

CELLULOSIC BIOFUELS

INDUSTRY PROGRESS REPORT 2012-2013

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.

THE FUEL

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.

THE TECHNOLOGY

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.

THE OPPORTUNITY

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.

INDUSTRY PROGRESS

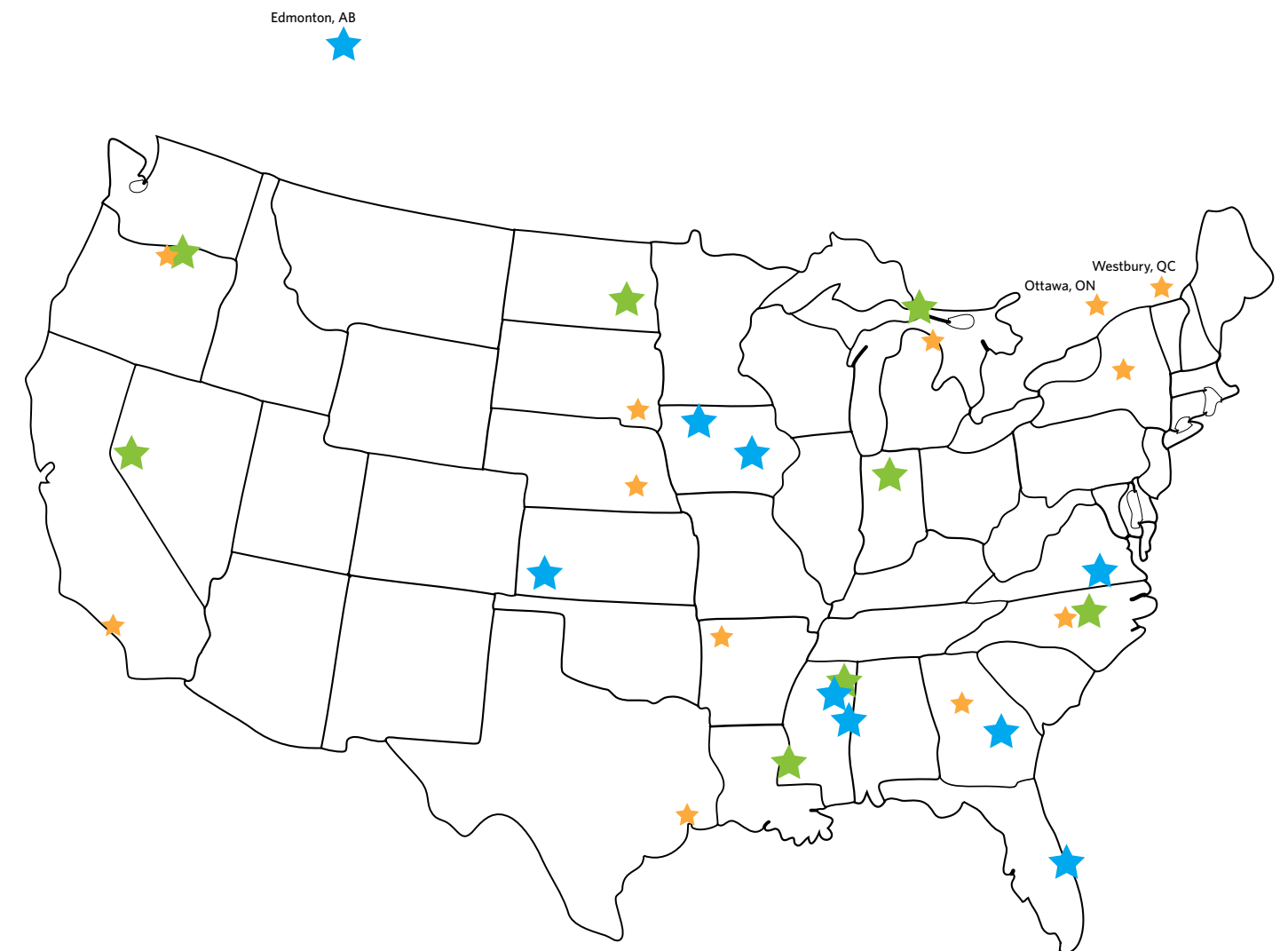
The RFS was amended to include cellulosic biofuels just 5 years ago. Despite the global recession, the cellulosic biofuels industry now has facilities and projects under development in more than 20 U.S. states representing billions of dollars in private investment. Enzyme costs are down 80% in the last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

THE CHALLENGE

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.

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 biofuel projects under development in the U.S and abroad, and does not cover other advanced biofuel sectors.

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.



KEY	 PILOT/DEMONSTRATION FACILITY
	 COMMERCIAL FACILITY (UNDER CONSTRUCTION/COMMISSIONING)
	 COMMERCIAL FACILITY (ENGINEERING STAGE)

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

BEGAN
OPERATIONS
2007



PILOT FACILITY

LOCATION: York, NE
FEEDSTOCK: Wheat Straw, Corn Stover
PRODUCTS: Cellulosic Ethanol
CAPACITY: 20,000 GPY
PLANT PROFILE: Completed and first cellulosic ethanol produced in September 2007



BEGAN
OPERATIONS
2009



DEMONSTRATION FACILITY

LOCATION: Salamanca, Spain
FEEDSTOCK: Wheat and barley straw
PRODUCTS: Cellulosic Ethanol
CAPACITY: 1.3 MGY
PLANT PROFILE: Construction completed and first cellulosic ethanol produced in 2009.



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 EPA 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.



ESTIMATED
COMPLETION
4Q 2013

ABENGOA BIOENERGY COMMERCIAL SITE

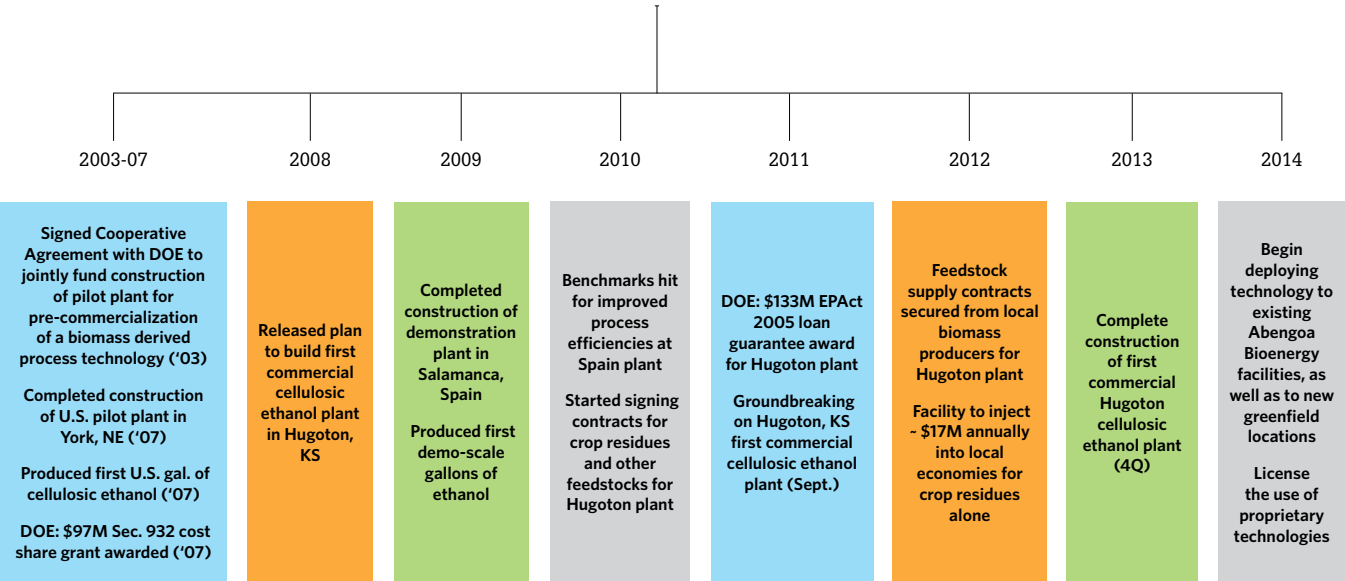


COMMERCIAL FACILITY

LOCATION: Hugoton, KS
STATUS: Under construction
FEEDSTOCK: Agriculture residues, dedicated energy crops, prairie grasses
PRODUCTS: Cellulosic ethanol, 20 MW renewable electric power
CAPACITY: 25 MGY
JOBS: 300 construction; 65 operations; 120 external biomass procurement
PROJECT PROFILE: Construction started September 2011; will utilize proprietary enzymatic hydrolysis technology; 1,100 dry tons per day feedstock; construction complete December 2013, feedstock partners secured.



