



Biomass and Biofuels Program

ASERTTI Clean Energy Outlook Meeting
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Presentation Overview

- **New Legislative Goals**
- **Program Strategy**
- **Key Activities**
- **Partnership Opportunities**



EISA 2007: New Targets & More



New Renewable Fuel Standard

- Expand use of renewable fuels to 36 billion gallons annually by 2022
- Cellulosic biofuels component
 - 3 billion gallons by **2015**
 - 16 billion gallons by **2022**

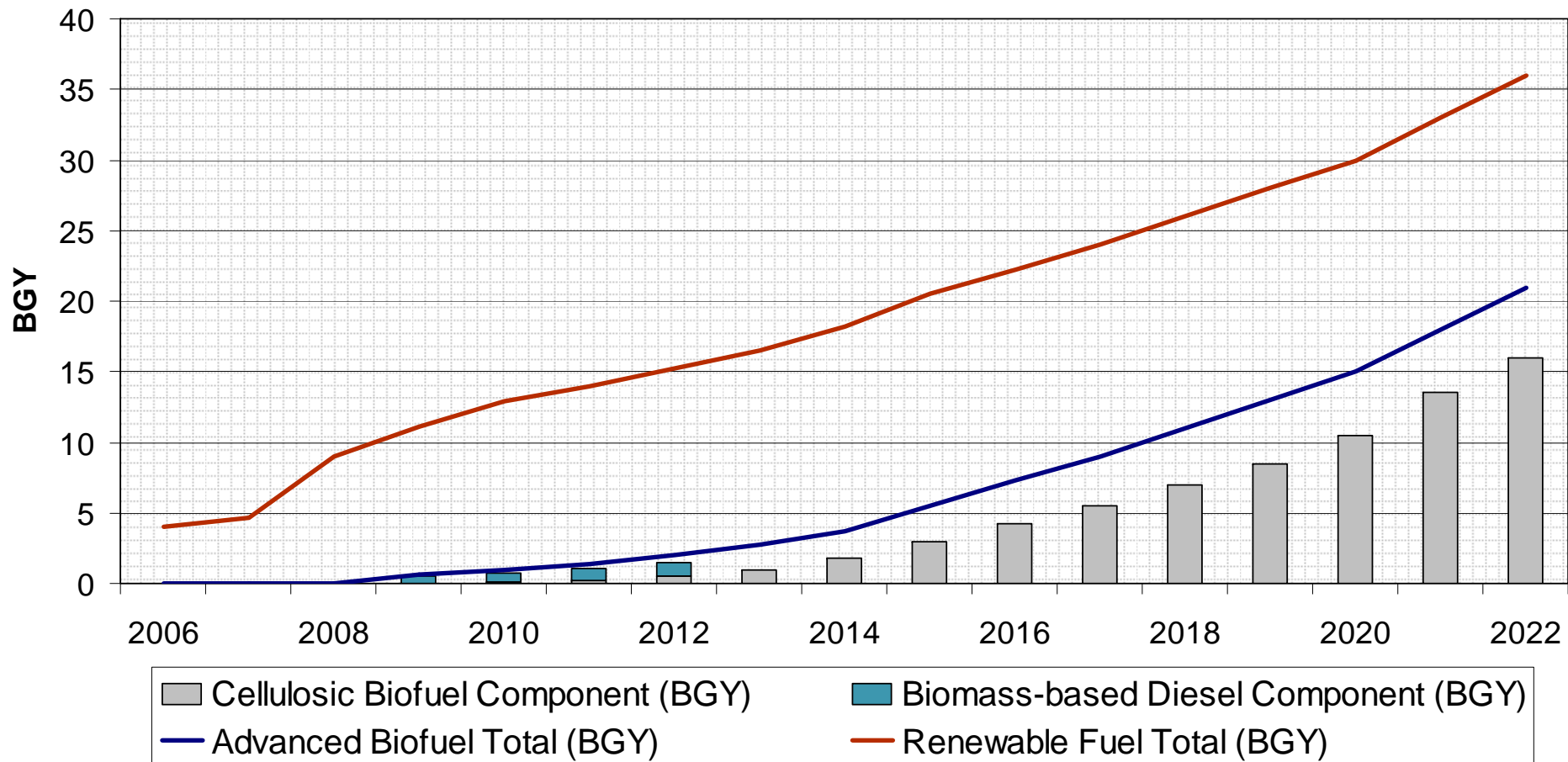
Additional Areas of Interest and Responsibility

- Infrastructure Development Grants
- Numerous studies, R&D on infrastructure and other topics



Ramp-up of ethanol production will require innovative and focused policies for infrastructure and feedstocks

RFS Minimum Blending Volume Schedule*



* EISA; Title II; Subtitle A; Section 202



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



Budget Overview



(Thousands of Dollars)

Activity	FY 2007 Actual	FY 2008 Actual	FY2009 CRB
Feedstock Infrastructure	9,725	12,386	15,500
Platforms R&D	49,306	67,282	53,400
Utilization of Platform Outputs	137,246	113,557	156,100
Others	0	4,955	0
TOTAL	196,277	198,180	225,000

