BIOENERGY TECHNOLOGIES OFFICE

Biomass R&D Technical Advisory Committee (TAC)
May 20, 2015

Elliott Levine
TAC Designated Federal Officer (DFO)
DOE Updates
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- Bioenergy Technologies Office (BETO) Announcements and Updates, Upcoming Events, Publications
- DOE Program Offices with Biomass Related Activities
- Other DOE Offices: Loan Programs Office, Vehicle Technologies Office, Office of Science, and ARPA-E Updates
- References and Useful Links
## Agenda at a Glance: Day 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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<tbody>
<tr>
<td>8:00 a.m. – 8:30 a.m.</td>
<td>Breakfast  <em>(to be provided for Committee)</em></td>
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<tr>
<td>8:30 a.m. – 9:00 a.m.</td>
<td>Welcome and Introduction of New Members</td>
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<td>9:00 a.m. – 9:15 a.m.</td>
<td>Opening Remarks: Cathie Woteki, Under Secretary, Research, Education, and Economics, USDA</td>
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<td>9:15 a.m. – 9:30 a.m.</td>
<td>Presentation: Committee Business for 2015</td>
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<td>Elliott Levine, DFO, U.S. Department of Energy</td>
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<td>9:30 a.m. – 10:00 a.m.</td>
<td>Presentation: U.S. DOE Updates</td>
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<td>Elliott Levine, Bioenergy Technologies Office, U.S. Department of Energy</td>
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<td>10:00 a.m. – 10:15 a.m.</td>
<td>Break</td>
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<td>10:15 a.m. – 10:45 a.m.</td>
<td>Presentation: USDA Update on Biomass R&amp;D Activities</td>
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<td>Todd Campbell, U.S. Department of Agriculture</td>
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<td>Marlen Eve, U.S. Department of Agriculture</td>
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<tr>
<td>10:45 a.m. – 11:00 a.m.</td>
<td>Presentation: Biomass Research and Development Initiative (BRDI) Solicitation and Update</td>
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<td>Daniel Cassidy, NIFA, U.S. Department of Agriculture</td>
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<td>11:00 a.m. – 12:00 p.m.</td>
<td>Panel: Manufacturing Innovation</td>
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<td>Todd Campbell, U.S. Department of Agriculture</td>
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<td>Mike Molnar, Advanced Manufacturing Program Office, NIST</td>
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<td>Mark Shuart, Advanced Manufacturing Office, DOE</td>
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<td>Robbie Barbero, Biological Innovation Office Science and Technology Policy</td>
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<td>12:00 p.m. – 1:00 p.m.</td>
<td>Lunch  <em>(to be provided for Committee)</em> <em>(Ethics Briefing)</em></td>
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<td>1:00 p.m. – 2:30 p.m.</td>
<td>Panel: International Biomass Activities</td>
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<td>Harry S. Baumes, U.S. Department of Agriculture</td>
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<td>Paul Niznik, Strata Advisors, A Hart Energy Company</td>
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<td>Laura Scandurra, Office of Global Analysis, USDA</td>
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<td>Leticia Phillips, UNICA- Brazilian Sugarcane Industry Association</td>
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<td>2:30 p.m. – 3:00 p.m.</td>
<td>Break</td>
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<td>3:00 p.m. – 5:00 p.m.</td>
<td>Panel: Biomass Research and Development Working Groups 2015 Activities and Priorities</td>
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<td>Alison Goss Eng, Bioenergy Technologies Office, U.S. Department of Energy</td>
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<td>5:00 p.m. – 5:15 p.m.</td>
<td>Public Comment:</td>
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<td>Aviva Glaser, National Wildlife Federation</td>
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<td>Andrew Miller, Policy Fellow, Biomass Thermal Energy Council (BTEC)</td>
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Agenda at a Glance: Days 2-3

Day 2: Technical Advisory Committee Meeting May 21, 2015

8:00 a.m. – 8:30 a.m. 
Breakfast (to be provided for Committee)

8:30 a.m. – 10:00 a.m. 
Discussion: 2015 Key Committee Topic Areas and Breakout Instructions
Committee Co-Chairs

10:00 a.m. – 12:00 p.m. 
Subcommittee Breakouts: (closed session)

12:00 p.m. – 1:00 p.m. 
Lunch (to be provided for Committee)

1:00 p.m. – 5:00 p.m. 
Subcommittee Breakouts: (closed session)

Day 3: Technical Advisory Committee Meeting May 22, 2015

8:00 a.m. – 8:30 a.m. 
Breakfast (to be provided for Committee)

