

**Biomass Research & Development
Technical Advisory Committee**

September 29-30, 2010

Meeting Summary

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List of Acronyms

Committee - Biomass Research and Development Technical Advisory Committee

Board - Biomass Research and Development Board

DOE - U.S. Department of Energy

USDA - U.S. Department of Agriculture

NAREEE - National Agricultural Research, Extension, Education and Economics

IBR - Integrated Biorefinery

Biomass Act - Biomass R&D Act of 2000

NREL - National Renewable Energy Laboratory

Navy - Department of the Navy

GTI - Gas Technology Institute

I. Purpose

On September 29-30, 2010, the Biomass Research and Development Technical Advisory Committee (Committee) held its third quarterly meeting of calendar year 2010. The purpose of the meeting was to receive updates and discuss recent activities of the U.S. Department of Energy (DOE), the U.S. Department of Agriculture (USDA), and the National Agricultural Research, Extension, Education and Economics (NAREEE) board. The Committee also heard presentations from Proton Power and from the USDA and Department of Navy on their joint efforts. In addition, the Committee hosted two panels, one on DOE's cellulosic ethanol integrated biorefineries (IBR) projects, and the other on DOE's "drop-in" fuels projects. Furthermore, the Technical Advisory Committee provided report-outs from breakout meetings focused on feedstocks, conversion, infrastructure, and sustainability. The one and a half-day meeting was held in Denver, Colorado.

A list of attendees is provided in Attachment A and the meeting agenda is in Attachment B. Meeting presentations can be viewed online at <http://biomass.govtools.us> (click on "Publications").

Background: The Committee was established by the Biomass R&D Act of 2000 (Biomass Act) which was repealed and replaced by Section 9008 of the Food, Conservation, and Energy Act of 2008.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 Research and Development 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 research and development.

II. DOE Update

Laura McCann, Biomass Program, U.S. Department of Energy

Laura McCann updated the Committee on the recent funding awards made by the Biomass Program. The Feedstock Sustainability solicitation has conditionally awarded funding to North Carolina State University (\$2.1M), Purdue University (\$1.6M), and the University of Minnesota (\$0.8M). These projects will support research focused on designing landscapes that produce bioenergy feedstock while protecting air, soil, water, and wildlife resources and enhancing ecosystem services. The Advanced Biofuels Technology Development awards selected include W.R. Grace and Company (\$3.3M), Pacific Northwest National Laboratory (\$3.1M), Gas Technology Institute (\$2.4M), and Battelle Memorial Institute (\$3.2M) and are intended to advance technologies for the thermochemical conversion of biomass into advanced biofuels that are compatible with existing fueling infrastructure. Finally, the DOE/USDA Joint Solicitation pre-application phase was completed. Full applications are due November 17, 2010.

Pamela Contag asked why National Renewable Energy Laboratory (NREL) employees are not considered employees of DOE even though NREL is DOE's dedicated Lab. NREL is government owned, but contractor operated.

Doug Hawkins asked for a general overview of the IBRs. Melissa Klembara said that most of the Biomass Program's IBR projects are ready to construct, but many will need a loan guarantee in order to move

forward. The Biomass Program is also subject to appropriations in order to be able to fund some of the demonstration projects. The Program has been conducting Comprehensive Project Reviews over the last six months of all the non-Recovery Act projects, in order to gain a better understanding of progress, technical issues, financing, and economics of the plant to assist with prioritization in case funding decreases.

III. USDA Update

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

Bill Hagy began by updating the Committee on the **Biomass Crop Assistance Program** which recently completed 400 awards. The proposed rule received 26,000 comments and responses should be published approximately four weeks from the meeting. The awards cover ten-year payments for energy crops, which includes subsidies for growing, harvesting, storing, and transporting.

The **Biorefinery Assistance Program** is primarily used for fuels, but can include biopower and bioproduct elements. Range Fuels is one of two awardees, and although the company is currently making butanol, it plans to eventually make ethanol. Sapphire Energy is the other awardee, whose facility will be built in New Mexico. The company will be growing algae using waste water from irrigation in an open pond configuration. The algae will be converted to gasoline, jet, and diesel fuels. USDA expects that loan guarantee announcements will be made on these projects in the next couple of weeks. A new solicitation is expected using the balance of funding from the 2008 Farm Bill.

The **Repowering Assistance Program** awarded funds for the Lincoln Way facility. The ethanol factory will be retooled to incorporate a combined heat and power system for greater efficiency. Four more applications are being reviewed under this program.

The **Advanced Biofuel Payment Program** had \$80M available for FY10, and in FY11 that number will increase to \$85M. This is a non-competitive program in which a share can be claimed if certain minimum requirements are met. The proposed rule is under review and will be published late 2010/early 2011 for FY12 funds.

