CELLULOSIC BIOFUELS
INDUSTRY PROGRESS REPORT 2012-2013
Cellulosic biofuel is a liquid fuel or feedstock produced from lignocellulose, a structural material that comprises much of the mass of plants, including grasses, wood and municipal/agricultural waste.

Most companies use some combination of heat (including gasification), enzymes and chemicals to break down complex cellulosic materials into simple sugars (for fermentation into ethanol) and other marketable products such as bio-crude and renewable power.

According to the Sandia National Lab, the U.S. could produce 75 billion gallons per year of cellulosic biofuels without displacing food and feed crops (the U.S. consumed ~134 billion gallons of gasoline in 2011). The U.S. advanced biofuels industry is ramping up to compete in the $2.5 trillion global clean energy marketplace. Compliance with the federal Renewable Fuel Standard (RFS) is forecasted to create up to 800,000 jobs by 2022.

The RFS was amended to include cellulosic biofuels just 5 years ago. Despite the global recession, the cellulosic biofuels industry now has facilities and projects under development in more than 20 U.S. states representing billions of dollars in private investment. Enzyme costs are down 80% in the last decade, and cellulosic biofuels are being produced for $2.00 per gallon or less today.

The cellulosic biofuels industry has reached the commercial deployment phase. However, high capital risk from OPEC-induced price distortions, constrained blending markets and policy uncertainty continues to slow the rate of deployment. The federal policies that put the United States at the global forefront of the development of the cellulosic biofuels industry are at risk. How U.S. policymakers address these challenges will determine whether the country leads or falls behind in the global race to produce next generation bio-based fuels and products.

This report provides a detailed snapshot of advances made toward the commercial deployment of cellulosic biofuels. The report profiles cellulosic biofuel production facilities and projects in roughly 20 U.S. states, several provinces in Canada, as well as China, Denmark, Italy, Germany and Spain. All companies profiled are working toward developing production capacity in the United States to meet the federal RFS.

Location of Cellulosic Biofuels Facilities Profiled by this Report

Non-U.S./Canada Technological Development, by Location
Cellulosic Biofuel Production Facilities Outside of the U.S./Canada Developing Technologies for Deployment in the U.S.

Disclaimer: This report provides a commercial deployment update for a number of first movers in the cellulosic biofuels sector. The report does not profile all cellulosic biofuels projects under development in the U.S. and abroad, and does not cover other advanced biofuel sectors.
**Company Profile**

Abengoa Bioenergy is a worldwide leader in the development of biofuels for transportation, as well as in chemical bioproducts which use biomass as raw material. Abengoa Bioenergy owns and operates 14 bioethanol facilities throughout the United States, Europe and Brazil with a total production capacity of 842 million gallons per year.

**Abengoa Bioenergy Partners**

- **Private Equity:** Abengoa Bioenergy equity
- **Strategic:** None; contracted with professional biomass harvesting and removal firms
- **Public/Government:** Selected for $97MM Section 932 Cost Share Grant (DOE) in 2007; awarded $133MM EPAct 2005 loan guarantee in 2011 for development of the Abengoa Bioenergy commercial facility in Hugoton, Kansas

The Abengoa Bioenergy Hugoton Biorefinery will utilize the company’s proprietary technology to produce 25 million gallons of cellulosic ethanol per year. The plant will utilize approximately 1,100 dry tons of agricultural waste per day for the ethanol production process. The residue of that process (approximately 300 tons per day of lignin) will be combusted to produce 20 megawatts of electricity. This will allow the facility to be fueled entirely by biomass.

**Path to Commercial Deployment**

- **2007-07**
  - Signed Cooperative Agreement with DOE to produce first cellulosic ethanol.
  - Planned to build first commercial cellulosic ethanol plant in Hugoton, KS.
  - U.S. Refinery operated in York, NE.
  - Successful demonstration of cellulosic ethanol.

- **2008**
  - Completed construction of demonstration plant in Salamanca, Spain.
  - Produced first demo-scale gallons of ethanol.

- **2009**
  - Completed construction of commercial cellulosic ethanol plant in Hugoton, KS.
  - MARKET MILESTONE: Production of 25 million gallons per year.

- **2010**
  - Completed construction of commercial cellulosic ethanol plant in Hugoton, KS.
  - Shipment of first commercial cellulosic ethanol.

- **2011**
  - Completed construction of commercial cellulosic ethanol plant (R&D).
  - Feasibility study for additional cellulosic ethanol plants.

- **2012**
  - Beginning deployment of technology to existing Abengoa Bioenergy facilities, as well as to new greenfield locations.

- **2013**
  - Complete construction of additional cellulosic ethanol plants.

- **2014**
  - Began deploying technology to existing Abengoa Bioenergy facilities, as well as to new greenfield locations.
  - License for use of proprietary technologies.
AMERICAN PROCESS

COMPANY PROFILE
Based in Atlanta, American Process Inc. was founded in 1994 as a consulting practice serving the forest products industry. Since 2005, the company has been developing technologies for the conversion of biomass into cellulosic sugars to be used in the production of biofuels and bio-based chemicals. American Process now owns two patented cellulosic technologies, Green Power+ and AVAP.

GREEN POWER+ TECHNOLOGY
Green Power+ is a cellulosic technology that co-locates with biomass power plants. The hemicelluloses are selectively extracted and hydrolyzed into monomer sugars. The resulting sugars are fermented into cellulosic ethanol. The process configuration enables Green Power+ to convert the hemicelluloses to higher value added products: cellulosic ethanol and renewable chemicals.

AVAP TECHNOLOGY
AVAP is a greenfield technology that fractionates any biomass via the proprietary, patented use of SO2 and ethanol into cellulose, lignin and hemicelluloses. The cellulose and hemicelluloses are then converted into sugars. Resultant sugars are high purity and low cost, making them an ideal feedstock for downstream conversion into bio-based chemicals and biofuels. The lignin is burned as fuel in the boiler.

