Biomass Research & Development Program
Technical Advisory Committee

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

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

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

Annual reporting obligations for the TAC are stated in §(g)(1); a report from the Advisory Committee on whether the funds appropriated for the Initiative have been distributed and used in a manner that is consistent with the objectives and requirements (of section 9008). The TAC charter provides for forming subcommittees that can address particular matters for the TAC as a whole. The TAC currently operates with three subcommittees; Feedstocks, Conversion, and Infrastructure/ Logistics, respectively.

SPECIFIC COMMITTEE REPORTING OBLIGATIONS

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

   Yes; the selected projects appropriately address the objectives and the defined technical areas.

   Throughout the last 3 years, BRDI has addressed more than 15 types of feedstocks. However, limited waste feedstocks are utilized and BRDI should expand feedstock types to include others waste residues, such as animal waste, crop residues, municipal solid waste (MSW), and food waste.

   1.1 Problem Statement**:** While BRDI has met the overall objectives of the Biomass Act (Section 9008 of FCEA of 2008), the portfolio of awards does not show clear technology

progression, nor is there a link from one year to the next or to the larger goals of the USDA or DOE programs.

Recommendation: BRDI awards should be in support of wider USDA/DOE Biomass goals and portfolio. Therefore, the Committee believes that the value of BRDI can be significantly enhanced by implementing a five year technology roadmap with goals, objectives and metrics (and follows existing USDA and DOE roadmaps).

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

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

1.3 Problem Statement**:** Awards to-date do not seem to be related mainly to current availability of feedstocks.

Recommendation: Both current and future availability of feedstocks should be an important selection criterion for awards.

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

Recommendation: Municiple Solid Waste (MSW) is mentioned occasionally in BRDI solicitations, but continues to be given low visibility as a viable feedstock by USDA and DOE. MSW has many advantages as a feedstock and so should be given appropriate visibility in discussions of feedstocks for future BRDI solicitations.

2. Were the solicitations open and competitive with awards made annually?

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

The BRDI merit review process appears to be in line with other federal R&D programs and appears to be effective and efficient. We commend the pre-proposal process, which avoids an unnecessary burden on the applicant community.

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

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

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

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

The pre-application criteria in FY2009 and FY2010 included a statement that implied a preference toward industry-academia collaborations. In FY2011, however, consortia were specifically allowed and encouraged in §(3)(5). Such collaborations are no longer limited to industrial and academic participants; we commend this expansion.

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

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

Recommendation: The application process should focus on the objectives, approach, timeline, budget and the human, equipment and materials available. Save the documents needed only for the award for only those proposals chosen for funding. This would enhance the time and thought available for both those preparing and those reviewing the grants.

4. Were proposals evaluated and selected on merit by use of independent panels predominantly composed of experts outside of USDA and DOE?

Yes; evaluation criteria and procedures were clearly presented in each solicitation and adhered to established merit review guidelines and procedures for both agencies. The Initiative is conducted through a two-phase submission process with pre-applications serving as a screening process prior to invitations for full applications' final merit review.

Review panels were gathered for both processes. During 2010 and 2011, a total of 107 panelists were involved, with most members having expertise in engineering, cropping systems, agronomy, and business. For the pre-application process, the percentage of reviewers coming from industry and academia was 80% and 87% for FY2010 and FY2011, respectively.

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

Recommendation: Develop a larger network of reviewers, and inform them of the scope/areas for review. Consider drawing reviewers from previous or current applicants or using a finalist peer review system. Qualifications of reviewers should be previously demonstrated. Reviewers should be drawn from industry, academia, government, and other groups to create a diverse pool of expertise.

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

Recommendation: We recommend that when a revised proposal is submitted to the BRDI, that the new reviewers be provided with a copy of the past review(s) and a two page response prepared by the submitters, to be submitted with the proposal. This action will help the current set of reviewers be better

informed and render a more useful and accurate review than if the past review and the submitters' response to that review are excluded from the decision.

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

Recommendation: Utilize the "NSF style" checklist with pre-proposals to allow BRDI managers to secure review teams with expertise matched to program ideas being developed for full proposals.

INFORMATION REQUESTS

While discussing and formulating their 2012 recommendations, the Committee felt that key information was not available and therefore made the following information requests.

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

   Recommendation: Implement an analysis on commercialization and technology transfer resulting from federally funded research programs. Identify what led to successes and its ability to replicate. Metrics should be stage-specific. In other words, which funded technologies reach development, advanced development, commercial, and if commercial, at what scale?

2. Problem Statement**:** BRDI does not seem to have a method of evaluating the success of awards, and results from past awards have not been shared with the TAC.

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

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

   Recommendation: Obtain program summaries for significant programs that are presented similarly to the BRDI program update that was provided by USDA-NIFA.

This will enable the BRDI Technical Advisory Committee to identify both trends and gaps in funding.

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

   Recommendation: Develop a check list for proposers to complete that will provide data that can be tracked. See NSF example.

FEEDSTOCKS RECOMMENDATIONS

The Feedstocks Sub-Committee expresses that without the ability to review the DOE and USDA responses to 2011 recommendations, the Sub-Committee reviewed the 2011 recommendations and would like to acknowledge that the 2011 recommendations are still relevant and supported by this Sub-committee.

1. Feedstock Sustainability

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

   Recommendation: The DOE Great Lakes Regional Center is making actual GHG exchange measurements. Building on their success, solicitations should be issued to develop more actual GHG exhcnage measurements.

2. 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: More emphasis is needed to ensure a balance of feedstocks production with logistics and energy density.

