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Energy efficiency and renewable energy research, development, and deployment activities help the Nation meet its economic, energy security, and environmental challenges concurrently

Energy Security

- Deploy the cheapest, cleanest, fastest energy source – energy efficiency
- One million plug-in hybrid cars on the road by 2015
- Develop the next generation of sustainable biofuels and infrastructure
- Increase fuel economy standards



Economic

- Create green jobs through Recovery Act energy projects
- Double renewable energy generation by 2012
- Weatherize one million homes annually

Environmental

- Implement an economy-wide cap-and-trade program to reduce greenhouse gas emissions 80 percent by 2050
- Make the US a leader on climate change
- Establish a national low carbon fuel standard

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
- Establish a domestic bioindustry



"Developing the next generation of biofuels is key to our effort to end our dependence on foreign oil and address the climate crisis -- while creating millions of new jobs that can't be outsourced. With American investment and ingenuity -- and resources grown right here at home -- we can lead the way toward a new green energy economy."

Secretary of Energy Steven Chu

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

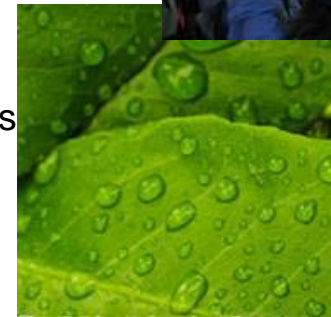
- Developing & demonstrating cellulosic and advanced biofuels to meet renewable fuel standard

Economic Prosperity

- Creating 50 to 75 jobs per new biorefinery
- Creating major new energy crop markets
- Reinvigorating rural economies

Climate Change

- Reducing greenhouse gas emissions by > 80% with advanced biofuels (relative to gasoline)



Develop and transform our renewable and abundant, non-food, biomass resources into sustainable, 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

Biomass Program

- Make cellulosic ethanol cost competitive, at a modeled cost for mature technology of \$1.76/gallon by 2012
- Help create an environment conducive to maximizing production and use of biofuels, 21 billion gallons of advanced biofuels per year by 2022 (Energy Information and Security Act)

Feedstocks

Conversion

**Integrated
Biorefineries**

**Biofuels
Infrastructure**

Sustainability & Analysis



Grain-based Ethanol

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



Cellulosic Ethanol

- DOE research ongoing
- Potential to lower GHG emissions >80%
- Uses biomass from waste and non-agricultural land



Other Advanced Biofuels

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

Barriers to Speed and Scale

Barriers	DOE Solution
Pioneer Plants: no process guarantees, financing uncertainty, no fixed price agreements, etc.	Fix loan guarantee program to include biofuels
Pilot and Demonstration Scale Biorefineries: financing uncertainty, NEPA process	DOE cost share; streamline the NEPA process; assist in developing parallel technology solutions
Policy: partial implementation of BCAP, lack of monetization of benefits, no Renewable Portfolio Standard, etc.	Full implementation of BCAP; policy that values carbon & other environmental services; passage of RPS
Feedstock availability & logistics systems	R&D on advanced feedstocks & logistics systems at scale that can support commercial biorefineries (for cellulosic & algal feedstocks)
Conversion technology breakthroughs	R&D on pre-treatment, cost-effective enzymes, pyrolysis oil upgrading, catalyst durability, etc.
Public Acceptance – Sustainability	R&D on GHG impacts, indirect land use, & carbon, nitrogen, phosphorus, & water fluxes; watershed-scale field trials
Near-term: Ethanol Blends; Long-term: Move to hydrocarbon fuels & power	Complete intermediate blends testing by Summer 2010; expansion of advanced biofuels R&D; focus on power & products

Technology Requirements

- Flexible, sustainable feedstocks
- Flexible conversion processes
 - Mix of biochemical (advanced enzymes), thermochemical (pyrolysis, gasification, etc.), and other conversion technologies
- Continue to increase yields and efficiency
- Continue to lower production costs
- Efficient logistics and deployment
- Modular systems to reduce capital costs

