

DOE Efforts to Accelerate Deployment and Commercialization of Advanced Biofuels

AGENDA

- Overview of DOE Biomass Program Mission and Goals
- Description of Demonstration and Deployment Activities
- Federal Funding and Incentive Programs
- Biomass Program MSW to Biofuels Projects
- Upcoming Biomass Program Funding Opportunities



Advancing Presidential Objectives

Science & Discovery

- Connecting basic and applied science
- Conducting breakthrough R&D

Economic Prosperity

- Creating jobs and reinvigorating rural economies
- Supporting the emerging U.S. bioenergy industry

Climate Change

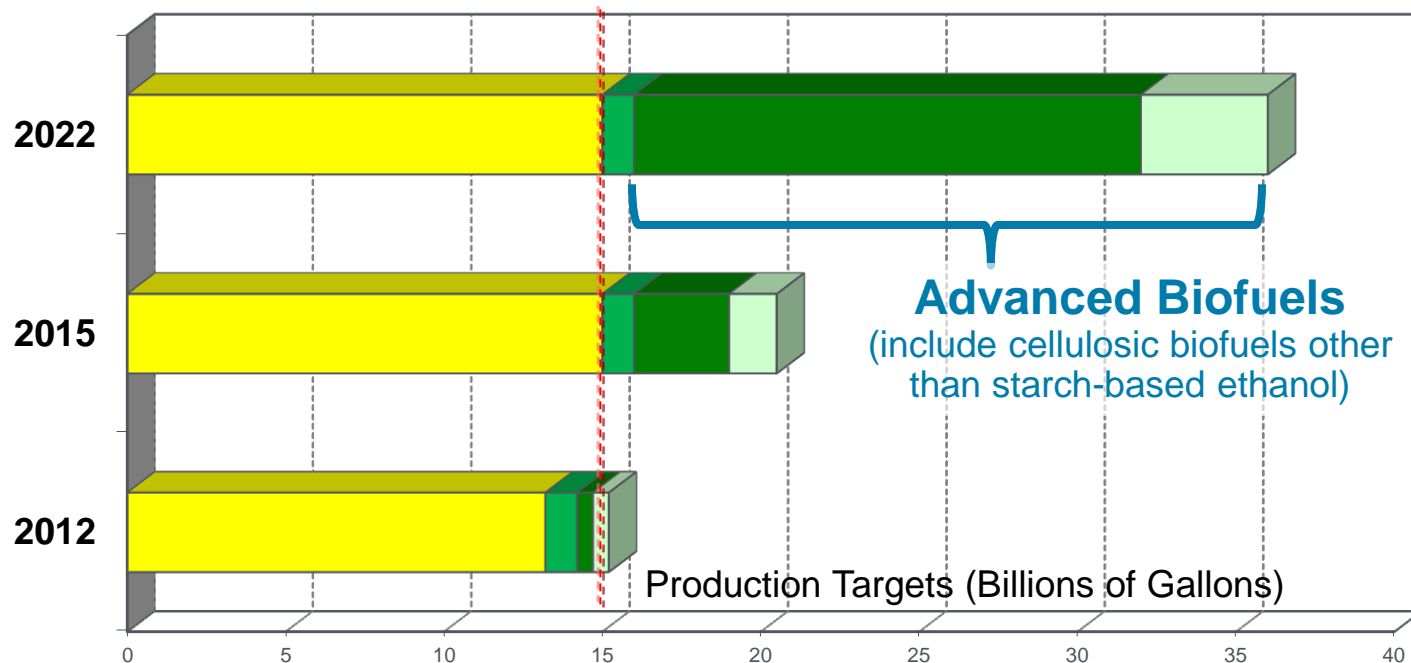
- GHG reductions: 50% (advanced) / 60% (cellulosic) biofuels
- Low-carbon power generation technologies
- Development of criteria for sustainable biofuel production

Clean, Secure Energy

- Developing & demonstrating advanced biofuels technologies



15 BGY Cap on Conventional (starch) Biofuels



Renewable Fuel Standard (RFS2)