8:30 a.m. – 10:15 a.m. 
Subcommittee Report Outs:

10:15 a.m. – 11:00 a.m. 
Discussion: Next Steps of Key Topic Areas for 2015
Committee Co-Chairs

11:00 a.m. – 11:30 a.m. 
Discussion: 2015 Site Visit Options

11:30 a.m. – 11:45 a.m. 
Public Comment:
Michele Jalbert, Corinne Young LLC
Susan P. Rupp, Enviroscape Ecological Consulting
David Waechter, Biomass Check Off

11:45 a.m. – 12:00 p.m. 
Discussion: Meeting Close
Committee Co-Chairs

12:00 p.m. – 1:00 p.m. 
Lunch (to be provided for Committee)
## TAC 2015 Work Timeline

<table>
<thead>
<tr>
<th>Date</th>
<th>Committee Objectives</th>
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<tr>
<td><strong>Q1 2015</strong></td>
<td>• Receive presentation on the interactions between the Biomass Board, Operation Committees, and Interagency Working Groups.</td>
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<tr>
<td>March 5, 2015</td>
<td>Webinar</td>
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<td><strong>Q2 2015</strong></td>
<td>• TAC will consider all inputs and list and rank topics for the TAC to consider.</td>
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<td>May 20-22, 2015</td>
<td>• Agree on TAC 2015 topic areas.</td>
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<td><em>(2 ½ day meeting)</em></td>
<td>• Adjust the TAC sub-committee structures (if necessary) to best address one or more topics per future meeting.</td>
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<td><strong>Q3 2015</strong></td>
<td>• Work in Subcommittees to develop recommendations on agreed upon topic areas.</td>
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<tr>
<td>Week of August 24th</td>
<td>• Possible site visit.</td>
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<tr>
<td><strong>Q4 2015</strong></td>
<td>• Finalize and vote on 2015 recommendations.</td>
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<tr>
<td>Week of November 16th</td>
<td><em>(1 ½ day meeting)</em></td>
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TAC Q2 Meeting Inputs and Outputs

Inputs

- 2014 Recommendations, parking lot items.
- Committee questions from Q1 meeting.
- Leverage working group related subjects.

Outputs / Deliverables

- Identify key problems to address with recommendations.
- Identify information gaps.
- Frame beginning of problem statements and possible recommendations.
- Review and prioritize list of possible topics.
Federal Partnerships

- The Bioenergy Technologies Office works directly within the Department of Energy and with other cabinet agencies on a number of high-level initiatives.
- By coordinating efforts across agencies, our Office can tap into others’ expertise, leverage existing initiatives in the Federal government, and stay informed on the latest innovations in the field.
- BETO works diligently to ensure steady collaboration across the entire supply chain – bringing together experts in the field to solve the major challenges facing the industry today.
### Summary of Federal Agency Roles across the Biomass-to-Bioenergy Supply Chain (from BETO MYPP, March 2015)

