Annual Report to Congress on the Biomass Research and Development Initiative for FY 2003

Submitted Jointly by

The U.S. Department of Agriculture
&
The U.S. Department of Energy

February 2005

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I. INTRODUCTION

A. Purpose

This Annual Report to Congress is submitted in accordance with section 309 of the Biomass Research and Development Act of 2000 (the Biomass Act), 7 U.S.C. 7624 note. For each fiscal year (FY) in which funds are appropriated to carry out this title, the Secretary of Agriculture and the Secretary of Energy must jointly submit a report to Congress that details the status of activities carried out under the Biomass Research and Development Initiative (Initiative). The Initiative is the multi-agency effort to coordinate and accelerate all Federal biobased products and bioenergy research and development (R&D). Its general purpose as outlined in section 307 of the Biomass R&D Act follows: "The Secretary of Agriculture and the Secretary of Energy, acting through their respective points of contact and in consultation with the Board, shall establish and carry out a Biomass Research and Development Initiative under which competitively awarded grants, contracts, and financial assistance are provided to, or entered into with, eligible entities to carry out research on biobased industrial products."

FY 2003 was the second fiscal year in which funds were made available to the Initiative by Congress through section 9008 of the Farm Security and Rural Investment Act of 2002 (Farm Bill) (P.L. 107-171). This amended section 310 of the Biomass Act to authorize a total of $75 million to the United States Department of Agriculture (USDA) for the purpose of carrying out activities under the legislation. In fiscal year 2003, funds allocated from the Farm Bill to the USDA *and* from the Energy and Water Development Appropriations Bill to the United States Department of Energy (DOE) were combined to create a joint solicitation with the availability of $21 million. Ultimately, $23 million was awarded during the FY 2003 joint solicitation through the combination of USDA funds from the Farm Bill and DOE funds from the Energy and Water Development Appropriations Bill.

This annual report on the Initiative details activities that USDA and DOE (or Departments) conducted during FY 2003. The activities highlighted in this report include activities that are not directly funded through the Biomass Act, but contribute to the advancement of biomass research and development. Specifically, this report does the following:

- Describes the current general status and progress of the Initiative
- Describes the current general status of cooperation and research and development efforts carried out at both the USDA and the DOE
- Details the Biomass Research and Development Technical Advisory Committee's (Committee's) assessment of biomass related research performed by USDA and DOE as it relates to the Committee's *Roadmap*
- Provides Committee advice and recommendations related to the joint solicitation process and projects funded under the Initiative

B. Coordination of Federal Integration

Coordination and collaboration between the two Departments have been steadily increasing and remains strong. Acting on behalf of their respective Secretaries, the points of contact for USDA and DOE have been working closely together to coordinate their Departments' activities, as well as the activities of the Biomass Research and Development Board (Board) and the Committee. To date, the increased coordination between the Departments has resulted in a number of joint projects and activities contained within this document.

The principle participants of the Initiative as identified in the Biomass R&D Act and their respective duties are shown in Exhibit 1.

Exhibit 1
Initiative Participants and Duties

Participant	Description	Duty
Points of Contact	A senior official from both DOE and USDA	Coordinate the biomass research and development programs within their respective Departments
Biomass Research and Development Board	A Cabinet level council co-chaired by the Points of Contact	Coordinate biomass research and development programs within and among Departments and Agencies of the Federal Government
Biomass Research and Development Technical Advisory Committee	A group of individuals from industry, academia, non-profits, the agricultural and forestry sectors	Communicate through the Biomass Research and Development Board to advise the Secretaries of Energy and Agriculture on administration of the Biomass R&D Act

The DOE's Office of the Biomass Program provides coordination support for both the Board and the Committee, carries out the directives of the Board, and responds to the recommendations of the Committee. A DOE senior official serves as the Designated Federal Officer (DFO) for the Committee.

- The points of contact serve as co-chairs of the Board. Current points of contact for DOE and USDA are David K. Garman, Assistant Secretary for Energy Efficiency and Renewable Energy, DOE; and Mark Rey, Under Secretary, Natural Resources and Environment, USDA, respectively.
- The Board works with the Federal Agencies to coordinate the integration of biomass R&D programs.
- The DOE's DFO facilitates communication between the Board and the Committee.

II. A REPORT FROM THE SECRETARIES OF AGRICULTURE AND ENERGY

Since the enactment of the Biomass Act, USDA and DOE have continued to forge a strong working relationship to fulfill the requirements of the Biomass Act and to improve coordination and integration of Federal biomass research and development activities.

Specific accomplishments during FY 2003 include:

- **Joint Solicitation** – USDA and DOE successfully coordinated a joint solicitation under the Initiative awarding 19 projects. The total Federal funds collectively requested by all eligible proposals exceeded $370 million. The FY 2003 joint solicitation stated that $21 million in funds would be made available. Ultimately, through the combination of DOE congressionally-appropriated funds and USDA funds from the Farm Bill, $23 million was awarded during the FY 2003 joint solicitation.

- **Roadmap for Biomass Technologies** - DOE and USDA supported Committee development of this *Roadmap* which was released in January 2003. It accompanies the Committee's *Vision* which was developed in 2002 and was requested of the Committee by the Secretaries of Agriculture and Energy. The *Vision* and *Roadmap* form the basis for future Committee evaluation of Federal biomass research and development activities.

- **Joint USDA and DOE Portfolio Assessment by the Committee** - A compilation of biomass-related research and development activities and investments being performed by USDA and DOE in alignment with *Roadmap* categories was provided to the Committee for a first-ever assessment of the joint biomass portfolios of USDA and DOE.

- **Joint Board – Committee Meetings** - Successful meetings of the Board and the Committee in February and October of 2003.

- **Interagency Meetings** – A series of regular interagency meetings between USDA and DOE staff was begun to identify opportunities for collaboration between our respective programs.

The achievements of FY 2003 improved coordination between USDA and DOE, as well as the other agencies of the Board. The joint solicitation process was completed in a coordinated fashion between the Departments with awards made on schedule. Further improvements to streamline the process were identified and were implemented for the 2004 joint solicitation.

III. STATUS AND PROGRESS OF THE BIOMASS INITIATIVE

A. Goals and Objectives

Since the establishment of the Initiative in June of 2000, USDA and DOE have been working together to ensure that their biomass R&D programs are carried out in accordance with the Biomass Act. As outlined in section 307 of the Biomass R&D Act, specific purposes are:

- "to stimulate collaborative activities by a diverse range of experts in all aspects of biomass processing for the purpose of conducting fundamental and innovation-targeted research and technology development;
- to enhance creative and imaginative approaches toward biomass processing that will serve to develop the next generation of advanced technologies making possible low cost and sustainable biobased industrial products;
- to strengthen the intellectual resources of the United States through the training and education of future scientists, engineers, managers, and business leaders in the field of biomass processing; and
- to promote integrated research partnerships among colleges, universities, national laboratories, Federal and State research agencies, and the private sector as the best means of overcoming technical challenges that span multiple research and engineering disciplines and of gaining better leverage from limited Federal research funds."

To further guide the Initiative in its funding of projects and in providing direction for achieving the goals of the Biomass Act, the Committee, through its *Vision for Bioenergy and Biobased Products in the United States*, has established the industrial targets shown in Exhibit 3 which help to guide R&D priorities.

Exhibit 3
Vision Goals

Goal Area	2001 (baseline)	2010	2020	2030
BioPower - Biomass share of electricity & heat demand in utilities and industry*	3% (2.7 quads)	4% (3.3 quads)	5% (4.0 quads)	5% (5.0 quads)
BioFuels - Biomass share of demand for transportation fuels†	0.5% (0.15 quads)	4% (1.3 quads)	10% (4.0 quads)	20% (9.5 quads)
BioProducts - Share of target chemicals that are biobased	5%	12%	18%	25%

These industry targets will be influenced by many factors, including legislation (e.g., ethanol mandate, tax credits for production of electricity from biopower), regulation (e.g., requirements for the purchase of bio-based products), and progress resulting from privately funded and

* Power generated from biomass will supply the given percentage of total industrial and electric generator energy demand for the given year.
† Transportation fuels from biomass will account for the given percentages of total U.S. transportation fuel consumption in the given years.

government-funded R&D. The Initiative seeks to advance R&D to help achieve the goals identified in the Biomass Act, and to make technological advances that may help industry achieve the targets shown above.

B. Measuring Progress

To measure technical progress in achieving industry targets (as set by the Committee), the Committee will begin to track the research funded under the joint solicitations. This tracking will include monitoring the technical success of each project, evaluating the contributions of each project to meeting *Vision* and *Roadmap* goals, and determining the contribution of each project as it relates to the goals of the Initiative. The Committee also will begin to measure market data related to each of the Committee's goals in biopower, biofuels, and biobased products.

C. Biomass Research and Development Board

The Board, which was established by section 305 of the Biomass Act, is co-chaired by the points of contact from USDA and DOE. Board members are senior officers from the Department of the Interior (DOI), the Environmental Protection Agency (EPA), National Science Foundation (NSF), Office of the Federal Environmental Executive (OFEE), and the Office of Science and Technology Policy (OSTP).

