Biomass Research and Development Technical Advisory Committee

November 8–9, 2011

Meeting Summary

Contents

List of Acronyms

ARPA-E – Advanced Research Projects Agency – Energy
Biomass Act – Biomass Research and Development Act of 2000
Board – Biomass Research and Development Board
BRDI – Biomass Research and Development Initiative
CARB – California Air Resources Board
Committee – Biomass Research and Development Technical Advisory Committee
DOE – U.S. Department of Energy
DOD – U.S. Department of Defense
DOI – U.S. Department of the Interior
DOT – U.S. Department of Transportation
DPA – Defense Production Act
DLA – Defense Logistics Agency (of DOD)
EPA – U.S. Environmental Protection Agency
FFVs – Flex-Fuel Vehicles
FY – Fiscal Year
GHG – Greenhouse Gas
ILUC – Indirect Land-Use Change
INL – Idaho National Laboratory
IWG – Interagency Working Group
LCA – Life-Cycle Assessment
MOU – Memorandum of Understanding
MSW – Municipal Solid Waste
NAS – National Academy of Sciences
NAREEE – National Agricultural Research, Extension, Education, and Economics
NBAP – National Biofuels Action Plan
NREL – National Renewable Energy Laboratory
NRC – National Research Council
NSF – National Science Foundation
PNNL – Pacific Northwest National Laboratory
QTR – Quadrennial Technology Review
REC – Renewable Energy Committee (of NAREEE)
RFP – Requests for Proposals
RFS – Renewable Fuels Standard
R&D – Research and Development
USDA – U.S. Department of Agriculture

I. Purpose

On November 8–9, 2011, the Biomass Research and Development (R&D) Technical Advisory Committee (Committee) held its fourth and final meeting of 2011. The purpose of the meeting was to finalize and vote on the Committee recommendations for the year. After some discussion and edits to various recommendations, the Committee voted on and unanimously approved the recommendations included in this report. During the course of the meeting, the Committee also divided into subgroups to meet with the Biomass R&D Board (Board) Interagency Working Groups (IWG) and discuss inputs for the update to the National Biofuels Action Plan (NBAP). The Committee also heard updates on recent activities of the U.S. Department of Energy (DOE) and the U.S. Department of Agriculture (USDA), as well as updates on the Defense Production Act (DPA) Initiative. The Committee also received a presentation from the National Research Council (NRC) on a recent report examining the economic and environmental impacts of achieving the Renewable Fuels Standard (RFS).

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 the federal agencies. The Committee is tasked with advising the Secretary of Energy and the Secretary of Agriculture on the direction of biomass R&D.

This report contains an overview summary of the presentations delivered at the meeting, key Committee questions and answers, and follow-up discussions with the Committee. Attachment A contains a full list of meeting attendees. Attachment B contains the final meeting agenda. Meeting presentations can found on the Biomass R&D website: http://biomassboard.gov/committee/meetings.html.

II. U.S. Department of Energy Update

Elliott Levine, Biomass Program, Office of the Biomass Program, U.S. Department of Energy

Elliott Levine opened the Committee meeting with a few general housekeeping items and a general overview of the activities and presentations planned for the course of the two-day meeting. Most importantly, Mr. Levine emphasized the primary purpose of the fourth quarter meeting—to finalize Committee recommendations and proceed with a full Committee vote to approve the recommendations for submittal to the Board.

Mr. Levine also updated Committee members on some recent changes to the DOE's Biomass Program, including the departure of Biomass Program Manager Paul Bryan—effective at the end of November—and the new organization of the Program. The Committee was very interested in the Program's new organizational structure, and members asked a variety of questions about the new structure, including inclusion of infrastructure, sustainability, and other topics, as well as the impact of the new organization on the Committee. Mr. Levine explained that the Program was

being divided into six Critical Technology Goals (CTGs) that are focused on pivotal areas of bioenergy R&D, but that other subject areas, particularly sustainability, would certainly continue to receive attention. Mr. Levine explained that this reorganization only applied to the Biomass Program, and he did not see an immediate need to reorganize the Committee around the CTGs.

Following a discussion about the Program reorganization, Mr. Levine provided an overview of other DOE news updates, including recent Advanced Research Projects Agency – Energy (ARPA-E) funding announcements, an upcoming Conversion Roadmapping Workshop, the DPA Initiative, and recent awards from DOE's Office of Science. He also discussed the results of DOE's *Quadrennial Technology Review* (*QTR*). The recently completed *QTR* posited several key recommendations related to bioenergy. The *QTR* states an imbalance in the DOE funding portfolio that deemphasized transportation fuels relative to stationary power. The *QTR* recommended that DOE put greater emphasis on the transportation sector, including light-duty vehicle electrification and the development of advanced hydrocarbon fuels. The *QTR* also recommended the prioritization of alternative "drop-in" biofuel replacements for diesel and jet fuel, and deemphasized conversion pathways that produce ethanol and the development of bioproducts in the absence of fuel production.

For more information on these items, please follow the links below:

Defense Production Act MOU –
http://www.rurdev.usda.gov/SupportDocuments/DPASignedMOUEnergyNavyUSDA.pdf

Quadrennial Technology Review –

http://energy.gov/sites/prod/files/ReportOnTheFirstQTR.pdf

Recent ARPA-E Awards –

http://arpa-e.energy.gov/LinkClick.aspx?fileticket=QHWJySjQEbk%3d&tabid=454

III. U.S. Department of Agriculture Update

Bill Hagy, Bioenergy Program, Rural Development, U.S. Department of Agriculture

Bill Hagy, Director of Alternative Energy Policy for USDA, delivered a presentation on the status of USDA-supported projects and other updates. Before beginning his presentation, he announced that after 39 years with USDA, he was retiring from federal service. Mr. Hagy served on the Committee six of the past seven years. He said he was proud of his service to the Committee and wished all members well in their ongoing efforts to help the government identify the most promising opportunities for bioenergy R&D.

