Western Sun Grant Center Algae Workshop

Tucson, AZ 31st March-1st April, 2011

Action Items and timelines

Task	Contact	Timelines
1. NDA/MTA	Janet Nelson and Jan Auyong	3 months for drafts
2. White paper (internal comprehensive data repository)*	Murthy, Jan Auyong	6 months for draft
3. Open Editorial	Identify the journal (Nelson) Basic framework (Chen and Lammers) Initial draft Complete draft	1 week 3 weeks 6 weeks 30th June, 2011
4. Conference presentations	Shulin Chen, Janet Nelson	May-June
5. Liason with potential partners: INL, Navy, NREL, USDA, DOE NASA, NOAA and NETL.	Jan Auyong, Stan Barnes and Janet Nelson.	Continuous
6. Collaborative proposal	Everyone	At least one before Oct, 2011
7. Gap analysis	Everyone	Continuous

Task list for the White paper:

1. Introduction/vision statement/new paradigm (Shulin/Pete)
2. Production systems/test beds/strain biology (Joel/Everyone contributes)
3. Processing technologies (Shulin/Murthy contributes)
4. Analytical chem. Product development/optimization (Dirk/Pete)
5. Capability statements/existing IP/facilities (Jan)
6. Techno-economic analysis and LCA (Murthy)
7. Integrated development/scalability (Stan)
8. Broiader socio-economic impacts/workforce development/education (Jan/Janet)
9. Summary of unique approaches/strengths (Shulin)
10. List of opportunity space (Stan/Janet/Peter)
11. Other technologies: Anaerobic digestion (TBD)
12. Summary/graphic of at least two technical pathways (Stan/Peter)

Detailed meeting minutes

Introductions

- Dirk NETL:
  - Growth on contaminated streams Sox, NOx and flue gases is an important area that NETL can contribute.
  - NETL has been benchmarking accurate methods for lipids composition and class determination.
  - Catalytic conversion to alkane based fuels.
- Joel Cuello
  - Design of low cost Accordian PBR (Patented).
  - H2 production from *Chlamydomonas reinhardtii*.
  - Participant in NAABB consortium: working on secondary treated waste water.
  - Development of mechanical harvester for algae.
  - Composite lighting→ light profile design.
  - Guided evolution.
  - Environmental modeling and LCA.
- Shulin Chen
  - Heterotrophic algae growth. Cellulose hydrolysis. (7 patents in the area)
  - Working on both heterotrophic and autotrophic growth.
  - Downstream processing for polysaccharide and protein productions.
  - Conversion of spent algal biomass
  - Lipid determination using NMR.
- Janet Nelson, URS, NETL
  - Extensive RES (Research engineering Services) network of URS with MATRIX, MRI and five universities. Living in D.C. Area so can help in any efforts on the hill.
- Peter Lemmers
  - Participant in NAABB.
  - At New Mexico State Univ. and part time at Solix.
  - Currently operating 4000L outdoor Solix PBRs.
  - Mostly upstream focus.
  - Megan Staqrbuck (economics and LCA), Shulin Dang (Extractions), Condon? And Joel (Innovations in raceway ponds)
  - Other work is in development of protocols for lipid analysis (using FT).
- Stan Barnes, Bioalgene
  - Working on screening algae species: 50screened, 5 good ones found and 3 strains being tested. All are fresh water strains.
  - Spokane municipal waste water treatment system could provide opportunities. Close proximity of the air force and civilian runways could provide some land.
  - Summer trials at PGE in ponds of 6 acre area.
- John Cushman
  - Water limited, waste water strains.
  - Density and staining based selections of high starch and lipid species.
  - Genomic sequencing of halophilic strains (Dunaleilla sp) being performed.
  - Selection for FFA and lipid content.
  - Two 20,000L ponds operated. Simulated geothermal heating.