The **Rural Energy for America Program** announced its latest round of awards, with 400 already made and approximately 2,000 more anticipated by the end of 2010. Funds are awarded to agricultural producers and rural small business owners. USDA anticipates that this program will continue, however some changes may be made to it during the next Farm Bill to address gaps in funding assistance. USDA is currently participating in early Farm Bill discussions taking place in Congress and sharing lessons learned when implementing programs established in the last Farm Bill.

The **Biofuels Roadmap** was released on June 23, 2010 and outlines steps to boost biofuels production. The Roadmap is an effort by USDA to help establish what each region needs to do in order to meet the renewable fuels mandate. Overall, USDA has calculated that 527 new biorefineries will need to be constructed, a \$168 billion investment, in order to meet the 2022 targets. The National Resources Conservation Service State Conservationist, Rural Development State Director, and Farm Service Agency

Executive Director are holding public meetings in all 50 states to hear feedback on the roadmap. The roadmap is a working document and is not meant to be finalized. Since many are unaware of the document, the public meetings will help open up the dialogue and provide feedback.

For instance, USDA has heard feedback that blender pumps only mean E85 to most people and will therefore be referring to them as flex fuel pumps. The biggest problem with a higher blend is the lack of infrastructure. Secretary Vilsack is supportive of increasing the blend to E15. Gil Gutknecht pointed out that Brazil has multiple choices as to what kind of pumps and fuels they want. As this is not a new idea, what are some of the obstacles?

Jay Levenstein noted that the report anticipates roughly 50 percent of the biomass supply will come from the Southeast, much of which will be supplied by his home state of Florida. Considering Florida has been unable to get its first plant in the ground, how do we use the report's information to get commercial operations up and running? Bill Hagy said that partnering with industry was crucial as the government cannot fund everything. That said, potential government solutions may include tax incentives, new programs, and a federal guarantee.

The **Sustainability Task Order** is moving forward at USDA's request that Booz Allen Hamilton to analyze the various models, databases, documents, reports, etc. that are available to assist with the assessment of the sustainability(economic, social and environmental) of future investments. This analysis may become the first step in the development of a tool to conduct this assessment. The purpose of the task order is to develop recommendations on what a sustainability tool would look like (data, parameters, etc.). A report on the progress of the task order is to be presented to the Biomass Board by Booz Allen Hamilton at the December 14th Board meeting.

The **Board** formed three new interagency working groups comprised of technical experts from various federal agencies. The Feedstock Sources/Supply group will examine genetic improvements and best practices. The Logistics and Distribution group will investigate feedstock logistics, fuels distribution and infrastructure. The Conversion group will cover research and development coordination and commercialization of conversion technologies.

Mr. Hagy also covered USDA's outreach and marketing initiatives. The **Farm Foundation** is holding renewable energy biomass education field days November 16-18, 2010, at the Crowne Plaza Hotel in Knoxville, Tennessee. The will include an educational lecture series aimed at land owners/managers free of charge.

The **Hawaii Initiative** is the first product of a USDA and Department of the Navy (Navy) memorandum of understanding to promote the use of biofuels. The Hawaii Biomass and Bioenergy Ag Conference was held the week of September 20, 2010. Much of the Navy's southern fleet is stationed in Hawaii and uses billions of gallons of fuel. Additionally, Charles Kinoshita pointed out that 92-98 percent of Hawaii's energy is imported. Of that, 88 percent is petroleum derived, mostly from foreign sources, including Indonesia and the Middle East, possibly due to the Jones Act. Of the energy that is imported, one-third goes to power production, one-third to aviation fuel, and one third to ground transportation. Furthermore, Hawaii imports approximately 95 percent of its food and typically has only one week's

supply. Both energy and food security issues are very important to the state. Coupled with Hawaii's potential for a suite of renewable energies (wind, solar, algae, geothermal, wave), and its remote location, Hawaii makes for a good test site.

IV. National Agricultural Research, Extension, Education and Economics Update

Carol Keiser-Long, Renewable Energy Committee Chair

Carol Keiser-Long updated the Committee on the NAREEE Board and its Renewable Energy Committee. This included a rundown of new Committee members and a review of its annual recommendations.

V. USDA and Department of the Navy Joint Efforts

Chris Tindal, Director for Operational Energy, U.S. Department of the Navy with an introduction from Bill Hagy, Rural Development, U.S. Department of Agriculture

USDA is partnering with the Navy in order to help the Navy receive the biofuels they need in order to meet their five energy goals. The Navy recognizes that in order to achieve success they need long-term supply contracts a minimum of 15 to 20 years. A policy change is expected to be included in the National Defense Authorization Act this year in order to allow for long-term contracts to help reach their goals. The Navy will also be partnering with the Air Transport Association in order to help increase demand. The government represents 2 percent of the petroleum market and DoD represents 93% of the total government consumption.