The Board held two joint meetings with the Committee, in February and October of 2003. The Board received recommendations from the Committee on the overall investment of Federal funds in biomass related research, the importance of Federal procurement of biobased products, and advice on the joint solicitation performed under the Initiative. In addition, a Board meeting was held in August 2003 to determine whether or not to affirm the procurement process and projects selected under the FY 2003 USDA/DOE Joint Biomass Solicitation. The vote to affirm the procurement process and projects selected by USDA and DOE passed unanimously.

Members of the Biomass Research and Development Board

Co-Chairs
Mark Rey, Under Secretary, Natural Resources and Environment, USDA
David K. Garman, Assistant Secretary, Energy Efficiency and Renewable Energy, DOE

Members
Bruce Hamilton, Director, Bioengineering and Environmental Systems Division, NSF
Jean-Mari Peltier, Counselor to the Administrator, EPA
Jim Tate, Science Advisor, DOI
Kathie Olsen, Associate Director for Science, OSTP
John Howard, Federal Environmental Executive, OFEE

D. Biomass Research and Development Technical Advisory Committee

The Committee was established by section 306 of the Biomass Act. During its 2003 work-year, which is a fiscal year, the Committee consisted of 31 individuals from industry, academia, non-profit organizations, and the agricultural and forestry sectors that are experts in their respective fields.

In 2001, the Committee prepared recommendations to the Secretaries of Agriculture and Energy for research and development and other activities necessary for advancing goals and challenges for biofuels, biobased products, and biopower.

In June 2002, the Secretaries of Agriculture and Energy requested that the Committee develop *Vision* and *Roadmap* documents to guide future biomass research and development activities. The documents would serve as a resource for the agencies in planning their biomass research and development portfolios. The Committee worked over the course of several months to develop these documents. The *Vision for Bioenergy and Biobased Products in the United States* was released in October 2002 and sets far-reaching goals for the role of biomass in future energy and product markets. The corresponding *Roadmap for Biomass Technologies* was released in January 2003.

In 2003, the Committee used the *Vision* and *Roadmap* as a baseline to develop recommendations for Federal agencies on biomass research and development. DOE and USDA assembled information on their biomass research portfolios and investment and organized the portfolio information along Committee *Roadmap* categories. The material was presented to the Committee in February of 2003 and was evaluated by the Committee over a period of seven months (February through August) through a series of meetings and conference calls. The Committee developed its assessment of the portfolio and developed recommendations provided in Section IV of this Annual Report.

2003 Members of the Biomass Research and Development Technical Advisory Committee

Co-chairs	
Glenn English	National Rural Electric Cooperative Association
Thomas Ewing	Davis & Harman LLP
Members	
Wayne Barrier	Metropolitan Energy Systems
Roger Beachy	Donald Danforth Plant Science Center
Tom Binder	Archer Daniels Midland
Robert Boeding	National Corn Growers Association
Dale Bryk	Natural Resources Defense Council
William Carlson	Wheelabrator Environmental Systems
Joseph Chapman	North Dakota State University
Robert Dorsch	Dupont
Carolyn Fritz	Dow Chemical Company
Charles Goodman	Southern Company
Brian Griffin	Southern States Energy Board
Pat Gruber	Cargill Dow LLC
William Guyker	Life Fellow – IEEE
John S. Hickman	Deere & Company
William Horan	Horan Brothers Agricultural Enterprises
Jack Huttner	Genencor International, Inc.
F. Terry Jaffoni	Cargill, Inc.
Kim Kristoff	Biobased Manufacturers Association
Michael Ladisch	Purdue University
David Morris	Institute for Local Self Reliance
William Nicholson	Potlatch Corporation, Retired
Gary Pearl	Fats and Proteins Research Foundation

Edan Prabhu	FlexEnergy
William Richards	Richards Farms, Inc.
Philip Shane	Illinois Corn Marketing Board
Larry Walker	Cornell University
John Wootten	Peabody Energy
Michael Yost	Yost Farm, Inc.
Holly Youngbear-Tibbetts	College of Menominee Nation

E. FY 2003 Initiative Activities

The funds authorized for the Initiative from the USDA through section 9008 of the 2002 Farm Bill and from the DOE through the Energy and Water Development Appropriation Bill were used in accordance with the priorities, criteria, and procedures outlined in the Biomass Act. On March 18, 2003, USDA released the request for proposals (RFP) for the 2003 USDA/DOE Joint Solicitation for the Initiative. USDA received approximately 400 proposals in response to the solicitation. Applications that did not satisfy basic requirements were deemed ineligible. All eligible proposals were competitively evaluated in a process that included a joint USDA/DOE technical merit review, as well as cost analysis and programmatic review based on the respective independent priorities of the Departments as published in the solicitation. The total Federal funds collectively requested by all eligible proposals exceeded $370 million. As previously stated, the total awards under the FY 2003 joint solicitation were $23 million. Note that the funds made available each fiscal year for the Initiative's joint solicitation are a combination of funds from the USDA (through the Farm Bill) and DOE (through the Energy and Water Development Appropriations Bill).

The joint solicitation announcement outlined specific details that the Departments would use for making grant awards, as shown in Exhibit 4. The solicitation pointed applicants to the web link for the *Roadmap for Biomass Technologies in the United States* prepared by the Committee to use as an added resource for developing proposals.

Jointly, USDA and DOE conducted a technical merit evaluation of all proposals. Then, USDA and DOE independently performed programmatic reviews of all proposals and independently selected suitable proposals for funding consistent with the technical merit evaluation and the program priorities and criteria specified in the solicitation announcement.

Exhibit 4
Solicitation Discussion of Purpose, Priorities, and Funding

Grants are awarded competitively, on the basis of:

- Technical merit, based on procedures that provide for scientific peer review by an independent panel of scientific and technical peers; and
- Program priorities that consider costs and preference for applications that:
    - involve a consortium of experts from multiple entities;
    - encourage the integration of disciplines and application of the best technical resources; and
    - demonstrate potentially viable market opportunities for bio-based products, bioenergy, biofuels, and biopower.

Higher priorities will be given to projects that --

- Demonstrate potential for significant advances in biomass production, handling, processing, and manufacturing;
- Demonstrate potentially viable distributed power generation opportunities using biomass suitable for moderate size operations, particularly addressing animal waste management issues;
- Improve understanding and ability to overcome technical and institutional barriers associated with connections to the commercial power grid and energy distribution and transmission system;
- Improve potential for developing rural based processing and manufacturing of biobased products and power production from biomass;
- Demonstrate potential to substantially further national objectives such as sustainable resource supply; reduced greenhouse gas emissions; healthier rural economies; and improved strategic energy security and trade balances; and
- Demonstrate commercial relevance of the proposal, expected marketability and potential commercial viability of biomass production, handling, processing, or manufacturing procedure and the biobased products that would be developed.

Grants may be used to conduct—

- Research on process technology for overcoming the recalcitrance of biomass, including research on key mechanisms, advanced technologies, and demonstration test beds;
- Research on technologies for diversifying the range of products that can be efficiently and cost-competitively produced from biomass;
- Research aimed at ensuring the environmental performance and economic viability of bio-based industrial products and their raw material input of biomass when considered as an integrated system; or
- Any research, development, and demonstration of technologies or processes consistent with the purposes and priorities of this initiative.

DOE will consider applications that fall under the first two categories and USDA will consider applications addressing any of the above areas, with an emphasis on the latter two.

F. Solicitation Results

Following the review process, 19 projects were selected for funding. The following provides a brief public summary of each of the selected projects and the funding amounts.

DOE Projects

1. *Title:* Integration of Leading Biomass Pretreatment Technologies with Enzymatic Digestion and Hydrolyzate Fermentation Thermotolerant Biocatalysts for Biomass Conversion to Products
   Main Proposer: Trustees of Dartmouth College (Hanover, NH)

Partners: Auburn University, Michigan State University, Purdue University, Texas A&M University, The University of British Columbia (UBC), National Renewable Energy Laboratory (NREL)
Estimated Duration of Project: 18 months
Federal Funds Requested: $1,882,866 (75 %)
Cost-Share Funds: $620,361 (25 %)
Total Project Cost: $2,503,227

The goal of this project is to develop and compare leading pretreatment technologies coupled with fermentation and enzymatic digestion. The project team also seeks to better understand interactions among pretreatment, fermentation, and enzymatic hydrolysis to gain insight that will facilitate selection and commercialization of cellulosic technologies and lead to step change cost reductions. Another goal is to train and educate students in biomass technologies. Corn stover will be used to tie to previous research, but the team will focus primarily on poplar, a leading woody energy crop, coupled with fermentation and enzymatic hydrolysis. The team will also work closely with Genencor International to apply commercial and new state-of-the-art enzyme formulations in this research. Although the fermentation portion focuses on ethanol, the results should be valuable in making other products.

