Biomass Research and Development

Technical Advisory Committee

November 14–15, 2012

Meeting Summary

Table of Contents

TABLE OF CONTENTS I
LIST OF ACRONYMS II
I. PURPOSE 1
II. INTRODUCTION AND WELCOME TO NEW COMMITTEE MEMBERS 1
III. DOE UPDATES ON BIOMASS R&D ACTIVITIES 1
IV. U.S. DEPARTMENT OF AGRICULTURE UPDATE 3
VII. BRDI UPDATE 4
V. 2012 BIOMASS RESEARCH AND DEVELOPMENT TECHNICAL ADVISORY COMMITTEE RECOMMENDATIONS 5
VI. USDA/DOE PROJECT UPDATES 6
VII. DEVELOP RECOMMENDATION PRESENTATION TO PRESENT TO THE BOARD 8
VIII. UPDATE ON JOINT DPA INITIATIVE 8
IX. PUBLIC COMMENT 9
X. CLOSING COMMENTS 15
ATTACHMENT A: COMMITTEE MEMBER ATTENDANCE – NOVEMBER 14-15, 2012, MEETING. A-1
ATTACHMENT B: AGENDA – NOVEMBER 14–15, 2012, MEETING B-1
APPENDIX C: 2012 RECOMMENDATIONS C-1

List of Acronyms

ADM – Archer Daniels Midland Company
BCAP – Biomass Crop Assistance Program
Biomass Act – Biomass R&D Act of 2000
Board – Biomass Research and Development Board
BRDI – Biomass Research and Development Initiative
Committee – Biomass Research and Development Technical Advisory Committee
Council – Forestry Research Advisory Council
DoD – Department of Defense
DOE – U.S. Department of Energy
DPA – Defense Production Act
EPA – Environmental Protection Agency
FOA – Funding Opportunity Announcement
GGF – Great Green Fleet
JGI – Joint Genome Institute
MOU – Memorandum of Understanding
NIFA – National Institute for Food and Agriculture
R&D – Research and Development
REAP – Rural Energy for America Program
RFI – Request for Information
RFS – Renewable Fuel Standard
SBIR – Small Business Innovated Research
USDA – U.S. Department of Agriculture
VW – Volkswagen

I. Purpose

On November 14 -15, 2012, the Biomass Research and Development Technical Advisory Committee (Committee) held its fourth quarterly meeting of 2012. The purpose of the meeting was to finalize and approve the Committee's 2012 recommendations. In addition, the Committee received updates on the recent activities of the U.S. Department of Energy (DOE) and U.S. Department of Agriculture (USDA). DOE representatives delivered presentations about the Biomass Program, and USDA representatives delivered presentations about current Agency activities, as well as the Biomass Research and Development Initiative (BRDI). Researchers from DOE and USDA funded projects provided updates on their research and the DOE, USDA, and Navy gave an update on the Defense Production Act (DPA) Initiative. Finally, the committee received public comments *from Corinne Young LLC., Myriant Corporation,* and *Karouna Consulting.*

See Attachment A for a list of meeting attendees. See Attachment B to review the meeting agenda. Meeting presentations can be viewed on the BRDI website: http://biomassboard.gov/committee/meetings.html.

Background: The Committee was established by the Biomass R&D Act of 2000 (Biomass Act), which was repealed and replaced by Section 9008 of the Food, Conservation, and Energy Act of 2008. The Biomass R&D Board (Board) was established under the same legislation to coordinate activities across federal agencies. The Committee is tasked with advising the Secretary of Energy and the Secretary of Agriculture on the direction of biomass R&D.

II. Introduction and Welcome to New Committee Members

Kevin Kephart, Committee Member

The Committee Co-Chairs, Steve Briggs and Ronnie Musgrove, were unable to attend the meeting. Kevin Kephart was asked to chiar the fourth quarter meeting. Kevin welcomed the Committee members in attendance and thanked the outgiong members whose terms' expried. Departing members include:

Bob Ames	Solazyme Inc.
William Berg	Dairyland Power
Mary McBride	CoBank
Steve Briggs	Section of Cell and Developmental Biology, UCSD (Co-Chair)
Bruce Dale	Michigan State University
Jennifer Holmgren	LanzaTech
Joseph Ecker	Salk Institute for Biological Studies

III. DOE Updates on Biomass R&D Activities

Elliott Levine, Designated Federal Officer, U.S. Department of Energy Biomass Program

Elliott Levine provided an overview on Committee business and DOE's Biomass Program activities. Mr. Levine proposed tentative dates for 2013 Committee Meetings. The following dates were proposed:

- Q1: February 25 - March 1, 2013
- Q2: May 20 - 24, 2013
- Q3: August 12 - 16, 2013
- Q4: November 18 - 22, 2013

Mr. Levine provided the Committee with a few announcements. They include:

- On November 7, 2012, the Biomass Program released a Request for Information (RFI) to invite public comment on the *Biomass Densification Workshop Report: Transforming Biomass to Feedstocks.* Comments are due November 21, 2012.
- On October 31, 2012, the Program released an RFI to invite public comment on the *Conversion Technologies for Advanced Biofuels (CTAB) Roadmap.* Proposals are due November 19, 2012.
- On December 5, 2012, from 1:00 - 2:30 p.m. EST, the Program will hold an International Webinar detailing some of the Program's international collaborations.
- Biomass Program 2013 Project Peer Review will be held at the Renaissance Arlington Capital View Hotel from April 8 - 12, 2013.
- Planning for the Biomass Program Peer Review and Biomass 2013 is currently underway for a combined three-day event in Washington, D.C., to occur in the July/August timeframe.
- The Biomass Program is developing a new "pathways" effort to identify the technologies that will enable the development of hydrocarbon fuels to meet national needs for aviation, heavy vehicle, and light vehicle transportation fuels.
- The Department of Energy recently announced up to $3.5 million for Iowa State University, collaborating with Catchlight Energy, LLC a 50/50 joint venture of Chevron Corporation and Weyerhaeuser NR Company.
- On August 15, 2012, awards for up to $15 million were announced to support production of stable bio-oils from lignocellulosic and algal biomass sources for blending within petroleum refineries to produce fungible transportation fuels with a renewable component.
- On August 15, 2012, DOE announced awards of up to $14 million to support outdoor phototrophic algae R&D. This research will support the Biomass Program's goals to model pathways for significant (>1 billion gallons per year) volumes of cost-competitive algal biofuels by 2022.
- On October 18, 2012, DOE announced awards for up to $2.5 million for applied research to advance clean biomass cookstove technologies for use in developing countries. The funding will support the development of innovative cookstove designs that allow users to burn wood or crop residues more efficiently and with less smoke than open fires and traditional stoves.
- Current OBP awards that are under review:
    - Up to $20 million to support production of hydrocarbon fuels (jet, diesel) at pilot- or demonstration-scale facilities that meet military blend specifications. Award announcement targeted for November - December 2012.

- Up to $12 million to support research on new techniques to enable the development of biological systems to produce advanced biofuels and bioproducts. Award announcement targeted for November - December 2012.

