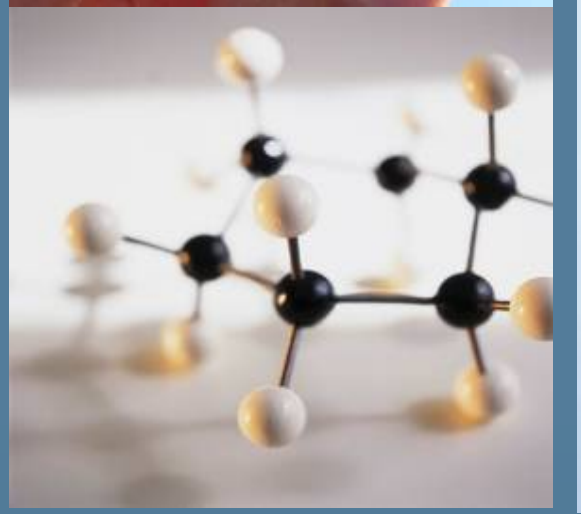


DOE's Bioenergy Program

John Ferrell

Office of the Biomass Program
Energy Efficiency and Renewable Energy

"The Role of Extension in Energy"
Little Rock, Arkansas June 30, 2009

Biomass Program Mission and Objectives

Program Mission

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

Focus on targeted research, development, and demonstration

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

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, 21 billion gallons of advanced biofuels per year by 2022 (EISA)

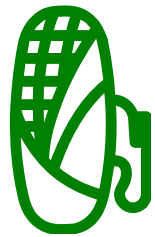
Biomass Program: The Impact

We are bringing a viable alternative to gasoline to the market, lowering greenhouse gas emissions in the transportation sector, and reducing the need for imported oil.

- In 2007 alone, the U.S. biofuels industry --
- Added $48 billion to U.S. gross domestic product
- Supported creation of 230,000 jobs
- Displaced 228 million barrels of oil and saved Americans $16.5 billion
- Displaced 3% of vehicle gasoline consumption
- Recent McKinsey study found that ethanol blending lowered gas prices by 17 cents per gallon in 2008

Global demand for transportation fuels (China and India), high oil price environment and concerns on climate change have made this program a portfolio priority.

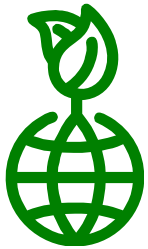
Successive Generations of Biofuels



Grain-based Ethanol

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

Program involvement limited to facilitating market uptake via blends testing, infrastructure development, etc.



Cellulosic Ethanol

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

Ongoing RD&D activities focus on multiple pathways to affordably and sustainably produce cellulosic ethanol from a broad range of biomass resources available across the nation.

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

Expanded strategy includes advanced biofuels that require governmental support and can significantly contribute to meeting the RFS (e.g., alternative light-duty and diesel replacement fuels). Update to *Multi-Year Plan* by December 2009.

Program Areas & Key Challenges

Research & Development

Feedstock Systems

- Diverse regional biomass resources
- Yield & price
- Water & fertilizer
- Land use
- Metrics & standards
- Extension

Conversion Technologies

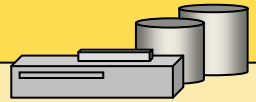
Biochemical

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

Thermochemical

- Cost & Efficiency
- Gasification Process
- Fuel Stabilization

Demonstration & Deployment



Integrated Biorefineries

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

Infrastructure

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

Product Development

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

Sustainability

- GHG emissions
- Water quality
- Land use
- Socioeconomics
- Predictive Modeling
- International

Sub-Program and Key Initiative Descriptions

Strategic Objectives: Toward Sustainable Biofuels

Feedstock Production → Conversion Technologies → Integrated Biorefineries → Infrastructure

Feedstocks

Supply

2012: 130 M TPY

Costs (Dry Ton)

2012:

Herbaceous: $51

Woody: $62

Biochemical Conversion

Reduce the modeled processing cost of converting feedstocks to ethanol to $0.92/gal by 2012.

Thermochemical Conversion

Reduce the modeled processing cost of converting woody feedstocks to ethanol to $0.86/gal by 2012.

Integrated Biorefineries

Demonstrate and validate integrated biorefineries across various pathways with at least 3 plants in successful operation by 2012. Validate modeled ethanol production cost and compare to targets.