AVAPCO THOMASTON GA DEMONSTRATION FACILITY
LOCATION: Thomaston, GA
FEEDSTOCK: Variety of biomass – up to 10 tons/day
PRODUCTS: Cellulosic sugars, Ethanol, Cellulose
CAPACITY: Up to 300,000 GPy Cellulosic Ethanol
JOBS ~30 operational, including biomass logistics
PROJECT PROFILE: Plant will begin startup in Q1/2013. Thomaston will be the site of AVAPCO’s supply chain integrated alliances with downstream sugar converters to chemicals, fuels and materials. AVAPCO is an affiliate of American Process, Incorporated. AVAPCO was created in 2011 in order to commercialize the AVAP technology developed by American Process. AVAPCO owns the Thomaston, GA AVAP Demonstration Facility.

GREEN POWER+ DEMONSTRATION FACILITY
LOCATION: Alpena, MI
FEEDSTOCK: Mixed hardwood
PRODUCTS: Cellulosic ethanol, Potassium acetate
CAPACITY: 700,000 GPy per product
JOBS ~25 operational, including biomass logistics
PROJECT PROFILE: The plant is co-located with the Decorative Panels International (DPI) hardboard manufacturing facility. Plant construction began April 2011; commissioning occurred in June 2012. The plant is in startup mode.

AMERICAN PROCESS & AVAPCO PARTNERS
Green Power+ Strategic: ArborGen, Decorative Panels International, Green Tech America, Metso
Green Power+ Public/Government: U.S. Department of Energy ($18MM grant to Alpena Biorefinery); Michigan Economic Development Corporation ($4MM grant for Alpena Biorefinery)
AVAP Strategic: ArborGen, Green Tech America, Metso, Novozymes
AVAPCO Strategic: ArborGen, Green Tech America, Metso, Novozymes
AVAPCO Public/Government: Private investment

PATH TO COMMERCIAL DEPLOYMENT
COMPANY PROFILE
Beta Renewables is a $350 million joint venture formed from the Chemtex division of Gruppo Mossi & Ghisolfi and TPG. The M&G Group (~$3b USD annual revenue) brings over 60 years of success in process development and plant commercialization worldwide. The joint venture has invested over $200 million in the development of its advanced PROESA™ cellulosic biorefining technology.

Beta Renewables Partners
Private Equity: Over $200 million invested in PROESA technology development by M&G’s Chemtex division. Beta Renewables formed as $350 million joint venture by Chemtex and TPG.
Strategic: GraalBio, Colbiocel, Novozymes, Genomatica, Gevo, Codexis, Amyris, Biofuels Center of North Carolina
Public/Government: USDA, $99M loan guarantee for Project Alpha in North Carolina, plus $4M BCAP award

U.S. COMMERCIAL FACILITY UNDER DEVELOPMENT: PROJECT ALPHA
LOCATION: Sampson County, NC
STATUS: $99M conditional loan guarantee awarded August 2012
FEEDSTOCK: Dedicated energy feedstock crops; $3.9M BCAP award
PRODUCTS: Cellulosic Ethanol, Bio-based Chemicals
CAPACITY: 20 MY
JOBS: 300+ direct and indirect jobs
PROJECT PROFILE: Project Alpha to use Chemtex PROESA technology; $3.9M Biomass Crop Assistance Program (BCAP) grant to facilitate the establishment of over 4,000 acres of energy crop development across eleven counties in North Carolina, with expected additional revenues to exceed $4.5M annually for local biomass producers

COMMERCIAL FACILITY
LOCATION: Crescentino, Italy
STATUS: Started operations 4Q 2012
FEEDSTOCK: A Mix of Wheat Straw, Rice Straw, Bagasse, Arundo Donax, Corn Stover and Poplar
PRODUCTS: Cellulosic Ethanol
CAPACITY: 20 MY
JOBS: 200+ direct and indirect jobs
PROJECT PROFILE: On schedule to be world’s first commercial-scale plant; multiple additional plants have licensed PROESA technology; technology to be utilized at Project Alpha in North Carolina

PATH TO COMMERCIAL DEPLOYMENT
COMPANY PROFILE

BlueFire was established to deploy the Arkenol Process Technology for the conversion of cellulosic waste materials into renewable fuels and other products. BlueFire is the exclusive North America licensee of the technology, which converts widely available, inexpensive, organic materials such as agricultural residues, wood residues, municipal solid wastes and purpose grown energy crops into renewable end products. BlueFire also operates SucrSource, which converts cellulose into intermediate sugars for the production of bio-chemicals and other products.

BlueFire Partners

Private Equity: Quercus Trust, Arkenol Inc., ARK Energy Inc.


Project Development: Launched SucrSource, a wholly-owned subsidiary constructing a cellulosic sugar facility in South Korea with GS Caltex for development of sugar to chemicals process. Designing cellulose to fuels plant with China Huadian Engineering Co and Sino BioWay - Both out of Beijing, China

SucrSource, a wholly-owned subsidiary of BlueFire Renewables, signed agreements in 2012 with GS Caltex, a Korean petroleum company, to build a cellulose to sugar plant in Korea. The facility will process 2 tons of construction and demolition debris per day into cellulosic sugar, which will be converted into a high-value chemical by GS Caltex. The facility will be owned and operated by GS Caltex with SucrSource providing the process design package, equipment procurement and technical and engineering support.