Ambitious Biofuels Timeline



2008

2012 Cost-competitive cellulosic ethanol

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

2022 U.S. transportation fuels contain at least **16 billion gallons** cellulosic biofuels*

2030 Displace **30%** of U.S. gasoline consumption**

- Ramp up the production of biofuels to **60 billion** gallons

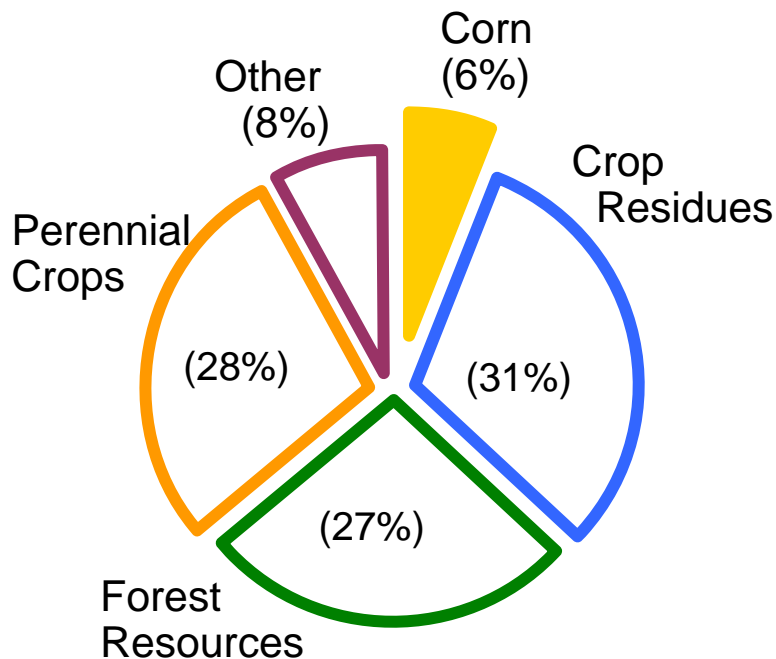
**Renewable Fuel Standards, Energy Independence and Security Act of 2007 – biofuels constitute 36 billion gallons of U.S. motor fuels by 2022.*

**light-duty vehicles only

Biomass Resources



Projected U.S. Biofuel Sources



Today: Nearly all ethanol is made from corn grain

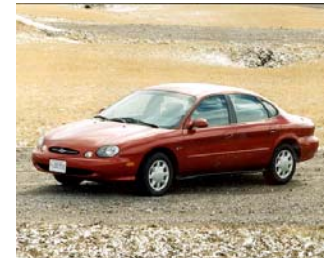
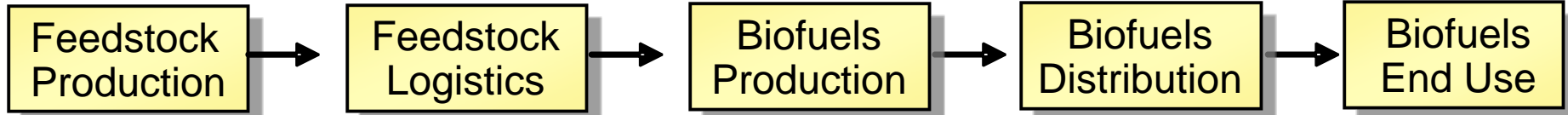
The Future: Cellulosic biomass will be the primary source for fuel ethanol

Sources of Cellulosic Biomass:

- Agricultural residues
- Forestry residues
- Terrestrial & aquatic crops and trees grown for energy purposes
- Selected municipal, agricultural, and industrial wastes

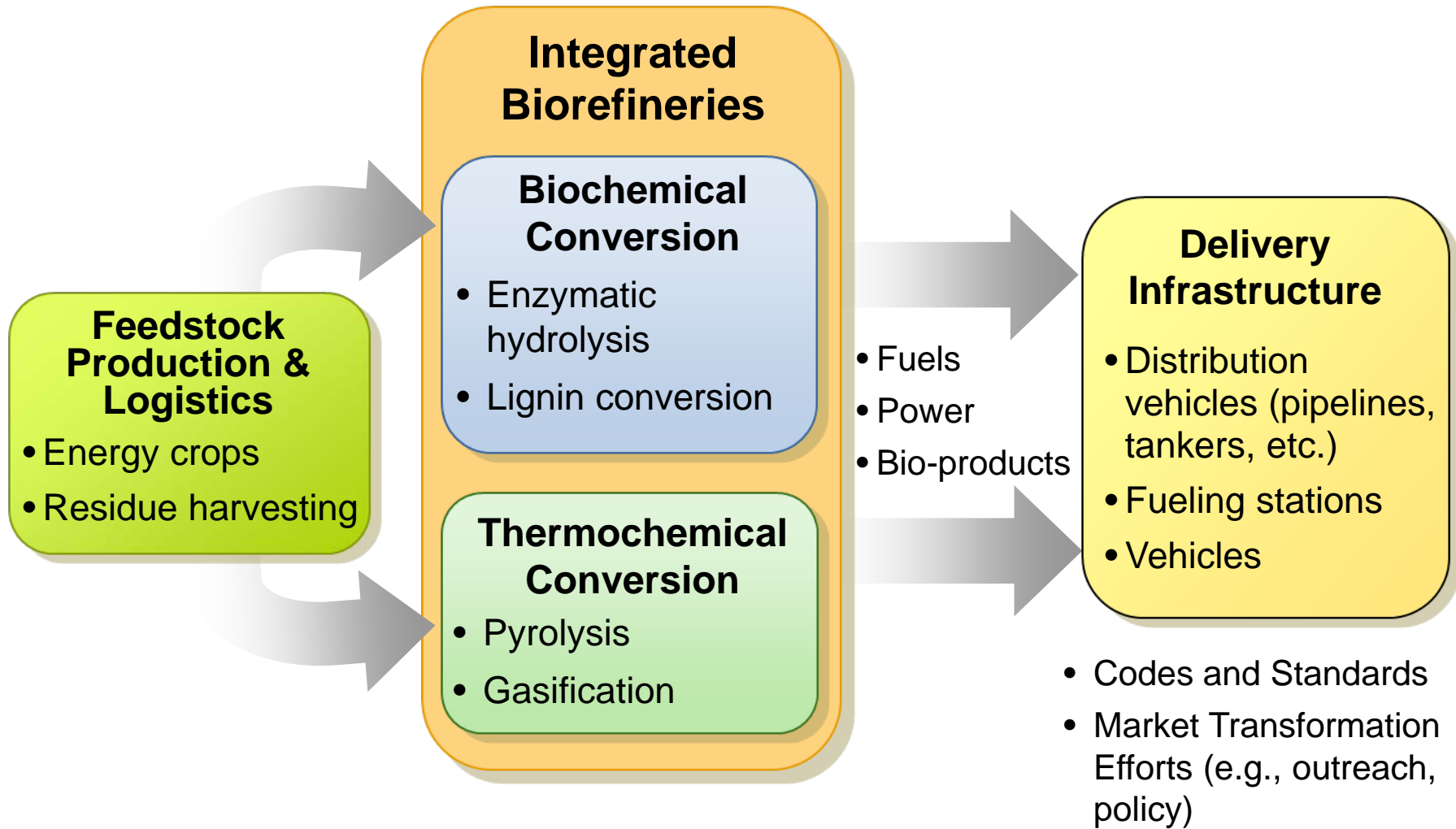
Program targets cellulosic biomass resources

Strategic Focus: Biofuels



- **Cellulosic Ethanol:** Primary focus of the program.
- **Alternative Light-Duty and Diesel Replacement Fuels:** A scoping study is underway to help prioritize future work on additional alternate fuels that require governmental support and can significantly contribute to achieving the President's goal.

