Biomass Program Mission

Develop and transform our renewable and abundant, non-food, biomass resources into sustainable, cost-competitive, high-performance biofuels.

Focus on targeted research, development, and demonstration

- Support through public and private partnerships
- Deploy in integrated biorefineries
2009 Program Priorities and Goals

Advancing Presidential Objectives

Science & Discovery
• Connecting basic and applied bioscience
• Conducting breakthrough R&D:
  − Advances in enzymes and catalysis
  − Engineering of new microorganisms
  − Novel sustainability indicators

Clean, Secure Energy
• Developing & demonstrating cellulosic and advanced biofuels to meet RFS

Economic Prosperity
• Creating 50 to 75 jobs per new biorefinery
• Creating major new energy crop markets
• Reinvigorating rural economies

Climate Change
• Reducing GHG emissions by up to 90% with advanced biofuels (relative to gasoline)
Program Areas & Challenges

Research & Development

Feedstock Systems
- Diverse regional biomass resources
- Yield & price
- Water & fertilizer
- Land use

Conversion Technologies

Biochemical
- Cost & Efficiency
  - Pretreatments
  - Enzymes/yields
- Fermentation

Thermochemical
- Cost & Efficiency
- Gasification Process
- Fuel Stabilization

Product Development
- Fuel purity & cost
- By-products/markets
- Infrastructure compatibility

Demonstration & Deployment

Integrated Biorefineries
- Integrating process technologies
- Financing
- Technical expertise
- Profit potential

Infrastructure
- Transport
- Storage
- Codes & Standards (Blend wall)
- Demand/markets
- Compatibility

Sustainability
- GHG emissions
- Water quality
- Land use
- Socioeconomics
- Predictive Modeling
- International
Critical Near-Term Market Hurdles

• Blend wall
  – E10 likely to saturate current markets by 2010

• Cost-effective commercial production of cellulosic biofuels
  – Cost of enzymes
  – Cost of pretreatment
  – Demonstration of thermochemical conversion

• Delivery and end-use infrastructure limitations
  – Infrastructure (rail, truck, pipeline, blending, storage) for non-compatible biofuels (e.g., ethanol)
  – Infrastructure to meet ramped up production of biofuels
  – UL approved E85 pumps
Program Plan for FY 2009

Biomass Program Fiscal Year 2009 Budget Request

Bioconversion

- Thermochemical Platform R&D
- Biochemical Platform R&D
- Feedstock Infrastructure
- Integration of Biorefinery Technologies
- Products Development
- SBIR/STTR

- Sustainability
- Small commercial scale
- Demonstration scale
- Pilot Scale
- Fuels
- Other Products
Biomass Program: Comparative Budgets

FY09 Budget

- Integration of Biorefinery Technologies: 61%
- Products Development: 7%
- Biochemical R&D: 15%
- Feedstock Infrastructure: 7%
- Thermochemical R&D: 9%
- SBIR/STTR: 1%

FY10 Budget Request

- Integration of Biorefinery Technologies: 57%
- Products Development: 6%
- Biochemical R&D: 13%
- Feedstock Infrastructure: 11%
- Thermochemical R&D: 12%
- SBIR/STTR: 1%

Gains in budget share:
Thermochem R&D & Feedstock Infrastructure
Biomass Program Performance Goals

Program Performance Goals

• Make cellulosic ethanol cost competitive at a modeled cost for mature technology: $1.76/gallon by 2012*

• Help create an environment conducive to maximizing production and use of biofuels, 36 billion gallons per year by 2022

* All costs are in 2007 dollars, based on EIA’s Annual Energy Outlook and corrected for the energy density of ethanol.
Feedstocks: Priorities & Activities

FY2010 Request: $27M (includes sustainability)

<table>
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<th>Analysis</th>
<th>Production</th>
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<th>Logistics</th>
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<td>• Billion Ton update</td>
<td>• Feedstock trials with Regional Biomass Energy Feedstock Partnerships</td>
<td>• Land use studies and lifecycle assessments</td>
<td>• INL lead</td>
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<td>• Economic Inter-agency Working Group Report</td>
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<td>– Process demo unit (PDU)</td>
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<td>• Bioenergy Knowledge Discovery Framework</td>
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<td>– Industrial Projects implemented</td>
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**Plans**
- Landscape-level analysis
- Collaboration with the Office of Science