Conventional (Starch) Biofuels



Biomass-based diesel



Cellulosic Biofuels

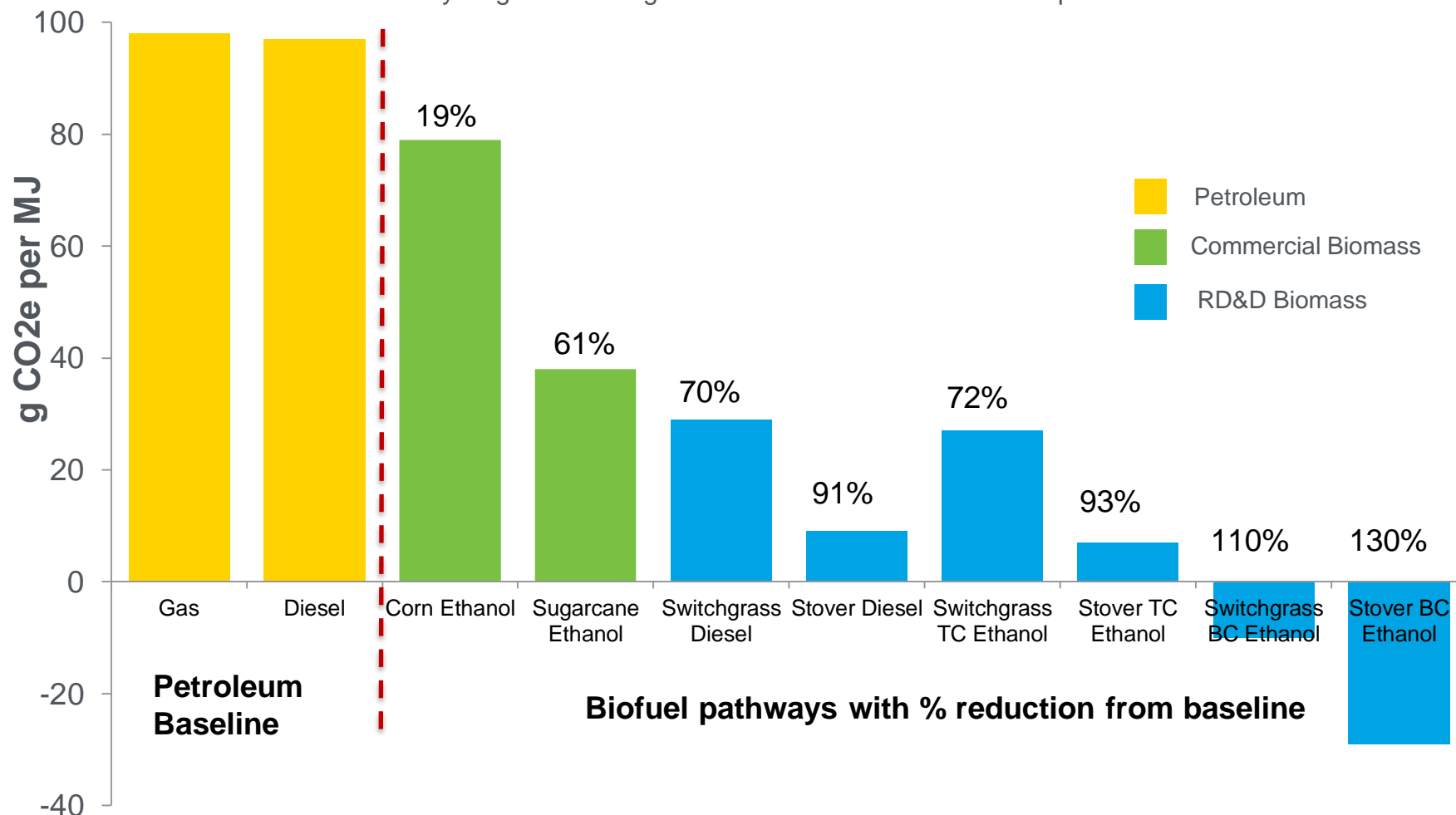


Other Advanced Biofuels

Climate Change: GHG Reduction/ Low Carbon Fuels

EPA RFS2 CO₂ e Intensity

Biofuel lifecycle greenhouse gas emission reductions relative to petroleum fuels



* TC = Thermochemical conversion | BC = Biochemical conversion

Source: EPA RFS2 Final Rule, March 26, 2010

Biomass Program Mission, Objectives, Goals

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

R&D Priorities

- Achieving biofuel cost targets (modeled)
 - <\$2/gal for cellulosic ethanol;
 - <\$3 for cellulosic drop-ins
- Developing bio-power and bio-products for important supporting roles
- Meeting the EISA Renewable Fuel Standard
- Investing to meet targets (~\$200M/yr)

