

U.S. Department of Energy, Biomass Program

Presentation to Biomass R&D
Technical Advisory Committee

February 2009
Valri Lightner, Biomass Program

Biomass Program Mission



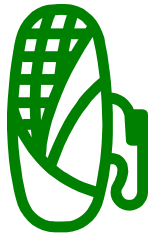
Develop and transform our renewable and abundant biomass resources into cost-competitive, high-performance biofuels, bioproducts, and biopower.

Focus on targeted research, development, and demonstration

- Support through public and private partnerships
- Deploy in integrated biorefineries



Successive Generations of Biofuels



Corn Ethanol

- Commercially available (no DOE research)
- Reduced GHG emissions
- Capacity constrained



Cellulosic Ethanol

- Focus of current DOE research
- Potential to lower GHG emissions 86%
- Uses biomass from waste and non-agricultural land



Advanced Cellulosic Biofuels

- Focus of planned DOE research
- Could minimize environmental footprint
- Energy content, fuel economy, and chemistry may be more similar to petroleum-based fuels

Biomass Program Goals



Short Term: Foster breakthrough technologies needed to make cellulosic ethanol cost-competitive by 2012 (cost target: \$1.33/gal).

Mid Term: Help create an environment conducive to maximizing the sustainable production of biofuels by 2017, including cost-effective technology, sufficient infrastructure, appropriate policies, and supportive consumers (cost target: \$1.20/gal).

Long Term: Increase the supply of cellulosic and advanced biofuels to 21 billion gallons by 2022 (per Renewable Fuel Standard in the Energy Independence and Security Act of 2007)

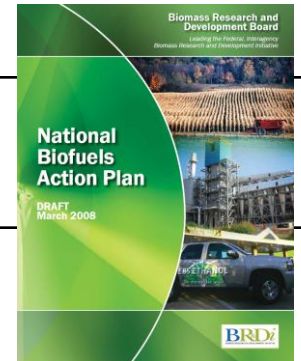


National Biofuels Action Plan

Released Oct. 7, 2008



| NBAP Action Area | Board Action Taken by Interagency Working Groups |
|--|---|
| Sustainability | <ul style="list-style-type: none"> • Inventory federal efforts & facilitate stakeholder collaboration |
| Feedstock Production | <ul style="list-style-type: none"> • Conduct feedstock availability and cost study • Formulate long-term interagency research plan |
| Feedstock Logistics | <ul style="list-style-type: none"> • Facilitate cellulosic feedstock logistics systems demonstrations |
| Conversion Science and Technology | <ul style="list-style-type: none"> • Inventory and coordinate interagency R&D activities • Develop 10 year interagency research plan |
| Distribution Infrastructure | <ul style="list-style-type: none"> • Integrate GIS mapping capabilities across federal agencies • Facilitate interagency collaboration on standards |
| Blending | <ul style="list-style-type: none"> • Monitor interagency testing program • Formulate blends policy statement |
| Environment, Health and Safety | <ul style="list-style-type: none"> • Inventory Federal activities • Identify research needs & mitigation options |