Two Major Paths to Success



Success relies on simultaneous development of the supply, conversion, and demand infrastructures for cellulosic ethanol.

Overcoming Barriers to Commercial Use



Barriers

- High cost of enzymatic conversion
- High cost of organisms for producing ethanol from complex sugars within cellulosic biomass
- Limitations of thermochemical conversion processes
- Demonstration/integration of technology in biorefineries
- Inadequate feedstock and distribution infrastructure



Solutions

- R&D to improve effectiveness and reduce costs of enzymatic conversion
- R&D on advanced micro-organisms for fermentation of sugars
- Re-establish thermochemical conversion as a second path to success
- Fund loan guarantees, commercial biorefinery demonstrations, and 10% scale validation projects
- Form interagency infrastructure and feedstock teams

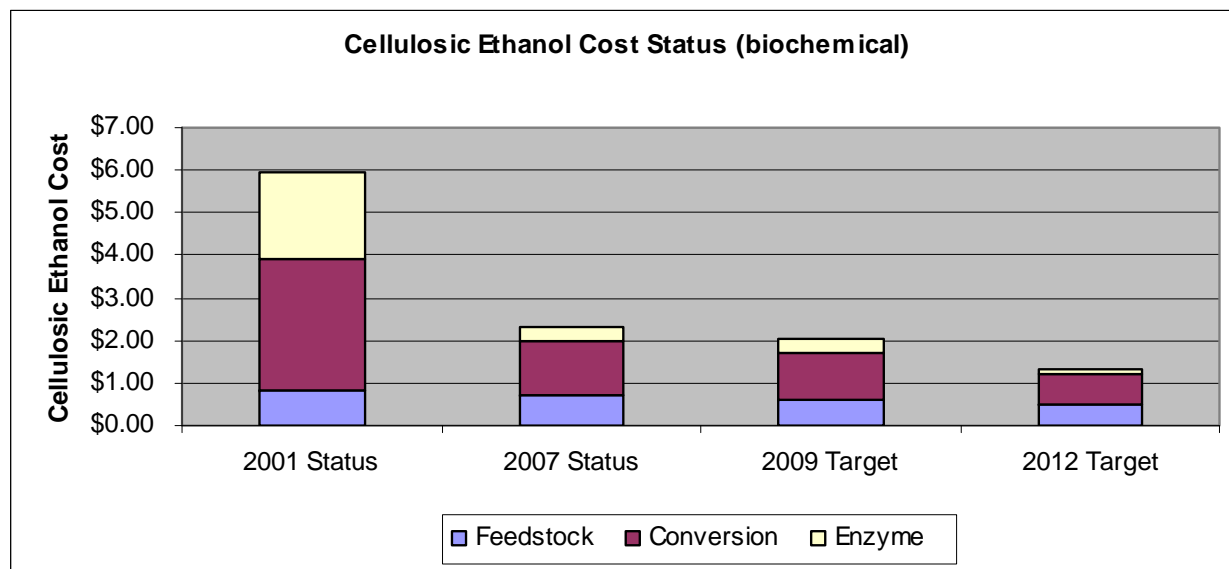
Future efforts address obstacles to biochemical and thermochemical routes to biofuels, support demonstrations, and resolve infrastructure issues.

Lowering Costs of Cellulosic Ethanol



DOE is working to ensure cellulosic ethanol cost competitiveness by 2012

Historical and Projected Cellulosic Ethanol Costs



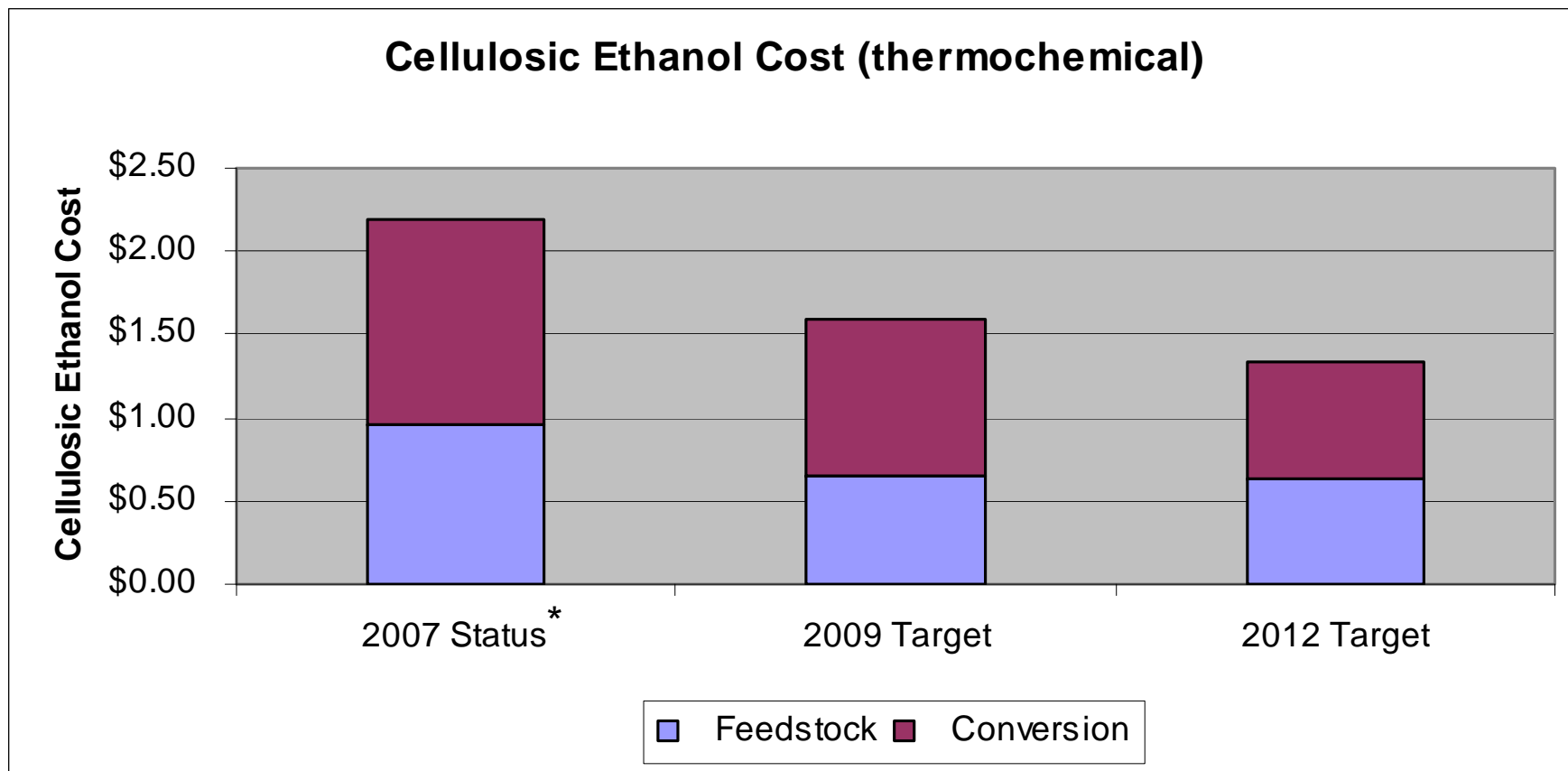
*** 2007 status is under review and may be adjusted**

