U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

2023 BETO Peer Review

Data, Modeling, and Analysis Overview

Jay Fitzgerald, Chief Scientist, Bioenergy Technologies Office

April 3, 2023

Data, Modeling, and Analysis (DMA) Team

Jay Fitzgerald
Chief Scientist,
Program Manager, DMA
Biotech, Plastics, Chemicals, Program Strategy

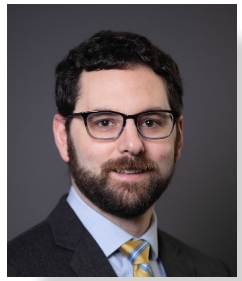
Andrea Bailey*
Technology Manager
Sustainability, Analysis, Budget, Design Cases

Zia Haq
Lead Analyst
Policy Analysis
SAF Grand Challenge

Michael Shell
Technology Manager
Modeling, Land Use, Lifecycle Assessment

Bryce Finch*
BCS
Project Monitor

Andrew Zimmerman
BCS – 50% DMA
Portfolio Analysis and Policy



Simon Roberts
Redhorse - 50% DMA
Business Support and Engagement

Bri Farber
BGS –50% DMA
Joint Office Priorities and JEDI

***Peer Review Session Leads for DMA**

DMA Supports BETO Strategic Goals

- Identify pathways to **maximize GHG reductions**
- **Standardize** data analysis assumptions
- Analyze **cross-sector strategy** (biomass, BEVs, hydrogen fuel cells)

- Analyze the **best use of biomass** for different end uses
- Analyze **cross-sector strategy** (biomass, electrification, CO_2)

- Use BETO tools to help communities with **place-based decarbonization strategies**
- Better understand **site specific impacts** of bioenergy

DATA, MODELING, AND ANALYSIS

INTERNAL COORDINATION

RENEWABLE CARBON RESOURCES

CONVERSION R&D

SYSTEMS DEVELOPMENT AND INTEGRATION

Modeling and providing data on cost, greenhouse gas reduction potential, and overall sustainability of different target technologies.

- Integrated analysis on decarbonization potential of different bioenergy technologies
- Standardized methods and analytical approaches
- Development and deployment of accessible tools and modeling frameworks

EXTERNAL COORDINATION

FEDERAL, STATE, LOCAL, INTERNATIONAL AGENCIES

Collaboration and engagement with external experts and informing international dialogues

Program Structure – Project Areas

Strategic Bioenergy Analysis

- Full bioenergy supply chain **scenario analysis**
- Assessments of potential for different **fuel types** and **end products**
- Database and tool development for important **bioenergy datasets**

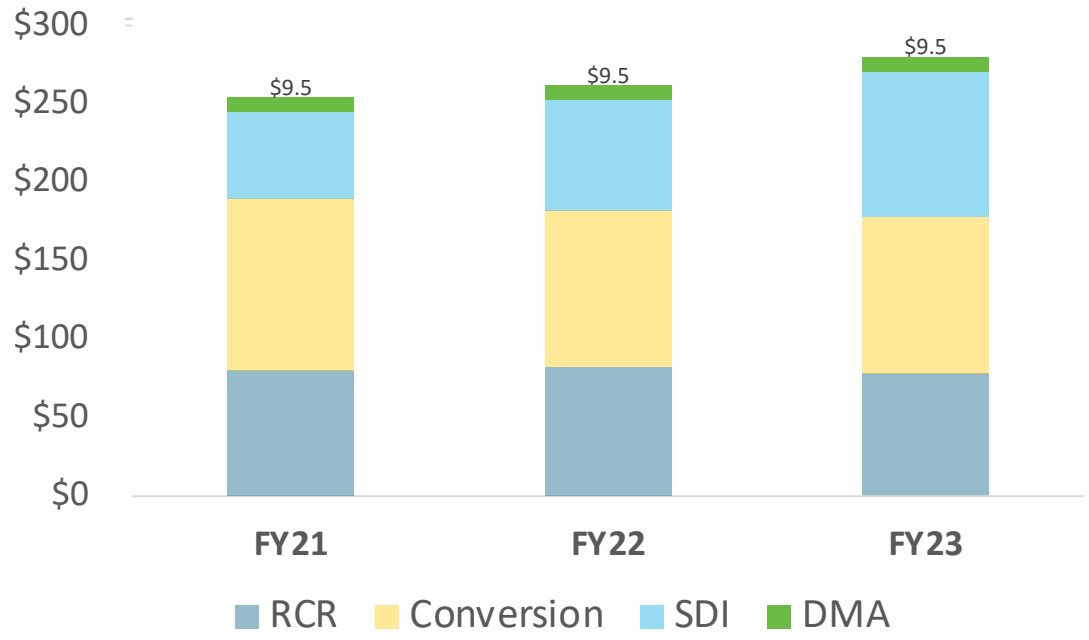
Analysis of the Sustainability of Bioenergy