Biofuels Infrastructure

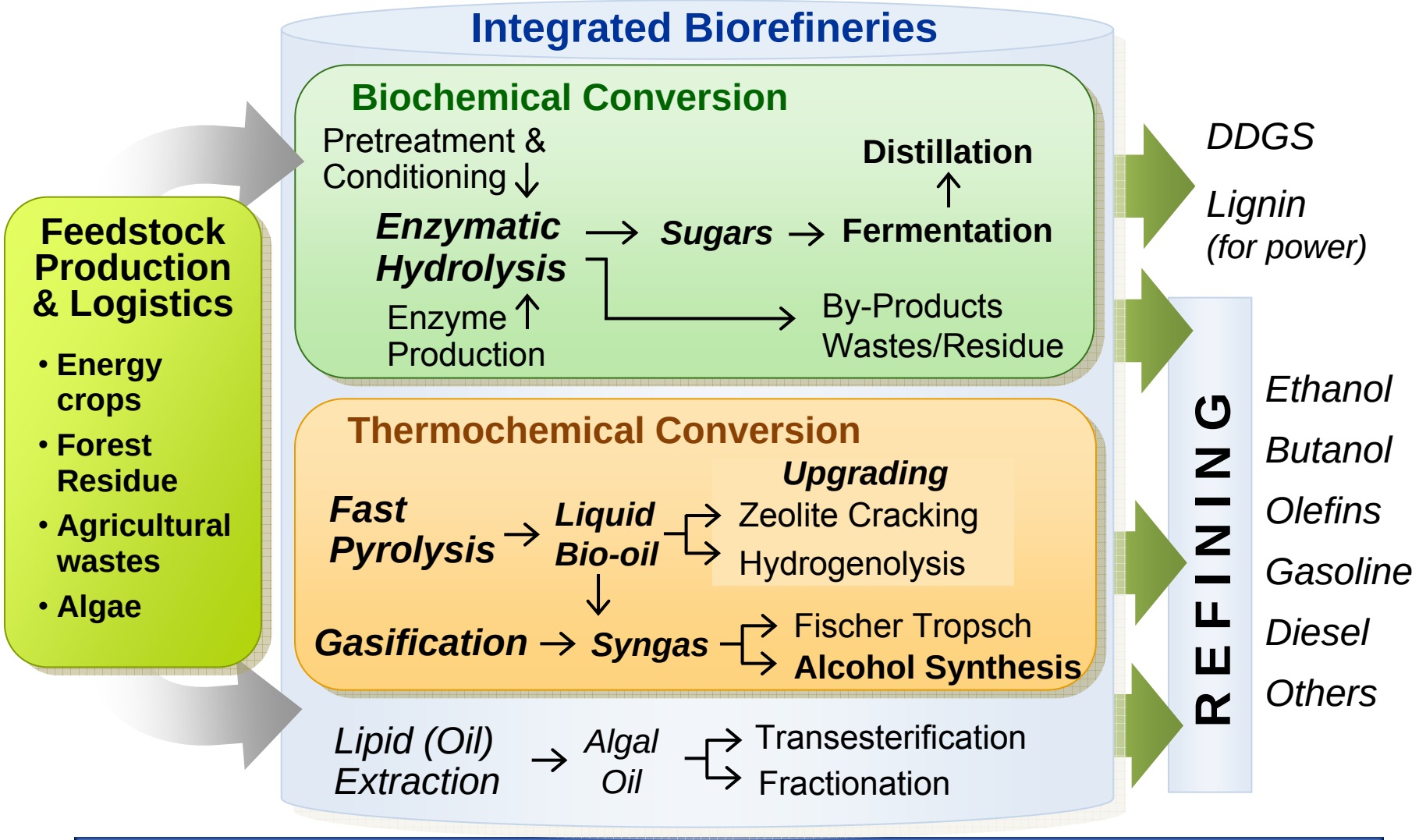
Complete standards development and testing of E15 and E20 distribution systems and vehicles. Support E85 on regional basis.

Sustainability & Analysis

Increase understanding of resources and impacts on environment and climate.