- DOE has issued a number of competitive solicitations in order to engage diverse R&D partners in reaching this cost goal.
- In addition, through a reinvigorated Biomass Research and Development Board, DOE and USDA have initiated a senior level multi-agency effort to ensure sustainability of the biofuels industry as it develops.

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

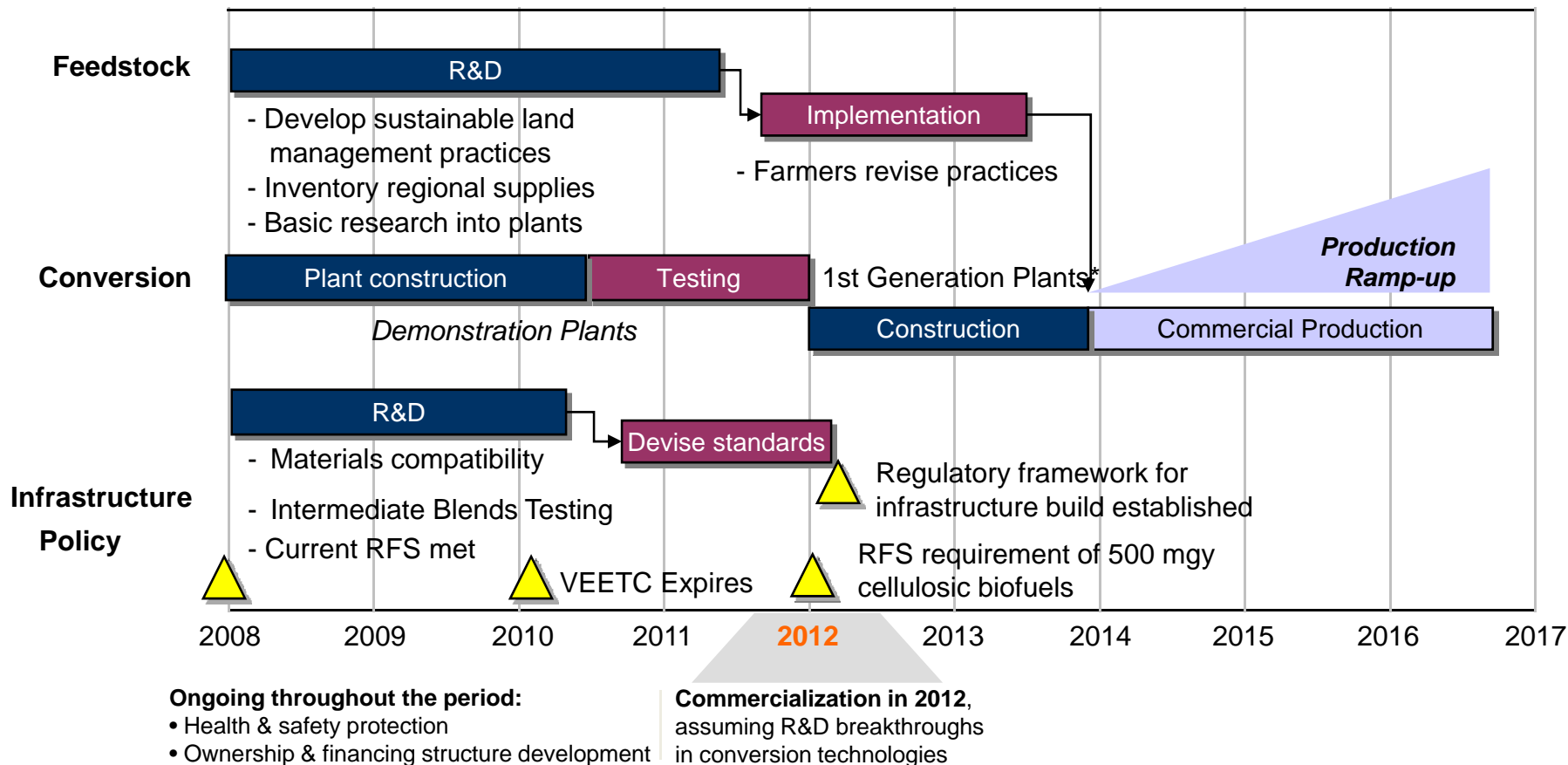


Thermochemical Platform



* 2007 status is under review and may be adjusted

Schedule of Activities Needed to Achieve Commercial Production



Competitive Solicitations Engage Diverse RD&D Partners



Commercial-Scale Biorefineries (up to \$385 million)

