Biomass Research and Development

Technical Advisory Committee

November 15–16, 2017

Meeting Summary

Table of Contents

List of Acronyms

ARS – Agricultural Research Service
BANF – Bioenergy Alliance Network of the Rockies
BETO – Bioenergy Technologies Office
BRDI – Biomass Research and Development Initiative
CAPs – Coordination Agricultural Projects
Committee – Biomass Research and Development Technical Advisory Committee
DOE – U.S. Department of Energy
FCIC – Feedstock Conversion Interface Consortium
FOA – Funding opportunity announcements
FY – fiscal year
NIFA – National Institute of Food and Agriculture
NP – National Program
R&D – research and development
USDA – U.S. Department of Agriculture

I. Purpose

On November 15–16, 2017, the Biomass Research and Development Technical Advisory Committee (Committee) held its fourth meeting of 2017. The Committee received updates from the U.S. Department of Energy's (DOE's) Bioenergy Technologies Office (BETO) and from the U.S. Department of Agriculture (USDA), who delivered a presentation about current USDA activities. Other presentations were given by the University of Florida, Colorado State University, University of Arizona, Humboldt State University, Water Environment and Reuse Foundation, and Booz/Allen/Hamilton. Additionally, the Committee had public comments from the University of Minnesota, Attis Innovations, and Campbell Consulting.

See Appendix A for a list of meeting attendees and Appendix B for the meeting agenda. Meeting presentations can be viewed on the Biomass Research and Development Initiative (BRDI) website.

Background:

The Committee was established by the Biomass Research and Development (R&D) Act of 2000, which was later repealed and replaced by Section 9008 of the Food, Conservation, and Energy Act of 2008. The Biomass R&D Board was established under the same legislation to coordinate activities across federal agencies. The Food, Conservation, and Energy Act has recently been amended by the Agricultural Act of 2014. The Committee is tasked with advising the Secretaries of Energy and Agriculture on the direction of biomass R&D.

II. Welcome

Kelly Tiller, Committee Co-Chair

Dr. Tiller welcomed the Committee to the forth meeting of the year and called the meeting to order.

The first order of business was to approve the drafted recommendations from the Q3 meeting. The Q3 recommendations on ***Biomass integration with existing fossil fuel infrastructure*** were approved by the Committee.

Dr. Tiller then briefly provided an overview of her presentation to the Biomass Board in September on the Committee's approved Q2 and draft Q3 recommendations. The recommendations were received well by the Board. There was good dialog during the meeting and the Board was appreciative of the Committee's work to date in 2017.

Lastly, Dr. Tiller introduced the forth quarterly meeting's focus, "Improve Feedstock Supply Chain Cost and Efficiency."

III. DOE Updates and Biomass R&D Activities

Mark Elless, Designated Federal Officer, DOE

Dr. Elless provided an update on the BETO budget request for fiscal year (FY) 2018. The President's budget request was $56.6 million, the House of Representative's mark was $90.0 million, and the Senate mark was $190.0 million. The Senate mark is a 7% decrease in funding from FY 2017 funds. The Senate and House will go to conference and agree to a number to send to the President for signature.

Dr. Elless then provided updates on DOE and BETO funding opportunity announcements (FOAs). DOE selected eight projects to negotiate for up to $15 million in total DOE funding to optimize integrated biorefineries. These projects will work to solve R&D challenges encountered for the successful scale-up and reliable operations of integrated biorefineries, decrease capital and operating expenses, and focus on the manufacture of advanced or cellulosic biofuels and higher-value bioproducts. These investments support the development of bioproducts, a workforce in bioenergy, and the creation of a sustainable domestic bioeconomy.

DOE announced the selection of one additional project, for up to $3.5 million, as part of BETO's Advanced Algal Systems Program funding opportunity. The FOA's objective is to reduce the production costs of algae-based biofuels and bioproducts through improvements in algal biomass yields. Previously in FY 2016, DOE awarded $15 million for three projects, Global Algae Innovations, Algenol Biotech LLC., and MicroBio Engineering, Incorporated.

Dr. Elless then gave a list of upcoming BETO events including the Feedstock Conversion Interface Consortium (FCIC) Workshop to be held on December 11, 2017. BETO will use this workshop as a kickoff meeting to provide participants with a summary of the intended R&D efforts, primary focus areas, and target goals of the consortium. Industry attendees will review the FCIC portfolio and research direction, and provide valuable inputs and recommendations to ensure FCIC is focused on solving industry relevant problems.