Rodney Williamson asked what the biggest impediment to production, development, and delivery is for biofuels use by the Navy. Mr. Tindal said that first and foremost we needed the biofuels industry to get a biorefinery up and running. Moving from a 5 year contract to a 15-20 year contract should help that along, as the biofuel company will be more able to recapitalize their costs.

Rodney Williamson followed up by asking whether the mature biodiesel industry is a viable option for the Navy. Mr. Tindal said biodiesel is an option for non-tactical vehicles (B20 used in trucks), but not for gas turbines or planes because it is not compatible. The Navy prefers third generation biofuels because they are "drop-in" replacements. Ethanol is used in the Navy's large fleet of flex fuel vehicles, and flex fuel pumps are being installed throughout the Navy to better use these vehicles and expand the fleet.

Gil Gutknecht asked if any research had been done on the cost points that the Navy might be willing to pay for fuels. Mr. Tindal said it depended on the value of energy security. At this point it is unclear how much that is worth. The fuel purchased for the Green Hornet, as an example, was \$60 per gallon. That fuel is now down around \$30 per gallon, and next year it will hopefully be in the \$15-20 per gallon range, and will continue to drop. The Navy recognizes that the industry is in the research and development stage now, but the ultimate goal is to be cost effective when entering a long term contract

with larger volumes. Biofuels producers are saying they can achieve \$2-3 per gallon once their facilities are scaled up.

Doug Hawkins noted that crude oil is being delivered to Hawaii and refined there and inquired whether the Navy had engaged the refinery industry in case a fuel reduction takes place and impacts them and or their businesses? Mr. Tindal said the Navy is engaged with the local utilities and the commercial airlines as they all plan on contracting for biofuels in Hawaii, which should help send a strong demand signal.

Steve Briggs wanted to know what biomass source is being used to make jet fuel. Mr. Tindal said initially they will be looking at converting sugarcane into biofuels since it is the most available feedstock. To avoid the food versus fuel debate they will be using the parts of the sugarcane not used for sugar. In the long run, the source does not matter as long it is not a food crop.

VI. IBR Projects Panel – Cellulosic Ethanol

DOE Procurement – Liz Moore

Liz Moore from DOE's Golden Field Office walked through the process of how projects are selected for IBR solicitations. Ms. Moore highlighted the IBR American Reinvestment and Recovery Act projects and went into more depth regarding the merit review process to choose those projects.

Abengoa – Bob Wooley

Bob Wooley from Abengoa provided an overview of the company and its bioenergy holdings, schedule, trials and tribulations. Abengoa is a large international company with diverse interests in renewable energy. Their bioenergy investments are focused on biochemical conversion to ethanol with plants in the United States, Brazil and Europe. Dr. Wooley discussed the company's cellulosic ethanol timeline in depth, which anticipates start-up in 2013.

ZeaChem – Tim Eggeman

ZeaChem's Tim Eggeman discussed the company's process, which although feedstock independent, is currently using hybrid poplar (supplied by Greenwood Resources) and will expand to other feedstocks later. The technology is a biochemical/thermochemical parallel hybrid process which Mr. Eggeman compared to a hybrid car. The yield of poplar farming and the processing yield in the factory drives the economics and the environmental footprint. Mr. Eggeman touched on a variety of other topics including challenges and policy recommendations.

Questions

J Read Smith asked what ZeaChem's supply of hybrid poplars is being used for now. Mr. Eggeman said it is currently managed for saw logs which must be tall and straight (12 year rotation). ZeaChem would like to change to a less labor intensive shorter rotation with smaller, bushier trees that last for five coppice harvests.

Gil Gutknecht inquired as to the price points each company has in mind. Abengoa is hoping that selling ethanol for \$3 with the credit will be profitable.

Bruce Dale asked what obstacles were looming largest for replicating their first commercial plants. Abengoa responded that it will be expensive and that they must continue to reduce costs. They will alter their conservative decisions after running their first plant and working out any unforeseen issues. Feedstock availability is still an issue and we will continue to work on the development of other dedicated energy crops. ZeaChem said that financing and feedstocks are the two biggest issues. In the corn ethanol industry's early years, after a couple of standard packages of technology were vetted, financing was much easier to obtain. In terms of feedstock availability, they will continue to work with both large and small growers to have a dedicated supply of hybrid poplar under contract for 80+ percent of their feedstock needs, with the remainder obtained from agricultural residues at market prices.