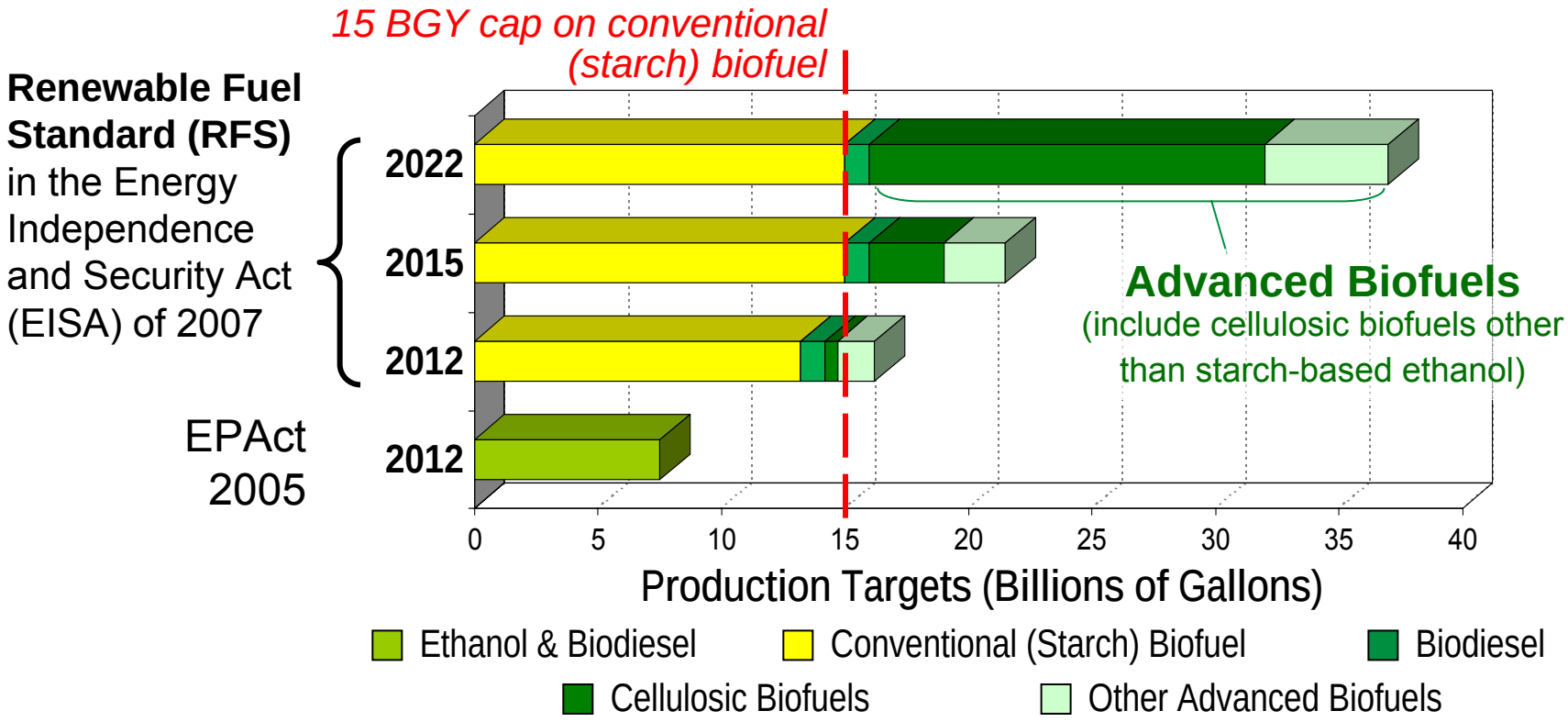
Assess extent, adequacy, and implications of resources, performance, efficiency, strategies, technologies, and impacts.

Exploring Routes to Produce Biofuels



Research on multiple conversion pathways aims to improve the efficiency and economics of biofuels production.

EISA Mandated Production Targets



EISA defines ***Cellulosic Biofuel*** as "renewable fuel derived from any cellulose, hemicellulose, or lignin that is derived from renewable biomass and that has lifecycle greenhouse gas emissions…that are *at least 60 percent less* than baseline lifecycle greenhouse gas emissions."

EISA defines ***Advanced Biofuel*** as "renewable fuel, other than ethanol derived from corn starch, that has lifecycle greenhouse gas emissions…that are *at least 50 percent less* than baseline lifecycle greenhouse gas emissions."

Key Recent Accomplishments and Deliverables
Integrated Biorefineries

Expediting Commercialization

Commercial-Scale Biorefineries (up to $272 M)

Expanded via Recovery Act

- 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 $210 M)

Expanded via Recovery Act

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

Key Recent Accomplishments and Deliverables

EPACT Section 932 "Commercial-Scale" Biorefineries

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

Performers	Feedstock Type	Conversion Technology	Fuel Type	Status
Poet Emmetsburg, IA	Corn Cob Corn Fiber	Biochemical	Ethanol	Award 2 TIA issued, engineering and construction in progress.
Range Fuels Soperton, GA	Woody Waste	Gasification + Mixed Alcohol synthesis	Mixed alcohols	Award 2 TIA issued, engineering and construction in progress.
Abengoa Hugoton, KS	Agricultural Residue	Biochemical	Ethanol	NEPA EIS process initiated. Award 2 anticipated in FY09.
Bluefire **Fulton, MS**	Sorted MSW	Biochemical-Concentrated Acid Hydrolysis	Ethanol	Lease and NEPA issues being resolved. Anticipate an Award 2 for construction in FY09.