Discussion points

General

- No matching fund from NETL as it is a federal lab.
- Residual waste streams account for 7% of US energy.
- Presently most of the sludge (with 10-+15% lipid content) is put in landfills.
- Lack of industry support to algae proposals.
- Education and outreach, training next generation researchers is critical. Especially considering the importance and scale of the challenges.
- USDA opportunity space
- DOE considers heterotrophic algae growth as fermentation.
- DOD → Phycal and solazyme on feedstocks.
- UOP →Imperium is a possible competitor.

Production systems/Test beds

- Geographical comparisons of test beds will be a critical aspect of this collaboration. Comparisons in various geographical locations, test beds, in collaboration with utility companies will be best.
- Initial focus should be on CO2 sequestrations and high value coproducts.
- Not really any vertical liftoff. As the production limits are close to theoretical limits in the open ponds. Solix maintained the cultures for 2.5 years without crashing.
- Vertically integrated testbeds.
- Control systems and automation.
- Production mix for the products will be driven by biomass (strains!).
- Lou Ogaard from CEHMM presented the details of their system and indicated that for more detailed techno-economic analyses and LCA are being performed on their systems.

Algae strains and nutrition

- Phosphorous is a very important nutrient and efforts must be made to reduce/reuse/recycle to the maximum extent possible.
- Work in this collaboration must focus on non-potable and/or waste water only.
- GMO strains will have significant regulatory issues although not insurmountable, may not be best strategy for this group at present.
- A lot of prior work has already been done in the strain selections, local strains vs. exotic strains. Unless it is drastically different from past efforts, it is highly unlikely to be successful.
- Important to note that Saline strains are 1/3 productive (in biomass terms) as fresh water strains. Therefore, higher lipid content does not automatically translate to higher lipid productivity. Need to look at the productivity in terms of the energy returns.
- Low lipid algae have competitive over competitors with high lipid content.
- Photoautrophic, monoculture, solix PBRs, Energy flow.
- Extremophiles (high pH, HCO3 to improve CO2 absorption), cyanobacteria,
- *Chlorella sorokinoma*→ mixotrophic process (heterotrophic in winter) acetate, sugars as substrates.
- Chlorella viruses is an issue that needs to be addressed.

- Production platform optimization

Processing technologies

- Low cost harvesting especially for algae grown on waste materials.
- Breakthroughs in downstream processing are critical for success of algae.
- Uncontrolled population of algae downstream processing.
- Integrated biorefineries for mono/poly cultures.
- Harvesting and processing can be done at smaller pilot scale, but should provide realistic information.
- Lots of poly saccharides → sequential extraction process
- 160 polysaccharides are removed.
- Reduces char production lipids.
- Hydrothermal liquefaction.
- Supercritical methanol can extract FA
- How do you maximize fuel yields from biomass.
- 3% EPA how can we capture that?
- First neutraceuticals, proteins, polymers and industrial products.
- A unified process pipeline based stripping FA and fractionation of methyl/ethyl esters (to recover polar/neutral lipds)
- Process separation technology and sequencing of processes.

Other issues that the Consortium should address

- How do we demonstrate current collaboration? We need to demonstrate a strong past work history. Already certain collaborations exist. Need to strengthen the same.
- Comparative data within the capabilities. It is important to have good analytical techniques those are structurally consistent. For example, the CAFI consortium for corn stover to ethanol has developed very robust laboratory protocols for analysis of different pretreatment technologies.
- Distributed farming: How do farmers benefit. Fuel and fertilizer: are critical for agriculture. Reduced cost of distribution of fertilizers /fuel.
- Aviation fuel
- Longer term purchase contracts from domestic renewable fuel suppliers. While clear target of $4-10 is good, it is important to show a decrease in price with time. Research goals indicating the progress towards the commercialization are best defined in terms of the cost reduction (%) from the current price levels. For example, Break down production cost →Say x% in y process that will be reduced by z% in this proposal. Rather than dollar value, show % reductions and match it to the team capabilities.
- Based on the discussions, three strains were chosen to be evaluated in the testbeds and demonstrate the process technologies (Table 1.). The main idea behind the selection of these strains is that these strains N. saline, Chlorella sp. And Cyanobacteria can be used to produce lipids, polysaccharides and high value neutraceuticals respectively. Since a lot of genetic efforts for these three strains has been accomplished, partial chemistry w.r.t the products from these strains is known. Additionally, these are the strains that have a reasonable potential for commercial success in near future. Presently, we do not have good grasp of the appropriate downstream technologies for these strains.

