



U.S. Department of Energy, Biomass Program

Presentation to Biomass R&D
Technical Advisory Committee

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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





Ambitious Biofuels Timeline

2008

2012 Cost-competitive cellulosic ethanol (goals \$1.33/gallon)

2015 U.S. transportation fuels contain **21 billion gallons** of renewable fuels including at least **3 billion gallons** of cellulosic biofuels**

2022 U.S. transportation fuels contain **36 billion gallons** of renewable fuels including at least **16 billion gallons** cellulosic biofuels**

2030 Displace **30%** of U.S. gasoline consumption*
• **60 billion** gallons biofuels

* Basis is 30% of 2004 gasoline consumption

***Renewable Fuel Standards, Energy Independence and Security Act of 2007*
– biofuels constitute 36 billion gallons of U.S. motor fuels by 2022.

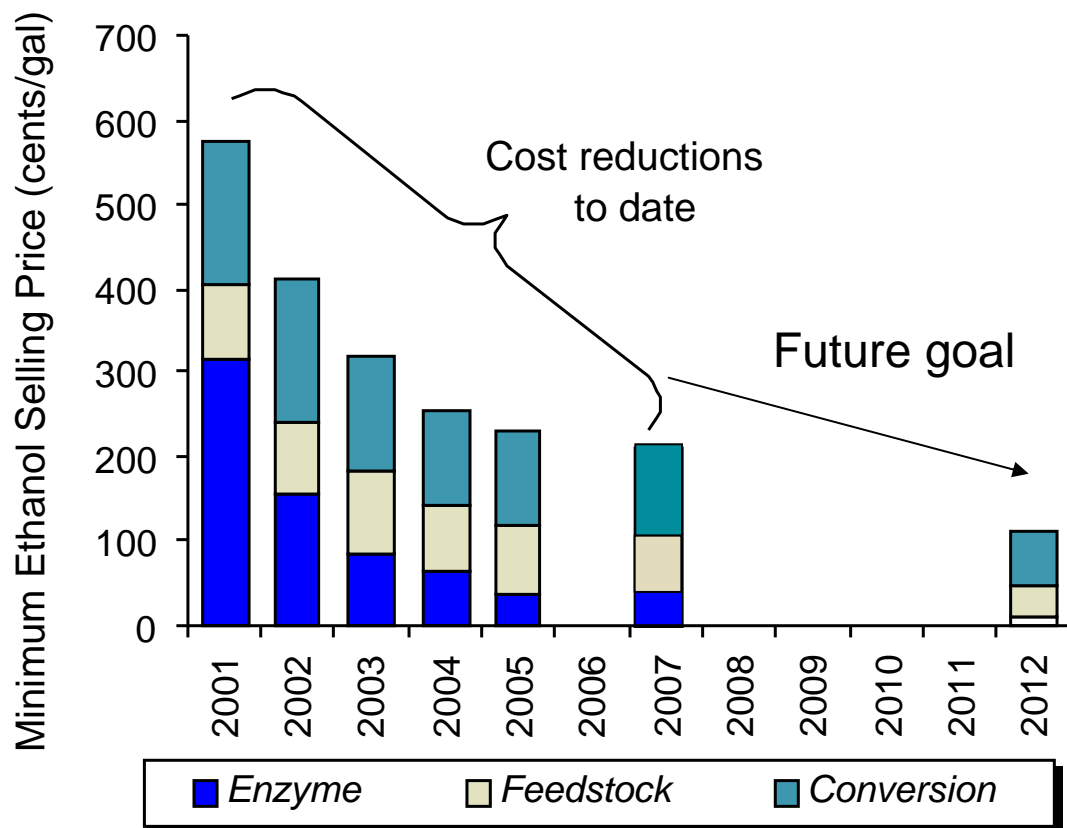


Cellulosic Ethanol Potential and Status



Cellulosic ethanol anticipated cost competitiveness and sustainability attributes are key to biofuels growth potential

Historical and Projected Cellulosic Ethanol Costs



All Costs are 2007 \$

	2001 (dollars per gallon)	2007 (dollars per gallon)	2012 (dollars per gallon)
Enzymes	3.11	0.32	0.10
Feedstock*	0.82	0.83	0.51
Conversion	2.02	1.28	0.72
Total	5.95	2.43	1.33

*Feedstock is assumed to be \$60 per dry ton in 2007 and projected at \$46 per dry ton in 2012. N-th plant scenario

NREL Modeled Cost

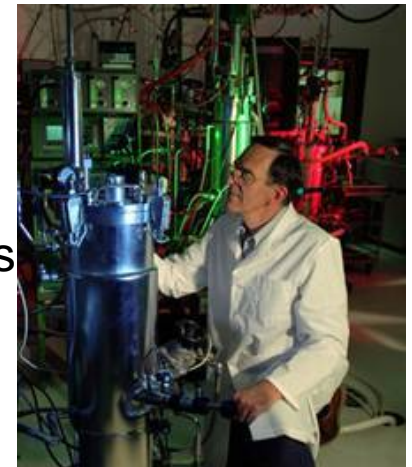
Federal research has achieved major reductions in the cost of cellulosic ethanol



Leveraging Partnerships to Achieve Goals



- **Commercial-Scale Biorefineries (up to \$385 million)**
 - Six cost-shared, integrated biorefinery demonstration projects to annually produce 130 million gallons of cellulosic ethanol in 5 years using variety of conversion technologies and cellulosic feedstocks
- **10%-Scale Biorefinery Validation (up to \$200 million)**
 - Seven cost-shared, integrated biorefinery demonstrations using cellulosic feedstocks to produce renewable fuels; one-tenth of commercial scale
- **Ethanologen Solicitation (up to \$23 million)**
 - Five selected research teams working on microorganisms
- **Enzyme Solicitation (up to \$33.8 million)**
 - Four teams selected to develop highly effective, inexpensive enzyme systems for commercial biomass hydrolysis; second phase: cellulase development with cost-sharing industry partners
- **Thermochemical Conversion (up to \$7.75 million)**
 - Five selected to integrate the technologies for gas clean up and fuel synthesis following biomass gasification
- **Joint DOE-USDA Solicitation (\$18 million)**
 - 21 selected under Biomass R&D Initiative on feedstocks, conversion, products and analysis



