Project owner	Projectc name	country	Technology	Raw material	Product	Facility Type	Status	Start-up year	Web	Technology brief
Aalborg University Copenhagen	BornBiofuels optimization	Denmark	biochemical conversion	ignocellulosics; wheat straw, cocksfoot grass	ethanol; biogas;	pilot	operational	2009	www.sustainablebiotechnology.aau.dk	BornBiofuels Optimization involves the further optimization of the 2nd generation bioethanol concept behind the BornBiofuels (EUDP) demo project of the company Biogasol. Optimization includes increasing the yield of bioethanol, biogas and hydrogen, reducing the input of energy and external enzymes, and improving the process robustness of the whole biorefinery scheme. Pilot testing will be performed on an optimized process integration including modified pretreatment and hydrolysis, on-site enzyme production, and with improved and adapted fermentation strains. New process configurations will be tested on potential biomass resources, relevant for the BornBiofuels project.
Abengoa Bioenergy Biomass of Kansas, LLC	Commercial	United States	biochemical conversion	lignocellulosics; corn stover, wheat traw, switch grass;	Ethanol;	commercial	under contruction	2013	www.abengoabioenergy.com	Steam explosion coupled with biomass fractionation, C5/C6 fermentation, distillation for ethanol recovery. Heat and power is provided by means of biomass gasification. Cogeneration of 18 MW gross electrical power.
Abengoa Bioenergy New Technologies	Pilot	United States	bioquemical conversion	lignocellulosics; corn stover	Ethanol;	pilot	operational	2007	www.abengoabioenergy.com	-
Abengoa Bioenergy, Biocarburantes Castilla y Leon, Ebro Puleva	Demo	Spain	biochemical conversion	lignocellulosics; cereal straw (mostly barley and wheat)	Ethanol;	demo	operational	2008	www.abengoabioenergy.com	Steam explosion, no fractionation, Enzymatic Hydrolysis (glucose)
Abengoa Bioenergy, S.A.	Abengoa Arance EC demonstration	France	biochemical conversion	lignocellulosics; agricultural and forest residues	ethanol;	demo	planned	2013	www.abengoabioenergy.com	Steam explosion , Saccharification, C6 sugars fermentation, Enzymes, Distillation, Anaerobic digestion process
Aemetis	Pilot	United States	biochemical conversion	lignocellulosics; switchgrass, grass seed, grass straw and corn stalks	Ethanol;	pilot	operational	2008	www.aebiofuels.com	ambient temperature starch/ cellulose hydrolysis (ATSCH)
AliphaJet Inc.	AliphaJet Pilot Plant	United States	chemical conversion	oils, fats; Oils from soy, beef tallow, waste veg. oil, and oil crops such as camelina, jatropha, pennycress, and pongamia	diesel; jet fuel;	pilot	planned	2013	www.aliphajet.com	AliphaJet's proprietary catalytic deoxygenation ("decarboxylation") technology converts any renewable oils and fats (such as waste vegetable oil, tallow, algal oil, and non-food oil crops like pennycress, camelina, jatropha, and pongamia), into true "drop-in" hydrocarbon fuels including diesel (F-76), jet fuel (Jet-A, JP-5, JP-8), and high-octane gasoline. It does this by catalytically removing the oxygen from the fatty acids contained in triglyceride oils, producing hydrocarbons and glycerine as the sole products
Amyris, Inc.	Amyris Antibioticos	Spain	biochemical conversion	fermentable sugars; sugar beet; dextrose	hydrocarbons;	commercial	operational	2011	www.amyris.com	Conversion of fermentable sugars to a 15-carbon hydrocarbon, called beta-farnesene using genetically modified microorganisms in fermentation. Farnesene can be converted to render: a. Fuels (primarily diesel) b. Lubricants c. Polymers and Plastic Additives d. Cosmetics e. Consumer Products Ingredients f. Flavors and Fragancies
Amyris, Inc.	Amyris Biomin	Brazil	biochemical conversion	fermentable sugars; sugarcane	hydrocarbons;	commercial	operational	2010	www.amyris.com	Conversion of fermentable sugars to a 15-carbon hydrocarbon, called beta-farnesene using genetically modified microorganisms in fermentation. Farnesene can be converted to render: a. Fuels (primarily diesel) b. Lubricants c. Polymers and Plastic Additives d. Cosmetics e. Consumer Products Ingredients f. Flavors and Fragancies
Amyris, Inc.	Amyris Paraiso	Brazil	biochemical conversion	fermentable sugars; sugarcane	hydrocarbons;	commercial	planned	2012	www.amyris.com	Conversion of fermentable sugars to a 15-carbon hydrocarbon, called beta-farnesene using genetically modified microorganisms in fermentation. Farnesene can be converted to render: a. Fuels (primarily diesel) b. Lubricants c. Polymers and Plastic Additives d. Cosmetics e. Consumer Products Ingredients f. Flavors and Fragancies
Amyris, Inc.	Amyris Pilot & Demonstration Plant	Brazil	biochemical conversion	fermentable sugars; sugarcane	hydrocarbons;	demo	operational	2009	www.amyris.com	Conversion of fermentable sugars to a 15-carbon hydrocarbon, called beta-farnesene using genetically modified microorganisms in fermentation. Farnesene can be converted to render: a. Fuels (primarily diesel) b. Lubricants c. Polymers and Plastic Additives d. Cosmetics e. Consumer Products Ingredients f. Flavors and Fragancies
Amyris, Inc.	Amyris Sao Martinho	Brazil	biochemical conversion	fermentable sugars; sugarcane	hydrocarbons;	commercial	planned	2013	www.amyris.com	Conversion of fermentable sugars to a 15-carbon hydrocarbon, called beta-farnesene using genetically modified microorganisms in fermentation. Farnesene can be converted to render: a. Fuels (primarily diesel) b. Lubricants c. Polymers and Plastic Additives d. Cosmetics e. Consumer Products Ingredients f. Flavors and Fragancies
Amyris, Inc.	Amyris Tate & Lyle	United States	biochemical conversion	fermentable sugars; corn dextrose	hydrocarbons;	commercial	operational	2011	www.amyris.com	Conversion of fermentable sugars to a 15-carbon hydrocarbon, called beta-farnesene using genetically modified microorganisms in fermentation. Farnesene can be converted to render: a. Fuels (primarily diesel) b. Lubricants c. Polymers and Plastic Additives d. Cosmetics e. Consumer Products Ingredients f. Flavors and Fragancies
Amyris, Inc.	Amyris USA	United States	biochemical conversion	fermentable sugars; sugarcane	hydrocarbons;	pilot	operational	2008	www.amyris.com	Conversion of fermentable sugars to a 15-carbon hydrocarbon, called beta-farnesene using genetically modified microorganisms in fermentation. Farnesene can be converted to render: a. Fuels (primarily diesel) b. Lubricants c. Polymers and Plastic Additives d. Cosmetics e. Consumer Products Ingredients f. Flavors and Fragancies
BBI BioVentures LLC	Commercial	United States	biochemical conversion	lignocellulosics; pre-collected feegnocellulosics; pre-collected feestocks that require little or no pretreatmentstocks that require little or no pretreatment	ethanol;	commercial	plans abandoned	2010	www.bbibioventures.com	-
Beta Renewables (joint venture of Mossi & Ghisolfi Chemtex division with TPG	Pilot	Italy	biochemical conversion	lignocellulosics; corn stover, straw, husk, energy crops (Giant Reed) woody biomass	ethanol; various chemicals;	pilot	operational	2009	www.betarenewables.com	Enzymatic conversion of selected Biomasses. Pretreatment, handling of pre-treated material and hydrolysis done in equipment specifically designed. Production of oher biochemicals will start in 2012/13.