Another event is the Advanced Development and Optimization Workshop on December 12-13, 2017. BETO will use this workshop to seek feedback on how the new program area can best serve stakeholders in developing the bioenergy industry, as well as raise awareness of existing assets from past investments and discuss future needs and opportunities for maximizing their value.

Dr. Elless then provided highlights for the national laboratories related to feedstock supply and costs and efficiency. He highlighted work by Oak Ridge National Laboratory on corn stover. Also, Idaho National Laboratory achieved the 2017 $84 feedstock goals target associated with the BETO multi-year program plan milestones.

Ray Miller asked what would happen to projects that have already been awarded if the BETO budget is reduced. Dr. Elless stated that existing projects could continue on their existing carryover funds from previous years until exhausted.

IV. USDA Update on Biomass R&D Activities

Harry Baumes, Office of Energy Policy and New Uses, Office of the Chief Economist, USDA

Dr. Baumes provided an update on USDA leadership. Ted McKinney is now the Under Secretary for Trade and Foreign Agriculture Affairs. Steve Censky is Deputy Secretary and Anne Hazlett is Assistant to the Secretary for Rural Development. Dr. Baumes then addressed the 2018-22 strategic goals for USDA under Secretary Purdue focusing on including:

- Maximize the Ability of American Agricultural Producers to Prosper by Feeding and Clothing the World
- Promote American Agricultural Products and Exports
- Facilitate Rural Prosperity and Economic Development
- Ensure Productive and Sustainable Use of our National Forest System Lands
- Strengthen the Stewardship of Private Lands through Technology and Research

Dr. Baumes provided updates on the Biofuels Infrastructure Partnership stating that grantee performance extensions were granted in December 2016 to 19 states and the performance deadline is December 31, 2017. Ten (10) States have requested an additional year-long extension for completion of grant performance. Construction timeline delays are occurring due to shifts in the fuel market and hurricanes, with direct impacts being shortages in labor and equipment, and vendor availability.

The Agricultural Research Service (ARS) National Program (NP213) Biorefining/Biofuels, as a standalone national program no longer exists as of October 1, 2017. The research projects and scientific staff have be incorporated into ARS, National Program (NP306) Agricultural Product Quality and Utilization. The proposed new National Program title of NP306 is: Product Quality, New Uses and Bioprocessing. Both NP 213 and 306 research projects are completing their five-year research cycle in 2018 with a new NP306 action plan expected to have researchable components addressing food, non-foods (including cotton, wool, and leather), and bioprocessing (biorefining/biofuels). The new five-year project plans will take effect in 2019.

The Biorefinery, Renewable Chemical, and Biobased Product Manufacturing Assistance Program (Section 9003 of the Farm Bill) submitted four projects to the Office of Management and Budget for review with one additional project pending. Two projects obligated with one to close and begin construction in 2017 and the other to close and begin construction in Q1 2018. Four additional applications were received for the 10/2/17 funding cycle.

Finally, the Agriculture and Food Research Initiative Coordination Agricultural Projects (CAPs) awarded two projects. The Southeast Partnership for Advanced Renewables from Carinata and the Sustainable Bioeconomy for Arid Regions (SBAR) focusing on guayule and guar.

V. BRDI Solicitation Status and Update

Daniel Cassidy, *National Institute of Food & Agriculture, USDA*

Dr. Cassidy provided an update of the most recent BRDI solicitation including its objectives and technical areas of focus. About 370 pre-applications were received and about 70 full proposals were submitted.

USDA has about $6 million available from combined BRDI funds from FYs 2016 and 2017 and DOE has up to $3 million available. They expect to make selection announcements in February 2018.

Dr. Cassidy then provided an update on National Institute of Food and Agriculture (NIFA) activities. In FY 2017 NIFA received about $56.7 million that was directed to biobased products, bioenergy/biofuels/analysis, and education/extension activities. USDA added additional CAPs now totaling nine. Other NIFA competitive programs include the Biodiesel Education Program, Joint Feedstock Genomics with DOE, Sun Grant Initiative (ending), Critical Agriculture, Materials Program (ended), Forest Research Initiative, and Innovation at the Nexus of Food, Energy, and Water.

VI. Key Findings from the Coordinated Agricultural Projects

Keith Paustian, Colordao State University
David Wright, University of Florida
Kim Ogden, Universtiy of Arizona

Dr. Keith Paustian from the Bioenergy Alliance Network of the Rockies (BANF) gave an update of the organization's activities and outcomes. One of its focuses is beetle-kill for bioenergy. Beetle kill is a result of managemetn practices and climate changes that have affected 42 million acres of predominatnly federal land. The advantages are large exissting resources, avoiding fuel-v-food issues, and low stumpage costs. The disadvantages are spotty and episodic resources, challenging access to the resource, and expsensive logistics.