2. *Title:* Engineering Thermotolerant Biocatalysts for Biomass Conversion to Products
Main Proposer: University of Florida (Gainesville, FL)
Partners: (None)
Estimated Duration of Project: 36 months
Federal Funds Requested: $1,437,620 (79 %)
Cost-Share Funds: $374,265 (21 %)
Total Project Cost: $1,811,885

The primary objective of this study is to construct novel thermotolerant biocatalysts (second generation) that function optimally under environmental conditions that are also optimal for the activity of fungal cellulases. Development of these second generation biocatalysts will significantly decrease the cost of cellulose bioconversion processes by facilitating a two-fold or more reduction in the amount of cellulase enzymes which are required in SSF process designs.

3. *Title:* Demonstration of the PureVision Biorefinery
Main Proposer: PureVision Technology, Inc. (Ft. Lupton, CO)
Partners: Genencor International, Inc. (Rochester, NY); Western Research Institute (Laramie, WY); Membrane Technology and Research (Menlo Park, CA); ENTEK Extruders (Lebanon, OR); Tennessee Valley Authority (Muscle Shoals, AL); The Harris Group, Inc. (Seattle, WA); National Renewable Energy Laboratory (Golden, CO); State University of New York (Syracuse, NY)
Estimated Duration of Project: 16 months
Federal Funds Requested: $2,000,000 (74%)
Cost-Share Funds: $701,035 (26%)
Total Project Cost: $2,701,035

This project will be carried out by a multidisciplinary consortium consisting of five private companies, a Federal corporation, a national laboratory, and two institutions of higher education to increase the scientific understanding of and ensure U.S. leadership in

biomass conversion. Funding under this grant will support Phase I of a two-phase project.

Phase I is expected to take 16 months to complete and consists of five tasks: (1) optimize parameters for continuous counterflow washing of biomass at elevated temperature followed by steam explosion to yield liquid fractions containing dissolved lignin, hemicellulose, and extractives and a solid fraction of highly reactive and essentially pure cellulose with supporting microscopy studies; (2) develop a unique enzyme system and optimize enzymatic hydrolysis of the pure cellulose fraction to produce sugar (glucose) at high yield; (3) characterize, separate and recover marketable components from the liquid fractions; (4) develop the design criteria to build a fully integrated demonstration biorefinery and perform economic modeling, evaluation and simulation of a commercial PureVision biorefinery; and (5) monitor, document and report on project progress and results. The ultimate goal of Phase I will be to determine a go/no-go scenario to proceed to Phase II.

4. *Title*: Platform Chemicals from an Oilseed Biorefinery
Main Proposer: Cargill, Inc. (Minneapolis, MN)
Partners: Bio-Technical Resources (Manitowoc, WI); Materia (Pasadena, CA); Batelle Memorial Institute (Columbus, OH)
Estimated Duration of Project: 24 months
Federal Funds Requested: $1,877,176 (50 %)
Cost-Share Funds: $ 1,879,047 (50 %)
Total Project Cost: $ 3,756,223

   This project will use a multidisciplinary approach to develop a platform of industrial chemicals based on novel applications of biocatalysts and chemistry that will serve as the foundation for an oilseed biorefinery, or an integrated carbohydrate/oilseed biorefinery. The first target of this program is the generation of novel platform intermediates from vegetable oils using metathesis chemistry. Modifying the oils by biocatalysis is expected to enhance the diversity and value of the resulting chemicals. Cargill will partner with Materia, Inc. and Caltech to develop and screen catalysts and to develop process flowsheets, simulations, and economic estimates for the metathesis industry. Battelle Memorial Institute will develop novel polymer applications for the platform of chemicals derived from this platform. Cargill will use this information to build an oilseed biorefinery model. Bio-Technical Resources will expand the concept by exploring the use of a novel enzyme for modifying the oils prior to chemical catalysis.

USDA Projects

1. *Title:* Advanced Biorefinery Feedstocks
Main Proposer: Metabolix, Inc. (Cambridge, MA)
Partners: Iowa State University
Estimated Duration of Project: 36 months
Federal Funds Requested: $2,000,000 (52 %)
Cost-Share Funds: $1,833,835 (48 %)
Total Project Cost: $3,833,835

   The objective of this project is to develop a genetically engineered biomass crop (switchgrass) that can be processed in a biorefinery to produce a family of biodegradable, biobased polymers, polyhydroxyalkanoates (PHAs) and energy. The ABF project

focuses on developing transgenic plants that produce PHAs at economic levels and retain robust agronomic characteristics. This project will apply recent advances in plant gene expression technology coupled with high-throughput metabolic profiling.

2. *Title:* Research and Demonstration of Anaerobic System on a Large Dairy Farm
Main Proposer: Utah State University (Logan, UT)
Partners: USDA's Natural Resources Conservation Service (NRCS)
Estimated Duration of Project: 24 months
Federal Funds Requested: $761,385 (78 %)
Cost-Share Funds: $208,875 (22 %)
Total Project Cost: $970,260

   The objective of this project is to develop a full-scale anaerobic digester dairy farm system that generates significant amounts of electricity (two 80 kW microturbines) that will be fed into the power grid. The three main goals of the project are to (1) demonstrate the induced blanket reactor (IBR) system in full scale on a large dairy farm and verify technology performance expectations, (2) identify areas of opportunity for system and technology improvement, and (3) investigate the commercial and economic viability of the IBR system and estimate the market potential.

3. *Title:* Animal Waste Management—Chicken Litter to Energy
Main Proposer: Earth Resources, Inc. (Carnesville, GA)
Partners: Gas Technology Institute (GTI), University of Georgia
Estimated Duration of Project: 24 months
Federal Funds Requested: $1,136,936 (76 %)
Cost-Share Funds: $357,500 (24 %)
Total Project Cost: $1,494,436

   This project's objective is to use chicken litter as a fuel for power generation and the combusted ash for fertilizer using waste combustion or gasification. Fixed-bed combustion will be experimentally compared with fluidized-bed gasification in terms of combustion and thermal efficiencies. The potential to generate hydrogen during fluidized-bed gasification will be investigated. A primary objective of this program is to develop cost-effective, environmentally sound thermochemical conversion technologies to convert biomass feedstocks into useful electric power, heat, and potential fuels and products. Data will be generated to demonstrate the technical feasibility of gasification of chicken litter to produce power (steam and eventually electricity) and fertilizer.

4. *Title:* New Technologies for Production of Methyl Esters
Main Proposer: West Central Cooperative (Ralston, IA)
Partners: Iowa State University, Ames Laboratory
Estimated Duration of Project: 24 months
Federal Funds Requested: $1,199,646 (66 %)
Cost-Share Funds: $627,002 (34 %)
Total Project Cost: $1,826,648

   The goal of this project is to refine, field-test, and install new technologies that have been developed and proven by scientists at Iowa State University for the production of methyl esters. The new technologies will reduce energy consumption, enhance economic competitiveness, and reduce environmental impacts of methyl ester production. Five generations of base-type catalysts will be synthesized for mounting on mesoporous solid

supports and for evaluating their efficiency and recyclability in catalyzing the transesterification of oils with methanol. Four generations of acid-type mesoporous solid catalysts will be synthesized for esterification of various oils and fatty acid feedstocks with methanol. The project team will (1) field test new, recyclable heterogeneous acid and base catalysts for converting various oils and fatty acid oils to methyl esters, (2) fine tune the performance characteristics of the new heterogeneous catalysts, and (3) conduct cost analysis using selected heterogeneous catalysts with various oils and fatty acid feedstocks. It is anticipated these technologies will result in yearly savings exceeding $100,000 at the West Central Cooperative Ralston plant, and significantly reduce environmental impacts of methyl ester production.

5. *Title:* Heterogeneous Catalyst Development for Biodiesel Synthesis
Main Proposer: Clemson University (Clemson, SC)
Partners: RTI; Süd-Chemie, Inc.; Biodiesel Industries, Inc.
Estimated Duration of Project: 36 months
Federal Funds Requested: $894,203 (79 %)
Cost-Share Funds: $230,836 (21 %)
Total Project Cost: $1,125,039

   The project team will investigate solid acid catalysts for use in the esterification of fatty acids, the transesterification of triglycerides, and the esterification of glycerol to compounds suitable for use in diesel engines. The catalysts being studied would permit continuous processes to be built around three-phase reactors such as slurry bubble column and trickle bed reactors. Single catalysts or mixtures of solid catalysts could be used to carry out multiple reactions simultaneously. Use of such catalysts should allow the processing of a wider range of biodiesel feedstocks, thus allowing for more economical processes. Determination of the commercial potential of the research findings is an integral part of this project.