- Geographic location (determines strains)→ products→ process technology--Science (how, what and why).

Table 1. Technology Platforms

<table>
<tr><td>Inputs</td><td>Strains</td><td colspan="3">Analytical chemistry, economic metrics</td></tr>
<tr><td>Waste CO_2</td><td></td><td rowspan="7">Production platforms</td><td rowspan="7">Process systems/Technology</td><td rowspan="7">Product stream</td></tr>
<tr><td>Water (non potable/waste)</td><td>N. salina</td></tr>
<tr><td>Nutrients</td><td>Chlorella</td></tr>
<tr><td>Land</td><td>Cyanobacteria</td></tr>
<tr><td>Light</td><td>Mixed consortia</td></tr>
<tr><td>Heat</td><td></td></tr>
<tr><td colspan="2">Identify scientific gaps/proposed innovations</td><td colspan="3">Sustainability metric (water saved/cleaned; CO_2 capture/Nutrients reused)</td></tr>
</table>

- For each of the strains, analyses describing the production potential, unit value in terms of the products, market potential for the products, known players and competition, scientific gaps in advancing the understanding and commercialization, potential for IP needs to be performed. As example of a preliminary analysis is presented in Table 2.

Table 2. Platform Analysis

N. salina example	Production potential	Unit value	Market potential	Known players	Scientific gaps	$, IP
Biopolymers						
Polysaccharides						
Lipid						
Sterols						
EPA/DHA	Yes	Yes	Yes	Martek	Freedom to operate/production potential	
Caratenoids						
Animal feed/fish meal substitutes						

- Where are we, who are the partners, working hypothesis formulation, identify scientific gaps, IP, economic opportunities
- Group MO
  - partnership with companies
  - Optimized product streams
  - Comparative test beds across west
  - Phased R & D process
- Probabilistic economic analysis.
- Well characterized and robust strains

- We have technology to realize and optimize product streams
- Environmental impact
- Protein: carbs: Lipids will be there in all systems maintain focus on one system when discussing with companies.
- Is there a niche? Why this western consortium: Western consortium because lipids platform; water considerations; emphasize the strengths; preexisting relationships between the collaborators and industrial partners.
- Not compete with food, produce feed and fertilizers. Blur the cellulosic and lipid platforms. No competition with fresh water. Energy and nutrient inputs sustainability metrics.

Format for the proposals

- Need driven/Hypothesis driven/strengths or unique capabilities/unique needs or barriers. In any case the approach should be unique \for a successful proposal.

SWOT analysis

- Strengths
    - Collaborative team
    - Technology: diverse prior experience, completions
    - Reach: collaborations
    - Nimble, durable, core/affiliates
- Weaknesses
    - Technology (not completed/define)
    - Strong partners needed
- Opportunity
    - Strains
    - Test beds
    - IP: Strains and perfecting processes
    - $$
    - Environmental friendliness
    - Waste water as nutrient source (global geochemical cycles)
- Threats
    - Time (always limited. Need to be focused and productive)
    - Focus Understand the focus of the audience
    - Mindsets preoccupied/ignorant/hostile/early adopters.
    - Oil and coal (CCS) Insurance for hydrofrac and CO2 sequestrations
- Minimum 3 years to 10 years for a productive consortium.
- Goals need to be SMART (simple, measurable, actionable, repeatable and timebound).
- In general the consortium should design processes with decreasing specificity as we move to downstream technologies.
- Idea is to develop the comprehensive technology platform which erases the distinction between the cellulosic and algal platforms. The integrated approach to lipids production will be demonstrated, while addressing the sustainability and techno-economic issues.

Meeting Overview
Algae Biofuels and Bioproducts: Feedstock logistics and processing technologies.

