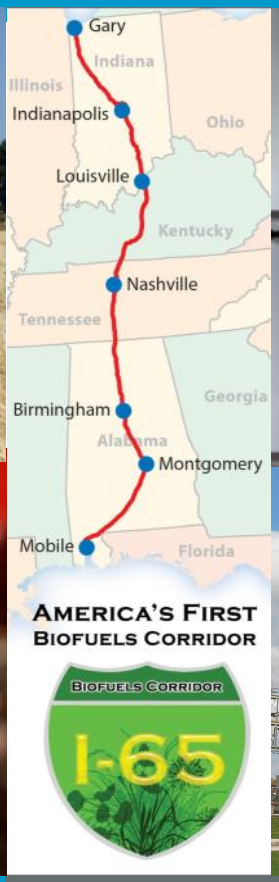
BIOENERGY TECHNOLOGIES OFFICE

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



State Energy Advisory Board

April 25, 2019

Alison Goss Eng

Program Manager

Bioenergy Technologies Office's Mission and Vision

Vision: A thriving and sustainable bioeconomy fueled by innovative technologies

Mission: Developing transformative and revolutionary sustainable bioenergy and bioproducts technologies for a prosperous nation

Strategic Goals: Develop industrially relevant technologies to enable domestically produced biofuels, biopower, and bioproducts

BETO Reduces Technology Uncertainties and Enables Affordability Through R&D

Bioenergy Delivers Unique Value

BETO funds research and development activities that reduce the price of production of biofuels and bioproducts which enable:

- Increasing domestic bioenergy production to support America's ***national security*** interests
- Creating American ***jobs***, boosting ***economic growth***, and encouraging ***investment*** across the nation
- Advancing U.S. ***competitiveness*** in global energy and bioproduct markets
- Maximizing the use of America's abundant biomass ***resources***
- Improving the ***quality of life*** for Americans

America's biomass resources could provide domestic energy, revenue, and jobs.

From Challenge to Opportunity

THE CHALLENGE

More than $215 million is spent **every day** on foreign oil **imports ($43/barrel/day in 2016*)**. Dependence on **foreign oil** can leave us vulnerable to disruptions in supplies and contributes significantly to our trade deficit.

Transportation accounts for 67% of petroleum consumption and 26% of emissions in the United States.

*Annual Energy Outlook 2017 with projections to 2050
eia.gov/outlooks/aeo/pdf/0383(2017).pdf

THE OPPORTUNITY

More than **1 billion tons of biomass** could be domestically converted into biofuels and products.

Biomass could displace **25%** of U.S. petroleum use annually by 2030, **keeping $260 billion in the United States**, adding **1.1 million direct jobs,** and reducing annual CO_2 emissions by 450 million tons or 7% of U.S. energy emissions**.

** Rogers et al. 2016, An assessment of the potential products and economic and environmental impacts resulting from a billion ton bioeconomy.
onlinelibrary.wiley.com/doi/10.1002/bbb.1728/full

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.

Project Partners

BETO works with partners in industry, universities, and the national labs.

Inter-Agency Collaboration

Other Federal Agencies

USDA — USDA focuses on feedstock production and rural development, co-chairs the BRDI Board with DOE, and partners with BETO on interagency efforts to support the bioeconomy.

FAA — BETO provides technical expertise on the Farm-to-Fly 2.0 initiative to produce renewable jet fuel.

EPA — The EPA administers the Renewable Fuel Standard and works with BETO on life cycle analysis for different fuel pathways.

DOT — The DOT invests in national infrastructure and works with BETO on challenges related to bioenergy transportation and logistics.

DOD — Under the Defense Production Act, the DOD partners with USDA and DOE to produce drop-in fuels for the military.

NSF — NSF supports innovative chemical, environmental and bio-engineering analysis which informs BETO research.

Key Partnerships of the Bioenergy Technologies Office

Department of Energy

Office of Energy Efficiency & Renewable Energy

Vehicle Technologies Office (VTO)

VTO partners with BETO on fuel and infrastructure characterization and new work on the co-optimization of fuels and engines.

Advanced Manufacturing Office (AMO)

AMO works with BETO to research and develop renewable, low-cost carbon fiber for lightweight vehicles.

Bioenergy Technologies Office (BETO)

BETO's mission is to accelerate the commercialization of advanced biofuels and bioproducts through targeted RD&D supported by public and private partnerships.

The White House Office of Science and Technology Policy

BETO contributes to White House goals for the reduction of GHG emissions and oil imports under the Climate Action Plan.

Fossil Energy — BETO collaborates with the Office of Fossil Energy to utilize biomass for carbon capture.

Office of Science — The Office of Science focuses on early stage basic science with eventual commercial applications for bioenergy.

ARPA-E — ARPA-E invests in innovative technologies including electro-fuels and the PETRO program for direct biofuel production.

ENERGY.GOV Loan Programs Office — The Loan Programs Office provides loan guarantees for commercial biorefinery projects.

EIA — BETO contributes data to the EIA to support their accurate energy forecasting for consumption and production.

