Bioenergy Technologies Office

2017 Program Management Review

Bioenergy Technologies Office Response

Jonathan Male
BETO Director
Arlington, Virginia
July 13, 2017
I. Welcome and Thank you
II. The Bioeconomy
III. BETO Impact
IV. Trajectory to Cost Competitiveness
V. FY17 Budget Request
VI. BETO Partners
Thank you again to the Steering Committee Members:

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
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<tbody>
<tr>
<td>Michael Lakeman*</td>
<td>Boeing</td>
</tr>
<tr>
<td>Steven Costa</td>
<td>U.S. Department of Transportation</td>
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<tr>
<td>Robert Graham</td>
<td>Ensyn</td>
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<tr>
<td>John May</td>
<td>Hamilton Clark</td>
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<tr>
<td>Shelie Miller</td>
<td>University of Michigan</td>
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<tr>
<td>Dawn Mullally</td>
<td>American Lung Association</td>
</tr>
<tr>
<td>Robert (Bob) Rummer</td>
<td>University of Kansas</td>
</tr>
<tr>
<td>Bob Wooley</td>
<td>Biomass <em>ad infinitum</em>, LLC.</td>
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Thank you!

As well as the Lead Reviewers:

<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Steve Searcy</td>
<td>Texas A&amp;M University</td>
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<tr>
<td>Gerson Santos Leon</td>
<td>Abengoa</td>
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<tr>
<td>Eric Jarvis</td>
<td>Nexajoule</td>
</tr>
<tr>
<td>Candace Wheeler</td>
<td>General Motors (Retired)</td>
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<tr>
<td>Suzanne Lantz</td>
<td>DuPont</td>
</tr>
<tr>
<td>Shawn Freitas</td>
<td>Thermochem Recovery International</td>
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<tr>
<td>F. Michael McCurdy</td>
<td>Leidos</td>
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<tr>
<td>Luca Zullo</td>
<td>VerdeNero, LLC.</td>
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Benefits of a Robust Domestic Bioeconomy

• **Job Creation and Balance of Trade** – Displacing oil imports offers a massive opportunity for domestic jobs creation, with virtually no consequent job destruction.

• **Energy Security** – Domestic production decreases vulnerability to short-term economic disruption due to war, civil unrest, OPEC action, speculation, etc.

• **Environmental Benefits** – Sustainable biomass production can reduce harmful emissions versus petroleum-based fuels on a life-cycle basis.

![Fuel from domestic biomass versus imported crude oil helps grow the US economy](image)
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.

1 billion tons of biomass could be sustainably produced in the United States.
BETO Impacts

Since 2009...

- **Lab Patents**: 246
- **Lab Publications**: 916
- **Lab Licenses**: 32
- **Biofuel Production**: 3,837,918* Gallons of Cellulosic Liquid Biofuel

More than **285K jobs** from biofuels in 2014**

1.1 million potential direct jobs by 2030**

* 2016 Renewable Fuel Standard Data
**BETO Technology in the Market**

### R&D + Industry Partnership

**Impact**

- Case New Holland commercialized their system, which doubled output while cutting costs by 33%
- Fort Drum Army base in NY is run by a 60-megawatt biomass power plant, partially fueled by woody biomass harvested with this technology
- Virent produces bio-intermediates for fuels and products
- Tesoro acquired Virent and plans to scale-up
- Coca-Cola and Virent plan to produce 100% PlantBottles by 2020 (35 billion bottles)

### Self-propelled woody crop harvester

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- Fort Drum Army base in NY is run by a 60-megawatt biomass power plant, partially fueled by woody biomass harvested with this technology

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**Coca-Cola**

**PlantBottle**

**Fuel Blend Stock**
## BETO Technology Approaching the Market

### BETO Technology Approaching the Market

- LanzaTech licensed microbial strains to produce alcohol
- Neat fuel meets alcohol-to-jet specs and 50% Jet A blend meets ASTM specs
- Demonstration fuel will be used in future flight test with Virgin Atlantic to support goal of adding to ASTM D7566, Annex 5

### R&D + Industry Partnership

- Ensyn produces renewable bio-oil to be co-processed with petroleum sources or to sell for heating
- Processing utilizes existing 6 million BBL/day US FCC capacity
- Co-processed diesel and gasoline were approved as EPA registered fuels and under LCFS by CARB
**BETO R&D plays a crucial role reducing the costs of biofuels without subsidies.**

- Biomass derived liquid transportation fuels have the potential to be competitive—without subsidies—with their fossil derived equivalents.
- The pathway presented here (the conversion of biomass into infrastructure-compatible hydrocarbon fuels via fast pyrolysis) represents a goal case targeting performance potentially available between now and 2017.
- Based on this design case, a total potential cost reduction of 75% can be achieved between 2009 and 2017 with continued funding of R&D activities.
- In FY17/18, BETO will initiate analysis on R&D needed to enable price competitive biofuels ($2/gge).

*EIA Annual Energy Outlook 2016 Reference Case BETO Multi-Year Program Plan*
## FY18 Budget Request

<table>
<thead>
<tr>
<th>Program Area</th>
<th>FY 2016 Enacted*</th>
<th>FY 2017 Enacted*</th>
<th>FY 2018 Request*</th>
<th>FY 2018 House Marks*</th>
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<tbody>
<tr>
<td>Conversion Technologies</td>
<td>85,500</td>
<td>90,230</td>
<td>34,600</td>
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<tr>
<td>Advanced Development and Optimization (Formally DMT)</td>
<td>75,100</td>
<td>54,041</td>
<td>6,000</td>
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<tr>
<td>Analysis and Sustainability</td>
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<td>10,729</td>
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<td>Advanced Algal Systems</td>
<td>0</td>
<td>30,000</td>
<td>5,000</td>
<td>-</td>
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<tr>
<td>Feedstocks Supply and Logistics</td>
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<td>20,000</td>
<td>6,000</td>
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<td>NREL Site-Wide Facility Support</td>
<td>6,900</td>
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<td>0</td>
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<tr>
<td>Total, Bioenergy Technologies</td>
<td>225,000</td>
<td>205,000</td>
<td>56,500</td>
<td>90,000</td>
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*Dollars in thousands
Bioenergy Technologies ($56.6 million) Priorities:

- **Advanced Algal Systems**: Multi-lab consortium to develop promising algae strains to improve algae strain productivity and yield

- **Feedstocks and Supply Logistics**: Improve the quality and consistency of bioenergy feedstocks with a specific emphasis on Feedstock-Conversion Interface R&D to improve downstream conversion efficiency.

- **Conversion**: Synthetic biology of engineered organisms and development of novel catalysts to improve yields and selectivity of renewable chemicals and drop-in biofuels

- **Advanced Development and Optimization**: Co-Optimization of Fuels and Engines to develop bio-based fuels/additives that enable 15-20% fuel economy gain when blended with petroleum and used in high-efficiency engines

- **Strategic Analysis and Sustainability**: Pathways to achieve target of $2/gge; sustainability research into strategies for increasing bioenergy production without detriment to food security, air, land, and water
THANK YOU again to all the Lead Reviewers and Steering Committee, as well as AetherQuest and BCS staff.