PATH TO COMMERCIAL DEPLOYMENT

Licensed technology with over 50,000 hours of pilot plant activity
Secured $350 MM grant under Bioenergy Program of Farm Bill
Began developing Fulton, MS facility
Completed site preparation and detailed engineering for Fulton facility
Completed financing for Fulton, MS facility
Secured agreement with GS Caltex to build cellulose to sugar plant in Korea
Began construction of Fulton, MS Facility
Began development of multiple sites for deployment

COMMERCIAL FACILITY

LOCATION: Fulton, MS
STATUS: Site Preparation
Complete. Pending financing for facility construction, receipt of $87 MM Dept of Energy grant

FEEDSTOCK: Forestry residues and other cellulosic wastes

PRODUCTS: Cellulosic Ethanol, Gypsum, Lignin and Protein Cream

CAPACITY: 19 MGY

JOBS: 750 peak construction jobs. Over 100 for plant operation and handling of biomass and products

PROJECT PROFILE: All permits for construction obtained, long-term contracts for all of feedstock and products complete. Turn-key EPC contract completed.
COMPANY PROFILE
Clariant, headquartered in Muttenz near Basel, Switzerland, is an internationally active specialty chemical company with $8 billion in annual turnover and over 22,000 employees worldwide. Clariant has over 100 group companies and production sites in 44 countries including the United States. The Clariant Biotech and Renewables Center is based in Munich and Straubing, Germany, and is focused exclusively on the development and commercial deployment of renewable technology solutions.

RESEARCH FACILITY
LOCATION: Munich, Germany
FEEDSTOCK: Various ligno-cellulosic feedstocks
PRODUCTS: Cellulosic Ethanol, Cellulosic Sugars, Biobased Chemicals
CAPACITY: 2 tons per year
PLANT PROFILE: Plant utilized to test and improve the sunliquid® technology across several different cellulosic feedstocks.

Clariant Partners
Private Equity: No funding was requested from Private Equity for the demonstration plant. Funding sources for the first commercial plant will be evaluated.
Strategic: No funding was requested from Strategic Partners for the demonstration plant. Funding sources for the first commercial plant will be evaluated.
Public/Government: The Bavarian State Government and the German Federal Ministry of Education and Research have each funded 5 million euros into the demonstration plant for research relating to the project. Funding sources for the first commercial plant will be evaluated.

PATH TO COMMERCIAL DEPLOYMENT

Enerkem Partners


Strategic: Waste Management (upstream: feedstock), Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

Government/Public: up to $50 MM cost-share (DOE) and $80MM loan guarantee (USDA) to support construction full-scale commercial facility in Pontotoc, MS; $18MM CAD grant (Québec Ministry of Natural Resources and Wildlife) and $9 MM loan (Investissement Québec) for commercial facility in Varennes, Québec; $23MM CAD (Alberta Innovates and Alberta Energy) for full-scale facility in Edmonton, Alberta; Natural Resources Canada, Sustainable Development Technology Canada (Investissement Québec) for commercial facility in Varennes, Québec; $23MM CAD (Alberta Innovates and Alberta Energy)

PATH TO COMMERCIAL DEPLOYMENT

U.S. COMMERCIAL STRATEGY

SUMMARY: Enerkem has identified dozens of potential sites in the United States to deploy its modular, copy-exact 10 MGy biorefineries.

FIRST PROJECT: Pontotoc, MS

FEEDSTOCK: MSW, wood residues

PRODUCTS: Syngas, Biomethanol, Acetates, Cellulosic Ethanol

STATUS: Under development

Launched construction of Syngas-to-Methanol Island

2010

Construction of Syngas-to-Methanol Island

2012

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2011

Completed Phase 1, full-scale ethanol plant

Full-scale ethanol plant in operation

2014

Construction of Syngas-to-Methanol Island

2016

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2015

Construction of Syngas-to-Methanol Island

2018

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2020

Construction of Syngas-to-Methanol Island

2022

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2024

Construction of Syngas-to-Methanol Island

2026

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2028

Construction of Syngas-to-Methanol Island

2030

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2032

Construction of Syngas-to-Methanol Island

2034

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2036

Construction of Syngas-to-Methanol Island

2038

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2040

Construction of Syngas-to-Methanol Island

2042

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2044

Construction of Syngas-to-Methanol Island

2046

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2048

Construction of Syngas-to-Methanol Island

2050

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2052

Construction of Syngas-to-Methanol Island

2054

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

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Construction of Syngas-to-Methanol Island

2058

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2060

Construction of Syngas-to-Methanol Island

2062

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2064

Construction of Syngas-to-Methanol Island

2066

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2068

Construction of Syngas-to-Methanol Island

2070

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2072

Construction of Syngas-to-Methanol Island

2074

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2076

Construction of Syngas-to-Methanol Island

2078

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2080

Construction of Syngas-to-Methanol Island

2082

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2084

Construction of Syngas-to-Methanol Island

2086

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2088

Construction of Syngas-to-Methanol Island

2090

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2092

Construction of Syngas-to-Methanol Island

2094

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2096

Construction of Syngas-to-Methanol Island

2098

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2100

Construction of Syngas-to-Methanol Island

2102

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2104

Construction of Syngas-to-Methanol Island

2106

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2108

Construction of Syngas-to-Methanol Island

2110

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2112

Construction of Syngas-to-Methanol Island

2114

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2116

Construction of Syngas-to-Methanol Island

2118

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2120

Construction of Syngas-to-Methanol Island

2122

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2124

Construction of Syngas-to-Methanol Island

2126

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2128

Construction of Syngas-to-Methanol Island

2130

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2132

Construction of Syngas-to-Methanol Island

2134

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2136

Construction of Syngas-to-Methanol Island

2138

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2140

Construction of Syngas-to-Methanol Island

2142

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2144

Construction of Syngas-to-Methanol Island

2146

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2148

Construction of Syngas-to-Methanol Island

2150

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2152

Construction of Syngas-to-Methanol Island

2154

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2156

Construction of Syngas-to-Methanol Island

2158

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2160

Construction of Syngas-to-Methanol Island

2162

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2164

Construction of Syngas-to-Methanol Island

2166

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2168

Construction of Syngas-to-Methanol Island

2170

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2172

Construction of Syngas-to-Methanol Island

2174

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2176

Construction of Syngas-to-Methanol Island

2178

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2180

Construction of Syngas-to-Methanol Island

2182

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2184

Construction of Syngas-to-Methanol Island

2186

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2188

Construction of Syngas-to-Methanol Island

2190

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2192

Construction of Syngas-to-Methanol Island

2194

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2196

Construction of Syngas-to-Methanol Island

2198

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)