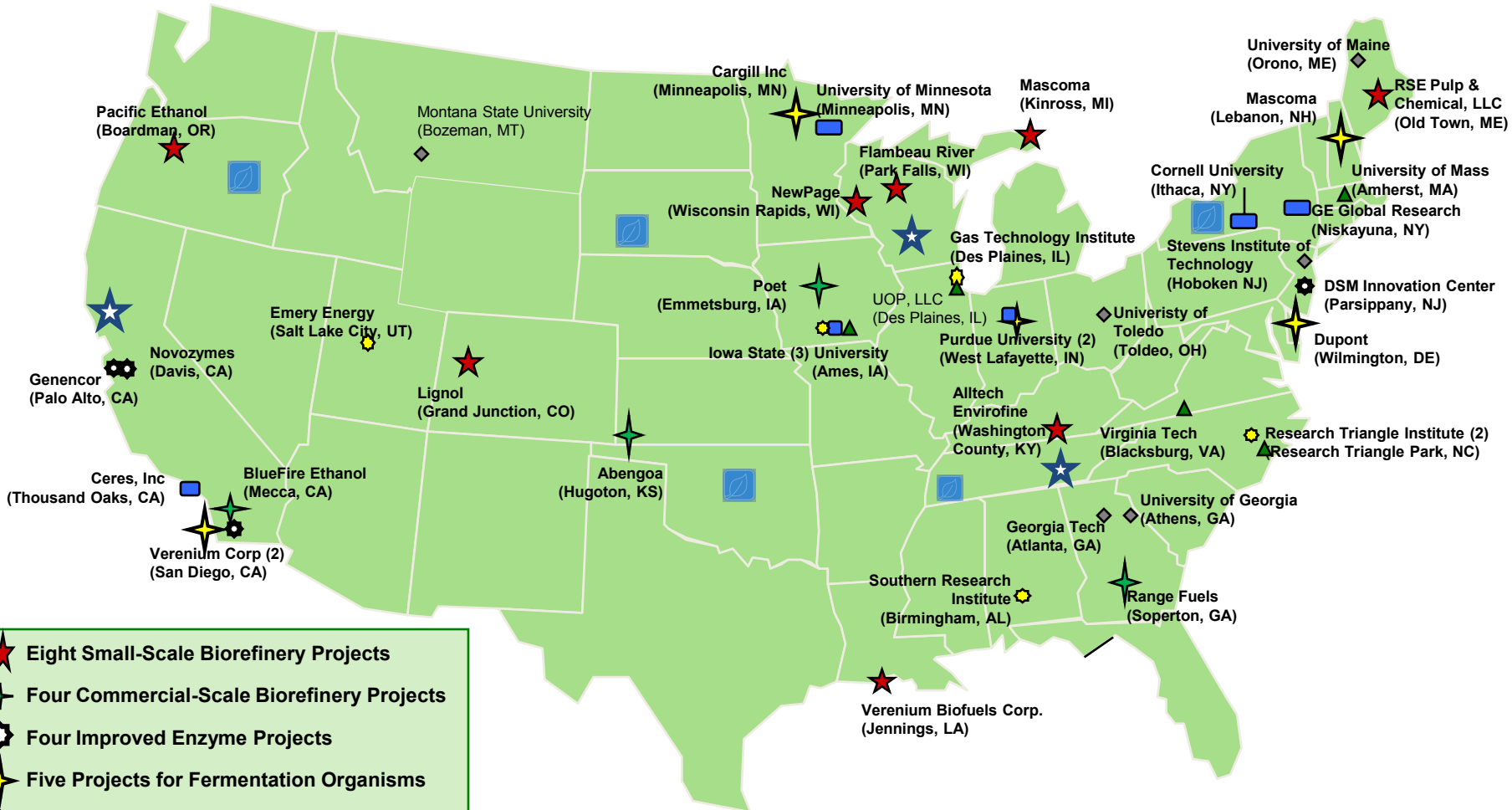
A Billion-Dollar Investment in Biofuels



Since early 2007, DOE has announced investments of *more than* \$1 billion for the RD&D of new biofuels technology, with a focus on non-food, cellulosic feedstocks.

- Cellulosic Ethanol Biorefinery Demonstrations at commercial and 10%-scale
- World-class Biomass Research Centers (Office of Science)
- University Research projects (including Advanced Biofuels)
- New and Improved Enzymes and Micro-organism R&D
- Thermochemical Processes R&D (Pyrolysis, Gasification)
- Annual USDA/DOE Joint Solicitation
- Field Trials under the Regional Biomass Energy Feedstock Partnership
- Biofuels Sustainability Studies and Modeling (Knowledge Framework)
- Joint EPA/DOE Ethanol Blend Studies

Major DOE Biofuels Project Locations



- Eight Small-Scale Biorefinery Projects
- Four Commercial-Scale Biorefinery Projects
- Four Improved Enzyme Projects
- Five Projects for Fermentation Organisms
- Five Thermochemical Syngas Projects
- DOE Joint Solicitation Biomass Projects
- Five Thermochemical Bio-Oil Projects
- Six University Conversion Projects

Office of Science Bioenergy Centers
 DOE Great Lakes, Madison, WI
 DOE Joint Bioenergy Institute, Berkeley, CA
 DOE Bioenergy Science Center, Oak Ridge, TN

Regional Partnerships
 South Dakota State Univ., Brookings, SD
 Cornell University, Ithaca, NY
 Univ. of Tennessee, Knoxville, TN
 Oklahoma State Univ., Stillwater, OK
 Oregon State Univ., Corvallis, OR

Biorefinery Demonstrations



Expediting Commercialization

Commercial-Scale Biorefineries (up to \$272 M)

- Four cost-shared, integrated biorefinery demonstrations to produce 98 million gallons of cellulosic ethanol in 5 years with variety of conversion technologies and cellulosic feedstocks