#### Table 1-2: Summary of Federal Agency Roles across the Biomass-to-Bioenergy Supply Chain

<table>
<thead>
<tr>
<th>Federal Agency</th>
<th>Feedstock Production</th>
<th>Feedstock Logistics</th>
<th>Biomass Conversion</th>
<th>Demonstration</th>
<th>Biofuels Distribution</th>
<th>Biofuels End Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Energy</td>
<td>- Plant and algal science&lt;br&gt;- Genetics and breeding&lt;br&gt;- Feedstock resource assessment&lt;br&gt;- Sustainable land, crop, and forestry management&lt;br&gt;- Algal feedstock cultivation and production systems.</td>
<td>- Sustainable logistics systems, including harvesting, handling, storage, &amp; preprocessing systems&lt;br&gt;- Testing logistics systems at demonstration scale.</td>
<td>- Biochemical conversion, (pre-treatment/enzyme cost reductions)&lt;br&gt;- Recalcitrance of all biomass resources&lt;br&gt;- Thermochemical conversion to increase yield of hydrocarbons to fuel blendsstocks and energy (crystallization and pyrolysis).</td>
<td>- Cost-shared projects and/or loan guarantees to bioeconomies to demonstrate and deploy integrated conversion processes at pilot, demonstration, and pioneer scale.</td>
<td>- Flexible, compatible, sustainable, and cost-effective biofuels&lt;br&gt;- Transportation/distribution systems development&lt;br&gt;- Material compatibility&lt;br&gt;- Alternative fuel dispensing infrastructure.</td>
<td>- Engine compatibility and optimization&lt;br&gt;- Vehicle emissions testing&lt;br&gt;- Bioproduct testing for market acceptance&lt;br&gt;- Education to improve awareness of positive impacts of biofuels.</td>
</tr>
<tr>
<td>Department of Agriculture</td>
<td>- Sustainable land, crop, and forestry management&lt;br&gt;- Plant science&lt;br&gt;- Genetics and breeding&lt;br&gt;- Planting/establishment payments to biomass crop producers.</td>
<td>- Sustainable harvesting of biomass crop and forest residue removal&lt;br&gt;- Equipment systems related to planting.</td>
<td>- Biochemical conversion, (pre-treatment/enzyme cost reductions)&lt;br&gt;- Recalcitrance of forest resources&lt;br&gt;- Thermochemical conversion to fuels and power&lt;br&gt;- On-farm biofuels systems.</td>
<td>- Loan guarantees to viable biomass-based facilities and grants to demonstration-scale facilities&lt;br&gt;- Payments to existing bioeconomies to retrofit power sources to be renewable&lt;br&gt;- Producers to support and expand production of advanced biofuels refined from sources other than corn starch.</td>
<td>- Loan guarantees and grants to support (1) safe and sustainable biofuel transportation/distribution&lt;br&gt;(2) Refineries &amp; blending facilities development&lt;br&gt;(3) Flex-fuel pumps installation&lt;br&gt;(4) Financing of transportation/distribution industry businesses.</td>
<td>- Market awareness and education for end users on advantages of increased biofuels use.</td>
</tr>
<tr>
<td>Environmental Protection Agency</td>
<td>- Effects of feedstock production systems, including effects on ecosystem services (water quality, quantity, biodiversity, etc.)&lt;br&gt;- Assessment of bioenergy crop impacts.</td>
<td>- Biochar to water, soil, and waste retention&lt;br&gt;- Characterization of air, water, and waste emissions&lt;br&gt;- Regulations/permitting&lt;br&gt;- TSCE review of intergenerically engineered microbes used for biomass conversion&lt;br&gt;- Testing protocols and performance verification.</td>
<td>- Health/environmental impacts of biofuels supply chain life cycle&lt;br&gt;- Characterization of air, water, and waste emissions; regulations/permitting&lt;br&gt;- Policy and research on waste-to-energy&lt;br&gt;- Testing protocols and performance verification&lt;br&gt;- Market impact of biofuels production.</td>
<td>- Permitting, air emission characterization&lt;br&gt;- Regulation of underground storage tanks&lt;br&gt;- Emergency management and remediation of biofuel spills.</td>
<td>- Materials reliability for storage containers, pipelines, and fuel delivery systems.</td>
<td>- Engine optimization/certification&lt;br&gt;- Characterization of vehicle emissions and air quality, and environmental and public health impacts&lt;br&gt;- Regulation of air emissions&lt;br&gt;- Market awareness/impact of biofuels on public health, ambient air, and vehicles.</td>
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<tr>
<td>Department of Commerce/National Institute for Standards and Technology</td>
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<td>- Catalyst design, biocatalytic processing, biomass characterization, and standardization&lt;br&gt;- Standards development, measurement, and modelling.</td>
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## Summary of Federal Agency Roles across the Biomass-to-Bioenergy Supply Chain (from BETO MYPP, March 2015) – Cont’d

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<td>Department of Transportation</td>
<td>Feedstock transport infrastructure development.</td>
<td>• Feedstock transport infrastructure development.</td>
<td>• Techno-economic analysis of processes that convert biomass to jet fuel.</td>
<td>• Builds relationships, share and collect data, identify resources, and direct research, development and deployment of alternative jet fuels by supporting Commercial Aviation Alternative Fuels Initiative.</td>
<td>• Safe, adequate, cost-effective biofuels transportation/distribution systems development.</td>
<td>• Promotion of safe and efficient transportation while improving safety, economic competitiveness, and environmental sustainability.</td>
</tr>
<tr>
<td>Federal Aviation Administration</td>
<td>• Plant genetics, algal science, and other paths to improve biofuels feedstocks and wastes as energy sources.</td>
<td>• Basic research on modifications or processes to improve feedstock preprocessing.</td>
<td>• Basic and applied research on catalysts, processes, characterization for biochemical and thermochemical conversion technologies Life-cycle analysis Environmental impact amelioration.</td>
<td>Supportive R&amp;D on health/environmental impacts of biofuels and bioproducts.</td>
<td>• Safe, adequate, compatible, cost-effective biofuels transportation/distribution system.</td>
<td>• Working toward certification of bio-derived jet fuels in coordination with the American Society for Testing and Materials with the entire aviation supply chain.</td>
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<tr>
<td>National Science Foundation</td>
<td>• Forest management.</td>
<td>• Forest management/fire prevention (recovery of forest thinnings).</td>
<td>• Bioenergy permitting on Department of Interior-managed lands.</td>
<td>• Through Defense Production Act, support biorefineries to demonstrate and deploy integrated conversion at commercial scale.</td>
<td>• Safe, compatible, cost-effective biofuels transportation/distribution systems developed for military use.</td>
<td>• Biofuels testing Standard reference materials, data, and specifications for biofuels.</td>
</tr>
<tr>
<td>Department of the Interior</td>
<td>Basic R&amp;D on feedstock processing (municipal solid waste/waste biomass).</td>
<td>• Solid waste gasification • Applied algal and cellulosic feedstock conversion R&amp;D • Partner in Defense Production Act.</td>
<td>• Through Defense Production Act, support biorefineries to demonstrate and deploy integrated conversion at commercial scale.</td>
<td>• Safe, compatible, cost-effective biofuels transportation/distribution systems developed for military use.</td>
<td>• Biofuels testing Standard reference materials, data, and specifications for biofuels.</td>
<td>• Biorefinery use in military vehicles/crafts.</td>
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BETO Announcements and Updates
Biomass Research & Development Initiative (BRDI)