6. *Title:* Design and Demonstration of a Commercial Prototype for Onsite Production of High Purity Hydrogen from Farm Animal Wastes
Main Proposer: New Energy Solutions, Inc. (Pittsfield, MA)
Partners: REB Research & Consulting; Panamerican Enterprises, Inc.; Cornell University; AA Dairy
Estimated Duration of Project: 24 months
Federal Funds Requested: $204,603 (65 %)
Cost-Share Funds: $111,888 (35 %)
Total Project Cost: $316,491

   New Energy Solutions, Inc. (NESI) has integrated REB Research and Consulting's (REB's) patented hydrogen selective tubes into the design of a compact plant for converting animal wastes into high purity hydrogen. The overall plant design includes an anaerobic digester to provide anaerobic digester gas (ADG) to generate pure hydrogen. The project objective is to demonstrate the operational, environmental, and economic features and benefits of an innovative plant designed for utilizing animal wastes to produce ultra high purity hydrogen for a variety of uses that include fuel for fuel cells, transportation, and industrial processes. NESI will conduct a three-phase program, the results of which will include verification of the design parameters and performance database for the plant; design and construction of a Beta demonstration plant; and demonstration of the operational, environmental, and economic features of this plant at an existing anaerobic digester site on a dairy farm in New York State.

7. *Title:* Biomass Research and Development for the Production of Fuels, Chemicals, and Improved Cattle Feed
   Main Proposer: Archer Daniels Midland Company (Quincy, IL; Decatur, IN)
   Partners: USDA's Agricultural Research Service (ARS)
   Estimated Duration of Project: 36 months
   Federal Funds Requested: $1,400,000 (70 %)
   Cost-Share Funds: $600,000 (30 %)
   Total Project Cost: $2,000,000

   This project's objective is to expand ethanol production while ensuring adequate feed supply to the cattle market from greater utilization of pretreated lignocellulosics derived from current crops and existing agricultural processing operations. The project team will outline new approaches to processing corn in dry mills, including cost-effectively improving fermentation of yeast through the supply of adequate nitrogen while improving the separation of germ and fiber for increased co-product value. The team will seek to create a bioavailable cattle feed by mixing pretreated agricultural processing by-products and pretreated agricultural residues. The materials examined in this study will be distillers' dried grains, soybean hulls, corn germ meal, corn stover, and wheat straw. Benefits to farmers, processors, cattle feed operations, consumers, animals, the environment, and imported energy will be the subject of a life cycle analysis generated through this research and included as an essential component of the final report.

8. *Title:* GrainValue Process: Pre-Commercialization Trials
   Main Proposer: GrainValue, LLC (St. Paul, MN)
   Partners: DENCO, LLC; MCGA & MCRPC; University of Minnesota
   Estimated Duration of Project: 36 months
   Federal Funds Requested: $1,763,160 (59 %)
   Cost-Share Funds: $1,210,800 (41 %)
   Total Project Cost: $2,973,960

   This project seeks to evaluate and advance to commercialization a novel biorefinery process to fractionate and refine corn grain, distinct from traditional wet and dry milling. The resulting more valuable coproducts—ethanol, protein, yeast, and germ or oil—could be sold into large, established markets under existing regulations. This should result in about $1.00 increased revenue and $0.70 increased profit for every bushel processed, along with a substantially increased return on investment, thereby improving the potential for the development of rural based processing and manufacturing of biobased products. This project is a cooperative effort involving GrainValue LLC (the developers), DENCO LLC (a farmer-owned ethanol plant), corn grower organizations, and university scientists aimed at bringing this technology to the point of commercialization. Project activities include pilot plant work to refine and validate the process, engineering and economic evaluation, feeding trials of protein and yeast byproducts, and continued improvement of our understanding of the underlying chemistry and biology involved.

9. *Title:* Coupled Processes for Bioenergy Production: Biological Hydrogen Linked with Microbial Fuel Cells
   Main Proposer: Pennsylvania State University (University Park, PA)
   Partners: National Renewable Energy Laboratory (NREL)
   Estimated Duration of Project: 36 months
   Federal Funds Requested: $614,913 (78 %)

Cost-Share Funds: $175,965 (22 %)
Total Project Cost: $790,878

This project involves developing processes that link a Microbial Fuel Cell (MFC) process directly to biohydrogen production in a two-step process. In the first process, animal wastewater and high-cellulose (low lignin) biomass sources such as corn stover will be fermented to produce hydrogen. In the second process, the products of the fermentation process (which are no longer capable of being converted to hydrogen) are converted directly into electricity in the MFC. The process will involve metabolic engineering of clostridia to produce hydrogen through the degradation of cellulosic substrates and the construction and testing of a flow-through microbial fuel cell to produce electricity from these fermentation systems. The Pennsylvania State University will be aided in its research through its collaboration with researchers at the National Renewable Energy Laboratory (NREL).

10. *Title:* Biopolymers and Other Value-Added Products from Distillers' Dried Grains
Main Proposer: Iowa State University (Ames, IA)
Partners: South Dakota State University, Midwest Grain Processing
Estimated Duration of Project: 24 months
Federal Funds Requested: $1,000,000 (80 %)
Cost-Share Funds: $250,757 (20 %)
Total Project Cost: $1,250,757

    The overall objective of this research is to develop value-added products from distillers' dried grains (DDG), a byproduct of ethanol fermentation via the dry grain milling process. The project team will extract readily accessible oils and proteins from DDG, followed by thermal gasification of the high fiber byproduct to produce syngas, a mixture of carbon monoxide (CO) and hydrogen (H_2), which then serves as feedstock in an anaerobic fermentation. Although a variety of fermentation products can be produced by "syngas fermentation," the focus of this study is polyhydroxyalkonates (PHA), polyesters with potential applications in the manufacture of biobased plastics, fibers, and films. This project is a collaboration among Iowa State University, South Dakota University, and Midwest Grain Processors Corporation.

11. *Title:* Biomass-Fired District Energy: A Source of Economic Development and Energy Security
Main Proposer: Local Energy (Tesuque, NM)
Partners: (None)
Estimated Duration of Project: 12 months
Federal Funds Requested: $1,286,768 (73 %)
Cost-Share Funds: $468,197 (27 %)
Total Project Cost: $1,754,965

    The purpose of this project is to design a district heating system for the downtown area of Santa Fe, New Mexico by utilizing woody biomass materials from overstocked fire prone forests surrounding the community. The design will be by the biomass district energy designer who won the 2003 Energy Globe Award. The design will be optimized not only for peak efficiency, but also for maximum creation of local economic benefit. Every aspect of the project—even the value of the emissions reductions credits, will be considered during the techno-economic optimization. The beneficial impacts on output, earnings, and jobs for the optimized model will be quantified, and the results will be used

to teach other communities how to develop their local economies and improve their energy security using renewable biomass energy.

12. *Title:* Steps Towards a Biorefinery Industry in Vermont
Main Proposer: Vermont's Alternative Energy Corporation (Williston, VT)
Partners: Intervale Foundation, Foster Brothers Farm, Intervale Compost Products, University of Vermont
Estimated Duration of Project: 24 months
Federal Funds Requested: $746,912 (70 %)
Cost-Share Funds: $320,390 (30 %)
Total Project Cost: $1,067,302

    This project represents collaboration between five organizations with specific expertise in `biomass production or utilization. The general goal of this proposal is to define avenues for the development of a biorefinery industry in Vermont based on the state's rich agricultural resources. The project team aims to conduct three separate investigations that, together, are crucial to understanding the potential for biomass utilization in Vermont and the Northeast. Through the project, the team aims to define a complete pathway to the development of economically sustainable biomass-based enterprises that match the geography as well as the social and environmental values of the region. More specifically, the project involves possible on-farm energy generation largely from animal wastes, off-farm electric generation, and processing of biomass into liquid fuels.

13. *Title:* Biomass for Tomorrow's Energy and Greenhouse Gas Management Needs: An Economic, Engineering and Environmental Appraisal of Opportunities and Policies
Main Proposer: Texas Agricultural Experiment Station (College Station, TX)
Partners: (None)
Estimated Duration of Project: 36 months
Federal Funds Requested: $716,388 (80 %)
Cost-Share Funds: $182,050 (20 %)
Total Project Cost: $898,438

    This project is designed to assemble a team of agricultural economists and chemical engineers to develop lifecycle energy, environmental, and economic biocomplexity accounting for major biomass pathways; adapt an existing national forest and agriculture sector model to analyze biomass pathways and how they are affected by alternative levels of greenhouse gas prices in competition with traditional agriculture and forestry production; develop an environmental-biocomplexity analysis to establish an understanding of the dynamic interplay between biomass for energy (BE) production/utilization and the global ecosystem; develop information on technical innovations and contemplated policy actions regarding CRP, forested lands, fuel composition regulations, and other policies; utilize the sector model to examine the sensitivity of the portfolio to possible technological and policy changes; and document and create a web site containing findings and models others can use.