- Six cost-shared, integrated biorefinery demonstration projects to 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)

- Cost-shared, integrated biorefinery demonstrations using cellulosic feedstocks to produce fuels, chemicals, and substitutes for petroleum-based feedstocks and products; one-tenth projected scale for first-of-a-kind commercial facilities

Ethanologen Solicitation (up to \$23 million)

- Five selected research teams working on microorganisms

Enzyme Solicitation (up to \$33.8 million)

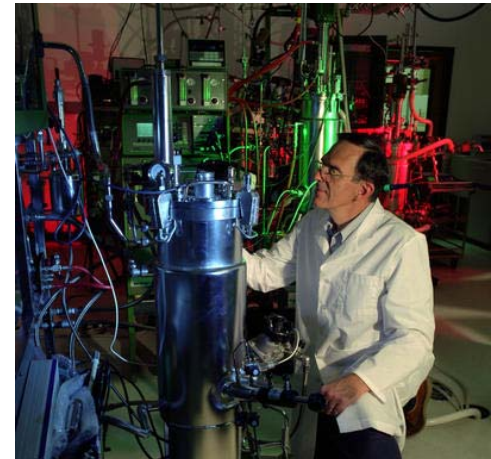
- Creating commercially available, highly effective, inexpensive enzyme systems for biomass hydrolysis; second phase: cellulase development with cost-sharing industry partners

Thermochemical Conversion (up to \$7.75 million)

- Integration of gasification and catalyst development

Joint DOE-USDA Solicitation (\$18 million)

- Biomass R&D Initiative



10% Scale Biorefinery Demonstrations



- Announced selections of four companies to receive up to \$114 million to develop small scale cellulosic biorefineries:
 - Stora Enso (NewPage), Lignol Innovations, ICM, Pacific Ethanol
- Additional selections expected to bring DOE's commitment to as much as \$200 million
- Biorefineries to be designed, built, and operated at a tenth of commercial scale
- These small-scale projects (1.5 - 2.5 million gallons of biofuels/year) will --
 - Demonstrate breakthrough technologies
 - Can quickly move to commercial scale
 - Operate on sound business strategies
 - Diversify our portfolio
 - Get the nation closer to widespread commercialization of cellulosic biofuels technologies and processes



Regional Feedstock Partnership



- Part of Sun Grant Initiative (Section 9011 of Farm Bill)
- Partnership between USDA, DOE, DOT, and land grant universities
- Corn stover removal tool
 - Identifies amount of corn stover that needs to be left in the field to ensure sustainability (yield-focused)
 - Prototype has been developed by ARS
 - Plan to begin validation next year through field trials
 - Partnership with USDA/ARS and industry partners
- Energy crop field trials
 - Address environmental impacts of growing energy crops on a dedicated basis
 - Soil carbon
 - Water quality and quantity
 - Air quality including GHG



- A spatially-referenced decision support system currently under development
- The Atlas will map—
 - Current and potential feedstocks with environmental and infrastructure constraints
- This tool will support a variety of needs
 - Assessing relevant resources and infrastructure regionally and nationally
 - Locating new feedstock production as well as processing facilities (e.g., biorefinery siting)
 - Evaluating the potential contribution of biofuels to the “20 in 10” goal, and beyond
 - Protecting air quality, water resources, and other land use requirements

DOE Loan Guarantee Program



- EPAAct 2005 gave DOE authority to issue loan guarantees for clean energy projects
 - \$4 billion in loan guarantee authority in FY07; \$10 billion in authority in FY08
- DOE Announces Final Rule for Loan Guarantee Program - October 4, 2007
 - Invited 16 Pre-Applicants to Submit Applications for Federal Support of Innovative Clean Energy Projects
 - Six biomass projects included among the 16.
- Commitment Letters for first round of projects expected early summer 2008.
- New Loan Guarantee solicitation expected April 2008.

Infrastructure Efforts



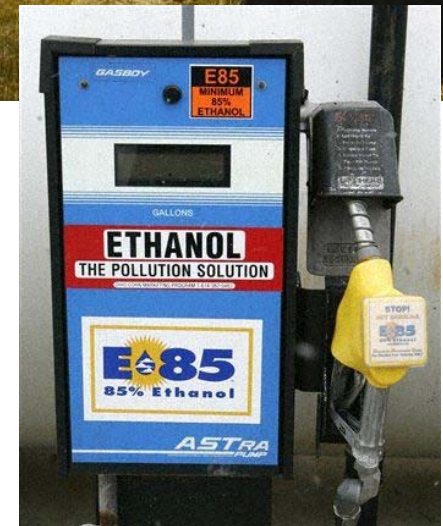
From Farm to Plant

- Feedstock Logistics
 - Improve harvesting machinery (Idaho National Laboratory)
- Integrated Biorefineries
 - Demonstration-scale cellulosic ethanol biorefineries drive efforts to optimize biomass supply practices



From Plant to Pump (New)

- Ethanol Blends Testing
- Infrastructure Analysis
- Codes and Standards
- Vehicle Optimization Studies
- Partnership with Governors' Ethanol Coalition



Intermediate Blends Testing



- **Scope:** Testing Vehicles and Non-Road Small Engines
- **Types of tests:** Emissions, Durability, Drivability, Materials
- **DOE Vehicles Quick Look Testing**
 - Actual vehicle testing (9) has just commenced. This testing is being conducted through ORNL, NREL, ANL and subcontractors and will include testing of emissions effects of E0, E10, E15 and E20 blends.
- **Vehicle Emissions Testing**
 - Pending RFP for larger plan to test 75 vehicles (vehicles and tests identified). This work will take >12 months and will be shaped by results of the quick-look tests.
- **EPA Testing at Southwest Research Institute (SWRI)**
 - EPA is testing vehicles at SWRI, focused on toxic emissions such as acidic aldehydes. With DOE support, E15 & E20 have been added to the fuels being tested.
- **Small Non-Road Engines**
 - “Quick-Look” testing of 6 engines (generators, leaf blowers and line trimmers) focused on emissions and was completed in October 2007. Testing of a larger set of small non-road engines is continuing, includes “full useful life” testing, and is expected to be completed in Spring 2008.
- **Other Intermediate Blends Testing:**
 - DOT is supporting testing of 24 vehicles at the Rochester Institute of Technology for E20 Operations and Emissions. Baseline emission testing on gasoline (E0) is completed. DOE providing technical guidance.
 - A number of other entities conducting tests (e.g., RFA/Minnesota)

