



FACT SHEET

Cellulosic Biofuels

July 2008

Cellulosic biofuels are not as far off as often assumed. EESI’s investigation of this issue found some pilot scale cellulosic biofuel production facilities already online and many more demonstration and commercial scale biorefineries under construction or on the drawing board. In fact, **55 cellulosic biorefineries are complete, under construction or in the planning stage in a total of 31 states across the country**, adding up to an expected nameplate capacity of 629.5 million gallons per year (MGY) and a potential expansion to 995 MGY. Most of the demonstration and commercial scale facilities are scheduled to start operation in 2009 or 2010.

CELLULOSIC BIOREFINERIES BY SCALE & STAGE OF DEVELOPMENT

| | Commercial Scale | Demonstration Scale | Pilot Scale |
|--------------------|------------------|---------------------|-------------|
| Completed | – | 2 | 3 |
| Under Construction | 1 | 3 | 5 |
| Planning Stage | 21 | 14 | 6 |
| Total | 22 | 19 | 14 |

The U.S. Department of Energy (DOE) defines a commercial scale biorefinery as one that uses at least 700 tons of feedstock per day to produce 10-20 MGY of biofuel. Small scale (demonstration) facilities use approximately 70 tons of feedstock per day, yielding at least 1 MGY.ⁱ Pilot scale facilities are generally smaller and are used to develop new methods and technologies.

CELLULOSIC BIOREFINERIES BY STATE

- | | | | |
|-----------------|---------------|--------------------|--------------------|
| Alabama (2) | Indiana (2) | Minnesota (1) | Pennsylvania (3) |
| Arkansas (1) | Iowa (1) | Missouri (1) | South Carolina (1) |
| California (2) | Kansas (1) | Montana (1) | South Dakota (1) |
| Colorado (3) | Kentucky (1) | Nebraska (1) | Tennessee (2) |
| Connecticut (1) | Louisiana (2) | Nevada (1) | Washington (1) |
| Florida (6) | Maine (1) | New York (3) | Wisconsin (3) |
| Georgia (1) | Maryland (1) | North Carolina (2) | Wyoming (1) |
| Hawaii (1) | Michigan (1) | Oregon (2) | |

Four facilities have not disclosed their locations.

TECHNOLOGIES

These facilities will produce cellulosic biofuels such as ethanol, methanol, bio-butanol, propanol, and Fischer-Tropsch diesel fuel, along with biobased products using a wide variety of technologies, including:

- Engineered microbes
- Fischer-Tropsch process
- Specialty enzymes
- Biomass fractionation
- Hydrogenolysis process
- Enzymatic hydrolysis
- Gasification
- Weak and strong acid hydrolysis
- Steam explosion hydrolysis
- Biochemical organosolv process
- Various biochemical, thermochemical, and proprietary technologies

Other biofuels such as renewable crude oil, biogasoline, cellulosic biodiesel, and jet fuel also are being pursued.

FEEDSTOCKS

National Renewable Energy Lab (NREL) defines a biorefinery as a facility that integrates biomass conversion processes and equipment to produce fuels, power, and chemicals from biomass. Many biorefineries utilize multiple cellulosic materials as feedstock. Here is a list of feedstocks cellulosic biorefineries are planning to use:

Agricultural Residues

- Citrus waste
- Corn cobs, fiber, and stover
- Grain, rice, and wheat straw
- Leafy material

Energy Crops

- Miscanthus
- Specially-bred energy cane
- Switchgrass
- Poplar, willow, and pine trees

Waste Products

- Municipal solid waste
- Yellow/trap grease
- Construction waste
- Urban wood waste

Woody Biomass

- Hazardous fuels (thinning & slash)
- Material from habitat restoration
- Logging and mill residue

FEDERAL INVESTMENT

The following companies were awarded DOE grants in February 2007 totaling \$385 million over four years:ⁱⁱ

- **Range Fuels** – Soperton, GA
- **BlueFire Ethanol, Inc.** – Corona, CA
- **Abengoa Bioenergy** – Hugoton, KS
- **Poet, LLC** – Emmitsburg, IA
- **ALICO, Inc.** – LaBelle, FL*
- **logen Biorefinery Partners, LLC** – Shelley, ID*

Range Fuelsⁱⁱⁱ has broken ground on a facility and expects to begin operations in 2009. BlueFire will also be constructing a smaller 3.1 MGY facility in Lancaster, CA.