Key Recent Accomplishments and Deliverables

Demonstration-Scale Biorefineries: FY08 Award One, Under Negotiation

Performers	Feedstock Type	Conversion Technology	Fuel Type
Alltech-Envirofine Washington County, KY	Corn Cobs, Corn Fiber	Biochemical-Solid State Fermentation	Ethanol
Lignol Innovations Grand Junction, CO	Woody Biomass	Biochemical-Organisolve	Ethanol
Mascoma Upper Peninsula, MI	Woody Biomass	Biochemical	Ethanol
NewPage Wisconsin Rapids, WI	Woody Biomass - Mill Residue	Thermochemical-Fischer-Tropsch	Fischer-Tropsch liquids
Pacific Ethanol Boardman, OR	Wheat Straw, Stover, Poplar Residuals	Biochemical-Biogasol	Ethanol
RSA Old Town, ME	Woody Biomass - Mill residues	Biochemical-Pentose Extraction	To be determined
Verenium Biofuels Corp. Jennings, LA	Energy Cane and Bagasse	Biochemical Process	Ethanol
Flambeau River Biofuels LLC Park Falls, WI	Forest residues and wood waste	Thermochem to Fischer-Tropsch	Fischer-Tropsch liquids

Key Recent Accomplishments and Deliverables
Solicitations

Recent Solicitations

Advanced Biofuels

- Integrated Pilot-Scale or Demonstration-Scale Biorefinery for Advanced Biofuels
  - Up to $480M over 5 years for up to 20 projects
  - Pilot-Scale requires ≥20% cost share
  - Demo-scale requires ≥50% cost share

Funded by Recovery Act

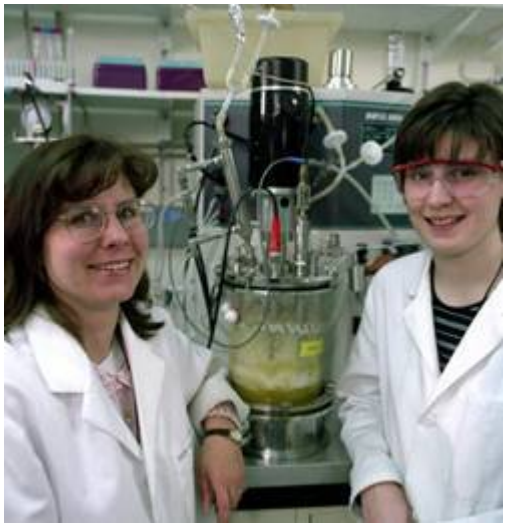
Feedstock Logistics

- Integrated Feedstock Logistics Demonstration
  - Up to $15M over 3 years for up to 3 projects
  - Requires ≥20% cost share
  - Projects to be awarded end of fiscal year

Key Recent Accomplishments and Deliverables

Solicitations

- **Annual USDA/DOE Joint Solicitation for Biomass Research and Development Initiative**
  - Up to $25M for awards of $1M-5M for up to 4 years
  - Technical areas for grants:
    - Feedstocks development
    - Biofuels and biobased products development
    - Biofuels development analysis
  - Project selection announcements will be made on or around July 23, 2009



Recovery Act Funding and Initiatives

Biomass R&D and Demonstration Projects - $800 Million in Funding

$480M **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:

- Up to $25M for each pilot-scale project
- Up to $50M for each demonstration-scale project