Moving Markets

- Close collaboration with USDA, EPA, DOD
- Pilot and commercial demonstrations
- Infrastructure for delivery (including fuel dispensers)
- Subsidies and other policy drivers

Research, Development, and Demonstration

Feedstocks

Biochemical and
Thermochemical
Conversion

Biopower
Biofuels
Bioproducts

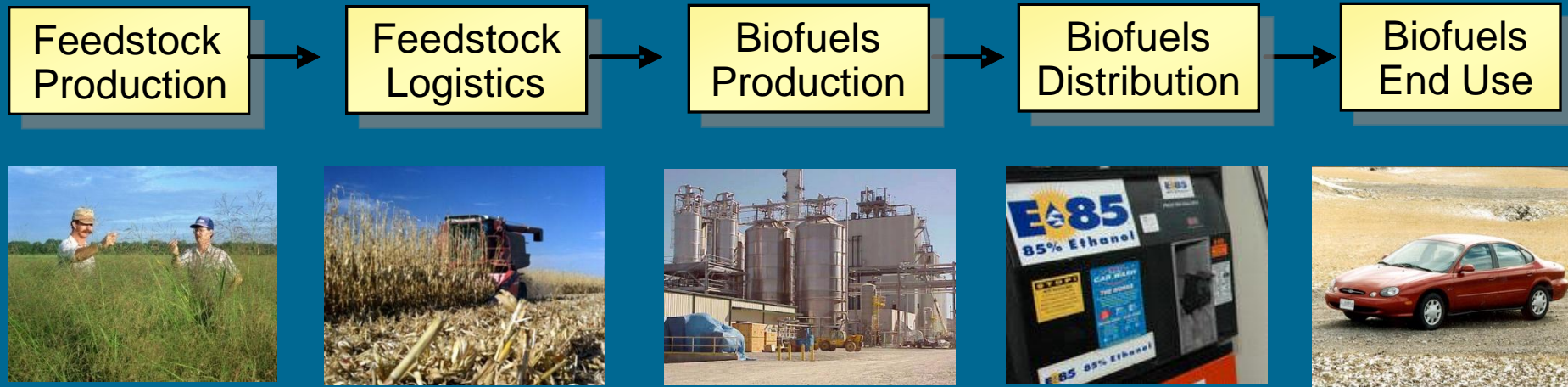
Integrated
Biorefineries

Infrastructure

Crosscutting Activities

Analysis; Sustainability; Partnerships, Communications, and Outreach

Strategic Focus: Biofuels



- **Cellulosic Ethanol:** Historically, the primary focus of the program has been on the conversion of lignocellulosic biomass to fuel ethanol. This work can be fully leveraged and applied to renewable hydrocarbon fuels.
- **Alternative Light-Duty and Diesel Replacement Fuels:** Over past few years, Biomass Program has expanded its technology portfolio to include the production of renewable hydrocarbon fuels from lignocellulosic biomass, including renewable gasoline, diesel and jet fuel, which will be required to meet the EISA goal.

Description of Demonstration and Deployment Activities

Recovery Act Funding and Initiatives

Biomass R&D and Demonstration Projects - \$800 Million

\$509M

Pilot and Demonstration-Scale Biorefineries

Validate technologies for integrated production of advanced biofuels, products, and power to enable financing and replication. DOE recently selected

- 14 pilot-scale projects for up to \$25M each
- 4 demonstration-scale projects for up to \$50M

\$81M

Commercial-Scale Biorefineries

Increase in funding for prior awards; one project
Expedite construction; accelerate commissioning and start-up