Mr. Levine included updates on the DOE's Office of Science, which include:

- Joint DOE-USDA Plant Feedstock Genomics for Bioenergy (DE-FOA-0000770). *FOA release anticipated November, 2012*
- DOE Joint Genome Institute (JGI): Emerging Technologies Opportunities Program. *Posted 10/4/0212; pre-proposals DUE December 15, 2012*
- *Planned Solicitations*
  - Genomic Sciences Program
  - DOE Systems Biology Knowledgebase
- *Reports released*
  - DOE - Joint Genome Institute (JGI) Strategic Planning Workshop (May 2012) http://genomicscience.energy.gov/userfacilities/jgi/futuredirections/index.shtml
  - JGI Strategic Plan http://www.jgi.doe.gov/whoweare/10-Year-JGI-Strategic-Vision.pdf

IV. U.S. Department of Agriculture Update

Todd Campbell, Rural Development, U.S. Department of Agriculture

Todd Campbell updated the Committee on various topics including the Farm Bill, Farm Bill Section 9000's Updates, Energy Website 2.0, and the Sixth Regional Biofuels System Award. The Rural Energy for America Program (REAP) added 14 additional biomass projects awarded in October bringing the total FY2012 projects to 35. The Biorefinery Assistance Program has 9 active projects with a total of $771 million in Guaranteed Loans, and the Biomass Crop Assistance Program has 11 approved project areas in 188 counties. Both programs need reauthorization in the Farm Bill for additional funds in the programs. The BioPrefered program needs additional appropriation to continue implemented. As of October 1, 2012, the 800 USDA Certified Biobased Products are still valid.

Next year's enhancements for the mapping feature of the Renewable Energy Website will include additional data and information, beyond transportation, such as: land use for producing biomass and energy crops; cost to produce alternative crops; competition for biomass; fueling stations; state and federal policy; USDA guidelines for financial assistance; and state and federal office locations for agriculture, energy, environmental protection, and conservation.

The Sixth Regional Biofuels Systems Award will be led by Dr. Richard from Penn State and include more than 20 university and industry partners that will address crop genetic development; harvesting, storage, and processing techniques; and sustainable production systems. It will also develop sustainable production practices to improve yield by 25% reduce costs by 20%; and enable private-sector partners to produce advanced ready-to-use liquid transportation and aviation biofuels. The goal will be to provide support to generate at least 100 supply contracts and support more than 50 new supply chain businesses to harvest, transport and preprocess biomass.

Steve Long stated that according to the last census, land use has dropped 10% and asked for clarification on the USDA Energy website land-use data. Mr. Campbell stated that this is the first year data has been collected for purpose grown dedicated energy crops. The crop acres data is derived from production data.

VII. BRDI Update

Daniel Cassidy, Senior Advisor - Renewable Energy and Natural Resources, Office of the Chief Scientist*, U.S. Department of Agriculture*
Neil Rossmeissl, Biomass Program, US Department of Energy

Daniel Cassidy provided an update of the BRDI portfolio. In FY 2012, of the $40 million that was authorized to USDA, $25 million was made available. DOE contributed $10 million. DOE's Office of Biomass and Golden Field Office administered pre-application process. USDA's, National Institute for Food and Agriculture (NIFA) administered the invited full application process. The FY 2012 solicitation was announced March 2012. A total of 178 pre-applications were reviewed. Of them, 42 were invited for full applications. NIFA made 4 awards prior to September 30, but they have not yet been publically announced. Mr. Cassidy provided a history of the Initiative objectives. In FY 2009, BRDI solicitations required only Technical Area (C) Analysis. In FY 2010, BRDI required the integration of all three technical areas, which was continued in FY 2011 and FY 2012. The new requirements for BRDI solicitations increased the number of awards that focus on adding value to current agriculture production, in addition to industrial processes. Also, projects with multiple value–added products have a greater likelihood of success. Mr. Cassidy provided a review of technical area investment and geographical project trends and discussed the analysis of program performance being developed form Congress. USDA has conducted site visits to 19 USDA–funded projects from FY 2005 to FY 2009. These site visits include 2 - 3 subject matter experts per site visit, primarily from academia, as well as USDA-ARS and NSF. The report will be included in the Secretaries' annual report to Congress.

David Bransby asked about the merit review process for the BRDI proposals. Mr. Cassidy stated that it is made clear that the pre-proposal review will be managed by DOE and the full proposal review will be managed by UDSA. The DOE pre-proposal review only determines if there is enough merit to proceed to the full proposal effort. There is no technical ranking of pre-proposals. The full proposal review is a scientific review. Mr. Cassidy stated that for consistency in the joint review process they look to keep the reviewers constant on both steps and use the same review criteria.

David Bransby also asked if BRDI has an emphasis on BioPower proposals. Mr. Cassidy said there are other UDSA and DOE solicitations that focus on transportation goals, but BRDI does accept BioPower proposals for review. Currently no BioPower proposal has been selected by the merit review process. Mr. Bransby asked if this due to the fact that BioPower is a known process and should funding be directed at new research in this area. Mr. Cassidy reminded the Committee that BRDI also allows for demonstration proposals. Mr. Campbell asked the committee to consider if there are new research needs related to BioPower or if new technologies are already developed, is there a need to demonstrate them to move them to commercialization.

The Committee then reviewed the Initiative Legislation to determine if BioPower is clearly within the scope of the Initiative. It was determined that BioPower is included as an acceptable byproduct if it is derived in connection with the conversion of biomass to fuel.

Neil Rossmeissl provided some historical perspective on the Initiative. He provided the example of the Integrated Biorefinery projects where many companies did not understand the complexities of the projects. The 2002 IBR awards that DOE funded were made under BRDI and amounted to over $45 million in funding. These projects had to address a fully integrated approach in these awards. Therefore, the BRDI adopted the integrated approach to address these complexities for all future solicitations. Mr. Rossmeissl provided the DOE's perspective on BRDI. DOE funding for BRDI is appropriated, not mandatory like USDA. DOE operates on a 2-year funding planning process. DOE uses BRDI projects to identify innovative projects that are not part of the current budget process. This gives them the ability to look beyond what is currently being done today. In FY 2011, only one project was funded by DOE due to the level of our appropriations. In FY 2012, DOE is operating under a Budget Continuing Resolution, which means we are not allowed to make any awards until a budget is approved. DOE is looking to BRDI to fund more pilot scale projects for drop-in fuels, similar to the awards we made in 2002.

Kevin Kephart asked Mr. Rossmeissl about BioPower. Mr. Rossmeissl stated that two IBR projects are using co-generation to make their revenue projections for the loans or loan guarantees. There are two others using waste to offset 60% of the power needs to make their fuel production processes more cost competitive. They are looking at the full cost and life cycle to benefit the process.

Joseph James asked if there is any direct R&D support for electric generation from biomass. Mr. Rossmeissl stated that DOE asked for a BioPower program in one of its budget cycles. A recent Cofiring report—currently in draft—indicated that electricity production costs would increase through large-scale cofiring. As a consequence, the Program elected not to pursue Biopower activities for the foreseeable future.

V. 2012 Biomass Research and Development Technical Advisory Committee Recommendations

After the opening presentations and agency updates, the Committee focused on the primary objective of the fourth Committee meeting—to discuss, refine, and approve all of the subcommittee recommendations. After reviewing each recommendation, the full committee voted to approve the recommendations. The approved recommendations can be found in Appendix C.