Commercial Scale Biorefineries Recipients



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
Range Fuels	Woody Waste	Gasification + Mixed Alcohol synthesis	Phase 1 & 2-Technology Investment Agreement – Signed Nov. 2007 Ground Breaking Nov. 2007
Abengoa	Agricultural Residue	Biochemical	Phase 1-Cooperative Agreement signed Sept. 2007
Bluefire	MSW	Biochemical	Phase 1-Cooperative Agreement signed Sept. 2007.
Poet	Corn Cob Corn Fiber	Biochemical	Phase 1-Cooperative Agreement signed Sept. 2007.
Alico	Vegetative Waste Woody Waste	Gasification + Fermentation	Award pending negotiation.
logen	Baled Barley Wheat Straw	Biochemical	Award pending negotiation.

10% of Commercial Scale Biorefineries Recipients



Performers	Feedstock Type	Conversion Technology	Status of Project
ICM Incorporated	Agricultural Residue	Integrated biochemical and thermochemical	Award pending negotiation.
Lignol Innovations	Wood Residue	biochem-organisolve	Award pending negotiation.
Pacific Ethanol	Agricultural and Forest Residues	Biochemical	Award pending negotiation.
NewPage Corporation	Wood Waste	Thermochemical	Award pending negotiation.
RSE Pulp & Chemical	Wood	Thermochemical	Award pending negotiation.
Mascoma	Wood Switchgrass	Biochemical	Award pending negotiation.
Ecofin, LLC	Agricultural Residue	Biochemical	Award pending negotiation.

Major DOE Biofuels Project Locations

Geographic, Feedstock, and Technology Diversity



RSE Pulp & Chemical, LLC (Old Town, ME)



- Seven Small-Scale Biorefinery Projects
- Six Commercial-Scale Biorefinery Projects
- Four Improved Enzyme Projects
- Five Projects for Advanced Organisms
- Five Thermochemical Biofuels Projects
- Three Bioenergy Centers
- DOE Joint Solicitation Biomass Projects

- 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





Future Opportunities

- Pyrolysis Solicitation for \$7M over 2 years closes May 29
- University Solicitation for Conversion R&D for \$4M over 3 years closes June 2
- Loan Guarantees
 - FY2007
 - 143 pre-applications received
 - Funds authorized February 2007
 - 16 full applications requested
 - 6 for biomass
 - Others in fossil, industrial, solar, hydrogen, alt. fuel vehicle, electricity delivery and reliability
 - FY2008
 - Plan issued April 11, 2008 for \$38B
 - \$10B for renewable energy and electricity transmission
 - \$18.5B for nuclear; \$2B for uranium enrichment; \$8B for fossil energy



Intermediate Blends Testing: An Alternative Approach to Market Penetration



- E10 market will be saturated within a few years – once ethanol supply reaches 13-14 billion gallons.
- DOE and EPA working together to assess feasibility of intermediate blends in allowing greater penetration of ethanol as part of fulfilling new RFS
- 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
 - Currently testing leaf blowers, line trimmers, pressure washers, and small generator sets
 - Launching expanded test plan for marine engines, all-terrain vehicles, and motorcycles in summer 2008 with input from industry.

Production is Not Enough -- Need Market Penetration



Our Commitment to Sustainability



EERE is committed to developing the resources, technologies, and systems needed for biofuels to grow in a way that enhances the health of our environment and protects our planet. To that end, we are working to...

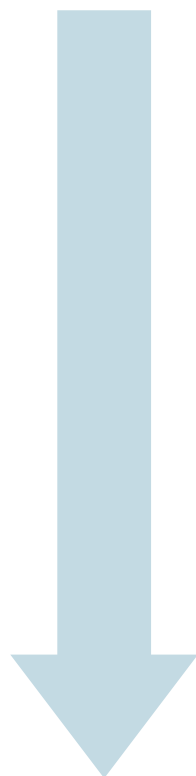
- Develop diverse, non-food feedstocks (e.g., switchgrass, sorghum) that require little water or fertilizer
- Foster sustainable forestry practices (e.g., advanced harvesting techniques) to enhance forest health
- Selectively harvest biomass components while leaving adequate soil nutrients
- Assess life-cycle impacts of major scale-up in biofuels production, from feedstocks to vehicles, addressing:
 - land use and soil health
 - water use
 - air quality issues
 - impacts on greenhouse gas (GHG) emissions



Biofuels Beyond Ethanol



Today



Future

Ethanol – as a blending agent from either grain or cellulosic material from Ag and/or Forestry industry

Biodiesel – Transesterified vegetable oils blended with diesel

Green Diesel – fats, algal oils, waste oils, or virgin oils converted to low-sulfur diesel in petroleum refinery

Higher alcohols – examples include: butanol, mixed alcohols, higher carbon alcohols (C5- and greater)

Fischer-Tropsch Liquids – and other products from syn gas including methanol, dimethyl ether, etc

Pyrolysis Liquids – alternative feedstock to petroleum refinery or gasification facility

Methanol derived fuels – Methanol to gasoline technology, dimethyl ether and other products

Other fuels – Liquid transportation fuels from sugars/oils refinery not discussed or yet envisioned