Other National Benefits

- Sustainable domestic energy
- Strong economic growth (new technology markets and jobs)
- Positive impact on climate and air quality



New & High-Yield Feedstocks

- Energy crops
- Residues utilization
- Algae



Advanced Biofuels

- Cellulosic Ethanol and Higher Alcohols
- Green Gasoline
- Renewable Diesel
- Renewable Jet Fuel Formulations



Value-added Bioproducts/Coproducts



Carbon Mitigation

- Potential role in future carbon legislation



Stimulate/Leverage Scientific Progress

“Commercial-Scale” Biorefineries



Energy Efficiency &
Renewable Energy

Performers	Location	DOE Award*	Feedstock Type	Conversion Technology	Fuel / Amount**	Status
Bluefire	Fulton, MS	\$87.6M	Sorted MSW Woody Biomass	Biochemical- Concentrated Acid Hydrolysis	19M gals ethanol/yr	Bluefire relocated its site from CA to MS. An EA has commenced for NEPA to be completed by March 2010 for a phase 2 Award by Sept 2010.
Poet	Emmetsburg, IA	\$100M	Corn Cob	Biochemical	25M gals ethanol/yr	POET recently held a “field day” to highlight its feedstock commercialization effort with farmers and equipment manufacturers. POET’s DOE LG application is under review. Estimated construction start up June 2010 if favorable LG decision. Estimated commissioning June 2011.
Range Fuels	Soperton, GA	\$76.2M	Woody Biomass	Gasification + Mixed Alcohol synthesis	21M gals per yr split 50/50 with ethanol and methanol	Currently in negotiations to modify the TIA. Range Fuel’s USDA Loan Guarantee is in negotiations. Initiated construction Dec 2007, estimated commissioning of Phase 1 by Dec 2010 Go/no go decision on the next phase.
Abengoa	Hugoton, KS	\$100M	Agricultural Residues	Biochemical	11.4M gals ethanol/yr	Record of Decision on EIS expect Feb 2010. Phase 2 award dependent on DOE LG decision. Estimated construction start up Dec 2010 and commissioning Dec 2012.

*Award amounts still under negotiation, based on contingencies, and go/no go decisions

**Amounts by fuel are based on estimates. Co-gen of steam/heat and power and not included.

Demonstration-Scale Biorefineries



Energy Efficiency &
Renewable Energy

Performers	Location	DOE Award*	Feedstock Type	Conversion Technology	Fuel / Amount	Status
Alltech Envirofine	Washington County, KY	\$30M	Corn Cobs	Biochemical-Solid State Fermentation	1M gals ethanol/yr	Unresponsive - DOE sent letter requesting response or withdraw.
Lignol Innovations	Grand Junction, CO	\$30M	Woody Biomass	Biochemical-Organisolve	2.5M gals ethanol/yr	SunCorp pulled out of the project. Decision on new partner and location expected March 2010.
Mascoma	Upper Peninsula, MI	\$32M	Woody Biomass	Biochemical	5M gals ethanol/yr	Modifying and operating pilot plant. NEPA to be completed by Sept 2010. Estimated start of construction Nov 2010. Estimated commissioning early 2012
NewPage	Wisconsin Rapids, WI	\$40M	Woody Biomass	Thermochemical-Fischer-Tropsch	5.5M gals FT Liquids/yr	Piloting underway, cost shared with Flambeau. NEPA to be completed by March 2010, Estimated start of construction June 2010, Estimated commissioning Dec 2011.
Pacific Ethanol	Boardman, OR	\$30M	Wheat Straw, Stover, Poplar Residuals	Biochemical-Biogasol	2.7M gals ethanol/yr	Parent company filed for reorganization, but the LLC continues to work on project planning.
RSA	Old Town, ME	\$33.9M	Hemicellulose from Wood	Biochemical-Pentose Extraction	2.2M gals of Ethanol or Butanol	Bankruptcy then acquired by Patriarch Partners. NREL conducting technology validation. NEPA determination expected by Jan 2010 (likely EA).
Verenium Biofuels Corp.	Jennings, LA	\$14.9M	Energy Cane and Sugar Cane Bagasse	Biochemical Process	1.5M gals ethanol/yr	Demonstration facility built. Feedstock and operational testing started. Fully integrated runs expected in April 2010.
Flambeau River Biofuels LLC	Park Falls, WI	up to \$80M	Woody Biomass	Thermochem to Fischer-Tropsch	9M gals FT Liquids/yr and 50M lbs of FT wax	Piloting underway, cost shared with NewPage. Phase 2 award dependent on favorable DOE LG decision. LG decision expected Sept 2010. NEPA determination by Feb 2010. Estimated start of construction Oct 2010, Estimated commissioning July 2012.