14. *Title:* Biomass Cogeneration Demonstration Plant at Central Minnesota Ethanol Cooperative
Main Proposer: Sebesta, Blomberg & Associates, Inc. (Roseville, MN)
Partners: Primenergy, LLC; Central Minnesota Ethanol Cooperative
Estimated Duration of Project: 12 months
Federal Funds Requested: $2,000,000 (14 %)

Cost-Share Funds: $12,186,868 (86 %)
Total Project Cost: $14,186,868

The project team will construct an innovative biorefining facility by integrating the CMEC plant with Primenergy's gasifiers and a steam turbine that will combust syrup waste to coproduce power and steam. The team will also consider as fuel forest and agricultural residues from neighboring forests, logging operations, sawmills and corn farms. The demonstration plant will provide the basis for accelerating the deployment of gasification-based electricity and heat generation so that biomass power plants can be built and integrated into ethanol plants.

15. *Title:* Feasibility of an Integrated System for Improving the Economic and Environmental Performance of Poultry and Ethanol Production in North Alabama
Main Proposer: T.R. Miles, Technical Consultants, Inc. (Portland, OR)
Partners: Tennessee Valley Authority Public Power Institute; Sparks Companies, Inc.; Energy Products of Idaho; Auburn Poultry Science; Tennessee Valley Resource Conservation Council
Estimated Duration of Project: 12 months
Federal Funds Requested: $254,274 (80 %)
Cost-Share Funds: $64,449 (20 %)
Total Project Cost: $318,723

The objective of this project is to assess the feasibility of an integrated ethanol and poultry production (IPEP) system in north Alabama that uses poultry litter as an alternative source of process energy for corn/ethanol production and is projected to improve the overall economic and environmental performance of both ethanol and poultry production. The technical and economic feasibility of an IPEP system in north Alabama will be assessed considering the following site-specific factors: (1) the competing price of natural gas; (2) the cost of converting poultry litter to thermal energy and ash feed supplement or fertilizer; (3) the delivered cost of poultry litter; (4) the value of poultry litter ash for use in poultry feed and fertilizers; (5) renewable energy incentives; (6) the value of DDGE for low-level use in poultry diets; (7) ethanol incentives; and (8) transportation costs for corn, ethanol, and DDGE for a corn-ethanol plant located in a concentrated poultry area versus locations closer to primary corn supplies. The expected outcome of the proposed project is to provide the necessary documentation for a project developer to develop a business plan and acquire financing for commercialization of an IPEP system in north Alabama.

IV. Report of the Biomass Research and Development Technical Advisory Committee & Departmental Response to Committee Recommendations

The Biomass Act charges the Committee with advising the Secretary of Energy, the Secretary of Agriculture, and the points of contact concerning the "technical focus and direction of requests for proposals issued under the Initiative and procedures for reviewing and evaluating the proposals." In addition, it assigns the Committee the duty of evaluating awards made, making recommendations to the Board to ensure that "funds authorized for the Initiative are distributed and used in a manner that is consistent with the goals of the Initiative," and that the "points of contact 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." The Initiative, as stated above, is described in section 307 of the Biomass Act.

As required by section 309 of the Biomass Act, the Committee is submitting this report to assess whether or not funds appropriated for the Initiative are being used in a manner that is consistent with the Biomass Act.

During Committee meetings held over the course of the year, USDA provided the Committee with updates on the status of the joint solicitation process. Following the announcement of the fiscal year 2003 joint solicitation awards, the Committee was provided with a written overview of the joint solicitation process and a summary of the awards made.

The following are summary comments made by the Committee on the joint solicitation process and the awards made. Comments are organized into four areas:

A. Recommendations on Changes to the FY 2004 Joint Solicitation,
B. Tracking the Progress of Research under the Joint Solicitation, and
C. Review of Awards Made under the Initiative
D. Committee Review of the USDA and DOE Biomass-related R&D Portfolio

Although this is the Committee's report, USDA and DOE responses have been added in italics at the end of each of the four areas listed above to correlate with each of the Committee's recommendations. No changes have been made to the actual content of the Committee's report by adopting this report structure.

A. Recommended Changes to the FY 2004 Joint Solicitation

1. Added emphasis should be placed upon the importance of enhancing "creative and imaginative approaches toward biomass production, handling, processing, and manufacturing…."

2. Bidders should be required to review the Committee's *Vision* and *Roadmap*, and specify how the proposed research addresses strategic recommendations outlined in the *Roadmap* and contributes to achieving *Vision* goals.

3. The Committee agreed with the "high priority" project areas described in the FY 2003 solicitation with the following recommended changes:

a. Since a large number of animal waste projects were selected under the FY 2003 joint solicitation, animal waste should be de-emphasized in the language used in the FY 2004 joint solicitation.
b. The priority listed in the FY 2003 solicitation on improving the "understanding and ability to overcome technical and institutional barriers associated with connections to the commercial power grid and energy distribution and transmission systems" should not be included in the FY 2004 solicitation.
c. Applicants proposing demonstration projects should be required to provide information as to why the technology involved is technically superior to other options and why it is commercially viable.
d. Priority should be given to applicants who plan to patent or publish their results.

4. For FY 2004, the Committee recommended revising the weighting of evaluation criteria used in scoring proposals. Specifically, the Committee recommended increasing the weight placed on "Technical Relevance and Merit" from 40 percent (in FY 2003) to 50 percent, and reducing the weight placed on "Technical Approach" and "Capability" from 30 percent each (in FY 2003) to 25 percent each. In addition, the minimum cost share should be increased from the 20 percent level used in FY 2003 to a range of 20 percent to 50 percent with a higher cost share required for projects that are further along in the research cycle.

5. As part of the DOE and USDA technical merit review, the Committee recommended that the Departments include non-Federal, non-laboratory experts in the review process. These may include retired experts from academia or private industry who can provide insights into the technical feasibility or relevant research history of proposed projects as well as other useful insights. The programmatic review should also ensure an appropriate balance of near-, medium-, and long-term research.

6. The Committee also recommended that, in general, projects should be funded on a graduated scale, with future funding dependent upon the accomplishment of key technical milestones. Alternatively, DOE and USDA could allow proposals to be submitted for follow-on phases of R&D. DOE and USDA should establish checkpoints on funded research to ensure that solutions to technical barriers are being identified and to continuously monitor technical progress of research. DOE and USDA should avoid committing large sums of funding to a project whose technical concept has not been proven to be viable at the small scale, and whose economic projections are not viable.

Departmental Responses to the Technical Advisory Committee's FY 2004 Joint Solicitation

A number of steps were implemented with regard to the RFP language and process for the FY 2004 Joint Solicitation to address Committee recommendations:

1. *Novelty, innovation, uniqueness, and originality were included as sub-criteria under Criterion 1: Technical Relevance and Merit in the FY 2004 Joint Solicitation.*

2. *In the FY 2004 Joint Solicitation, applicants were encouraged to review The Roadmap for Biomass Technologies in the United States and are directed to a website where the document can be assessed. In addition, an Appendix was included in the solicitation that linked each of the eight solicitation topic categories to the Roadmap.*

3. *In response to the Committee recommended changes on the "high priority" project areas from those described in the FY 2003 solicitation to those that should be described in the FY 2004 solicitation:*

    a. *Animal waste was not highlighted in the FY 2004 solicitation.*
    b. *"Understanding and ability to overcome technical and institutional barriers associated with connections to the commercial power grid and energy distribution and transmission systems," were not specifically included in the FY 2004 solicitation.*
    c. *Biomass Development and Production was identified as one of the 4 technical topic areas for USDA. Of the eight technical topic areas, only USDA Topic 8, "Incentives" mentions demonstration projects and, in particular, applications that address viable options for mobile or small-scale biopower projects for rural locations and communities. A minimum of 20% cost share was required with the expectation that a greater cost-share would most likely be needed by a successful applicant.*
    d. *Patents were requested as part of the application package and will be favorably considered.*

4. *The weighting of evaluation criteria was adjusted in the FY 2004 solicitation to reduce "Technical Approach" and "Capability" from 30% to 25 % in accordance with the Committee recommendations. A "Benefits" criterion was added this year at 20%, which meant that "Technical Relevance and Merit" was limited to 30%, less than the 50% that the Committee had requested. The Departments will again evaluate the weighting of these criteria next year based on the Committee's recommendation of this new weighting structure.*

5. *In developing a technical merit review committee for this year's solicitation, the Departments included non-Federal, non-laboratory experts in the review process.*

6. *DOE is planning to use a Stage Gate management system to monitor technical project progress and "stage" funding based on reasonable progress. USDA will utilize a similar system to ensure that technical progress is being made and funded accordingly for projects selected through this solicitation.*

B. Tracking the Progress of Research Performed under the Joint Solicitation

The Committee made several specific recommendations to the Departments to facilitate evaluation of research performed under the joint solicitation:

1. DOE and USDA should develop a method to quantitatively track progress towards the Committee's *Vision* goals. This should include the status of the use of biomass energy and biobased products in the United States. Such information will provide the Committee with insight on the effectiveness of Federal biomass-related programs and activities and provide the Committee guidance in developing future recommendations.

2. DOE and USDA should develop a matrix for aligning research projects selected under the joint solicitations with evaluation criteria such as relevant *Roadmap* category, near-/medium-/long-term research, and other criteria. This will help the Committee to track and evaluate projects selected under the joint solicitations over time.