The objectives of BANF are:

1. Compile a regional general feedstock atlas and select site-specific biomass inventories
2. Develop feedstock specifications and low-cost harvest and processing systems
3. Quantify local-scale economics and environmental sSustainability limits
4. Determine wider economic and climate value of biofuel products and biochar co-product
5. Articulate social and policy barriers and make aecommendations
6. Develop education curricula, extension/outreach programs, and health and safety guides

With regard to objective #2, BANF found that beetle-kill biomass performs as well as southern pine mill residue and its also lower-moisture. They have produced 10 gallons of beetle-kill-derived blend-stock and several tons of beetle-kill-derived biochar. With regard to objective #3, BANF conducts technoeconomic analysis to estimate net present value based on Industrial partners' conversion efficiencies, costs of inputs (biomass), and product prices.

Ray Miller asked if stumpage fees are included in the financial modeling of the analysis. Dr. Paulstian explained that the model includes stumpage costs and that it varies, but most cases that contract with the U.S. Forest Service have low stumpage costs.

Dr. David Wright from the University of Florida provided an overview of the Southeast Partnership for Advanced Renewables from Carinata. The group is focused on developing Brassica carinata as a sustainable feedstock for advanced renewables including advanced jet fuel, bio-diesel, and other value added co-products as well as a high protein source for animal feed.

Charles Abbas asked if anyone was looking at carinata as a feedstock. Dr. Wright explained that Cargill has shipped carinata to Europe and APM has a facility interested.

Dr. Kim Ogden from the University of Arizona presented on SBAR. SBAR's objective is to develop sustainable agriculture in semi-arid regions by looking at feedstocks such as guayule and guar and developing high-value commodity products in addition to jet fuel. The impacts include value to the bioeconomy for rural, arid regions through production of rubber, fuel, guar gum, and high-value products. It also impacts long-term sustainability of water usage in Southwest through cultivation of drought resistant crops.

Katrina Cornish asked about restrictions of utilizing guayule as a feedstock across state boarders. Dr. Ogden explained that the plan is to utilize the feedstock in Arizona and New Mexico only at this stage.

VII. Niche Feedstock Use and Competitive Advantages

Han-Sup Han, Humboldt State University
Aaron Fisher, Water Environment & Reuse Foundation

Dr. Han-Sup Han from Humboldt State University presented on the production of quality feedstock from forest residues. The University is looking to develop sorting and chipping techniques along with reducing moisture content to improve the quality of the feedstock. Key findings show that sorting stem wood and tree tops from other residues during a timber harvest operation facilitates the use of a chipper. Also, through sorting and chipping of forest residues, they are able to produce various types of quality feedstock that is small, uniform in size, low-moisture content (<20%), low-ash content (<1%), and high-bulk density.

Dr. Aaron Fisher from the Water Environment & Reuse Foundation then discussed the use of sludge from waste water treatment as a bioenergy feedstock. Currently, facilities spend a quarter of their budget to dispose of sludge through fertilizing of land or land fill. The challenges with sludge are that it is a wet feedstock which is difficult to transport. Also, the facilities' main objective is to treat water, not to develop a viable feedstock. There are also three categories of sludge. Primary Sludge is processed by screens and tanks and is energy diverse. Secondary sludge is processed by bioreactors and is hard to dewater. Sludge from a digester is already reused for energy.

Joe James asked if there are uses for sludge on spray fields. Dr. Fisher stated that there are regulations regarding sewer sludge and that impacts permitting for sludge use in different parts of the country.

Esteban Chornet asked about the presence of metals in the sludge. Dr. Fisher said that utility permits direct what is allowed in the sludge. Currently selenium and chromium are the only metals that have created issues.

VIII. Advanced Micro Sensors System for Biofuel Feedstock Systems

David Lee, Booz/Allen/Hamilton

Dr. David Lee from Booz/Allen/Hamilton provided an overview of the Advanced Micro Sensors System for Biofuel Feedstock Systems projects out of the TERRA (Transportation Energy Resources from Renewable Agriculture)/ROOTS (Rhizosphere Observations Optimizing Terrestrial Sequestration) programs of the Advanced Research Projects Agency-Energy (ARPA-E). The goal is to integrate biology, engineering, and computer science to develop a precision breeding system through diverse technologies such as phenotypes, sensors, computations, genetics, and environments. The objectives are to maximize system productivity, minimize unfavorable outcomes, and expand freedom of choice. Next steps include a workshop in early 2018 to evaluate pathways to maximize theoretic yields; measure, map and model feedstock quality; and secure data architectures.

