DOE Bioenergy Technologies Office (BETO)
2021 Project Peer Review

Novel Method for Biomass Conversion to Renewable Jet Fuel Blend

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System Development and Integration

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Technology Holding

Project Overview

- *Higher Energy Density drop-in renewable jet fuel blendstock*
- *Project goal: Develop the process to produce renewable superior jet fuel blend*
- ***Project Description***
  - *Commercialize renewable jet fuel*
  - *Current Alternatives: Petroleum derived jet and Hydrotreated renewable (F-T fuels) or hydrotreated esters and fatty acids (HEFA)*
  - *Important to demonstrate superior jet fuel from biomass*
  - *Risks: First of a kind plant capital, competition with petroleum jet*

1 – Management

Personnel

Mukund Karanjikar, PI – THL (overall process integration, project management and de-risking)

Advisory Board (Ash Upadhyaya, Bill Schinski)

Paul Chirik, Princeton U (Catalysis development)

Benjamin Harvey (Continuous catalysis, Fuel qualification)

Robert Price, THL (Bioprocess development)

Risk Management

Project management

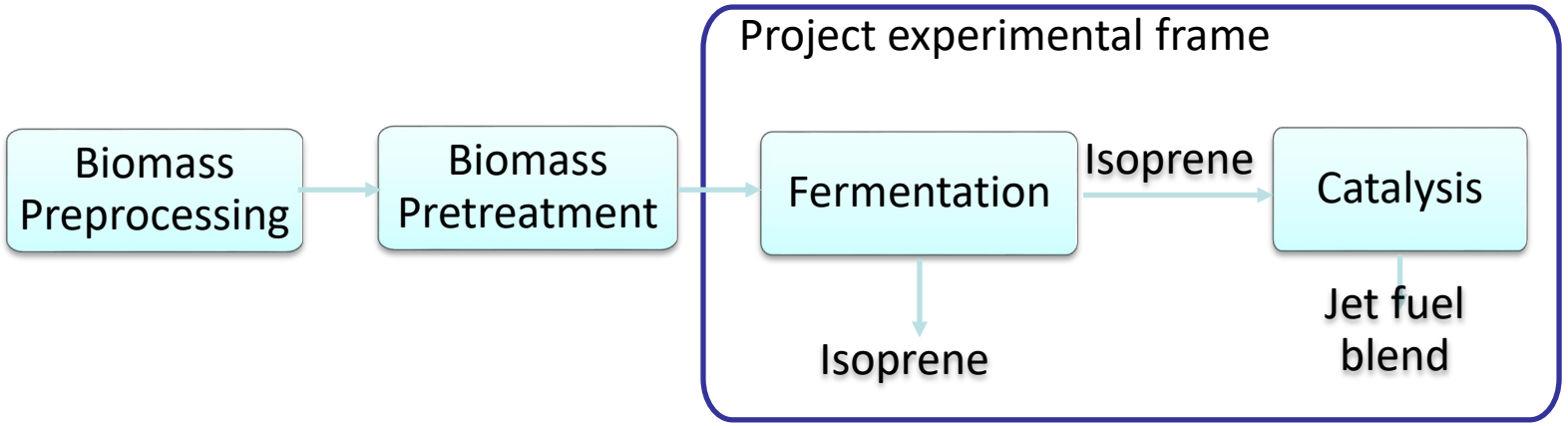
Team charter

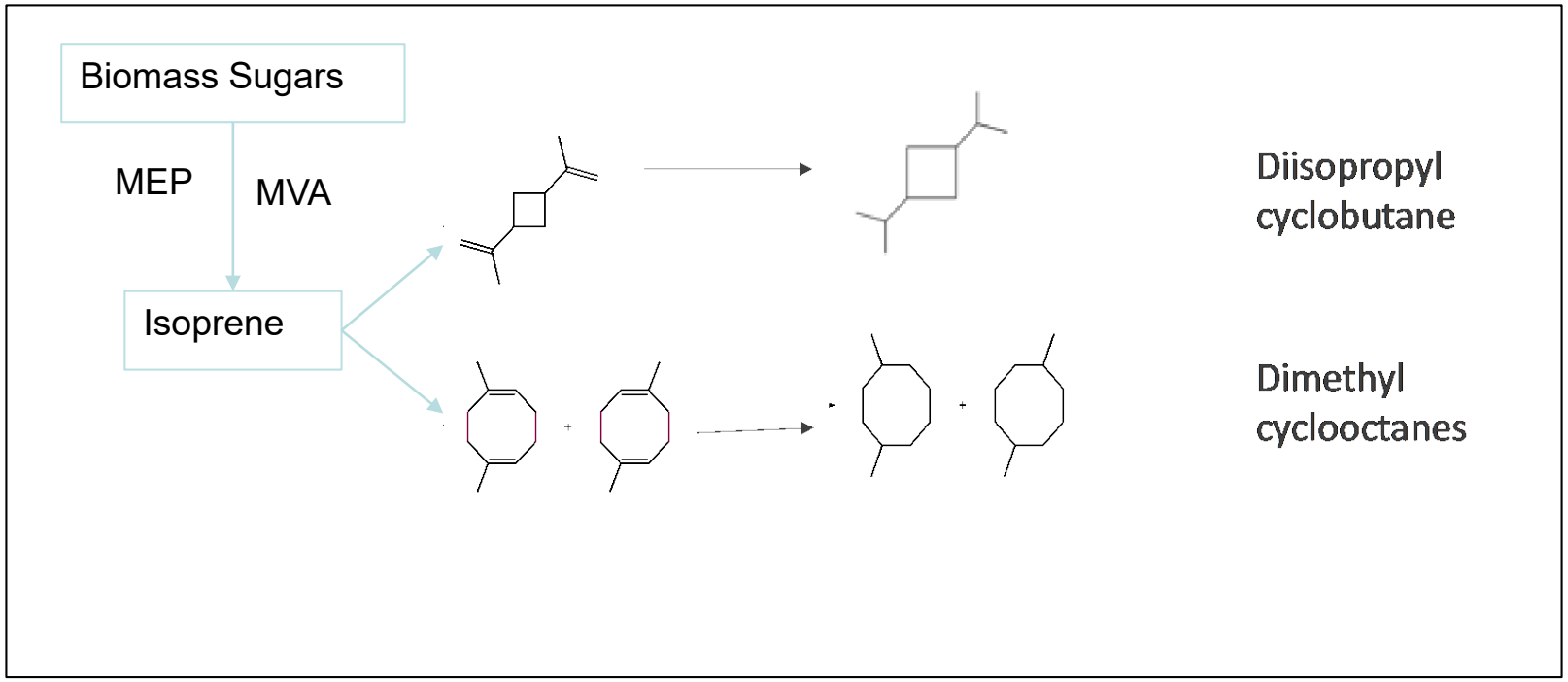
Communication Infrastructure

Schedule → Decisions

Realignment → Feedback

2 – Approach





- *Optimize and scale-up isoprene production using biomass hydrolysate*
- *Optimize the catalytic conversion of isoprene to drop-in jet fuel blend to produce higher specific energy jet fuel*
- *Process integration*
- *Deliver 100 gallons of fuel blend for characterization*
- *Develop overall process system, LCA and TEA models*

3 – Impact

Attribute	DMCO	Jet A	Benefit
Gravimetric net heat of combustion (MJ/Kg)	43.822 §	42.8	2.4% higher
Volumetric net heat of combustion (MJ/L)	36.222	34.7	4.5% higher
Freezing point (°C)	-70 to -80	-40	30 C lower
Density (g/ml)	0.827	0.81	2% higher
Viscosity (cP)	4.17	8*	Exceeds
Flash point (°C)	50	38-66	Meets