**Plants**
- Establish more trials (woody & herbaceous)
- Develop synthesis reports
- Collect watershed-scale data

**Leveraging**
- Great Lakes Bioenergy Research Center Partners (ARRA $5M, FY09-11)

**Plans**
- Deploy PDU
- Support IBR partners
Biochemical Conversion: Priorities & Activities

FY2010 Request: $31M

**Enzyme Conversion**
- Conduct R&D to improve effectiveness and **reduce the costs** of enzymatic conversion
- Validate integrated pretreatment and enzymatic hydrolysis of corn stover (dry and wet) at pilot scale

**Activities**
- Enzyme solicitation
- Advanced Biofuels University solicitation

**C5 Sugars Conversion**
- Conduct R&D on advanced micro-organisms for fermentation of sugars

**Activities**
- Ethanologen solicitation

**Process Integration**
- Validate/optimize integrated production of ethanol from corn stover derived sugars at pilot scale
- Validate integrated pretreatment and enzymatic hydrolysis of switchgrass at pilot scale

**Leveraging**
Fund loan guarantees, commercial and demonstrations scale validation projects

**Future efforts address obstacles to biochemical routes to biofuels, support demonstrations, and resolve infrastructure issues**
Thermochemical Conversion: Priorities & Activities
FY2010 Request: $27M

Gasification
- Conduct process integration & modeling
- Syngas cleanup & conditioning
- Fuel synthesis

Pyrolysis
- Improve bio-oil quality
- Stabilize bio-oils for transport

Activities
- Pyrolysis Oil Stabilization (up to $7.5 M)
- Core R&D at National Labs

Advanced Biofuels (thru Recovery $)
- Explore pathways to green gasoline, green diesel, cellulosic biobutanol, algal-based hydrocarbons

Leveraging
- Advanced Biofuels University Solicitation
- 1-Ton/day Pilot or 50-Ton/day Demonstration of advanced biofuels
- Core R&D at National Labs

Related Activities
Commercial-Scale Biorefineries, 10% Scale Validations, Joint DOE-USDA Solicitations

Developing technology to enable cost-effective biofuels and researching ways to improve the quality of biofuels and intermediates
Integrated Biorefineries: Priorities & Activities
FY2010 Request: $132M (includes infrastructure)

**Demonstration & Deployment**
- Initiate construction of at least one additional commercial-scale IBR project
- Approve engineering design of one additional commercial-scale IBR (two in total)
- Approve prelim. engineering design, market analysis for at least 4 demo-scale IBRs selected in 2008

**Technical Assistance**
- Conduct smaller R&D projects critical to improving biorefinery operations

**Leveraging**
- Expertise of National Laboratories and DOE Bioenergy Research Centers

**Analysis**
- Conduct technical, economic, and environmental analyses to assess progress of individual IBRs and collective status
- Verify that unit operations operate as designed and meet all performance metrics

Wider scope potentially opens IBRs to additional feedstocks and biofuels.
Biofuels Infrastructure: Priorities & Activities

FY2010 Request: about $5M (part of integrated biorefineries)

**Strategic Analyses**
- Cost and feasibility analysis
- Regional Plot distribution networks

**Policy & Regulation**
- Conduct test program on intermediate ethanol bends

**Communications & Outreach**
- Conduct scoping study to identify gaps and needs for standards development

**Strategic Partnerships**
- National Commission on Energy Policy
- BRDI Distribution Infrastructure Interagency Working Group
- Governors’ Biofuels Coalition
- Standards organizations

**Leveraging**
- Coordinating closely with EPA
- Joint initiative with Vehicle Technologies Program
- Working with Coordinating Research Council, other stakeholders

**Plans**
- Establish cost goals for biofuel distribution
- Feed and tap Bioenergy Knowledge Discovery Framework to inform infra-structure planning

Fostering systematic development of cost-effective competitive distribution networks and end use applications.
Sustainability: Priorities & Activities
FY2010 Request: about $1M (part of feedstocks)

**Feedstocks**

**Leveraging**
- Through Sun Grant Initiative, use field trials to collect data on sustainability

**Land Use**
- Quantify future land use impacts for various scenarios using Purdue’s GTAP, ANL’s GREET models
- Incorporate land use data and yield assumptions

**Water**
- Conduct LCA of water use in production
- Analyze regional variations due to climate & soil

**International Efforts**
- Work with Conservation International to identify land and preserve best production locations
- Participate in Council for Sustainable Biofuels Production to develop standards
- Provide data and analysis to Roundtable on Sustainable Biofuels, Global Bioenergy Partnership, others
- Contribute to International Biofuels Forum

Leveraging
- Tap expertise of Great Lakes Bioenergy Research Center

Building understanding to reduce the potential impacts of biofuels production on the environment.