VI. USDA/DOE Project Updates

Harrison Dillon, President and Chief Technology Officer, Solazyme
Kristi Snell, Director, Plant Sciences, Metabolix
Lowell Rasmussen, University of Minnesota

Harrison Dillon from Solazyme gave the first project update. Solazyme was awarded a DOE Integrated Biorefinery project titled, *Solazyme Integrated Biorefinery (SzIBR); Diesel Fuels from Heterotrophic Algae* in 2010. The project objective is to build, operate, and optimize a pilot-scale "Solazyme Integrated Biorefinery." SzIBR is demonstrating the integrated scale-up of Solazyme's novel heterotrophic algal oil biomanufacturing process, validating the projected commercial-scale economics of producing renewable oils for multiple applications including production of advanced biofuels, and enabling Solazyme to collect the data necessary to complete design of its first commercial-scale facility. The total project cost is shared 80:20 between the Department of Energy and Solazyme; the total government cost share of the project is $21,765,738. The project has created or preserved approximately 52 jobs per year directly and 103 jobs per year indirectly. The project is in three phases. Phase I was the engineering design, procurement, planning and construction of the SzIBR and extended from commencement of the project through Q3 of 2012. Here all equipment was installed and operated in integrated process. The first crude algal oil was produced from the SzIBR in June 2012. Phase II, which is currently underway, consists of algal oil manufacturing. Phase II includes procurement of domestically sourced sugarcane-derived feedstocks; procurement of cellulosic-derived feedstocks and operation of the SzIBR; and production of algal oil. Phase III of the project will involve fuel production and is planned for Q4 2013 – Q1 2014. In Phase III, the company will work with a refining partner to convert algal oil from SzIBR into drop-in transportation fuel.

John Tao asked about the economics of **lignocellulosic** as a feedstock. Dr. Dillon stated that Solazyme's economics work with existing feedstocks**, and that lignocellulosic** feedstocks are not yet market ready. Solazyme has not identified a source at the cost and volume needed to meet their current demand. They will have to find partners to provide **lignocellulosic** feedstocks at large volumes that are priced competitively with existing feedstocks.

Jim Seiber asked if Solazyme received any other federal R&D funds for the project. Dr. Dillon stated their first grant was a Small Business Innovated Research (SBIR) project. Their first sizable funds came from the NIST-ATP program. They have not received any BRDI or USDA funding.

Due to the discussions that DoD should not allow the purchase of any fuel over the price of conventional fuel, Neal Murphy asked where Dr. Dillon expected Solazyme price of fuel to be in Q1 2014. Dr. Dillon stated that with existing feedstocks Solazyme will be cost competitive with conventional fuels at fit for purpose fuel-scale plants, and that Solazyme makes higher value grades of oil than petroleum.

Huey-Min Hwang asked about heterotrophic vs. autotrophic production processes. Dr. Dillon stated that early in Solazyme's history the methods the company employed were to grow algae in ponds.

Solazyme feels that this is not an economically viable technology to manufacture commodity cost structure materials due to many factors, including contamination and evaporation issues.

Steve Long asked what makes producing ethanol in Brazil and other countries attractive. Dr. Dillon explained that Brazil has plenty of sugar cane as a feedstock. It is also a stable democracy that has good intellectual property protection which makes it very stable for business. However, Dr. Dillon stated that Solazyme has just partnered with Archer Daniels Midland Company (ADM) to begin producing oil in ADM's Clinton, Iowa facility.

John Tao asked about Solazyme's partnership with Volkswagen (VW). Dr. Dillon stated that VW is using a 100% renewable diesel engine. Their fuel has been used in road vehicles manufactured by VW, BMW, Mercedes and Jeep. They have found that emissions from their fuel are cleaner than petroleum based fuels. Mr. Tao asked if Solazyme is only interested in the fuels industry. Dr. Dillon stated that in addition to fuels, Solazyme has a chemicals division, a food division and a skin & personal care division, and these divisions have partnered with companies such as Dow, Unilever, Roquette, Sephora, QVC, Bunge and ADM.

Kevin Kephart asked how the partnership with federal research program has worked for Solazyme. Dr. Dillon stated that working with the federal program has gone very well. Solazyme has had to make adjustments to their project plans and the DOE has worked with Solazyme to make the adjustments.

Kristi Snell from Metabolix provided the second project update on *Renewable Enhanced Feedstocks for Advanced Biofuels and Bioproducts (REFABB*) to produce chemicals directly from PHB biomass crops. This project was a BRDI project award. The project has two tasks. Task A focused on core plant science activities for producing high levels of PHB in switchgrass. This includes developing C4 crop model system; increasing carbon flow to PHB in C4 model system; increasing carbon flow to PHB in switchgrass; developing novel gene containment technology in switchgrass; and increasing transgene expression via alternative plastid transformation strategies. In previous studies on the production of PHB in tobacco using plastid transformation, Metabolix achieved up to 18% dry weight in leaf samples and 8.8% in whole tobacco plants. Task B focused on developing and validating key process technologies for an integrated biorefinery through developing and optimizing torrefaction process and crotonic acid recovery; and developing a catalyst technology to convert crotonic acid to commodity chemicals.

Joe James asked if the **herbaceous** biomass had ash and chlorine issues. Ms. Snell stated that they are aware of these potential issues and are collecting data on chlorine. The switchgrass expertise they have is in house at Metabolix.

Lowell Rasmussen, University of Minnesota provided the third project update on *Biomass Gasification: A Comprehensive Demonstration of a Community Scale Biomass Energy System*, another BRDI award. Mr. Rasmussen provided the Committee an overview of the University of Minnesota, Morris commitment to sustainability. They first performed a strategic asset allocation to understanding how the natural resources in the region could provide a roadmap to carbon management. The solution was a combined heat and power system with biomass feedstock along with two wind turbines. He then described the challenges the university faced to implement such a project including limited technology suppliers and

lack of internal experience. The university has contracted with a local farmer who supplies corncobs to the University. This gives the university a cost-effective feedstock and allowed the farmer to generate revenue with minimal impact to his systems.

Todd Werpy asked if there are any additional research needs that would benefit this project. Mr. Rasmussen stated that no preprocessing with the feedstock cobs. If preprocessing was necessary it would not be as cost effective with regards to natural gas. Torrefaction and pyrolysis are needed at the front end to provide a consistent input.

VII. Develop Recommendation Presentation to Present to the Board

The Committee took some time during the meeting to review the approved recommendations and provide direction on who the presentation to the Biomass Board should be structured. The Committee identified key messages to presentation to the Board and identified which recommendations were strategic go the Initiative or tactical for Biomass R&D in general.

VIII. Update on Joint Defense Production Act (DPA) Initiative

Zia Haq, Biomass Program, U.S. Department of Energy
Harry Baumes, U.S. Department of Agriculture
Chris Tindal, U.S. Navy

Zia Haq gave an update on the DOE activities related to the Joint DPA Initiative. DOE released an Innovative Pilot/Demonstration Funding Opportunity Announcment (FOA) with the objective to produce hydrocarbon fuels at pilot- or demonstration-scale facilities that meet military specifications for JP-5 (jet fuel primarily for the Navy), JP-8 (jet fuel primarily for the Air Force), or F-76 (diesel). Two topic areas listed in the FOA include: (1) Algal biofuels production (micro, macro, cyanobacteria, heterotrophic), and (2) technologies that utilize other renewable and waste feedstocks. These topic areas support the Navy/DOE/USDA MOU by funding technologies that are ready for pilot/demonstration-scale testing. Projects will allow DOE, developers, and investors to obtain accurate data on cost of production. The scale DOE is looking for is 1 to 50 dry tons/day biomass feedstock input to produce 3,500 to 400,000 gallons/year of hydrocarbon fuels. The target audence for the FOA is private industry, national laboratories, and universities.