2200

Construction of Syngas-to-Methanol Island

2202

Secured: Valero (downstream: blending), GreenField Ethanol (distributor: largest traditional ethanol producer in Canada)
Fiberight is a privately held company founded in 2007 with current operations in Virginia, Maryland, and Iowa. Fiberight applies its proprietary technology to refine municipal solid waste (MSW) and waste fiber pulp into cellulosic sugars that can be further processed into cellulosic biofuels. Fiberight demonstrated the ability to produce commercial scale batches of cellulosic ethanol at its Iowa plant in 2010. Fiberight is targeting rapid expansion of its prototype commercial plants in population dense municipalities with high-stranded trash costs or landfill limitations.

**REFERENCE COMMERCIAL FACILITY**
**LOCATION:** Lawrenceville, VA
**FEEDSTOCK:** Municipal solid waste, commercial waste, energy crops
**PRODUCTS:** Cellulosic Ethanol/biofuels, Cellulosic Sugars, Bio-chemicals
**CAPACITY:** 1 MGY
**PLANT PROFILE:** Utilized to test core business and technology platforms since 2007; upgraded in 2011 to be fully integrated MSW-to-biofuels reference commercial plant; operations commenced in 2012 with 20+ employees.

**PATH TO COMMERCIAL DEPLOYMENT**

- **2008**: Lab scale research continues
- **2009**: Pilot scale testing in Lawrenceville
- **2010**: Purchase of Blairstown commercial ethanol facility
- **2011**: Engineering and design completed for full-scale demo testing in Blairstown
- **2012**: Equity funding for reference commercial plant secured
- **2013**: Design & engineering for Lawrenceville reference commercial plant
- **2014**: USDA loan guarantee secured
- **2015**: Lawrenceville reference commercial plant processing begins
- **2016**: Novozymes partnership formalized
- **2017**: Fiberight to let put MSW-to-cellulosic ethanol EPA pathway approved
- **2018**: Blairstown commercial facility constructed; operations commence
- **2019-2020**: 2-4 additional commercial plants constructed in Mid-Atlantic, Iowa Expansion
- **2021-2022**: Estimated completion 2013

**Fiberight Partners**
**Private Equity:** Confidential Private Equity Fund, SEC Reg. D offering completed in 2012 - $15M
**Strategic:** Novozymes
**Government/Public:** Iowa Power Fund - $2.9M, USDA Loan Guarantee - $25M
Fulcrum BioEnergy

Company Profile

Founded in 2007, Fulcrum BioEnergy is headquartered in Pleasanton, California. The company operates a process demonstration unit in Durham, North Carolina that converts synthesis gas to ethanol. Fulcrum is ready to begin construction on a commercial-scale advanced biofuels facility, the Sierra BioFuels Plant, that will convert municipal solid waste (MSW) into ethanol. Sierra is located near Reno, Nevada.

Process Demonstration Facility

**Location:** Durham, NC  
**Feedstock:** Synthesis Gas  
**Products:** Ethanol  
**Capacity:** Fulcrum’s alcohol synthesis PDU operates with a full-scale tubular reactor packed with catalyst under the same operating parameters that will be used at its commercial-scale plants  
**Plant Profile:** The PDU converts synthesis gas to ethanol – the second step in Fulcrum’s waste-to-ethanol process. The PDU has operated in excess of 20,000 hours over a period of three and a half years.

Fulcrum Partners

**Private Equity:** Raised $93 million of capital in 2011 from investors such as US Renewables Group, Rustic Canyon and Waste Management.  
**Strategic:** Fulcrum has partnered with Waste Connections and Waste Management, two of the nation’s largest waste companies, for long-term feedstock supply and joint development activities. These agreements give Fulcrum the ability to produce more than 700 million gallons of ethanol per year throughout the United States.  
**Government/Public:** Fulcrum received a $105 million conditional commitment for a USDA loan guarantee in August 2012. The final terms are currently being negotiated with the USDA.

**Path to Commercial Deployment**

2008  
- Acquired development rights for Sierra; entered into technology licensing and development agreements; executed MSW feedstock agreement for Sierra

2009  
- Engineered, constructed and commenced operation of alcohol synthesis PDU; demonstrated at full-scale Fulcrum’s proprietary process for the conversion of synthesis gas to alcohol
- Signed EPC contract with Fluor Corporation
- Executed offtake agreement with Sierra BioFuels

2010  
- Raised $93 million of equity capital for Sierra BioFuels
- Began site preparation work for Sierra BioFuels

2011  
- Sierra BioFuels began construction activities for its 10 MGy plant
- Completed engineering phase of Sierra BioFuels
- Completed engineering phase of Sierra BioFuels

2012  
- Completed engineering phase of Sierra BioFuels

2013  
- Continued EPC activities of Sierra BioFuels
- Commercial operations to begin at Sierra BioFuels Plant
- Construction of additional commercial scale MSW-to-ethanol projects to commence throughout the US

2014  
- Continued EPC activities of Sierra BioFuels
- Commercial operations to begin at Sierra BioFuels Plant
- Development of additional commercial scale MSW-to-ethanol projects to commence throughout the US

2015  
- Construction of additional commercial scale projects to begin
Inbicon began pioneering biomass conversion technology in the late 1990s. Using steam, enzymes, and yeast, Inbicon turns soft lignocellulose (e.g., wheat straw, corn stalks, energy grasses) into cellulosic ethanol, as well as renewable lignin and industrial sugar molasses for power and bio-chemicals. Inbicon is a subsidiary of DONG Energy, Denmark’s largest energy company with 6,000 employees and $9.8 billion in revenues (2011). DONG Energy has invested over $100 million to develop and commercialize Inbicon technology, which is licensed worldwide.