Opportunities:

- Increasing fossil fuel consumption and competition for limited energy resources.
- Global climate change due to anthropogenic greenhouse gas emissions.
- Increasing pressure on arable land for food production worldwide.
- Constraints on availability of critical resources such as land, water and phosphorous.
- Increasing animal/ aquaculture feed market needs around the world.

Challenges:

- Present cost of production of algae oil is estimated to be $30-60/gal.
- Almost every aspect of algae production needs improvements before commercially viable large scale production can be achieved.
- Many of the companies are working in these areas, however a lot of knowledge is proprietary and not a lot of information is available in public domain. It is important that land grant Universities address this challenge and develop sustainable technologies that are economically viable.

Meeting Outcomes:

1. One white paper (15-20 pages) on the research needs to make the algae biofuels techno-economically feasible in western US. *(within one week of the meeting)*
2. One collaborative proposal addressing the proposed research objective: Identify and demonstrate (10,000L scale) algae production, harvesting and processing technologies with a final cost of $4.00-10.00/gal algal oil. *(within six months of the meeting).*

Proposed Format

1. One video conference with meeting attendees with discussion focused on:
    - Preliminary critical path analysis to identify challenges.
    - Meeting agenda
2. Discussion topics:
    a. Algae strains
    b. Nutrient resource analysis
    c. Feedstock production pathways.
    d. Harvesting and processing technologies
    e. Conversion technologies for biofuels
    f. Bioproducts
    g. Systems analysis
    h. Expertise available

Meeting Agenda

31st March, 2011 (Day 1)

Introductory remarks (8.00 am-8.15 am)

Session I (8.15 am-10.00 am)

1. Overview of the challenges and critical path analysis.
2. Algae strains: Fresh, brackish and saline water strains
    - Identify five strains in each category.
3. Nutrition for large scale production of algae
    - Nitrogen:
    - Phosphorous
    - Carbon (CO2)
    - Other minerals

Break (10.00-10.15 am)

Session II (10.15-12.00pm)

4. Production systems:
    - Heterotrophic, autotrophic, mixotrophic production
    - Open ponds and low cost photobioreactors
    - Identify the best possible configuration for PNW regions.
5. Processing technologies for oil and coproduct recovery
    - Harvesting technologies.
    - Dry and wet processing technologies.
    - Lipid extraction technologies: hexane, enzyme and novel technologies.
    - Fermentation pathways
    - Anaerobic digestion

Lunch Break (12.00-1.00 pm)

Session III (1.00-3.00pm)

6. Continue discussion of processing technologies for oil and coproduct recovery.
7. Upgradation of algal biomass, oil and carbohydrates to biofuels:
    - Biodiesel
    - Bioethanol
    - Aviation fuel

Break (3.00-3.15 pm)

Session IV (3.15-3.50pm)

8. Presentation by Dr. Louis Ogaard, Lead scientist, CEHMM, Carlsbad, New Mexico.

Session IV (3.50-5.00pm)

9. Critical path analysis:
    - Discussion on possible technologies and targets for production, harvesting and processing that will enable production of algal biofuels at $4-10 /gal.
    - Identify combinations of technologies for various production strategies.
    - Arrive at estimates for each unit operation in algal biofuel production.

1st April, 2011 (Day 2)

Session V (8.00 am-9.30 am)

10. Potential high value bioproducts: docosahexanoic acid (DHA), beta carotene
11. Sustainability and techno-economic analysis: Process modeling and life cycle analysis.

Break (9.15-9.30am)

Session VI (9.30 am-12.00 pm)

12. Pacific Northwest/Oregon/OSU resource base
    - Academic and research institutions
    - Private companies
    - Research projects: Active and planned projects
    - Collaboration opportunities and synergies
        - Research grants
        - SBIT/STTR
        - Research projects
        - Demonstration projects
13. Update challenges and critical path analysis based on discussion.
14. Meeting follow-up
    - White paper
    - Research proposal outline
    - Specify research objectives
    - Identify/ outreach to potential research collaborators.
    - Proposal preparation.