During the course of his presentation, Mr. Hagy provided a brief update on the 2008 Farm Bill Title IX Energy Program, including the Biorefinery Assistance Program, the Repowering

Assistance Program, and the Biomass Crop Assistance Program. He said that after talking to some of the beneficiaries of these programs, he was aware that in many cases these programs were absolutely critical to keeping these facilities open—providing much needed jobs in rural areas and helping the country build a competitive advantage on advanced bioenergy technology. In responding to a question from James Seiber about vulnerabilities of Farm Bill reauthorization, Mr. Hagy acknowledged there was some uncertainty about what would come out of the "Super Committee," but affirmed that the bioenergy legislation in the Farm Bill was one of Secretary Vilsack's top priorities.

Mr. Hagy also discussed recent progress in updating the USDA Roadmap and a new energy Web page under development at USDA, which was designed to be a powerful tool in depicting the cross-cutting benefits of bioenergy in job creation, positive environmental impacts, and rural development across all regions of the United States. In response to a question from Neal Gutterson about a perceived shift in focus away from sustainability issues, Mr. Hagy said that USDA recognized that public concerns about sustainability are one of the key roadblocks to increased public support for bioenergy and discussed contracts with Booz Allen Hamilton to refine crosscutting sustainability models.

Finally, Mr. Hagy discussed recent progress in the nomination process for new Committee members. He said seven new candidates were under review with the Office of the Secretary, and once the candidates received approval from DOE and USDA, they would hopefully be eligible to join the Committee for the quarterly meeting in March.

IV. Subcommittee Reports, Discussion of Recommendations, Committee Vote

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. Each subcommittee chair delivered a presentation outlining the recommendations proposed by their subcommittee. In each subcommittee presentation, Committee members discussed the recommendations, made suggestions to revise the existing language or to combine or delineate specific recommendations, and then discussed the 2–3 priority areas of focus. The end result of this discussion, along with the final prioritization of recommendations, is reflected in the final listing of Committee recommendations included in this summary.

As chair of the infrastructure subcommittee, Mark Maher led the discussion about the infrastructure recommendations. Most of the discussion focused around the need to integrate higher volumes of ethanol into the market, increase the ethanol tolerance of the vehicles in the car parc, and better define and understand the concept of 'drop-in' fuels.

In the feedstock presentation, subcommittee co-chair Bruce Dale emphasized the need to improve production yields, and Todd Werpy and other Committee members discussed ongoing concerns about life-cycle assessment (LCA), indirect land-use change (ILUC), and the impact of related policy changes at the Environmental Protection Agency (EPA) and the California Air Resources Board (CARB).

In the conversion subcommittee discussion, subcommittee co-chair Todd Werpy emphasized the critical gap in R&D funding for separations technology and Maureen McCann and others agreed on the need to focus more effort on hydrogen production and energy densification.

During the sustainability presentations, discussions again turned to LCA and land-use issues, particularly within the context of water use, toxicity, and health impacts. All Committee members agreed on the critical importance of having conventional fuels, including oil from tar sands, judged along the same rigorous criteria as renewable fuels.

Following a discussion about each of the subcommittee focus areas, Rodney Williamson announced a motion to adopt the revised version of all Committee recommendations. The motion was seconded, and the full Committee voted to unanimously approve the 2011 Technical Advisory Committee Recommendations.

Finally, Committee Co-Chair Ronnie Musgrove asked the Committee to discuss which three recommendations could likely have the most significant impact on the future of the bioenergy industry. Bruce Dale again emphasized the need for a clearer comparison between increased biofuels production and the costs of our continued dependence on oil, and the need for analysis of the environmental impacts of biofuels in comparison to existing petroleum fuels. David Bransby said the key point to convey to the public was the economic benefits of biofuels, the potential for job creation, and the fact that new jobs in the bioenergy industry couldn't be outsourced to other countries. In terms of priority research areas, Craig Kvien said that increasing feedstock productivity should be prioritized as this would help alleviate concerns about land and water use, nitrogen, and a host of other issues. Bill Provine spoke about the importance of bringing algal biofuels to market and Maureen McCann emphasized the importance of research focusing on high density feedstock logistics. Neal Gutterson suggested that the government was missing opportunities to promote innovation by having overly structured Requests for Proposals (RFPs), and recommended less prescriptive RFP requirements. Most Committee members agreed that there were significant hurdles to achieving the RFS targets and attracting the estimated $100 billion investments needed to build hundreds of new biorefineries; limitations in the policy framework are a significant impediment to achieving this goal.

V. Updating the National Biofuels Action Plan (NBAP)

Sarah Lynch, U.S. Department of Energy

Sarah Lynch provided an overview of recent activities of the Biomass R&D Board (Board) and outlined the Board's plans for an update to the 2008 NBAP. She explained the role of the Operations Committee in soliciting input to the process and outlined the goals for the afternoon session of the Technical Advisory Committee meeting. The Board has established working groups or teams to draft each section of the NBAP update, and is planning to have the plan finalized by early 2012. The overall goals of the update are to:

1) Incorporate changes to the strategic direction and overall bioenergy landscape, since the first NBAP was published in late 2008
2) Provide integrated updates on the status and progress of research, development, and deployment activities across the supply chain and delineate additional needs and challenges
3) Clearly map out federal responsibilities and activities
4) Provide a forum for consensus-building and collaboration among a broad range of federal stakeholders.

After the presentation, the Technical Advisory Committee members divided into three breakout groups: feedstock supply and logistics, conversion, and distribution infrastructure/end use/fuel applications. In the breakouts, working group members representing USDA, DOE, the Department of Transportation, the Environmental Protection Agency, and the White House Office of Science and Technology Policy facilitated wide-ranging discussions about the status of various bioenergy technologies and the appropriate focus of federal RD&D activities.

