Biomass Program

2007 Accomplishments Report

Table of Contents

Biomass Program Accomplishments

Introduction

The Office of Energy Efficiency and Renewable Energy's (EERE's) Biomass Program works with industry, academia and its national laboratory partners on a balanced portfolio of research in biomass feedstocks and conversion technologies. Through research, development, and demonstration efforts geared toward the development of integrated biorefineries, the Biomass Program is helping transform the nation's renewable and abundant biomass resources into cost-competitive high-performance biofuels, bioproducts, and biopower.

The Biomass Program conducts R&D in cooperation with a Project Management Center hosted at the Department of Energy's Golden Field Office in Colorado. Project work is conducted at national laboratories across the country, including the National Renewable Energy Laboratory, Argonne National Laboratory, Oak Ridge National Laboratory, and Pacific Northwest National Laboratory. In addition, across technology areas, the Program seeks to collaborate with industry and academia to conduct R&D and integrate their programmatic feedback. Recent partners have included ADM, DuPont, Abengoa and multiple large university groups including the Sun Grant Universities. R&D projects are also conducted by groups from across the spectrum of organizations at local, state, regional and interagency levels. International activities (i.e., Memoranda of Understanding with Brazil and China) round out the Program's approach to efficient and timely fulfillment of its goals.

Program Goal

To develop cost-competitive biomass technologies to enable the production of biofuels nationwide and reduce dependence on oil through the creation of a new domestic bioindustry supporting the President's goal of reducing gasoline use 20 percent by 2017.

The U.S. Department of Energy (DOE) recognizes the importance of a diverse energy portfolio in meeting the nation's energy security challenges. DOE has, therefore, set a goal in its Strategic Plan to promote energy security through a diverse energy supply that is reliable, clean, and affordable. As a key strategy for attaining both Presidential and Department goals, the EERE's Biomass Program is focused on developing biofuel, bioproduct and biopower technologies in partnership with other government agencies, industry and academia.

The Biomass Program supports four key priorities of the EERE Strategic Plan:

- Dramatically reduce dependence on foreign oil;
- Promote the use of diverse, domestic and sustainable energy resources;
- Reduce carbon emissions from energy production and consumption; and
- Establish a domestic bioindustry,

Biomass is the single renewable resource that has the potential to supplant our use of liquid transportation fuels, providing the opportunity to fuel our cars using indigenously grown feedstocks and thus helping to create a more stable energy future.

Program Progress & Accomplishments

Analysis

- Developed the "Biomass Scenario Model" tool to understand the transition dynamics associated with the development of a cellulosic ethanol industry. Specifically the model allows for investigating potential market penetration scenarios for cellulosic ethanol and identifies high-impact drivers as well as bottlenecks to system evolution.
- Extensively tested an ethanol-optimized Saab vehicle, including exhaust specification, acceleration and fuel mileage evaluations. These tests determined that the vehicle's fuel economy is very good

compared to the US FFV fleet and that the performance advantage is not at the expense of emissions or fuel economy.

- Continue to develop a spatially referenced decision support system that will map current and potential feedstock availability and environmental and infrastructure constraints to collection of that feedstock. The tool will be utilized to assess relevant resources and infrastructure both regionally and nationally.

Feedstock Platform

- Established the Regional Feedstock Partnership in all five regions of the U.S. through a series of workshops.
- Established separate teams within the Regional Feedstock Partnership to: a) create, implement, and maintain a GIS-based resource assessment tool; b) conduct sustainable corn residue removal trials; and c) to conduct energy crop trials.
- Completed regional feedstock supply curves, as well as an inventory of existing feedstock work in each region.

Biochemical Conversion Platform

- Achieved a modeled cost target of $0.125 (2007$ estimated) per pound of sugars (equivalent to $2.43 per gallon of cellulosic ethanol) through the formulation of improved enzyme mixtures and pretreatments.
- Made awards to applicants selected for improving saccharifying enzymes to meet the target of reducing the cost of enzyme systems to $0.10 per gallon of ethanol produced by 2012.
- Conducted two Funding Opportunity Announcements to address key areas within the biochemical platform that can assist in meeting the $1.33/gallon ethanol target.

Thermochemical Conversion Platform

- Developed the public Thermochemical Conversion Design Case that was industry validated under a current ethanol cost goal of $1.33 per gallon.
- Developed correlations for tar yields from components of various types of biomass feedstocks for gasification.
- Identified catalyst deactivation mechanism and metal-substrate interactions in gas clean-up/conditioning process. Additionally, the platform improved tar-cracking catalyst activity by 2.5 times, meeting the 2010 target.