Meeting Attendees:

1. Joel Cuello, ASU <jcuello@cals.arizona.edu>
2. Jan Auyong, OSU on Day 2 <Jan.Auyong@oregonstate.edu>
3. Ganti Murthy, OSU <murthy@engr.orst.edu>
4. Shulin Chen, WSU <chens@wsu.edu>
5. Peter Lammers, Univ. of New Mexico <plammers@nmsu.edu>
6. John Cushman, UN (Via. Skype) on Day 1<jcushman@unr.edu>
7. Dirk Link, NETL on Day 1
8. Janet Nelson, NETL <Janet.Nelson@UR.NETL.DOE.GOV>
9. Stan Barnes, BioAlgene <StanB@Bioalgene.com>
10. Lou Ogaard, CEHMM (Via Skype) on Day 1< lou.ogaard@cehmm.org>

Participating Organizations:

1. Academic Institutions: OSU, ASU, WSU, Univ. of Nevada, Univ. of Idaho
2. Govt. Organizations/companies: NETL, General Atomics, CEHMM, BioAlgene

BIOMASS RESEARCH AND DEVELOPMENT INITIATIVE
Funding Opportunity Announcement Number: DE-FOA-0000510
Announcement Type: Initial Posting 000
CFDA Number: 81.087

Issue Date: 04/15/2011

Pre-Application Due Date: 05/31/2011, 5:00 PM Eastern Time

Invited Full Application Due Date: 10/04/2011, 5:00 PM Eastern Time

A. Project Description

Pre-Applications are being solicited that integrate all three of the technical topic areas described below and on the following pages. Applicants are encouraged to develop partnerships with other entities, as needed, to ensure that all three technical areas are adequately addressed (additional information on eligibility is provided in Section III). **Only applications that address the integration of all three technical areas, including applications specific to farm and industrial demonstration(s) of using biodiesel to improve grain or cellulosic ethanol production, will be reviewed.**

(A) Feedstocks Development – Research, development and demonstration activities regarding feedstocks and feedstock logistics (including harvest, handling, transport, preprocessing, and storage) relevant to production of raw materials for conversion to biofuels, bioenergy, and biobased products.

The lack of logistics systems capable of handling and delivering sufficiently high tonnage of feedstocks year-round to support the rapid escalation of cellulosic biofuels production has been identified as a significant barrier to the expansion of a sustainable domestic biofuels industry. Feedstocks or combinations of feedstocks that will be considered include: agricultural residues, energy crops (switchgrass, miscanthus, energycane, sorghum, poplar, willow, etc.), forest resources (forest thinnings, wood chips, wood wastes, small diameter trees, etc.), and urban wood wastes. **Other feedstocks that will be considered include oilseed crops, animal waste, other waste streams that are byproducts of alternative energy processes, such as anaerobic digestion and algae.** Additional information on acceptable feedstocks may be found in the definitions for "Advanced Biofuel" and "Renewable Biomass"[1] which are presented in Appendix A – Definitions. Projects should include the use or development of the following:

[1] **"Renewable Biomass"** means
(1) Materials, pre-commercial thinnings, or invasive species from National Forest System land (as defined in section 11(a) of the Forest and Rangeland Renewable Resources Planning Act of 1974 (16 U.S.C. 1609(a)) and public lands (as defined in section 103 of the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1702)) that—
(i) are byproducts of preventive treatments that are removed to reduce hazardous fuels; to reduce or contain disease or insect infestation; or to restore ecosystem health;
(ii) would not otherwise be used for higher-value products; and
(iii) are harvested in accordance with—
(I) applicable law and land management plans; and the requirements for H. R. 2419—383
(A) old-growth maintenance, restoration, and management direction of paragraphs (2), (3), and (4) of subsection (e) of section 102 of the Healthy Forests Restoration Act of 2003 (16 U.S.C. 6512); and
(B) large-tree retention of subsection (f) of section 102 of the Healthy forests Restoration Act of 2003 (10 U.S.C. 6512); or