PATH TO COMMERCIAL DEPLOYMENT





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.

BEGAN
OPERATIONS
2012



AMERICAN PROCESS GREEN POWER+ DEMO 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
PLANT 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);
AVAPCO Strategic: ArborGen, Green Tech America, Metso, Novozymes
AVAPCO Public/Government: Private investment

ESTIMATED
STARTUP
1Q 2013



AVAPCO THOMASTON GA DEMONSTRATION FACILITY



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.



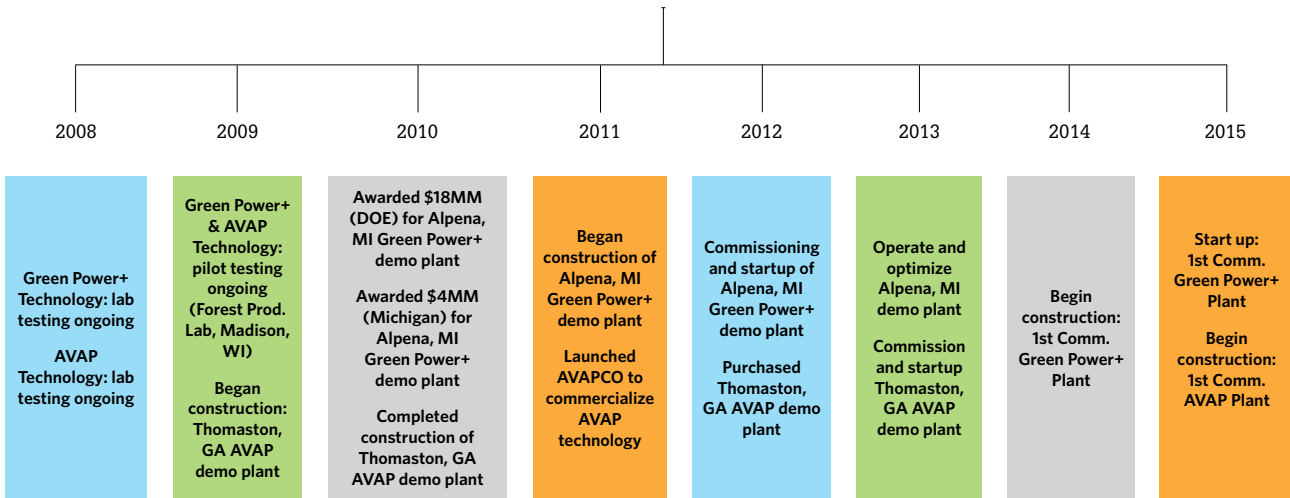
AVAP DEMONSTRATION FACILITY

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.



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.

BEGAN
OPERATIONS
2009



BETA RENEWABLES DEMONSTRATION FACILITY



DEMONSTRATION FACILITY

LOCATION: Rivalta, Italy

FEEDSTOCK: Variety of cellulosic, non-food biomass

PRODUCTS: Cellulosic Ethanol, Bio-based Chemicals

CAPACITY: One ton per day

PLANT PROFILE: Continuous operation since 2009.

BETA RENEWABLES COMMERCIAL FACILITY



STARTED
OPERATIONS
4Q 2012

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 MGY

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.



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

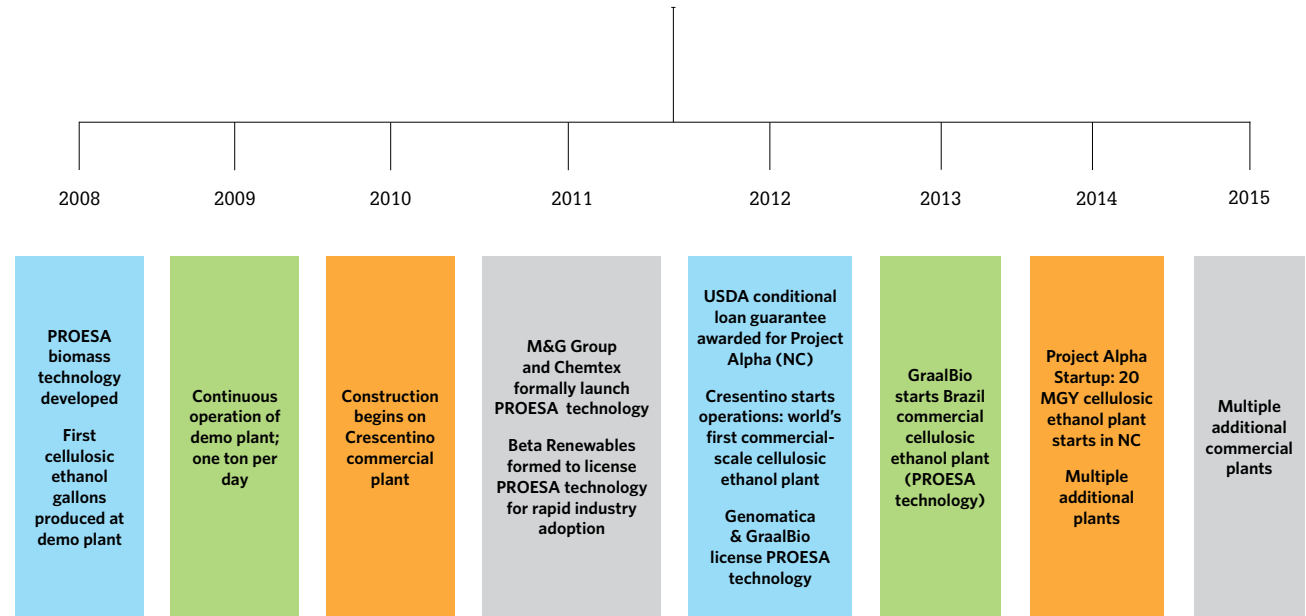
PRODUCTS: Cellulosic Ethanol, Bio-based Chemicals

CAPACITY: 20 MGY

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

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 SucreSource, which converts cellulose into intermediate sugars for the production of bio-chemicals and other products.



BEGAN
OPERATIONS
2010



BLUEFIRE DEMONSTRATION FACILITY



DEMONSTRATION FACILITY

LOCATION: Anaheim, CA

FEEDSTOCK: Various wood and paper wastes, MSW, bagasse

PRODUCTS: Cellulosic Sugars

CAPACITY: 200 lbs per day

PLANT PROFILE: Pilot testing complete; now utilized for production of cellulosic sugars for sale to companies developing processes to convert sugar to bio-products.

Bluefire Partners

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

Strategic: Feedstock Contract with Cooper Marine Timberlands, Off-Take Agreement with Tenaska Biofuels. EPC contract with MasTec North America, Applied Power Concepts

Project Development: Launched SucreSource, 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



BLUEFIRE PROCESS DESIGN

SucreSource, 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 SucreSource providing the process design package, equipment procurement and technical and engineering support.