10%-Scale Biorefinery Validation (up to \$240 M)

- Cost-shared, integrated biorefinery demonstrations using cellulosic feedstocks to produce renewable fuels at one-tenth of commercial scale
- Eight projects now in progress

Impacts of Intermediate Ethanol Blends



Preliminary Report Issued Oct. 7, 2008

- DOE studying intermediate ethanol blends (allocated \$2.1 million in FY07 and \$12.5 million in FY08).
- The DOE test program is evaluating --
 - Vehicle exhaust and evaporative emissions
 - Catalyst durability and aging
 - Cold-start operation and drivability
 - Fuel-system and catalyst materials compatibility
- DOE is also evaluating impacts of higher ethanol blends on small engines
 - Testing leaf blowers, line trimmers, pressure washers, and small generators
 - Expanded test plan for marine engines, all-terrain vehicles, and motorcycles in summer 2008 with input from industry.
- Additional durability testing is required



Upcoming & Pending Solicitations



In Progress

- Annual USDA/DOE Joint Solicitation for Biomass Research and Development Initiative
 - Up to \$25M for awards of \$1M to \$5M for up to 4 years
- Clean Cities Solicitation for Biofuels Outreach and Education
 - Up to \$1.8M for training so that vehicles and fueling equipment are installed, maintained, and operated in a safe and proper manner
- Integrated Pilot-Scale or Demonstration-Scale Biorefinery for Advanced Biofuels
 - Up to \$200M over 6 years for 5-12 projects



Future Solicitations

- R&D Lab Call

USDA/DOE Joint Solicitation



- The Food, Conservation, and Energy Act of 2008 (Farm Bill) Section 9008:
 - Technical areas for grants (with at least 15% of funding going to each area):
 - Feedstocks Development
 - Biofuels and Biobased Products Development
 - Biofuels Development Analysis
- USDA providing \$20M; DOE providing \$5M
- Funding Opportunity Announcement released January 30, 2009
- Closing date for pre-applications: March 6, 2009



Clean Cities Solicitation



- Joint U.S. Department of Energy Clean Cities/
Biomass Program Solicitation for Education
and Outreach Projects
 - Subarea focus on expanding infrastructure
and markets for ethanol, E85, and biodiesel
 - Education & Outreach Workshops
 - Outreach may target fleet owners, code
and safety officials, retailers, end users,
students, media
 - Up to \$1.8M for up to 4 projects over 2 years
 - Teaming arrangements strongly encouraged
 - Due 3/31/09



Advanced Biofuels



- Integrated Pilot-Scale or Demonstration-Scale Biorefinery for Advanced Biofuels
 - Up to \$200M over 6 years for 5-12 projects
 - Pilot-Scale requires $\geq 20\%$ cost share
 - Demo-scale requires $\geq 50\%$ cost share
 - Applications due 4/30/09
- National Algal Biofuels Roadmap Workshop, held Dec. 9-11, 2008
 - Participants provided input to a first draft for an algal biofuels roadmap.