- Dedicated biofuel or industrial product crops with desired features, including enhanced productivity, broader site range, low requirements for chemical inputs, and enhanced processing characteristics;
- Advanced crop production methods and management technologies and systems to achieve optimal yields while conserving soil and water resources;
- Innovative equipment designs and systems for harvest, handling, preprocessing, transport, and storage that will be compatible with the biomass conversion technology;
- Innovative uses of alternative waste streams that increase the cost, environmental impacts, greenhouse gas footprint or complexity of renewable energy systems for farm or small commercial applications
- Compatibility of the selected feedstock with potential conversion systems;
- Strategies for integrating feedstock production into existing managed land;
- Generation of data that can contribute to a best management practices database; and
- Development of tools that land managers and community developers can use to evaluate the technical and economic viability of biomass production systems; tools should integrate management, harvesting, and processing technologies and methods with economic analyses of utilization options for biofuels, bioenergy, and biobased products.

(B) <u>Biofuels and Biobased Products Development</u> - Research, development, and demonstration (R,D,&D) activities to support:

(i) Development of diverse cost-effective technologies for the use of cellulosic biomass in the production of biofuels, bioenergy, and biobased products; and
(ii) Product diversification through technologies relevant to production of a range of biobased products (including chemicals, animal feeds, and cogeneration power) that potentially can increase the feasibility of fuel production in a biorefinery.

The DOE Biomass Program has been focused on developing, demonstrating, and deploying cellulosic ethanol to enable a 2012 goal of making cellulosic ethanol cost-competitive with corn-based ethanol. Over the last two decades, research and development have led to significant progress in the biochemical processes used to convert cellulosic biomass to ethanol. First-generation technology for cellulosic ethanol production is now in the demonstration phase. USDA-NIFA and DOE will also support other advanced biofuels and/or biobased products, such as biobutanol, hydrocarbons and Fischer-Tropsch gasoline and diesel, which are still in the early stages of investigation in terms of production technologies, cost-effectiveness, and performance characteristics. Additional information on acceptable biofuels and biobased products may be found in the definitions for “Advanced Biofuel” and “Biobased Product” which are presented in Appendix A – Definitions.

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(2) any organic matter that is available on a renewable or recurring basis from non-Federal land or land belonging to an Indian or Indian tribe that is held in trust by the United States or subject to a restriction against alienation imposed by the United States, including—
(i) renewable plant material, including feed grains; other agricultural commodities; other plants and trees; **algae**; and
(ii) waste material, including crop residue; other vegetative waste material (including wood waste and wood residues); animal waste and byproducts (including fats, oils, greases, and manure); and food waste and yard waste.

For FY 2011, DOE and USDA-NIFA have identified areas of particular interest for BRDI. These areas of interest will not be given a priority over applications that address other technologies and are not intended to deter submission of applications that address other technologies. Research, development, and demonstration projects of particular interest include, but are not limited to, technologies that would address:

- Small scale gasification and pyrolysis R,D,&D to address issues of local and on-farm production of biofuels from cellulosic feedstocks;
- Gasification and pyrolysis of animal manure – manures from each major livestock and poultry species (beef, dairy, swine, and poultry) have different characteristics and, therefore, each will have specific requirements for thermochemical energy recovery (direct combustion of livestock manure will not be included in this FOA);
- Research and development of local-scale woody biomass-to-energy conversion with a major thrust focusing on the simultaneous generation of electricity and useful heat;
- Conversion, via biological, thermal, catalytic, or chemical means of acceptable feedstocks into advanced biofuels and/or biobased products, including intermediate and end-use products;
- Improvement of the production and performance or commercial viability of biobased products and co-products;
- Improvement of the potential for developing rural based processing and manufacturing of biofuels and/or biobased products;
- Demonstration of commercial relevance of the technology, its expected marketability, and its potential commercial viability for processing and manufacturing biobased products; and
- Demonstration of biobased products to evaluate functional and environmental performance and to facilitate amending or developing industry standards and specifications.