4.5% higher energy density compared to Jet A

*limit, § - Measured using ASTM D4809

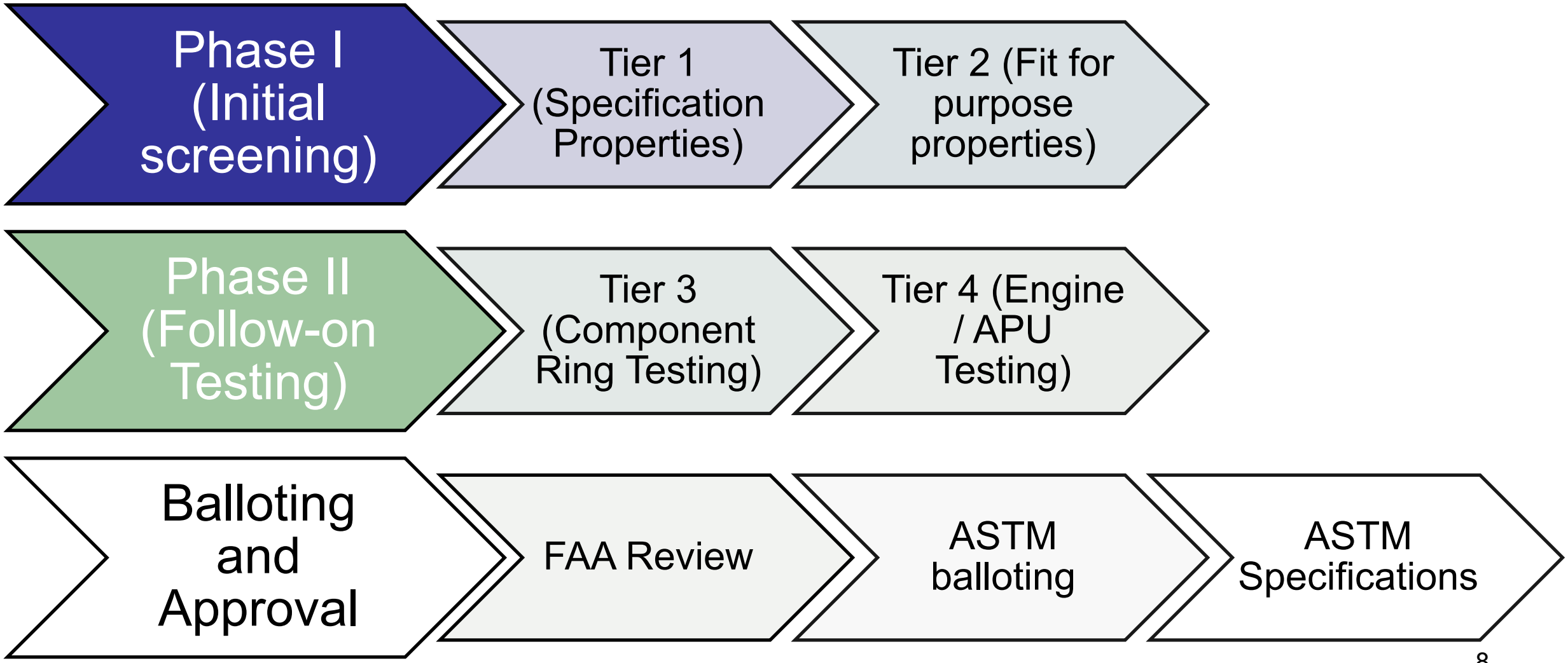
3 – Impact

- *Feasible to replace aromatics (ring swelling issue addressed)*
- *In-service Engine maintenance addressed*
- *Co-product (intermediate) isoprene as a feedstock to chemical industry*
- *In discussions with one Aircraft manufacturer and two Oil and Gas Companies*
- *Interest from Air Force Research Laboratory for defense applications*
- *Interest from various segments of the US Navy*

4 – Progress and Outcomes

- ✓ BP1 (verification) Go/No-Go (task 1)
- ✓ Successful chromosomal integration (2.1)
- ✓ Performed directed evolution using biomass hydrolysate (Milestone 2.2)
- ✓ Master cell banking (Milestone 2.3)
- ✓ Bioreactor parametric optimization (3.1) - 2X improvement in titer of isoprene compared to verification period (in progress)
- ✓ Catalyst optimization for DIPCB (4.1)
- ✓ Catalyst/Activator Optimization for Hydrogenation Protocols (4.2)
- ✓ Integrated cyclodimerization and hydrogenation (4.3)
- ✓ Produced 2 Liter DMCO for detailed characterization as a blend with HEFA (6.1)

Path to ASTM Certification



Summary

- Higher energy content (2.4% higher gravimetric and 4.5% volumetric)
- Promising renewable jet fuel blend
- Valuable intermediate / co-product
- High level of industrial and DOD interest
- Highly favorable full spectrum characterization for blending
- Potential to replace aromatics
- Potentially reduced engine maintenance

Quad Chart Overview

Timeline

- 10/01/2018
- 11/30/2021

	FY20 Costed	Total Award
DOE Funding	$442,525.19	$2,499,999
Project Cost Share	$110,631.30	$625,001

Project Goal

Demonstrate techno-economic feasibility of producing high energy density renewable jet fuel blend

End of Project Milestone

1. Production of 100 gallon finished fuel blend
2. complete a non-location specific basic engineering package (BEP) for the renewable jet fuel engineering scale (1 dry metric tonne per day biomass feedstock) process
3. Detailed fuel characterization profile

Project Partners

- Princeton University
- Naval Airfare Warfare Center, Weapons Division

Funding Mechanism
FOA: DE-FOA-0001926
Topic Area 1: Drop-in renewable jet fuel blendstocks
FOA year: 2018