Beta Renewables (joint venture of Mossi & Ghisolfi Chemtex division with TPG)	IBP - Italian Bio Fuel	Italy	biochemical conversion	lignocellulosics;	ethanol;	commercial	under construction	2012	www.betarenewables.com	Enzymatic conversion of selected Biomasses. Pretreatment, handling of pre-treated material and hydrolysis done in equipment specifically designed.
BFT Bionic Fuel Technologies AG	OFT Alyssa	Denmark	other innovative conversion	lignocellulosics; straw pellets	diesel; hydrocarbons;	demo	stopped	2008	www.microfuel.eu	Bionic microfuel technology transforms biomass to lightoil using advanced microwave technology: The Bionic Fuel Technologies Group (BFT) has significantly enhanced a method for a catalytic low temperature depolymerization of hydrocarbons. The method itself and its chemo physical foundations have been well known for many decades and have proven their principal functionality on multiple occasions. The critical breakthrough for BFT came with the application of microwave technology as the primary source of reaction energy. With this approach it became not only possible to overcome all obstacles associated with earlier plant developments, but also additional beneficial effects could be achieved. During a pre processing phase, which, regarding its detailed lay out, depends strongly on the chosen feedstock, the input material is shredded initially to the required particle size. Subsequently it is mixed with a zeolite based catalyst and some additives and finally pelletized. The pellets are transferred to the main reactor where they are gradually heated up. The steam building up in the interior of the pellets first induces a partial hydrogenation of the carbohydrates contained, until they burst due to the rising pressure, while the remaining steam escapes. After more heating to close to 300 degrees Celsius through the application of microwaves the catalyst becomes active. It cracks the hydrocarbons present to a chain length of around C16, which instantly vaporize, escape from the reaction mass and get distilled as a diesel like oil fraction. From the remaining reaction mass the reusable part gets separated and cycled back to the preprocessing for further use. The residues are extracted and have to be disposed of. In a follow up process the produced oil can be cleaned through an additional distillation if necessary and can be refined to standards conform heating oil or diesel through the necessary additives. For certain feedstock it may be required to add a desulphurization process.
Bioenergy 2020+	FT synthesis	Austria	thermochemical conversion		FT diesel, FT waxes	demo	planned	2014	www.bioenergy2020.eu	-
Bioenergy 2020+	Mixed alcohols	Austria	thermochemical conversion	wood chips	mixed alcohols	pilot	operational	2011	www.bioenergy2020.eu	-
BioGasol	BornBioFuel2	Denmark	biochemical conversion	lignocellulosics; straw, various grasses, garden waste.	ethanol; biogas; lignin; fertilizer	demo	planned	2016	www.biogasol.com	Integration of core BioGasol technologies into a complete plant; Reduce technical and financial risk for future full-scale plants; Demonstrate technical feasibility and feedstock flexibility; Test centre for technology developments at semi-industrial scal
BioGasol	BornBioFuel1	Denmark	biochemical conversion	lignocellulosics; flexible	ethanol; pretreated biomass;	pilot	operational	2008	www.biogasol.com	Process- and equipment design and development of core technologies (Pre-treatment and C5 fermentation) at pilot capacity scale; Maturation and up-scaling of core technology to industrial standards; Proof-of-technology to achieve commercially viable soluti
Biomassekraftwerk Guessing	SNG demo	Austria	thermochemical conversion	lignocellulosics; syngas from gasifier	SNG;	demo	operational	2008	www.eee-info.net	After lab testing in a scale of 10 kW during the last few years, the pilot and demonstration unit (PDU) with an outout of 1 MW of SNG was inaugurated in June 2009. The plant uses a side stream of the existing Güssing gasifier. The syngas is further purifed before entering the catalysis reactor, where the conversion to methane takes place. The plant has been designed to work in a fairly wide pressure (1-10 bar) and temperature range (300-360°C) in order to optimize the efficiency of the system. SNG upgrading downstream of the reactor is focussed at reaching H-Gas quality in order to meet the feed in conditions for natural gas pipelines. Achieved peformance of the plant is above expectation and the CNG filling station has beed supplied with high quality H-gas. CNG cars have been run successfully with the gas produced.
BioMCN	BioMCN commercial	Netherlands	chemical conversion	glycerine; crude glycerine, others	methanol;	commercial	operational	2009	www.biomcn.eu	converting glycerine (a by-product from biodiesel production) into bio-methanol
Blue Sugars Corporation (formerly KL Energy)	Blue Sugars	United States	biochemical conversion	lignocellulosics; Sugarcane bagasse and other biomass	ethanol; lignin;	demo	operational	2008	www.bluesugars.com	-
Borregaard AS	BALI Biorefinery Demo	Norway	biochemical conversion	lignocellulosics; sugarcane bagasse, straw, wood, energy crops, other lignocellulosics	ethanol; biogas; lignin; hydrogen;	demo	operational	2012	www.borregaard.com	Chemical pretretment, saccharification with commercial enzymes, conventional fermentation of hexoses, aeorobic fermentation or chemical conversion of pentoses, chemical modification of lignin
Borregaard Industries LTD	ChemCell Ethanol	Norway	biochemical conversion	lignocellulosics; sulfite spent liquor (SSL, 33% dry content) from sprucewood pulping	ethanol;	commercial	operational	1938	www.borregaard.com	Pulp for the paper mill is produced by cooking spruce chips with acidic calcium bisulfite cooking liquor. Hemicellulose is hydrolyzed to various sugars during the cooking process. After concentration of the SSL, the sugars are fermented and ethanol is distilled off in several steps. A part of the 96% ethanol is dehydrated to get absolute ethanol.
BP Biofuels	Jennings Demonstration Facility	United States	biochemical conversion	lignocellulosics; dedicated energy crops	cellulosic ethanol;	demo	operational	2009	www.bp.com/biofuels	-
Butamax Advanced Biofuels LLC	Biobutanol demo	United Kingdom	other innovative conversion	other; various feedstocks	biobutanol	demo	planned	2010	www.butamax.com/	-
Chempolis Ltd.	Chempolis Biorefining Plant	Finland	biochemical conversion	lignocellulosics; non-wood and non-food lignocellulosic biomass such as straw, reed, empty fruit bunch, bagasse, corn stalks, as well as wood residues	ethanol; pulp;	demo	operational	2008	www.chempolis.com	Chempolis' core products are the two patented biorefining technologies: 1) formicobio™ for the production of cellulosic ethanol and biochemicals from non-food biomasses and 2) formicofib™ for the production of papermaking fibers (i.e. pulp) and biochemicals from non-wood biomasses. These two technologies share a common technology platform that enables selective fractionation of various biomasses with a novel biosolvent, full recovery of biosolvent and co-production of biochemicals. Chempolis' technologies enable highly profitable and environmentally sustainable biorefining deriving from higher revenues and reduced operating costs while CO2 emissions and other pollution to atmosphere and waterways can be eliminated practically completely.