BRDI FOA was released on February 26, 2015

- USDA-NIFA-9008-004957 (full solicitation information is available on Grants.gov)
- This opportunity addresses USDA and DOE programmatic objectives, administrative roles, and areas of interest in implementing Biomass Research and Development Initiative grants.
  - USDA anticipates awarding grants and DOE anticipates awarding Cooperative Agreements under this FOA
  - Anticipated funding level: $8.7M (USDA: $5.7M, DOE: $3.0M)
  - Awards range: $500K – 2.0M
- Concept Papers were requested to address one of three technical topic areas:
  1. Feedstocks Development
  2. Biofuels and Biobased Products Development
  3. Biofuels and Biobased Products Development Analysis
- Concept Papers were due: 03/27/2015 – 379 received
- Full Application due date: 7/27/2015, 5:00 p.m. EST
**Targeted Algal Biofuels and Bioproducts Funding Opportunity**

- **Goal:** The [Targeted Algal Biofuels and Bioproducts (TABB) FOA](#) seeks to reduce the cost of algal biofuels from $7 per gallon – the current projected state of technology for 2019 – to less than $5 per gallon algal biofuel by 2019.

- **Topics:** The FOA selection process will identify projects in two topic areas:
  1. Multi-disciplinary consortia that bring together upstream and downstream expertise to develop algae cultures that produce **valuable bioproduct precursors, and fuel components**, to increase the overall value of the biomass; and
  2. Single investigator or small team technology development projects focused on developing **algae culture protection and CO₂ uptake improvement** technologies to increase yields.

- **Topic 1 consortia award size of $5M to $10M (1-3 awards)**
- **Topic 2 project award size of $500K to $1M (3-7 awards)**
- **20% Cost Share is required.**
- **Up to 4 year project durations** (to accommodate multiple growing seasons), with external validations and Stage Gate reviews.

- **Status:**
  - Closed December 19, 2014
  - Awards anticipated in June 2015

Photo credits FSU and NREL
Landscape Design FOA

Landscape Design Funding Opportunity Announcement (FOA)

• Released on October 20, 2014.
• DOE announced up to $14 million to support landscape design approaches that maintain or enhance the environmental and socio-economic sustainability of cellulosic bioenergy.
  – Examples might include growing energy crops on marginal lands to improve both agricultural productivity and water quality, or utilizing agricultural residue in a way that enhances both profitability and soil quality.
• Previous DOE projects have shown the potential for improved sustainability by strategically placing bioenergy feedstock production within a landscape.
• Applications were submitted on January 26, 2015.
• Evaluation of applications is currently underway.
• Expected date for EERE Selection Notifications: June 18, 2015.
Analyzing biofuel pathways to quantify progress towards reducing lifecycle greenhouse gases, regulated emissions, and fossil energy use.

Developing strategies and tools for producing biomass feedstocks while maintaining or enhancing soil quality.

Advancing landscape design approaches that increase biomass production while maintaining or enhancing ecosystem services and food, feed, and fiber production.

Assessing the water resource use and water quality of bioenergy production, and investigating opportunities for bioenergy crops to improve water quality.

Investigating relationships between bioenergy crops and biodiversity, and engaging with diverse experts to understand and promote practices that conserve wildlife and biodiversity.