**These projects are no longer being pursued.^{iv}*

The following companies were awarded DOE grants in January, April, and July 2008 for small scale biorefinery projects totaling \$240 million over four years:^v

- **ICM Incorporated** – St. Joseph, MO
- **Ecofin, LLC** – Nicholasville, KY
- **Mascoma Corporation** – Vonore, TN
- **Pacific Ethanol** – Boardman, OR
- **Verenium Corporation** – Jennings, LA
- **Lignol Innovations, Inc.** – Commerce City, CO
- **Stora Enso, North America** – Wisconsin Rapids, WI
- **RSE Pulp & Chemical, LLC** – Old Town, ME
- **Flambeau River Biofuels, LLC** – Park Falls, WI

In May 2008, Verenium Corporation commissioned a demonstration scale facility in Jennings, LA and expects to produce 1.5 MGY of cellulosic ethanol from sugarcane bagasse and other regional feedstocks.^{vi}

In addition to grant awards for the construction of biorefineries, DOE awarded grants for the research and development of new conversion technologies. So far in 2008, DOE has provided over \$60 million in funding to numerous research institutions and companies, including **SunEthanol, Inc.**; **Novozymes, Inc.**; and **Genencor**, a division of Danisco which has partnered with DuPont to form **DuPont Danisco Cellulosic Ethanol, LLC**.^{vii} In June 2007, DOE awarded \$375 million to three bioenergy research centers located in Berkeley, CA, Madison, WI, and Oak Ridge, TN.^{viii} The USDA is also providing funding for research and development and is expected to expand funding following the recent enactment of this year's farm bill.

STATE INVESTMENT

The following companies are currently planning demonstration or commercial scale facilities and have received significant state grants and other substantial financial investment:

- **AE Biofuels** – Butte, MT
- **Citrus Energy, LLC** – Clewiston, FL^{ix}
- **Liberty Industries** – Hosford, FL
- **KL Process Design Group** – Upton, WY
- **Sun Opta, Inc.** – Little Falls, MN
- **Coskata** – Madison, PA^x
- **Catalyst Renewables Corporation** – Lyonsdale, NY
- **Gulf Coast Energy** – Livingston, AL and Mossy Head, FL
- **Southeast Biofuels, LLC** – Auburndale, FL
- **Florida Crystals Corporation** – Okeelanta, FL
- **ZeaChem, Inc.** – Boardman, OR

STATE POLICY

State governments have supported the development of cellulosic biofuels through research and development grants, loan programs, production incentives, tax credits, tax exemptions, and fuel standards. Below is a brief overview of some policies in five states across the country:

Florida

R&D matching grants authorized through their “Farm to Fuel” Grant Program^{xi} and Renewable Energy Technologies Grant Program; a hydrogen and biofuels tax exemption; and a hydrogen and biofuels investment tax credit.^{xii}

Kansas

Kansas Development Finance Authority authorized revenue bonds to cover the costs of construction or expansion of biomass-to-energy facilities, including facilities that produce cellulosic alcohol; which can be combined with a state property tax exemption for up to 10 years.^{xiii}

Maryland

Cellulosic ethanol research and development tax credit of up to 10% for qualified research and development expenses for cellulosic ethanol technology (tax credit cannot exceed \$250,000 in a single calendar year).^{xiv}

Michigan

Under the Michigan Next Energy Authority Act, taxpayers engaged in the research, development, or manufacturing of alternative energy technology, which includes renewable fuel^{xv}, may claim a nonrefundable credit against their single business tax liability^{xvi}. The Michigan Biomass Energy Program provides grants for projects related to biofuels and bioenergy education, biofuels infrastructure, and biomass technology development and demonstrations.^{xvii}

Washington

Enacted Energy Freedom Program, an alternative fuel grant and loan program that funds research and development of new and renewable energy and biofuel sources including infrastructure, facilities, research and development, and market development for byproducts.^{xviii}