3. DOE and USDA should provide the Committee with additional information on the historical progress of research in the areas of gasification, cellulosic ethanol, and co-firing. This will help the Committee better understand progress that has been made in past decades and better evaluate current and future research investments.

USDA and DOE Response to Committee Recommendations on Tracking the Progress of Research Performed under the Joint Solicitation

1. *During the Committee's meeting in March 2004, the Departments presented a matrix that quantifies progress towards achieving the Committee's Vision goals. The Departments will maintain the matrix for future Committee meetings.*

2. *DOE and USDA presented a matrix to the Committee during its March 2004 meeting that aligned projects selected under the solicitations for the past 3 years with evaluation criteria including relevant Roadmap categories, research time frames, and other criteria such as major technical milestones. The Departments will maintain this matrix for future meetings.*

3. *During the March 2004 Committee meeting, DOE presented information on historical progress for cellulose ethanol, gasification, and co-firing to help the Committee better understand and evaluate the need for current and future research investment.*

C. Review of Awards Made Under the Initiative

1. The projects selected in FY 2003 do not appear to increase consumer awareness or confidence in biobased products.

2. Federal agencies and laboratories do not have a strong track record in disseminating the results of research to the private sector or in fostering commercial readiness of biobased products. A larger number of companies in the bio-industries should be involved in the activities under the joint solicitation to increase the likelihood of market penetration of biomass energy and biobased products. There is an immediate need to identify biomass technologies or biobased products that are close to commercial readiness and to nurture them to success through demonstration. Examples include bioenzymes, thermal conversion agents, solvents, various biopolymers, and fuels and additives.

USDA and DOE Response to Committee's Comments on Awards Made Under the Initiative

1. *As described in Section IV.A, the Departments made a number of revisions to the FY 2004 joint solicitation. This included adding technical topics on "Biobased Products" and "Incentives." In addition, the Departments are continuing their efforts to increase public awareness and use of biobased products. DOE is performing analysis to identify top biobased products for future focus. USDA is moving forward with a program to increase Federal procurement of biobased products and institute a labeling program.*

2. *The availability of funding each fiscal year is a significant factor in determining the number of companies that participate in Federally-funded R&D. Moreover, the Departments must develop an R&D portfolio that effectively addresses their respective goals. This may require a larger number of research performers participating in smaller-scale research projects, or a smaller number of research performers participating in larger-scale research projects.*

D. Committee Review of USDA and DOE Biomass-related R&D Portfolio

In February of 2003, the agencies that comprise the Board presented to the Committee their respective portfolios of research and non-R&D activities as they relate to the Committee's *Roadmap*. Following that presentation, through a series of meetings and conference calls, Committee members reviewed the detailed research portfolios of DOE and USDA as they relate to the *Roadmap* in order to provide recommendations on the strategic direction of future research funding. This review included critiquing the research jointly funded through R&D solicitations in FY 2002 and FY 2003 by USDA and DOE.

While the Committee stands by the goals set forth in the *Vision* and continues to believe they are achievable within the timeframes we have established, it does not believe current U.S. government efforts put the industry on track to meet these goals. To the contrary, the Committee believes that the current DOE and USDA biomass activities will make only a very modest contribution towards this end.

The Committee does not believe that the U.S. government's current funding for biomass programs is sufficient to implement the *Roadmap*. Committee members reviewed information provided by USDA and DOE on their respective R&D portfolios as they relate to the Committee's *Roadmap*. This section contains specific recommendations from the Committee to the Secretaries of Energy and Agriculture on their biomass-related research and the Departments' non-R&D activities. Crosscutting recommendations and general observations on the Departments' research portfolios are also included. The Committee's recommendations are intended to assist DOE and USDA in achieving the findings set forth in the Biomass Act as well as the *Vision* and *Roadmap* goals.

Underlying the Committee's recommendations is the consensus that that an effective research and development program in the biomass area must work in a coordinated fashion with the goal of demonstrating technologies at a commercial scale and the implementation of public policies, including public education, incentives, government purchasing, and removal of regulatory roadblocks. A role for USDA, DOE, and other sectors of the Federal Government exists across these areas, including financial support prior to transfer to the private sector. This fundamental premise is the foundation on which the *Vision* and *Roadmap* were built.

The Committee does not believe that the Departments' current biomass programs, in the current policy context, are adequate to achieve the goals set forth in the *Vision*. While the specific recommendations in this report are designed to help the agencies modify current programs to bring them into conformity with the *Roadmap*, one overall recommendation is that the *Roadmap* cannot be effectively implemented and the *Vision* goals cannot be achieved without an order of magnitude increase in financial and policy support for biomass. Specific first steps in this direction should include:

1. A request for $60 million to support the construction of three cellulose-to-ethanol plants capable of processing a variety of cellulose raw materials and using different production technologies to be operational by 2008.
2. Active support for substantial procurement and incentive policies that will dramatically increase the production of biomass energy and biobased products.

The following are Committee findings and recommendations per review of the joint DOE and USDA 2003 biomass portfolio as it corresponds to the Committee's *Roadmap*.

1. Committee Recommendations on Biomass Feedstock Production

a. The Committee believes that additional funding for biomass feedstock research is essential. While there does not appear to be significant duplication of work between USDA and DOE based upon review of the materials provided, increased coordination should be pursued to avoid future duplication and to better coordinate planning within and among Federal agencies.

b. Most of the research emphasis is on harvesting/collecting/processing/ transporting/storing stover, straw, herbaceous crops [Conservation Reserve Program (CRP)], short rotation woody crops, and forest feedstocks. This is appropriate given the potential impact of these processes on overall economics of biomass products. Equal emphasis should be given to finding non-invasive perennial biomass crops as well as supporting research related to crop residue (e.g., straw and stover). Perennial herbaceous (grassy) energy crops offer lifecycle benefits and help reduce soil erosion.

c. Continued DOE and USDA collaborative research to examine soil carbon, fertility, and impacts of biomass removal on sustainability is very appropriate. A full feedstock life cycle analysis is needed to determine the sustainability of biomass collection. The parameters of the full feedstock life cycle analysis must be defined, considering elements such as ash recycling. Coordination needs to occur at the public policy level to identify the appropriate factors to include in such life cycle analyses.

d. USDA and DOE need to coordinate between and within programs in all feedstock research areas. It is also critical to coordinate feedstock research activities with conversion technology development to assure feedstock research is addressing the appropriate needs.

e. There does not appear to be significant duplication of feedstock work between USDA and DOE. Some of the reasons for low duplication are the differing feedstock foci that DOE (straw and stover) and USDA (herbaceous and woody) are using. USDA also focuses more on feedstock-related research through harvesting and collection, while DOE's feedstock-related research concerns the processing and conversion characteristics of the feedstocks.

f. There appear to be some research gaps, including biomass storage life and sensor development in support of conversion and pre-conversion technologies. Some of these issues should be identified in the *Roadmap* for Agricultural Biomass Feedstock Supply in the United States, currently under review; but this effort is focused on corn stover and wheat straw. Similar needs should be identified for herbaceous and woody biomass materials. There may be opportunities to improve storage strategies that enable biomass to be used throughout the year (harvest to harvest). Strategies should include using crop byproducts after harvest in combination with dedicated biomass crops that have growth characteristics that allow them to stand when dormant. Another strategy, which would require further research to be cost-competitive, is to gasify biomass at harvest and store the gas.

g. Committee members feel there may be DOE Office of Science and USDA research, including basic plant science, which was not included in the portfolio information provided. Although this research may not be specific to biomass technologies, it could have both direct and indirect application to biomass feedstock R&D. Specific harvesting technologies are particularly critical, especially one-pass harvesting for corn and corn stover, and storage technologies. Cost-effective and sustainable removal of biomass waste from forests is also critical. It is important that the impacts of this research be recognized and coordinated with overall biomass feedstock and conversion R&D activities.