Integrated Biorefinery Platform

- Three of the 932(d) selected projects were awarded but may not cost until one or two conditions are met, primarily the production of a risk mitigation plan satisfactory to DOE. The three awards are Abengoa Bioenergy of Kansas, Poet Project Liberty, and BlueFire Cellulose to Ethanol plant.
- Fermentation organism work at DuPont and NREL was concluded in FY 2007. A strain was demonstrated to meet the milestone levels for the rate of ethanol production, final ethanol titer, extent of glucose and xylose conversion. This task was thus completed and a milestone report will be submitted next quarter. This strain is not yet adequate for a production strain.

Infrastructure Platform

- The Infrastructure Platform is in it’s infancy as a new platform. In FY 2007, activities were centered on evaluating next steps for future information exchange and joint efforts.
- Co-developed and co-funded with EERE’s Vehicle Technologies Program an ethanol intermediate blend testing program on light-duty vehicles and small non-road engines.

Market Transformation & International

- Initiation of a Bilateral Working Group to manage collaborative efforts between the U.S. and Sweden on topics including: a) research and development for new and improved sources of biomass production for energy use, (b) research and development of conversion technologies for different

types of liquid biofuels and other kinds of renewables, and (c) research and development for more efficient engines and lightweight vehicles.

- On April 25, 2007, Assistant Secretary Andy Karsner met with Ambassador Antonio Simões, Director of the Department of Energy, Ministry of External Relations (MRE) of Brazil. The Principals agreed to cooperate on a study to quantify use of biofuels and greenhouse gas reduction. Ethanol was selected as the first biofuel to be evaluated. The National Renewable Energy and Argonne National Laboratories are involved in the study.

New Projects Selected

In FY 2007, the Biomass Program competitively selected many new projects to address key barriers in the development of cellulosic ethanol technologies. These included the following:

- Six biorefinery projects ($385 million over five years) for the commercial demonstration of advanced biorefineries that use cellulosic feedstocks to co-produce ethanol, bioproducts, heat and power. The proposed plants are expected to produce over 130 million gallons of cellulosic ethanol annually.
- Five ethanologen projects ($23 million over three years) that focus on developing highly efficient fermentative organisms to convert biomass material to ethanol. Commercialization of fermentative organisms, capable of fermenting both hexose and pentose sugars, is crucial to the success of biochemical-based integrated biorefineries.

External Coordination, Input and Assessment

- The Biomass Program collaborates with 11 Federal agencies and administrations via the Biomass R&D Board, co-chaired by EERE Assistant Secretary Alexander A. Karsner and U.S. Department of Agriculture Under Secretary for Rural Development Thomas C. Dorr. Ongoing Board activities include compilation of a National Biofuels Action Plan drafted by working groups for the following areas:
  - Sustainability Working Group
  - Feedstock Production Working Group
  - Feedstock Logistics Working Group
  - Conversion Science and Technology Working Group
  - Distribution Infrastructure Working Group
  - Environment, Health and Safety Working Group
  - Blending

- The Program supports EERE's effort to facilitate international discussion, agreements and cooperation on energy-related issues. 2007 actions included Memoranda of Understanding with China and Brazil and an Implementing Agreement with Sweden (including organization of a Bilateral Working Group).

- The Biomass R&D Technical Advisory Committee is an external group providing input to the Departments of Agriculture and Energy under the auspices of the Federal Advisory Committee Act (FACA). The group's annual recommendations to the Secretaries are provided to the public and Congress on their website (www.biomass.govtools.us), and include discussion of key issues in Biomass R&D: cellulosic recalcitrance, feedstocks logistics and handling, bioproducts development, and strategic analysis. The Program collaborates with USDA to provide comprehensive responses to each recommendation, and incorporate the annual feedback into ongoing Program activities.

- During 2007, Program Technology Managers and staff met with projects' Principal Investigators, conducted a comprehensive peer review of its Technology Platform R&D projects, and invited peer review of the Program as a whole. Independent reviews were provided by 31 technological, finance, and policy experts. The Program is providing direct responses to the feedback from these reviews in the final Program Peer Review Report.

In Closing

We are pleased to present the first edition of the U.S. Department of Energy's 2007 Biomass Program Annual Accomplishments Report. The report is divided into sections and organized by platforms (e.g., Feedstock, Biochemical Conversion, etc.). Each section is introduced with an overview written by the DOE Technology Manager and includes project descriptions submitted for the Peer Review by the principal investigators (PIs) of the projects supported by the platform. The format of these project descriptions differ slightly, as the template was revised during the Program Review process.