DOE has allocated $20 million in FY 2012 (of which $10 million will be for algae technologies) and reqeusted $20 million in FY 2013. Industry cost share requirement would be minimum 1:1. The FOA will allow funding of new pilot/demonstration-scale facility construction and operation; retrofit of existing pilot/demonstration-scale facilities and operation; and operation of existing pilot/demonstration-scale facilities. Eligible feedstocks include:

- Lignocellulosic biomass (agricultural residues, forestry residues, urban wood waste/mill residues, organic fraction of separated municipal solid waste, energy crops)
- Algae (micro, macro, cyanobacteria, heterotrophic)
- Systems making use of carbon dioxide from any source including fossil sources (e.g. flue gas to cyanobacteria to fuel or products)

Harry Baumes gave an update on the USDA activites. Mr. Baumes stated that UDSA is involved in all aspects of the DPA intitiave including criteria development, proposal submission reviews, and industry day. USDA funds up to $170 million will support the reduction of the cost of feedstocks.

Todd Werpy asked if existing feedstocks were eligible in the solicitation. Mr. Baumes stated they were only if they included a transition plan to cellulosic.

Chris Tindal, Director for Operational Energy, Deputy Assistant Secretary of the Navy for Energy provided an update on the Great Green Fleet (GGF) demonstration exercise and the Defense Production Act (DPA) initiative for the Navy. The GGF conduced 1,800 hours of shipboard gas turbine operation and included 240 flight hours. Four ship-to-ship refueling at sea (RAS) evolutions and one air-to-air refueling were conducted. No operational differences noted related to logistics infrastructure and ship power plants and aircraft. In fact, filters operated more efficiently due to fewer impurities in the fuel.

The DPA Title III Office issued a FOA in June 2012. Phase 1 Finalists were notified in the Fall 2012 and awards are to be made in early 2013. Phase 2 proposals and negotiations are expected to occur in FY 2014. The planned first fuel delivered from this DPA effort will be in 2015-2016.

IX. Public Comment

Corinne Young, Corinne Young LLC.

FOSTER JOBS, INNOVATION ECONOMY THROUGH

RENEWABLE CHEMICALS, BIOBASED MANUFACTURING

PUBLIC COMMENTS SUBMITTED TO THE BIOMASS TECHNICAL ADVISORY COMMITTEE

CORINNE YOUNG LLC

NOVEMBER 14, 2012

PUBLIC BENEFIT

Drive new jobs and innovation-based economy forward for cross-sector return on investment (ROI) in every region. Ensure BioEconomy Takes Root here, grows sustainable, advanced manufacturing to feed global demand for renewable chemicals, biopolymers and advanced materials. Ensures U.S. competitiveness in low carbon, global economy to help reverse trade deficit in chemicals and plastics sector. Specifically:

- Stem significant job loss in the plastics and chemicals industry, gird 100,000 jobs already supported by the bioproducts industry, create over 200,000 new homegrown, clean tech manufacturing jobs in 5 – 10 years;[1]
- Usher advanced manufacturing, through green chemistry technology that reduces waste, emissions, energy and water consumption;[2]
- Enable U.S. companies to capture $190 billion of the $1 trillion global renewable chemical market production.[3]
- Spur $2 trillion in capex investment to meet potential 20% of global biopolymer demand;
- Lessen reliance on foreign oil as chemical feedstock;
- Green chemical manufacturing, deploy replacements for chemicals of concern (such as replacements for phthalates, suspected endocrine system disruptors);
- Provide cost advantaged, higher performing products to improve our quality of life;
- Combat climate change with technologies that significantly reduce greenhouse gas (GHG) emissions and lower carbon footprint of multiple products by a total of 1.0-2.5 billion tones of carbon dioxide equivalent by 2030.[4]
- Support sustainable value chains, including better end-of-life options with cradle-to-cradle compostability or recycling.

HISTORIC OPPORTUNITY, TRANSFORM CHEMICALS INDUSTRY FOR SUSTAINABLE, NEW ECONOMY, GLOBAL COMPETITIVENESS

---

[1] See: http://www.stabenow.senate.gov/?p=press_release&id=820, Senator Stabenow press release, Agriculture Chairwoman Kicks Off Jobs of the Future Tour, August 6, 2012.

Biobased Chemicals and Products: A New Driver, Biotechnology Industrial Organization (BIO), 2010.

[2] See: http://www.peri.umass.edu/fileadmin/pdf/other_publication_types/green_economics/Green_Chemistry_Report_FINAL.pdf,
The Economic Benefits of a green Chemical Industry in the United States, Renewing Manufacturing Jobs While Protecting Health and the Environment, Heintz and Pollin, Political Economy Research Institute (PERI), University of Massachusetts, Amherst, Commissioned by the BlueGreen Alliance, 2011.
See: http://www.epa.gov/gcc/, EPA's Green Chemistry Program.

[3] BIO report, 2010.

[4] *IndustrIal Biotechnology More than green fuel in a dirty economy? Exploring the transformational potential of industrial biotechnology on the way to a green economy,* Bang, Foller and Buttazzoni, World Wildlife Fund Denmark, September 2009.

Producing Bio-Based Bulk Chemicals Using Industrial Biotechnology Saves Energy and Combats Climate Change, Herman, Blok, and Patel, Science, Technology & Society, Utrecht University, Heidelberglann, 2007.

Renewable chemistry and biobased manufacturing stand poised to meet the White House's Advanced Manufacturing Initiative and BioEconomy Blueprint, to grow jobs and support sustainable, advanced manufacturing that includes "biotechnology, nanotechnology and advanced materials."

Since the 1940's the petrochemicals industry created multiple sector, aggregate economic growth. However, U.S. chemicals employment is down 20% in the last two decades. Between 1997-2003, the U.S. trade balance in chemicals plummeted from a $20 billion surplus to a $10 billion deficit.[5] These downward economic trends – coupled with technological breakthroughs in green chemistry – spurred the USDA, DOE, EPA and leading analysts to identify opportunities to substitute existing petrochemical-derived products with biobased chemicals.[6] They saw the analogous impact the green chemicals industry would have in the U.S., while at the same time address a growing global demand for safer, less toxic chemicals, products, and manufacturing.

Green chemicals (advanced materials made from industrial biotechnology) transform household and industrial products into energy efficient, foreign oil displacing, renewably sourced, economy stimulators. Petrochemical, (oil derived) formulations are the material basis for most of the things we touch every day. The U.S. chemicals industry is central to our national economy, with businesses dependent on the chemical industry accounting for approximately one quarter of the U.S. GDP, or $3.6 trillion.[7] With green chemistry innovation, *Renewable chemicals* (plant derived) have distinct advantages and are made from renewable resources in non-hazardous industrial agricultural processes, like fermentation or Nobel Prize winning metathesis technology. The products they create are biodegradable plastics, plant based polymers, environmentally benign solvents, renewably sourced auto parts, natural cosmetic ingredients, and compostable carpets. These innovative, biobased products are finding their way into a wide variety of sectors in our economy, creating jobs along the value chain from field to ubiquitous household and vital industrial applications.

