale-up process	Ancillary service providers supply knowledge gained to advise producers and other supply chain participants	All regulatory compliance is complete	Performance confirmed for feedstock conversion and effects on fuel properties, engines, and components
6.2			Turbine hot section testing		Produce feedstock planting materials to meet demand		Determine feedstock production capacity when linked to market outlets - price and quantity			
6.3			Component/rig/ emissions testing							
6.4			Engine/APU Testing - ASTM Research Report		Engine/APU testing					
7	Certification/Fuel Approval (Determine go or no-go)	Fuel Class Listed in International Fuel Specifications	Fuel class/type listed in international fuel standards	Feedstock Commercial Deployment	7	Feedstock Availability	Commercial-scale production and feedstock delivery to conversion facility - payments made for feedstock	Utilize risk management tools to reduce uncertainty of feedstock production	Continue service program participation as needed	
8	Commercialization		Business model validated for production go-ahead - airline/military purchase agreements secured		8	Commercialization	On-going monitoring and research to improve production system performance while managing multiple resource concerns	Market established - make necessary adjustments to the supply chain as the feedstock market evolves	Maintain regulatory compliance and make adjustments as needed	Sustainable full-scale production of biofuel and co-products
9	Production Capacity Established		Full-scale plant operational		9	Sustainable Feedstock Production Capacity Established	Full array of private services support feedstock production sector - understanding of feedstock sector evolves - make adjustments as commercial-scale biofuel production expands	Market functions to support sustainable feedstock production	Federal, state, and private programs function with minimal disruption from unintended economic, environmental or social consequences	

<sup>†</sup> Examples of considerations for regulatory compliance include pre-importation regulations, invasive species; gene escape; U.S. Environmental Protection Agency Feedstock Certification for greenhouse gas reductions under the Energy Independence and Security Act and Renewable Fuel Standard 2; and U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) conservation plan support.

<sup>‡</sup> Multiple natural resources concerns include the USDA-NRCS conservation planning framework SWAPAE+H (Soil, water, air, plant, animal, energy, plus human effects). Various decision tools are available to estimate feedstock production impacts on metrics of soil erosion, fuel use, pest risk assessment, and greenhouse gas emissions.

<sup>§</sup> Examples of service agency programs include: USDA Farm Service Agency, Biomass Crop Assistance Program (BCAP); USDA-NRCS, Environmental Quality Incentive Program (EQIP); and USDA Risk Management Agency, Crop Insurance Program.

<sup>¶</sup> Monitor and analyze market transactions, producer decisions, technical developments, and resources availability.

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