U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Techno-Economic Analysis of Biofuel Production Pathways

Alternative Aviation Fuels: Developing an Action Plan for the Southeast

Zia Haq

U.S. Department of Energy

April 24, 2019

Bioenergy Technologies Office's Critical Program Areas

Production & Harvesting

Feedstock Supply & Logistics
Works to reduce the cost, improve the quality, and increase the volume of sustainable feedstocks available for delivery to a conversion process.

Advanced Algal Systems
Focuses on improving the productivity of algal biomass and enhancing the efficiency of cultivation and harvesting.

Conversion & Refining

Conversion
Develops technologies to convert non-food feedstocks into biofuels, bioproducts, and biopower.

Conducts feedstock blend testing, separations, materials compatibility evaluations, and techno-economic analyses to focus research on highest impacts.

Distribution & End Use

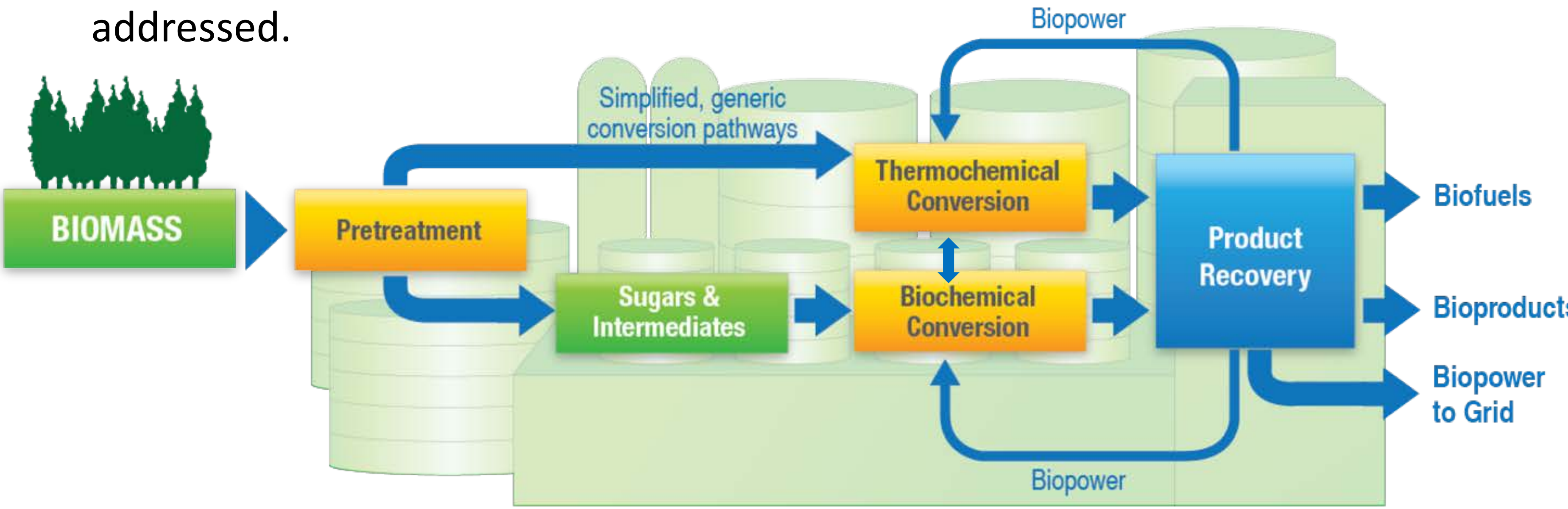
Advanced Development and Optimization
Aims to reduce technology uncertainty in bioenergy by integrating individual technologies into a system/process and provides vital knowledge fed back to research programs.

Crosscutting

Sustainability and Strategic Analysis
Supports program decision-making and develops science-based strategies to understand and enhance the economic and environmental benefits of advanced bioenergy.

Biofuels Conversion Technologies

- DOE is focusing on advancing renewable gasoline, diesel, and jet fuels technologies, in addition to bio-products and bi-power.
- Technical, construction, operational and financial/market risks need to be addressed.



Key Challenges			
Biomass	**Pretreatment**	**Conversion**	**Product**
• Reliable supply • Consistent quality • Affordable delivery	• Biomass feeding, sizing and moisture • Solids handling • Material of construction	• Products Yields • Material of construction • Catalysts • Fermentation organisms	• Separations • Catalytic upgrading • Recycle loops

Fuels Market and Demand for Jet Fuels

US Liquid Fuels and Products Market Size (billion gallons/year)

	2017	2050	Growth Rate 2018 – 2050 (%/year)
Gasoline	143	109	-0.8%
Diesel	60	61	-0.1%
Liquefied Petroleum Gas[1]	41	61	1.0%
Other[2]	31	38	0.7%
Jet Fuel	26	35	0.9%
Residual fuel oil	5	4	-0.6%
Total	**305**	**309**	

1. Includes ethane, natural gasoline, and refinery olefins.
2. Includes kerosene, petrochemical feedstocks, lubricants, waxes, asphalt, and others commodities.
Source: Energy Information Administration, “Annual Energy Outlook 2019”, Reference Case, Table 11.