Chemrec	BioDME	Sweden	Thermochemical conversion	Liquefied biomass - black liquor from forest raw material	DME	large pilot / demo	operational	2011	www.biodme.eu	The recovery boiler in the paper mill is replaced or supplemented by a gasification based fuel generating and pulp mill cooking chemicals recovery system. The BioDME pilot is an integrated part of heavy DME fuelled vehicle fleet trials.

CHOREN Fuel Freiberg GmbH & Co. KG	beta plant	Germany	thermochemical conversion	lignocellulosics; dry wood chips from recycled wood and residual forestry wood; additionally in the future fast growing wood from short-rotation crops	FT-liquids;	demo	stopped	Start up was originally planned for 2012	www.choren.com	-
CHOREN Industries GmbH	sigma plant	Germany	thermochemical conversion	lignocellulosics; dry wood chips from recycled wood; fast growing wood from short-rotation crops	FT-liquids;	commercial	stopped	2016	www.choren.com	-
Coskata	pilot	United States	biochemical conversion	lignocellulosics; various	ethanol;	pilot	operational	2003	www.coskata.com	-
Coskata	Lighthouse	United States	biochemical conversion	lignocellulosics; wood chips, natural gas	ethanol;	demo	operational	2009	www.coskata.com	"The plant will employ the Plasma Center's gasifier to superheat raw materials at temperatures up to 1700 degrees Fahrenheit (1000°C), then release the resulting synthetic gas, or ""syngas,"" into a bioreactor, where it will become food for microorganisms that convert it into ethanol. Mr. Roe said Coskata's process will produce 100 gallons of ethanol from a ton of feedstock, compared with 67 gallons produced from the same amount of corn, and that the fuel will cost less than $1 a gallon to produce. Coskata is commercializing a proprietary process and related technologies for the conversion of a wide variety of input materials into ethanol. Coskata has an efficient, affordable, and flexible three-step conversion process: 1. Incoming material converted to synthesis gas (gasification) 2. Fermentation of synthesis gas into ethanol (bio-fermentation) 3. Separation and recovery of ethanol (separations) Ethanol can be manufactured using this cutting edge technology at a variable cost of under US$1.00 per gallon - the lowest cost of manufacture in the industry. During gasification, carbon-based input materials are converted into syngas using well-established gasification technologies. After the chemical bonds are broken using gasification, Coskata's proprietary microorganisms convert the resulting syngas into ethanol by consuming the carbon monoxide (CO) and hydrogen (H2) in the gas stream. Once the gas-to-liquid conversion process has occurred, the resulting ethanol is recovered from the solution using ""pervaporation technology."" Coskata's proprietary microorganisms eliminate the need for costly enzymatic pretreatments, and the bio-fermentation occurs at low pressures and temperatures, reducing operational costs. In addition, the Coskata process has the potential to yield over 100 gallons of ethanol per ton of dry carbonaceous input material, reducing both operational and capital costs. Coskata's exclusively licensed separation technology dramatically improves the separations and recovery component of ethanol production, reducing the required energy by as much as 50%. The entire process includes a gasifier, gas clean-up, fermentation, and separation (both distillation and membrane separation) similar to what is in the process illustration."
DuPont	DuPont Cellulosic Ethanol Demonstration plant	United States	biochemical conversion	lignocellulosics; corn stover, cobs and fibre; switchgrass	ethanol;	demo	operational	2010	www.dupont.com	enzymatic hydrolysis
Dynamic Fuels LLC	Geismar Project	United States	chemical conversion	oils, fats; hydrotreatment of animal fats, used cooking greases	diesel;	commercial	operational	2010	www.dynamicfuelsllc.com	Hydroprocessing of animal fats, used cooking greases and the like, into renewable synthetic diesel meeting teh US ASTM D975 diesel spec.
ECN	pilot	Netherlands	thermochemical conversion	lignocellulosics; clean wood and demolition wood	SNG; syngas;	pilot	operational	2008	www.ecn.nl	Production of Substitute Natural Gas from woody biomass using MILENA gasification, OLGA tar removal, gas cleaning, gas upgrading and methanation
ECN	demo	Netherlands	thermochemical conversion	lignocellulosics;	SNG; heat;	demo	planned	2013	www.ecn.nl	-
Enerkem	Sherbrooke pilot plant and research center	Canada	thermochemical conversion	biomass /biomass coal blends; Municipal solid waste (MSW) from numerous municipalities and more than 25 different feedstocks, including wood chips, treated wood, sludge, petcoke, spent plastics, wheat straw. Feedstocks can be in solid, slurry or liquid form.	ethanol; methanol; power; syngas; acetates;	pilot	operational	2003	www.enerkem.com/en/facilities/innovation-centers/sherbrooke-quebec-canada.html	-
Enerkem	demo	Canada	thermochemical conversion	biomass /biomass coal blends; Treated wood (i.e. decommissioned electricity poles, and railway ties), wood waste and MSW	ethanol; methanol; hemicelluloses; power; syngas;	demo	operational	2009	www.enerkem.com/index.php?module=CMS&id=11&newlang=eng	Enerkem develops biofuels and chemicals from waste. With its proprietary thermochemical technology, Enerkem converts abundantly available municipal solid waste (mixed textiles, plastics, fibers, wood and other non-recyclable waste materials) into chemical-grade syngas, and then methanol, ethanol and other chemical intermediates that form everyday products.
Enerkem	Edmonton Waste-to-Biofuels Project	Canada	thermochemical conversion	biomass /biomass coal blends; Post-sorted municipal solid waste (MSW)	ethanol; methanol; syngas;	commercial	under construction	2013	www.enerkem.com/en/facilities/plants/westbury-quebec-canada.html	Enerkem develops biofuels and chemicals from waste. With its proprietary thermochemical technology, Enerkem converts abundantly available municipal solid waste (mixed textiles, plastics, fibers, wood and other non-recyclable waste materials) into chemical-grade syngas, and then methanol, ethanol and other chemical intermediates that form everyday products.
Enerkem - Varennes Cellulosic Ethanol L.P.	Varennes commercial facility	Canada	thermochemical conversion	biomass /biomass coal blends; Sorted industrial, commercial and institutional waste	ethanol; methanol; syngas;	commercial	planned		www.enerkem.com/en/facilities/plants/varennes-quebec-canada.html	Enerkem develops biofuels and chemicals from waste. With its proprietary thermochemical technology, Enerkem converts abundantly available municipal solid waste (mixed textiles, plastics, fibers, wood and other non-recyclable waste materials) into chemical-grade syngas, and then methanol, ethanol and other chemical intermediates that form everyday products.