VIII. Biorefinery Experience with Improving Feedstock Supply Chain Cost & Efficiency and Upgrading of Biomass into Feedstock

Brandon Emme, Cellulose Team Lead, Principal Scientist, ICM Technology Development

Brandon Emme from ICM provided an overview of ICM's Generation 2.0 Front-End Processes for feedstocks. He started by discussing feedstock process challenges including scale up, milling, conveying, pretreatment feeding, separations, and slurry pumping. He then went on to discuss lessons learned and work ICM has done to address these challenges. For example he discussed the work ICM has done with the Northwest Advanced Renewable Alliance to address milling challenges. He discussed washing activities necessary to reduce acid requirement for pretreatment. Finally, he listed unaddressed needs including storage stability and supply, harvesting practices for agricultural wastes, quality consistency, milling that gives higher consistency downstream, and washing to remove ash without adding water load to the plant.

IX. Public Comment

Eric Singsaas, University of Minnesota, Natural Resources Research Institute, Initiative Director for Wood Products and Bioeconomy

Public Statement for the BRDI Board

Both the State of Minnesota and the federal government have made long-term commitments to attract and develop renewable biofuels and bio-based chemicals industries. These emergent sectors provide opportunities for economic development and job creation in rural communities, which have been hurt by the decline of the paper industry, shuttering of many wood product manufacturing plants, and the cyclicality of the mining sector. It is possible to develop this new industry while preserving natural resources and ensuring long-term economic viability of our incumbent forest products industry. The use of cellulosic feedstocks from highly productive, managed plantations and farms is supported through federal bioenergy research and incentive programs. However, there are gaps in support for currently

underutilized biomass from private, state, county, and federal forest lands that need management for fire hazard reduction and productivity.

Excluding certain forestlands from the biomass market is a missed opportunity to create a public policy synergy between public interests. Developing a bioeconomy sector resourced in part by the currently unmerchantable portion of timber harvests is both economically and ecologically sustainable; providing economical biomass feedstocks while supporting jobs and maintaining ecosystem services in these forests. For example, landowners with fire prone forests and low-value trees depend on healthy biomass markets for forest management. Also, because existing forest harvest operations rely primarily on forest inventory analysis data and cut-to-length round wood harvest, they leave behind the unmerchantable small diameter trees, limbs, and tops to be burned. Improved markets for the unmerchantable portion of forest harvests can have a positive effect on legacy saw timber and pulpwood markets by improving economic return from private forest harvest as well as from other management operations.

In Minnesota, there have been efforts to develop biomass markets to address this opportunity. The Minnesota State Wood Innovation team, funded by the U.S. Forest Service, has worked with public, private industrial, and family-owned forestlands to connect these resources to markets. These efforts leverage saw timber and pulpwood operations that already have well-developed wood supply chain partnerships to supply the traditional forest products industry. The Laurentian Energy Authority was created as the managing partner of a joint venture between the public utilities of two cities to incorporate the use of biomass for power production. Laurentian Energy also has a power purchase agreement to sell 35 megawatts of biomass-produced power to Xcel Energy.

These tasks, however, are often dominated by competing interests. Competition from subsidized wind energy and natural gas is reducing demand for biomass energy production. This dynamic led the Minnesota Legislature to permit Xcel Energy to buy out its long-term biomass energy contract. The ripple effects of this decline are now being felt by landowners who no longer have markets for forest thinnings, the forest harvest industry which has made investments in workers and equipment, and the pulpwood and saw timber industries whose market development depend indirectly on the lower-value biomass markets. Long-term there is concern that forestlands will continue to become overgrown thereby increasing the risks from wildfires.

There is an unmet opportunity to reconnect forest management activities to biomass markets through research and public policy. Addressing the gap in support for use of forest thinnings and residuals from harvesting in renewable energy markets will require public funding similar to that given to biomass production in tree plantations and croplands.

Publicly supported research will provide data and decision making tools to public and private land managers to help foster the development of the 21st century bio-economy by:

1) Assessing the availability of forest resources, particularly on private forest lands
2) Predicting how future management decisions will affect wood availability for new and existing industries

3) Developing understanding of the potential for conversion of a portion of forest resources into bio-based chemicals and advanced biofuels
4) Ensuring the sustainability of forest ecosystem services.