Areas of particular interest for Biochemical, Thermochemical, and Chemical conversions, based on known barriers to successful commercialization, include, but are not limited to, research, development, and demonstration of technologies that would address:

Biochemical Conversion:

- Pretreatment technologies
- Hydrolysis and saccharification technologies that enhance advanced biofuels production
- Fermentation technologies for advanced biofuels
- Advanced bioprocessing technologies

Thermochemical Conversion:

- Gasification
- Pyrolysis

Chemical Conversion:

- Tolerance to inhibitory compounds
- Exothermic reactions for waste heat
- Reduction of celluosic components at mild conditions with recycle of reactants
- Selective dehydrations without side reactions

- Catalyst development for cleaving C-O and C-C bonds
- Cleavage of C-N bonds while preserving molecular structure

(C) <u>Biofuels and Biobased Products Development Analysis</u> – This technical area addresses methods to quantify the proposed technology and/or the project's positive impact on sustainability and on the environment; therefore, successful applications will consider the life-cycle (cradle-to-grave) impacts including environmental, social, and economic implications that are attributable to the project. As appropriate, the proposed project should include one or more of the following:

(i) Strategic guidance – The development of analysis that provides strategic guidance for the application of renewable biomass technologies to improve sustainability and environmental quality, cost effectiveness, security, and rural economic development.

(ii) Energy and Environmental Impact – Development of systematic evaluations of the impact of expanded biofuel production on the environment (including forest land) and on the food supply for humans and animals, including the improvement and development of tools for life cycle analysis of current and potential biofuels.

(iii) Assessment of Federal land – Assessments of the potential of Federal land resources to increase the production of feedstocks for biofuels and biobased products, consistent with the integrity of soil and water resources and with other environmental considerations.

To integrate Technical Area (C) with (A) and (B), the proposed project should consider the full life-cycle of the technology, which can be characterized by stages listed below. Where appropriate, Biofuels Development Analysis projects should generate, geographically specific, primary, social, economic, and environmental data that can be made publically available to be used in local, state, regional, and national analytical tools and models.

- Biomass feedstock development and cultivation;
- Feedstock harvesting and preparation;
- Feedstock logistics (handling, storage, and transportation);
- Waste stream logistics (handling, storage, and transportation);
- Biomass pre-processing (as appropriate);
- Biomass conversion;
- Production of biofuels/bioenergy/biobased products;
- Product logistics and distribution;
- Product consumption; and
- End of useful life.

(D) <u>Use of Biodiesel for the Production of Grain or Cellulosic Ethanol</u>

In FY 2011, USDA is interested in funding projects that specifically address the demonstration and analysis of farm-based and commercial operations that use biodiesel for the production of grain or cellulosic ethanol. These demonstration and analysis projects should inherently integrate the three technical areas (A), (B), and (C) described above. This area of interest will not be given priority over applications that address other technologies and analyses, and is not

intended to deter submission of applications that address other technologies.

In the 2008 Farm Bill, Section 9008 (e)(4) "Additional Considerations" expands upon the three technical areas:

(A) To create continuously expanding opportunities for participants in existing biofuels production by seeking synergies and continuity with current technologies and practices.

(B) To maximize environmental, economic, and social benefits of production of biofuels and derived biobased products on a large scale.

To meet the intent of this section, USDA will support demonstration project(s) that will quantify the economic, environmental, and social benefits of using biodiesel across the ethanol supply chain. Demonstration(s) will engage farming operations as key factors for potentially improving sustainable production of ethanol as well as promoting the use of biodiesel. Ethanol production facilities should consider using biodiesel as well as biodiesel coproducts in appropriate applications. The demonstration(s) are not intended to be paper studies, but actual farm-based and commercial processing facility operations that utilize biodiesel to the maximum extent practical. Objectives are to improve the sustainability footprint of ethanol production, to determine the benefits of using biodiesel over petroleum diesel and other fossil energy sources, and to update data and assumptions currently used in economic and environmental models, in the context of sustainability that includes social benefits and impacts.