National Laboratories

NREL National Renewable Energy Laboratory; INL Idaho National Laboratory; Los Alamos National Laboratory Est. 1943; Oak Ridge National Laboratory; Argonne National Laboratory; Pacific Northwest National Laboratory; Sandia National Laboratories; Brookhaven National Laboratory; Lawrence Livermore National Laboratory; Berkeley Lab Lawrence Berkeley National Laboratory

BETO partners with other DOE Offices, other Federal agencies, and the national labs to achieve U.S. goals on bioenergy

The Biomass Research & Development Board

- The Biomass Research and Development Act of 2000 established the Interagency **Biomass R&D Board**, the **Technical Advisory Committee**, and the **Biomass R&D Initiative (BRDi)**.
- The BR&D Board facilitates coordination among federal government agencies that affect the research, development, and deployment of biofuels and bioproducts.

Membership

Senate-confirmed sub-cabinet officials from 8 executive branch agencies

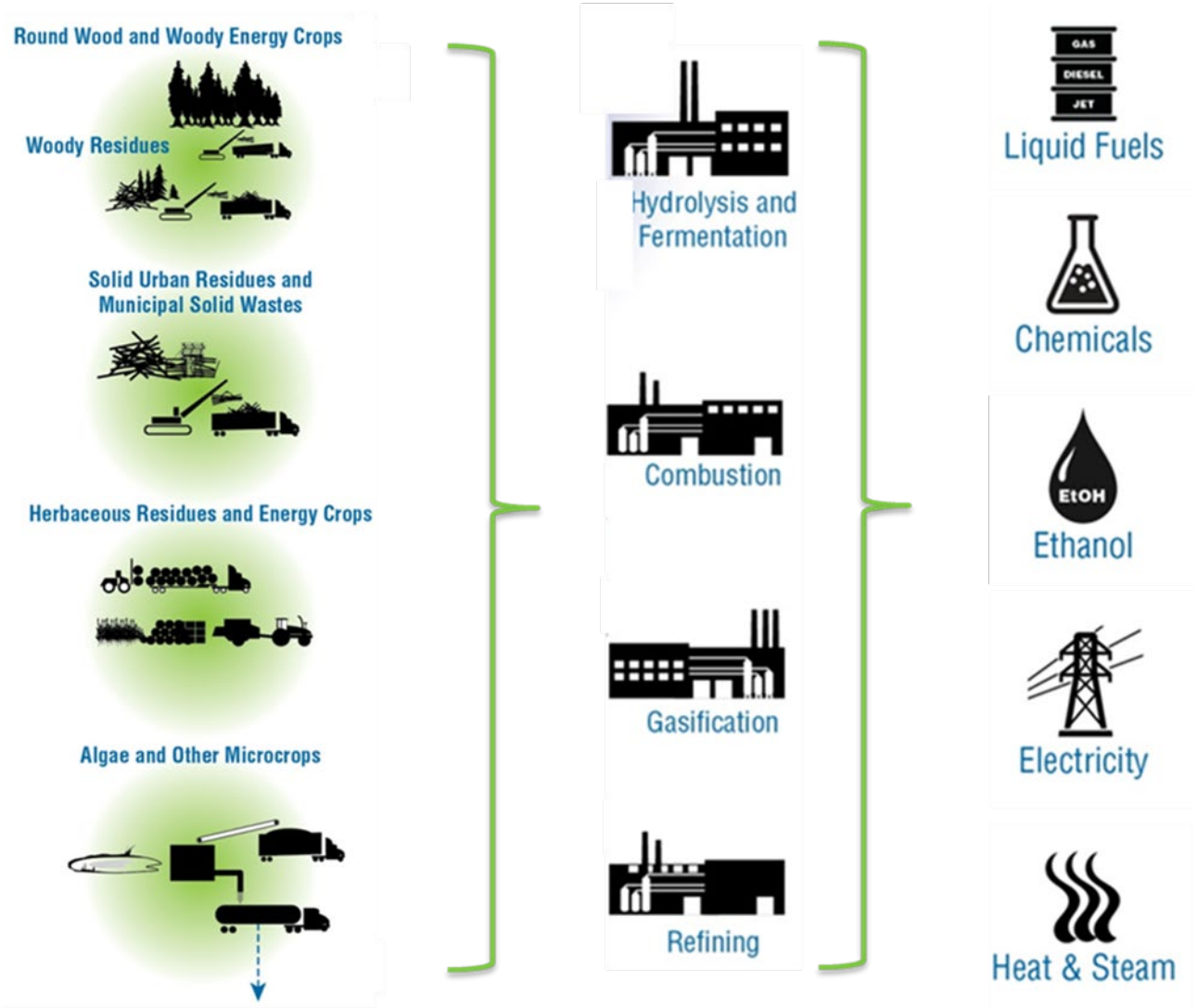
Co-chair *Co-chair*

What is the Bioeconomy?

The **bioeconomy** is a global industrial transition of sustainably utilizing renewable aquatic and terrestrial biomass resources in energy, intermediate, and final products for economic, environmental, social, and national security benefits.