USDA and DOE Response to Committee Recommendations on Biomass Feedstock Production

a. The Departments are pleased that the Committee did not find significant duplication of R&D related to feedstock production and will continue to work together to increase coordination and decrease duplication. For instance, the DOE's National Bioenergy Center (NBC) is considering adding the USDA's Agricultural Research Service (ARS) as a member in order to improve coordination between the USDA and DOE relating to biomass research (including feedstock production) to meet the Committee's precept of more coordination. The Departments will consider the Committee's comments on the level of funding for biomass feedstocks as they make future R&D investment decisions. In making R&D investments, the Departments are constrained by the level of unencumbered funding available each year and must design a balanced portfolio to address the range of technical barriers that exist.

b. The Committee's recommendation to support non-invasive perennial biomass crops as well as supporting research related to crop residues is addressed in the joint solicitation by the USDA's Technical Topic 5, "Feedstock Development and Production," that targets non-invasive perennial biomass crops (such as switchgrass and poplars) for research development and demonstrations.

c. The broad scope of USDA Topic 5, "Feedstock Development and Production," and USDA Topic 6, "Biobased Products – Economic and Environmental Performance," could cover proposals that address research gaps identified in the Committee's recommendations, such as the need for a feedstock life cycle analysis, biomass storage, and sensor development in support of conversion and pre-conversion technologies.

d. In response to the recommendation that USDA and DOE feedstock research be coordinated, the USDA and DOE have collaborated on a Roadmap for Agriculture Biomass Feedstock Supply in the United States (Feedstock Roadmap). In 2003, joint meetings between USDA and DOE were held where feedstock programs were described and discussed. In addition, formal meetings were held with major land grant universities and DOE managers to discuss programs and areas of mutual interest. A meeting was recently held between the USDA's Agricultural Research Service scientists specializing in feedstocks and the DOE's National Renewable Energy Laboratory conversion researchers to develop better working relationships for conversion and feedstock interface.

e. The Departments are pleased that the Committee did not find significant duplication of R&D related to feedstock production.

f. The broad scope of USDA Topic 5, "Feedstock Development and Production," and USDA Topic 6, "Biobased Products – Economic and Environmental Performance," could cover proposals that address research gaps identified in the Committee's recommendations, such as the need for a feedstock life cycle analysis, biomass storage, and sensor development in support of conversion and pre-conversion technologies.

g. Harvest and collections systems for small diameter wood from forest thinnings were identified as one of the areas of interest under USDA Technical Topic 5 in the Joint Solicitation. Specific harvesting technologies have been identified in the Feedstock Roadmap, including the one-pass harvesting system. These were discussed at DOE's Biomass Program Multi-Year Technical Review Meeting last November. Quite a few Committee members participated in the Review Meeting either as formal reviewers or attendees.

2. Committee Recommendations on Processing and Conversion

a. Recommendations in this area relate to thermochemical conversion, bioconversion, and the integrated biorefinery. Committee members felt that reorganization of DOE biomass programs has helped the Department focus its biomass planning. While the Committee recognizes that the dispersed nature of USDA and the Department's need to address regional priorities makes it more difficult for USDA to use the *Roadmap* for planning, increased effort is needed to coordinate USDA bioconversion R&D.

b. The overall level of funding for bioconversion is inadequate.

c. Increased effort is needed on the part of both DOE and USDA to coordinate research as it relates to bioconversion.

d. The Committee has had a difficult time evaluating USDA's portfolio as it relates to the *Roadmap*. The Committee would like more transparent reporting of USDA R&D activities in alignment with the *Roadmap* categories.

e. The portfolio of research related to thermochemical conversion is not sufficiently diverse. As much emphasis should be placed on gasification from waste and surplus feedstocks as is currently being placed on gasification from grain-based biomass feedstocks.

f. 50-50 cost share funding to demonstrate black liquor and woody biomass gasification with associated power generation should be continued until both high pressure and atmospheric pressure black liquor technologies and one wood gasification technology are each operated successfully for at least two years at commercial scale. Absent such demonstrations, these technologies are not likely to be implemented because of financial risk, and the many economic and environmental benefits of the technologies will not be realized. The current Federal level of funding will not support these demonstrations.

g. There are major gaps in basic research applied to sustainable chemicals. This is especially true in the areas of organic chemistry and biochemistry of oils, lipids, proteins, and carbohydrates. Specifically, the National Science Foundation (NSF)

and DOE's Office of Science should increase funding in this area. There is a great need for reactivating known, but unused, chemistry to replace existing petrochemical feedstocks with renewable ones. We will need to find equivalent or new functionalities from renewable resources.

USDA and DOE Response to Committee Recommendations on Processing and Conversion

a. The DOE's NBC is considering adding the USDA's ARS as a member in order to improve coordination between the USDA and DOE relating to biomass research (including bioconversion) to meet the Committee's precept of more coordination.

b. The Departments will consider the Committee's comments on the level of funding for bioconversion as they make future R&D investment decisions. The DOE's Biomass Program FY 2004 Energy and Water Development appropriations included approximately $41.0 million, or nearly half of the biomass budget, targeted to specific projects not identified in program plans. By redirecting funds away from the Program's planned R&D investments which contribute to a balanced portfolio addressing a range of technical barriers that exist, Congressional earmarking delays progress toward the Program's goals and diminishes core research capabilities at the National Laboratories.

c. The Departments will continue to use the BioInitiative and other methods to increase coordination.

d. In response to the Committee's comments concerning the level of USDA information provided, a USDA program manager made a presentation at the October 2003 Committee meeting on how to secure detailed project level data through the Internet website and offered to provide more specific information as requested by the Committee.

e. The Committee's comments concerning a lack of technology diversity for thermochemical conversion and the range of feedstocks being addressed. DOE responded by including a technical topic in the thermochemical processing category of the FY 2004 solicitation. Pyrolytic Bio-Oils and black liquor gasification also was targeted by DOE. Under the USDA solicitation incentives category, small biomass power projects were cited as having special interest.

f. Since Congress directed further work in FY 2004 for black liquor gasification, DOE is continuing its project with its partner on a demonstration of the low temperature black liquor gasification technology. In addition, for the FY 2004 Joint Biomass Solicitation with USDA a DOE topic is addressing the needs of Kraft black liquor gasification, thereby supporting the majority of United States' pulp and paper mills.

g. One of the DOE's Biomass Program core R&D areas focuses on Products, which is working with industry to determine the top valued added chemicals from biomass. This could contribute to future areas of basic research.

3. Committee Recommendations on Product Uses and Distribution

a. A number of biobased products and biofuels are currently ready for commercial use. For these products, the Departments should facilitate--through cost-sharing

arrangements, independent testing, and validation of product performance--public education on the benefits of those products. Additional R&D is needed to decrease the cost and improve the performance of products currently ready for commercial use and to expand the slate of biobased products available to consumers. DOE and USDA should work with EPA to ease regulatory hurdles that currently exist for natural products to displace petrochemicals. Some of these barriers are very difficult to overcome, particularly for small start-up companies with new products.

b. Because many products are already ready for commercial use, USDA and DOE activities in this area should focus on educating consumers on the benefits of these products and facilitating the development of more widespread distribution systems to get biobased products to consumers. The Departments should foster these public education efforts. However, funding for these efforts should not be obtained from resources currently dedicated to research. Public education needs to be as direct as possible and use well-established commercial marketing concepts.

c. DOE and USDA should fund analysis to validate performance of biobased products and continue research to improve the competitiveness of those products. Increased Federal procurement will require biobased content certification/decertification and an assessment of the viability of existing technologies and products to fulfill the various purchasing requirements. Moreover, demonstration audit services are needed to compare existing products to available alternatives. USDA should also include comparison testing of biobased product performance and an evaluation of the plausible time for delivery.

d. A full life cycle cost and environmental analysis of biobased fuels and products in relation to petroleum-based alternatives should be performed so that a balanced cost and environmental comparison can be made and the public can be educated on the full cost of both biobased and petroleum-based fuels and products. Life cycle analyses should include terrestrial carbon sequestration. They also should compare grain-based renewable transportation fuels, ethanol from corn, and soy diesel to liquid transportation fuels from perennial cellulosic crops and/or carbohydrate-rich materials going to landfills.

USDA and DOE Response to Committee Recommendations on Product Uses and Distribution:

a. USDA is working to implement section 9002 of Title IX of the Farm Bill. Implementation of this program meets the Committee's recommendation to establish an aggressive purchasing program for biobased products. Further, this program has the force of law since USDA is implementing a statute. When fully implemented, the program will require Federal agencies to greatly increase their use of biobased industrial products. That increase is expected to contribute to the development of a broad range of new biobased products. Agencies will be required to purchase biobased industrial products whenever their cost is not substantially higher than fossil energy-based alternatives, when biobased industrial products are available and when biobased industrial products meet the performance requirements of the Federal user.

b. The Office of Procurement and Property Management (OPPM) in USDA's departmental administration mission area is developing a model procurement plan that will be exported to other Federal agencies in cooperation with the Office of

Management and Budget. Education and outreach will be a significant component of the program. A labeling program is also provided for in the statute. A "U.S.D.A. Certified Biobased Product" label and logo will be available for future use. Requirements for use of the label will be based on product information provided to the buyer. USDA hopes to have a proposed rule out this calendar year.

c. *The proposed rule details the process by which USDA will designate "items," which are generic groupings of similar biobased products, such as hydraulic and transmission fluids. To designate an item, USDA must obtain and make available information such as availability, relative price, performance, and environmental and public health benefits for the items and biobased materials designated for preferred procurement. Items will be designated through subsequent regulations. Once an item is designated, every manufacturer and vendor producing and marketing products contained within that item are eligible for preferred procurement status when marketing their products to Federal agencies. Manufacturers must certify that the biobased content in their products is consistent with the statutory definition of biobased products. They must also certify that they have had third-party testing of the biobased content.*

d. *To help in responding to this comment, the FY 2004 joint solicitation included USDA's Technical Topic 6 "Biobased Products – Environmental and Economic Performance" and USDA's Technical Topic 8 "Incentives" which covered life cycle and economic analysis and environmental of biobased products -- including effects on greenhouse gases and carbon sequestration.*

4. Committee Recommendations on Public Policy Measures

While Committee members were pleased with much of the work the agencies are undertaking in the areas of economic analysis, education and outreach, and Federal procurement, we found significant gaps in the area of policy support for biomass, which we believe will seriously jeopardize the prospects for successfully achieving the goals set forth in the *Vision*. In particular, we recommend a substantial increase in efforts to commercialize proven biomass technologies and remove regulatory barriers to their widespread adoption.