\$107M

Fundamental Research

\$24M: Integrated Process Development Unit - LBNL

\$5M: Sustainability research with the Office of Science

\$34M: Advanced Biofuels Technology Consortium

\$44M: Algal Biofuels Consortium to accelerate demonstration

\$20M

Mid-Level Blends Testing and Infrastructure Research

\$13.5M

Expand NREL Integrated Biorefinery Research Facility

\$69.5M

SBIR and Program Direction



- **29 R&D, pilot, demonstration, and commercial-scale projects selected to validate IBR technologies**
- **Diverse feedstocks represented**

Agricultural
Residues
Energy Crops

Algae/CO₂
Forest Resources

Municipal Solid
Waste
Non-edible oils

- **A variety of transportation fuels, biobased products, and biopower will be developed**

Cellulosic
Ethanol
Butanol
Methanol

Renewable
Gasoline
Renewable
Diesel
Jet Fuel
Biodiesel

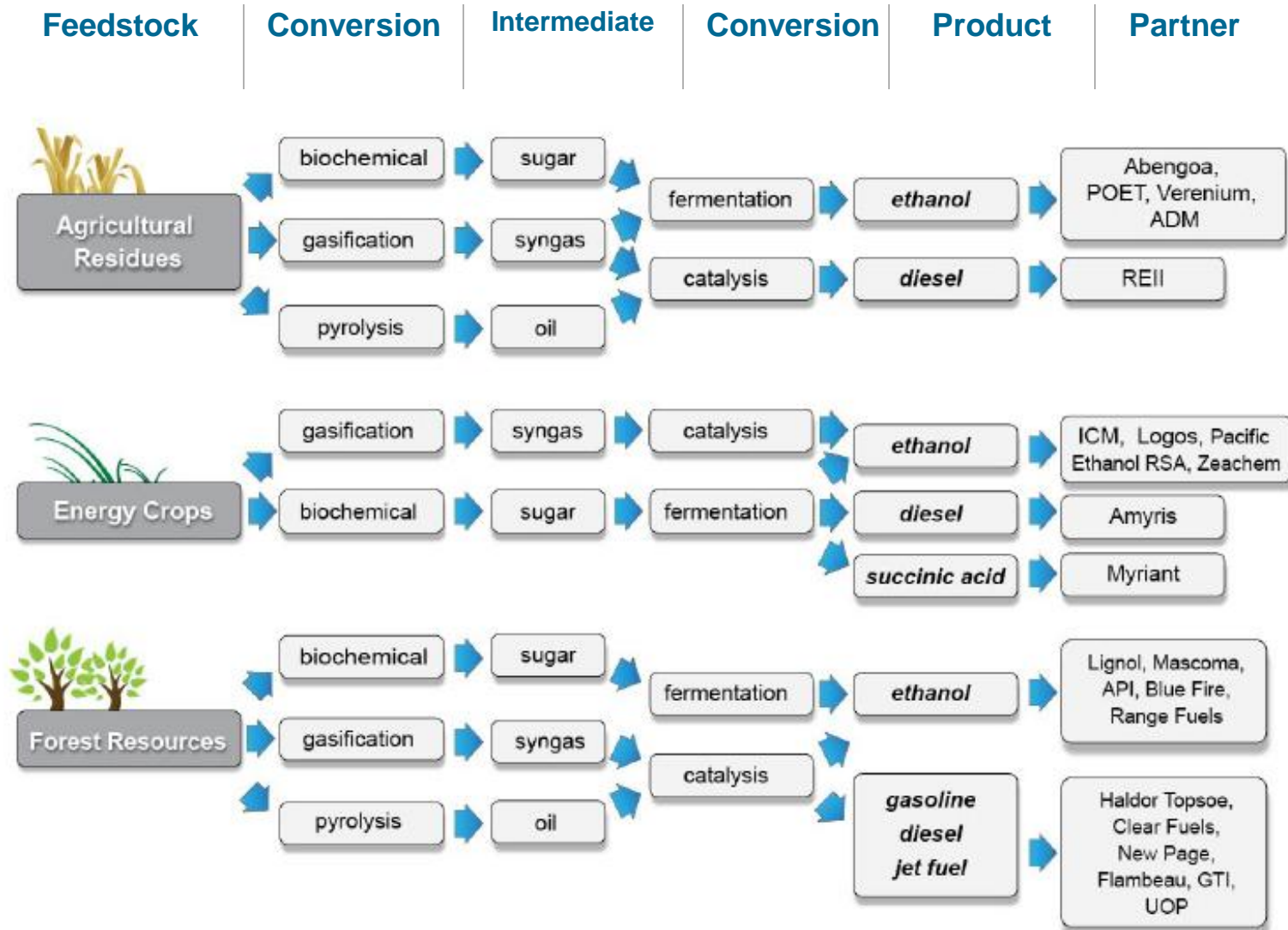
Biobased
Chemicals
Process heat and
steam
Electricity