From 2014 Report: *Why Biobased? Opportunities in the Emerging Bioeconomy: Why BioPreferred*
biopreferred.gov/files/WhyBiobased.pdf

The Bioeconomy Concept

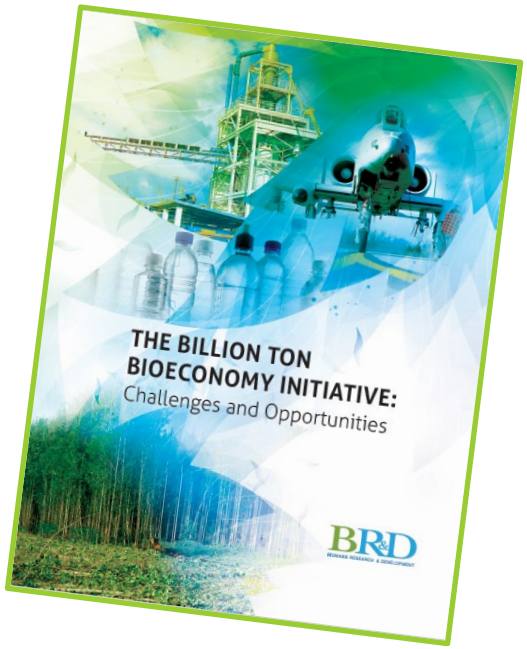


- **Revenue and economic growth**
- **Broad spectrum of new jobs**
- **Rural development**
- **Advanced technologies and manufacturing**
- **Reduced emissions and Environmental Sustainability**
- **Export potential of technology and products**
- **Positive societal changes**
- **Investments and new infrastructure**

Bioeconomy Implementation Framework

The Framework (formerly called the Action Plan) will serve as a guiding document for BR&D Board member agencies to implement the multi-agency Bioeconomy Initiative while:

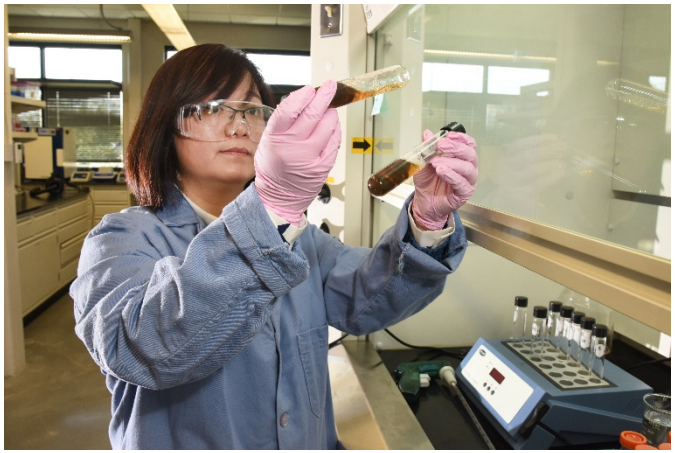
1. Increasing government accountability and efficiency
2. Maximizing interagency coordination on research and other activities
3. Accelerating innovative and sustainable technologies that harness the nation's biomass resources.



https://biomassboard.gov/pdfs/Bioeconomy_Initiative_Implementation_Framework_FINAL.pdf

Example Implementation Framework Goals

- Leverage high-value bioproducts to develop algae industry infrastructure
- Establish a fully developed biofuel and bioproducts production pipeline for manufacturing advanced biofuels, industrial chemicals, and other biobased products
- Enable new markets for biomass by facilitating feedstock establishment and management
- Remove barriers to biointermediate refining and upgrading via existing infrastructure
- Facilitate end-user market expansion by streamlining testing and certification of novel fuels for use in existing surface vehicles, vessels, and aircraft
- Validate cost estimates and market prices at representative engineering scales under various scenarios and assumptions to examine process robustness and fully understand research issues with scale-up



Critical Research Areas Under Implementation Framework

- Develop superior feedstock crop plants with improved yields and quality and less recalcitrance to deconstruction
- Improve enzyme and catalyst effectiveness, efficiency, and regeneration
- Improve catalytic and separations processes
- Develop new products, co-products, and robust processes
- Advance industrial efficiency through a more complete understanding of cellulosic breakdown and reformulation
- Understand and model materials characteristics and handling
- Waste gaseous carbon utilization

Implementing the Bioeconomy Initiative

The Framework lays out a number of fundamental actions across different focus areas in order to implement the Bioeconomy Initiative.

- Knowledge sharing, including:
  - Analyzing gaps in existing online resources
  - Using the STEM Workforce Development program
- Stakeholder Engagement, including:
  - Emulating existing successful public-private partnership models (ex., CAAFI)
- Technology Transfer, including:
  - Provide access to experts to discuss technology/tech transfer opportunities
  - Provide IP for industry with working with public entities
- Industry Partnerships, including:
  - Summarize existing and potential future activities to engage industry
- Project Finance, including:
  - Work to better understand funding barriers, key risks, and options
  - Improve coordination of options and mechanisms for providing financial funding support

Thank you!

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