Efforts also include evaluating sustainability indicators across the bioenergy supply chain, contributing to global scientific dialogues on bioenergy sustainability, and engaging with international organizations to understand and promote more sustainable outcomes.
Workshop: Bioenergy with Carbon Capture & Sequestration (BECCS)

- **Monday, May 18, 2015, Washington, DC**
  Sponsored by Office of Fossil Energy (FE) and BETO
- Workshop focused on carbon-negative power systems and the use of biomass in power generation to achieve lower greenhouse gas emissions.
- BETO and FE are seeking inputs from experts in bioenergy, power generation, and algae from industry, academia, non-profit organizations, government, and national laboratories.
- Workshop incorporated discussion sessions to facilitate future research and development.
- Results from these discussion sessions will be compiled into a workshop report.
- Workshop report will be used to assist:
  - DOE leadership in identifying opportunities for technology development and deployment in the power industry, and
  - FE and BETO in strategic planning for future joint program activities.
May 27, 2015
12:30 PM to 1:30 PM EDT

http://www.energy.gov/eere/bioenergy/events/webinar-changing-market-biofuels-and-bioproducts

• Discussion topics will include:
  – Results of the BETO-funded report, the U.S. Billion-Ton Update, and how this and other research efforts are helping to enhance a secure and sustainable annual supply of biomass for the U.S. bioeconomy.
  – Oil price forecasts and their impact on the bioeconomy.
Waste-to-Energy (WTE) Updates and Upcoming Events

- WTE priority areas currently identified include the need to manage variable feedstocks, assess spatially resolved resources; improve microbial consortia for processing biosolids and other waste streams; and determine opportunities to improve biosolids treatment.

- In FY 2016, the WTE portion of the Conversion Technologies Subprogram will initiate projects to address these R&D targets.

**Workshop Series (BETO-WETT collaboration)**

- March 2015 (joint with Fuel Cell Technology Office): Anaerobic Membrane Bioreactors, Microbial Electrochemical Cells, and combinations thereof to produce hydrogen and higher hydrocarbons from wastewaters.
  - Report available on BETO/FCTO websites.
- June 22-24, 2015: Bioenergy 2015, with sessions on Renewable Gaseous Fuels and Beyond Biogas: Challenges for Wet Waste-to-Energy.
Peer Review 2015 Highlights

- Held during March 23-27, 2015 Hilton Mark Center Alexandria, Virginia
- 380 Attendees, $400M in reviewed projects
- Presentations now available online at:
  http://www.energy.gov/eere/bioenergy/2015-project-peer-review

- "The use of grants have been necessary to reduce the project capital investment; has provided project credibility which has acted as an attractant for private investment; and have provided a path for demonstrating technology proof of concept and market viability which is necessary for private industry to invest in future projects."

- "The biggest strengths of the portfolio were the actual construction of facilities which were preparing to produce significant quantities of advanced biofuels."

- "BETO should continue to fund IBR projects in the pilot, demo, and commercial stage with a larger number of pilot-scale, with fewer demonstration plants and even fewer commercial plants. All of these are important."
Bioeconomy Update

• An initiative to sustainably reaching the full potential of biomass-derived products to expand the nation’s economy, while providing energy security, economic, environmental, and social benefits.
  – Develop and provide innovative ways to expand the sustainable use of the nation’s abundant biomass resources for biofuels, bioproducts, and biopower.

• Interagency collaboration continues among DOE, USDA, EPA, DOT, NSF, and other agencies for strategy development and formulation of a Bioeconomy initiative.
  – Federal Strategy Workshop held May 4-6, 2015, Washington, DC
  – Stakeholder Engagement
    – Workshops and Strategy Development

• By involving other agencies and stakeholders, as a collaborative effort, the initiative will strengthen the current federal commitment and coordination by leveraging existing resources across federal agencies.
  – Future public workshops are being planned for inputs from stakeholders.
Potential Impact of a Billion Ton Bioeconomy

A BILLION DRY TONS OF BIOMASS
HAS THE POTENTIAL TO PRODUCE

1.5 MILLION JOBS
and keep about $200 BILLION dollars in the U.S. every year.

92 BILLION kWh of electricity to power 8 MILLION households.

60 BILLION gallons of biofuels displacing almost 30% of all transportation fuels.

50 BILLION POUNDS of biobased chemicals and bio-products, replacing a significant portion of the chemical market.

reductions of CO₂ emissions by 500 MILLION TONES a year.