ESTIMATED
COMPLETION
2014



BLUEFIRE COMMERCIAL SITE



COMMERCIAL FACILITY

LOCATION: Fulton, MS

STATUS: Site Preparation Completed. Pending financing for facility construction, recipient of \$87.5MM Dept of Energy grant

FEEDSTOCK: Forestry residues and other cellulosic wastes

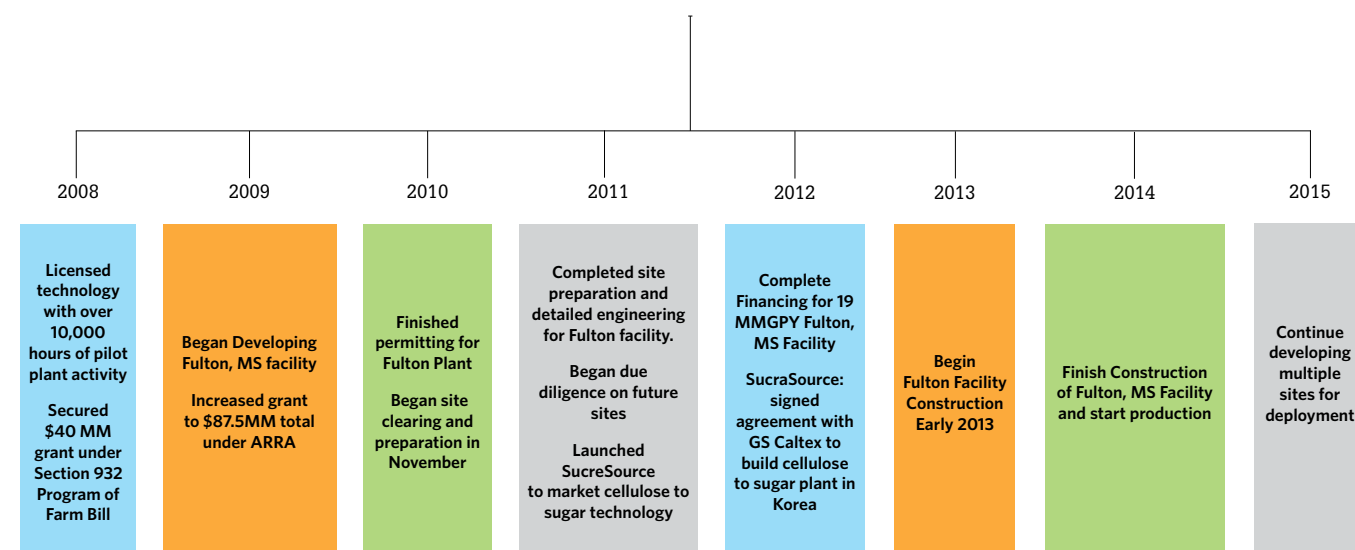
PRODUCTS: Cellulosic Ethanol, Gypsum, Lignin and Protein Cream

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.

PATH TO COMMERCIAL DEPLOYMENT



COMPANY PROFILE

Clariant, headquartered in Muttensz 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.



BEGAN
OPERATIONS
2009



CLARIANT RESEARCH FACILITY



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.



CLARIANT COMMERCIAL STRATEGY

STATUS: Clariant is in the process of evaluating site locations for the first commercial sunliquid® production plant in the U.S., EU, Brazil and Canada

FEEDSTOCK: Agricultural residues

PRODUCTS: Cellulosic Ethanol, Cellulosic Sugars, Bio-based Chemicals

CAPACITY: Feedstock dependent; range between 18-60 MGY

JOBS: To be determined

BEGAN
OPERATIONS
2012



CLARIANT DEMONSTRATION FACILITY



CLARIANT DEMONSTRATION FACILITY

DEMONSTRATION FACILITY

LOCATION: Straubing, Germany

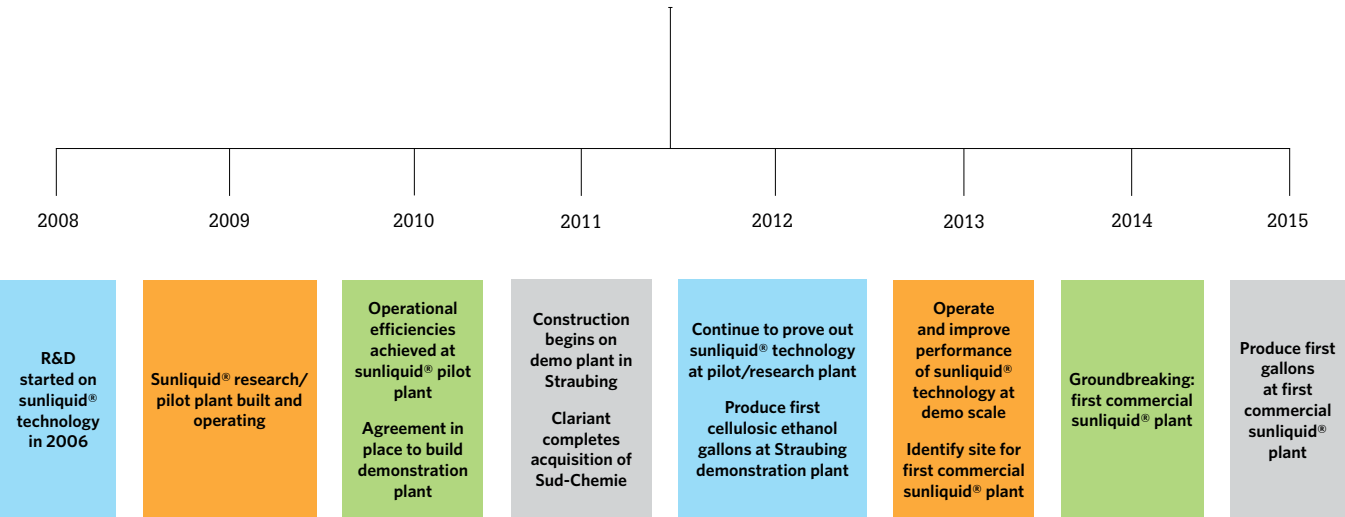
FEEDSTOCK: Agricultural Residues (Phase 1); Dedicated Energy Crops (Phase 2)

PRODUCTS: Cellulosic Ethanol, Cellulosic Sugars, Biobased Chemicals

CAPACITY: 330,000 GPY

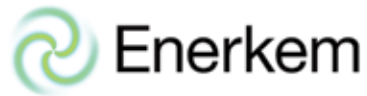
PLANT PROFILE: The plant produced the first volumes of cellulosic ethanol on July 20, 2012. The sunliquid® demonstration plant will produce cellulosic ethanol from a number of ligno-cellulosic feedstocks. The sunliquid® demo plant will demonstrate the technical and economical advantages of feedstock specific enzyme utilization, on-site process integrated enzyme production, simultaneous C5 and C6 fermentation in a one-pot reaction and an energy saving ethanol separation and purification process.

PATH TO COMMERCIAL DEPLOYMENT

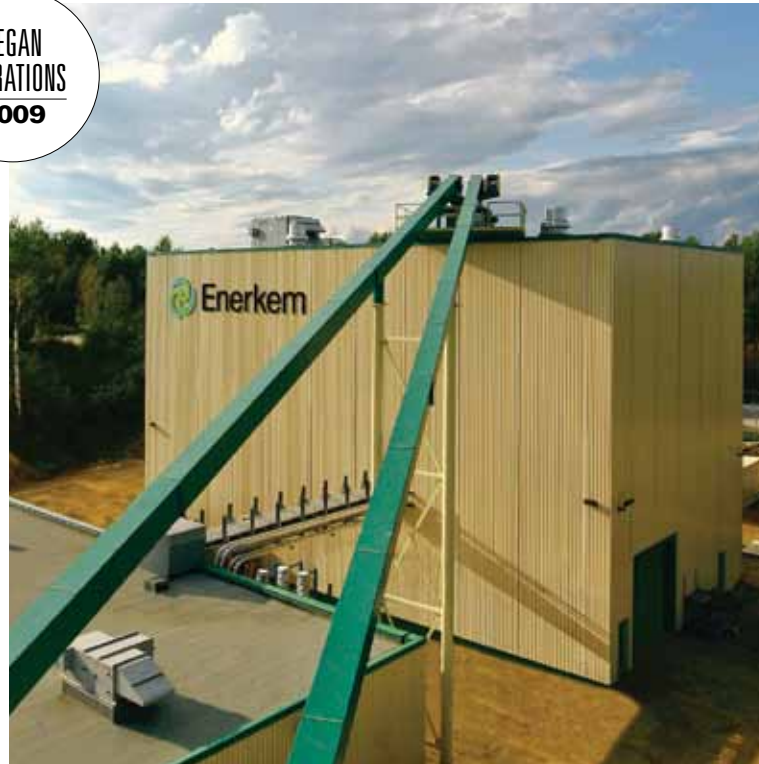


COMPANY PROFILE

Headquartered in Montreal, Canada, Enerkem employs 140 employees in the U.S. and Canada. Enerkem builds modular, copy-exact and scalable 10 million gallon per year biorefineries that utilize its proprietary thermochemical conversion technology to produce advanced ethanol and bio-chemicals from municipal solid waste (MSW). Founded in 2000, Enerkem started piloting its technology in 2003.



