Atlantic Biomass Conversions, Inc.

A SBA HubZone Certified Small Business Company

Biofuels Capability Statement

1. Overcoming Biomass Recalcitrance and Reducing Biofuel Production Costs

One of the most significant roadblocks to the market rate production of non-food advanced biofuels is the cost and availability of biofuel and biochemical sugar precursors. Atlantic Biomass is focused on overcoming this roadblock through the development and commercialization of enzyme based systems that can be deployed in decentralized systems ranging from agricultural processing plants to portable in-field units. Among the advantages of enzyme hydrolysis in biofuel applications are:

1. Enzyme hydrolysis preserves proteins in plant biomass for animal feed. This process increases agricultural residue revenue for growers and provides better balance for the food/fuel use of agricultural crops. This dual-use advantage is not available with acid hydrolysis systems.

2. An efficient enzyme hydrolysis can be manipulated to improve saccharification rates and yields to commercial levels. In addition, the process can be customized to produce specific mixtures of oligomeric and monomeric sugars (sugar fractionation) that match the needs of specific biofuel producing organisms and chemical processes.

Atlantic Biomass focuses on three technical approaches to meet these objectives:

- Order of Biomass Deconstruction
- Genetic Engineering of Biomass Deconstruction Enzymes
- Decentralized Sugar Production Systems

Order of Biomass Deconstruction

While enzymatic hydrolysis of plant cell walls for the production of biofuel/biochemical sugars is an attractive process, existing drawbacks of enzyme hydrolysis are well documented: high enzyme loadings, low yields, and excessive processing times.

Our answer to solving this problem has been to go back to the micro structure of the plant cell wall to see if the order of biomass disassembly can be manipulated to improve saccharification rates and yields. Results from our research has produced a step-wise process that greatly speeds-up conversion rates while also increasing yields and decreasing enzymes loads. In addition, this sequence of enzymes can be used to produce separate streams of soluble sugars; galacturonic acid, hemicelluloses C-5 sugars, and glucose for use in different biofuel and biochemical production pathways.

Genetic Engineering of Biomass Deconstruction Enzymes

Using a modification of directed evolution Atlantic Biomass, in conjunction with Hood College, has genetically engineered a thermostable pectin methylesterase (PME) JL25 with activity at 65^0C. This modification was made so the enzyme could be used in commercial sugar beet sucrose refineries, thereby utilizing the energy contained in the sugar beet pulp as it leaves the sucrose diffusion process to speed sacacharification. Details on this enzyme (US PTO provisional application 61262504), are included in, Chakiath et al. "Thermal Stabilization of *Erwinia chrysanthemi* Pectin Methylesterase A for Application in a Sugar Beet Pulp Biorefinery." Appl. and Env. Micribiol. 75:7343-7349, December 2009.

Decentralized Biofuel Sugar Production

The economies of scale that allow the US petroleum industry to minimize both production and transportation costs are currently not available to the biofuel industry because of the high cost of transporting large quantities of low density, low value biomass to biorefineries.

Using the Atlantic Biomass sequential enzyme process, the pretreatment/sacacharification of biomass will be taken out of centralized biorefineries and distributed to low-capital enzyme based subsystems located in growing or agricultural processing locations. These decentralized facilities will convert low-density, low value biomass into high density biofuel intermediates that would be shipped via tank truck, or even lower cost trains, to large scale biorefineries for conversion to finished biofuels. The location of biorefineries would therefore not be limited to the immediate radius determined by the cost of biomass transport.

The use of these decentralized pretreatment/sacacharification systems would also allow biofuel production to be based on a year-round National "pool" of crops and agriculture residues. This would increase the supply of biofuel biomass to include rotated cover crops, single season croppings of conservation area grasses, and relatively small stands of energy crops. In addition, many of the problems of crop storage would be avoided.

Atlantic Biomass is currently working with American Crystal Sugar on the first deployment of this system. The sequential enzyme system would be installed at existing sugar refineries to convert residual sugar beet pulp to biofuel C-5 and C-6 sugars. American Crystal Sugar owns five sugar beet processing facilities located 30 to 110 miles from Grand Forks, ND, the site of a major USAF base. Installation of the sequential enzyme system at these five existing plants would be able to deliver 320,000 tons/year of soluble biofuel sugars from current crop residues to a jetfuel biorefinery located adjacent to or on the Grand Forks, ND airbase.

2. Providing Perspectives on Biofuel Markets and Public Policy

In addition to technical expertise, the people of Atlantic Biomass are focused on understanding how public and interest group support drive both the adoption of biofuel innovations and the creation of new biofuel markets. Robert Kozak, the founder of Atlantic Biomass, is also one of the founders and a Board Member of Advanced Biofuels USA, a 501 (c) (3) non-profit educational organization. Kozak works closely with Joanne Ivancic, a former staffer for Senator Chuck Grassley, who is Executive Director of Advanced Biofuels USA on technology issues.

Through the Advanced Biofuels website www.advancedbiofuelsusa.org, with over 60,000 page views/week people worldwide get the latest information on advanced biofuels. In addition, Mr. Kozak has good ties with the Green Racing community including such biofuel racing leaders as Lord Paul Drayson, former UK Minister of Science and Innovation.