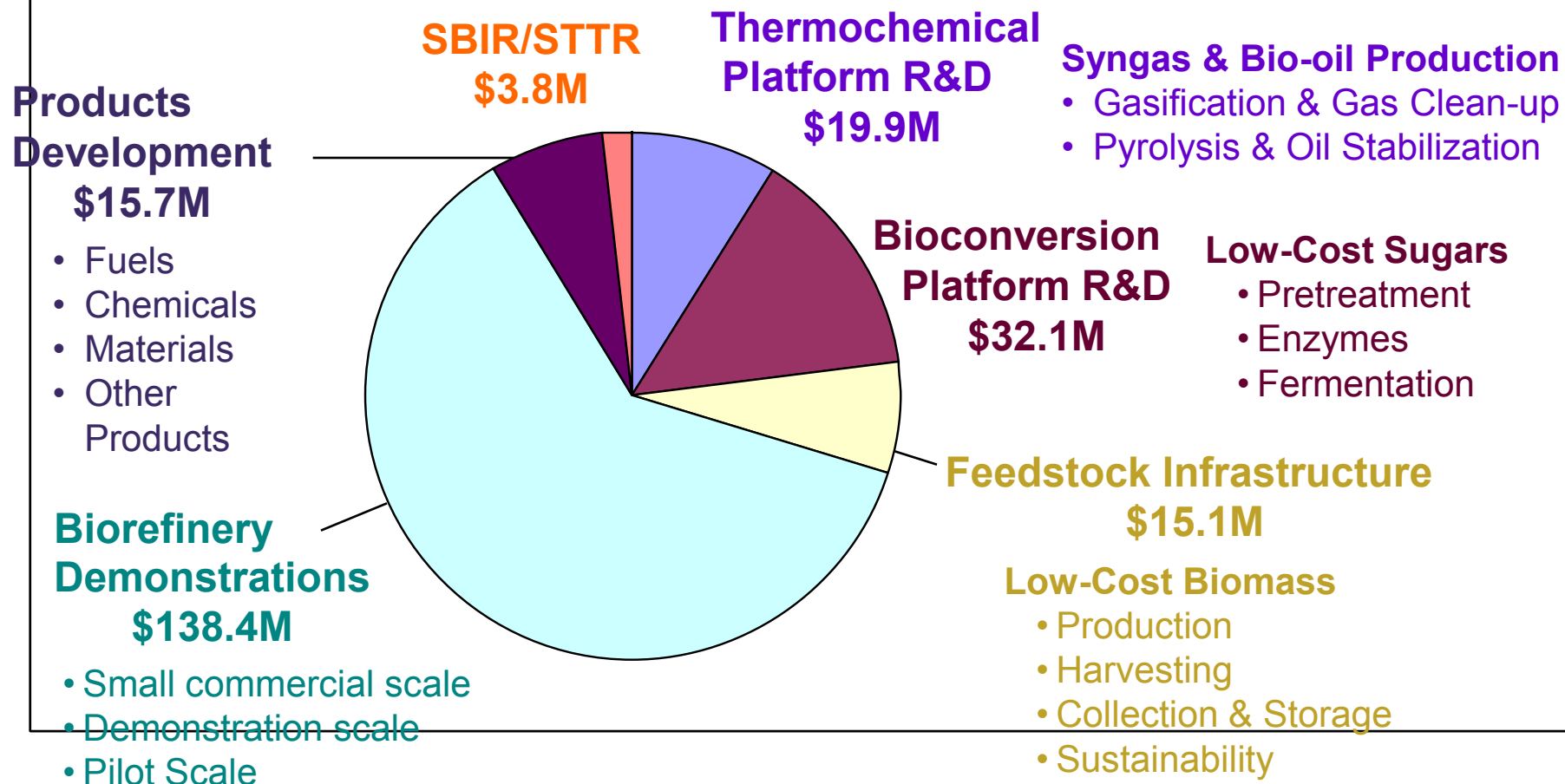


Program Plan for FY 2009



Biomass Budget Request, by Technology Area

Biomass Program Fiscal Year 2009 Budget Request



American Recovery and Reinvestment Act, 2009



- **Renewable R&D and Demonstration Projects:** \$2.5 billion to support DOE RD&D activities, including biomass technologies (\$800 million)
- **Renewable Energy Loan Guarantee Program:** \$6 billion to support loan guarantees for renewable energy projects. Up to \$500 million of this amount is allocated to innovative biofuels technologies that are capable of deployment on a commercial scale. Must begin construction by September 30, 2011.
- **Tax credits:**
 - Extends the Production Tax Credit for biomass and other renewable energy facilities through 2013
 - Extends the Investment Tax Credit, allowing owners of biomass and other renewable technology projects that are eligible for the PTC to use the full 30% ITC previously available only to solar facilities
 - Allows renewable energy project developers to apply for a Treasury Dept. grant equal to 30% of the cost of an eligible project if construction starts in 2009 or 2010 (in lieu of ITC)

2009 Program Priorities and Goals



Advancing Presidential Objectives

Science & Discovery

- Connecting basic and applied bioscience
- Conducting R&D at universities and national labs to achieve transformational breakthroughs:
 - 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 (compared to gasoline)



Biomass Program Peer Review 2009



**An external, independent review of the Program's
research portfolio and strategic direction**

MARCH 19 - 20

**Platform Series I
National Harbor, Maryland**

- Integrated Biorefineries
- Infrastructure
- Analysis

APRIL 8 - 10

**Platform Series II
Washington, DC**

- Feedstocks Technology
- Sustainability

APRIL 13 - 17

**Platform Series III
Denver, Colorado**

- Biochemical Conversion & Biobased Products
- Thermochemical Conversion & Products

JULY 14 - 15

**Program Review Meeting
Rosslyn, Virginia**

- Strategic Direction
- Results of Platform Reviews



Biomass 2009: Fueling Our Future

March 17 and 18

Gaylord National in National Harbor, Maryland

This unique conference will explore the future role of biofuels in our nation's energy portfolio and the technology, market, and policy advances needed to meet aggressive biofuels targets and move toward energy independence.