Enerkem Mississippi Biofuels LLC	Enerkem Mississippi Biofuels	United States	thermochemical conversion	biomass /biomass coal blends; Sorted municipal solid waste and wood residues	ethanol; methanol; syngas;	commercial	planned	-	www.enerkem.com/en/facilities/plants/pontotoc-mississippi.html	Enerkem develops biofuels and chemicals from waste. With its proprietary thermochemical technology, Enerkem converts abundantly available municipal solid waste (mixed textiles, plastics, fibers, wood and other non-recyclable waste materials) into chemical-grade syngas, and then methanol, ethanol and other chemical intermediates that form everyday products.
Fiberight LLC	Commercial Plant	United States	biochemical conversion	municipal solid waste;	ethanol; biogas; power; sugars;	commercial	under construction	2013	www.fiberight.com	Fiberight's innovative technology efficiently fractionates the organic components of MSW such as contaminated paper, food wastes, yard discards and other degradables for the production of cellulose and hemicellulose into fuel grade ethanol and other sugar platform biochemicals using enzymatic hydrolysis and fermentation. The plastic fraction and methane collected from Fiberight's processes may also used to create co-generation electricity to power its plant facilities for zero energy input. Fiberight's proprietary extraction, pulping and digestion processes have the potential to unlock over 5 billion gallons of renewable biofuel contained in the 175 million tons of non-recyclable Municipal Solid Waste (MSW) generated each year in the US.
Fiberight LLC	Integrated Demonstration Plant	United States	biochemical conversion	municipal solid waste;	ethanol; biogas; power; sugars;	demo	operational	2012	www.fiberight.com	-
Flambeau River Biofuels Inc.	Project Trixie	United States	thermochemical conversion	lignocellulosics; Forest residuals, non-merchantable wood	FT-liquids;	demo	plans abandoned	Start up would have been in 2013.	www.flambeauriverpapers.com	Thermochemical conversion of biomass using advanced gasification technologies followed by FT catalytic conversion into renewable liquid fuels and waxes. Currently pilot plant testing; start of construction anticipated for fall 2011.
Frontier Renewable Resources	Kinross Plant 1	United States	biochemical conversion	lignocellulosics; wood chip	ethanol; lignin;	commercial	planned	-	-	-
GÃ¶teborg Energi AB	GoBiGas Plant - Phase 1	Sweden	thermochemical conversion	lignocellulosics; Forest residues, wood pellets, branches and tree tops	biomethane;	demo	under construction	2013	www.gobigas.se	-
GraalBio	GraalBio plants	Brazil	biochemical conversion	sugarcane bagasse; Sugarcane bagasse and straw	ethanol;	commercial	planned	-	www.betarenewables.com	-
Greasoline GmbH	sts-plant	Germany	thermochemical conversion	oils, fats; bio-based oils and fats, residues of plant oil processing, free fatty acids, used bio-based oils and fats	diesel; hydrocarbons; gasoline type fuel;	pilot	operational	2011	www.greasoline.com	Catalytic cracking of bio-based oils + fats primarily produces diesel fuel-range hydrocarbons. Preferred catalysts are activated carbons. Variation in process conditions, catalysts and input material lead to alkenes, LPG, gasoline and drop-in jet fuels.
GTI Gas Technology Institute	Flex-Fuel and Advanced Gasification Test Facilities, Wood to Gasoline	United States	thermochemical conversion	lignocellulosics; Forest residues: tops, bark, hog fuel, stump material	FT-liquids;	pilot	Operational	2004	www.gastechnology.org	-
GTI, Gas Technology Institute	IH2 â€“ 50 Continuous Pilot Plant	United States	thermochemical conversion	lignocellulosics; Wood, Corn-stover, Bagasse, Algae	FT-liquids; gasoline type fuel;	pilot	operational	2012	httpwww.gastechnology.org	The IH2 pilot plant contains a first stage fluidized bed catalytic hydropyrolysis reactor, and a second stage hydroconversion reactor. Hydrogen produced in the process is continuously recycled. The biomass is continuously fed while liquid, gas, and char products are continuously removed. The pilot plant operates 24 hours a day in test campaigns lasting 30 days or longer.
Inbicon (DONG Energy)	pilot 1	Denmark	biochemical conversion	lignocellulosics; straw	ethanol; c5 molasses; solid biofuel;	pilot	operational	2003	www.inbicon.com	hydrothermal pre-treatment, high gravity hydrolysis, yeast fermentation
Inbicon (DONG Energy)	pilot 2	Denmark	biochemical conversion	lignocellulosics;	ethanol; c5 molasses; solid biofuel;	pilot	operational	2005	www.inbicon.com	hydrothermal pre-treatment, high gravity hydrolysis, yeast fermentation
Inbicon (DONG Energy)	demo	Denmark	biochemical conversion	lignocellulosics; wheat straw	ethanol; c5 molasses; solid biofuel;	demo	operational	2009	www.inbicon.com	-
INEOS Bio	Indian River County Facility	United States	biochemical conversion	lignocellulosics; Vegetative Waste, Waste wood, Garden Waste	ethanol;	commercial	under construction	2012	www.ineosbio.com	-
Iogen Corporation	demo	Canada	biochemical conversion	lignocellulosics; wheat, barley and oat straw; corn stover, sugar cane bagasse and other agricultural residues	ethanol;	demo	operational	2004	www.iogen.ca	Iogen technology makes it economically feasible to convert biomass into cellulosic ethanol using a combination of thermal, chemical and biochemical techniques. The yield of cellulosic ethanol is more than 340 litres per tonne of fibre. The lignin in the plant fibre is used to drive the process by generating steam and electricity, thus eliminating the need for fossil CO2 sources such as coal or natural gas. Pretreatment: Iogen developed an efficient pretreatment method to increase the surface area and "accessibility" of the plant fibre to enzymes. We achieve this through our modified steam explosion process. This improves ethanol yields, increases pretreatment efficiency, and reduces overall cost. Enzyme Production: Iogen has new, highly potent and efficient cellulase enzyme systems tailored to the specific pretreated feedstock. Iogen already has a worldwide business making enzymes for the pulp and paper, textiles and animal feed industries. Enzymatic Hydrolysis: Iogen developed reactor systems that feature high productivity and high conversion of cellulose to glucose. This is accomplished through separate hydrolysis and fermentation using a multi-stage hydrolysis process. Ethanol Fermentation: Iogen uses advanced microorganisms and fermentation systems that convert both C6 and C5 sugars into ethanol. The "beer" produced by fermentation is then distilled using conventional technology to produce cellulosic ethanol for fuel grade applications. Process Integration: Large-scale process designs include energy efficient heat integration, water recycling, and co-product production that make the overall process efficient and economical. Iogen has successfully validated these improvements within its demonstration scale cellulosic ethanol facility.
Iowa State University	BioCentury Research Farm	United States	biochemical and thermochemical conversion	lignocellulosics; grains, oilseeds, vegetable oils, glycerin	ethanol; FT-liquids; biodiesel; pyrolysis oils;	pilot	operational	2009	www.biocenturyresearchfarm.iastate.edu	The Iowa State University BioCentury Research Farm is an integrated research and demonstration facility dedicated to biomass production and processing. Activities at the Farm include cultivar development and testing; biomass harvest, storage, and transportation; biomass processing; and byproduct disposal. The bioprocessing facility will offer three different lines for processing ground and pretreated biomass: a biochemical train, a thermochemical train, and a bioprocessing train (hybrid technologies). The products can be fuels and other biobased products. Byproduct recycling to the field shall be optimized.