BEGAN
OPERATIONS
2009



DEMONSTRATION FACILITY

LOCATION: Westbury, QC, Canada

FEEDSTOCK: Used utility/telephone poles, municipal solid waste

PRODUCTS: Syngas, Biomethanol (2011), Cellulosic Ethanol (2012)

CAPACITY: 1.3 MGY

PROJECT PROFILE: Enerkem's Westbury facility is the first plant in the world to utilize used electricity poles (a negative-cost and heterogeneous material) to produce ethanol and methanol. The plant, co-located with a saw mill that recycles wood from utility poles, utilizes the portion of the pole that cannot be reclaimed. The plant began producing conditioned syngas in 2009, methanol in 2011, and cellulosic ethanol in 2012.



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

Enerkem Partners

Private Equity: Raised \$136MM in 3 rounds of financing since 2008 (Rho Ventures, Braemar Energy Ventures, Waste Management, Valero, BDR Capital, Cycle Capital, The Westly Group, Fondation CSN and Quince Associates, L.P.)

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

ESTIMATED
COMPLETION
2013



COMMERCIAL FACILITY

LOCATION: Edmonton, AB, Canada

STATUS: Phase 1 Completion in 3Q 2013

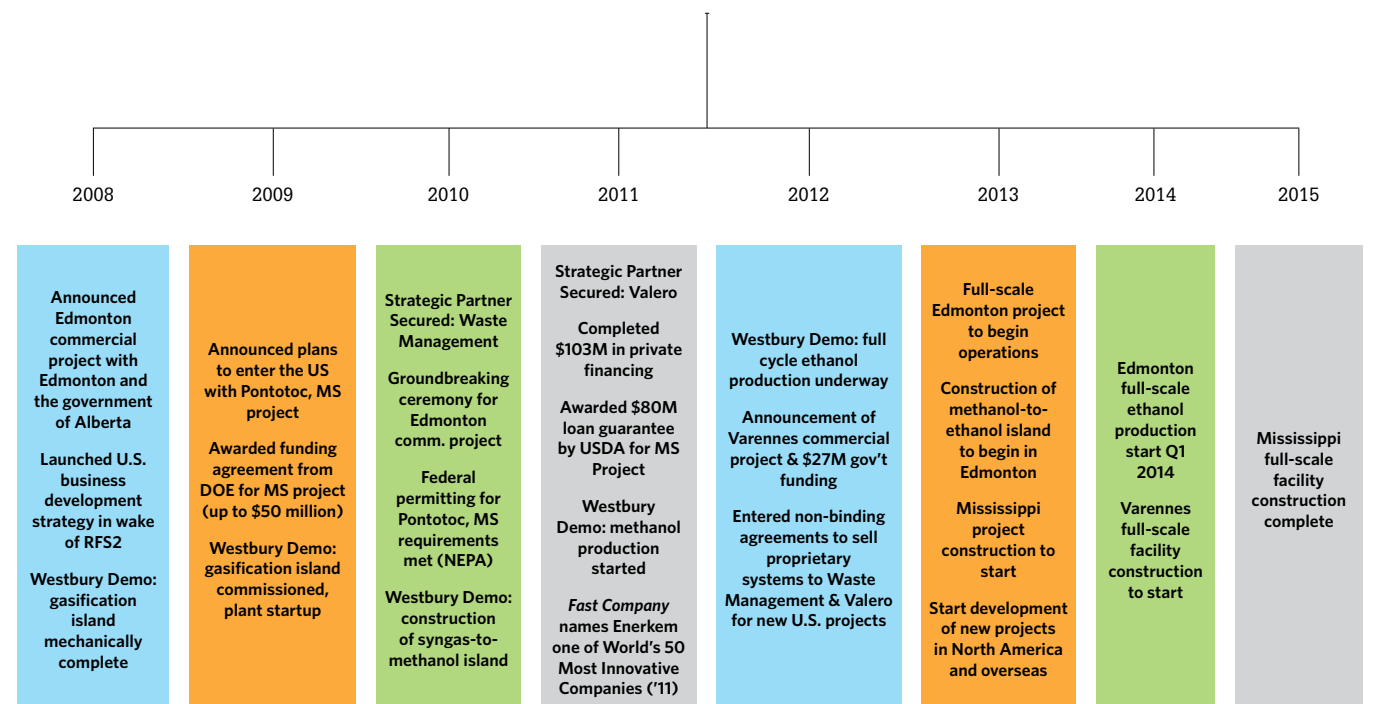
FEEDSTOCK: MSW from the City of Edmonton

PRODUCTS: Syngas, Biomethanol, Acetates, Cellulosic Ethanol

CAPACITY: 10 MGY

PLANT PROFILE: Enerkem has a 25-year agreement with the City of Edmonton to build and operate a plant that will produce next-generation biofuels from non-recyclable, non-compostable municipal solid waste (MSW). It is the world's first major collaboration between a metropolitan centre and a waste-to-biofuels producer to turn MSW into methanol and ethanol. The plant will produce U.S. RFS-eligible cellulosic biofuels and enable Edmonton to increase its residential waste diversion rate to 90 percent.

PATH TO COMMERCIAL DEPLOYMENT



COMPANY PROFILE

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.



BEGAN
OPERATIONS
2012



FIBERIGHT REFERENCE COMMERCIAL FACILITY



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.

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

ESTIMATED
COMPLETION
2013



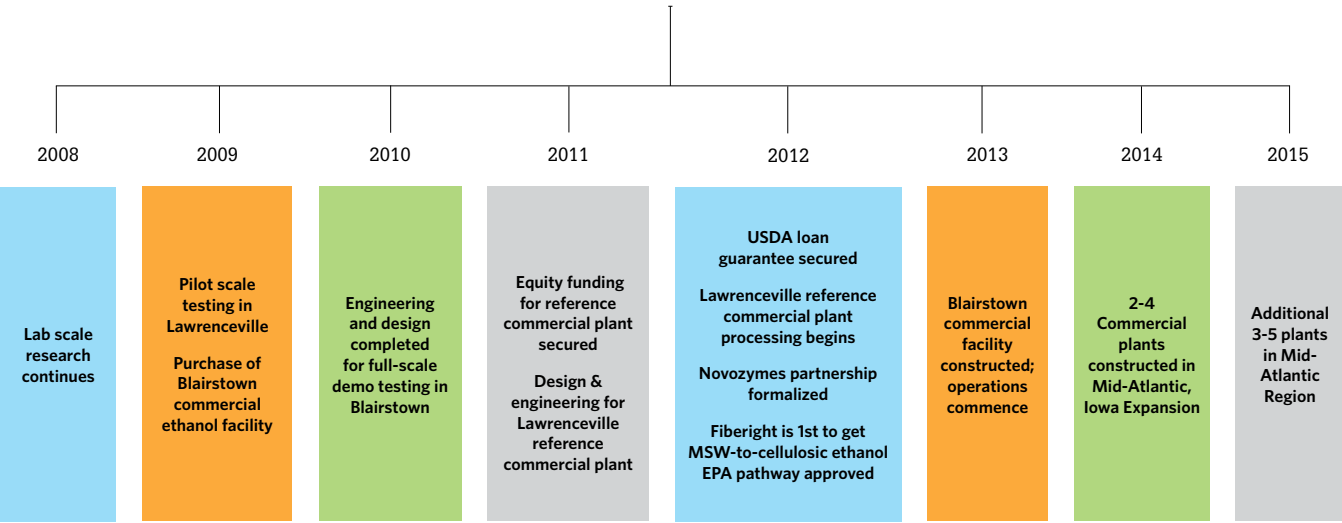
FIBERIGHT BLAIRSTOWN, IOWA COMMERCIAL FACILITY



COMMERCIAL FACILITY

LOCATION: Blairstown, IA
STATUS: Existing Facility To Be Modified in 2013
FEEDSTOCK: Municipal Solid Waste, Non-Food Wastes
PRODUCTS: Cellulosic Ethanol, Bio-chemicals
CAPACITY: 6 MGY
JOBS: 55 Full-time Operational Positions
PROJECT PROFILE: Facility is a retro-fitted former corn ethanol plant within 30 miles of well over 1,000 tons per day of MSW.

PATH TO COMMERCIAL DEPLOYMENT





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.



FULCRUM'S PROCESS DEMONSTRATION UNIT

BEGAN
OPERATIONS
2009



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.