Topics include:

- **Sustainability**
- **Advanced biofuels**
- **Regulation and policy**
- **International biofuels policies and markets**
- **Biofuels commercialization**

Join us!

Back-Up Slides

Commercial-Scale Biorefinery Demonstrations



DOE investments in cellulosic biofuels will accelerate commercialization and help create a biofuels market based on non-food feedstocks.

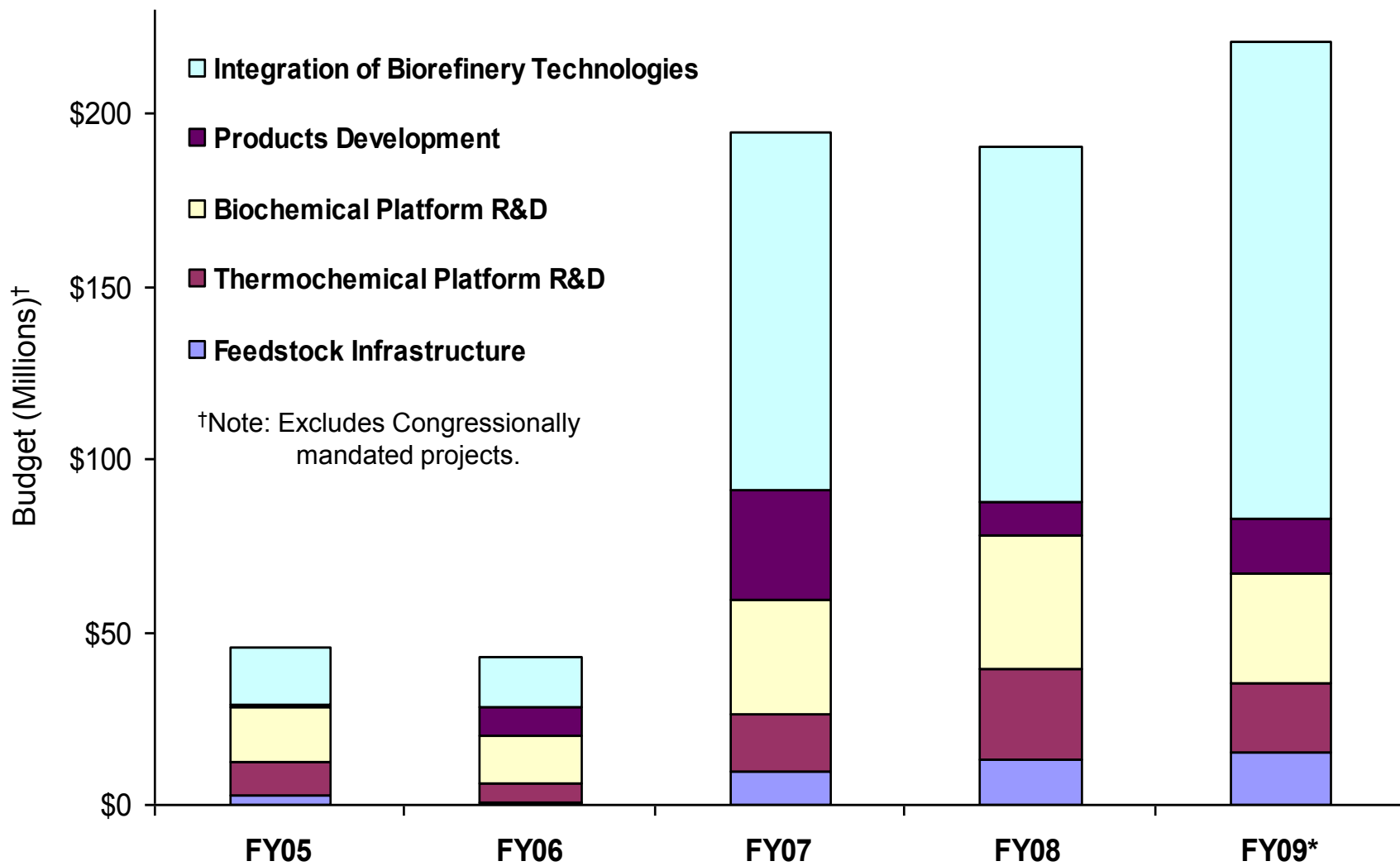
| Performers | Feedstock Type | Conversion Technology | Status of Project |
|--------------------|-------------------------|--|---|
| Abengoa | Agricultural Residue | Biochemical | Phase 1-Cooperative Agreement signed Sept. 2007 |
| Bluefire | MSW | Biochemical | Phase 1-Cooperative Agreement signed Sept. 2007. |
| Poet | Corn cobs Corn Fiber | Biochemical | Phase 2-Technology Investment Agreement – Signed Oct. 2008 |
| Range Fuels | Woody Waste | Gasification + Mixed Alcohol synthesis | Phase 2-Technology Investment Agreement – Signed Nov. 2007 Ground Breaking Nov. 2007 |

