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

U.S. Department of Energy Bioenergy Technologies Office Leveraging First Generation Bioethanol Production Workshop

September 25-26, 2019

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Outline

I. BETO Overview

II. Workshop Objectives

III. Workshop Agenda

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

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.

THE OPPORTUNITY

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

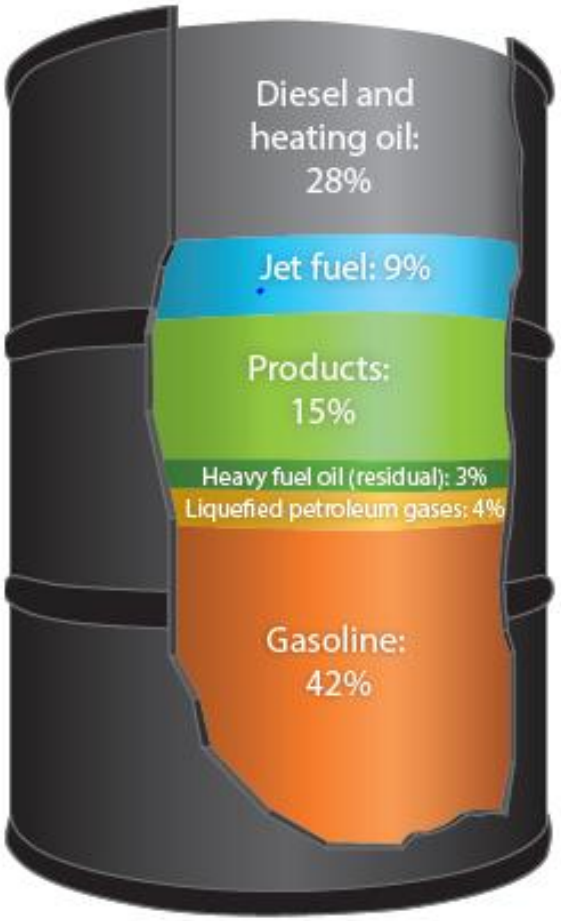
Biomass could displace up to **25%** of U.S. petroleum use annually by 2030, **keeping revenues in the United States**, adding **jobs,** and reducing annual CO_2 emissions**.

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

** 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

Replacing the Whole Barrel – Fuels & Products

- Enhancing U.S. security requires producing fuels and bioproducts from our large supply of biomass.
- Supporting U.S. Farmers rather than buying foreign oil.
- EERE R&D focuses on **"drop-in" hydrocarbon** biofuels, and **bio-based products.**
- "Drop-in" hydrocarbon fuels will be fully compatible with existing infrastructure and equipment, including diesel and jet engines.
- **Products**
  - Fuels makes up 76% of the volume of U.S. oil products and is worth $935B.
  - Chemicals make up 17% of the volume of U.S. oil products and worth $812B.
- Maximizing biofuels production in conjunction with the development of chemical intermediates will drive down the cost per gallon.



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.

Selected Bioenergy Technologies Office's Consortia

Feedstock-Conversion Interface Consortium
(FCIC)

Chemical Catalysis for Bioenergy
(ChemCatBio)

Agile BioFoundry
(ABF)