VI. Review of Current Biomass Solicitation Processes

Carmela Bailey, National Institute of Food and Agriculture, U.S. Department of Agriculture
Mark Decot, Biomass Program, U.S. Department of Energy

In the final presentation topic for Day 1, Carmela Bailey and Mark Decot provided the Committee with an overview of the Biomass R&D Initiative (BRDI) FY 2011/2012 solicitation process and status updates. Carmela explained that the FY 2011/2012 BRDI initiative was focused on advanced biofuels and biobased industrial products, with an emphasis on small-scale, rural based, processing and manufacturing and that projects would fall in a funding range of $3–$7 million. As in earlier solicitations, all proposed projects are required to integrate feedstock development/production/logistics, with conversion technology/product development and systems/sustainability analysis. For 2011, approximately 248 pre-applications were reviewed and 51 were invited to submit full applications.

Following up on the discussions about the committee recommendations, Todd Werpy asked about the level of prescriptive detail in the BRDI solicitations. Carmela explained that the BRDI was bound by legislation to include a certain level of detail and key requirements, but that they were designed to be as minimally prescriptive as possible. She invited the Committee members to review the funding opportunity announcement on the BRDI website and provide specific feedback. Carmela emphasized that the Board took Committee recommendations very seriously

and provided a number of examples of where previous recommendations had been incorporated into the BRDI solicitations. These included: an expansion of interest beyond biofuels to include products and power; a more effective integration of feedstock conversion technologies; greater attention to woody biomass and animal waste; and an emphasis on quantifying environmental, economic, and social impacts.

After Carmela's presentation, Mark Decot provided a brief overview of DOE's perspective on the BRDI solicitation process and took questions from the Committee. He explained that DOE had a significantly smaller funding contribution and that a major priority of DOE was to keep other federal agencies and the private sector involved in the process. In a response to another Committee question related to the Committee's recommendations, Mark explained that DOE does except unsolicited applications and that he was charged with fielding questions about and reviewing these proposals.

VII. Overview of the Defense Production Act Initiative

Zia Haq, Biomass Program, U.S. Department of Energy
Sarah Bittleman, U.S. Department of Agriculture

On the second day of the Committee meeting, Zia Haq and Sarah Bittleman met with the Committee to provide an update on the recently announced DPA Initiative—a joint initiative of DOE, USDA, and the Department of the Navy to invest up to $510 million in the production of advanced hydrocarbon biofuels. Although a representative from the Navy was unable to attend the meeting, Mr. Haq spoke about the national security imperative for developing these fuels, the risks of continued dependence on imported oil, and the high cost in resources and soldiers' lives of fuel convoys in Iraq and Afghanistan. As a result, the Navy has adopted an ambitious target for the use of 50% renewable fuels by 2020.

Under the DPA framework, technology risk will be spread out across the three different agencies involved in the initiative. The DPA allows the federal government to make capitol investments in manufacturing sectors found to be (1) necessary for national defense purposes; and (2) found to be lacking, domestically. USDA will provide some of the funding through the Commodity Credit Corporation and will bring experience in feedstock production and crop yields, while DOE will provide expertise in the viability of different conversion technologies, and the U.S. Navy will provide the specs to which the fuel will need to be produced. The DOE and Navy will provide funds to buy down the capitol costs of the biorefineries. All fuels produced will have to meet military specifications for use in 50% jet or diesel fuel blends. While these fuels will be designed for use by the Navy, the effort has attracted significant attention from the commercial aviation industry, which anticipates a market of 9–10 billion gallons of bio-jet fuel a year and is preparing to manage new carbon regulations in the European Union (EU), which will impact all flight carriers originating in or traveling to EU countries.

During the Q&A portion of the discussion, Bruce Dale raised concerns about whether or not the government was moving too quickly to build commercial-scale facilities before the technology had matured. Mr. Haq and Ms. Bittleman recognized the validity of those concerns and explained how the DPA initiative was designed to mitigate those risks as much as possible, by

establishing DLA as an end market for the fuels and putting funding mechanisms in place to make up the difference between what the fuel cost to produce and what it cost to purchase at market rates. They also noted that all proposals would be subject to a rigorous techno-economic analysis and that only those projects assessed to be financially viable within a five-year time frame would receive funding support. In response to further Committee discussion about project scale-up and financial viability, the presenters acknowledged that the question of scale, as well as size requirements, were issues still being discussed internally and that while there were advantages to supporting smaller scale projects, the Navy was committed to achieving its ambitious volumetric targets, which would eventually require larger scale projects.

Members of the Committee also discussed the DPA's feedstock requirements and potential exceptions. In response to a variety of questions from the Committee, the presenters explained that the DPA reviewers would look at a number of feedstocks, including sugar cane, wheat straw, sorghum, algae, and municipal solid waste (MSW). During this discussion, Harrison Dillon raised an important point about the use of first generation feedstocks to produce advanced hydrocarbon fuels. He argued that many advanced second generation feedstock facilities were likely to be built alongside advanced first generation feedstock refineries and that if the government insisted on producing "drop-in" fuels only from second generation feedstocks, that the United States would risk permanently ceding to other countries its head start in developing these technologies. Mr. Haq and Ms. Bittleman said that the DPA reviewers would be primarily focused on the end-product and that reviewers would consider first generation feedstocks, such as corn starch, if projects had a plan to transition to second generation feedstocks.

VIII. NAREEE Advisory Board Update

Carol Keiser-Long, NAREEE Committee Chair

After the DPA presentation and discussion, Carol Keiser-Long provided a brief update on the recent activities of the Renewable Energy Committee (REC) of the National Agricultural Research, Extension, Education, and Economics (NAREEE) Advisory Board. The REC's mission is to provide recommendations on the scope and effectiveness of the research, extension, and economics programs within USDA. Recent recommendations of the Committee included: a determination to study the reallocation of government funding to avoid duplication; a recommendation to expand agricultural data to benchmark current status and assess changes in feedstock production systems; the adoption of a public relations strategy to communicate research, education, and economics accomplishments to the general public; and further analysis of emerging feedstock production systems, including algae in the bioenergy supply chain.