Factors to be taken into consideration for demonstration include the following:

- Biodiesel must be specification-grade based on most current ASTM standard and/or BQ 9000 certified.
- Determining the cost of replacing petroleum diesel with biodiesel, including changes in equipment performance, maintenance, and storage.
- Generating primary (directly collected) data to measure and analyze life-cycle:
  - environmental, social, and economic impacts;
  - energy balance;
  - crop production and/or crop residue removal best management practices, including tillage and crop rotations; and
  - analysis parameters include agricultural production, harvest, handling, storage, transportation, and ethanol plant mechanical operations.

SECTION II – AWARD INFORMATION

C. Maximum and Minimum Award Size

- Ceiling (i.e., the maximum amount for an individual award made under this announcement): $7,000,000 (total, not per year)
- Floor (i.e., the minimum amount for an individual award made under this announcement): $3,000,000 (total, not per year)

F. Period of Performance

- DOE and USDA anticipate making awards with project periods of up to four years.

SECTION III - ELIGIBILITY INFORMATION

B. Cost Sharing

Cost Share 20% and 50%

Pursuant to Section 9008(e)(6)(B) of FSRIA (7 U.S.C. 8108(e)(6)(B)), as amended, the cost share must be at least 20% of the total allowable costs for research and development projects, and at least 50% of the total allowable costs for demonstration or commercial projects. These percentages are currently required by both USDA and DOE. The cost share must come from non-Federal sources unless otherwise allowed by law. The sum of the Government share, including Federally Funded Research and Development Center (FFRDC) contractor costs, if applicable, and the recipient share of allowable costs, equals the total allowable cost of the project. Applicable cost sharing requirements for DOE are included in 10 CFR Part 600.
To ensure proper cost share determinations for Pre-Applications, Applicants will be required to identify whether the Applicant is proposing a research, development, demonstration, or a commercial project.

The term "demonstration" is defined as demonstration of technology in a pilot plant or semi-works scale facility, including a plant

SECTION IV – PRE-APPLICATION AND SUBMISSION INFORMATION

B. Letter of Intent and Pre-Application

Pre-application

Pre-applications are required. You must complete the SF 424, attach your Pre-Application Project Summary and Pre-Application Project Narrative in the "Other Attachments Form," and submit electronically through Grants.gov at www.Grants.gov.

As described in Section I.D – Project Description (pages 7 - 11 of the FOA), all proposed projects submitted under this FOA must address all three technical areas, including those projects that are specific to farm and industrial demonstration(s) of using biodiesel to improve grain ethanol production. Pre-Applications and Applications that do not address these requirements will not be reviewed.

a. Project Summary/Abstract File

The Pre-application project summary should not exceed 1 page when printed using standard 8.5" by 11" paper with 1" margins (top, bottom, left and right) with font not smaller than 10 point. Save the information in a single file named "Summary.pdf," and click on "Add Optional Other Attachment" to attach.

b. Project Narrative File - Mandatory Other Attachment

The project narrative must not exceed five (5) pages, when printed using standard 8.5" by 11" paper with 1 inch margins (top, bottom, left, and right), single spaced.

F. Submission Dates and Times

1. **Pre-application Due Date – May 31, 2011, 5:00 PM Eastern Time**
   Pre-applications must be received by May 31, 2011, not later than 5:00 PM Eastern Time.

2. **Anticipated Notice of Invitation to Submit Full Applications**
   After the Pre-application review, selected Pre-Applicants will be invited to submit a Full Application. USDA-NIFA anticipates issuing invitations to submit Full Applications by August 3, 2011.

3. **Application Due Date – October 4, 2011, 5:00 PM Eastern Time**
   Only Full Applications from Pre-applicants invited to submit a Full Application will be considered. Pre-applicants who have been invited to submit Full Applications will be notified when Full Applications are due. At this time, USDA-NIFA anticipates Full Applications will be due by October 4, 2011, not later than 5:00 PM Eastern Time. You are encouraged to transmit your application well before the deadline. **APPLICATIONS RECEIVED AFTER THE DEADLINE WILL NOT BE REVIEWED OR CONSIDERED FOR AWARD.**