SIERRA BIOFUELS COMMERCIAL PROJECT

ESTIMATED
COMPLETION
2014



COMMERCIAL FACILITY

LOCATION: McCarran, Storey County, NV

STATUS: Initial site preparation work completed. Construction will begin once the USDA loan guarantee is closed

FEEDSTOCK: Municipal solid waste contracted with Waste Connections and Waste Management

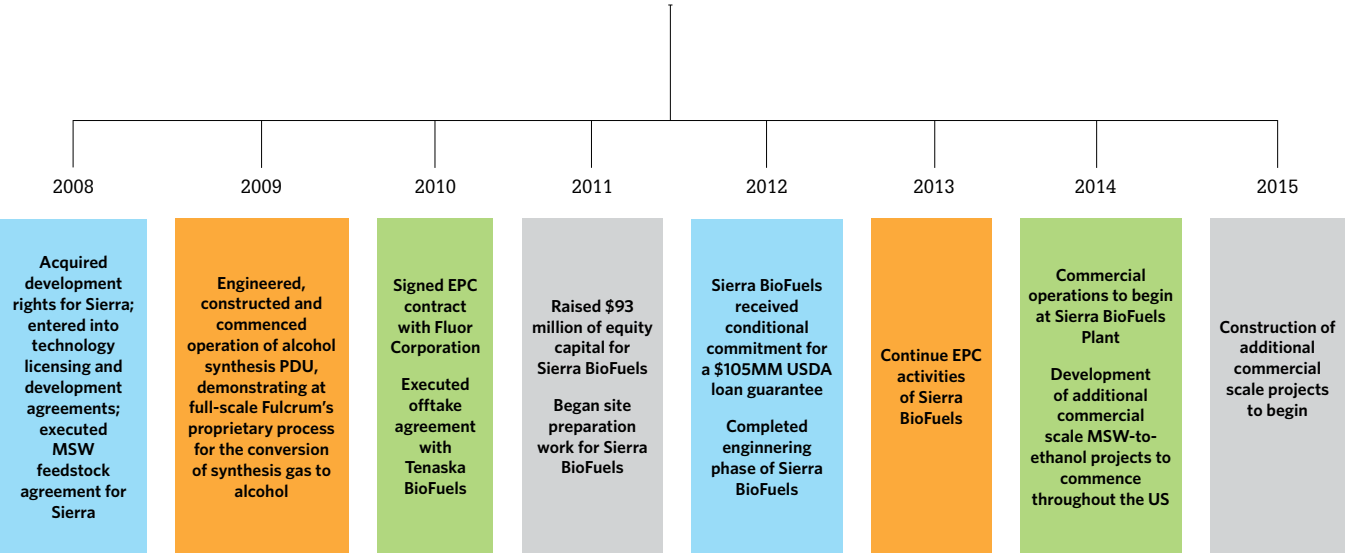
PRODUCTS: Advanced Ethanol

CAPACITY: 10 MGY

JOBS: 430 engineering and construction jobs; 53 permanent jobs

PROJECT PROFILE: Located at the Tahoe-Reno Industrial Center approximately 20 miles east of Reno, Nevada, Sierra will be one of the first projects of its kind to be built in the United States. Designed to produce approximately 10 MGY of low-carbon, renewable transportation fuel annually, the project will combine new, innovative technology with existing commercial systems.

PATH TO COMMERCIAL DEPLOYMENT



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.



COMPANY PROFILE

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.

BEGAN
OPERATIONS
2009



DEMONSTRATION FACILITY

LOCATION: Kalundborg, Denmark

FEEDSTOCK: Wheat Straw

PRODUCTS: Cellulosic ethanol, renewable electricity

CAPACITY: 1.5 MGY of cellulosic ethanol, 11,400 metric tons of lignin fuel pellets, and 13,900 metric tons of industrial sugar molasses

PLANT PROFILE: Fully operational. Integrated with adjacent power station to utilize excess steam. Cellulosic ethanol sold at 98 Statoil petrol stations (E5 gasoline blends). Lignin co-product replaces coal in Danish power generation. Sugar molasses co-product used for biogas production.



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.

Cellulosic ethanol produced at the Inbicon Kalundborg plant is currently sold at almost 100 Statoil fueling stations in Denmark in E5 blends (5% cellulosic ethanol, 95% gasoline)



ESTIMATED
COMPLETION
1Q 2016

MAABJERG ENERGY CONCEPT



COMMERCIAL PROJECT

LOCATION: Maabjerg, Denmark

STATUS: Engineering and Permitting

FEEDSTOCK: Wheat Straw (50 Tons per hour)

PRODUCTS: Cellulosic Ethanol, Biogas, Renewable Electricity, Renewable Fertilizer, Solid Biofuel

CAPACITY: 20 MGY (Cellulosic Ethanol); 1.7 Billion Cubic Feet (Biogas), Renewable Electricity for 25,000 households, 565,000 TPY of renewable fertilizer, 56,000 TPY of solid biofuel for power/heat

PROJECT PROFILE: Integrates 6 Danish technologies on a 247-acre site in northwestern Jutland; to utilize 400,000 tons of wheat straw and 770,000 tons of livestock waste annually.

DAKOTA SPIRIT AG ENERGY CONCEPT



ESTIMATED
COMPLETION
3Q 2015

COMMERCIAL PROJECT

LOCATION: Spiritwood, ND

STATUS: Engineering, Permitting

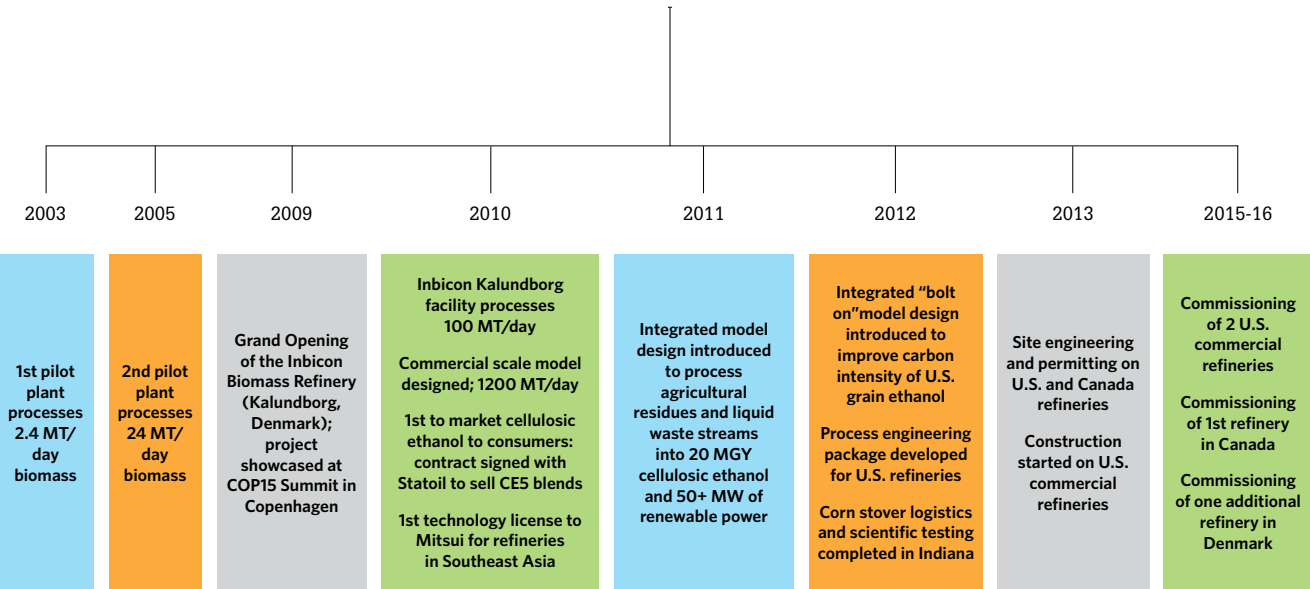
FEEDSTOCK: Wheat Straw (25 TPH)

PRODUCTS: Cellulosic Ethanol; Renewable Power; Industrial Molasses

CAPACITY: 10+ MGY Cellulosic Ethanol; 83,000 TPY Renewable Biofuel Pellets, 94,000 TPY Industrial Molasses

PROJECT PROFILE: Project of Great River Energy; sited adjacent to its Spiritwood Station CHP plant in North Dakota. A conventional dry mill ethanol plant is planned for Phase 1, with cellulosic ethanol production from wheat straw added in Phase 2 (using Inbicon Biomass Refinery technology). Partners include the North Dakota Utilization Commission (APUC) and the North Dakota Industrial Commission-Renewable Energy Council.