FY 2019 Commercial Trucks and Off-road Applications FOA

Total Federal funding: $51.5M

Integrated, multi-fuel approach

- Natural gas, Hydrogen, Biopower, and Electrification Technologies

Topic 1B: Cost-effective Biopower Production from Municipal Solid Waste

- Low-cost biogas cleanup
- Innovative anaerobic digestion/gasification
- Lower the cost of electricity from incineration

Further information available at:
http://eere-exchange.energy.gov

FY 2019 Advanced Vehicle Technologies Research FOA

Total Federal funding: $59M

AOI 4: Predictive Modeling Capabilities for the Co-Optimization of Fuels and Multimode (SI/CI) Engines:

- Improve submodels and enhance not only the accuracy and predictive capability of multi-mode engine simulations, but also the algorithms to expedite simulation times.

Submodels of interest:

- Direct injection sprays
- Chemical kinetics and emissions formation
- Heat transfer
- Turbulent flame development and propagation
- High-energy ignition

Further information available at: http://eere-exchange.energy.gov

NREL: Strategic Support - Public DOE BETO Biofuels TEA Database

MOTIVATION: Support transparency of and ease of access to DOE BETO supported public techno-economic analysis data.

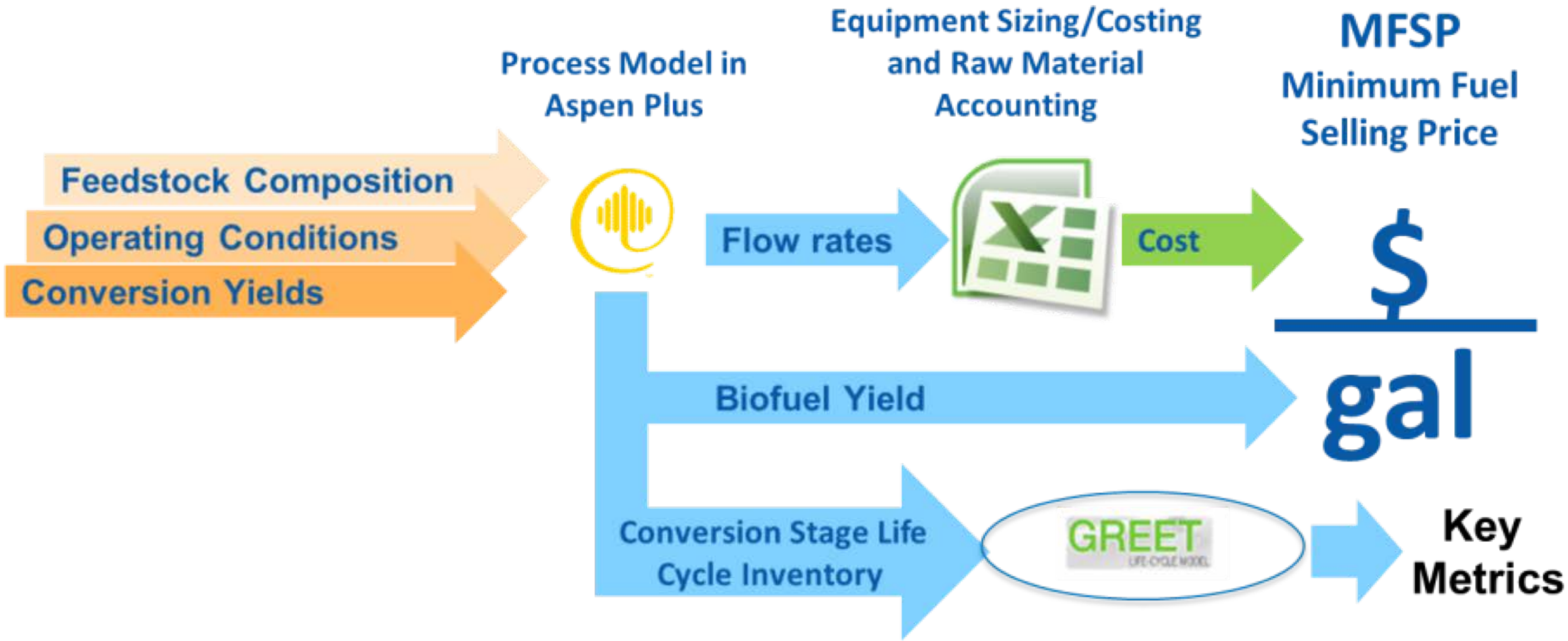
GOAL: Develop and publicly release a biofuels cost data base that summarizes key inputs utilized in conversion TEAs.

APPROACH:

- Currently contains over 40 DOE BETO funded conversion TEA studies, including design reports and publications.
- Reviewed by lead analysts to ensure consistency as well as modify format per suggestions (NREL/PNNL).
- Available for download on the Biomass KDF: https://bioenergykdf.net/content/beto-biofuels-tea-database
- Will be updated yearly with new BETO funded TEAs.