- \$509M Pilot and Demonstration-Scale Biorefineries**
Validate technologies for integrated production of advanced biofuels, products, and power to enable financing and replication.
10 to 20 awards for refineries to be operational within 3 years
- \$81 M Commercial-Scale Biorefineries**
Increase in funding for prior awards to expedite construction and accelerate commissioning and start-up
- \$108M Fundamental Research**
- \$20 M Infrastructure Research**
Optimize flex-fuel vehicles operating on E85
Evaluate impacts of intermediate blends on conventional vehicles
Upgrade existing infrastructure for compatibility with E85
- \$13 M NREL Integrated Biorefinery Pilot Plant Expansion**
- \$40 M Small Business Innovation Research**
- \$29 M Departmental Administration**



The U.S. DOE Biomass Program 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 that require little water, fertilizer, or new land
- Foster sustainable forestry practices
- Harvest biomass components selectively, 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



Sustainability Program Purpose: To understand and address the potential environmental impacts of biofuels production activities—encouraging the benefits while mitigating any concerns

Feedstocks

- Through a partnership with Sun Grant Initiative, use field trials to collect data on sustainability
- Work with Council for Sustainable Biomass Production to develop criteria

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
- Evaluate mitigation potential of bioenergy crops

International Efforts

- Work with Conservation International to identify land and preserve best production locations
- Provide data and analysis to Roundtable on Sustainable Biofuels, Global Bioenergy Partnership, others
- Contribute to International Biofuels Forum

Leveraging--Great Lakes Bioenergy Research Center

- Biogeochemical, biodiversity, and socioeconomic responses to expansion and intensification of agriculture and silvicultural practices
- Spatially explicit land use change forecast on crop area changes

Climate Change

- GREET Model development
- EISA Lifecycle Analysis – Monitoring and improving carbon footprint of bioenergy

The goal of the sustainability efforts in the Biomass Program is to anticipate and navigate requirements and inquiries with regard to the environmental benefits and impacts of Biomass Program activities

- **Full Useful Life Emissions Testing**
 - 58 Tier 2 vehicles (19 models); 24 Tier 1 vehicles (8 models)
 - Data for all Tier 2 vehicles at 90K or higher mileage by June 2009
 - Close collaboration with EPA; provide data as it becomes available
- **Tailpipe Emissions**
 - Testing 27 fuels on up to 19 vehicles at 50°F, 75°F, 95°F
 - Report expected Spring 2010
- **Evaporative Emissions**
 - Testing 16 vehicles, 2 vapor pressures
 - Report expected Spring 2010
- **Fuel System Materials Compatibility**
 - Evaluating fuel system components, sub-system and system
 - Report expected winter 2010
- **Cold Start and Driveability**
 - Testing at high ambient temperature and high altitude
 - Data will support ASTM specifications development
 - Testing completion Summer 2010

For More Information:

Office of Biomass Program

<http://www1.eere.energy.gov/biomass/>

Alternative Fuels Data Center

<http://www.eere.energy.gov/afdc/fuels/ethanol.html>