VII. "Drop-In Fuels" Projects Panel

Amyris – Todd Pray

Todd Pray from Amyris provided an overview of the company. Farnesane - Amyris renewable diesel - is the primary product of their IBR project. Farnesane is derived from the fermentation intermediate farnesene, which is also used to make a suite of other marketable products. Mr. Pray also discussed process performance and scale-up. They are adapting the process being used at their Brazilian facility using feedstocks available in the United State.

ClearFuels – Warren Davis / Rentech – Joshua Pearson

ClearFuels' main technology is a biomass reformer producing syngas which can be converted to an array of products. By integrating the ClearFuels process with Rentech's Fischer-Tropsch process the syngas will be converted to diesel and jet fuel. The feedstocks for the integrated biorefinery will be virgin woodwaste and bagasse. The piloted ClearFuels process and the demonstrated Rentech process will be a first of a kind integration to convert biomass to liquid drop in fuels. ClearFuels intends on partnering with other companies like Rentech at later dates.

Gas Technology Institute – Terry Marker

The Gas Technology Institute (GTI) is a non-profit company with a background in gasification and fluidized bed conversion. Their project produces gasoline and diesel using integrated hydrolysis and hydroconversion. The current project is a 14 month project that is now beginning the semi-continuous testing phase. An extension of the project will begin long term catalyst testing in Jun 2011.

Questions

Steve Briggs asked if the panelists thought their technologies will be taken up and used by any of the grain ethanol producers. Ms. Marker thinks they could and should be used. Amyris is bolting their first plant onto an existing ethanol plant. ClearFuels can also bolt on to ethanol plants to use the non-sugar plants.

Doug Hawkins wanted to know the investment cost needed to build the biorefineries, or put another way, what the capital cost is per gallon of fuel. Amyris could not comment on specific costs, and stated that part of the proceeds from their recent IPO will be used to fund capital investment in Brazil, where they are minimizing cost by leveraging existing infrastructure. ClearFuels responded by saying that money will flow to good ideas. GTI said that low capital costs are the key to success. Gasification often

needs a large scale to be economically attractive; therefore GTI is expanding its research to include new technologies that work on smaller scales.

Bruce Dale asked what happens to the sulfur, nitrogen and phosphorus in thermal conversion systems. Rentech said that a lot of the sulfur ends up in the syngas, and that they use sulfuric acid as a recovery mechanism. There is sulfur and ammonia in the resulting char, which can be sent back to the forest as a soil amendment.

VIII. Proton Power

Dr. Sam Weaver, President and CEO, Proton Power

Dr. Sam Weaver from Proton Power spoke to the Committee regarding a scalable thermochemical gasification system to take cellulosic biomass to hydrogen and power. The system has low capital expense costs and boasts the highest hydrogen content of any syngas output at 65 percent. It eliminates the need for hydrogen storage and distribution systems and is a carbon neutral process. The process can even be adapted to create liquid fuels and is ready now.

Jim Martin asked how sensitive the pretreatment process is to moisture. Dr. Weaver said driers are not used and that the process can handle up to 45 percent moisture. As a follow-up Mr. Martin asked if silica in the char was ever a problem. Dr. Weaver answered that it could be a problem with a feedstock like rice hulls. Another problem Proton Power is working on is sulfur, an issue with feedstocks like cotton waste and animal wastes.

Rodney Williamson asked whether their business model was that of an equipment seller or power producer. Dr. Weaver said that they are a manufacturing company, and as such, plan to sell the equipment they make.

Bruce Dale inquired as to the overall efficiency of the process. Dr. Weaver said that the process can be 85 percent efficient thermally, whereas coal is only 30 percent when converting to electricity.

Douglas Hawkins asked how much electricity can be produced with the 1 tonne per hour system. Dr. Weaver said one and a half megawatt hours at \$3 an installed watt, which is roughly equivalent to \$3 million for a one megawatt system.

Gil Gutknecht inquired as to how scalable the technology is, and if there was an optimum size. Dr. Weaver answered that they were not sure on a single unit, but that they can be placed side by side to produce more electricity at one location. A half of megawatt generation capacity, for example, could easily be achieved in a single unit. However, it is unclear as you go larger if design changes will be necessary as there may be heat transfer problems.

Bob Ames asked what Proton Power's ultimate market consisted. Dr. Weaver said that requests are being received across the spectrum from home owners to larger system operators. Large units are simpler from the company's perspective, since it is easier to sell to larger buyers, rather than lots of

individual homes. The system can reduce energy costs by as much as 75 percent to a homeowner. A home system fuel cost would be about \$800 a year for 2,500 square feet.

Steve Briggs wanted to know if low sulfur grade coal is required for the coal to liquid fuel process. Dr. Weaver said that they mainly work with coal char which is low in sulfur and is expected to produce liquid fuel at about \$27 a barrel.