Inbicon Partners
Marketing: Leifmark, LLC is the independent Inbicon partner authorized to license Inbicon Biomass Refinery technology in North America. Leifmark has developed a pipeline of U.S. projects, including the Fair Oaks (IN) and Spiritwood (ND) projects.
U.S. Engineering: To assure quality control for U.S. projects, Inbicon has certified three American firms to perform engineering for U.S. projects: Harris Group (Seattle, WA); Pöyry (Appleton, WI); and, APS (Richmond, VA).
Enzyme: Novozymes; DuPont Genencor
Project Finance: Inbicon is working with the Danish Export Fund (EKF) to bring loan guarantees to its North American projects.

Inbicon Kalundborg plant is currently sold at almost 100 stations/biogas stations in Denmark in E5 blends (5% cellulosic ethanol, 95% gasoline)
COMPANY PROFILE
INEOS Bio is a BioEnergy company producing advanced biofuels and renewable power from a wide range of low-cost carbon materials. The company’s highly innovative technology provides an alternative to waste disposal for communities around the globe. INEOS Bio is one of the global businesses in INEOS.

Company Profile
INEOS Bio is a BioEnergy company producing advanced biofuels and renewable power from a wide range of low-cost carbon materials. The company’s highly innovative technology provides an alternative to waste disposal for communities around the globe. INEOS Bio is one of the global businesses in INEOS.

The INEOS Bio technology is a combined thermo-chemical and bio-chemical process that efficiently converts a wide range of organic materials, including municipal solid waste, yard, forestry and agricultural waste into ethanol and renewable energy. This flexibility allows facilities to be built anywhere in the world, providing jobs and locally sourced renewable energy for urban and rural communities.

COMMERClAL FACILITY
LOCATION: Vero Beach, FL
STATUS: Commissioning Stage
FEEDSTOCK: Vegetative and Yard waste; MSW
PRODUCTS: Cellulosic ethanol and renewable power
CAPACITY: 8 MGY; 6MW (gross) electricity generation
JOBS: 400 direct and indirect jobs, 60 full time
PLANT PROFILE: The site, adjacent to the Indian River County landfill, ensures flexibility and long-term feedstock availability.

INEOS Partners
Marketing: JV Project between INEOS Bio and New Planet BioEnergy
Strategic: (Project) AMEC, Air Products, VogelBusch, Emerson, CDM-Smith
Public/Government: $50MM (DOE) grant, $75MM (USDA) loan guarantee, $2.5MM (State of Florida) grant

PATH TO COMMERCIAL DEPLOYMENT

INoES-VErO BEnACH CoMMERcIAl FACILITy

FEEDSTOCK STORAGE AT INEOS FACILITY

OPERATIONAL SINCE 2003

RESEARCH AND DEVELOPMENT FACILITY
LOCATION: Fayetteville, AR
FEEDSTOCK & PRODUCTS: Synthesis Gas, Ethanol, Other
CAPACITY: 1.5 tons per day
PLANT PROFILE: INEOS Bio utilizes its integrated pilot plant to test, prove and optimize its proprietary technology. INEOS Bio’s pilot plant and research and development facility represents a vitally important step on the road to commercialization. The company will continue to operate its pilot plant in parallel with its commercial and licensed facilities. Experience has shown that continued development and research with an integrated pilot plant supports an overall continuous improvement process that benefits our licensees and operating facilities.
Since Iogen’s founding in the late 1970s, more than $425 million has been invested in Iogen’s cellulosic ethanol technology, including more than $75 million in the Iogen demonstration plant in Ottawa. Investors include Royal/Dutch Shell, Goldman Sachs, Petro Canada, and Volkswagen. The company, based in Ottawa, has produced more than $50,000 gallons of cellulosic ethanol to date and holds more than 250 patents. Iogen also operates a thriving business making enzymes that digest fiber.

**Demonstration Facility**

**Location:** Ottawa, ON, Canada

**Feedstock:** Cereal Straw, Bagasse, Corn Stover, Grasses

**Products:** Cellulosic Ethanol

**Capacity:** 1 MGY

**Plant Profile:** Fully integrated plant with all key unit options; started ethanol production in 2005. Has undergone regular upgrades and improvements resulting from learnings of integrated 24x7 operation and technology improvements from R&D.

**Iogen Partners**

**Private Equity:** $425 million aggregate investment through partners including: Royal Dutch/Shell Group, Goldman Sachs & Co., Volkswagen and Petro-Canada.

**Strategic:** Iogen is currently working closely with Raízen, Brazil’s largest sugar and ethanol producer and a 50:50 JV between Royal/Dutch Shell and Cosan.

**Government/Public:** $20MM from Government of Canada, of which $10MM (Technology Partnership Canada) was for Ottawa demonstration facility.

**Commercial Strategy**

**Location:** Piracicaba, São Paulo, Brazil

**Status:** Development and Engineering

**Feedstock:** Bagasse

**Products:** Cellulosic Ethanol

**Capacity:** To be Determined

**Project Profile:** Raízen Group, the world’s largest producer of sugarcane ethanol, has made an initial investment in Iogen Energy to develop a commercial cellulosic ethanol project in Brazil. The investment will cover development and engineering costs associated with the front end design of a bagasse-to-ethanol facility to be co-located with Raízen’s Costa Pinto facility in Piracicaba, São Paulo.