- Full **lifecycle assessment** of different full bioenergy pathways
- Assessment of different **environmental indicators** for the full bioenergy supply chain including water use, **water** quality, and **air** quality

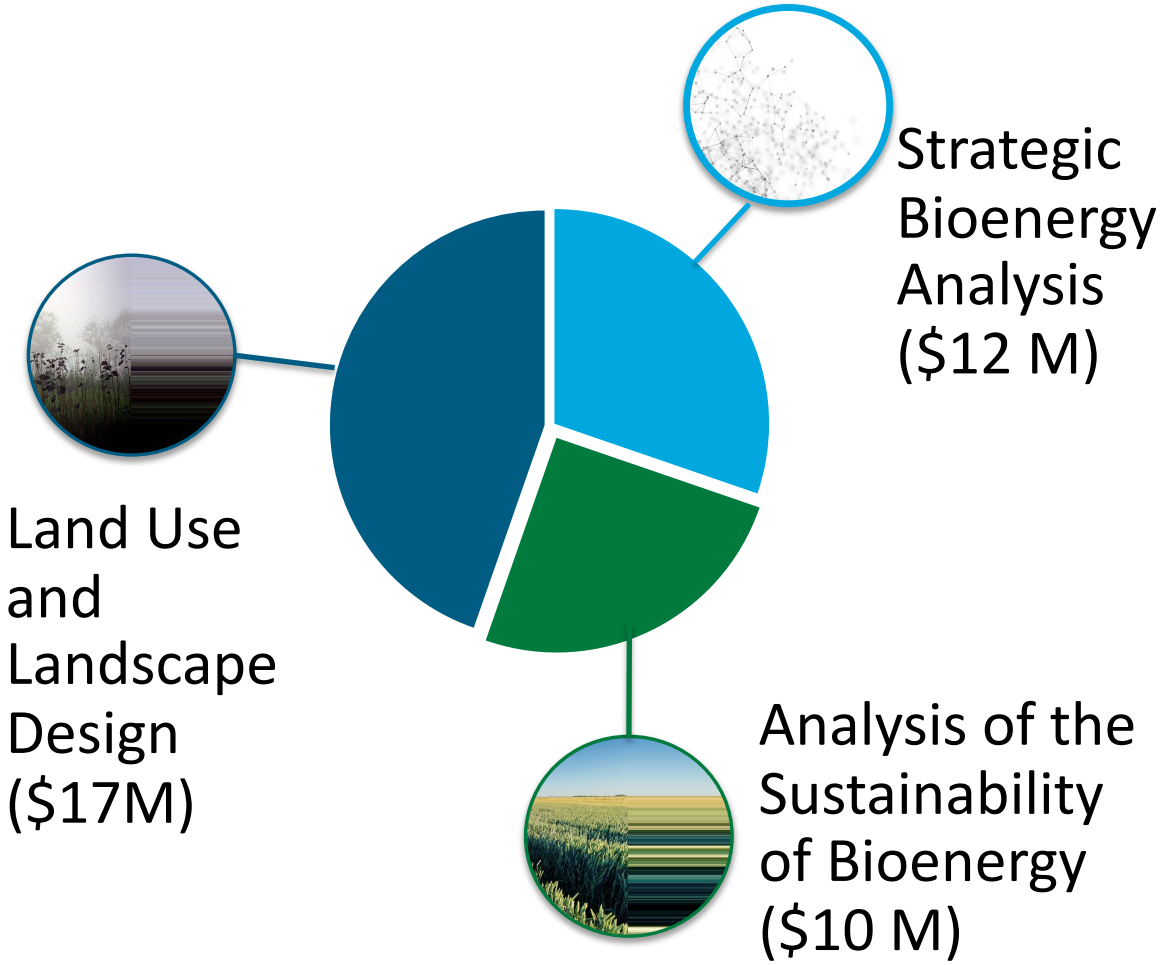
Land Use and Landscape Design

- Regional studies of ability to integrate different types of biomass feedstocks into existing **land management** plans