Bill Hagy asked if they had a year's worth of data at their demonstration scale and were ready to go commercial. Dr. Weaver said that the system has run every day for about a year and half, although not continuously. The company would ultimately like to be a supplier of a power facility, not the owners.

IX. Subcommittee Report-Outs

The Feedstocks, Conversion, Infrastructure and Sustainability Subcommittees each presented the latest drafts of their 2010 recommendations to the Secretaries of Energy and Agriculture. Those recommendations can be viewed in Attachment C.

X. Public Comments

No public comments were offered at the meeting.

Attachment A: Committee Member Attendance – September 29-30, 2010 Meeting

Co- Chairs	Affiliation	Attended?
Gil Gutknecht		YES
Steve Briggs		YES

Members	Affiliation	Attended?
Robert Ames	Tyson Foods	YES
William Berg	Dairyland Power Cooperative	YES
David Bransby	Auburn University	NO
Pamela Reilly Contag	Cygnnet Biofuels	YES
Bruce Dale	Michigan State University	YES
Bob Dinneen	Renewable Fuels Association	NO
Joseph Ecker	Salk Institute for Biological Studies	YES
Richard Hamilton	Ceres Inc.	NO
Douglas Hawkins	Rohm & Haas	YES
Dermot Hayes	Iowa State University	NO
Jennifer Holmgren	LanzaTech	YES
E. Alan Kennett	Gay & Robinson Sugar	NO
Charles Kinoshita	University of Hawaii	YES
Craig Kvien	University of Georgia	YES
Eric Larson	Princeton University	NO
Jay Levenstein	Florida Department of Agriculture and Consumer Services	YES
Stephen Long	University of Illinois	NO
Mark Maher	General Motors	NO
Jim Martin	Omni Tech International	YES
Jim Matheson	Flagship Ventures	NO
Mary McBride	CoBank, ACB	YES
Mitchell Peele	North Carolina Farm Bureau	YES
Michael Powelson	The Nature Conservancy	YES
J. Read Smith	Agricultural Energy Work Group	YES
David Vander Griend	ICM	NO
Todd Werpy	Acher Daniels Midland Company	NO
Edwin White	State University of New York	YES
Rodney Williamson	Iowa Corn Promotion Board	YES

Total – 19 of 30 members attended

Attachment B: Agenda – September 29-30, 2010 Meeting

Day 1: Technical Advisory Committee Meeting:

September 29, 2010

8:00 am – 8:30 am	<i>Breakfast (to be provided for Committee)</i>
8:30 am – 8:45 am	Welcome, Introduction of New Members <i>Co-Chairs – Gil Gutknecht and Steve Briggs</i>
8:45 am – 9:15 am	<u>Presentation:</u> DOE Update on Biomass R&D Activities <i>Laura McCann, Biomass Program, U.S. Department of Energy</i>
9:15 am – 10:00 am	<u>Presentation:</u> USDA Update on Biomass R&D Activities <i>Bill Hagy, Rural Development, U.S. Department of Agriculture</i>
10:00 am – 10:15 am	<i>Break</i>
10:00 am – 10:15 am	New Member Swearing In
10:15 am – 10:30 am	<u>Presentation:</u> NAREEE Update <i>Carol Keiser-Long, NAREEE Committee Chair</i>
10:30 am – 11:30 am	<u>Presentation:</u> USDA and Department of Navy Joint Efforts <i>Bill Hagy, Rural Development, U.S. Department of Agriculture</i> <i>Chris Tindal, Director for Operational Energy, U.S. Department of Navy</i>
11:30 am – 12:30 pm	<i>Lunch (to be provided for Committee)</i>
12:30 pm – 1:45 pm	<u>Presentation:</u> IBR Projects Panel – Cellulosic Ethanol <i>Liz Moore, Golden Field Office</i> <i>Bob Wooley, Abengoa</i> <i>Tim Eggeman, Zeachem</i>
1:45 pm – 2:00 pm	<i>Break</i>
2:00 pm – 3:30 pm	<u>Presentation:</u> “Drop-In Fuels” Projects Panel <i>Todd Pray, Amyris</i> <i>Joshua Pearson, Rentech/Clearfuels</i> <i>Terry Marker, Gas Technology Institute</i>
3:30 pm – 5:00 pm	Breakout: Subcommittees

5:00 pm *Adjourn at the discretion of each Subcommittee*

Day 2: Technical Advisory Committee Meeting: September 30, 2010

8:00 am – 8:30 am *Breakfast (to be provided for Committee)*

8:30 am – 9:15 am Presentation: Proton Power
Dr. Sam Weaver, President and CEO, Proton Power