IX. NRC Report: "Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy"

Wallace E. Tyner, Report Co-Chair, Purdue University

In the final presentation of the Committee meeting, Dr. Wallace E. Tyner delivered a presentation on a recent report from the National Research Council for which he was the co-chair, titled "Renewable Fuels Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy." The report focused on the potential for achieving the RFS target for the use of 36 billion gallons of biofuels by 2022 and the potential positive and negative impacts of achieving this goal. Overall the report found a very high degree of uncertainty surrounding most of the key drivers in biofuels production and consumption and emphasized the complex relationship between a variety of competing factors, including oil prices, feedstock costs and availability, technical advances, and government policy.

Despite this uncertainty, the report posited a number of key findings. The report found that the RFS2 mandate for cellulosic biofuels was unlikely to be met by 2022, primarily as a result of the relatively high cost of producing cellulosic biofuels and ongoing policy and market uncertainties. Given that no commercial-scale cellulosic biorefineries currently exist, the report argued that the capacity build-rate would have to more than double that for grain ethanol over the next 10 years in order to produce 16 billion gallons of cellulosic biofuels by 2022. The report found that biofuels would be cost competitive with petroleum biofuels only in an environment characterized by high oil prices, technological breakthroughs, and an implicit or explicit price on carbon. Key barriers to achieving RFS2 are the high cost of producing cellulosic biofuels compared to petroleum-based fuels and uncertainties in future biofuel markets.

Following the presentation of the report, the Committee engaged in a robust discussion about some of the report's key assumptions and conclusions. Todd Werpy presented an issue about the impact of ethanol demand on driving yield improvements and other technologies that actually result in larger corn harvests. Craig Kvien and others suggested that the report did not thoroughly examine the negative impacts of petroleum use or the role of subsidies for the petroleum industry, and Dr. Tyner generally agreed that this was an area of research that needed further scrutiny. Other Committee members asked about the inclusion of MSW and algae and Dr. Tyner explained that MSW received some consideration, but that algae had been considered beyond the scope of this report and was the subject of another National Academies report currently under development.

A link to the NRC Report can be found here:
http://www.nap.edu/openbook.php?record_id=13105&page=201

X. Approved 2011 Committee Recommendations

FEEDSTOCK RECOMMENDATIONS

1) **Productivity**

- *Problem Statement*: Maximizing efficiency or yield is critical to the introduction of bioenergy crops. To support genetic improvement there is a need to continuously expand the genetic base. Importation of new germplasm is one mechanism to expand the genetic base. The current quarantine process is recognized as a bottleneck to importation.
- *Recommendation*: Potential pests, pathogens, and invasiveness associated with emerging bioenergy crops needs to be addressed by quarantines to achieve more efficient quarantine practices.
- *Recommendation**:*** Update procedures for collecting, treating and evaluating plant accessions to minimize risks associated with germplasm introduction.

- *Problem Statement*: There is a need to develop optimal management practices for sustainable bioenergy crop production.
- *Recommendation*: Continue and expand upon fundamental agronomic and silvicultural research for dedicated/purpose-grown energy crops (woody and herbaceous).
- *Recommendation*: Conduct research on new bioenergy feedstocks to investigate production potential and assess potential environmental impacts of future production.
    - Examine impacts of feedstock production on wild communities.

2) **Long-Term Commitment**

- *Problem Statement*: The current 3-year research funding cycle is inadequate to provide long-term assessment of emerging dedicated/purpose-grown energy crops (both woody and herbaceous). Five-year cycles or longer are needed to support R&D on sustainability of long-term production of bioenergy crops.
- *Recommendation:* Per peer review evaluation, prioritize existing long-term trials rather than establishing new trials.
- *Recommendation:* Undertake long-term measurement of greenhouse gasses (GHGs) and ecosystem services from various emerging feedstocks. This should be performed through long-term horizon programs. These could be modeled after programs such as the National Ecological Observatory Network at the National Science Foundation and USDA Watershed Program. This will better inform LCA models.
- *Recommendation*: Evaluate opportunities through field trials and tech-economic studies for biofuel crops in non-irrigated semi-arid lands.

3) **Improving Biomass Logistical Systems**

- *Problem Statement*: Feedstock production is very distributed and low density. Design and implementation of logistical systems that densify feedstocks and deliver to

processing nodes is a limiting factor to creating a lignocellulosic-based biofuels industry.

- *Recommendation:* Need well-developed logistical models to deliver feedstock to processors in a cost-effective manner, including integration of national efforts.
- *Recommendation:* Develop densification systems and assess their energy efficiency.
- *Recommendation:* Linking feedstocks to end uses is critical to determining the optimum logistics system.
- *Recommendation:* Need research to evaluate the processes needed to increase the energy density of feedstocks and to determine impacts on chemical composition and conversion, including lignin separation and potential synergies between logistical operations and downstream conversion operations.

4) **Indirect Effects**

- *Problem Statement*: There are currently more stringent system boundaries applied for biofuels than competing types of transportation fuels.
- *Recommendation*: Perform analysis on the indirect effects across all fuel types including petroleum. This analysis should include current and future fuel sources including fossil fuels (e.g. tar sands, deep sea oil).
- *Recommendation*: The Committee recognizes the current work underway on indirect land use and recommends that the current research continue to completion.

5) **Access to Land-Use Information**

- *Problem Statement*: Although there is substantial acreage that could be used for bioenergy production, effective decision making on use is impaired by insufficient information on current use patterns.
  Recommendation: Develop a dataset on land use that identifies land that can be used for bioenergy initiatives.

6) **Algae and Other Organisms**

- *Problem Statement*: The economic and environmental viability of photosynthetic algae is unknown. Water needs are a key concern for the viability of algae as a feedstock.
- *Recommendation*: Perform a techno-economic engineering and systems analysis for photosynthetic algae including LCA and environmental analysis.