$176.5M **Commercial-Scale Biorefineries**

Increase in funding for prior awards; two or more projects

Expedite construction; accelerate commissioning and start-up

$110M **Fundamental Research**

$20M: Integrated Process Development Unit

$5M: Sustainability research with the Office of Science

$35M: Advanced Biofuels Technology Consortium

$50M: Algal Biofuels Consortium to accelerate demonstration

$20M **Ethanol Infrastructure Research**

Optimize flex-fuel vehicles operating on E85

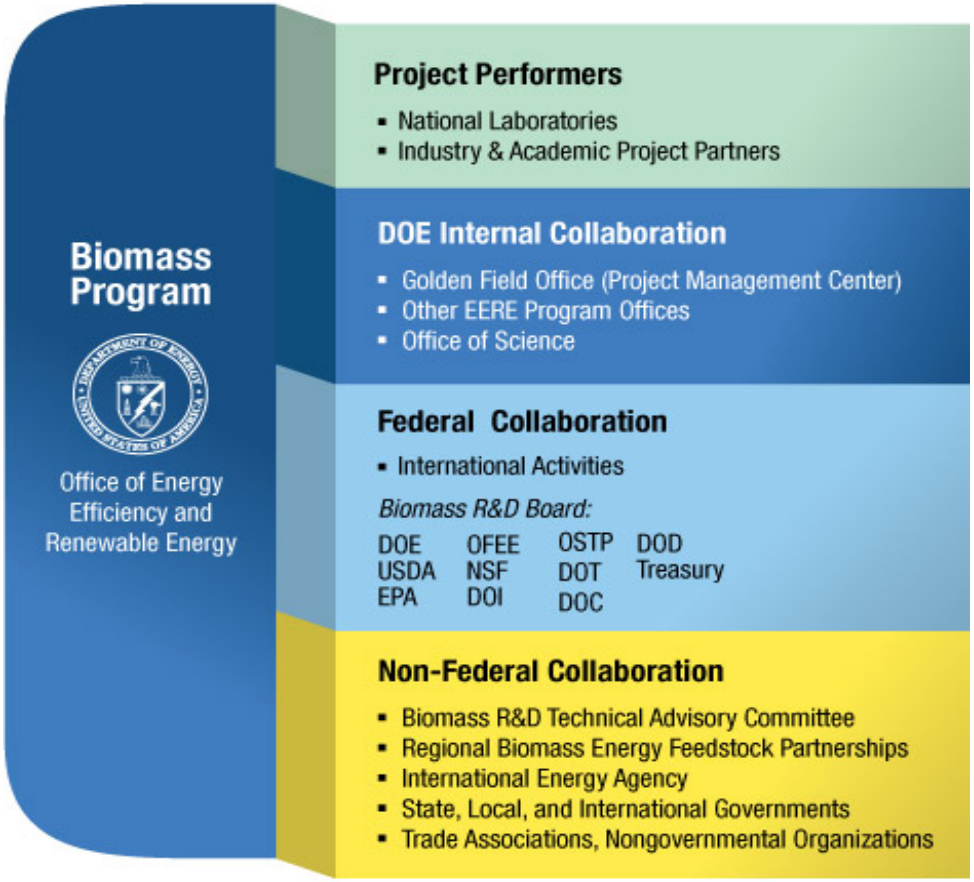
Evaluate impacts of intermediate blends on conventional vehicles

Upgrade existing infrastructure for compatibility with E85

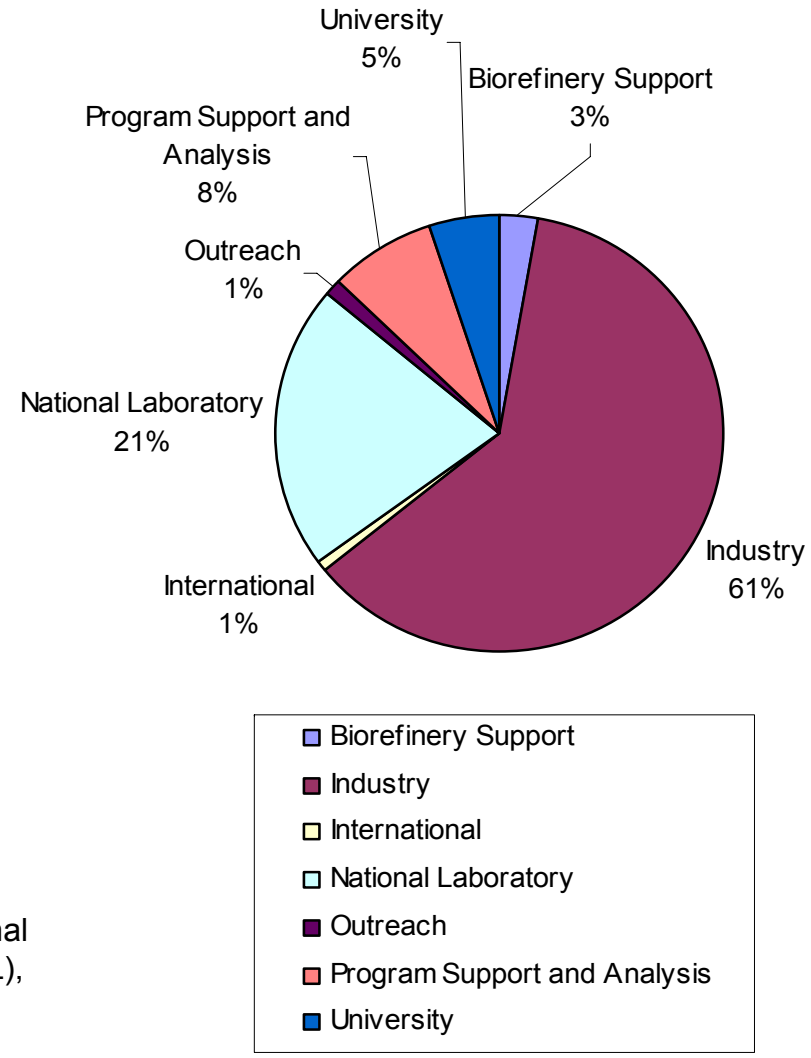
$13.5M NREL Integrated Biorefinery Research Facility: expand the pretreatment capacity