Jacques Beaudry-Losique, Program Manager
Department of Energy
Office of the Biomass Program, EE-2E
1000 Independence Avenue, SW. Washington, DC 20585-0121

Valri Lightner, Technology Manager
Department of Energy
Office of the Biomass Program, EE-2E
1000 Independence Avenue, SW. Washington, DC 20585-0121

Analysis

Introduction

The Biomass Program conducts a broad spectrum of analyses to support decision-making, demonstrate progress toward goals, and direct research activities. The analysis group, a combination of Headquarters Biomass Program and National Laboratory staff, performs both programmatic (strategic) and platform-level analysis. Platform analysis activities help to monitor and check the program accomplishments in each platform and results from these activities integrate into cross-cutting strategic analysis tasks. Current strategic analysis activities are focused on ethanol, but as the Program expands its interest into other biofuels, the analysis group is evaluating other alternative biofuels that may have the potential to make significant contributions in the U.S. transportation sector.

Platform Performance Goal

To support the Program in realizing a competitive processing cost for sustainable conversion of cellulosic feedstocks to ethanol and other biofuels. Additionally, the Analysis Group will be performing resource and market assessments.

Objectives

- Develop standards and a process for development of state of technology (SoT) reports and updates. These SoTs will be completed for priority biorefinery pathway/fuel combinations.
- By 2012, model an nth plant production cost of $1.33/gallon ethanol from a cellulosic resource.
- By 2012, evaluate the potential and risk of investing in R&D on alternative biofuels.

FY 2007 Accomplishments

- Funded a study with the DOE Policy and International Affairs Office on the *World Biofuel Assessment: Potential for US Imports.*
- Commissioned a supply chain analysis to analyze constraints to rapid biofuels expansion and support DOE initiative planning. The effort focused on the development of Infrastructure requirements (for sustainable production of cellulosic ethanol at 5, 10 and 20 billion gallons per year) and identification of the technology targets and policy factors that would be necessary to achieve 2017 cellulosic ethanol production scenarios.
- Developed the “Biomass Scenario Model” tool to understand the transition dynamics associated with the development of a cellulosic ethanol industry. Specifically the model allows for investigating potential market penetration scenarios for cellulosic ethanol and identifies high-impact drivers as well as bottlenecks to system evolution.
- Extensively tested an ethanol-optimized Saab vehicle, including exhaust specification, acceleration and fuel mileage evaluations. These tests proved the vehicle’s fuel economy to be very good compared to the US FFV fleet and determined that the performance advantage does not come at expense of emissions or fuel economy.
- Partially funded the 2007 Northwest Biomass Business Study. This study assessed potential opportunities for use of biomass and biofuels in the future for the Pacific Northwest.

Budget

The President’s FY 2008 budget allows for the acceleration of research into cellulosic ethanol conversion from a wide range of feedstocks in order to meet the near- and longer-term goals of the Initiative. The Analysis budget is a cross-cut activity that amounts to approximately $7.5 million.

2008 Plans

- Develop an analytical tool to address the issue of direct and indirect land use changes associated with enhanced biofuels production.
- Develop a spatially referenced decision support system (using GIS) that will map current and potential feedstock availability and environmental and infrastructure constraints to collection of that feedstock. The tool will be utilized to assess relevant resources and infrastructure both regionally and nationally.
- Enhancing and using the GREET model to run new scenarios for energy and GHG emissions of biofuels.
- Conduct a “Water Use for Ethanol Production” study that will provide a baseline of current consumptive water use in the biofuel and petroleum industry.
- Develop a biorefinery siting model in partnership with ORNL, University of California Davis, Western Governors Association and USDA. This model will take into account feedstock availability and infrastructure issues in determining optimal sites for future biorefineries.
- Develop several reports in joint activity:
  - Integrated biochemical and thermochemical pathway analysis and biorefinery design report; this will be an update of the 2002 and 2006 Aden design report and will look at the impact of refinery sizes and issues for the integration of biochemical and thermochemical processing technologies.
  - An industry/lab joint alternative fuels assessment that will be developing ASPEN based model of biochemical and thermochemical processes to produce alternative biofuels (i.e., green gasoline, green diesel, biobutanol) and other value-added products.
  - A woody feedstock supply system design report; the report is being coordinated with the US Forest Service.
  - An herbaceous feedstock design report. This report will cover issues with sustainable biomass resource assessment and removal analysis.

Zia Haq, Senior Analyst
Department of Energy
Office of the Biomass Program, EE-2E
1000 Independence Avenue, SW. Washington, DC 20585-0121