**Path to Commercial Deployment**

<table>
<thead>
<tr>
<th>Year</th>
<th>Cumulative Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>129,547 (34,233)</td>
</tr>
<tr>
<td>2006</td>
<td>16,811 (4,441)</td>
</tr>
<tr>
<td>2007</td>
<td>2,598 (686)</td>
</tr>
<tr>
<td>2008</td>
<td>264,525 (70,508)</td>
</tr>
<tr>
<td>2009</td>
<td>581,042 (153,495)</td>
</tr>
<tr>
<td>2010</td>
<td>538,781 (144,426)</td>
</tr>
<tr>
<td>2011</td>
<td>371,025 (98,368)</td>
</tr>
<tr>
<td>2012</td>
<td>219,090 (57,877)</td>
</tr>
</tbody>
</table>

*2012: to July 31, 2012*
KiOR is a next-generation renewable fuels company that has developed a unique two-step proprietary technology platform to convert abundant and sustainable biomass resources into cellulosic gasoline, diesel, jet fuel and fuel oil. KiOR’s cellulosic biofuels may be transported using existing distribution networks and are suitable for use in vehicles on the road today. KiOR strives to help ease dependence on foreign oil, reduce lifecycle greenhouse gas emissions and create high-quality jobs and economic benefit across rural communities.

KiOR has developed a proprietary technology platform to convert sustainable, low-cost biomass into a hydrocarbon-based renewable crude oil. The platform combines proprietary catalyst systems with a process based on existing Fluid Catalytic Cracking (FCC) technology, a standard process used for over 60 years in oil refining. KiOR processes its renewable crude oil in a conventional hydrotreater into gasoline and diesel blendstocks that can be combined with existing fossil-based fuels used in vehicles on the road today.

**KiOR Partners**

**Private Equity/Investment:** Initial public offering proceeds were approximately $148.6 million. Major stock ownership: Class A & B shares - 57.2 million/Khosla Ventures; 17.5 million/Artis Capital Management; 8.5 million/Alberta Investment Management Corporation. Class C shares 3.0 million – Khosla Ventures.

**Public/Government:** Mississippi Development Authority loan for $75 million, and significant support from other state departments as well as local economic development teams.

**COMPANY PROFILE**

KiOR demonstration facility

**KIOR COMPANY PROFILE**

KiOR began operations in 2010

KiOR Partners

KiOR has developed a proprietary technology platform to convert sustainably sourced, low-cost biomass into a hydrocarbon-based renewable crude oil. The platform combines proprietary catalyst systems with a process based on existing Fluid Catalytic Cracking (FCC) technology, a standard process used for over 60 years in oil refining. KiOR processes its renewable crude oil in a conventional hydrotreater into gasoline and diesel blendstocks that can be combined with existing fossil-based fuels used in vehicles on the road today.

**Demonstration Facility**

LOCATION: Pasadena, TX

FEEDSTOCK: Forestry Residuals

PRODUCTS: Cellulosic Gasoline, Cellulosic Diesel for R&D and business development purposes

CAPACITY: 15 barrels per day

**Plant Profile:** Produces up to 15 barrels of renewable crude oil per day; facility co-located with R&D operations with approximately 100 employees, 30 of whom are Ph.D.’s.

**2nd Commercial Project Under Development**

LOCATION: Natchez, MS

FEEDSTOCK: Forestry Residuals

PRODUCTS: Cellulosic Gasoline & Cellulosic Diesel

CAPACITY: 40 MGy

JOBS: 60-70 direct, several hundred indirect

**Project Profile:** $350 million investment; flagship commercial project serving as logistical hub for production and delivery; construction beginning early 2013 with ~500 construction employees.

**PATH TO COMMERCIAL DEPLOYMENT**

- 2008
  - “Proof of concept” achieved at Pilot Plant in Pasadena
- 2009
  - Validated technical feasibility of proprietary processes
  - Successfully converted biomass into an intermediate renewable crude oil that can be refined into cellulosic gasoline
- 2010
  - Continued work on technical feasibility, R&D & commercialization
- 2011
  - Demonstration unit installed in Pasadena (50X scale up from pilot plant), capable of producing up to 15 barrels per day at Site selection for first commercial facility
  - Break ground at Columbus commercial plant (500X scale up from demo plant), capable of producing up to 13 million gallons of cellulosic biofuels per year
  - Signed off-take agreements with Hunt Refining, Castlight Energy and FedEx
  - Initial public offering (IPO) successful
- 2012
  - Secured additional financing
  - Completed construction of Columbus commercial plant & commenced operations
  - Received Title 79 Registration from EPA for sale of cellulosic gasoline and diesel
  - Due diligence on next facility started
- 2013
  - Start construction at two additional plants
- 2014
  - Start construction at two additional plants
- 2015
  - Start construction at two additional plants

KiOR Demonstrations Facility

KiOR Commercial Project in Columbus, MS
**COMPANY PROFILE**

Founded in 2005 LanzaTech offers a fully integrated sustainable fuels and chemicals platform that uses available waste resources to produce fuels such as ethanol and chemicals such as 2,3Butanediol (2,3BDO) at high selectivity and yield. Since 2008, the company has been operating a 15,000 gallon per year waste-gas to ethanol facility in New Zealand and this year scaled its platform to a 100,000 gallons per year demo facility in Shanghai, China. LanzaTech is headquartered in Chicago, IL and has additional offices in New Zealand, China and India.

**LANZATECH PARTNERS**

Private Equity: LanzaTech has raised more than $100 million in private equity and debt financing. Investors include Khosla Ventures, Qiming Venture Partners, K1W1, Malaysian Life Sciences Capital Fund, Western Technology Investment, PETRONAS Technology Ventures Sdn Bhd, Dialog Group

Strategic: PETRONAS, INVISTA, Baosteel, Capital Steel, Virgin Atlantic


LanzaTech’s gas fermentation technology converts carbon containing gases produced by industries such as steel manufacturing and oil refining, as well as gases generated from forestry and agricultural residues, municipal waste, and coal, into valuable fuel and chemical products.