- Valuation of **ecosystem services** associated with different biomass feedstocks

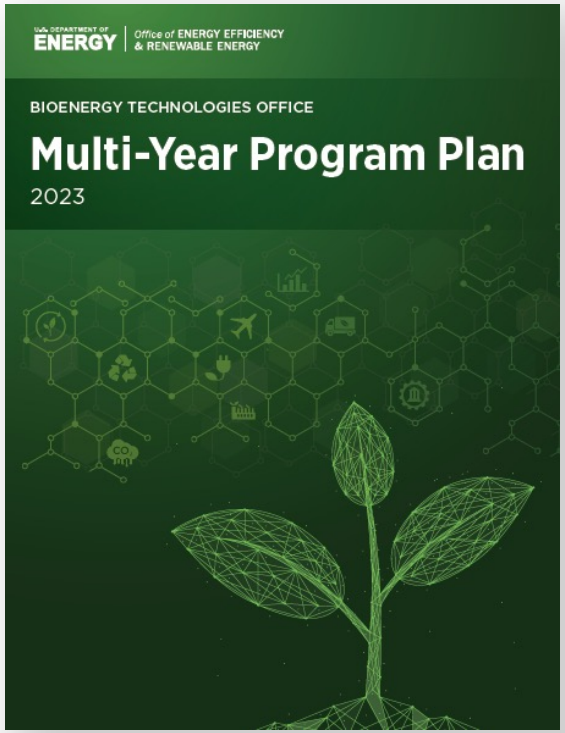
BETO Total Enacted Budget ($M)



DMA total budget $9.5M/year



Key Accomplishments



Program Accomplishments

External Coordination Accomplishments

Updated Modeling Frameworks

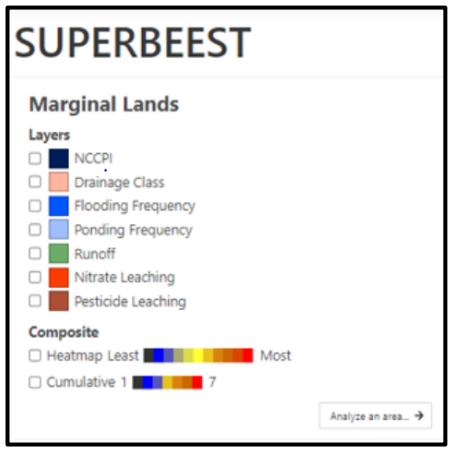
GREET
LIFE-CYCLE MODEL

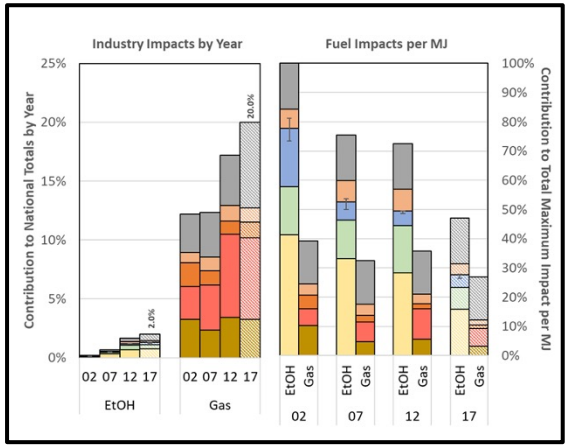
GREET (ANL)