CONVERSION RECOMMENDATION

1) Conversion Technology Database

- *Problem Statement:* DOE/USDA and the Merit Review Process lack a comprehensive database of conversion technologies and the technical focus of various universities, companies, and institutes.

- *Recommendation:* Conduct a domestic and international assessment of innovative conversion technologies and incentives to accelerate technology deployment in order to assess the position of the United States relative to other countries and to broadly leverage promising technologies.
- *Recommendation:* DOE should maintain a domestic and global database that should be a resource for merit reviews and publicly available to ensure that the federal government reduces redundancies and to guide content of future solicitations.

2) <u>Separations Technologies</u>

- *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.
- *Recommendation:* Conduct a review of the status of chemical and physical separations R&D, 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.

3) <u>Prescriptive Solicitations</u>

- *Problem Statement:* Proscriptive solicitations can be too narrowly focused and limit the potential of promising new technologies.
- *Recommendation:* Solicitations should not exclude feedstock blending for conversion processes that can excel if they utilize multiple feedstocks in their development to reduce the risks involved with introducing multiple new technologies. For example, cellulosic sugars blended with traditional carbohydrate feedstocks or MSW blended with agricultural or energy crop feedstocks.
- *Recommendation:* Solicitations should allow for as much flexibility as possible in biofuel output requirements. Solicitations focused on minimum biofuel output requirements for a new commercial biorefinery (100%, 51%, etc.) can be arbitrary and not economically viable for some technologies. Diversification and flexibility are often needed to make plants economically viable, though strategic intention of such solicitation must be preserved.

4) <u>Scale of Supply/Conversion Systems</u>

- *Problem Statement:* DOE solicitations often do not take into account variations in the optimal size range (energy, environment, and socioeconomic) for different technology pathways using different feedstocks.

- *Recommendation:* DOE (including the Loan Guarantee Program) should incorporate more flexibility in the size requirements for commercial plants.
    - No technology can jump more than 1 scale and work should progress in methodical scale increases; reflect on solicitation processes to ensure that projects have first demonstrated lab success before pilot and firm piloting results at appropriate scale before demonstration/commercial deployment.
    - Small-scale systems can be commercially viable and still generate profits. Any minimum size requirements should be explained in the funding opportunity announcement.
    - Biomass scale-up requirements are different than those for petroleum refineries and need to be better understood.

5) <u>Drop-In Fuels – Definition</u>

- *Problem Statement:* There appears to be no formal, standardized definition of "drop-in biofuels" and how this definition differs from that of "advanced biofuels," which are defined in the Energy Title of the *Energy Independence and Security Act of 2007* as "renewable fuel, other than ethanol derived from corn starch, that has lifecycle greenhouse gas emissions, as determined by the Administrator, after notice and opportunity for comment, that are at least 50 percent less than baseline lifecycle greenhouse gas emissions."
- *Recommendation*: Develop a clear definition of the term "drop-in biofuels" that emphasizes the distinction between this group of biofuels and "advanced biofuels." The definition should be well connected to the societal drivers (e.g., reduction in GHG and deployment without extra infrastructure investment), and DOE should attempt to maintain consistency of usage throughout agencies.

6) <u>Drop-In Fuels - R&D on Hydrogen (H2) Production</u>

- *Problem Statement:* Many technology platforms require H2; research investment is needed to explore ways to produce H2 for conversion processes from biomass and incorporate scalability needs and cost reductions. (e.g., innovative membrane technologies and process intensification). In general, new methods are needed to chemically reduce biomass.
- *Recommendation:* Begin investment on potential opportunities to produce cost-effective H2 for catalytic upgrading of intermediates derived from thermochemical and biochemical processes for production of renewable drop-in fuels.

7) <u>Merit Review</u>

- *Problem Statement:* The merit review process often suffers from a lack of technical industry perspectives on the challenges involved in commercial production and scale-up.
- *Recommendation:* Invite more private industry experts, particularly those with commercial scale-up experience, to participate in the merit review process (except for exploratory programs).

INFRASTRUCTURE RECOMMENDATIONS

1. Drop-In Biofuel Timing and Viability

- *Problem Statement:* First and second generation ethanol blend fuels provide immediate GHG and energy diversity benefits. Third generation and later "drop-in" biofuels hold the promise of future GHG and energy diversity benefits and we must continue to invest in these. Resolution of immediate implementation issues associated with first and second generation fuels is being deferred on the grounds that drop-in fuels will preclude the need to spend time, money, and effort to resolve these issues. These issues include vehicle and other end-use device fuel compatibility issues, distribution issues, and interaction with complex emission, fuel economy, and carbon dioxide (CO2) regulations.

- *Recommendation:* Planning and analysis activities should be undertaken to compare the GHG and energy diversity benefits of near-term biofuel alternatives, such as ethanol versus longer term drop-in fuel options. Consideration must include the transitional benefits and certainty of current alternatives. Pursuit of drop-in fuels as an avoidance mechanism for investment in first and second generation biofuel infrastructure must be supported by sound planning and analysis. This planning and analysis must include factors such as probability of drop-in fuel technological readiness on all available feedstocks, timing, investment, and product cost.

- *Recommendation:* An action plan should be established based on the described planning and analysis activity to establish an immediate growth pathway for first and second generation biofuels along the Energy Infrastructure and Security Act/RFS pathway. The action plan should be formulated across DOE, USDA, EPA, National Highway Traffic Safety Administration, and industry to address and remove all roadblocks to growth. Industry partners must include fuel retailers, fuel distributors, fuel producers, and auto manufacturers.

2. Drop-In Biofuel Definition and Specification

- *Problem Statement:* There is no consistent and broadly recognized definition for drop-in fuels. Specific technical definitions for "drop-in" fuels are critical building blocks for research on the fuels themselves, as well as infrastructure issues and end use adoption.