Key Stakeholder Relationships
Program Partners

Biomass Program Partners Organization Chart



Biomass Program Partner Funding



The national laboratories that the Program partners with are the National Renewable Energy Laboratory (NREL), Idaho National Laboratory (INL), Oak Ridge National Laboratory (ORNL), Argonne National Laboratory (ANL), and Pacific northwest national laboratory (PNNL).

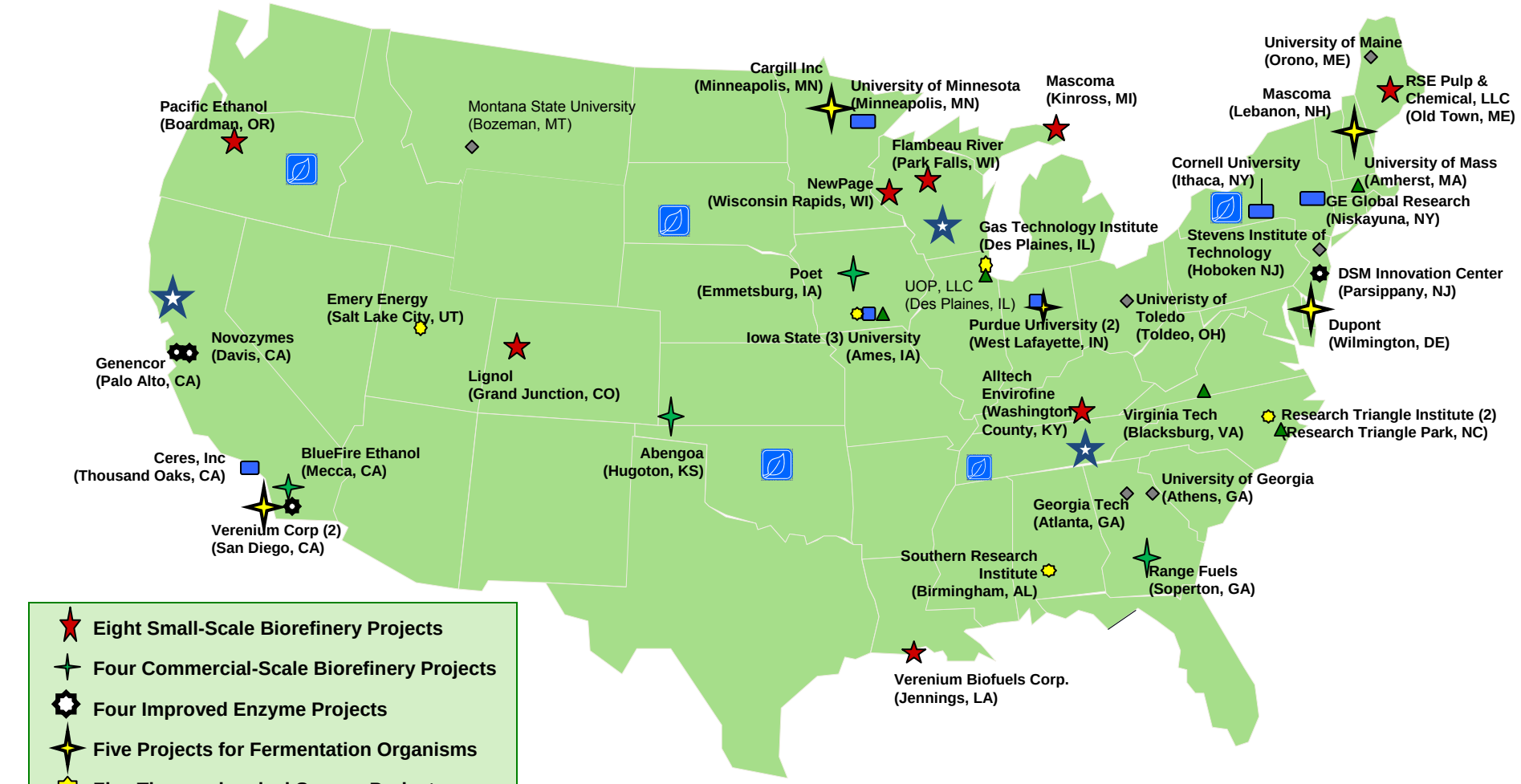
Key Stakeholder Relationships
DOE Bioenergy Research Centers (BRCs)