During an August "Jobs of the Futures Tour" with Senate Agriculture Committee Chairwoman Stabenow, Secretary Vilsack stated, "The biobased products sector brings together two of the most important economic engines for rural America: agriculture and manufacturing. Today, more than 3,000 companies are producing more than 25,000 biobased products made from renewable sources grown here at home, and supporting 100,000 American jobs. These companies are developing a wide variety of products - from cleaners and paints to parts for automobiles. Using agricultural products grown by farmers right here in the Midwest, Michigan has the potential to lead the nation in bio-based manufacturing and create sustainable economic opportunities for the entire region."

Moreover, the opportunity before us is not just about rural America or the biobased economy. It is an historic opportunity to transform the chemical industry, drive the innovation economy, and foster sustainable, advanced manufacturing for cross-sector ROI in every region.

---

[5] BIO report, 2010.

[6] *Top Value Added Chemicals from Biomass Volume 1 – Results of Screening for Potential Candidates from Sugars and Synthesis Gas*, Department of Energy, 2004.

[7] BlueGreen Alliance PERI report, 2011.

The BlueGreen Alliance asserts implementing federal policies such as tax incentives, grant that spur investment in sustainable chemistry, and scale up public support for technological innovation are key to revitalizing the chemical industry and providing macro-economic benefits in every region, "Development of this sector could help sustain U.S. manufacturing into the 21st century while preventing the further erosion of good quality jobs…Moreover, the shift towards alternative approaches to chemical manufacturing will reduce toxic releases, lower health risks, decrease reliance on non-renewable resources, and improve our quality of life without compromising economic performance."

For communities and states across the country, the micro benefit, direct jobs, and infusion of vital revenue into local economies from biorefineries are substantial. Stemming from a single production facility alone, the local economic and job creation impacts are significant lifelines to floundering economies: scores of direct jobs with a $50K a year average salary; over $3.6 million of municipal tax revenue; over $2 million state tax revenue; $95 million of initial spending within the region and annual regional spending of over $30 million. However, unless specific federal incentives appear, the infrastructure projects, jobs growth and manufacturing increases will not develop. The industry is simply too capital intensive in the initial stages to take root and ***there are no stand-alone renewable chemical incentives to date. Meanwhile, other countries are offering significant incentives to lure this sought after renewable industry abroad.***

TIME URGENT: 3 POLICY ACTIONS TO FOSTER JOBS, ADVANCED MANUFACTURING

For the industry to take off here in the U.S. rather than abroad, it needs a federal overlay of three pragmatic and consensus-derived incentives: access to existing grant programs using existing programmatic authority, Senate-passed Farm Bill language that opens ξ9003 loan guarantees, and enactment of a modest $500 million Renewable Chemical Production Tax Credit.

Without Agency support on the following incentives, the U.S. could lose this nascent but fast moving economic engine overseas, along with the hundreds of thousands of projected new jobs, and $190 billion of the $1 trillion renewable chemical market production.[8]

1. **Low hanging fruit – direct existing grant programs and USDA Loan Guarantee Programs, consistent with the White House's April 2012 BioEconomy Blueprint & July 2012 Advanced Manufacturing Initiative**[9]:

- Department of Energy:
  - *Biomass Program* – funding to date prioritized biofuels over biochemicals,

[8] BIO report, 2010.

[9] *Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing, Executive Office of the President,* President's Council of Advisors on Science & Technology Policy, July 2012, www.whitehouse.gov/the-press-office/2012/07/17/fact-sheet-white-house-advanced-manufacturing-initiatives-drive-innovati.
The National BioEconomy Blueprint, The White House, April 2012, www.whitehouse.gov/sites/default/files/microsites/ostp/bioeconomy_fact_sheet_april_26_2012_0.pdf

- *Advanced Manufacturing Office* – first funding round awarded to petrochemical incumbents and Advanced Manufacturing Partnership Steering Committee entities, excluded renewable chemical projects,
- *Advanced Research Project Agency-Energy, ARPA-E* – traditionally funds energy generation, transmission, and efficiency technologies; several renewable chemical proposals pending decision for open funding opportunity to be announced in September.

- US Department of Agriculture:
  - *Biomass Research & Development Initiative* – funding to date has prioritized feedstock development, biofuels and biopower, time to prioritize higher value biochemicals and products,
  - *National Institute of Food and Agriculture, Critical Agriculture Materials (NIFA-CAM)* – program scope targets high value bioproducts, funding should be increased above annual $1 million,
  - *Business & Industry (B&I) Loan Guarantee Program* – help fill gaps in project finance by providing up to $25 million as high priority projects,
  - *Open REAP Guarantees* – recognize the biorefinery as energy efficient technology platform, with aggregate total benefits surpassing installation of 1 unit operation.

- Department of Commerce
  - *National Institute of Standards & technology (NIST)* – funnel portion of new Advanced Manufacturing Initiative funding to industry private sector R&D projects to accelerate deployment, not just regional innovation hubs.

2. **Farm Bill – preserve in conference deliberations, Senate Farm Bill, Energy Title IX, ξ9003 "Grow it Here, Make it Here" bi partisan language in S 3240** – The Ag Reform, Food and Jobs Act of 2012 – that opens ξ9003 Biorefinery Assistance Program (BAP) Loan Guarantees to renewable chemicals and biobased manufacturing facilities, as defined in the Senate-passed bill:

- ξ**9001. Renewable Chemical:** The term `renewable chemical' means a monomer, polymer, plastic, formulated product, or chemical substance produced from renewable biomass.

- ξ**9003. Biobased Product Manufacturing:** The term `biobased product manufacturing' means development, construction, and retrofitting of technologically new commercial-scale processing and manufacturing equipment and required facilities that will be used to convert renewable chemicals and other biobased outputs of biorefineries into end-user products on a commercial scale.

3. **Tax incentive – champion bi partisan introduced legislation, establishing renewable chemical production tax credits:**

- HR 4953 – Qualifying Renewable Chemical Production Tax Credit Act of 2012 – introduced by Congressmen Pascrell (D-NJ) & Bilbray (R-CA), and Senate companion S 3491 – introduced by Senator Stabenow.

- Modest score of only $500 million for five-year capped program that pulls through manufacturing & production along value chain, to downstream partners.

- Framework based on 48(C) model:
  - Amends the Internal Revenue Code to allow a business-related tax credit for the production of renewable chemicals. Defines "renewable chemical" as any chemical that is: (1) produced in the United States from renewable biomass; (2) sold or used by the taxpayer as polymers, plastics, or formulated products or for the production of polymers, plastics, or formulated products; and (3) not sold or used for the production of any food, feed, or fuel.
  - Directs the Secretary of Agriculture to establish a five-year program to allocate credit amounts. Limits the total amount of allocable credits under such program to $500 million, with a $25 million limit to any taxpayer in any taxable year.
  - Requires production and sale of qualifying renewable chemical, thus spurs capex investment and advanced manufacturing.

- Needed to level playing field for US to compete against sovereign nations luring this industry abroad, such as S.E. Asian countries providing 10-year tax holidays.

Amy Miranda, Myriant Corporation

Ms. Miranda introduced herself as Manager of Communications and Government Affairs at Myriant but explained she once worked at the Department of Energy's Biomass Program, was the Bioconversion Lead, and is familiar with the Committee. Ms. Miranda explained that Myriant is headquarter out of Boston, Massachusetts and is working with sorghum and sugar as a feedstock to develop organic acids for end-users. This work is being conducted at their biorefinery located in the Port of Lake Providence, Louisiana. Ms. Miranda offered to update the Committee on their progress at a future meeting. Ms. Miranda also offered some suggestions for the Committee to consider. First she stated that the integrated proposal approach incorporated by the BRDI solicitation process was difficult to address given the timeframe given to develop a proposal. Second she suggested that if BRDI solicitations were to address specific topics per year they would be more manageable.