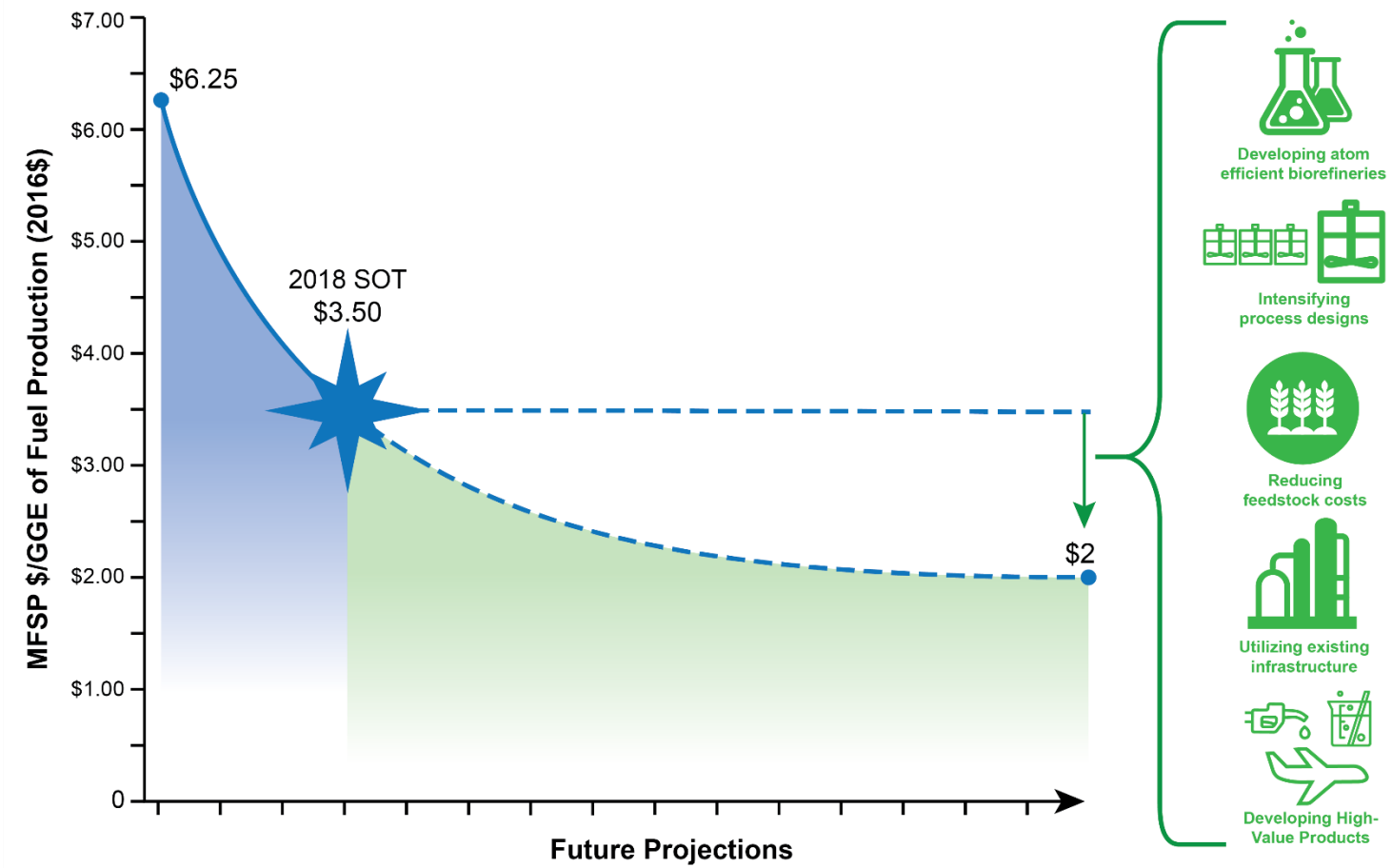
Bioprocess-ing Separations Consortium
(BioESep)

Co-Optimization of Fuels and Engines
(Co-Optima)

Consortium for Computa-tional Physics and Chemistry (CCPC)

Opportunities to Reach BETO Price Goals

BETO completed an analysis of strategies to reduce the cost of biofuels toward $2/GGE



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Potentially Untapped Carbon Resources

Leveraging DOE's National Laboratories expertise in polymer deconstruction in biomass and applying it to distributed sources of waste carbon to make molecular building blocks for fuels, products, and energy

Wet Wastes:
Biosolids, Food Wastes, Manures

Economically Advantageous Feedstocks

Solid Wastes:
Sorted Municipal Solid Waste including Plastics

Gaseous Wastes:
CO and CO_2

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The Carbon Based Economy

Our economy is built on carbon, it surrounds us in products that improve our everyday lives. This is not going to change only the source of carbon will be more diverse from waste solids, liquids and gases in the future. This is the emerging bioeconomy.

Leveraging First Generation Bioethanol Production

- Purpose
  - To better understand process and product opportunities applicable to the existing fleet of first generation ethanol plants
  - To discuss R&D needs and challenges
    - Gen 1.5 In-Situ and Ex-Situ
    - CO_2
    - Analytical Methods
  - Information to help inform BETO research priorities, as part of its annual planning process.
  - Solicit feedback from industry, academia, research laboratories, government agencies, and other stakeholders to help ensure research areas are relevant, timely, appropriate for federal government funding, and aligned with Administration priorities.
  - Inform a potential Funding Opportunity Announcement
    - EERE may issue a FOA in the future based on or related to the content and responses to this Workshop; however, EERE may also elect not to issue a FOA. There is no guarantee that a FOA will be issued as a result of this Workshop.

BETO Request for Information / DE-FOA-0002150

- BETO is seeking information related to the development and integration of technologies that could increase the production of cellulosic fuels, cellulosic sugars, and chemicals from corn fiber.
- BETO, in coordination with DOE's Office of Fossil Energy (FE) is also seeking information about technologies to convert or activate gaseous carbon dioxide (CO_2) emitted from fermentation of corn-starch feedstocks, as well as other gaseous emissions from other biorefinery processes.
- BETO is particularly interested in information on the development and verification of innovative process technologies to enable integration and retrofit into existing first generation corn-starch ethanol plants. Such technologies could facilitate the cost-competitive production of cellulosic biofuels and bioproducts from corn kernel fiber, and increase renewable fuel production from existing domestic production facilities while also reducing waste and emissions from these facilities.

RFI Topics - Gen 1.5 Cellulosic Ethanol Process Technology Development and Plant Integration

- Describe promising technologies for fiber conversion that maximizes yield of cellulosic ethanol with low operating cost and low capital investment.
- What is the state of the art and maturity of the proposed Gen 1.5 process technology?
- Describe how to address integration challenges with existing plant systems to minimize capital cost (shorten payback period), minimize energy and water consumption, and minimize waste / effluent generation?
- Describe the advantages and disadvantages of *in-situ vs*. separate fiber conversion process options.
- For *ex-situ* implementations, would it be better to have a dedicated separation and dehydration setup for the cellulosic ethanol or can the cellulosic ethanol be combined to the existing separation and dehydration section of the plant?
- Describe the degree to which Federal R&D funding would accelerate transformational technology advances that industry by itself is not likely to undertake because of technical and financial uncertainty.