- LCA tool that looks at the impacts of vehicle technologies, fuels, products, and energy systems.
- GREET 2022 released March 24th

SUPERBEEST (ANL)

- Geospatial tool that assesses the potential values of converting marginal land to bioenergy crops
- Has been piloted with landowners through American Farmland Trust





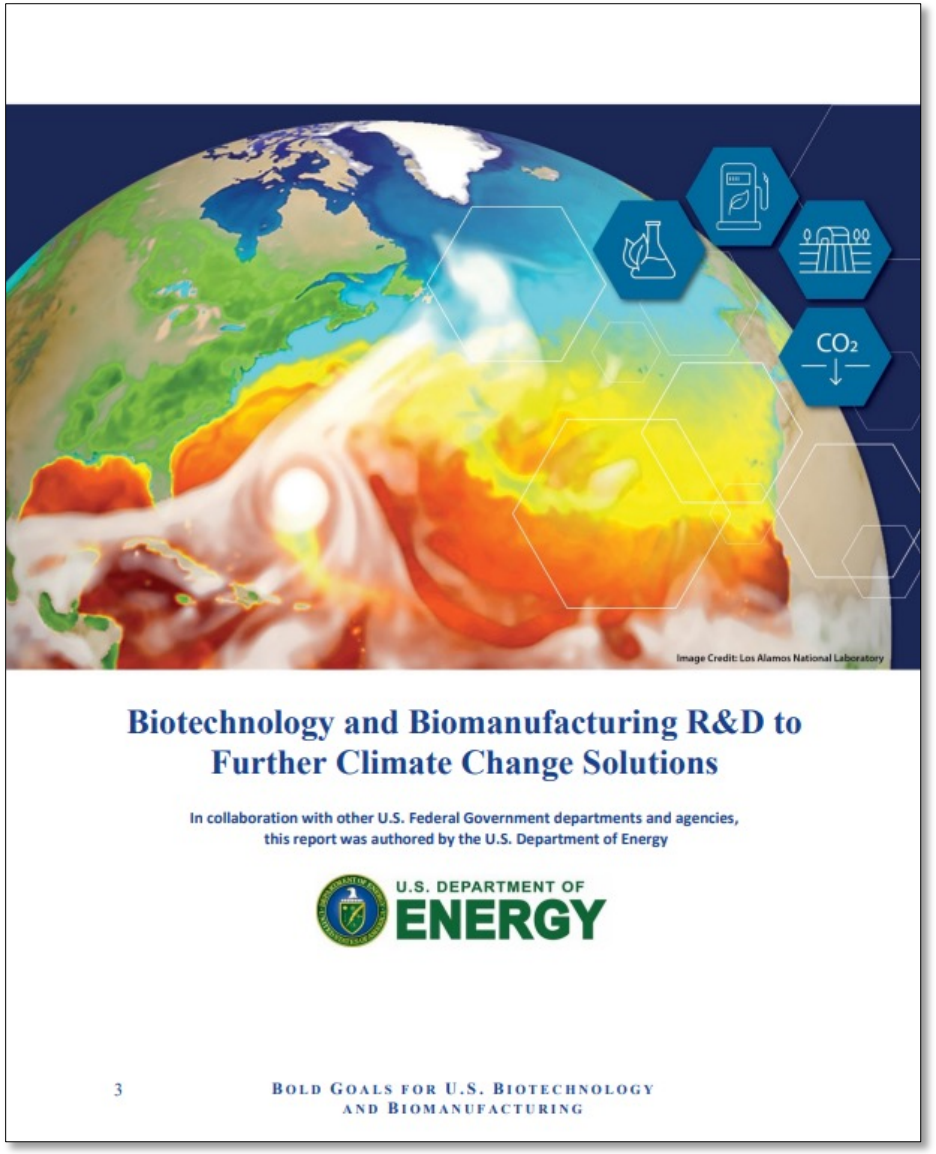
BEIOM (NREL)

- Aims to quantify the effects of an expanding U.S. bioeconomy at national and regional levels
- Development coordinated with EPA

KDF (ORNL)

- Provides access to a variety of data sets, publications, and visualization tools that support bioenergy research, analysis, and decision making
- Houses BT16 data and visuals