PATH TO COMMERCIAL DEPLOYMENT





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.

FEEDSTOCK STORAGE AT INEOS FACILITY



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.



OPERATIONAL
SINCE
2003

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

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.



INEOS VERO BEACH COMMERCIAL FACILITY



COMMERCIAL FACILITY

LOCATION: Vero Beach, FL

STATUS: Commissioning Stage

FEEDSTOCK: Vegetative and Yard waste; MSW

PRODUCTS: Cellulosic ethanol and renewable power

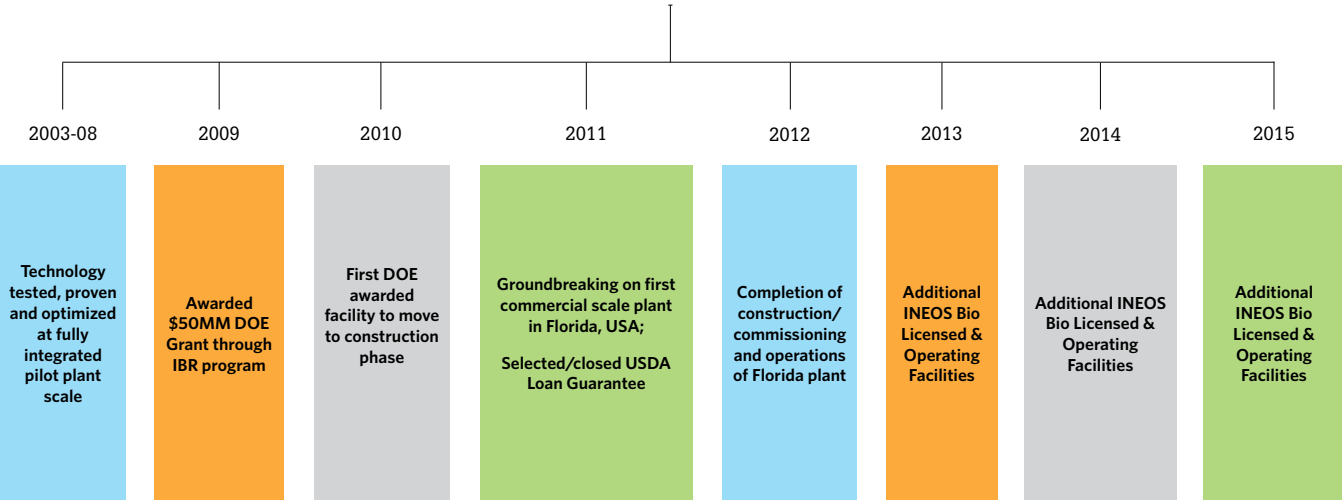
CAPACITY: 8 MGY; 6MW (gross) electricity generation

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.

ESTIMATED
STARTUP
2012

PATH TO COMMERCIAL DEPLOYMENT





COMPANY PROFILE

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 550,000 gallons of cellulosic ethanol to date and holds more than 250 patents. Iogen also operates a thriving business making enzymes that digest fiber.



BEGAN
PRODUCTION
2005



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 DEMO PLANT FUEL PRODUCTION

Year	Ethanol		Cumulative Production	
	(Liters)	(Gallons)	(Liters)	(Gallons)
2005	129,547	34,223	219,418	57,964
2006	16,811	4,441	236,229	62,405
2007	2,598	686	238,827	63,091
2008	206,525	54,558	445,352	117,650
2009	581,042	153,495	1,026,394	271,145
2010	508,781	134,406	1,535,175	405,550
2011	371,606	98,168	1,906,781	503,718
*2012	219,090	57,877	2,125,871	561,595

*to July 31, 2012

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 Raizen, 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.

BAGASSE
DEMONSTRATION
2012

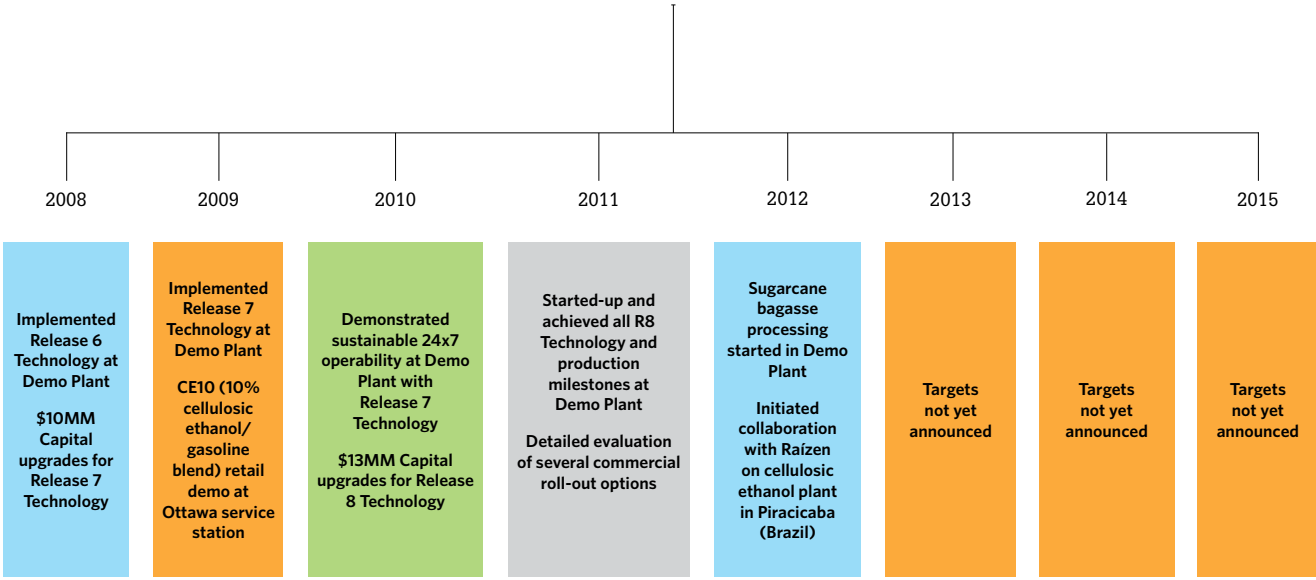


COMMERCIAL STRATEGY

LOCATION: Piracicaba, São Paulo, Brazil
STATUS: Development and Engineering
FEEDSTOCK: Bagasse
PRODUCTS: Cellulosic Ethanol
CAPACITY: To Be Determined

PROJECT PROFILE: Raizen 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 Raizen's Costa Pinto facility in Piracicaba, São Paulo.

PATH TO COMMERCIAL DEPLOYMENT





COMPANY PROFILE

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.

BEGAN
OPERATIONS
2010



KIOR DEMONSTRATION FACILITY



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.

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.

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.



ESTIMATED
STARTUP
4Q 2012



KIOR COMMERCIAL PROJECT IN COLUMBUS, MS



COMMERCIAL FACILITY

LOCATION: Columbus, MS

STATUS: Operational

FEEDSTOCK: Forestry Residuals

PRODUCTS: Cellulosic Gasoline & Diesel

CAPACITY: 13 MGY

JOBS: ~60 direct; several hundred indirect

PROJECT PROFILE: Facility completed ahead of schedule with a project cost of \$213 million; production fully committed prior to end of construction; will produce enough fuel for 25,000 vehicles when fully lined out.