- *Recommendation:* Agencies are advised to engage in research, planning, and analysis activities to develop clear definitions of different categories of "drop-in" fuels:
  - Drop-in fuels for spark-ignited engines (gasoline engines)
  - Drop-in fuels for compression-ignition engines (diesel engines)
  - Drop-in fuels for jet-aviation engines
  - Drop-in fuels for combined heat and power

- *Recommendation:* Agencies are advised to engage in collaborative research with standard setting organizations, such as the American Society for Testing and Materials, the Centre on Regulation and Competition, trade associations, and the military for end use devices (Auto Alliance, Small Engine Manufacturers Association, American Petroleum Institute, Department of the Navy, etc.) as the definitions for drop-in fuels are developed. Consider comparable standard setting process for other industries, such as the pharmaceutical industry (for bio-similar products).

3. <u>Octane of Low- and Mid-Level Ethanol Blend Fuels</u>

- *Problem Statement:* The opportunity to raise the octane value of commercial gasoline-ethanol blend fuels has not been realized with the transition to E10 blend fuel in the United States.

- *Recommendation:* Agencies are advised to undertake planning and analysis to realize the tank-to-wheel efficiency potential of mid-level ethanol blend fuels by increasing the required octane rating of those blends. As certification fuels are adjusted to reflect ethanol blends found in the field, gasoline blend-stocks should be adjusted to allow the certification fuels to have higher octane characteristics. This would allow improved thermal-efficiency and optimization of engine size (lower displacement and weight) over time, as auto manufacturers take advantage of those fuel characteristics in new model design. Octane requirement increases for ethanol blend fuels can and should be pursued regardless of policies related to flex fuel or ethanol tolerant vehicles.

4. <u>Near-Term Recommendations for Higher Blend Ethanol Fuel Use:</u>

- *Problem Statement:* Biofuel growth along the RFS trajectory is falling behind. Planning and analysis activities should be immediately undertaken in key areas to increase the compatibility of the car parc at a rate that can support growth along the RFS trajectory. Failing to take immediate action will result in lost energy independence opportunity and lost CO2 reduction opportunity. Vehicle and fuel compatibility choices should be designed to account for the fuels that vehicles are most likely to see in the field (E10-15), while enabling growth in ethanol concentration over time per the RFS, without durability or other consumer dissatisfaction issues. Certification fuels should reflect field fuel realities with appropriate accommodation for energy density.

- *Recommendation:* Option 1 – Define and implement a new category of vehicles defined as Blend Optimized Ethanol Tolerant Vehicles.
  In light of EPA's approval of E15 for use in model 2001 vehicles and later, adopt the design of a regulatory framework for the fuels vehicles are likely to use, while accounting for planned increase in the amount of ethanol in gasoline-ethanol blend fuels over time, per the RFS.

  Adopt certification fuels that reflect the field fuel waiver for 2001 and later vehicles, with adjustment for energy density; for example, E15 certification fuel for model year 2014 or later, with accompanying energy density adjustment (approximately 5%). Adjust certification fuel subsequently in 5 year increments; for example, adjust certification fuel in 2019 to E20, with associated further energy density adjustment (approximately 6.5%).

  Adjust the vehicle certification protocol to require vehicle optimization on the defined mid-blend certification fuel while requiring tolerance of ethanol blends ranging from E0 to E85 in vehicle design. Tolerance is defined here as the ability to operate on blends from E0 to E85 without damage to the vehicle or substantial loss in drivability/performance under defined operating conditions. Emission performance, diagnostics, and fuel economy would only be demonstrated in the certification process on the certification fuel blend itself (initially E15), not on higher blends for which the vehicle is only designed to be tolerant. This would result in vehicles being optimized on the fuels they are more likely to see in the field, without the cost of full flex fuel vehicle (FFV) functionality. This would allow the production of vehicles that are tolerant of a range of blends with greatly reduced interaction with emission and on-board diagnostic regulations.

- *Recommendation:* Option 2 – Pursue broader implementation of FFVs in the car parc thru incentive or mandate.

  Research, planning, and analysis should be undertaken on the barriers to harmonize FFV technology with new Tier 3/LEV 3 tailpipe/evaporative emission, CO2, and on-

board diagnostic requirements administered by the EPA and the CARB in the United States. Since new CO2 and fuel economy regulations are designed to be technology forcing toward electrification, auto manufacturers are unlikely to produce FFVs in high volume going forward, without harmonization of the new standards with FFV certification requirements and protocols.

Vehicles that are designed to work with varying blends have different regulatory interaction than vehicles designed to work with a single or small range of blends. The need for this accommodation is based on differences in the vapor pressure and boiling characteristics of low-level gasoline ethanol blends and high-level gasoline ethanol blends.

5. **Market Creation – Non-Vehicle End-Use Devices**

- *Problem Statement:* The fuel related capability of non-vehicle end-use devices must match that of vehicles with which they share fuel distribution infrastructure.
- *Recommendation:* Research should be undertaken to understand the design requirements of establishing a minimum biofuel blend capability in non-vehicle end-use devices (marine, outdoor power equipment, other). This should follow the EPA vehicle fuel waiver.

6. **Market Creation – Fuel Blends and Distribution**

- *Problem Statement:* Vehicles and other end-use devices will require different ethanol blend fuels over time due to legacy effects.
- *Recommendation:* Research should be undertaken to explore the barriers to implementing blender pumps that are capable of dispensing fuels to meet the design specification of all end-use devices (vehicles, marine, outdoor power equipment) (specifically call out certification fuels in non-vehicle end-use devices). Research should be undertaken to explore the potential benefits of implementing technology and conducting education and outreach to prevent mis-fueling of end-use devices within the flex fuel (blender) pump context. Planning and analysis should be undertaken to identify methods that successfully encourage consumer selection of the highest biofuel blend available to them. This study should include flex fuel (blender) pump configurations and consumer economic factors.

7. **Market Creation – Post Bio-Refinery Infrastructure**

- *Problem Statement:* Fuel distribution terminals and refueling stations must be configured to allow for efficient and air quality compliant delivery of ethanol and gasoline components in the (blender) pump context.