Projection based on the 2011 Billion Ton Study Report

Steps to Building the Bioeconomy

1. Accelerate research & technology development
2. Develop production, conversion and distribution infrastructure
3. Deploy technology
4. Create markets and delivery methods
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
BETO Strategic Planning

• **Continuous process**

• **Provides framework**
  - Alignment with EERE/DOE/Federal goals
  - Interactions with stakeholders
  - Inter- and intra-office collaborations/discussions across technology areas
  - Alignment of Office activities from project level to multi-year goal horizons

• **Purpose**
  - Align objectives and activities across multiple stakeholders and interests
  - Document goals, current state of technology, and strategic plans
  - Inform budget processes
  - Track progress
  - Integrate learning

• **Based on best practices for technology R&D planning and systems engineering**
BETO Multi-Year Program Plan (MYPP)

- Updated version of the BETO’s Multi-Year Program Plan was released in March 2015.
  - Includes assessment of additional pathways.
- A new version of the Update to the Billion-Ton Study is under-development.
Bioenergy 2015: Opportunities in a Changing Energy Landscape

• Washington Convention Center, Washington, DC
• This year’s event, co-hosted with the Clean Energy Research and Education Foundation (CEREF), will highlight the opportunities and challenges in our dynamic energy ecosystem.
• Discuss issues critical to the continued growth and success of the bioeconomy such as changing oil prices, the Renewable Fuel Standard, algae-based biofuels, sustainability, innovative technologies, and the bioenergy market.
• Bioenergy 2015 will be an opportune time to network with your peers and others in the bioenergy community.
LPO has three open Title XVII solicitations*: (1) Advanced Fossil Energy Projects, (2) Renewable Energy and Efficient Energy Projects, and (3) Advanced Nuclear Energy Projects. LPO is proposing guidance that would clarify eligibility issues that have arisen as LPO has responded to questions and reviewed applications under the open Title XVII solicitations. The eligibility issues, as applied to areas for BETO interest, are as follows:

- **Mixed-Feedstock Inputs**: LPO has received applications for projects that use multiple feedstocks, such as a mix of biomass and fossil fuels. Currently, there is no guidance to direct applicants to the appropriate solicitation based on the feedstock inputs of the project.

- **Chemical or Other End-Product Outputs**: In addition to applications for projects that would produce electricity or fuels, LPO has received applications for projects, under both the Advanced Fossil Energy solicitation and the Renewable Energy solicitation that would produce chemicals or other end-product outputs. Title XVII does not provide guidance on what output from an eligible project is acceptable.

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**Bioenergy related eligible project areas include:**

**Drop-in Biofuels:**
- New bio-refineries that produce gasoline, diesel fuel, and/or jet fuel;
- Bio-crude refining processes; and
- Modifications to existing ethanol facilities to gasoline, diesel fuel, and/or jet fuel.

**Waste-to-Energy:**
- Methane from landfills or ranches via biodigesters to heat and power;
- Municipal solid waste to electricity;
- Crop waste to fuel and/or energy and bioproducts; and
- Forestry waste to fuel and/or energy potentially via cofiring.

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Vehicle Technologies Office (VTO)

Optima: co-optimization of fuels and engines

- The nation requires new low carbon fuels and advanced engines that are co-optimized—designed in tandem to work for maximum performance and carbon efficiency.
- The Optima initiative will accelerate the widespread deployment of significantly improved fuels and vehicles (passenger to light truck to heavy-duty commercial vehicles) by 2030.
- Optima goals include:
  - Develop new fuels and vehicles with higher performance that can be produced affordably, sustainably, and at scale.
  - Identify and mitigate barriers to wide-scale deployment of new fuels and vehicles.
  - Through a coordinated DOE and national lab effort, maximize value to widest range of stakeholders.
- **Upcoming Workshop:** Stakeholders Listening Day, June 16-17, 2015, Golden, CO
The Challenge: 80% reduction in transportation GHG emissions by 2050

Status
- Optima included in President’s FY16 budget at $27M ($17M VTO + $10M BETO)
- Selected as lead Transportation “Big Idea” candidate from April 2015 Big Idea Summit.

Next Steps
- Stakeholder outreach (“Listening Day”)
- Visits to auto-, energy-companies and biofuel companies ongoing since December.
- Coordinate with complementary efforts (e.g., U.S. DRIVE)
- Develop detailed R&D plans.
Office of Science - Recent Biofuels Related Activities

Office of Biological & Environmental Research (BER)

Current Funding Opportunity Announcements (FOAs):

• Systems Biology Research to Advance Sustainable Bioenergy Crop Development
  – DOE Genomic Science Program FOA DE-FOA-0001207.
  – Systems biology research on biomass crops related to stress resilience/adaptation, resource use efficiency, and response to environmental variables.
  – Genome-enabled research on interactions between plants, microbial communities, and soil ecosystems relevant to sustainable biomass production.