Karlsruhe Institute of Technology (KIT)	bioliq	Germany	thermochemical conversion	lignocellulosics;	diesel; gasoline type fuel;	pilot	under construction	2013	www.bioliq.de	Fast pyrolysis, high pressure entrained flow gasification, hot gas cleaning, DME- and gasoline-synthesis Status: Fast pyrolysis: in operation; Gasification, DME- and gasoline synthesis under construction finished end of 2011
LanzaTech - Concord Enviro Systems PVT Ltd.	MSW Syngas to Electricity and Fuel	India	biochemical conversion	Any gas containing Carbon Monoxide; Municipal solid waste	ethanol;	demo	planned	2013	www.lanzatech.com	Facility using municipal solid waste-derived syngas.
LanzaTech (Beijing Shougang LanzaTech New Energy Technology Co., Ltd.)	Waste Gas to Fuel	China	biochemical conversion	Any gas containing Carbon Monoxide; Industrial off gas	ethanol;	demo	under construction	2013	www.lanzatech.com	-
LanzaTech BaoSteel New Energy Co., Ltd.	Waste Gas to Fuel	China	biochemical conversion	Any gas containing Carbon Monoxide; Industrial flue gasses	ethanol;	demo	operational	2012	www.lanzatech.com	Convertion of CO-rich gases from steel production facilities into fuels and chemicals.

LanzaTech New Zealand Ltd	waste gas to fuel	New Zealand	biochemical conversion	Any gas containing Carbon Monoxide; industrial flue gasses	ethanol;	pilot	operational	2008	www.lanzatech.com	waste gas to fuel conversion using proprietary microbial catalysts
LanzaTech, Inc.	LanzaTech Freedom Pines Biorefinery	United States	biochemical conversion	lignocellulosics; Biomass syngas	ethanol;	commercial	planned	2013	www.lanzatech.com	Gas fermentation process using biomass syngas derived from forestry residues
Licella	Commercial demonstration plant	Australia	thermochemical conversion	lignocellulosics; Radiata Pine, Banna Grass, Algae	bio-oil;	demo	operational	2008	www.licella.com.au	Using our proprietary Catalytic Hydrothermal Technology (Cat-HTR), Licella can use any form of lignocellulosic biomass feedstock to produce its Bio-Crude oil. Licella's process can in one step produce a high energy density (34-36 MJ//Kg) Bio-Crude within 30 minutes, that can be blended with traditional fossil crude and dropped in to existing refineries to make the same range of fuels e.g. petrol, diesel and jet and chemical feedstocks.
Lignol Energy Corporation	pilot	Canada	biochemical conversion	lignocellulosics; hardwood & softwood residues	ethanol; cellulose; lignin; various chemicals; sugars;	pilot	operational	2009	www.lignol.ca	Lignol Innovations is commercializing its unique integrated cellulose to ethanol process technology for biorefining ethanol (fuel alcohol), pure lignin and other valuable co-products from renewable and readily available biomass. The technology is based on original 'Alcell' biorefining technology that was developed by General Electric and Repap Enterprises at a cost of over $100 million. The Lignol delignification process was first developed by General Electric Corp. in the early 1970s to produce ethanol and organosolv lignin to be used as a clean burning gas turbine fuel. The process was subsequently applied to the pulp and paper industry, commercialized by Repap Enterprises between 1987 and 1997 to generate wood pulp. Repap refocused the Alcell delignification process as a pulping process in which lignin (the natural glue in wood) was removed, and following bleaching, produced a 100% cellulose/hemicellulose wood pulp.
Lignol Energy Corporation	demo	United States	biochemical conversion	lignocellulosics; hardwood & softwood residues; agri -residues	ethanol; lignin;	demo	plans abandoned	originally planned to start 2012	www.lignol.ca	-
Mascoma Corporation	Demonstration Plant	United States	biochemical conversion	lignocellulosics; Wood Chips, Switchgrass and other raw materials	ethanol; lignin;	demo	operational	2003	www.mascoma.com	The unique technology developed by Mascoma Corporation uses yeast and bacteria that are engineered to produce large quantities of the enzymes necessary to break down the cellulose and ferment the resulting sugars into ethanol. Combining these two steps (enzymatic digestion and fermentation) significantly reduces costs by eliminating the need for enzyme produced in a separate refinery. This process, called Consolidated Bioprocessing or "CBP", will ultimately enable the conversion of the solar energy contained in plants to ethanol in just a few days.
Neste Oil	Porvoo 1	Finland	chemical conversion	oils, fats; hydrotreatment of palm oil, rapeseed oil and animal fat	biodiesel;	commercial	operational	2007	www.nesteoil.com	-
Neste Oil	Porvoo 2	Finland	chemical conversion	oils, fats; hydrotreatment of oils and fats	biodiesel;	commercial	operational	2009	www.nesteoil.com	-
Neste Oil	Rotterdam	Netherlands	chemical conversion	oils, fats; hydrotreatment of oils and fats	biodiesel;	commercial	operational	2011	www.nesteoil.com	-
Neste Oil	Singapore	Singapore	chemical conversion	oils, fats; hydrotreatment of oils and fats	biodiesel;	commercial	operational	2010	www.nesteoil.com	-
New Energy and Industrial Technology Development Organization (NEDO)	Development of an Innovative and Comprehensive Production System for Cellulosic Bioethanol	japan	biochemical conversion	lignocellulosics; wood chips	ethanol;	pilot	operational	2011	www.ojipaper.co.jp/ Nippon Steel Engineeringï¼š http//www.nsc-eng.co.jp/ AISTï¼šhttp://www.aist.go.jp/	Mechanochemical Pulping Process for conversion of cellulose to ethanol. The projectâ€™s goal is to develop a coherent bioethanol production system from biomass plantation to ethanol production. The targeted cellulosic biomass in the project is wood from eucalyptus. The development includes basic studies on raw material production, pretreatment using pulping technology, simultaneous saccharification and fermentation using thermal and acid tolerant yeast, and saving energy technology with self-heat recuperation.
NREL (National Renewable Energy Laboratory)	Integrated Biorefinery Research Facility (IBRF)	United States	biochemical conversion	lignocellulosics;	ethanol;	pilot	operational	1994 (expansion completed 2011)	www.nrel.gov/biomass/	-
NREL (National Renewable Energy Laboratory)	Thermochemical Users Facility (TCUF)	United States	thermochemical conversion	lignocellulosics;	various chemicals; transport fuels;	pilot	operational	1985 (expansion in progress)	www.nrel.gov/biomass/	-
NSE Biofuels Oy, a Neste Oil and Stora Enso JV	demo	Finland	thermochemical conversion	lignocellulosics; forest residues	FT-liquids;	pilot	stopped	2009	www.nesteoil.com; www.storaenso.com	Fischer-Tropsch production of paraffins from biomass; fluid bed gasifier with tar reformer
NSE Biofuels Oy, a Neste Oil and Stora Enso JV	commercial reference plant	Finland	thermochemical conversion	lignocellulosics; forest residues	FT-liquids;	commercial	plans abandoned	-	-	Fischer-Tropsch production of paraffins from biomass; fluid bed gasifier with tar reformer
Pacific Ethanol	West Coast Biorefinery (WCB)	United States	biochemical conversion	lignocellulosics; wheat straw, corn stover, poplar residuals	ethanol; biogas; lignin;	demo	plans abandoned	Originally planned for start up in 2010	www.pacificethanol.net	-
Petrobras	Bioethanol second generation production	Brazil	biochemical conversion	sugarcane bagasse;	ethanol;	pilot	plans postponed	-	-	Acid hydrolysis as pretreatment and enzymatic hydrolysis to convert cellulose into glucose and fermentation with Saccharomyces cerevisae yeast. The sugars of five carbons from hemicellulose fraction are submitted to the fermentation process using Pichia stiptis yeast.