2ND COMMERCIAL PROJECT UNDER DEVELOPMENT

LOCATION: Natchez, MS

FEEDSTOCK: Forestry Residuals

PRODUCTS: Cellulosic Gasoline & Cellulosic Diesel

CAPACITY: 40 MGY

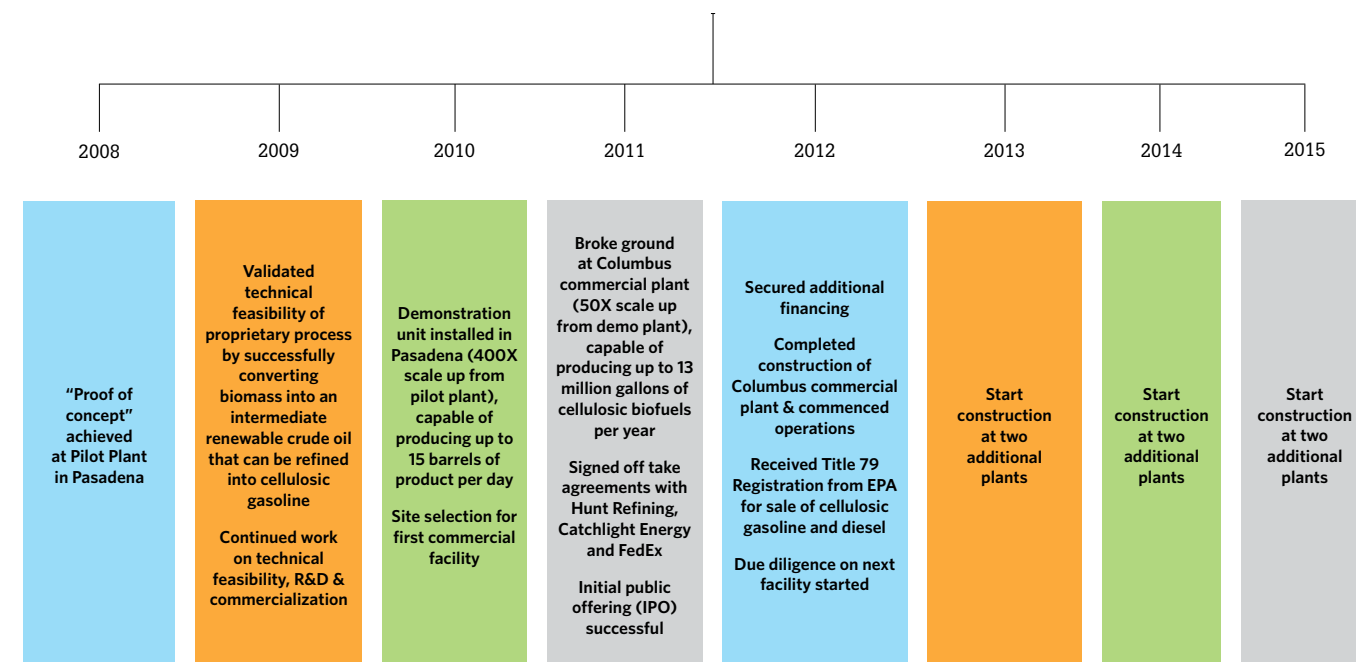
JOBS: 60-70 direct; several hundred indirect

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

ESTIMATED
COMPLETION
2014



PATH TO COMMERCIAL DEPLOYMENT



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.



BEGAN
OPERATIONS
2012



BAOSTEEL DEMO FACILITY

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.



BEGAN
OPERATIONS
2012



CAPITAL STEEL DEMO FACILITY

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.



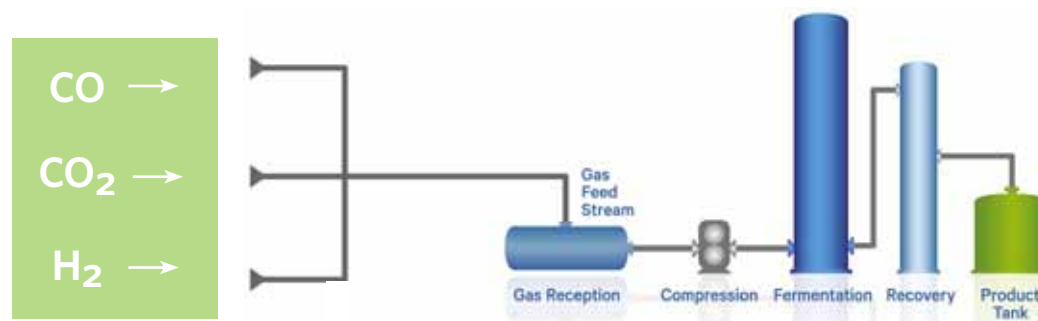
LANZATECH PARTNERS

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

Public/Government: Federal Aviation Administration, U.S. Department of Energy, Defense Advanced Research Projects Agency, Pacific Northwest National Laboratory, National Renewable Energy Laboratory, Michigan Technological University

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.



FREEDOM PINES PRODUCTION FACILITY



COMMERCIAL FACILITY

LOCATION: Soperton, GA

STATUS: Under Development

FEEDSTOCK: Waste biomass from regional forest operations

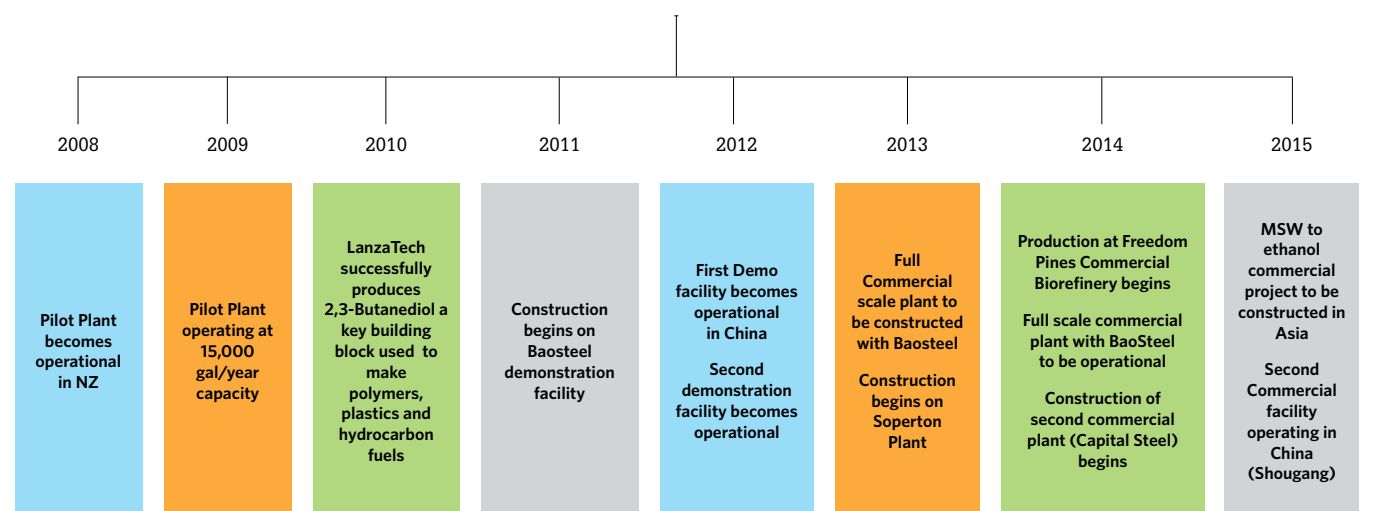
PRODUCTS: Ethanol, chemicals, aviation fuel

CAPACITY: 4 MGY

JOBS: Estimated 75 direct jobs in 2014

PLANT PROFILE: Freedom Pines is expected to begin production in 2014.

PATH TO COMMERCIAL DEPLOYMENT



ESTIMATED
STARTUP
2014

COMPANY PROFILE

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.



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.