3. System Optimization

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

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

Problem Statement**:** Although sugarcane is used extensively in Brazil for fuel ethanol production, the high value of sucrose from sugarcane makes this approach uneconomical in the U.S. at this time. Alternative sweet crops are available for the U.S. which could be used to produce renewable fuels with modest modifications of mature industrial processes.

Ethanol is currently produced in the U.S. from corn starch, and now represents a mature conversion technology using inexpensive enzymes to convert starch into glucose. Glucose is then converted to ethanol using conventional yeasts. This simple process coupled with the efficiencies of corn production and public policy have allowed corn starch to serve as the low-cost feedstock for ethanol production in the U.S., a commodity fuel that can compete in price with petroleum products. Other starch crops (cassava, potato, sweet potato, agave, Jerusalem artichoke, sugar beets) can be grown in the U.S. and could be converted to fuels with modest modifications of the corn-ethanol process.

Lignocellulosic biomass residues and energy crops/trees are relatively inexpensive based on competing values for steam production or pulping in the U.S. From 60% to 70% of the dry weight of these materials is composed of a mixture of carbohydrates, primarily cellulose (glucose) and hemicellulose (xylose, arabinose, mannose). Unlike starch, lignocellulose was designed by nature to resist deconstruction. Chemical treatments that break down these polymers are harsh. Enzymes that depolymerize starch function at more than 200-fold the rate of enzymes that depolymerize crystalline cellulose. Higher costs for a more complex process and the larger amounts of cellulase enzymes needed have thus far served to offset the advantages of lignocellulose as a low cost feedstock. Considerable progress has been made in this area and several biorefineries with a cellulosic-fuel component are under construction or planned for the near future. Forestry residues, short rotation coppice crops (willow, sweet gum), and energy fiber crops could be used to rapidly deploy such biorefineries as industrial experience in this area matures. Additional forest and agronomic research are needed to define regional feedstocks, best practices, harvesting schemes, etc.

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

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

i. Sugar crops for fuel and chemical production

ii. Starch crops other than corn for fuel and chemical production

iii. Lignocellulosic biomass for fuel and chemical production

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

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

CONVERSION RECOMMENDATIONS

1. Problem Statement**:** Conversion—pre-treatment through fuel production— is the major barrier to bringing down costs, and this issue cannot be properly addressed in the systems approach currently being applied in BRDI solicitations.

   Recommendation: Some funds should be reserved for funding- pre-treatment focused grants.

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

   Recommendation: What constitutes 'commercial scale' should be based on profitability and commercial impact rather than size or production capacity. Small-scale systems can be commercially viable and still generate profits. The rationale for any minimum size requirements should be explained in the FOA. Biomass conversion scale-up requirements are different than those for petroleum refineries and need to be better understood.

LOGISTICS, STORAGE, HANDLING, AND INFRASTRUCTURE RECOMMENDATIONS

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

1) Densify and preprocess to improve logistics and facilitate storage.

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

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

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

2) Mitigate seasonality concerns and associated problems.

Problem Statement**:** Typically, biomass has seasonal growth and harvest patterns that impact supply, storage, and use. Bioenergy production generally requires year-round feedstock supplies—sometimes with peak demands at times very different from peak feedstock supply seasons. Storage often leads to feedstock losses along with moisture and combustion issues. Matching seasonal supplies with year-round or seasonal demands requires the development of extensive storage, multiple feedstocks, altered

harvesting practices, and various forms of preprocessing and/or densification. This can be both expensive and challenging in terms of implementation.

Recommendation: Ways need to be developed for field-to-user systems to accommodate seasonality.

i. Research projects need to develop low cost preprocessing or multi-feedstock provisions, logistics, and storage systems designed to accommodate seasonality.
ii. Develop mobile feedstock processing operations, to accommodate seasonality issues, as well as unexpected changes in weather, beetle kill, etc.

3) Increase biopower:

Problem Statement**:** Electric generation faces issues of GHG emissions, in addition to a number of unique issues related to biomass densification, handling, storage, and other logistical matters. At the same time, some companies are looking for alternatives to fossil material in their manufacturing processes.

Forests in several U.S. regions are in severe need of fuel reduction to reduce the likelihood of catastrophic fires, or may be in areas with little demand for forest products. There is land available upon which a variety of bio-feedstock can be grown and opportunities are amiable to convert these available bio-feedstocks into low net GHG fuels or bioproducts.

At the same time, European utilities have fast-growing demand for renewable alternatives to coal, due to mandates, and they are able to pay substantial prices for such fuels, due to government incentives. New technologies are needed to sustainably convert wood and plant biomass into advanced solid fuels that are much higher density. This would have significant impact on the cost of transportation logistics. This is important not only for bio-power but for development a resource base for advance biofuels and bio-products. Logistics are one of the key costs in building biorefineries at a scale that can be economically competitive. Biorefineries in this context would include biopower, biofuels and bioproducts.

The Biomass Act, which created the BRDI and the Committee, clearly lists bio-products and bio-power as areas in which research should be conducted. Unfortunately, relatively little research has been funded, in recent years, on these topics.

Recommendation : Conduct more BRDI-funded R&D projects that that support improved biomass logistics for biopower and bioproducts:

i. Support the commercialization of new technologies and processes that improve the energy and physical density (pelletization and briquetting); handling characteristics; and logistics and storage features of plant and woody biomass, so that they may be better used for bio-power and electric generation.
ii. Support co-firing demonstrations in coal-fired boilers.
iii. Help U.S. companies and biomass surplus areas compete in export markets by developing technologies that produce a superior biomass-based solid fuel for biopower based on higher density materials.