Petrobras	Pilot	Brazil	biochemical conversion	sugarcane bagasse;	ethanol;	pilot	operational	2007	-	Acid hydrolysis as pretreatment and enzymatic hydrolysis to convert cellulose into glucose and fermentation with Saccharomyces cerevisae yeast. The sugars of five carbons from hemicellulose fraction are submitted to the fermentation process using Pichia stiptis
Petrobras and Blue Sugars	Second generation ethanol demo plant	United States	biochemical conversion	sugarcane bagasse;	ethanol;	demo	operational	2011	-	Specific Petrobras test programm that has been running on Blue Sugars demo plant of which name plate capacity is described in the Blue Sugars fact sheet.
POET	Scotland	United States	biochemical conversion	lignocellulosics; corn fiber, corn cobs and corn stalks	ethanol;	pilot	operational	2008	www.poet.com	Enzymatic Hydrolysis
POET-DSM Advanced Biofuels	Project Liberty	United States	biochemical conversion	lignocellulosics; agricultural residues	ethanol; biogas	commercial	under construction	2013	www.projectliberty.com	Integrated technology package that converts corn crop residue to cellulosic bio-ethanol to third parties, as well as the other 26 existing corn ethanol plants in POET's network. The process makes use of corn stover that passes through the combine during harvest. We use approximately 25% of the material, leaving about 75% on the ground for erosion control, nutrient replacement and other important farm management practices.
PROCETHOL 2G	Futurol Project	France	biochemical conversion	lignocellulosics; flexible; woody and agricultural by-products, residues, energy crops	ethanol;	pilot	operational	2011	www.projet-futurol.com	-
Queensland University of Technology	Mackay Renewable Biocommodities Pilot Plant	Australia	biochemical conversion	lignocellulosics, sugarcane bagasse, trash, wood chip, sweet sorghum, energy grasses, stover	ethanol, lignin, chemicals	pilot	Operational	2010	www.ctcb.qut.edu.au/programs/pilot.jsp	Soda pulping and ionic liquid based pretreatments, lignin recovery, saccharification with commercial enzymes, conventional fermentation of hexoses
Range Fuels, Inc.	K2A Optimization Plant	United States	thermochemica conversion	lignocellulosics; Georgia pine and hardwoods and Colorado beetle kill pine	mixed alcohols;	pilot	Stoped	2008	www.rangefuels.com/	The thermochemical process employed by Range Fuels invovles two steps: Step 1: Solids to Gas: Biomass (all plant and plant-derived material) that cannot be used for food, such as agricultural waste, is fed into a converter. Using heat, pressure, and steam the feedstock is converted into synthesis gas (syngas), which is cleaned before entering the second step. Step 2: Gas to Liquids: The cleaned syngas is passed over our proprietary catalyst and transformed into mixed alcohols. These alcohols are then separated and processed to maximize the yield of ethanol of a quality suitable for use in blending with gasoline to fuel vehicles. A Simple Process: Because Range Fuels process utilizes a thermochemical process, it relies on the chemical reactions and conversions between forms that naturally occur when certain materials are mixed under specific combinations of temperature and pressure. Other conversion processes use enzymes, yeasts, and other biological means to convert between forms. Feedstock Flexibility: The Range Fuels process accommodates a wide range of organic feedstocks of various types, sizes, and moisture contents. This flexibility eliminates commercial problems related to fluctuations in feed material quality and ensures success in the real world, far from laboratory-controlled conditions. Tested and True Range Fuels technology has been tested and proven in bench and pilot-scale units for over eight years. Over 15,000 hours of testing has been completed on over 30 different non-food feedstocks with varying moisture contents and sizes, including wood waste, olive pits, and more. Range Fuels continues to optimize the conversion technology that will be used in our first commercial cellulosic ethanol plant near Soperton, Georgia using a 4th generation pilot plant in Denver, Colorado that we have been operating since the first quarter of 2008.
Range Fuels, Inc.	commercial	United States	thermochemical conversion	lignocellulosics; Wood and wood waste from nearby timber harvesting operations	ethanol; methanol;	commercial	plans abandoned	Start up would have been in 2010.	www.rangefuels.com/	Range Fuels is focused on commercially producing low-carbon biofuels, including cellulosic ethanol, and clean renewable power using renewable and sustainable supplies of biomass that cannot be used for food. The company uses an innovative, two-step thermo-chemical process to convert biomass, such as wood chips, switchgrass, corn stover, sugarcane bagasse and olive pits to clean renewable power and cellulosic biofuels. In the first step of the process heat, pressure and steam are used to convert the non-food biomass to a synthesis gas or syngas. Excess energy in this step is recovered and used to generate clean renewable power. In the second step the cleaned syngas is passed over a proprietary catalyst and transformed into cellulosic biofuels, which can then be separated and processed to yield a variety of low carbon biofuels, including cellulosic ethanol and methanol. This suite of products can be used to displace gasoline or diesel transportation fuels, generate clean renewable energy or be used as low carbon chemical building blocks; all of which can reduce the country's dependence on foreign oil, create immediate jobs, and dramatically reduce GHG emissions.