DOE Bioenergy Research Centers

- Joint BioEnergy Institute (LBNL)
- Bioenergy Science Center (ORNL)
- Great Lakes BioEnergy Research Center (Univ. of WI)

Targeting breakthroughs in biofuel technology to make abundant, affordable, low-carbon biofuels a reality

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

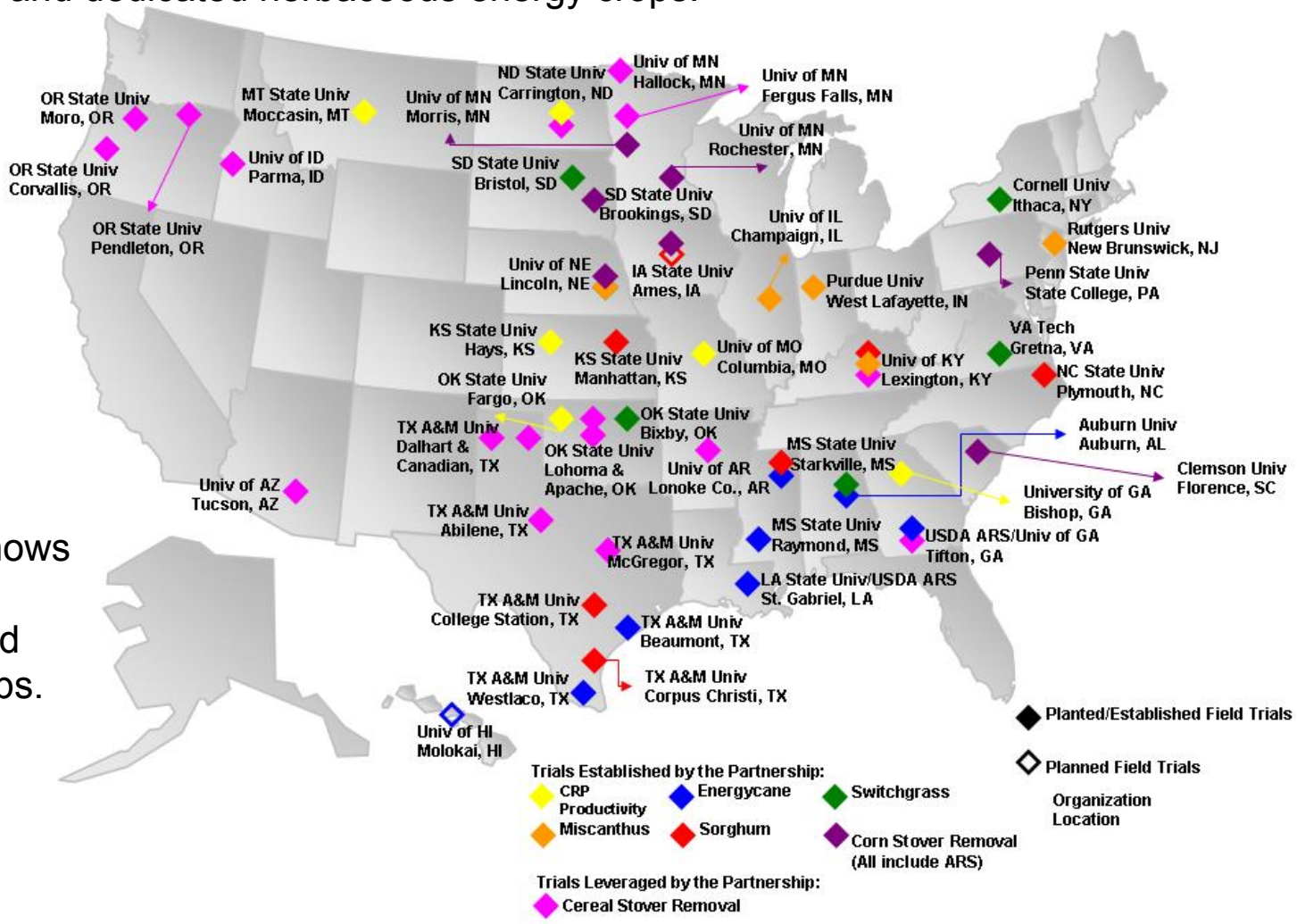
Modified 10/1/2008

Key Stakeholder Relationships

Regional Biomass Energy Feedstock Partnership Bioenergy Crop Trials

In 2008, the Biomass Program, Sun Grant Initiative universities, and USDA selected, and in some cases established the first round of replicated field trials of corn stover removal and dedicated herbaceous energy crops.

This map shows the selected locations and types of crops.



Key Stakeholder Relationships
Biomass R&D Board

Charter and Leadership

- The Biomass R&D Board is legislated by Section 9008 of the 2008 Food, Conservation, and Energy Act (FCEA) to:
  - Coordinate R&D activities relating to biofuels and biobased products
    - Between the Departments of Agriculture and Energy
    - With other departments and agencies of the Federal Government
  - Provide oversight to Biomass Research and Development Initiative
- The Board is co-chaired by Presidential-appointed, Senate-confirmed officers from USDA and DOE, selected by the Secretaries of Agriculture and Energy, respectively.

Membership

Members from 11 executive branch agencies

Co-chair ***Co-chair***

OFFICE OF THE FEDERAL ENVIRONMENTAL EXECUTIVE

Key Stakeholder Relationships

Biofuels Interagency Working Group

On May 5, 2009, President Obama signed the directive establishing a new working group to be chaired by the Secretaries of Energy and Agriculture and the Administrator of the EPA.

The group will work with the National Science and Technology Council's Biomass R&D Board on:

- Creating a *biofuel market development program* to boost next-generation biofuels, increase use of flex-fuel vehicles, and assist retail market development
- Coordinating infrastructure policies
- Identifying policies to promote sustainable production of biomass feedstocks
- Restructuring investments in renewable fuels to preserve employment, accelerate biofuel production, and reduce dependence on fossil fuels