Aggressive Federal Purchasing of Biobased Products - The positive impact of Federal procurement in fostering new markets is significant, as demonstrated by Federal purchasing of recycled materials in the 1980s and 1990s. Federal procurement played a significant role in expanding the recycling industry in the United States. A similar opportunity exists for fostering the biobased economy. Since the Federal Government is the Nation's largest purchaser of products, the Committee believes that aggressive purchasing of biobased products by DOE and USDA, as well as other parts of the Federal Government, is an important step in achieving the goals of the Biomass Act. The production of fuels, power, chemicals, and materials from biomass will encourage healthier rural economies and reduce American dependence on imported oil. The Federal Government should also encourage state and local governments to purchase and use these products.

The Committee formally recommends that the Secretaries of Energy and Agriculture immediately establish an aggressive purchasing program for biobased products. The Secretaries should establish a departmental-wide goal in which biobased products, defined as products that contain over 90 percent plant or animal matter by weight, account for a minimum of 30 percent of all purchases in each product category for which biobased products are available, exhibit equal or superior performance characteristics and have a total product cost--including the cost of disposal and handling--no more than 10 percent higher

than their conventional counterparts with a benchmark goal date of January 2006. To evaluate progress in reaching this goal, the Committee requested that the Secretaries of Energy and Agriculture report in January 2004 on the progress to date and the procurement strategy to achieve the goal.

The Secretaries should recommend to other parts of the Federal Government and to State and local government that they should have a similar program. A report to the Committee shall be made by June 2004 as to progress with expanding biomass purchasing beyond USDA and DOE.

The ARS facility in Beltsville, Maryland, has already made significant progress in displacing chemicals with biobased products. To help facilitate the use of biobased products, the biobased products industry has offered to assist the Federal Government in educating procurement officers and other key department personnel on the availability and performance characteristics of biobased products. The Federal Government and other interested parties should take advantage of this offer.

Biobased products are currently available in over 22 product categories, including those listed below:

- Absorbents, Adsorbents, and Activated Carbon
- Cleaning Chemicals, Surfactants, Soaps, Detergents
- Construction / Composite Materials (Panels, Laminates)
- Fibers, Bonded Fabrics, Textiles
- Foods, Beverages, Nutrients
- Fuels and Fuel Additives
- Gases And Vapor Technology
- Inks, Dyes, Pigments
- Landscaping Materials, Soil Amenders, Fertilizers & Agricultural Chemicals
- Oils, Waxes, Binders, Lubricants, Rust Inhibitors, and Functional Fluids
- Packaging
- Paints, Coatings, Adhesives
- Paper and Paper Products
- Personal Consumer Items / Cosmetics
- Pharmacology & Neutracuticals
- Plastics, Polymers and Films
- Solvents & Co-Solvents
- Specialty Chemicals
- Water & Wastewater Treatment
- Biopesticides

Both farmer-owned and rural production facilities should be favored in the procurement of biobased products, fuels, and power.

USDA and DOE should expand the BuyBio program to include the development of a labeling program to better promote biobased products by signifying to consumers that the products conform to established standards for quality and performance. Specifically, the Departments should work with EPA in this effort to utilize their experience with “green” labeling.

Efforts to commercialize proven biomass technologies are an essential element of the *Roadmap*, but at present they are woefully under funded. Small piecemeal efforts such as those included within the State Technologies Advancement Collaborative will do little if anything to make these promising technologies commercially viable. The Committee would like information on the purpose for funding of both the “Consortium for Plant Biotechnology Research Initiative” and the “State Technologies Advancement Collaborative (STAC)” and suggests these activities be re-evaluated.

The $23 million grant program established pursuant to §9006 of the 2002 Farm Bill is promising, but only a small portion of those funds are likely to support biomass projects, and the current budget for fiscal year 2004 proposes an 86 percent reduction in funding to $3 million. This is a giant step in the wrong direction. (Note: the Omnibus appropriations bill ultimately passed allocated $23 million in fiscal year 2004.)

Both Departments, but particularly DOE, should give much greater attention to public policy measures that can dramatically increase the commercial viability of biomass technologies at relatively low cost. The Committee's *Roadmap* outlines strategies and recommendations on Federal incentives, financial incentives to support existing facilities, and a public benefits fund. The *Roadmap* also includes measures to foster procurement of biomass energy and biobased products including Federal procurement, performance standards, renewable portfolio standards, and other measures. Incentives available from the Commodity Credit Corporation in FY 2004 should not be reduced from FY 2003 levels. Federal incentives should not subsidize businesses' waste disposal costs. In addition, Federal incentives for methane-to-electricity generation should be allotted per ton of manure disposed of rather than per kilowatt-hour generated. A discussion of these and other policy initiatives are discussed in further detail in the *Roadmap* available at < http://www.bioproducts-bioenergy.gov/pdfs/FinalBiomassRoadmap.pdf>.

The economic analysis that the agencies currently undertake is of high quality and an essential element of the *Roadmap*. However, the agencies could improve this work by ensuring that it includes both economic and environmental life cycle analyses (LCAs) for all promising biomass feedstocks and conversion technologies. The agencies should also use the results of these analyses more directly to guide primary research so that, as noted in the feedstock-related recommendations above, the agencies do not waste resources conducting R&D on feedstocks and technologies with unfavorable LCAs.

Committee members find DOE workshops to be effective. In general, the agencies should conduct education and outreach with materials that are developed at the Federal level, focusing on technologies that are identified at the Federal level, rather than approaching this work in an ad hoc way or directing it at local issues. State and local entities can facilitate such workshops. DOE should consider providing financial assistance to small businesses and other organizations that may require assistance to attend these workshops.

In conducting outreach and education efforts, the agencies could make better use of state and regional offices to promote specific biomass technologies. For example, the agencies can invest in demonstration projects that are likely to attract public interest and earn the media's interest.

Centers for Excellence at the university level should be established to help train university students in areas related to biomass R&D and commercialization thereof.

While Committee members support the development of K-12 educational programs to help make young people aware of the promise of bioenergy and biobased products, we have mixed feelings regarding the ability of the Federal Government to do this successfully with the limited dollars available for policy initiatives. There might be an opportunity for the agencies to work collaboratively with industry by pooling existing dollars that companies are already allocating for public education efforts. Project Learning Tree is an example of this kind of public-private effort.

USDA and DOE Response to Committee Recommendations on Public Policy Measure:

Many of the Committee's policy-related recommendations surrounding biobased products are addressed in Section IV.3. In addition, at the Committee's March 2004 meeting USDA provided an update on the implementation of the Federal Biobased Products Preferred Procurement Program, including product designation, labeling and other program activities. USDA will continue to provide periodic updates to the Committee.

The Departments are continuing to work with colleges and universities as well as conduct outreach and educational activities within their mission and resources. For example, DOE has awarded grants to foster educational programs on bioenergy and biobased products at the college level. Through the Small Business Innovative Research Program, DOE also funds biomass-related research to small businesses. In terms of education and outreach, USDA is hosting a conference on Agriculture as a Producer and Consumer of Energy. Both Departments provide educational materials on bioenergy and biobased products on their respective websites.

5. Committee's Crosscutting Recommendations

A number of recommendations provided by the Committee are crosscutting in nature, including the following:

For FY 2005 and out years, the Secretaries of Agriculture and Energy should request $49 million in funding for the joint solicitation as authorized in the Biomass Act, as well as the additional $14 million in R&D funding available from the Commodity Credit Corporation under §9008 of the Farm Bill. The Committee recognizes that current funding is not adequate to achieve *Vision* goals.

Economic analysis, including life cycle analysis, should be performed to help guide research investments and the selection and development of investments leading to demonstration and commercialization, as well as to educate the public.

A study should be performed and independently validated that develops baseline indicators of the bioeconomy. This baseline should include economic, energy, environmental, agricultural, and other indicators to help characterize the current status of the bioeconomy and measure progress on at least an annual basis.

Product performance standards should be established for biobased products and biofuels.

Performance measures should be established for tracking R&D progress.

The Federal Government should continue to be involved in co-funding demonstration projects at a commercial scale when the financial risk is too high for industry. Without such support, the monies previously invested to develop technologies will go for naught. Examples of such technologies are black liquor gasification and power production.

To the extent feasible, DOE and USDA should seek out information on private sector and Federal and State R&D to make informed investment recommendations (i.e., not duplicate work being performed elsewhere).

USDA and DOE responses provided in Sections IV.1 through IV.4 address crosscutting recommendations made by the Committee.