9:15 am – 10:45 am Breakout: Subcommittees

10:45 am – 11:00 am *Break*

11:00 am – 12:45 pm Discussion: 2010 Committee Recommendations
Feedstocks, Conversion, Infrastructure, and Sustainability, EH&S

12:45 pm – 1:00 pm *Box Lunches (to be provided for Committee)*

1:00 pm – 1:15 pm Public Comment

1:15 pm – 1:30 pm Closing Comments
Co-Chairs – Gil Gutknecht and Steve Briggs

1:30 pm Adjourn

Attachment C: Committee 2010 Recommendations

CROSS-CUTTING RECOMMENDATIONS

Data Accessibility

- Federal agencies should foster sharing of data from funded organizations to a greater extent through a variety of mechanisms including, but not limited to, conferences, periodic follow-up surveys, databases, tools, etc.

More RFS Pathways

- The departments should provide an assessment of more biomass/biofuel pathways to help EPA accelerate their certification of those pathways in order to eventually qualify towards meeting the RFS. The Committee believes the private sector will be reluctant to go forward with commercialization if their pathway is not assured status under RFS.

Biopreferred program

- USDA should expedite the approval of new materials eligible under the biopreferred program.

Success rates

- The Committee acknowledges that not all projects will ultimately succeed due to the high risks associated with unproven technologies. Although project failure should be managed where possible, it should not preclude the funding of new and innovative technologies by the Federal government.

Merit Review Process

- Federal agencies should seek continual improvement of the merit review process while ensuring fairness to all projects and staying focused on identifying the most promising ones. For example:
 - Consider a smaller number of compensated and highly-qualified reviewers to review proposals.
 - Construct solicitations to garner streamlined proposals that focus on technical and business aspects of a project, minimize redundancy and reduce forms, especially those that apply only if selected.

Integrating Large Scale Bioenergy Production with Food and Feed Production

- Existing agricultural and forestry systems were not designed with large scale bioenergy production as a goal. The agencies should conduct efforts to envision, study, and then implement sustainable systems that gracefully reconcile what appear to be competing demands for land to produce feed, food, fiber, and feedstocks for biofuels and biopower. The committee notes that such efforts will likely require a significant increase in sustainable biomass output per acre. Some possible examples include:
 - Winter crops and companion crops integrated into corn/soybean production.
 - Increased output for existing pasture lands
 - Sustainable harvesting of forests, forest residues

- More land efficient animal feeds and feeding systems to increase land available for bioenergy production
- Utilization of non-arable land with non-fresh water
- Utilization of alternative feeding strategies that will allow the most efficient use of crops and crop residues

FEEDSTOCK RECOMMENDATIONS

Woody Biomass

- Whereas federally funded research and development projects and Federal permitting have limited the utilization of woody biomass, strategies should be developed to encourage the utilization of woody biomass derived from federal, state, and private lands, including non-plantation private lands. Possible strategies include:
 - Federally funded projects, including R&D projects, should not exclude utilization of these feedstocks;
 - Stand establishment date (after enactment of EISA) should not be a factor in determining eligibility; however, studies should be conducted to determine appropriate restrictions needed to protect environmentally sensitive and old growth forests shall be restricted;
 - Studies should be conducted that will enable the creation of policies regarding long-term (10 year minimum) contracts for utilization of woody biomass from federal lands should be allowed.

Indirect Land Use

- Whereas the Committee observes that the impact of utilizing energy feedstock in the U.S. on land-use changes in other countries is greatly influenced by various assumptions, more sensitivity analysis, evaluation, and validation of the current indirect land use models needs to be done. Furthermore, all indirect land use models should be publicly available (i.e. transparent).
 - Example: The impact of rising prices on higher yields has been shown in the FAPRI model to potentially negate all land-use changes.
 - Further data used in these analyses needs to be current in order to be meaningful.
 - Example: Yield data used in the GTAP model is over 8 years old.

Environmental, Economic, and Social Impacts

- An effort should be put forth to quantify the environmental, economic and social impacts of increased biomass feedstock supply on a watershed, regional and/or eco-region scale moving from small, replicated field plot trials to larger-size demonstration plantings. One example could be using the Regional Feedstock Partnerships to develop information on yield, sustainability, social issues, etc. of scaled-up biomass feedstock production, monetizing environmental services.

Food and Fuel

- Whereas opportunities for all crops to be used in biobased products should be explored, food and feed crops should not be excluded as feedstocks for conducting R&D for conversion to biobased fuels and materials.