KDF



Theme 1: Transportation and Stationary Fuels

- Goal 1.1: Expand Feedstock Availability
- Goal 1.2: Produce Sustainable Aviation Fuel (SAF)
- Goal 1.3: Develop Other Strategic Fuels

Theme 2: Chemicals and Materials

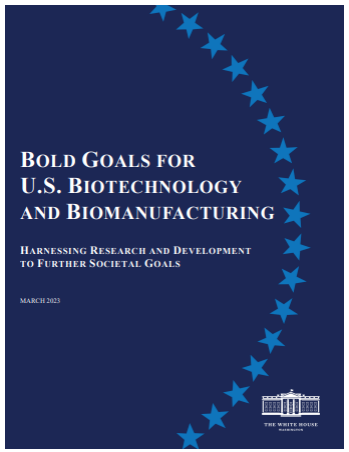
- Goal 2.1: Develop Low-Carbon-Intensity Chemicals and Materials
- Goal 2.2: Spur a Circular Economy for Materials

Theme 3: Climate-Focused Agricultural Systems and Plants

- Goal 3.1: Develop Measurement Tools for Robust Feedstock Production Systems
- Goal 3.2: Engineer Better Feedstock Plants
- Goal 3.3: Engineer Circular Food Protein Production Systems

Theme 4: Carbon Dioxide Removal

- Goal 4.1: Develop Landscape-Scale Biotechnology Solutions
- Goal 4.2: Enable Biomass with Carbon Removal and Storage (BiCRS)



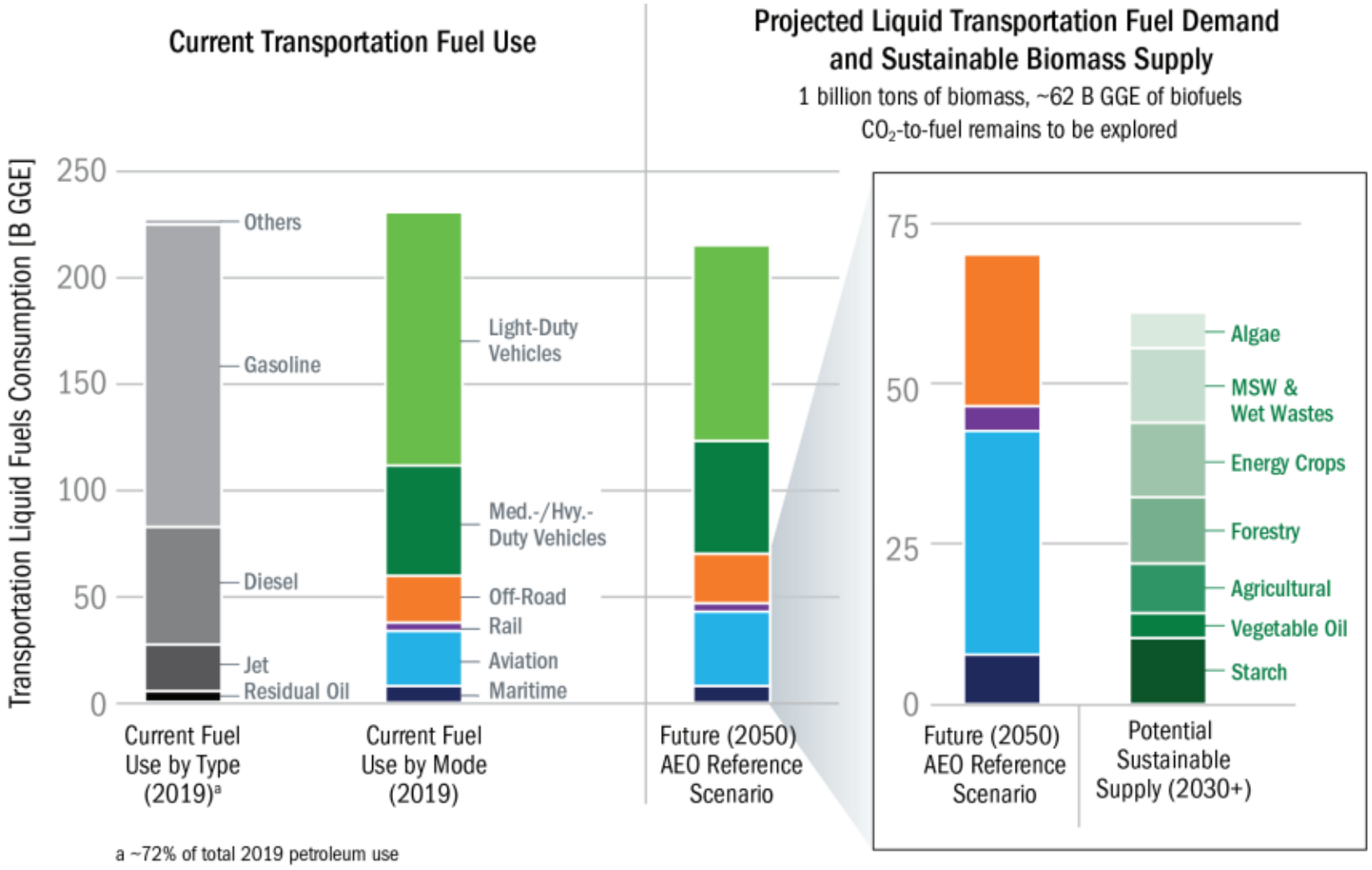
SAF Grand Challenge Interagency LCA Working Group