Changes in public policy to level the playing field between forest biomass thinnings and harvest residuals and bioenergy from row crops will encourage the development of markets. A significant impact of these changes will be the creation of well-paying jobs throughout the spectrum of workforce positions needed for resource management, and establishment of new businesses in depressed rural economies.

Eric Singsaas
Initiative Director for Wood Products & Bioeconomy
Natural Resources Research Institute
University of Minnesota

Mike Reichenbach, EdD
Extension Professor
University of Minnesota

Neil Nelson
Acting Manager, Production Forestry Group
Natural Resources Research Institute
University of Minnesota

George Host
Initiative Director for Forest and Land
Natural Resources Research Institute
University of Minnesota

Helen Petersen, Attis Innovations

Public comment submitted to the BRDI
Technical Advisory Committee
November 15, 2017

Good morning. My name is Helen Petersen and I serve as the Director of Policy for Attis Innovations. My colleagues and I would first like to take the time to thank the Committee for giving us the opportunity to speak today as well as your continued vigilance in pushing for a better, more sustainable bioeconomy. With your guidance and objective comments, the BRDI Board is able to make informed decisions that continue to positively shape our governments policy toward feedstock and biobased product development. We urge you to continue your efforts as we strongly believe that it is in the best interest of the U.S. economy, and our country as a whole, to have a strong bioeconomy built on renewable feedstocks for biobased products.

Attis Innovations is a company focused on the responsible and sustainable conversion of rapidly renewable biomass into every day, high-value products. Specifically, Attis has developed a technology portfolio that looks to capitalize on cost effectively recovering lignin from biomass at small or large scales to greatly expand the revenue potential for existing biobased industries and exploit rarely used sources of biomass. By employing our technology today in current biomass processing facilities like pulp and paper mills or cellulosic biorefineries, Attis can generate between 35% and 100% more revenue per ton of biomass and drastically improve their profitability and future vitality.

The Attis technology platform is largely in response to the current inefficiencies and outdated technology used in the pulp and paper and cellulosic fuel industries. While the pulp and paper industry has prospered using clean process technologies and sustainable land management practices, its core technology is more than 100 years old and unable to implement efficient separation and biorefining upgrades. The current antiquated pulp and paper processing methods are designed to only recover and sell about 50% of the processed biomass into high-value applications, meaning that the remaining 50% must be incinerated to recover and recycle the sodium-based solvents.

The cellulosic fuel industry's weakness has been its sole focus on cellulose. Like pulp and paper they too are only able to utilize about 50% of the biomass feedstock effectively and incinerate the remaining as a low-grade, low-value energy pellet. These biobased industries are largely inefficient and will be unable to compete with crude oil refineries which have evolved over time to create high-value products from 100% of their feedstock stream. Oil refineries convert 92% percent of their feedstock into high-volume, low-value fuels (gasoline, diesel) and about 8% into materials such as plastics, lubricants, and specialty chemicals accounting for as much as 50% of their revenue. Attis will operate a true integrated biorefinery that targets 100% utilization of biomass into products that displace those made from crude oil.

Attis' commercial exploitation of lignin is crucial to overcoming the revenue shortfalls faced by the lignocellulosic biofuel industry; the additional value-added uses would improve the competitiveness of biobased fuels versus petroleum-based fuels. Lignin is the most concentrated source of carbon in a plant, and ironically is not being effectively used to replace non-renewable carbon-based products.

Attis is able to recover and produce a unique melt-flowing form of lignin. The production of a melt-flowing form of lignin is a major breakthrough that allows an otherwise undervalued lignin stream to capitalize on a host of new market opportunities that were previously thought too difficult to explore. As an example, when used as a high-performance resin extender in thermoplastics, lignin brings a value of $600 to $2,000 per ton, depending on the performance requirements, substantially greater than the $50 per ton value when incinerated

Attis focuses heavily on the displacement of high performance plastic resins like ABS, Polypropylene, and other common olefins with our unique lignin. Our goal? To increase the use of biobased materials in every day products like building and construction materials, automotive parts, adhesives, and many more. However, Attis has the ability to transform more than just the plastics industry. By taking

advantage of the remaining cellulose and hemicellulose from its production process, Attis will be able to manufacture not just a unique lignin, but also a host of green chemicals, cellulosic sugars, and specialty pulp fibers for use in a multitude of industries.

Furthermore, Attis is able to cost effectively build biomass processing systems that range in capacity from 200 to 2,000 tons per day and do so at the same capital intensity per ton as traditional pulp and paper and cellulosic facilities. This allows us to process small volumes of biomass at the same capital intensity, while generating 35% to 100% more revenue.