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ⁱ U.S. Department of Energy. "U.S. Department of Energy Selects First Round of Small-Scale Biorefinery Projects for Up to \$114 Million in Federal Funding." 29 January 2008. <http://www.doe.gov/5903.htm>

ⁱⁱ U.S. Department of Energy. "DOE Selects Six Cellulosic Ethanol Plants for Up to \$385 Million in Federal Funding." 28 February 2007. <http://www.doe.gov/news/4827.htm>

ⁱⁱⁱ U.S. Department of Energy. EERE News. "Range Fuels Breaks Ground on Commercial Cellulosic Ethanol Plant." 7 November 2007. http://www.eere.energy.gov/news/news_detail.cfm/news_id=11409

^{iv} Greentech Media. "Plans for Two Cellulosic-Ethanol Plants Scrapped." 4 June 2008. <http://www.greentechmedia.com/articles/plans-for-two-cellulosic-ethanol-plants-scrapped-972.html>

^v U.S. Department of Energy. "U.S. Department of Energy Selects First Round of Small-Scale Biorefinery Projects for Up to \$114 Million in Federal Funding." 29 January 2008. <http://www.doe.gov/5903.htm>

U.S. Department of Energy. "DOE Selects 3 Small-Scale Biorefinery Projects for up to \$86 Million of Federal Funding in Maine, Tennessee and Kentucky." 18 April 2008. <http://www.doe.gov/6164.htm>

U.S. Department of Energy. "DOE to Provide up to \$40 Million in Funding for Small-Scale Biorefinery Projects in Wisconsin and Louisiana." 14 July 2008. <http://www.energy.gov/news/6413.htm>

^{vi} Verenium Corporation. "Verenium Begins Commissioning of Nation's First Cellulosic Ethanol Demonstration-Scale Plant." 28 May 2008. <http://ir.verenium.com/phoenix.zhtml?c=81345&p=irol-newsArticle&ID=1151140&highlight=>

^{vii} U.S. Department of Energy. DOE Announces up to \$7 Million for Biomass Research." 17 April 2008. <http://www.doe.gov/news/6161.htm>

U.S. Department of Energy. "DOE Announces up to \$4 Million for University Research into Advanced Biomass Conversion." 11 April 2008. <http://www.doe.gov/news/6153.htm>

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^{viii} U.S. Department of Energy. "Energy Department Selects Three Bioenergy Research Centers for \$375 Million in Federal Funding." 26 June 2007. <http://www.doe.gov/news/5172.htm>

^{ix} Florida Department of Environmental Protection. State Awards Grants for Renewable Energy Technologies. 22 February 2007. http://www.dep.state.fl.us/secretary/news/2007/02/0222_01.htm

^x Coskata. "GM, Coskata Partner in Breakthrough Ethanol Technology." 13 January 2008. <http://www.coskata.com/GM-CoskataLaunch.htm>

^{xi} Florida Department of Agriculture and Consumer Services. "Bronson Announces 'Farm To Fuel' Grant Winners" 22 January 2008. <http://www.doacs.state.fl.us/press/2008/01222008.html>

^{xii} U.S. Department of Energy. Energy Efficiency and Renewable Energy. *Alternative Fuels and Advanced Vehicles Data Center* http://www.eere.energy.gov/afdc/progs/all_state_summary.php/afdc/0 (accessed on June 9, 2008).

^{xiii} Ibid

^{xiv} Ibid

^{xv} NextEnergy. "Michigan NextEnergy Authority Certification Guidebook." June 2003. <http://ref.michigan.org/medc/cm/attach/F815CBED-04EB-4D6D-98C0-E0634C2536D0/GuidebookJune17.pdf>

^{xvi} Ibid

^{xvii} Database of State Incentives for Renewables and Efficiency. "Michigan Incentives for Renewable Energy." 12 September 2007. http://www.dsireusa.org/library/includes/incentive2.cfm?incentive_Code=MI08F&state=MI¤tPageID=1

^{xviii} U.S. Department of Energy. Energy Efficiency and Renewable Energy. *Alternative Fuels and Advanced Vehicles Data Center* http://www.eere.energy.gov/afdc/progs/all_state_summary.php/afdc/0 (accessed on June 9, 2008).