Research Triangle Institute	Synfuel production	United States	thermochemical conversion	lignocellulosics;	FT-liquids; mixed alcohols;	pilot	under construction	-	www.rti.org/process	"Biomass-derived syngas will be generated in the University of Utah's pilot-scale gasification system from woody biomass and a combination of wood and lignin-rich hydrolysis residues generated at NCSU. RTI will integrate their dual fluidized bed reactor system called the "therminator" into the gasification process. The "therminator" which operates between 600–700ºC (1112–1292ºF) with a novel attrition-resistant triple function catalyst system, to simultaneously reform, crack, or remove tar, ammonia (NH3), and hydrogen sulfide (H2S) down to ppm levels. The catalyst is circulated between coupled fluidized-bed reactors to continuously regenerate the deactivated catalyst. The gas leaving the therminator will be cooled and filtered before it enters the second (polishing) stage, consisting of a fixed-bed of a mixed-metal oxide-sorbent catalyst, to further reduce the tar, NH3, H2S, and heavy metals to less than 100 ppb each so that the syngas can be directly used in a downstream process for synthesis of liquid transportation fuels. Once installed in the University of Utah gasification facility, therminator gas cleanup performance will be validated during for 300 hours of operation in Phase 1 of the project. The results from these Phase I trials will be used as input for gasification process models that will also be developed during Phase I. The results from the gasification trials, and the process and economic modeling will then be used to guide the Phase 2 work. In particular these results, in consultation from DOE and industry, will be used to direct the selection of the gas to liquids catalyst towards a Fischer-Tropsch catalyst system for hydrocarbon production or a molybdenum sulfide-based catalyst system for mixed alcohol synthesis. Phase 2 will follow the successful demonstration of the gas cleanup technology to produce a clean syngas that is suitable for a fuel synthesis process. The targeted tar, sulfur, chloride, and nitrogen impurity concentrations will meet or exceed the levels required for the projected 5-year operation of a Fischer-Tropsch catalyst system for hydrocarbon production or a molybdenum sulfide-based catalyst system for mixed alcohol synthesis. RTI will design and build a slurry bubble column reactor system to convert the clean syngas into a liquid transportation fuel. This unit operation will be installed in the University of Utah gasification facility downstream of the therminator and operated for 500 hours (at least 100 hours continuously) in an integrated biomass gasification/gas cleanup and conditioning/fuel synthesis process. RTI will be the prime contractor and will be responsible for the overall project. The project will be managed within the Center for Energy Technology (CET) and Dr. David C. Dayton will serve as the overall project manager. The NCSU team will be led by Dr. Steven Kelley and include four faculty, two from Wood and Paper Science and two from Chemical Engineering. Dr. Kevin Whitty will lead the University of Utah team in the Institute for Clean and Secure Energy that will be responsible for the operation of the gasification facility. Successful validation of these integrated gas cleanup and fuel synthesis operations will provide invaluable data and operating experience to reduce the risk of scale-up and commercialization of these technologies and contribute to the development of a robust biofuels industry."
Schweighofer Fiber Gmbh	biorefinery	Austria	biochemical conversion	lignocellulosics; sulfite spent liquor (SSL, 33% dry content) from spruce wood pulping	ethanol;	demo	plans postponed	-	www.schweighofer-fiber.at	Pulp for the paper mill is produced by cooking spruce chips with acidic magnesium bisulfite cooking liquor. After concentration of the sulfite spent liquor (SSL) in the evaporation plant it is incinerated in the combustion boiler to produce steam and electricity, whereas magnesium oxide and sulfur dioxide are recycled to produce new cooking liquor. The concept for the production of ethanol is to ferment the wood sugars from SSL and to distil off the ethanol in the distillation plant. Afterwards the 96% ethanol is dehydrated by molecular sieves to get water free absolute ethanol. The mash will be recycled as described above.
SEKAB	commercial plants	Sweden	biochemical conversion	lignocellulosics;	ethanol;	commercial	plans postponed	Start up was originally planned for 2016.	www.sekab.com	reference plant on best method
SEKAB	planned demo plant	Poland	biochemical conversion	lignocellulosics; Wheat straw and corn stover	ethanol;	demo	planned	2014	www.sekab.com	Enzymes with pretreatment of diluted acid in one step.
SEKAB Industrial Development AB	IDU	Sweden	biochemical conversion	lignocellulosics; flexible for wood chips and sugarcane bagasse	ethanol;	demo	plans abandoned	originally planned to start 2011	www.sekab.com	Enzymes with pretreatment of diluted acid in one step.
SEKAB/EPAP	demo plant	Sweden	biochemical conversion	lignocellulosics; primary wood chips; sugarcane bagasse, wheat, corn stover, energy grass, recycled waste etc have been tested.	ethanol;	pilot	Operational	2004	www.sekab.com	2 step diluted acid + enzyme hydrolysis
Southern Research Institute	technology development laboratory and pilot plant - thermochemical	United States	thermochemical conversion	lignocellulosics; Cellullulosics, Municipal wastes, syngas	FT-liquids; mixed alcohols; bio-char; power;	pilot	operational	2007	www.SouthernResearch.org	thermochemical conversion, catalytic liquids synthesis, hot and cold syngas cleaning
Sued-Chemie AG	sunliquid	Germany	biochemical conversion	lignocellulosics; wheat straw	ethanol;	demo	operational	2012	www.sunliquid.com	biotechnological process for the conversion of lignocellulosic feedstock to cellulosic ethanol via enzymatc hydrolysis and fermantation; turn-key technology solution from pretreatment to separation: process-integrated enzyme production using a small amount of the pretreated feedstock, feedstock and process specific enzymes (patented), one-batch-fermentation of C5 and C6 sugar (50% higher production compared to a pure C6 fermentation), ethanol purification on the basis of an adsorption-desorption-process replacing the destillation (50% less energy consumption); all process heat comes from the use of residual materials incl. the lignin which is separated after saccharification
Technical University of Denmark (DTU)	Maxifuel	Denmark	biochemical conversion	lignocellulosics; wheat straw, corn fibre	ethanol; biogas; lignin;	pilot	stopped	2006	www.biogasol.com	-
Tembec Chemical Group	demo	Canada	thermochemical conversion	lignocellulosics; spent sulphite liquor feedstock	ethanol;	demo	operational	2003	www.tembec.com	-
Terrabon	Energy Independence I	United States	biochemical conversion	lignocellulosics; municipal solid waste, sewage sludge, manure, agricultural residues and non-edible energy crops	ethanol; mixed alcohols; various chemicals;	demo	operational	2009	www.terrabon.com/	The MixAlcoÂ® technology converts biomass to biofuel using carboxylic acid fermentation followed by conventional chemistry that processes the resulting carboxylic salts into valuable chemicals that can be further refined through separate, well-established processes in the chemical industry to produce renewable biofuels. The technology uses conventional non-sterile, anaerobic digestion with standard processing equipment, resulting in competitive capital and operating costs. Depending on the lignin content, the biomass can be pretreated before being fed to a mixed culture of acid-forming microorganisms derived from a saline environment. An organic acid broth is created, which is then converted to its corresponding organic salt with a buffer used to manage pH at the optimal biological conditions. The carboxylate salts are filtered, dewatered, concentrated, and then thermally converted to ketones. During ketonization, the salts decompose into mixed ketone vapors and carbonates. Conventional chemical process technology is used to convert the residual purified ketones into secondary alcohols through hydrogenation. The hydrogenated alcohols then undergo oligomerization and further conversion and purification to produce a drop-in fuel (conventional gasoline, diesel, and/or jet fuel).