**PATH TO COMMERCIAL DEPLOYMENT**


- **Pilot Plant becomes operational in NZ**
- **First Plant operating at 15,000 gal/year capacity**
- **LanzaTech successfully produces 2,3-Butanediol in key building block used to make polymers, plastics and hydrocarbon fuels**
- **Construction begins on Baosteel demonstration facility**
- **First demo facility becomes operational in China**
- **Second demonstration facility becomes operational**
- **Full commercial scale plant to be constructed with Baosteel**
- **Construction begins on Soperton Plant**
- **Production at Freedom Pines Commercial Biorefinery begins**
- **Full scale commercial plant with Baosteel to be operational**
- **Construction of second commercial plant (Capital Steel) begins**
- **MSW to ethanol commercial project to be constructed in Asia**
- **Second Commercial Facility operating in China (Shougang)**

- **COMMERCIAL FACILITY**

  **LOCATION:** Soperton, GA
  **STATUS:** Under Development
  **FEEDSTOCK:** Waste biomass from regional forest operations
  **PRODUCTS:** Ethanol, chemicals, aviation fuel
  **CAPACITY:** 4 MGY
  **JOBS:** Estimated 75 direct jobs in 2014
  **PLANT PROFILE:** Freedom Pines is expected to begin production in 2014.

- **DEMONSTRATION FACILITY**

  **LOCATION:** Caofeidian, China
  **FEEDSTOCK:** Waste CO from Capital Steel Mill
  **PRODUCTS:** Ethanol
  **CAPACITY:** 100,000 Gpy
  **PLANT PROFILE:** Will be a fully integrated demonstration facility. Capital Steel will take LanzaTech’s process to commercial scale.

- **DEMONSTRATION FACILITY**

  **LOCATION:** Shanghai, China
  **FEEDSTOCK:** Waste CO from Baosteel Steel Mill
  **PRODUCTS:** Ethanol
  **CAPACITY:** 100,000 Gpy
  **PLANT PROFILE:** The demo facility is the pre-cursor to a full commercial facility, planned for 2013, with an estimated capacity of 30 million gallons per year.
Mascoma Corporation, founded in 2005, is a renewable fuels company that has developed an innovative, highly adaptable technology for the low-cost conversion of abundant biomass into cellulosic ethanol and renewable chemicals. Using its proprietary consolidated bioprocessing (CBP) technology platform, Mascoma has also developed bioengineered yeasts and other microorganisms to reduce costs and improve yields in the production of renewable fuels and chemicals. The company operates a demonstration facility in Rome, New York to evaluate new technologies and conduct large-scale process demonstration runs. Mascoma also operates a research and development laboratory in Lebanon, New Hampshire and maintains offices in Waltham, Massachusetts and Toronto, Canada.

Mascoma Partners


Commercial: Lallemand Inc., a global developer, producer and marketer of yeast, bacteria and related products, to commercialize the TransFerm yeast product, which is the first commercial application of Mascoma’s proprietary consolidated bioprocessing (CBP) technology platform.

Public/Government: Cooperative agreement with DOE for up to $80MM to assist in the design, construction and operation of commercial-scale hardwood cellulosic ethanol facility in Kinesso, Michigan; $20MM in R&D assistance (DOE) for Kinesso, MI project; $20MM grant agreement with the Michigan Economic Development Corporation for Kinesso, MI facility; $20MM grant agreement with the NY State Energy Research and Development Authority to assist building and operation of demonstration plant in Rome, New York.

Path to Commercial Deployment


- 1st gallon of cellulosic ethanol produced at Rome, NY demonstration facility
- Initiated complete cellulosic ethanol process validation runs at Rome, NY demonstration facility
- Awarded $20MM grant from Michigan Economic Development Corporation for Kinesso, MI project
- Awarded $20MM grant agreement with the Michigan Economic Development Corporation for Kinesso, MI facility
- Awarded $20MM grant agreement with the NY State Energy Research and Development Authority to assist building and operation of demonstration plant in Rome, New York
- Awarded up to $30MM in funding from DOE to assist in development of a commercial-scale cellulosic ethanol facility in Kinesso, MI
- Demonstrated $2.00/gallon cash operating cost and hardwood to ethanol conversion yield of 71 gallons per bone dry ton at NY demonstration facility
- Acquired SunOpta Bioprocess, a company that provides pretreatment equipment and process solutions for biomass conversion
- Received contractor bids for Kinesso, MI facility and conducted final engineering design work
- Ground breaking at Kinesso, MI commercial facility
- Ground breaking at 2nd commercial-scale cellulosic ethanol facility in Drayton Valley, Alberta, Canada
- Construction completed, first gallons produced at Kinesso, MI commercial facility
- Target: 2016/17 timeframe
- Target: 2015/16 timeframe
- Target: 2014/15 timeframe
- Target: 2013/14 timeframe
- Target: 2012/13 timeframe
- Target: 2011/12 timeframe
- Target: 2010/11 timeframe
- Target: 2009/10 timeframe
- Target: 2008/09 timeframe
- Target: 2007/08 timeframe
- Target: 2006/07 timeframe
- Target: 2005/06 timeframe

Commercial Project

Location: Kinesso, MI
Status: Final Engineering, Closing Financing
Feedstock: Wood pulp and chips
Products: Cellulosic ethanol
Capacity: 20 MGY
Jobs: 150 construction jobs; 60 permanent operations jobs, up to 500 indirect jobs according to State of Michigan
Project Profile: First-of-its-kind 20 million gallons per year cellulosic ethanol facility utilizing proprietary CBP technology, agreement in place for hardwood pulpwood feedstocks to be sourced from Michigan counties located within a 150-mile radius area of the site.

Demonstration Facility

Location: Rome, NY
Feedstock: Multiple feedstock (biomass)
Products: Cellulosic ethanol, biochemicals
Capacity: 200,000 GPY
Plant Profile: Ground breaking, December 2007; first fermentation, June 2008. Currently employs 15 operations staff. Completed 1,000 hour extended validation run using Mascoma’s hardwood CBP microorganisms.