MASCOMA COMMERCIAL PROJECT



ESTIMATED
COMPLETION
2014/15



COMMERCIAL PROJECT

LOCATION: Kinross, MI

STATUS: Final Engineering, Closing Financing

FEEDSTOCK: Wood pulp and chips

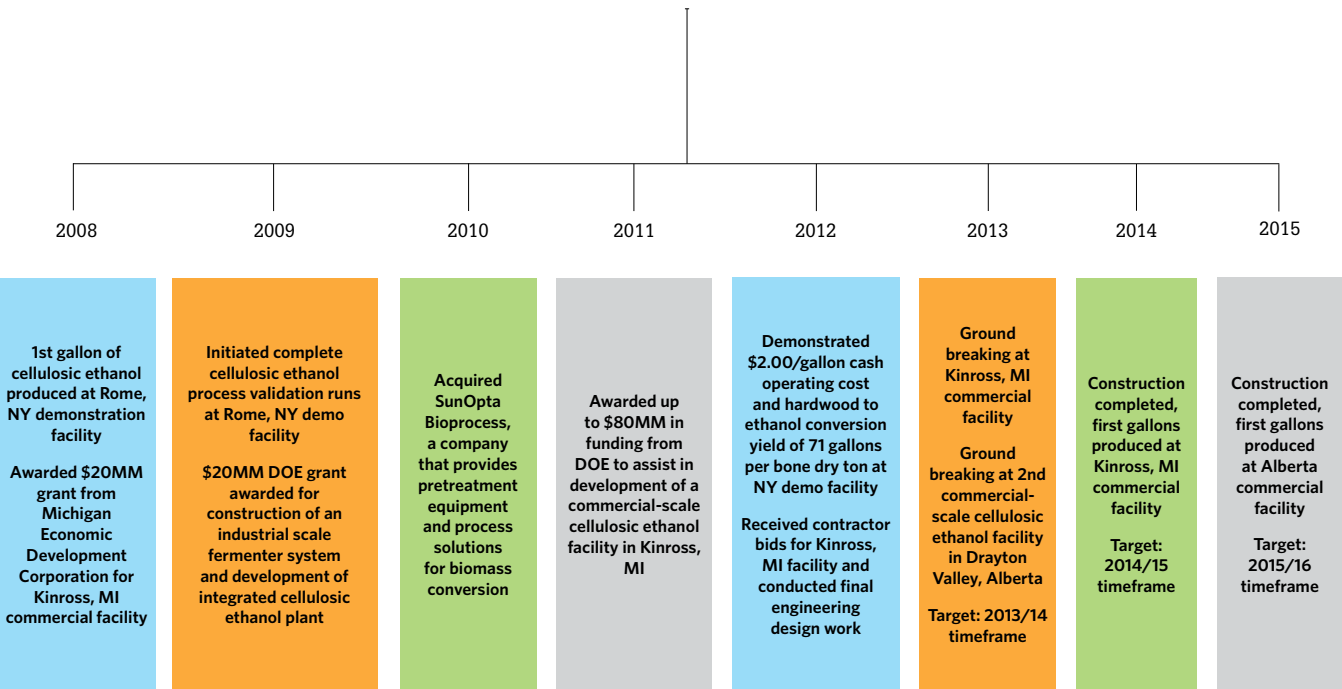
PRODUCTS: Cellulosic ethanol

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 feedstock to be sourced from Michigan counties located within a 150-mile radius area of the site.

PATH TO COMMERCIAL DEPLOYMENT



MASCOMA PARTNERS

Private Equity: Raised \$120MM in four rounds of financing (Khosla Ventures, Flagship Ventures, General Catalyst Partners, Kleiner Perkins Caufield & Byers, Pinnacle Ventures, VantagePoint Partners, Jeremy Grantham, Valero Energy Corporation, Marathon Petroleum Company, General Motors Ventures).

Commercial: Lallemand Inc., a global developer, producer and marketer of yeast, bacteria and related products, to commercialize the TransForm 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 Kinross, Michigan; \$20MM in R&D assistance (DOE) for Kinross, MI project; \$20MM grant agreement with the Michigan Economic Development Corporation for Kinross, 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.

COMPANY PROFILE

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.



BEGAN
OPERATIONS
2008



POET DEMONSTRATION FACILITY



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.

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.

Project LIBERTY will make use of corncobs, leaves, husk, and some stalk that pass through the combine during harvest. The process uses about 25% of the available material, leaving 75% on the ground for erosion control, nutrient replacement and other important farm management practices. The co-product from the cellulosic ethanol process will be energy, enough to power LIBERTY and send excess to the adjacent corn grain-based plant.



PROJECT LIBERTY



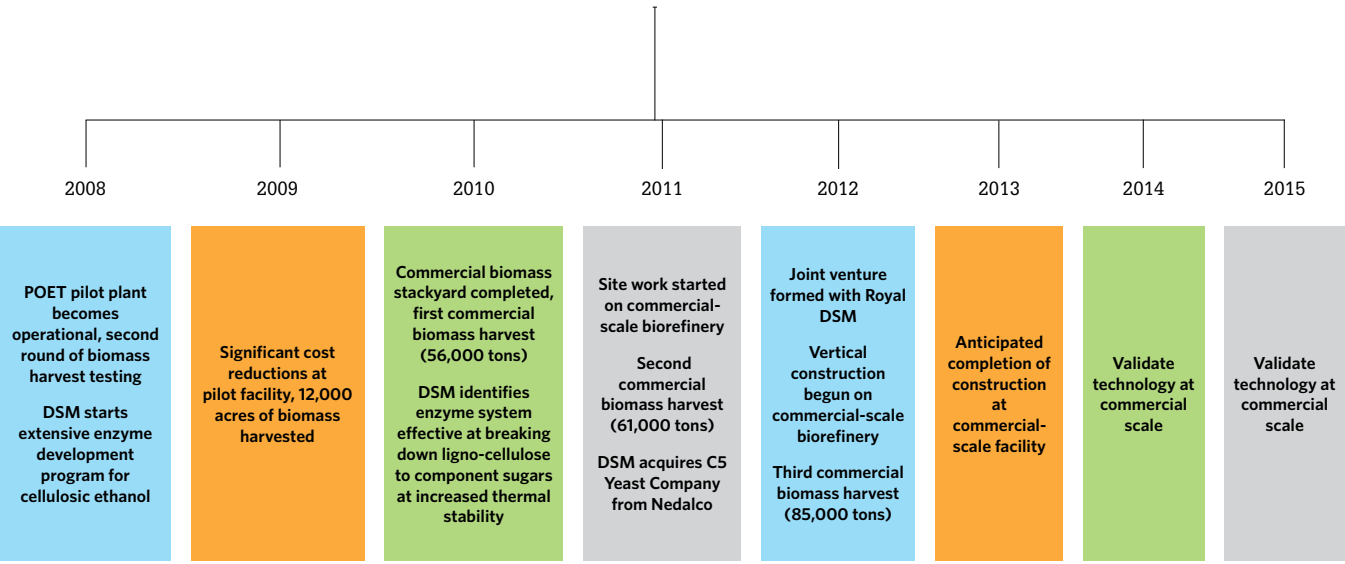
ESTIMATED
COMPLETION
4Q 2013



COMMERCIAL FACILITY

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 storage site is complete, biorefinery construction underway with anticipated completion in 4Q 2013; continuing to ramp up farmer contracts for biomass harvesting toward goal of 285,000 tons per year.

PATH TO COMMERCIAL DEPLOYMENT



ZeaChem

COMPANY PROFILE

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.

BEGAN
OPERATIONS
2012



ZEAICHEM DEMONSTRATION FACILITY

**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 50 construction jobs and employs 35 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).

ESTIMATED
COMPLETION
1Q 2015

**COMMERCIAL FACILITY**

LOCATION: Boardman, OR

STATUS: USDA Conditional Loan Guarantee Awarded

FEEDSTOCK: Poplar Trees, Wheat Straw

PRODUCTS: Cellulosic Ethanol, Bio-Chemicals

CAPACITY: 25+ MGY

JOBS: 200 direct construction jobs; 65 full-time operations jobs; 250 indirect jobs for construction and full-time operations

PLANT PROFILE: Located adjacent to ZeaChem's demo plant; agreements in place for 100% of the required feedstock from GreenWood Resources and local agricultural residue processors.



ZEAICHEM COMMERCIAL FACILITY SITE

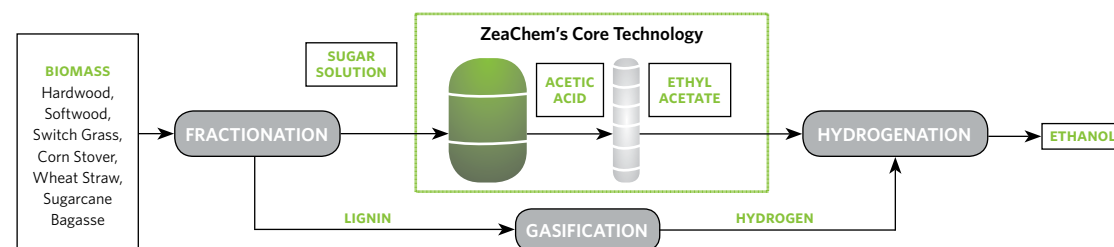
ZEACHEM PARTNERS

Private Equity: Raised \$65MM in three rounds of financing (Birchmere Ventures, Firelake Capital, Globespan Capital Partners, Mohr Davidow Ventures, PrairieGold Venture Partners, Spring Ventures, Itochu, and Valero Energy Corporation)

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**