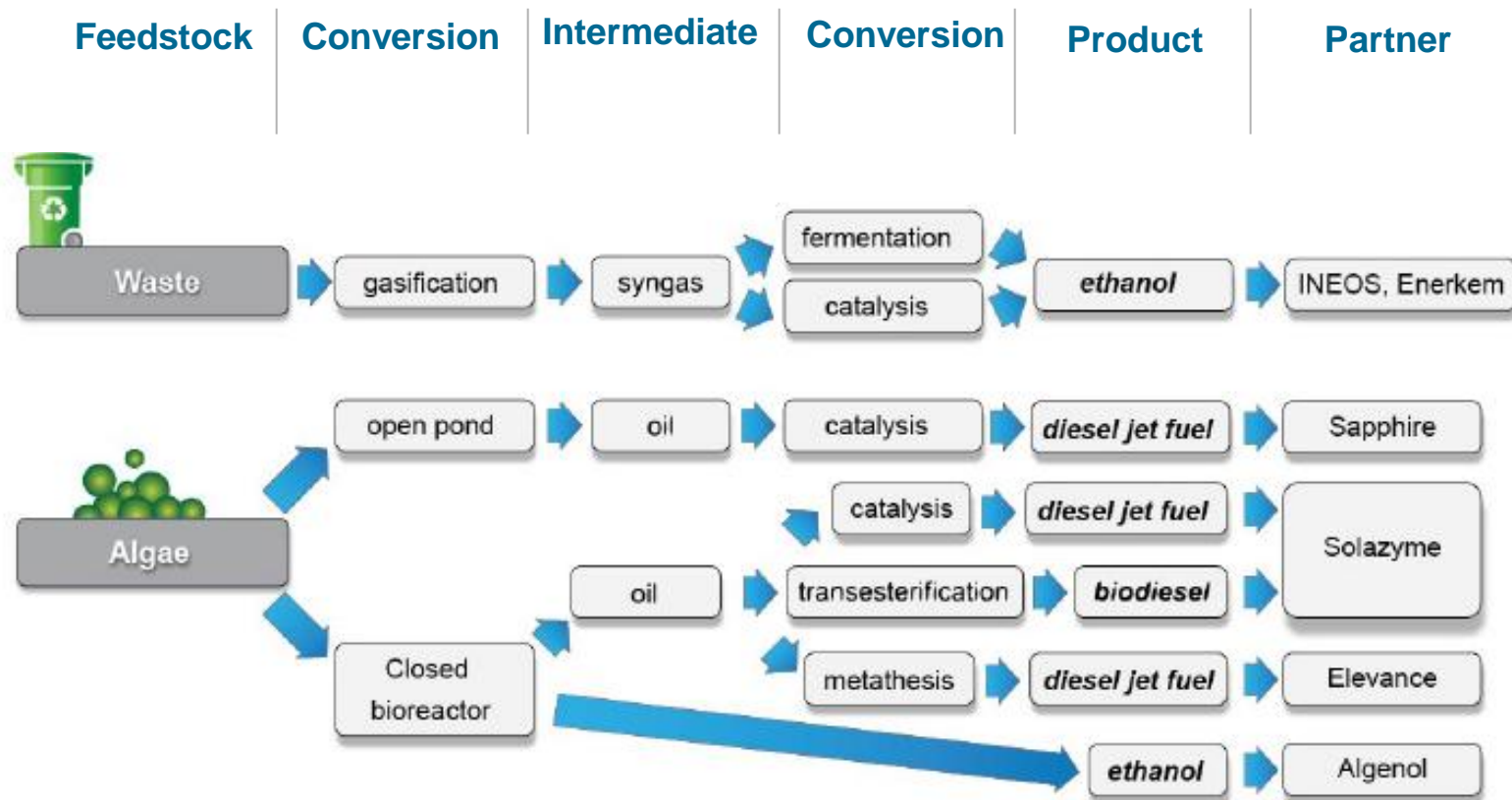
Energy Efficiency & Renewable Energy



Integrated Biorefinery Portfolio – Pathway Diversity



Integrated Biorefinery Portfolio – Pathway Diversity



Key Recent Accomplishments:

EPA Act 2005 Section 932: "Commercial-Scale" Biorefineries

Performer	Location	DOE Award*	Feedstock Type	Conversion Technology	Fuel / Capacity**
Bluefire	Fulton, MS	\$87.6M	Wood Wood Waste Sorted MSW	Biochemical- Concentrated Acid Hydrolysis	19M gals ethanol/yr
Poet	Emmetsburg, IA	\$100M	Corn Cob	Biochemical	25M gals ethanol/yr
Range Fuels	Soperton, GA	\$76.2M	Wood Waste	Gasification + Mixed Alcohol synthesis	20M gals per yr mixed alcohols
Abengoa	Hugoton, KS	\$100M	Agricultural Residues	Biochemical	15M gals ethanol/yr & 75 MW power

*Award amounts still under negotiation.

**Fuel capacities are based on performers estimates.

Key Recent Accomplishments:

Demonstration-Scale Biorefineries Selected in FY2008

Performers	Location	DOE Award*	Feedstock Type	Conversion Technology	Fuel / Amount
Alltech Envirofine	Washington County, KY	\$30M	Corn Cobs	Biochemical-Solid State Fermentation	1M gals ethanol/yr
Lignol Innovations	TBD	\$30M	Woody Biomass	Biochemical-Organisolve	2.5M gals ethanol/yr
Mascoma	Upper Peninsula, MI	\$32M	Woody Biomass	Biochemical	5M gals ethanol/yr
NewPage	Wisconsin Rapids, WI	Up to \$50M	Woody Biomass	Thermochemical-Fischer-Tropsch	5.5M gals FT Liquids/yr
Pacific Ethanol	Boardman, OR	\$30M	Wheat Straw, Stover, Poplar Residuals	Biochemical-Biogasol	2.7M gals ethanol/yr
RSA	Old Town, ME	\$33.9M	Hemicellulose from Wood	Biochemical-Pentose Extraction	2.2M gals of Ethanol or Butanol
Verenium Biofuels Corp.	Jennings, LA	\$14.9M	Energy Cane and Sugar Cane Bagasse	Biochemical Process	1.5M gals ethanol/yr
Flambeau River Biofuels LLC	Park Falls, WI	up to \$80M	Forest Residues and Wood Waste	Thermochem to Fischer-Tropsch	9M gals FT Liquids/yr and 50M lbs of FT wax
*Award amounts still under negotiation					

Key Recent Accomplishments:

ARRA Biorefineries Selected in FY2010



Energy Efficiency & Renewable Energy

Project	Feedstock	Technology	1° Product	Scale (gal/yr)	Class
Algenol	Algae	Closed Ponds	Ethanol	100,000	Pilot
Solazyme	Sugar/Hydrolysates	Heterotrophic Algae	Oil	300,000	Pilot
American Process Inc.	Hardwood Hydrolysate	Biochemical	Ethanol	894,000	Pilot
Renewable Energy Inst. Inc.	Rice Hulls & Forest Residues	TC Gasification	RE Diesel	625,000	Pilot
Haldor Topsoe	Wood Waste	TC Gasification	RE Gasoline	345,000	Pilot
ADM	Corn Stover	Biochemical	Ethanol	25,800	Pilot
ICM	Corn Fiber, Switchgrass, Energy Sorghum	Biochemical	Ethanol	345,000	Pilot
Clear Fuels	Wood Waste, Bagasse	TC Gasification	RE Diesel, RE Jet	151,000	Pilot
Zechem	Hybrid Poplar, Stover, Cobs	BC/TC Hybrid	Ethanol	250,000	Pilot
Amyris	Sweet Sorghum	Biochemical	RE Diesel	1,370	Pilot
Logos	Corn Stover, Switchgrass, Wood Waste	Biochemical	Ethanol	50,000	Pilot
UOP	Forest Residues, Corn Stover, Bagasse, Switchgrass, Algae	TC-Pyrolysis	RE Gasoline, RE Diesel	60,000	Pilot
Sapphire	Algae	Open ponds	Oil	1,000,000	Demo
Enerkem	MSW, Forest Residues	TC Gasification	Ethanol	10,000,000	Demo
Ineos	MSW	Hybrid/TC Ferm	Ethanol	8,000,000	Demo
Myriant	Sorghum	Biochemical	Succinic Acid	30,000,000 lbs/yr	Demo
Elevance	Algae oil, Plant oil, Animal oil	Chemical-Metathesis	RE Diesel, RE Jet	NA	R&D only
Gas Technology Institute	Wood Waste, Corn Stover, Algae	TC-Pyrolysis	RE Gasoline, RE Diesel	NA	R&D only

Federal Funding and Incentive Programs

- **DOE Loan Guarantee Program**

Section 1703 of Title XVII of the Energy Policy Act of 2005 authorizes the U.S. Department of Energy to support innovative clean energy technologies that are typically unable to obtain conventional private financing due to high technology risks.

- **Current Applications under review:**

- **Abengoa (ethanol)**
- **POET (ethanol)**
- **Mascoma (ethanol)**



- **USDA Loan Guarantee Program: SECTION 9003 Biorefinery assistance program**
- **Biorefinery assistance loan guarantees**

Loan guarantees are made to fund the development, construction, and retrofitting of commercial-scale biorefineries using eligible technology. The maximum loan guarantee is \$250 million. Mandatory funding is available through FY 2012.

- **Current Applications approved or under review:**

RangeFuels (ethanol) – approved

Sapphire (algal jet fuel/diesel) – approved

BlueFire (ethanol)

Flambeau (FT diesel/waxes)

Enerkem (ethanol)

Coskata (ethanol)

• **Cellulosic Reverse Auction**

- Accelerate deployment and commercialization of biofuels in delivering the first billion gallons in annual cellulosic biofuels production by 2015
- Not acquisition (DOE does not take possession of the fuel) - basically a fuel subsidy
- Annual cap: \$100 million ; Lifetime cap: \$1 billion
- Project cap: 25% of funds, minimum 4 recipients
- Applicant – Fuels producer (intends to) own and operate an eligible cellulosic biofuels production facility in “Commercially Significant Quantities” and places bid for amount of subsidy
- Only for biofuels (not products or power): Lignocellulosic Ethanol, “Green” Diesel, and Other fuel substitutes – alcohols, oxygenates
- Must have lifecycle greenhouse gas emissions that are at least 60 percent less than the baseline lifecycle greenhouse gas emissions (EISA 2007 Sec. 202)

- **Blender's Credit for Ethanol (VEETC).** The Volumetric Ethanol Excise Tax Credit extended through 2011 at the current rate of 45 cents per gallon.
- **Tariff on Imported Ethanol.** The 54 cent per gallon tariff on imported ethanol has been extended through 2011.
- **Small Producer Tax Credit.** The 10 cent per gallon producer tax credit for small ethanol producers producing no more 60 million gallon of ethanol a year was also extended through 2011 . The tax credit is applicable to just the first 15 million gallons of production for eligible producers.
- **Excise tax credits for alternative fuel and alternative fuel mixtures.** The measure extends through 2011 the \$0.50 per gallon alternative fuel credit and the alternative fuel mixture tax credits, excluding black liquor (liquid fuel derived from a pulp or paper manufacturing process) from credit eligibility.
- **Alternative fuel vehicle refueling property.** The measure extends the 30 percent investment tax credit for alternative vehicle refueling property for one year, through 2011.