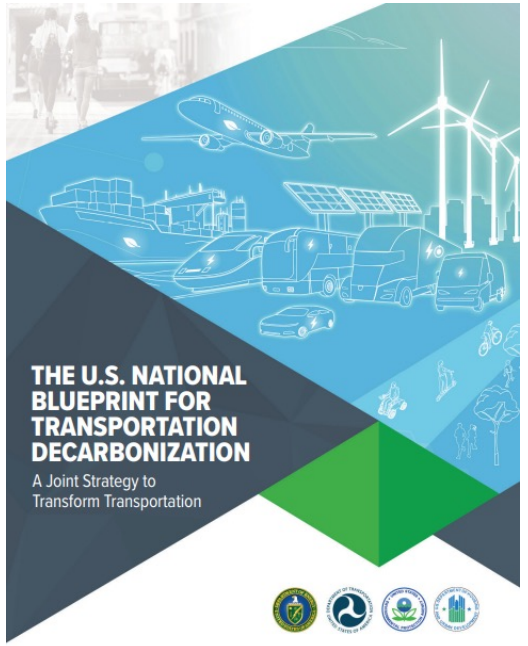
2030 Policy and Valuation Analysis Impact Highlights

Convene life cycle analysis working group

A life cycle greenhouse gas emissions working group will be convened. As requested by the SAF Grand Challenge memorandum of understanding, this working group will define and agree on the appropriate science-based methodology for establishing life cycle emissions reductions under the SAF Grand Challenge, recognizing the need for credibility and taking note of consistency with international criteria, such as those developed by ICAO. The working group will focus on domestic needs for life cycle GHG emissions analysis (see Activity PA.1.1).

- The working group is supporting ongoing development of methods and tools to estimate life cycle GHG emissions for use in SAF Grand Challenge activities that require GHG evaluation.
- Working Group includes DOE, USDA, EPA, FAA, Treasury


Current Transportation Fuel Use
Projected Liquid Transportation Fuel Demand and Sustainable Biomass Supply
1 billion tons of biomass, ~62 B GGE of biofuels
CO_2-to-fuel remains to be explored
Transportation Liquid Fuels Consumption [B GGE]
250
200
150
100
50
0
Others
Gasoline
Diesel
Jet
Residual Oil
Light-Duty Vehicles
Med.-/Hvy.-Duty Vehicles
Off-Road
Rail
Aviation
Maritime
75
50
25
0
Algae
MSW & Wet Wastes
Energy Crops
Forestry
Agricultural
Vegetable Oil
Starch
Current Fuel Use by Type (2019)a
Current Fuel Use by Mode (2019)
Future (2050) AEO Reference Scenario
Future (2050) AEO Reference Scenario
Potential Sustainable Supply (2030+)
a ~72% of total 2019 petroleum use
AEO = annual energy outlook | GGE = gasoline gallon equivalent | MSW = municipal solid waste