TNO	Superheated steam pilot plant	Netherlands	biochemical conversion	lignocellulosics; Wheat straw, grass, corn stover, bagasse, wood chips	pretreated biomass ;	pilot	operational	2002	www.tno.nl	In a reactor a continuous flow of SHS passes through a heap of grass or straw, in contrast with the usual stagnant and saturated steam. By using SHS the heat is not transferred by condensation but by convection. The initial dry matter contents can be 20-45% w/w and probably higher. Such high dry matter content decreases the use of thermal energy since a lower amount of mass is heated. Moreover, as a result of lower water content less acid catalyst is required to reach the effective concentrations and by evaporation of water a desired increase in acid concentration can be created. High dry matter concentrations are important for the economy of fermentation and downstream processing, as higher substrate concentrations lead to higher product concentrations, which makes recovery more cost-effective. The fast temperature increase and decrease within a few seconds allows a better process control. By evaporation of water the final dry matter content can be increased to values between 30% and 60% w/w. The amount of water evaporation can be adjusted by the pressure in combination with the superheating temperature. Flexibility in acid concentration has been observed as well. The user can choose between less acid and longer reaction times or more acid and shorter times. In addition, the user can choose between various inorganic and organic acids. The process can be carried out within a few minutes and a temperature of 160Â°C already is effective, which can be placed within the fastest and coldest existing thermal mild acid pretreatment processes, which adds to a favourable economy of the process. After SHS pretreatment a conversion of more than 95% of cellulose and hemicellulose after enzymatic hydrolysis can be reached, which can be regarded as high. Samples have been successfully subjected to ethanol fermentation at 38% DM. The pretreatment step can be carried out in TNOâ€™s superheated steam pilot plant. SHS dryers are already on the market at the sizes required for lignocellulose biorefineries / cellulosic ethanol production, although they should be adapted to shorter residence times and higher pressures.
TUBITAK	TRIJEN (Liquid Fuel Production From Biomass and Coal Blends)	Turkey	thermochemical conversion	biomass /biomass coal blends; combination of hazelnut shell, olive cake, wood chip and lignite blends	FT-liquids;	pilot	planned	2013	trijen.mam.gov.tr/	The aim of the project is to develop and demonstrate the technologies for liquid fuel production from biomass and/or biomass-coal blends at the laboratory and pilot scale systems. The technological areas within the scope of the project are gasification, gas clean-up, gas conditioning, CO2 separation and liquid fuel production via Fischer-Tropsch (FT) synthesis. Activities related to the technological research areas consist of the pre-design of the units, laboratory tests, detailed design, engineering, manufacturing, commissioning and testing at pilot scale. In the gasification step, two types of gasifiers circulating fluidized bed gasifier and pressurised fluidized bed gasifier have been studied in laboratory scale (150 kWth). 1.1 MWth capacity pressurised fluidized bed gasifier have been designed for pilot scale. The aim of the gas cleaning step is to remove impurities from raw gas of gasifier. Both hot and cold gas clean-up technologies have been used in laboratory scale experiments. Hybride hot and cold gas clean-up pilot system has been designed. The third step of project is gas conditioning. The aim of this step is to adjust H2/CO ratio in syngas and capture CO2. H2/CO ratio in syngas will be adjusted in a water gas shift (WGS) reactor and CO2 will be captured by chemical absorption technique. One of the main work packages of the project is the production of liquid fuels via Fischer-Tropsch synthesis since the activities related to both FT catalyst development and fixed bed and slurry phase reactor applications have been performed in this work package. Low temperature FT process with multi tubular fixed bed reactor will be used to produce synthetic diesel in pilot plant. Iron based FT catalyst has been developed to convert syngas into hydrocarbon chains. All units of the pilot scale system are under construction currently.
Weyland AS	Weyland	Norway	biochemical conversion	lignocellulosics; various feedstocks, mostly spruce & pine	Ethanol; lignin; sugars;	pilot	operational	2010	www.weyland.no	-

Vienna, University of Technology	FT synthesis	Austria	thermochemical conversion	wood chips	FT diesel, FT waxes, FT kerosene	pilot	operational	2005	www.vt.tuwien.ac.at	"Aim of the work is to convert the product gas (PG) of the Biomass gasification plant with a Fischer-Tropsch (FT) process to liquid fuels, especially to diesel. A FT-PDU (process development unit) is operated, which converts about 7 Nm3/h PG at 25bar in a Slurry reactor to FT-products. The gas cleaning of the raw PG consists of several steps. First a RME-scrubber is used to dry the gas. After the compression step, chlorine is separated with a sodium aluminate fixed bed. Organic sulphur components are hydrated with a HDS-catalyst and the H2S is chemically separated with Zinc oxide. Both is realised in fixed bed reactors. In alternative to the HDS also activated carbon filter can be used for gas cleaning. As catalyst in the slurry reactor, iron and cobalt based catalyst are used. The results from a Cobalt catalysts give mainly an n-alkan distribution from C1 to compounds higher than C60 n-alkanes. The iron based catalysts give more alkenes and oxygenated compounds. The analyses of the diesel fraction from the distillation of the FT-raw product show that the obtained diesel from the Cobalt catalyst has cetan-numbers of about 80 and is free of sulphur and aromatics."
Virent, Inc.	Eagle Demonstration Plant	United States	thermochemical conversion	lignocellulosics; Cane sugar, beet sugar, corn syrup, hydrolysates from cellulosic biomass including pine residues, sugarcane bagasse and corn stover	various chemicals; gasoline type fuel; industrial sugars; lignin specialty chemicals;	demo	operational	2009	www.virent.com	Virentâ€™s BioFormingÂ® platform is based on a novel combination of Aqueous Phase Reforming (APR) technology with modified conventional catalytic processing. The APR technology was discovered at the University of Wisconsin in 2001 by Virentâ€™s co-founders. The BioForming platform expands the utility of the APR process by combining APR with catalysts and reactor systems similar to those found in standard petroleum oil refineries and petrochemical complexes. The BioForming process converts aqueous carbohydrate solutions into mixtures of â€œdrop-inâ€ hydrocarbons. The process has been demonstrated with conventional sugars obtained from existing sugar sources (corn wet mills, sugarcane mills, etc.) as well as a wide variety of cellulosic biomass from nonfood sources. A key advantage to the BioForming process is the ability to produce hydrogen in-situ from the carbohydrate feedstock or utilize other sources of hydrogen such as natural gas for higher yields and lower costs.
ZeaChem	Demonstration scale biorefinery	United States	biochemical conversion	lignocellulosics; ppoplar trees, wheat straw	ethanol; mixed alcohols; diesel; acetates; jet fuel;	demo	operational	2011	www.zeachem.com	The conversion process uses naturally-occurring organisms and proven, industrial equipment in order to reduce scale-up risk. Non-GMO bacteria ferment cellulosic sugars with nearly 100% carbon efficiency and the combination of biological and thermochemical processes deliver a 40% yield advantage compared to other processes. Like a petrochemical refinery, ZeaChem biorefineries can make multiple fuels and chemicals, shifting production to the highest margin products. Fuel products include ethanol, jet fuel, diesel and gasoline; chemical products include acetic acid, ethyl acetate, ethylene and propylene.
ZeaChem Inc.	Commercial scale biorefinery	United States	biochemical conversion	lignocellulosics; poplar trees, wheat straw	ethanol; acetates;	commercial	planned	2014	www.zeachem.com	The conversion process uses naturally-occurring organisms and proven, industrial equipment in order to reduce scale-up risk. Non-GMO bacteria ferment cellulosic sugars with nearly 100% carbon efficiency and the combination of biological and thermochemical processes deliver a 40% yield advantage compared to other processes. Like a petrochemical refinery, ZeaChem biorefineries can make multiple fuels and chemicals, shifting production to the highest margin products. Fuel products include ethanol; chemical products include acetic acid, and ethyl acetate.