Productivity

- Strategies to increase sustainable yield of second generation feedstocks need to include R&D on:
 - sequencing the genome of plants to identify new genes that will improve the productivity and sustainability of the crop
 - searching for yield enhancement, stability and resource use efficiency genes in model species such as Arabidopsis and Brachypodium;
 - developing transformation systems to utilize these genes;
 - breeding programs as part of an integrated effort to improve productivity;
 - public germplasm collections to facilitate the latter; and
 - high throughput screening technologies and facilities, particularly with respect of photosynthetic productivity.
- Geographically dispersed trials of potential energy crops and their sustainability need to be continued and expanded to allow prioritization of crops for further development. The Federal government should support collection and evaluation of germplasm for new energy crops.

MSW

Whereas MSW is potentially a valuable source of low-cost cellulosic feedstock that can be used for energy conversion and may be used synergistically with agricultural and forestry feedstocks by partially offsetting the relatively higher price of these materials; whereas several private companies are developing technologies to separate and process MSW into an environmentally acceptable cellulosic feedstock for production of energy; and whereas it is noted that no Federal agency is contributing to these and similar efforts, DOE, USDA and other Federal agencies should document work in the private sector on processing MSW for use as an energy feedstock and include that type of research in future feedstock solicitations.

Algae and other organisms

- Algae and other organisms could provide a significant source of biomass (including oils/lipids), and it is recommended that research and development be conducted on performance and economics of algae and other organisms as it relates to:
 - Carbohydrate/Polysaccharide production and utilization
 - Source of Biomass
 - Source of Oils/Lipids
 - Production and Processing
 - Carbon Sequestration and Reuse

Improving Biomass Logistical Systems

- Investment is needed to improve the harvesting, transport, and logistics for large-scale bioenergy production so that adequate quantities of sustainable feedstocks will be available as conversion technologies are rolled out. Research and development priority should be given to pre-processing and logistical systems which can deliver very large quantities (~1 billion tons per year) of dense, uniform, stable, storable biomass feedstocks.

CONVERSION RECOMMENDATIONS

International technology

- Conduct a worldwide study of conversion technologies and incentives to accelerate technology deployment in order to assess the position of the United States relative to other countries and leverage promising technologies.

Separations technologies

- Conduct a review of the status of chemical and physical separations R&D, with the goal of identifying gaps and opportunities (e.g. hemicellulose and lignin, alcohol and water, etc.). Separations are an important cost element for both the front and back ends of the conversion process.

Scale of supply/conversion systems

- For different technology pathways using different feedstocks the optimal (energy, environment and socio-economics) size range of biomass conversion plants vary. The DOE and USDA, including the loan guarantee programs, should consider commercial plants as anything economically viable and sustainable and not impose a minimum or maximum size.

INFRASTRUCTURE RECOMMENDATIONS

Market Creation – General Approach

- In light of the progress that has been made in biofuel technology and production, it is critical that Federal resources be focused on research and policy efforts to create, stabilize, and mature markets for biofuels, specifically ethanol.
- Technological, timing, cost, and investment uncertainty concerning the future availability of fungible biofuels (drop-in biofuels) make further delay in market creation efforts for ethanol (and biodiesel) infeasible if U.S. economic, energy independence and CO₂ benefits are to be achieved. The promise of future commercially viable drop-in fuels should not be used to avoid needed infrastructure action on current biofuels for which technical solutions to growth constraints are known today.

Market Creation – Vehicles

- Agencies and Departments should be advised to harmonize vehicle emission, diagnostic and fuel economy test procedures for all commercial biofuel blend levels; low-level, mid-level, and high-level, based on the known physical properties of the blends. Required test fuels should match commercially available fuels to protect consumer interests. Immediate rule making should be

undertaken to incorporate E10 fuels as emission and fuel economy test fuels with appropriate accommodation for their fuel properties. Certification fuels should be reviewed as time goes on to adjust the certification fuels to reflect commercially relevant blends.

- Research and development should be undertaken to assess economic impacts, purchaser decision impacts, effect on ethanol sales volumes, and overall impact on the car park of making all or a higher portion of the vehicles produced and sold in the United States gasoline-ethanol blend flex-fuel vehicles (FFV). It is expected such action would accelerate the ability of the U.S. car park to accept evolving blend levels over time.
- Research should be undertaken on the barriers to harmonize FFV technology with tailpipe/evaporative emission, fuel economy/ CO_2 , and onboard diagnostic (OBD) requirements administered by the EPA and the CARB in the U.S. 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.

Market Creation – Non-Vehicle End Use Devices

- 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).

Market Creation – Fuel Blends and Distribution

- Research should be undertaken to explore the barriers to implementing flexible fuel pumps that are capable of dispensing fuels to meet the design specification of all end use devices (vehicles, marine, outdoor power equipment).
- Research should be undertaken to explore the potential benefits of implementing technology and conducting education to prevent mis-fueling of end-use devices within the flexible fuel pump context.