THE U.S. NATIONAL BLUEPRINT FOR TRANSPORTATION DECARBONIZATION
A Joint Strategy to Transform Transportation

Future Directions

Enhanced Modeling Capabilities

- Modeling directed at SAF Grand Challenge Goals including more user- friendly GREET SAF modules
- Policy and economic models

Integrated Assessment Modeling

- Interaction of bioeconomy supply chains and other economic factors with a focus on uncertainty quantification
- Equity and siting considerations

Chemical Sector Analysis

- Coordinated analysis on sustainable carbon sources for chemicals from biomass, waste, hydrogen, CO_2
- Joint with IEDO, AMMTO, HFTO*

*dependent on appropriations

Increased External Collaboration

- Expanded coordination and collaboration within DOE as well as with partner offices and agencies including FAA, USDA, EPA, NSF, DoD and others

Program Response to 2021 Peer Review

1. Harmonize across models within the BETO portfolio

- Standardizing LCA assumptions across agencies
- Formed multi-lab TEA/LCA working group to coordinate work
- Holding a workshop in early Fall 2023

2. Continue/expand field research to ground-truth models and analyses

- BioRestore FOA awards will present in 2023 (did not present in 2021)
- Future field work transitioning to Renewable Carbon Resources
- USDA Climate Smart Agriculture program stood up since 2021, coordination ongoing

3. Increase support for social science research, including a focus on equity and justice

- Funded a joint project at ORNL/NREL to examine BETO's portfolio with a focus on equity and justice as well as the potential for bioenergy DEI indicators
- This is an area of ongoing commitment

Reviewers

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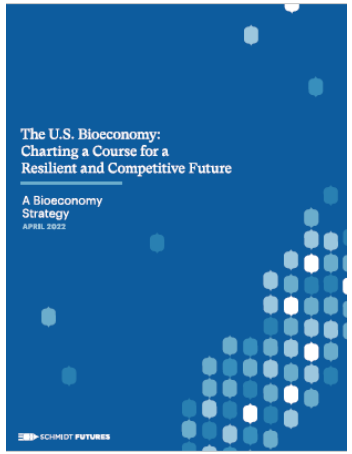
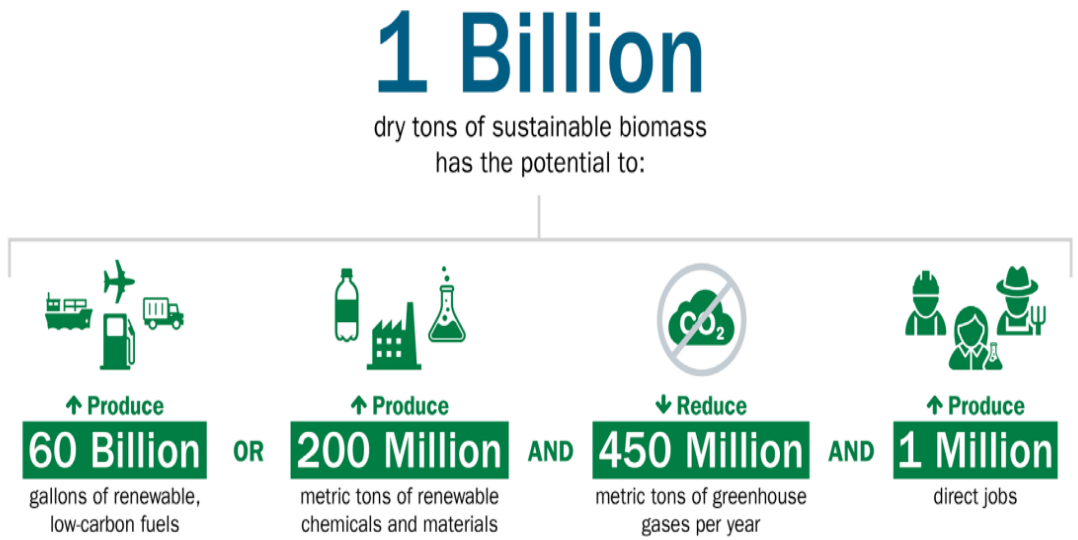
Jason Jones
Director, Economics, ICF