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Strategic TEA - Approach



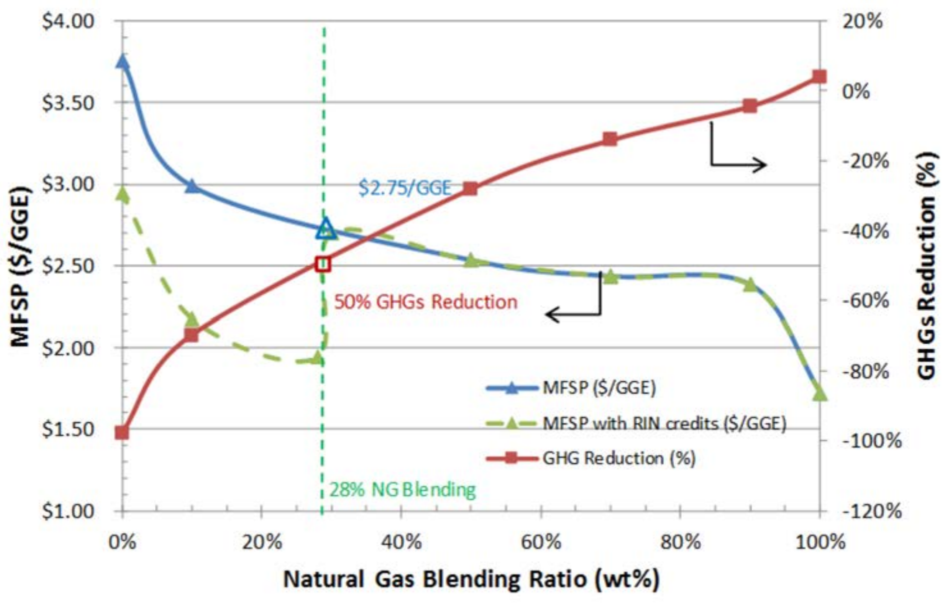
- Modeling is rigorous and detailed with **transparent assumptions**.
- Baseline assumes nth-plant equipment costs.
- Perform **pioneer plant** evaluations to understand the near-term cost of jet fuel production pathways.
- Quantify the underlying uncertainties through **sensitivity analysis**.
- Prioritize TEAs based on programmatic requests and data availability.

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Strategic TEA - Results

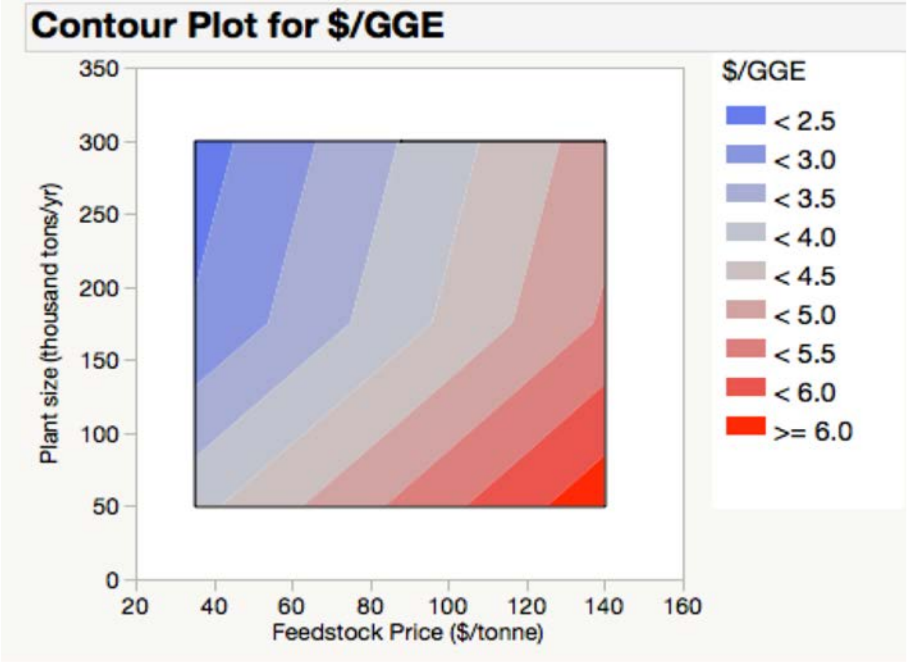
Explored strategies to meet a $2.50/GGE cost target for jet fuel pathways

An example for achieving $2.50/GGE via Fischer-Tropsch as a function of natural gas to biomass ratio



Not shown in figure but included in analysis is impacts of RIN credits

An example contour map for achieving $2.50/GGE for HEFA-SPK pathway



Key Takeaways to $2.50/GGE study: A combination of strategies required such as: 1) low cost feedstocks (such as waste feeds – WTE strategies), 2) high process yields (conversion needs), 3) larger scales (ADO strategies), 4) coproducts (conversion strategies), 5) renewable/cheap H_2 sources (AMO) and 6) RIN/LCFS credits (on-going discussions CARB).