Partnering with the States



- Feedstock
 - Working on field trials with state land grant universities, SDSU, Texas A&M, Oklahoma State, Cornell, University of Tennessee, Oregon State
- Conversion Technologies
 - State incentives to complement DOE efforts, e.g. New York, Tennessee, Oklahoma
 - State universities tied to BioEnergy research centers.
- Ethanol blending
 - Remove barriers to full nationwide E10 penetration
 - Cooperate on engaging industry and testing higher blends
- Infrastructure Planning
 - Participation in GEC infrastructure workshops (“City-to-Region”)
- Codes and Standards
 - Increased engagement needed between Federal Government and States, e.g. Health & Safety, Handling, Fuel Quality Specs.

DOE and the States are committed to increased Information Sharing



Information Resources



- DOE Biomass and Biofuels Program - www.eere.energy.gov/biomass/
- DOE Office of Science, Bioenergy Research Centers - <http://genomicsgtl.energy.gov/centers/>
- Alternative Fuels Data Center - <http://www.eere.energy.gov/afdc/fuels/ethanol.html>
- Bioenergy Feedstock Information Network - <http://bioenergy.ornl.gov/>
- Biomass R&D Initiative – www.biomass.govtools.us
- USDA Farm Bill proposals – www.usda.gov
- Grant Solicitations - www.grants.gov

Contact Information



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- EERE INFO CENTER - <http://www1.eere.energy.gov/informationcenter/>

Additional Slides



First-generation Biofuel Technologies Have High Costs & Limited Scalability...



2nd Generation Biofuels

- **R&D focus:**
 - Increase range of biofuel feedstocks
 - Reduce conversion costs
- **Main technology platforms:**
 - *Biochemical pathway* – Breakdown of cellulose into sugars followed by fermentation to alcohol fuels
 - *Thermochemical pathway* – Gasification of biomass to syngas and conversion to mixed alcohols and ethanol
- **Commercial renewable diesel plants under construction**

1st Generation Biofuels

- **Ethanol** – Clean-burning, high-octane alcohol fuel used as a replacement and extender for gasoline
 - Commercially produced since the 70s in US and Brazil, still the market leaders
- **Biodiesel** – high-cetane, sulfur-free alternative to (or extender of) diesel fuel and heating oil
 - Commercialized in Europe in the 90s
 - Worse economics (and smaller market) than ethanol

DOE focuses on second-generation technologies to resolve these limitations

Cellulosic Biorefinery Investments

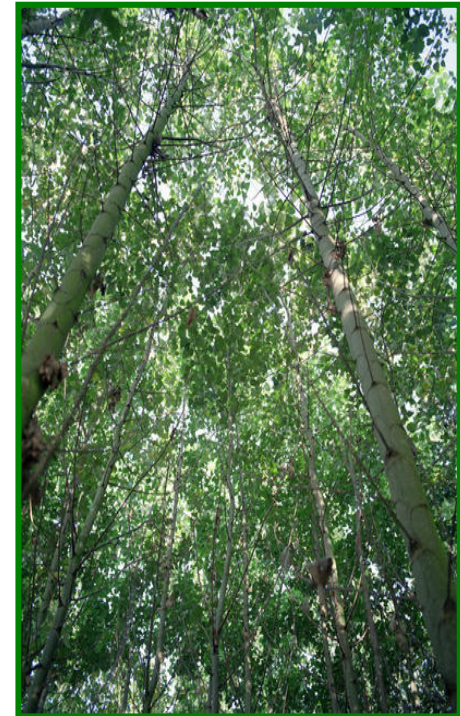


Abengoa Bioenergy (up to \$76 million)

- Process: Biochemical and thermochemical routes
- Capacity: 11.4 million gallons of ethanol annually using ~700 tons per day of corn stover, wheat straw, milo stubble, switchgrass, and other feedstocks
- Additional Products: Enough energy to power the facility, with any excess going to power the adjacent corn dry grind mill.
- Investors/participants include: Abengoa; Antares Corp.; and Taylor Engineering.

ALICO, Inc. (up to \$33 million)

- Process: Gasification and fermentation
- Capacity: 13.9 million gallons of ethanol annually using ~770 tons per day of yard, wood, and vegetative wastes (and eventually energy cane)
- Additional Products: 6,255 kilowatts of electric power, as well as 8.8 tons of hydrogen and 50 tons of ammonia per day.
- Investors/participants include: Bioengineering Resources, Inc.; Washington Group International; GeoSyntec Consultants; BG Katz Companies/JAKS, LLC; and Emmaus Foundation, Inc.



Cellulosic Biorefinery Investments (continued)



BlueFire Ethanol, Inc. (up to \$40 million)

- Process: Mixed conversion using concentrated acid hydrolysis/fermentation
- Capacity: 19 million gallons of ethanol annually using ~700 tons per day of sorted green waste and wood waste from landfills (located at landfill)
- Investors/participants include: Waste Management, Inc.; JGC Corporation; MECS Inc.; NAES; and Petro-Diamond.



POET (up to \$80 million)

- Process: Advanced corn fractionation and lignocellulosic conversion technologies
- Capacity: 125 million gallons of ethanol annually (~25% will be cellulosic ethanol). Cellulosic feedstocks ~ 842 tons per day of corn fiber, cobs, and stalks.
- Participants include: E. I. du Pont de Nemours and Company; Novozymes North America, Inc.; and the National Renewable Energy Laboratory.