Biomass Program MSW to Biofuels Projects

Biomass Program: MSW to Biofuels Projects

- **BlueFire Ethanol, LLC**

- **Location/Cost:** Fulton, MS / \$330MM (DOE ~27%)
- **Feedstock(s):** Woody biomass, logging residues or chips, sorted MSW
- **Size/Scale:** 770 Dry tons per day / Commercial Scale
- **Technology/Process:** Biochem – Concentrated Acid Hydrolysis
- **Primary Products:** Cellulosic ethanol
- **Capacity:** 19 million gallons per year
- **Award Date:** September, 2007 and December, 2009
- **Start of Operations:** April, 2013 (est.)
- **GHG Reduction:** 60-150% reduction versus fossil product
- **Anticipated Job Creation:** 250 Construction jobs and 45-50 full-time jobs

- **Enerkem Corporation**

- **Location/Cost:** Pontotoc, MS / \$120MM (DOE ~42%)
- **Feedstock(s):** MSW and wood residues
- **Size/Scale:** 330 Dry tons per day / Demonstration Scale
- **Technology/Process:** Thermochem – Catalytic Conversion of Syngas
- **Primary Products:** Cellulosic ethanol
- **Capacity:** 10 million gallons per year
- **Award Date:** January, 2010
- **Start of Operations:** April, 2013 (est.)
- **GHG Reduction:** 80% reduction versus gasoline
- **Anticipated Job Creation:** 210 Construction jobs and 130 full-time jobs

Biomass Program: MSW to Biofuels Projects

- **INEOS/New Planet Bioenergy LLC**

- **Location/Cost:** Vero Beach, FL / ~\$100MM (DOE ~50%)
- **Feedstock(s):** Vegetative & Yard waste, MSW
- **Size/Scale:** 300 Dry tons per day / Demonstration Scale
- **Technology/Process:** Hybrid Thermochem/Biochem Syngas Fermentation
- **Primary Products:** Cellulosic ethanol, renewable power
- **Capacity:** 8 million gallons per year and 6 MW (gross) of electricity generation
- **Award Date:** September, 2010
- **Start of Operations:** January, 2012 (est.)
- **GHG Reduction:** > 90% GHG Reduction compared to gasoline
- **Anticipated Job Creation:** 175 Construction jobs and 50 full-time jobs

Upcoming Biomass Program Funding Opportunities

Upcoming Funding Opportunities

Algae Research

- Halophyte Algae Consortium
- Reduction of Water Intensity or Nutrient Input
- Storage and Transport of Algal Biomass and Biofuel Intermediates
- Integrated Process Improvements; from Pretreatment to Substitutes for Petroleum-based Feedstocks, Products and Fuels
- Non-ethanol products (including fuels, chemicals and intermediates) – 2 - 3 projects with an 80/20 cost share, over 3 years

For more information, visit:
www.fedconnect.net/FedConnect
or www.grants.gov

Biopower

- Improvements to densify and enhance biomass for efficient combustion
- R&D to improve efficiency levels for cofiring densified biomass with coal in utility boilers

Biomass Research and Development Initiative

- Annual Joint Solicitation between DOE and USDA - feedstocks development, biofuels and biobased products development, and biofuels development analysis (FY11 FOA)

Reverse Auction

- Accelerate deployment and commercialization of biofuels in delivering the first billion gallons in annual cellulosic biofuels production by 2015

- Office of the Biomass Program - <http://www.biomass.energy.gov>
- Biomass Publication Library – <http://www.biomass.energy.gov/publications.html>
- Biofuels Atlas - <http://maps.nrel.gov/bioenergyatlas>
- Energy Empowers - <http://www.energyempowers.gov>
- DOE on Twitter - <http://twitter.com/energy>
- Secretary Chu on Facebook - <http://www.facebook.com/stevenchu>
- EERE Info Center - <http://www1.eere.energy.gov/informationcenter>
- Alternative Fuels Data Center <http://www.eere.energy.gov/afdc/fuels>
- Bioenergy Feedstock Information Network - <http://bioenergy.ornl.gov/>
- Biomass R&D Initiative – <http://www.usbiomassboard.gov/>
- Grant Solicitations - <http://www.grants.gov>
- Office of Science - <http://www.science.doe.gov>
- Loan Guarantee Program Office - <http://www.lgprogram.energy.gov>
- Loan Guarantee Final Rule - <http://www.lgprogram.energy.gov/lgfinalrule.pdf>

"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