Kir George Karouna, President, Karouna Consulting

Mr. Karouna asked the Committee about the use of waste from orchards and supermarkets and potential feedstock sources and if any studies have been conducted to measure the amount of potential feedstock that goes to waste. Mr. Campbell from USDA stated that USDA has an Organic Recycling project that is working with the citrus industry to supply feedstock for an anerobic digester.

X. Closing Comments

Meeting was adjourned.

Attachment A: Committee Member Attendance – November 14 -15, 2012, Meeting

Co- Chairs	Affiliation	Attended?
Steve Briggs	University of California	No
Ronnie Musgrove	Former Governor, MS	No

Members	Affiliation	Attended?
Bob Ames	Solazyme	No
Dean Benjamin	NewPage Corporation	Yes
William Berg	Dairyland Power	No
David Bransby	Auburn University	Yes
Pamela Reilly	Contag Cygnet Biofuels	Yes
Bruce Dale	Michigan State University	No
Harrison Dillon	Solazyme	Yes
Joseph Ecker	Salk Institute for Biological Studies	No
Neal Gutterson	Mendel Biotechnology	No
Jennifer Holmgren	LanzaTech Limited	No
Huey-Min Hwang	Jackson State University	Yes
Joseph James	Agri-Tech Producers, LLC	Yes
Coleman Jones	General Motors	No
Kevin Kephart	South Dakota State University	Yes
Craig Kvien	University of Georgia	Yes
Jay Levenstein	FL Dept. of Ag. and Consumer Services	Yes
Stephen Long	University of Illinois	Yes
David Nothmann	Battelle	No
Mary McBride	CoBank	Yes
Maureen McCann	Purdue University	Yes
Bruce McCarl	Texas A&M	Yes
Neil Murphy	State University of New York,	Yes
Jimmie Powell	The Nature Conservancy	No
William Provine	Dupont	No
James Seiber	University of California	Yes
Abolghasem Shahbazi	North Carolina A&T State University	Yes
John Tao	O-Innovation Advisors LLC	Yes
Alan Weber	MARC-IV Consulting / Weber Farms	Yes
Todd Werpy	Archer Daniels Midland Company	Yes

Total: 19 of 31 members attended

Attachment B: Agenda – November 14–15, 2012, Meeting

Day 1: Technical Advisory Committee Meeting November 14, 2012

1:00 p.m. – 1:10 p.m.	Welcome
1:10 p.m. – 1:30 p.m.	Presentation: Committee Business and U.S. DOE Updates *Elliott Levine, DFO, U.S. Department of Energy*
1:30 p.m. – 1:50 p.m.	Presentation: USDA Update on Biomass R&D Activities *Todd Campbell, U.S. Department of Agriculture*
1:50 p.m. – 2:40 p.m.	Presentation: BRDI Solicitation and New Awards Update *Daniel Cassidy, U.S. Department of Agriculture* *Neil Rossmeissl, Biomass Program, U.S. Department of Energy*
2:40 p.m. – 3:00 p.m.	*Break*
3:00 p.m. – 5:00 p.m.	Presentations: Subcommittee Reports and Discussion of Recommendations
5:00 p.m. – 5:15 p.m.	Vote: FY 2012 Annual Recommendations
5:15 p.m. – 5:30 p.m.	Public Comment: *Corinne Young, Corinne Young LLC.* *Amy Miranda, Myriant Corporation*

Day 2: Technical Advisory Committee Meeting November 15, 2012

9:00 a.m. – 11:15 a.m.	Panel: USDA/DOE Key Project Updates *Harrison Dillon, President and Chief Technology Officer, Solazyme* *Kristi Snell, Director, Plant Sciences, Metabolix* *Lowell Rasmussen, University of Minnesota*
11:15 a.m. – 11:30 a.m.	*Break*
11:30 a.m. – 1:00 p.m.	*Lunch (to be provided for Committee)*
1:00 p.m. – 1:45 p.m.	Discussion: Develop recommendation presentation to present to the Board *Committee*

1:45 p.m. – 2:30 p.m.	Discussion: What are your needs for next year? *Committee*
2:30 p.m. – 2:45 p.m.	*Break*
2:45 p.m. – 3:30 p.m.	Presentation: Update on Joint DPA Initiative *Harry Baumes, U.S. Department of Agriculture* *Zia Haq, Biomass Program, U.S. Department of Energy* *Chris Tindal, U.S. Navy*
3:30 p.m. – 3:45 p.m.	Public Comment: *Kir George Karouna, President, Karouna Consulting*
3:45 p.m. – 4:15 p.m.	Closing Comments: *Departing Committee Members*
4:15 p.m.	Adjourn

Appendix C: 2012 Recommendations

The Technical Advisory Committee (Committee) for the Biomass Research and Development Act was authorized through section 9008(d) of the Food, Conservation, and Energy Act of 2008 (FCEA). The Committee has specific reporting obligations to the Biomass Research and Development Board (Board), including:

In §(d)(3)(B) – evaluate and make recommendations in writing to the Board regarding whether - -

i. funds authorized for the Initiative are distributed and used in a manner that is consistent with the objectives, purposes, and considerations of the Biomass Research and Development Initiative [§(e)(2)];
ii. solicitations are open and competitive with awards made annually;
iii. objectives and evaluation criteria of the solicitations are clearly stated and minimally prescriptive with no areas of special interest;
iv. the points of contact [§(c)(2)(A)] are funding proposals under this title that are selected on the basis of merit, as determined by an independent panel of scientific and technical peers predominantly from outside the Departments of Agriculture and Energy; and
v. activities under this title are carried out in accordance with the title.

Annual reporting obligations for the Committee are stated in §(g). In adherence to these obligations, the Committee shall issue a report on the status of funds appropriated for the Initiative, indicating that all funds are distributed and used in a manner that is consistent with the objectives and requirements of section 9008.

The Committee charter provides for forming subcommittees that can address particular matters for the Committee as a whole. The Committee currently operates with three subcommittees; Feedstocks, Conversion, and Infrastructure/Logistics.

SPECIFIC COMMITTEE REPORTING OBLIGATIONS

- Were funds distributed and used consistent with the Initiative's objectives, purposes, and considerations?

  While BRDI has met the overall objectives of the Biomass Act (Section 9008 of FCEA of 2008), and projects address the objectives and the defined technical areas, the Committee identified areas that could be improved and provided the following recommendations.

  1. Problem Statement**:** The portfolio of awards does not show clear technology progression, nor is there a link from one year to the next, or to the larger goals of the USDA or DOE programs.

     1.1 Recommendation: BRDI awards should be in support of wider USDA/DOE

Biomass goals and portfolio. Therefore, the Committee believes that the value of BRDI can be significantly enhanced by implementing a five-year technology roadmap with goals, objectives, and metrics, which follows existing USDA and DOE roadmaps.

- Were the solicitations open and competitive with awards made annually?