Cellulosic Biorefinery Investments (continued)

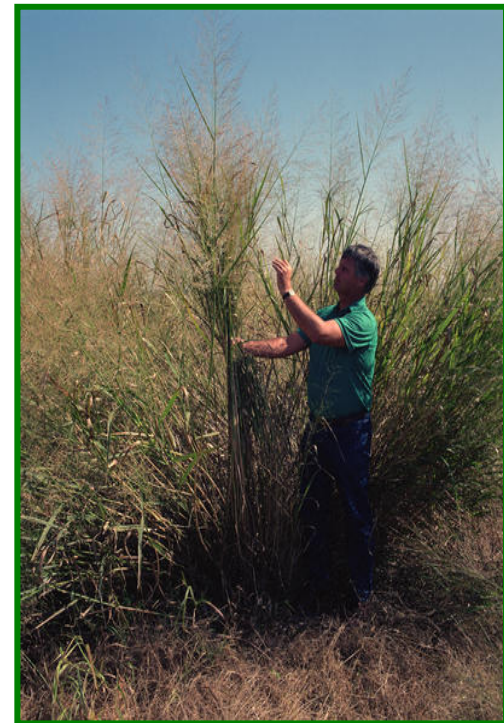


logen Biorefinery Partners, LLC (up to \$80 million)

- Process: Enzymatic hydrolysis
- Capacity: 18 million gallons of ethanol annually using ~700 tons per day of agricultural residues including wheat straw, barley straw, corn stover, switchgrass, and rice straw
- Investors/partners include: logen; Goldman Sachs; and The Royal Dutch/Shell Group.

Range Fuels (up to \$76 million)

- Process: Thermochemical with catalytic upgrade to methanol and ethanol
- Capacity: 40 million gallons of ethanol annually and 9 million gallons per year of methanol, using ~1,200 tons per day of wood residues and wood based energy crops
- Investors/participants include: Merrick and Company; PRAJ Industries Ltd.; Western Research Institute; Georgia Forestry Commission; Yeomans Wood and Timber; Truetlen County Development Authority; BioConversion Technology; Khosla Ventures; CH2MHill; Gillis Ag and Timber



Key EISA articles impacting Biomass (1)



Section of EISA 2007	Agencies	Timeframe	Brief Activity Description
203 – Feedstock Impact Study of RFS	DOE, EPA, USDA, National Academy of Sciences	18 months	Impacts of RFS on each industry relating to production of feed grains, livestock, food, forest products, and energy
204 – Environmental and Resource Conservation Impacts	EPA, DOE, USDA	3 years	Current and future impacts of RFS affecting environment and resource conservation issues in the US and abroad
221 – Report on barriers to increasing volume of biodiesel sold in US	DOE, EPA, NIST	180 days	R&D challenges of increased US biodiesel use
222 – Report on Barriers to Using Biogas as a Transportation Fuel	DOE, EPA	180 days	Report on R&D challenges to increasing volumes of biogas and biogas blends sold in the US as transport fuels
225 – FFV E85 Optimization Study	DOE, DOT, EPA	180 days	Study to determine whether optimizing FFVs for E85 would increase fuel efficiency
226 – Study of Engine Durability and Performance with Biodiesel Use	DOE, EPA	24 months (30 days to initiate)	Effects analysis of engine and engine system performance and durability when using pure biodiesel and multiple biodiesel blends
227– Study on Optimizing Natural Gas Vehicles for Biogas	DOE, EPA, DOT	180 days	Study on increased vehicle efficiency by optimizing natural gas vehicles to operate on biogas

* EISA; Title II; Energy Security Through Increased Production of Biofuels



Key EISA articles impacting Biomass (2)

Section of EISA 2007	Agencies	Timeframe	Brief Activity Description
229 – Biofuels and Biorefinery Information Center	DOE, USDA	Not specified	Develop a biofuels information repository housing data relating to all facets of renewable fuels
232 – Modifies Biomass Research and Development Act of 2000	DOE, USDA, EPA	Not specified	Directs R&D efforts to include lifecycle GHG emissions, environmental impacts of RFS, and on-farm biofuels production
242 – Reports on Market Penetration of FFVs and E85 Availability	DOE, DOT	FFV – annually; E85 – 24 months	Geographic analysis of FFV population and E85 availability
243 – Dedicated Ethanol Pipeline Feasibility Study	DOE, DOT	15 months	Assess market, technical, regulatory, financial, and other factors associated with ethanol pipelines
245 – Biofuels Transportation Infrastructure Adequacy Study	DOE, DOT	180 days	Study of adequacy of existing biofuels infrastructure to transport domestically produced renewable fuels by rail and other modes
248 – Biofuels Distribution and Advanced Biofuels Infrastructure	DOE, DOT, EPA	Not specified	RD&D program to test physical and chemical properties of biofuels as they relate to existing and new distribution infrastructure

* EISA; Title II; Energy Security Through Increased Production of Biofuels





Key EISA articles impacting Biomass (3)

Section of EISA 2007	Agency	Timeframe	Brief Activity Description
206 – RFS Renewable Energy Credits for Electric Vehicles 2000	EPA	18 Months	Feasibility study on issuing RFS credits for to electric vehicles powered by renewable electricity
207 – Grants for Advanced Fuels with 80% GHG Reduction	DOE	2008 - 2015	Advanced biofuel technology development
209 – RFS Vehicle Emissions Impacts on Air Quality	DOE, DOT	18 months	Includes analysis of multiple blend levels, renewable fuel types, and vehicle technologies requiring cross-industry participation
223 – Grants for Biofuels Production Technology R&D in Low Ethanol-producing States	DOE	2008-2010	Biofuels conversion technology advancement in low ethanol production areas of the US
224 – RD&D Program for Energy Efficiency Increase in Existing Corn Based Biorefineries	DOE	Not specified	Includes retrofit technologies for conversion of existing grain facilities to cellulosic biomass
230 – Grants for Universities to collaborate with Bioenergy Centers	DOE	Initiates in 2008	Cellulosic ethanol and biofuels research and development
231 – Adds Funding for Commercial Section 932 Projects in 2010	DOE	2010	Augments funding for existing initiative being implemented by DOE
233 – Increases the Number of Bioenergy Centers to Seven	DOE	5 year grants	Expands biofuels R&D efforts to every PADD and to seven total facilities

* EISA; Title II; Energy Security Through Increased Production of Biofuels



Key EISA articles impacting Biomass (4)