• USDA/DOE Plant Feedstock Genomics for Bioenergy (Joint FOA)
  – Genomics-based research on biomass plant traits related to plant response to pathogens, with a long-term focus on crop improvement.

Reports and Strategic Planning Documents:

• DOE Genomic Science Program: 2014 Strategic Plan Update
  http://genomicscience.energy.gov/strategicplan/index.shtml

• Lignocellulosic Biomass for Advanced Biofuels & Bioproducts: 2014 Workshop Report
  http://genomicscience.energy.gov/biofuels/lignocellulose/index.shtml
Office of Science - Recent Biofuels Related Activities (1 of 2)

Office of Basic Energy Sciences (BES)
Chemical Sciences, Geosciences and Biosciences Division

The BES Biosciences programs, Photosynthetic Systems and Physical Biosciences, support basic research on the physical, chemical and molecular mechanisms that plants and microbes use for energy capture, conversion and storage.

– Preapplications and Proposals are solicited through the Office of Science Annual FOA.
  • This FOA is the annual, broad, open solicitation that covers all of the research areas in the Office of Science and is open throughout the Fiscal Year (until September 30, 2015).
– The goal of BES Biosciences is to provide a basic understanding of the biological and biochemical processes that can provide foundational knowledge related to DOE’s mission to efficiently capture and utilize solar energy and to convert renewable resources into fuels, chemicals and other energy-enriched products.
– Example Biosciences research areas:
  • Light Harvesting in Natural Systems, Photon Capture and Transfer
  • Charge Separation, Electron Transfer, Redox Reactions
  • Carbon Fixation, RuBisCO and Calvin-Benson Cycle
  • Processes and Mechanisms of Energy Capture and Conversion
  • Carbon Storage in Organic Molecules
  • Metabolism in Relation to Energy Storage and Use
  • Application of Physical Science Tools to Address Structure/Function and Mechanistic Studies
  • Active Site Protein Chemistry, Redox Reactions
  • Regulation of Energy-Relevant Biological Reactions
  • Biochemistry and Biophysics of Cell Architecture including Cell Wall
  • Biosynthesis, Structure, and Self-Organizing Processes
  • Assembly and Maintenance of Energy Transduction Systems
Basic Energy Sciences Annual Open Funding Opportunity Announcement.

http://science.energy.gov/bes/funding-opportunities/

For information on all projects that are funded in BES:


http://science.energy.gov/bes/research/

For information on the biosciences-focused programs in BES, Photosynthetic Systems and Physical Biosciences:

http://science.energy.gov/bes/csgb/research-areas/photosynthetic-systems/
http://science.energy.gov/bes/csgb/research-areas/physical-biosciences/

Open Recompetition of the Energy Frontier Research Center program resulted in 32 awards for FY 2014; 5 centers related to biosciences.

http://science.energy.gov/bes/efrc/

– Catalysis Center for Energy Innovation (CCEI); Dionisios Vlachos, University of Delaware
– Center for Direct Catalytic Conversion of Biomass to Biofuels (C3Bio); Maureen McCann, Purdue University
– Photosynthetic Antenna Research Center (PARC); Robert Blankenship, Washington University in St. Louis
– Center for Biological Electron Transfer and Catalysis (BETCy); John Peters, Montana State University
– Center for Lignocellulose Structure and Formation (CLSF); Daniel Cosgrove, Pennsylvania State University
Advanced Research Projects Agency-Energy (ARPA-E) builds programs with ambitious performance metrics in mind so that the technologies developed will truly be techno-economically viable in the marketplace.
## ARPA-E Developed Programs for Highly Efficient Bioconversion Processes for Fuels and More