RFI Topic - Analytical methods for *in-situ* corn kernel fiber conversion

- Describe barriers for corn kernel fiber co-processing that could be addressed with new or improved analytical methods.
- What analytical technologies or techniques would provide the most improvement to current methods in corn kernel fiber co-processing?
- Describe the degree to which Federal R&D funding could address critical scientific challenges and would accelerate transformational technology advances that industry by itself is not likely to undertake because of technical and financial uncertainty.

RFI Topic - Opportunities in Management of CO_2 and Other Gaseous Emissions

- What is the overall interest in leveraging these process emissions gases, including carbon oxide capture and utilization provisions of § 45Q of the Internal Revenue Code, as amended within the Bipartisan Budget Act of 2018? Are the tax credits associated with 45Q sufficient to deploy carbon capture and/or utilization technologies at existing biorefineries? Are there other state or federal directives which are notable to consider when discussing such technologies?
- What are the major barriers to deploying such technologies at biorefineries?
- Describe the degree to which federal R&D funding would accelerate transformational technology advances in ethanol process emissions at the biorefinery scale (20+ million gallon per year) that industry by itself is not likely to undertake because of technical and financial uncertainty. BETO and FE are specifically not interested in CO_2 utilization in the form of enhanced oil recovery. BETO and FE are seeking inputs particularly on the following:
  - innovative technology to activate CO_2 and utilize the molecular building blocks to make fuels and products from biorefineries.
  - innovative technology to activate CO_2 and utilize the molecular building blocks to make fuels and products from other power industrial sources.
  - innovative technology to convert other gaseous emissions, such as methane and other hydrocarbons, to make fuels and products.

Day 1 Agenda

Day 1 - September 25, 2019			
8:00	Coffee and Networking		
8:30	Introductory Remarks	Mark Shmorhun	BETO
8:45	"Risk" Overview - A Lender's Perspective	Tom Houser	Co-Bank
9:15	U.S. Ethanol Demand: Challenges and the Role of Policy	Gabriel Lade	Macalester College
9:30	Carbon Capture and Sequestration from Biorefineries	Dan Sanchez	UC Berkeley
10:00	Break		
10:15	DSM's Solutions for Corn Fiber Conversion	Paul Klassen	DSM
10:30	Kernel Fiber Technology	Delayne Johnson	Quad County Corn Processors
10:45	A Hybrid Approach to Generation 1.5 for High Volumes of Cellulosic Ethanol	Brandon Emme	ICM
11:00	Cellulosic Ethanol from Corn Fiber: Technology, Challenges and Future Improvements	Mark Yancey	D3MAX
11:15	Cost Effective Pure Corn Fiber for Cellulosic Conversion	Neal Jakel	Fluid Quip
11:30	Perspectives on Corn Kernel Fiber Commercialization	Shon Van Hulzen	POET
11:45	The Challenge of Cellulose	Justin Sluiter	NREL
12:00	Lunch		
12:45	Verification of the NCERC Starch and Cellulose Methods for Testing Corn Matrix Samples	Yan Zhang	NCERC
1:00	Preliminary Techno-Economic Analysis of Gen 1.5 Technology	Ling Tao	NREL
1:15	Rapid Fire Talks		
2:15	Break		
2:30	Break Out Sessions		
5:00	Day 1 End		

Day 2 Agenda

Day 2 - September 26, 2019			
8:00	Introduction to Ames Laboratory	Adam Schwartz	Iowa State
8:15	Utilizing 1st Generation Biofuel Production Facilities to Develop Enabling Biorefinery Technology	Brent Shanks	NSF CBiRC
8:30	Valorizing Corn Fiber: Cellulosic Sugars and More	Robert Brown	Iowa State
8:45	Catalysts an Mechanisms for Efficient Conversions of Under-Utilized Waste Feedstocks	Aaron Sadow	Iowa State
9:00	Demystifying Biomass Structure by Solid-State NMR	Fred Perras	Iowa State
9:15	Breakout Groups Reconvene		
10:30	Break		
10:45	Breakout Groups Report Out		
12:00	Lunch		
1:00	Optional: Ames Lab Tour Optional: Lincolnway Energy Dry Mill Ethanol Plant Tour (3 hours)		

Details

- All Slide Decks to Carlos Villacis
- Rooms for Breakouts
  - Analytical 301 Spedding
  - CO2 140 TASF
  - Process 205 TASF
- Lunch in the Hach Hall Atrium
- Please sign up for either the Ames Lab or Lincolnway Energy Tours
  - Bus for Lincolnway departs 1PM Thursday
- We plan to send out an attendee list with Name, Affiliation, Email Address
  - Please email Melinda or Mark if you want to opt out