Section of EISA 2007	Agency	Timeframe	Brief Activity Description
234 – University Renewable Energy R&D Program	DOE	Not specified	Advanced technology R&D
241 – Prohibition of Franchise Agreement Restrictions Relating to Renewable Fuel Infrastructure	Private Sector	Not specified	Alleviates franchise restrictions to retail biofuels sales
244 – Renewable Fuel Infrastructure Development Grants	DOE	12 months – selection criteria; 24 months first pilot program; annual reporting	Covers infrastructure development, technical and marketing assistance, and promotes the construction of refueling infrastructure corridors
246 – Federal Fleet Fueling Infrastructure	All Federal Agencies	Jan 1, 2010	One renewable fuel pump must be installed at each Federal refueling center in the US
247 – Standard Specification for Biodiesel and Biodiesel Blend Inspection and Enforcement Program	EPA	1 yr. rulemaking; 18 months final rule; 180 days to develop inspection and enforcement program	IF ASTM does not develop B5 and B20 specifications in the next year, EPA shall initiate a rulemaking to develop standards; EPA will develop an inspection and enforcement program for biodiesel blends
251 – Waiver for Fuel or Fuel Additives	EPA	Immediate	Extends application final action timeframe to 270 days

* EISA; Title II; Energy Security Through Increased Production of Biofuels

EPACT 2005 provisions



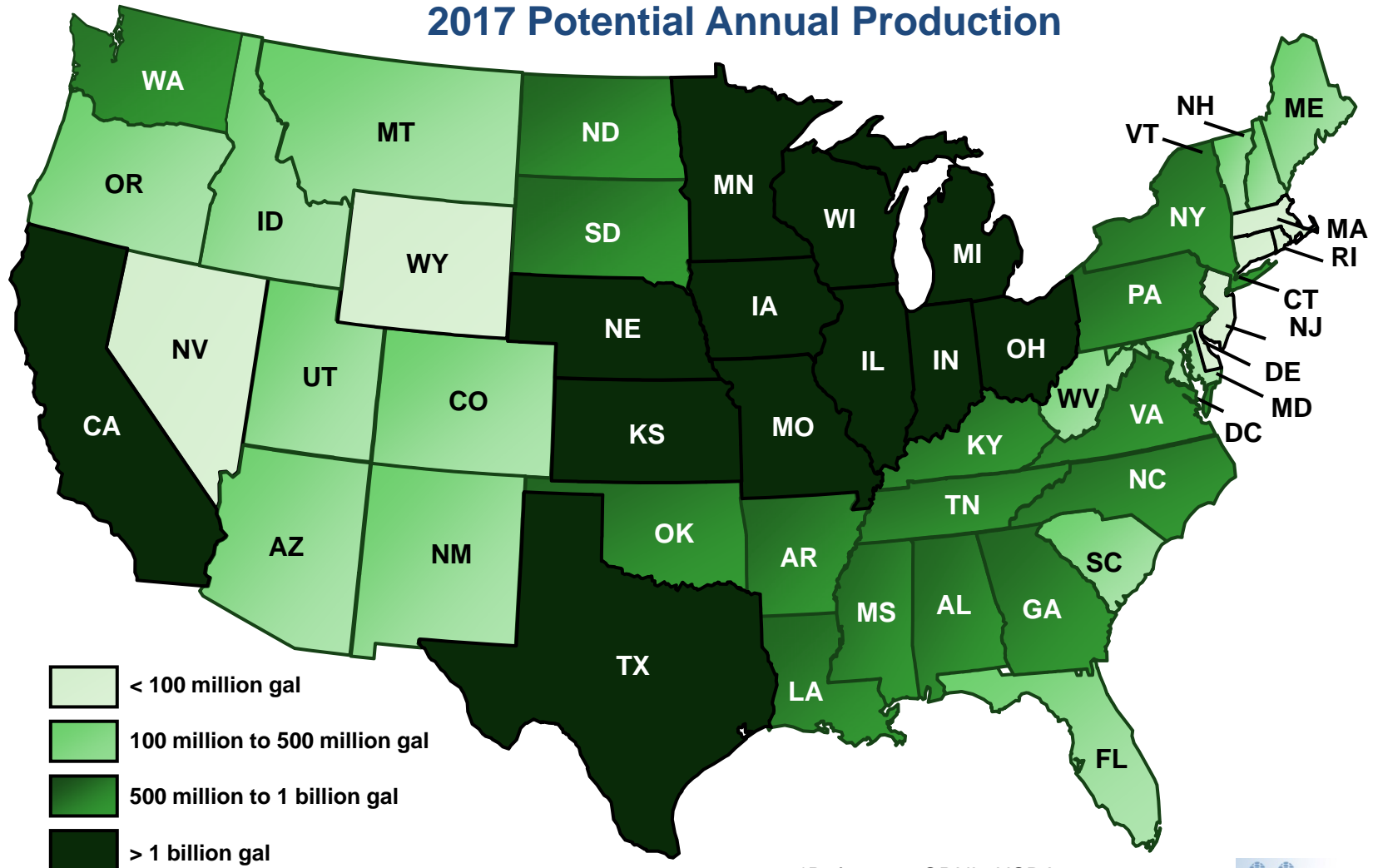
Energy Policy Act 2005 (EPAct 2005)

- Section 932: **Commercial Integrated Biorefineries**
 - Six awards made in February 2007; four agreements negotiated to date
 - Up to \$385 million in DOE funds over next 5 years
- Section 941: **Revisions to Biomass R&D Act of 2000**
 - Interagency workshop Fall 2006; National Biofuels Action Plan early 2008
- Section 942: **Cellulosic Ethanol Reverse Auction**
 - Request for Information completed
 - \$5 million available in FY08
 - May be superceded by EISA
- Sections 1510, 1511, and Title XVII: **Loan Guarantees**
 - In Aug. 2006, under Title XVII DOE issued guidelines for constructing facilities to process solid waste and cellulosic biomass into fuel ethanol; candidates for formal application under review
 - \$4 billion in loan guarantee authority in FY07; \$10 billion in authority in FY08

Domestic Biomass Sources, 2017



Starch (Corn/Wheat) and Cellulosic Ethanol 2017 Potential Annual Production



*Reference: ORNL; USDA