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Status</th>
<th>Summary</th>
<th>Program Director</th>
<th>SETA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrofuels [Status: All projects have closed]</strong></td>
<td></td>
<td>Targets the development of new chemoautotrophic biocatalysts for the production of fuels from inorganic energy feedstocks. The program successfully developed and demonstrated the production of fuel molecules from $\text{H}_2/\text{CO}_2$, HCOOH, and direct current/CO$_2$ via engineered microorganisms and new bioprocesses. ARPA-E has identified ancillary technical challenges beyond microbial engineering that need to be addressed for techno-economic viability.</td>
<td>Ramon Gonzalez (<a href="mailto:ramon.gonzalez@hq.doe.gov">ramon.gonzalez@hq.doe.gov</a>)</td>
<td>Chad Haynes (<a href="mailto:chad.haynes@hq.doe.gov">chad.haynes@hq.doe.gov</a>)</td>
</tr>
<tr>
<td><strong>REMOTE, Reducing Emissions using Methanotrophic Organisms for Transportation Energy [Status: 15 projects under active program management]</strong></td>
<td></td>
<td>Targets the development of new methane bioconversion technologies for small scale, low CapEx gas-to-liquids (GTL) processing. Current GTL state-of-technology is challenged by high CapEx and technologically-complex processes. Bioconversion of methane is a viable option for GTL if technologies addressing energy efficient, carbon yield, and kinetics are developed with attention to cost. The program objectives aim to develop new, more efficient biological routes to activate methane, engineer metabolic pathways to convert activated methane to liquid fuel with high energy density, and develop process intensification for methane bioconversion.</td>
<td>Ramon Gonzalez (<a href="mailto:ramon.gonzalez@hq.doe.gov">ramon.gonzalez@hq.doe.gov</a>)</td>
<td>Chad Haynes (<a href="mailto:chad.haynes@hq.doe.gov">chad.haynes@hq.doe.gov</a>)</td>
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</tbody>
</table>
ARPA-E Developed Programs for New Biofuel Feedstocks

**PETRO: Plants Engineered to Replace Oil**  [Status: 12 projects active]

Targets the production of fuel molecules, such as oils and hydrocarbons, directly in the plant feedstock through metabolic engineering.

The program successfully generated a variety of crop feedstocks that accumulate at least 1% of the fuel molecule by DW, and has demonstrated a number of promising plants in small scale field trials. In parallel, multiple traits have been observed to increase photosynthetic efficiency. PETRO has also applied novel agronomic approaches to increase yields of the bioenergy crops under development.

Program Director: Jonathan Burbaum (jonathan.burbaum@hq.doe.gov)
SETA: David Lee (david.lee2@hq.doe.gov)

**TERRA: Transportation Energy Resources from Renewable Agriculture**  [Status: Applications under review]

Targets the development of (1) high throughput field sensing platforms for bioenergy crops and (2) analytic tools to mine the phenotyping data from the field and correlate phenotypes with genetic loci.

The program is currently reviewing full applications, and expects to award approximately $30M of funding in May, 2015.

Program Director: Joe Cornelius (joe.cornelius@hq.doe.gov)
SETA: David Lee (david.lee2@hq.doe.gov)
PETRO Program Technical Advancement

PETRO projects have observed very promising technical results, but need to identify new funding or deployment opportunities now.

<table>
<thead>
<tr>
<th>Research Stage</th>
<th>Deployment Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synthetic carbon fixation pathways.</td>
<td>Cold tolerant sugarcane, and oil producing cane.</td>
</tr>
<tr>
<td>Plant metabolic flux modeling.</td>
<td>Terpene production in tobacco and high density production in the field.</td>
</tr>
<tr>
<td>Photorespiratory channeling to increase specific metabolite yields in crop plants.</td>
<td>Young pine trees over accumulating terpenes with efficient tapping methods.</td>
</tr>
<tr>
<td>Increased photosynthetic activity through altered light harvesting antenna complex.</td>
<td>Camelina with improved oil content for fuel use and terpene accumulation, and phenomic chambers capable of predicting field performance.</td>
</tr>
<tr>
<td>Producing carboxysomes in plant cells to enhance photosynthesis.</td>
<td>Traits to increase carbon flux to terpene and lipid production, stress tolerance, accelerate flowering, seed yield, and biomass production.</td>
</tr>
</tbody>
</table>
References and Useful Links

References:
2. Bioenergy KDF https://www.bioenergykdf.net/
4. Bioenergy KDF YouTube http://www.youtube.com/user/BioenergyKDFChannel
7. Committee Resources Library http://www.biomassboard.gov/committee/committee.html
9. I-75 Clean Fuels Corridor http://www.cleanfuelscorridor.com

Useful Links:
1. BETO Web page http://www.energy.gov/eere/bioenergy/bioenergy-technologies-office
2. BETO's Meetings Web page http://www.energy.gov/eere/bioenergy/meetings
3. BETO News and Announcements http://www.energy.gov/eere/bioenergy/listings/bioenergy-news
5. The Targeted Algal Biofuels and Bioproducts (TABB) FOA https://eere-exchange.energy.gov/
7. ARPA-E TERRA funding opportunity announcement
9. DOE/EERE, Sustainable Transportation Office Web page http://www.energy.gov/eere/transportation
10. ARPA-E Web page http://arpa-e.energy.gov/