As cellulose content and scale are no longer business constraints, Attis can build and locate processing systems that reach a wider variety of feedstock opportunities such as peanut shells, rice hulls, corn stover, cotton stems, peach pits, perennial grasses, woody biomass and other crop residuals. These are the types of feedstocks described in the *Billion Ton Report* and, without an ability to build scalable processing systems, they can never be effectively utilized. Rural America will benefit from the addition of new, green collar jobs and will enable the United States to fully realize the potential of a true bioeconomy.

We applaud the USDA and DOE in their commitment to stimulate and support the domestic bioeconomy. It is of our opinion that the key to a successful and self-sustaining biobased enterprise is the targeting of high-value derivative bioproducts.

For decades, government and industry forces have joined in a concerted effort to push cellulose-derived products and fuels to drive the biobased industry. Unfortunately, this has left a significant portion of biomass to be categorized as low-value byproducts. To realize the full potential of the *Billion Ton Report*, unbiased funding must be directed toward all-inclusive feedstocks and end-use applications of biomass.

On behalf of Attis Innovations, I urge the Committee to support equitable funding opportunities for all forms of biomass feedstocks, not just those rich in cellulose content, as well as the downstream development of biobased products derived from lignin and hemicellulose. With this all-inclusive approach, funding will be allocated in such a way that enables biomass to be utilized to its full potential, biorefineries to realize additional revenue streams, and tax payer dollars to reap the maximum return.

X. Draft Q3 Meeting Recommendations

Full Committee

Source: Biomass Research and Development Technical Advisory Committee

Advisory To: Biomass Research and Development Board

Report Date: November 2017

Issue: ***Feedstock Supply Chain Costs and Efficiencies: Opportunities in the Nearer Term***

Opportunities:

- ☐ Develop uniform, on-specification industrial biomass feedstocks
- ☐ Improve the understanding of the impacts that feedstock characteristics and compositions have on handling, processing, and conversion steps
- ☐ Exploit currently available specialized, stranded, and opportunistic resources
- ☐ Conduct research on low-acreage but scalable crops that can produce high-value biofuels and bioproducts in the near term
- ☐ Improve the use and reuse of all the components of biomass to increase value

Context

Development efforts have resulted in commercial production of a range of bioproducts and biofuels at a variety of scales. However, *essentially all* of these facilities have encountered feedstock issues related not only to the cost, quality, and availability of those feedstocks, but also to the ability to successfully handle them. These issues create ongoing challenges not only to specific projects, but also to the entire industry that is striving to achieve ≥90% on-stream performance goals. While biomass has been used for centuries, the reality of handling it in advanced biomass conversion systems is more difficult than was initially assumed.

Biomass generally requires preparation and processing before it can be used as an industrial feedstock. Examples of preprocessing include size reduction, moisture content adjustment, chemical treatment, and others. Because each processing step adds incremental costs, it is critical that the feedstock supply chain is efficient in changing initial biomass into an industrial feedstock fed directly to a process reactor. Funding from both the Biomass Research and Development Initiative (BRDI) and the individual agencies participating in the Initiative has advanced knowledge in this area. Programs of the U.S. Departments of Agriculture and Energy, such as the Coordinated Agricultural Projects (CAP) and the Regional Feedstock Partnership (RFP) field trials, have improved the understanding of regionally-based biomass and related industrial feedstocks. Commercial partners' involvement in the CAP and RFP projects has provided increased industrial relevance. The agencies participating in the BRDI have also funded core research to reduce the cost of biomass, to address the interface between biomass and conversion, and to otherwise improve the feedstock supply chain.

Additional efforts are needed in the relatively near term (approximately five years) to assist with biomass and industrial feedstock issues. These efforts are crucial to reducing the recurring problems experienced in commercial biorefineries.

Key Challenges of Effective Feedstock Supply Chains

- *A lack of uniformity of industrial feedstocks exists.* The variable, non-uniform nature of current feedstocks creates difficulties in processing and increases conversion costs. The characteristics of feedstocks vary significantly by biomass type, but they also vary due to factors such as localized agricultural practices, availability of moisture during growth, temperature and length of time in storage, and others.
- *Insufficient information is available to correlate feedstock properties with conversion behavior.* Prior analytical work has provided information about the basic characteristics of biomass and some industrial feedstocks, but there are little data correlating that with conversion behavior. No easy-to-access public database is available to support industry efforts.
- *Utilization of specialized, stranded, and opportunistic biomass is difficult*. Currently available, specialty biomass provides a potential economic entry point to help establish the bioeconomy infrastructure, but matching those resources with appropriate, cost-effective conversion technologies is difficult.
- *The cost of biomass and industrial feedstocks continues to be challenging*. Biomass must be used efficiently for biorefineries to be successful, and continued improvements in the use of all components of the biomass are needed to help defray the cost of the biomass.