- *Recommendation:* Planning and analysis should be undertaken to establish the parameters of hydrocarbon fuel blend stock compatibility and feasible delivery/transportation mechanisms that could support the (blender) pump market model. This study must include fuel volatility compliance, tankage, and transportation issues.

  USDA predictions are that biofuels production will be located mainly in the southeast and east central regions. Major fuel markets are concentrated along the west and east coasts. The current transportation infrastructure is insufficient to accommodate the volumes of biofuels that will be produced. Research should be undertaken into the barriers and solutions of transporting biofuels from biorefineries to markets.

8. Biopower vs. Liquid Alternative Transportation Fuels

- *Problem Statement:* Biomass for electricity (pure biomass and co-firing with coal) vs. biomass for liquid transportation fuels must be explored. More planning and analysis should be focused on the relative value of using biomass to produce electricity versus liquid transportation fuels, in the short, medium, and long term.

- *Recommendation:* Research should be undertaken on the infrastructure needs and regulatory barriers of biopower, including the optimal locations, scale of plants, and potential densification strategies and technologies. The influence of battery energy density in the short and medium term (significantly lower than the energy density that can be achieved from liquid fuel alternatives) must be factored in the analysis. Factors including timing, car parc impact, carbon intensity, rural development, magnitude of capital required for infrastructure investments along different technology pathways and the energy requirements for heating/cooling vehicles (utility aspects) must be understood.

SUSTAINABILITY RECOMMENDATIONS

1) Environmental Sustainability – Land and Resource Use

- *Problem Statement:* Converting existing land to alternative uses will be considered. The complete ecological impacts may not be covered in life-cycle analysis due to incomplete data on the current ecosystem. For example, baseline data on the existing plant system would be helpful for decision making to support the maintenance of biodiversity and the increase of biofuels production.

- *Recommendation*: We recommend continuing the environmental assessment activity and those activities under development to analyze the current ecosystem as a baseline indicator for direct land-use issues. The analysis should be compared to other energy systems.

2) <u>Economic Sustainability</u>

- *Problem Statement*: There are currently no good models for growth and economic analysis of a sustainable bioenergy industry
- *Recommendation*: Using best in class analysis of both successful and unsuccessful biofuels projects funded by the DOE and/or USDA with funding in excess of $25 million, do an analysis to identify the risks and potential de-risking solutions in order to create a decision tree for those projects with the highest potential for success.
- *Recommendation*: We recommend a comparative economic analysis of other countries' management of their sustainable, renewable industries by using an economic systems approach to:
  - Capital allocation
  - Capital markets
  - Systems analysis
  - Comparative economic analysis.

- *Problem Statement*: Energy industry capital assets are currently under used.
- *Recommendation*: We recommend studies to examine the potential to leverage existing capital assets to advance bioenergy and bioproduct production.

- *Problem Statement*: Government and industry timelines with regards to research and commercialization are not aligned.
- *Recommendation*: We recommend that there be studies to explore how to match the timelines of Program decision making with R&D timelines and commercialization timelines to determine the "best in class" (most robust and sustainable) template for bench to market implementation.

3) <u>Economic, Environmental, and Social Sustainability</u>

- *Problem Statement*: To expand the industry, we have to manage multiple social issues such as job creation, training, access, and infrastructure. Growth management issues need further study.
- *Recommendation*: A comprehensive study should be conducted on the potential social and economic impacts of the emergence of a biofuels, biopower, and biobased products economy. The study should:
  - Investigate the number and kinds of jobs created, the workforce required, workforce availability in rural areas, and the likelihood and size of population shifts from urban to rural areas.
    - Estimate and project the consequential increase in demand for human infrastructure especially in rural areas—e.g., housing, education, healthcare facilities, communication, police and fire protection, etc.

        - Estimate and project the consequential need for transportation infrastructure for both the movement of biomass and the movement of the increased population—e.g., roads, bridges, rail, highway, air service, power lines, natural gas and fuel transmission, etc.
        - Develop a comprehensive plan at the federal level and communicate anticipated needs to state governments and agencies, which will bear the brunt of these changes.
        - The study should include research and analysis into the appropriate size of biomass-based businesses and industries for the economic, natural, and social resources in the area.
- *Recommendation*: We recommend studies to inform a plan to drive adoption of the bioeconomy (biofuels, bioproducts, and biopower). Further, the impacts, both positive and negative, of such changes on the current business community should be studied. Such a study should try to address such questions as:
    - How to maximize opportunities for rural economic development utilizing business and technology systems that encourage local ownership of biofuel, bioenergy, and bioproduct systems?
    - Will existing agricultural supply and agricultural processing be negatively impacted?
    - Will competition for labor increase wages in rural communities forcing some marginal businesses to close?

4) <u>Crosscutting</u>

- *Problem Statement*: Genetically modified organism regulation processes may make it too expensive to deploy some bioenergy crops.
- *Recommendation:* We recommend (as a crosscutting issue with the feedstock subcommittee) that studies be performed to specifically address high-cost issues regarding bioenergy crop. Studies are needed to define the appropriate tests to review genetic modification and the differences in risks that exist between bacteria, yeast, algae, and higher plants, including differences in cultivation methods.

- *Problem Statement:* Water quality and availability is emerging as a key issue in the growth of the bioeconomy.
- *Recommendation*: Water utilization in the production of biofuel crops and in the production of biofuels has gained additional scrutiny in recent years. Enhanced and integrated research should be conducted to better understand and compare water use regionally at all stages of biofuels production and ways in which to conserve water—and maintain water quality—throughout this life cycle. The analysis should be compared to other energy systems.