"If we are to be a leader in the 21st century global economy, then we must lead the world in clean energy technology." -- President Barack Obama

Key Stakeholder Relationships
Working with Partners Globally

International Energy Administration ($170K in FY09)

- The IEA Bioenergy organization was established in 1978 as an effort to foster communication and coordination among countries engaged in bioenergy activities for better results in research, development, and deployment.
- DOE's interest in IEA Bioenergy tasks is focused in the following areas:
  - Gasification
  - Liquid Fuels – with a focus on the entire range of possibilities rather than a single fuel
  - Greenhouse Gases
  - Life Cycle Analysis
  - Pyrolysis – with emphasis on product utilization rather than production or characterization
  - Bioproducts – as they support biorefineries
- IEA Bioenergy tasks ($140K in FY09) that the Biomass program participates in are:
  - Short Rotation Crops for Bioenergy Systems
  - Biomass Production for Energy from Sustainable Forestry
  - Thermal Gasification for Biomass
  - Pyrolysis of Biomass
  - Greenhouse Gas Balances of Biomass and Bioenergy Systems
  - Commercializing 1st and 2nd Generation Liquid Biofuels from Biomass
  - Sustainable International Bioenergy Trade – Securing Supply and Demand
  - Bioenergy Systems Analysis

Key Stakeholder Relationships
Working with Partners Globally (continued)

Biodiversity ($1.1 million in FY09)

- Working with **Conservation International** ($1.1 million in FY09) to:
  - Identify land that should not be developed into biofuel crops
  - Conduct pilot studies to identify best places for biofuel crops
  - Implement standards for biofuel crop production

Standards Development

- Participating in **Council for Sustainable Biomass Production** ($50K in FY09) to develop principles and standards for bioenergy feedstocks
- Providing data and analysis to inform a variety of international and domestic discussions on sustainability standards
  - Roundtable on Sustainable Biofuels
    - Participation from NREL and DOE headquarters
  - Global Bioenergy Partnership (GBEP)
    - Effort led by State Department to develop methodology for GHG emissions estimates and global sustainability criteria
    - Information on activities at (http://www.globalbioenergy.org/)

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)