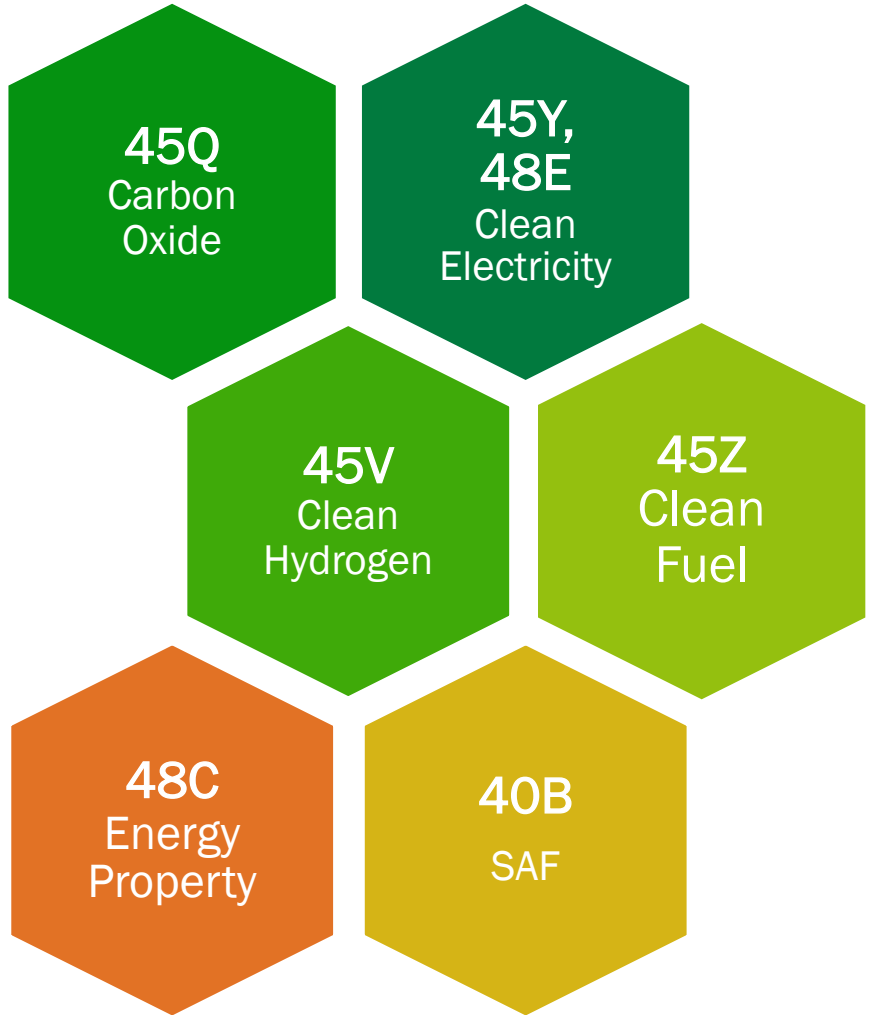
Sarah Mittlefehldt
Professor, Northern Michigan University

Nikita Pavlenko
Fuels Program Lead, ICCT Fuels Team

The Time is Right to Design the Bioeconomy for Decarbonization







Executive Order on Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy

Thank You!

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Feedstock | Algae | Conversion | Systems | Data

Addressing Challenges

Bioenergy Challenges

- Improving data accessibility and streamlining assumptions
- Quantifying the economic, environmental, and social benefits of bioenergy
- Addressing the need for improved mechanisms to inform and involve stakeholders
- Closing data gaps

DMA Activities

- Researching, developing, and deploying tools and standardized practices
- Conducting analyses at different geographic scales and across multiple supply chain components and sustainability categories
- Developing, refining, and deploying high-quality publicly available analytical tools and models