Opportunity 1

Fund additional research to identify a cost-effective method to produce more stable, dense, uniform feedstocks for easier handling and transport.

⇒ ***Create on-specification industrial feedstock streams that allow for reliable (≥90%) continuous processing at the fully commercial biorefinery.***

⇒ ***Consider on-stream processing availability as a target in BRDI projects.***

Opportunity 2

Develop improved technical information that correlates feedstock chemical and physical characteristics to handling, processing, and conversion yield behavior. Provide the information in a publicly available database that is readily accessible to biorefinery operators.

⇒ ***Develop improved correlations between the "as delivered" feedstock characteristics and subsequent conversion performance. Better understand the chemistry and physics involved.***

⇒ ***Develop "quick and easy" compositional measurement tools (e.g., advanced nano-based sensors, near-infrared, or others) that can be used in the field or at the feedstock preparation facility.***

⇒ ***Develop a public database of feedstock composition and correlations to conversion behavior that can ultimately link to commodity feedstock specifications.***

Opportunity 3	Fund research to better utilize currently available specialized, opportunistic, and stranded biomass resources that provide a potential economic entry point to expand the bioeconomy. ⇒ ***Develop a comprehensive listing and database of specialized biomass sources with quantities and locations of currently available resources (e.g., wastewater treatment sludges, municipal solid waste, beetle-killed pine, etc.).*** ⇒ ***Match feedstock to appropriate-scale conversion technologies, particularly those with more profitable products and co-products.***
Opportunity 4	Fund research on current low-acreage crops that are readily scalable and that can yield high-value, high-impact bioproducts/biofuels in the near term. ⇒ ***Focus on additional oil seed crops that have the ability to produce higher oil content than current oil seed crops.*** ⇒ ***In addition, examine crops with near-term commercial potential for products, such as rubbers, plastics, or fillers, which will enhance performance.***
Opportunity 5	Fund research that will improve the use and reuse of all components of biomass or the industrial feedstock to increase its value. ⇒ ***Examine processes to increase the value and use of lignin. Characterize and evaluate market applications for processes to produce different types of lignin that result in up to 100% feedstock valorization. The emphasis should be on near-term processes with potential to yield a better type of lignin***. ⇒ ***Examine the efficient use and reuse of bio-crops and their biomass in sequential applications to increase the value of the biomass.***

XI. Closing Comments

The meeting was adjourned.

Appendix A: Committee Member Attendance—Nov. 15–16, 2017

Co-Chairs	Affiliation	Attended?
Kelly Tiller	Genera Energy, Inc.	Yes

Members	Affiliation	Attended?
Charles Abbas	Archer Daniels Midland	Yes
Dean Benjamin	Verso Corporation	Yes
Esteban Chornet	Enerkem	Yes
Katrina Cornish	Ohio State University	Yes
Steve Csonka	Commercial Aviation Alternative Fuels Initiative	Yes
Vonnie Estes	Consultant	No
William Frey	Georgia-Pacific	Yes
Emily Heaton	Iowa State University	No
Beth Hood	Arkansas State University	Yes
Raymond Huhnke	Oklahoma State University	Yes
Joseph James	Agri-Tech Producers, LLC	Yes
Randy Jennings	Tennessee Department of Agriculture	No
Coleman Jones	General Motors	Yes
Man Kit Lau	BioAmber, Inc.	Yes
Bruce McCarl	Texas A&M University	Yes
Christine McKiernan	BIOFerm Energy Systems	No
Ray Miller	Michigan State University	Yes
Shelie Miller	University of Michigan	No
Marina Moses	American Academy of Microbiology	No
Neil Murphy	State University of New York	Yes
Kimberly Ogden	University of Arizona	Yes
Manuel Garcìa Pèrez	Washington State University	No
Anna Rath	NEXSTEPPE	No
Matthew Rudolf	SCS Global Services	No
Patricia Scanlan	Scanlan Environmental, LLC	Yes
Abolghasem Shahbazi	North Carolina A&T State University	Yes
Don Stevens	Cascade Science and Technology Research	Yes
Valerie Thomas	Georgia Institute of Technology	No
Alan Weber	MARC-IV Consulting/Weber Farms	Yes
Michael Wolcott	Washington State University	Yes