- *Problem Statement*: Additional data needs to be developed to expand the ability of the LCA models to analyze and compare bioenergy systems.
- *Recommendation*: We recommend that USDA and DOE institute a program to monitor and measure relevant environmental parameters for inclusion in the model that is used, especially the current and expected feedstocks for biofuels, biopower,

and biobased products. These measurements should be made in different geographies and climates and should remain in place for at least 5 years, to cover the impacts of weather and soil variability

- *Problem statement:* DOE and USDA have made awards to large-scale commercialization projects, which have typically faced significant challenges that altered the path to success, but may have provided important lessons learned for future initiatives. The Administration recently announced a new initiative for large-scale production of "advanced drop in biofuels" for use by the U.S. military. This subcommittee believes that the success of this drop-in biofuel project would benefit by understanding some of the issues, as well as their solutions, that were part of the previous DOE large project experience.
- *Recommendation:* We recommend that DOE institute a transparent risk analysis process that incorporates these "lessons learned" and that this process be used to develop the criteria in the RFPs under which competing projects will be selected. Based on previous experience, these criteria might include more in-depth knowledge of the feedstock biology, harvesting and storage challenges, and scale of the potential feedstock, prior validation of the key technologies at an appropriate scale, and an experienced management team. The statement of criteria ought to be sufficiently rigorous so that the administering agencies would be in a position to make no awards if the criteria were not satisfied.

Attachment A: Committee Members

Attendance – November 8–9, 2011

Co- Chairs	Affiliation	Attended?
Steve Briggs		YES
Ronnie Musgrove		YES

Members	Affiliation	Attended?
Bob Ames	Tyson Foods	NO
William Berg	Dairyland Power	YES
David Bransby	Auburn University	YES
Pamela Reilly Contag	Cygnet Biofuels	YES
Bruce Dale	Michigan State University	YES
Harrison Dillon	Solazyme	YES
Joseph Ecker	Salk Institute for Biological Studies	NO
Neal Gutterson	Mendel Biotechnology	YES
Dermot Hayes	Iowa State University	NO
Jennifer Holmgren	LanzaTech Limited	NO
Huey-Min Hwang	Jackson State University	YES
E. Alan Kennett	Gay & Robinson Sugar	NO
Kevin Kephart	South Dakota State University	YES
Craig Kvien	University of Georgia	YES
Jay Levenstein	FL Dept. of Ag. and Consumer Services	NO
Stephen Long	University of Illinois	NO
Mark Maher	General Motors	YES
Jim Matheson	Flagship Ventures	NO
Mary McBride	CoBank	NO
Maureen McCann	Purdue University	YES
David Nothmann	Arborgen	NO
Mitchell Peele	North Carolina Farm Bureau	NO
Michael Powelson	The Nature Conservancy	NO
William Provine	Dupont	YES
James Seiber	University of California	YES
J. Read Smith	Agricultural Energy Work Group	YES
John Tao	O-Innovation Advisors, LLC	YES
David Vander Griend	ICM	YES
Todd Werpy	Archer Daniels Midland Company	YES
Rodney Williamson	Iowa Corn Promotion Board	YES

Total: 20 of 32 members attended

Attachment B: Meeting Agenda

Day 1: Technical Advisory Committee Meeting:
November 8, 2011

8:00 a.m.–8:30 a.m.	*Breakfast (to be provided for the Committee)*
8:30 a.m.–9:00 a.m.	Welcome *Co-Chair – Steve Briggs* *Co-Chair – Ronnie Musgrove*
9:00 a.m.–9:30 a.m.	Presentation: Committee Business and DOE Updates *Elliott Levine, Biomass Program, U.S. Department of Energy*
9:30 a.m.–10:00 a.m.	Presentation: USDA Update on Biomass R&D Activities *Bill Hagy, Rural Development, U.S. Department of Agriculture*
10:00 a.m.–10:15 a.m.	*Break*
10:15 am–12:00 pm	Presentations: Subcommittee Reports and Discussion of Recommendations *Feedstock* *Conversion* *Infrastructure* *Sustainability*
12:00 p.m.–1:00 p.m.	*Lunch (to be provided for the Committee)*
1:00 p.m.–1:30 p.m.	Vote: FY 2011 Annual Recommendations
1:30 p.m.–1:45 p.m.	Presentation: Updating the National Biofuels Action Plan *Sarah Lynch, U.S. Department of Energy*
1:45 p.m.–3:15p.m.	Discussion: TAC Input Session to Plan Update Rooms TBD *Facilitated by Board WG Co-Chairs and Operations Committee Members*
3:15 p.m.–3:30 p.m.	*Break*
3:30 p.m.–5:30 p.m.	Presentations: Review of Current Biomass Solicitation Processes *Mark Decot, Biomass Program, U.S. Department of Energy* *Carmela Bailey, NIFA, U.S. Department of Agriculture*
5:30 p.m.–5:45 p.m.	Public Comment
5:45 p.m.	Adjourn

Day 2: Technical Advisory Committee Meeting:
November 9, 2011

8:00 a.m.–8:30 a.m.	*Breakfast (to be provided for Committee)*
8:30 a.m.–10:00 a.m.	Presentation: Overview of Defense Production Act Title III Technology for Advanced Drop-in Biofuels Production *Zia Haq, Biomass Program, U.S. Department of Energy* *Sarah Bittleman – U.S. Department of Agriculture*
10:00 a.m.–10:30 a.m.	Presentation: NAREEE Update *Carol Keiser-Long, NAREEE Committee Chair*
10:30 a.m.–10:45 a.m	*Break*
10:45 a.m.–12:00 p.m.	Presentation: NRC Report: "Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy" *Wallace E. Tyner, Report Co-Chair, Purdue University*
12:00 p.m.–12:15 p.m.	Discussion: Next Biomass TAC Meeting Agenda Topics
12:15 p.m.–12:30 p.m.	Closing Comments with Farewell to Departing Members *Co-Chair – Steve Briggs* *Co-Chair – Ronnie Musgrove*
12:30 p.m.–1:30 p.m.	*Lunch (to be provided for the Committee)*
1:30 p.m.	Adjourn