Small-Scale (10% of Commercial Scale) Biorefinery Demonstrations



| Performers | Feedstock Type | Conversion Technology |
|-------------------------|--------------------------------------|-----------------------|
| Alltech Envirofine, LLC | Wood Residue | Biochemical |
| Flambeau River | Wood Residue | Thermochemical |
| Lignol Innovations | Wood Residue | Biochem-organosolv |
| NewPage Corporation | Wood Waste | Thermochemical |
| Mascoma | Switchgrass & hardwoods | Biochemical |
| Pacific Ethanol | Agricultural & Forest Residue | Biochemical |
| RSE Pulp & Chemical | Wood chips (mixed hardwood) | Biochemical |
| Verenium Biofuels | Bagasse, Agricultural & Wood Residue | Biochemical |





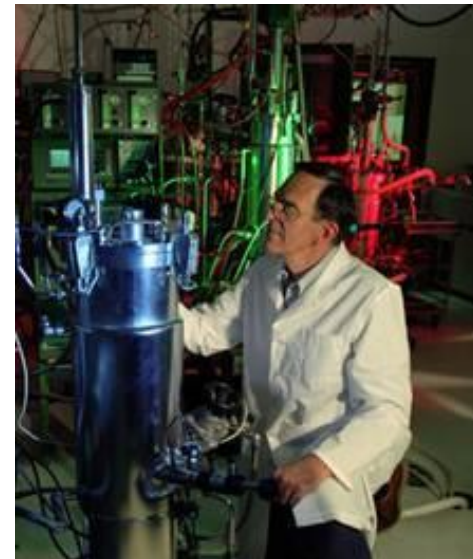
*These are FY09 Budget Request figures, not actual appropriations or expenditures, due to the Continuing Resolution

Solicitation Selections Announced Since September 2008



University R&D for up to \$4.4M (\$5.7M w/ cost share)

- **Montana State University** - Evaluate algae cultures and identify populations that naturally have higher rates of oil production
- **University of Georgia** - Develop processes for harvesting algae and processing into biofuels and bioproducts
- **University of Maine** - Model conversion and fermentation pathways for pre-pulping extracts and seaweed sludge
- **Georgia Tech Research Corporation** - Evaluate and model the reaction kinetics in two experimental gasifiers using forest residue
- **University of Toledo** – Simultaneously convert cellulose to sugar and ferment 5 and 6 carbon sugars to ethanol with native yeasts
- **Steven's Institute of Technology** - Evaluate and demonstrate a novel microchannel reactor to reform pyrolysis oil to synthesis gas



Pyrolysis Oil R&D for up to \$7M (\$8.75M w/ cost share)

- **Virginia Polytechnic Institute & State University** – Perform catalytic hydrodeoxygenation (HDO) and upgrading together with pyrolysis in a single fluidized bed reactor
- **Iowa State University** - Improve biomass pretreatment, bio-oil filtering fractionating recovery, and catalytic post-treatment
- **RTI International** - Develop highly active and stable catalysts for the stabilization of bio-oil
- **University of Massachusetts** - Produce a stable bio-oil that has low char content and a neutral pH using a combination of membrane and catalytic technologies
- **UOP LLC** - Develop and demonstrate at pilot scale an efficient, economical system for pyrolysis oil stabilization

Loan Guarantees



FY2007

- 143 pre-applications received
- Funds authorized February 2007
- 16 full applications requested
 - 6 for biomass
 - 2 submitted full applications
 - Others in fossil, industrial, solar, hydrogen, alternative fuel vehicles, electricity delivery, and reliability



FY2008

- Announced solicitation for \$30.5B on June 30, 2008
 - \$10B for renewable energy and electricity transmission
 - Applications due February 26, 2009

ARRA

- Permits guarantees for leading-edge, pilot- or demonstration-scale biofuel projects for technologies that will substantially reduce GHGs and commence construction prior to 9/30/11