Began Operations 2008

Mascoma Commercial Project

Estimated Completion 2014/15
POET-DSM Advanced Biofuels, LLC is a 50/50 joint venture between Royal DSM and POET, LLC. Based in Sioux Falls, SD, the joint venture utilizes a proprietary technology to convert corn crop residue into cellulosic bio-ethanol. POET-DSM’s first commercial-scale plant, dubbed Project LIBERTY, will produce 20 MGY of cellulosic bio-ethanol. Based on this plant the JV plans to license globally an integrated technology package for the conversion of corn crop residue to cellulosic bio-ethanol.

**Company Profile**

POET-DSM partners

**Strategic:** JV between DSM (enzymes and yeast) POET (process, feedstock procurement). Each party to contribute ~ 50% of the value to the JV. DSM will contribute $150MM in equity and debt financing. POET will contribute the existing Project LIBERTY, including secured grants from the U.S. Department of Energy and the State of Iowa.

**Public/Government:** $100MM in grants from U.S Department of Energy; $14.8MM grant from State of Iowa for biorefinery construction, engineering and feedstock acceleration activities; $5.25MM in credits from State of Iowa for tax and training.

**Demonstration Facility**

**Location:** Scotland, SD

**Feedstock:** Corn Crop Residue

**Products:** Ethanol, Biogas

**Capacity:** 20,000 GPy

**Plant Profile:** POET’s pilot/demo cellulosic ethanol plant has been crucial to improving the process for commercial-scale production. Preliminary harvests by Iowa farmers are helping solidify the feedstock pipeline for Project LIBERTY.

**Began Operations:** 2008

**Project LIBERTY**

**Location:** Emmetsburg, IA

**Status:** Under Construction

**Feedstock:** Corn Crop Residue

**Products:** Ethanol, Biogas

**Capacity:** 20 MGY, later growing to 25 MGY

**Jobs:** 37 biorefinery jobs, 309 direct construction jobs

**Project Profile:** Located adjacent to current POET grain ethanol plant; 22-acre biomass stackyard completed, first commercial biomass harvest (56,000 tons) (85,000 tons); significant cost reductions at pilot facility, 12,000 acres of biomass harvested; DSM identifies enzyme system effective at breaking down lignino-cellulose tocomponent sugars at increased thermal stability; continuing to ramp up farmer contracts for biomass harvesting toward goal of 265,000 tons per year.

**Path to Commercial Deployment**

- **2008:** Poet pilot plant becomes operational, second round of biomass harvested testing
- **2009:** DSM starts extensive enzyme development program for cellulosic ethanol
- **2010:** Significant cost reductions at pilot facility, 12,000 acres of biomass harvested
- **2011:** Commercial biomass stackyard completed; first commercial biomass harvest (56,000 tons)
- **2012:** DSM identifies enzyme system effective at breaking down lignin-cellulose to component sugars at increased thermal stability; second commercial biomass harvest (61,000 tons)
- **2013:** Site work started on commercial-scale biorefinery; site work started on commercial-scale biorefinery
- **2014:** Second commercial biomass harvest (65,000 tons); DSM acquires C5 Yeast Company from NovoC
- **2015:** Joint venture formed with Royal DSM; vertical construction begins on commercial-scale biorefinery; third commercial biomass harvest (65,000 tons); anticipated completion of construction at commercial-scale facility; validate technology at commercial scale; validate technology at commercial scale; validate technology at commercial scale
Incorporated in 2002, ZeaChem Inc. is headquartered in Lakewood, Colorado. The company operates a research and development laboratory facility in Menlo Park, California, and a 250,000 gallon per year demonstration biorefinery in Boardman, Oregon. ZeaChem has developed a cellulose-based biorefinery platform capable of producing advanced biofuels and bio-chemicals.

**DEMONSTRATION FACILITY**

LOCATION: Boardman, OR  
FEEDSTOCK: Poplar Trees, Wheat Straw  
PRODUCTS: Cellulosic Ethanol, Bio-Chemicals  
CAPACITY: 250,000 GPY  
PLANT PROFILE: Construction completed on schedule and significantly under budget; created 52 construction jobs and employs 36 full-time operations staff in the region.  
Phase 1: high-value bio-chemicals for paints and lacquers  
Phase 2: cellulosic ethanol and bio-chemicals by YE12  
Phase 3: cellulosic jet and diesel (‘13).

**COMPANY PROFILE**

ZeaChem Partners


Strategic: Chrysler Group LLC (fuels); P&G (bio-chemicals)

Government/Public: $25MM (DOE) cooperative agreement to support construction of demonstration facility; $40MM (USDA) cooperative agreement with Univ. of Washington and others to expand the demo plant for bio-based jet and diesel production; $17MM Biomass Crop Assistance Program (BCAP) grant from the USDA to GreenWood Resources, ZeaChem’s primary feedstock supplier to establish and maintain 7,000 acres of intercropped poplar trees for the demo and 1st commercial facilities; $232.5MM (USDA) conditional loan guarantee to support the financing of the 1st commercial plant.

ZeaChem utilizes a hybrid process of biochemical and thermochemical processing that preserves the best of both approaches from yield and economic perspectives.

**PATH TO COMMERCIAL DEPLOYMENT**

- **2008**
  - Raised $34MM Series B
  - Selected as one of 19 advanced biofuels projects for DOE Integrated Biorefinery cooperative agreement ($25MM)
  - Proved technology at pilot scale
- **2009**
  - Established partnerships with Chrysler and P&G
- **2010**
  - Begun operations at demonstration biorefinery, cellulosic ethanol production by YE10
  - Estimated start of production of cellulosic jet and diesel fuel at demo scale
- **2011**
  - Begun operations at demonstration biorefinery, cellulosic ethanol production by YE12
  - Selected for USDA conditional loan guarantee for 1st commercial plant
  - Anticipated start of construction on 1st commercial biorefinery
- **2012**
  - Anticipated start of production at 1st commercial biorefinery
- **2013**
  - Anticipated start of production at 2nd commercial biorefinery
- **2014**
  - Anticipated start of production at 3rd commercial biorefinery
- **2015**
  - Estimated start of production at 4th commercial biorefinery