The solicitations were made available through Grants.gov and were announced through social media and other routine means. The joint agencies shared in the workload, with DOE's Office of the Biomass Program (OBP) leading the review process for pre-applications. This process pre-screened applications and was used to identify the most promising projects that would be invited to submit full proposals. Evaluation and selection of full proposals was led by USDA's National Institute of Food and Agriculture (NIFA).

The BRDI merit review process appears to be in line with other federal research and development (R&D) programs, as well as effective and efficient. We commend the pre-proposal process, which can avoid placing unnecessary burden on the applicant community. The following are recommendations to improve the process:

2. Problem Statement: The separation of responsibilities, with DOE-OBP handling pre-application process and USDA-NIFA handling evaluation and selection, may eliminate excellent projects based on inadequate coordination between the agencies, particularly in the pre-application process.

   2.1 Recommendation: Both pre-application and full application processes should have integrated agency oversight to support improved coordination regarding the grant review process.

- Were the objectives and evaluation criteria for each solicitation clearly stated, minimally prescriptive, and aimed toward no special interests?

The Initiative objectives were clearly presented in each solicitation and were consistent with §(e)(2). The solicitations also presented the Initiative technical areas that were consistent with §(e)(3).

The pre-application criteria in fiscal year (FY) 2009 and FY 2010 included a statement that implied a preference toward industry-academia collaborations. In FY 2011, however, consortia were specifically allowed and encouraged. Such collaborations are no longer limited to industrial and academic participants; we commend this expansion. The following are recommendations to continue improvement.

3. Problem Statement**:** BRDI solicitations are prescriptive, in terms of requiring a full systems approach including feedstock, conversion, and systems analysis components. The integrated systems approach may not address specific gaps in knowledge that we

know exist. Research is warranted in specific technical areas, as defined in the technical recommendations, in addition to an integrated approach.

3.1 Recommendation: For the next solicitation, include more specific R&D efforts. A portion of the available funds should be reserved for grants to address gaps. Consider a two-tiered approach—one at a systems level and one at a systems-component level.

4. Problem Statement**:** The time from releasing the BRDI solicitation to the deadline for proposal submission has sometimes been too short, and BRDI draft solicitations have never been made available for public comment prior to releasing the final draft, as is done by some other federal grant programs.

   4.1 Recommendation: In order to ensure high-quality proposals, adequate time should be allowed between the pre-proposal and full proposal submission deadlines. BRDI Programs should make a draft FOA available to the public to allow for comments and revisions.

   4.2 Recommendation: The application process should focus on the objectives, approach, timeline, and budget, as well as the work force, equipment, and materials available. Require only the necessary documentation for the merit review. Review regulatory paperwork after projects have been recommended by the merit review. This will make better use of the time available for both those preparing and those reviewing the grants.

- Were proposals evaluated and selected on merit by use of independent panels pre-dominantly composed of experts outside of USDA and DOE?

  Evaluation criteria and procedures were clearly presented in each solicitation and adhered to established merit review guidelines and procedures for both agencies. The Initiative conducts grant reviews through a two-phase submission process, with pre-applications serving as a screening process prior to invitations for full applications' final merit review.

  Review panels were gathered for both processes. During 2010 and 2011, a total of 107 panelists were involved, with most members having expertise in engineering, cropping systems, agronomy, and business. For the pre-application process, the percentage of reviewers coming from industry and academia was 38% and 42% in 2010 and 48% and 39% in 2011, respectively. The following are the Committee's recommendations:

5. Problem Statement**:** BRDI review and site visit panels seem to have a limited number of representatives from the private sector.

   5.1 Recommendation: Develop a larger network of reviewers and inform them of the scope/areas for review. Consider drawing reviewers from previous or current applicants or through the use of a finalist peer review system. Qualifications of

reviewers should be previously demonstrated. Reviewers should be drawn from industry, academia, government, and other groups to create a diverse pool of expertise.

6. Problem Statement**:** Ensuring merit review panels include expertise to adequately review proposed programs is essential to the success of BRDI. Abbreviated timeframes between pre-proposal submittal and review and full proposal submittal and review decreases the amount of time program managers have to invite an appropriate merit review panel.

   6.1 Recommendation: Utilize a checklist (e.g., National Science Foundation) with pre-proposals to allow BRDI managers to secure review teams with expertise matched to the program ideas being developed for full proposals.

7. Problem Statement**:** Proposal submitters should reasonably expect that rejected BRDI proposals will be improved by responding to the reviewers' comments in a later submission. While responding to comments can never guarantee approval in a later submission, it is only fair for the submitters to expect that their efforts to respond were duly noted and taken into account. Many federal funding programs make explicit provision to consider the response to reviewers' comments in a resubmitted proposal, but the BRDI does not. The credibility and value of the BRDI program, and its institutional memory, will be strengthened if this deficiency is corrected.

   7.1 Recommendation: We recommend that when a revised proposal is submitted to the BRDI, that the new reviewers be provided with a copy of the past review(s) and a two-page response prepared by the submitters, to be submitted with the proposal. This action will help the current set of reviewers be better informed and render a more useful and accurate review than if the past review and the submitters' response to that review are excluded from the decision.

INFORMATION REQUESTS

While discussing and formulating their 2012 recommendations, the Committee felt that key information was not available and would therefore like to make the following information requests:

8. Problem Statement**:** The Committee wishes to have a better understanding of the scope of projects funded by other significant federal research programs being conducted, particularly in agencies that are represented in the multi-agencies BRDI Board [§(c)].

   8.1 Recommendation: Obtain focus areas and program summaries for significant federal biomass-to-energy programs and present them in a manner similar to the BRDI program update that was provided by USDA-NIFA. This will enable the

Committee to identify both trends and gaps in funding.

9. Problem Statement**:** BRDI does not seem to have a method of evaluating the success of awards, or the results, as past awards have not been shared with the Committee.

   9.1 Recommendation: Measureable outputs of awards should be established; success of the funded technologies should be shared and reviewed by the Committee. At least some funded projects should be presented at Committee quarterly meetings, focusing on substantive challenges and milestones.

10. Problem Statement**:** The Committee needs a better understanding on how the awarded projects are meeting expectations toward commercialization of technologies and creation of new industries.

    10.1 Recommendation: Implement analysis of commercialization and technology transfer resulting from federally funded research programs. Identify what factors contributed to a project's success and allowed the technology to be replicated. Metrics should be stage-specific. In other words, which funded technologies reach development, advanced development, or commercialization? And if commercialized, at what scale?

11. Problem Statement**:** The Committee does not have a complete picture of the types of proposals submitted in the pre-application and proposal submission.

    11.1 Recommendation: Develop a check list for proposers to complete that will provide data that can be tracked. The Committee recommends that BRDI implements a tracking process similar to the one used by the National Science Foundation.

FEEDSTOCKS RECOMMENDATIONS

The Committee did not have an opportunity to review the DOE and USDA responses to the 2011 recommendations, but the Committee believes that the substance of those recommendations are still relevant and still supported by the Committee. The following are the Committee's 2012 Feedstocks recommendations:

- Feedstock Sustainability

12. Problem Statement**:** Currently, greenhouse gas (GHG) exchange data for life-cycle assessment is provided by models. Actual measurements on GHG exchange are needed for more accurate life-cycle assessments.

    12.1 Recommendation: The DOE Great Lakes Regional Center is making actual GHG exchange measurements. Building on their success, solicitations should be

issued to develop more actual GHG exchange measurements.