Total: 21 of 31 members attended

Appendix B: Agenda—Nov. 15–16, 2017

DAY 1	Technical Advisory Committee Meeting		November 15, 2017
8:00 – 8:30 am		***Continental Breakfast******	
8:30 – 8:50 am	**Welcome***	Introductions	*Co-Chairs*
	Vote	3rd Quarter Meeting Recommendations	
	Report	BRDI Board Presentation & Feedback	
	Introduction	4th Quarter Focus Topic: Improve Feedstock Supply Chain Cost & Efficiency	
8:50 – 9:05 am	**Presentation***	Committee Business & U.S. DOE Updates	*Mark Elless, DFO US DOE*
9:05 – 9:15 am	**Presentation***	USDA Biomass R&D Activities and Bioeconomy Initiative Update	*Harry Baumes, USDA*
9:15 – 9:30 am	**Presentation***	Biomass R&D Initiative (BRDI) Solicitation, Status & Update	*Daniel Cassidy, National Institute of Food & Ag, USDA*
9:30 – 9:50 am	**Discussion***	TAC Recommendations on BRDI Program, Solicitations, Process & Awards	*Co-Chairs*
	Action	2018 BRDI Program Solicitation, Process and Awards Recommendations	*Full Committee*
9:50 – 10:00 am		***Coffee Break***	
10:00 – 11:00 am	**Panel 1***	Key Findings from the Coordinated Agricultural Projects (CAPs)	
		- Bioenergy Alliance Network of the Rockies	*Keith Paustian, Colordao State University*
		- Southeast Partnership for Advanced Renewables from Carinata	*David Wright, University of Florida*
		- Sustainable Bioeconomy for Arid Regions	*Kim Ogden, Universtiy of Arizona*

11:00 – 11:45 am	**Panel 2***	Niche Feedstock Use and Competitive Advantages - Waste to Wisdom: Utilizing forest residues for the production of bioenergy and biobased products - Sludge from Waste Water Treatment as a Bioenergy Feedstock	*Han-Sup Han, Humboldt State University* *Aaron Fisher, Water Environment & Reuse Foundation*
11:45 – 11:55 am	**Presentation***	Advanced Micro Sensors System for Biofuel Feedstock Systems	*David Lee, Booz/Allen/Hamilton*
11:55 – 12:05 pm	***Public Comment***	– *Eric Singsaas, University of Minnesota, Natural Resources Research Institute, Initiative Director for Wood Products and Bioeconomy* – *Helen Petersen, Attis Innovations*	
12:05 – 12:30 pm		***Lunch****	
		Recognition of Retiring Members of the Biomass R&D TAC	
12:30 – 1:15 pm	**Panel 3***	Biorefinery Experience with Improving Feedstock Supply Chain Cost & Efficiency & Upgrading of Biomass into Feedstock - ICM	*Brandon Emme, ICM*
1:15 – 1:45 pm	**Discussion***	Subcommittee Instructions	*Co-Chairs*
1:45 – 4:15 pm	**Breakout ****	Subcommittee Breakouts (*Coffee Break as needed*)	*Subcommittees*
4:15 – 5:30 pm	**Discussion***	Subcommittee Day One Reports	*Full Commjittee*

DAY 2	Technical Advisory Committee Meeting		November 16, 2017
7:30 – 8:00 am		***Continental Breakfast******	
8:00 – 8:30 am	**Discussion***	Subcommittee Instructions, Report Format	*Co-Chairs*
8:30 – 10:00 am	**Breakout ****	Subcommittee Breakouts	*Subcommittees*
10:00 – 10:30 am	**Presentation***	Subcommittee Breakout Reports	*Full Committee*
10:30 – 11:15 am	**Action***	Recommendations on Improving Feedstock Supply Chain Cost & Efficiency	*Full Committee*
11:15 – 12:15 pm	**Discussion***	2018 Work Plan & Quarterly Focus Topics	*Full Committee*
12:15 – 12:30 pm		***Public Comment***	
12:30 – 1:45 pm		***Lunch****** (*cont'd through QFT Discussion)*	
1:00 – 1:45 pm	**Discussion***	2018 Work Plan & Quarterly Focus Topics (*cont'd*)	*Full Committee*
1:45 pm		***Adjourn***	

* *Full Committee Meetings, Presentations, and Public Comment Hearings are open to the public.*

** *Subcommittee Meetings are closed to the public.*

*** *Meals and Break Service are closed to the public and provided for Committee Members only.*