Market Creation – Fuel Blend Pricing

- Research should be undertaken to identify methods that successfully encourage consumer selection of the highest biofuel blend available to them. This study should include flexible fuel pump configurations and consumer economic factors.

Market Creation – Post Bio-Refinery Infrastructure

- Research should be undertaken to establish the parameters of hydrocarbon fuel blend stock compatibility and feasible delivery/ transportation mechanisms that could support the flexible fuel 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, while major fuel markets are in the west and northeast. 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.

Biopower

- Research should be undertaken on the infrastructure needs and regulatory barriers of non-transportation biopower.
- Research should be undertaken to explore the optimal location and scale for optimal utilization of biopower plants.

Federal Trade Commission pump labeling

- The Federal Trade Commission pump labeling rule should not apply to advanced biofuels that are molecularly equivalent to their petroleum counterparts.

SUSTAINABILITY RECOMMENDATIONS

Direct Land Use Changes

- Direct land use changes such as pasture or CRP land to biomass crops should be estimated on a regional basis and the environmental impacts of such changes calculated.

Water Use/Quality

- 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 by USDA, DOE, and EPA to better understand and compare water use at all stages of biofuels production and ways in which to conserve water, and maintain water quality, throughout this lifecycle.

Market/Economic Sustainability

- A sustainable renewable fuel effort requires that biofuels enter the market, are adopted by consumers, fulfill criteria to meet the renewable fuel standard, reduce imported fossil fuels and reduce carbon intensity. Research and development should be conducted in the following areas:
 - Biofuels as they blend with fossil fuels especially E20, E85
 - Emissions
 - Mile per gallon and/or cost per mile
 - Required infrastructure (see infrastructure recommendations)
 - Market research into consumer response and adoption of those blends
 - A consumer education program and/or platform to improve understanding of biofuels data. For example:
 - Miles per gallon and/or cost per mile
 - Environmental impact (e.g. Energy Star)

Resource Conservation

- The production, transport, processing and distribution of bio-energy feedstocks and products have a largely unknown impact on natural resources, especially on a specific geographic area's resources of concern. A comprehensive, coordinated and complete strategy for R&D should be developed to determine sustainability thresholds, establish sustainable production systems, and identify/implement best management practices.

Lifecycle Analysis

- USDA and DOE should institute a program to monitor and measure relevant environmental parameters for 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 variability. They should also be compliant with IPCC standards, such as the FLUXNET system. Further, USDA and DOE should update and maintain measurements of all crop/forest inputs and offtakes, including water use, utilizing contractors where necessary to obtain ample diversity. These should be collected and published as standardized Life Cycle Inventories (LCIs) available for public scrutiny. These LCI should be continuously updated and republished on at least a biannual basis.
- LCA assessments should include energy return on energy invested (EROI) estimates for biofuel and biopower systems, including both the agriculture/forestry production component and the biofuel/biopower conversion component. Such LCA studies should be conducted in sufficient detail to direct future research and development to improve EROI for biofuel/biopower systems.
- USDA and its contractors should partner with producer organizations and other stakeholders to verify the accuracy of the LCIs. LCAs based on these LCIs should be peer reviewed before acceptance as a basis for any regulatory or policy decisions.
- LCA studies done with USDA/ DOE support should be published in conformity with ISO's standards of transparency, system boundaries, allocation, etc.
- A priority list of feedstocks for GHG monitoring should be established in consultation with stakeholder groups. The list should include at minimum:
 - two or more woody biomass species under investigation for use as energy crops such as willow or poplar,
 - three or more perennial grasses under investigation for use as energy crops and at a minimum switchgrass, miscanthus and energy cane,
 - grain and oilseeds currently used for biofuel production such as corn, soybeans and canola
 - comparisons of residue removal/non-removal for corn stover and wheat straw, other alternative energy crops under investigation as combined sources of sugars and cellulose such as sugar beets, sugar cane, sweet cane/sorghum hybrids.
- Deployment of monitoring sites and data collection should begin as soon as possible, but no later than June 2012.

Social Sustainability

- A comprehensive study should be conducted on the potential social and economic impacts of the emergence of a biofuels, biopower, and biobased products economy as envisioned by the USDA Biofuels Roadmap. The study should:
 - Investigate the number and kinds of jobs created, the manpower required, the availability of that manpower 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- i.e. 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- i.e. 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.
- 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? If acres switch from grain to biomass will the local grain elevator lose business and ultimately close? The same could be asked for a myriad of businesses tied to local agriculture.
 - Will competition for labor increase wages in rural communities forcing some marginal businesses to close?