- Cropping Systems Optimization

13. Problem Statement**:** Although sugarcane is used extensively in Brazil for fuel ethanol production, the high value of sucrose makes this approach uneconomical in the United States. Alternative sweet crops are available (sorghum, sweet potato, sugar beets, etc.), which could be used to produce renewable fuels with modest modifications of the mature industrial corn-ethanol process.

    Ethanol from corn uses inexpensive enzymes to convert starch into glucose for fermentation by conventional yeasts. The corn ethanol industry also provides co-products that are used for food animal production such as beef, dairy, pork, and poultry. This mature process coupled with the efficiencies of corn production and public policy has allowed corn starch to serve as the low-cost feedstock for ethanol in the United States.

    Lignocellulosic biomass residues and energy crops/trees are relatively inexpensive, based on competing values for steam production or pulping. From 60% to 70% of the dry weight of these materials is carbohydrate that could be converted into sugars using enzymes and chemical treatments; a non-food non-feed material.

    Unlike starch, lignocellulose was designed by nature to resist deconstruction. Harsh chemical treatments and/or high levels of enzymes are required. Resulting processing costs have served as a barrier to offset the advantages of these inexpensive feedstocks.

    Considerable progress has been made in these cellulosic processes and several biorefineries with a cellulosic-fuel component are under construction or planned for the near future. Forestry residues, short-rotation trees, and energy fiber crops could be used to rapidly deploy such biorefineries as industrial experience matures. Additional research is needed to define regional feedstocks, best practices, harvesting, and storage.

    The fermentative conversion of sugars into fuels and commodity chemicals that compete with petroleum products can be distilled into a single focus, the production of low-cost sugars.

    13.1 Recommendation: The United States should invest in sugar-platform programs for the development of cost-effective processes and crops for the near-term expansion of fuel ethanol production (starch and sugars) and for intermediate-term expansion (lignocellulose).

i. Sugar crops for fuel and chemical production

ii. Starch crops, in addition to corn for fuel and chemical production

iii. Lignocellulosic feedstocks for fuel and chemical production.

Each sugar-platform program should have a low-cost, fermentable sugar yield as a key milestone and goal. Additional considerations should include identification of single or multiple feedstocks that can be produced locally or regionally and allow operation for at least 9 months per year.

Research should identify the best near-term crops and processes for each class of substrate, recognizing that these will often be regional.

14. Problem Statement**:** A cropping systems approach is lacking to maximize efficiency or yield of bioenergy crops.

    14.1 Recommendation: Research is needed to identify the best integrated cropping system approach maximizing land use and other inputs such as modifying growing seasons to maximize use of land, water, and other inputs throughout the entire year.

15. Problem Statement: Throughout the last 3 years, BRDI has addressed more than 15 types of feedstocks. However, limited waste feedstocks are utilized.

    15.1 Recommendation: Future BRDI solicitations should expressly recognize the eligibility of waste feedstocks such as animal waste, crop residues, municipal solid waste (MSW), and food waste.

    15.2 Recommendation: Specialty crop biomass residues should be recognized as important to overall BRDI goals, even though the availability of these residues may be relatively low. Examples include almond and walnut shells and hulls, rice hulls, cotton gin wastes, grape pomace, citrus juicing wastes, orchard prunings, etc. BRDI solicitations should encourage proposals involving specialty crop biomass residues as feedstocks, along with the higher profile residues such as sugarcane bagasse, corn stover, etc.

    15.3 Recommendation: Guidance should be provided in future solicitations on volumetric requirements for minimal feedstock availability to ensure projects economic sustainability and scalability if this is a scoring criteria for reviewers.

CONVERSION RECOMMENDATIONS

The following are the Committee's 2012 Conversion recommendations:

16. Problem Statement**:** Conversion—pre-treatment through fuel production—is a major barrier to bringing down costs.

    16.1 Recommendation: Give priority to research for pre-treatment as part of a conversion process.

17. Problem Statement**:** There is a critical gap in the existing solicitations portfolio on separations technology. Improved separations technology can significantly reduce capital and operating requirements, as well as life-cycle emissions.

    17.1 Recommendation: Conduct a review of the status of chemical and physical separations R&D for biofuel precursors with the goal of identifying gaps and opportunities in product purification (e.g., alcohol and water). R&D should focus on reducing capital expenses, operating expenses, energy intensity, etc., for separations technology.

18. Problem Statement**:** Some bioenergy grants outside BRDI programs (for example, the Defense Production Act) restrict eligibility to 'commercial-scale' projects, defined as those that use at least 700 tons per day of biomass or produce 10 million gallons per year of biofuel. This restriction could result in eliminating extremely promising and valuable technologies.

    18.1 Recommendation: The criteria designating a project as 'commercial scale' should be based on profitability and commercial impact, rather than size or production capacity. Small-scale systems can be commercially viable and still generate profits. The rationale for any minimum size requirements should be explained in the funding opportunity announcement. Biomass conversion scale-up requirements are different than those for petroleum refineries and need to be better understood.

LOGISTICS, STORAGE, HANDLING, AND INFRASTRUCTURE RECOMMENDATIONS

In support of GHG emissions reductions, the unique issues related to bioenergy and bioproducts, creating new jobs, reducing fossil fuel use, and improving rural economies, the Committee recommends:

- Research to densify and preprocess biomass to improve logistics, storage, handling, processing, and conversion performance.

19. Problem Statement**:** Biomass—the raw material for production of biofuels and bioproducts—has many serious logistical disadvantages as an industrial feedstock. Compared to fossil feedstocks, biomass is much less dense per unit of energy; is more heterogeneous; more spatially dispersed; less stable; more difficult to handle, store, and transport; more variable in year-to-year yields and chemical properties; and presents some additional safety challenges (e.g., dust explosions and spontaneous combustion). Most forms of biomass pose cost, logistical, and processing challenges. It seems very unlikely that large-scale commodity industries can be built up around biomass feedstocks until these disadvantages are overcome.

    19.1 Recommendations: To overcome these serious disadvantages with biomass, we recommend research in the following areas:

    i. Development of relatively low capital/operating cost, distributed processes that can increase the energy or physical density of biomass near where the biomass is produced. Emphasis is also needed on overcoming heterogeneity, and the removal of moisture and other problematic substances
    ii. Development of integrated land use, harvesting, handling, transport, processing, and blending methods that can improve logistics and storage stability of biomass feedstocks plus manage availability uncertainties
    iii. Development of strategies on how more distributed biomass production and processing can promote rural communities and accelerate industry emergence.

- Research to mitigate seasonality concerns and associated problems.

20. Problem Statement**:** Typically, biomass has seasonal growth and harvest patterns that impact supply, storage, and use. Bioenergy production generally requires year-round feedstock supplies—sometimes with peak demands at times very different from peak feedstock supply seasons. Storage often leads to feedstock losses, along with moisture and combustion issues. Matching seasonal supplies with year-round or seasonal demands requires the development of extensive storage, multiple feedstocks, altered harvesting practices, and various forms of preprocessing and/or densification. This can be both expensive and challenging in terms of implementation.

    20.1 Recommendation: Field–to-user systems need to be developed to accommodate seasonality.

    i. Research projects need to develop low-cost preprocessing or multi-feedstock provisions, logistics, and storage systems designed to accommodate seasonality.

ii. Develop mobile feedstock processing operations to accommodate seasonality issues, as well as unexpected changes in weather, beetle kill, etc.