BioEnergy International, LLC. a Biorefinery Company

Corinne Young
BioEnergy International, cyoung@bioenergyllc.com

Follow this and additional works at: https://scholarworks.umass.edu/timbr


This Article is brought to you for free and open access by ScholarWorks@UMass Amherst. It has been accepted for inclusion in Conference on Cellulosic Biofuels by an authorized administrator of ScholarWorks@UMass Amherst. For more information, please contact scholarworks@library.umass.edu.
BioEnergy International, LLC
a Biorefinery Company

Umass TIMBR Cellulosic Conference
September 19, 2008
Management Team, BioEnergy’s X Factor

Stephen J. Gatto, Chairman, CEO
Advisor to President Clinton and Bush

Dr. Lonnie Ingram, Chief Science Officer
University of Florida

Dr. Joseph P. Glas, SVP R&D
VP DuPont Biotechnology

Dr. Mohammed Moniruzzaman, VP R&D
Genencor International

Samuel McConnell, SVP Development
Project finance over $2 B

Rudy Fogleman, VP Operations
Commercial ethanol plant experience

Experience
Proven track record
Recognized worldwide

President Bush on BioEnergy’s Chief Science Officer:
“on the leading edge of change”
Our Vision - the BioRefinery

A Day When A Pound Of Sugar Can Replace A Barrel of Crude For Everything From The Fuel We Put In Our Cars To The Plastics and Fabrics We Use In Our Everyday Lives.

www.bioenergyllc.com
Today’s oil and gas bases technology

- Oil
- Natural gas
- Coal
- Natural gas
- Oil

2500 °C

- Naphta
- Methanes
- Coke
- Butane
- Naphta
- Butadiene

Acetylene
Maleic anhydride
1,4 diacetoxy-2-butene

1,4 Butanediol

200 °C

BioEnergy’s second generation technology – 3 years from today

25 °C

- Sugar
- Succinic

1,4 Butanediol

200 °C

BioEnergy’s second generation technology – 7 years from today

25°C

- Sugar

1,4 Butanediol

35 °C
BioEnergy’s margin comparison

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Cost of Sugar ($ / lb)</th>
<th>Ethanol Gross Margin ($ / lb sugar)</th>
<th>Bio-polymer Gross Margin ($ / lb sugar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>$0.08-0.17</td>
<td>$0.01-0.10</td>
<td>$0.51</td>
</tr>
<tr>
<td>Sugar Cane</td>
<td>$0.08-0.10</td>
<td>$0.08-0.10</td>
<td>$0.58</td>
</tr>
<tr>
<td>Cellulosic</td>
<td>$0.03-0.08</td>
<td>$0.10-0.15</td>
<td>$0.60</td>
</tr>
</tbody>
</table>

The focus is on diversifying plant revenues while building the sustainable sugar platform. Cellulosic technology is not the end game; rather it is a means to an end.
The Market

Biofuels
→ 90 billion gallons

Bio-based chemicals and polymers
→ 350 billion pounds
The Strategy

**Secure cash flow** from traditional corn plants and cheap sugar platforms

**Diversify revenue** by introducing novel biocatalysts for the manufacture of green chemicals and biopolymers

**Integrate cellulosic technology** by retrofitting or building plants to drive down costs and move away from food-based raw materials

New Paradigm needs a Beginning, Middle and End

www.bioenergyllc.com
Our strategic business model is supported by proprietary technology; BioEnergy is a leader in the new industrial revolution.
Biorefinery Platform
Cellulosic Destination Sites

Clearfield, Pennsylvania

- 110Mgpy, Fagan EPC; ICM Design
- 5-year off-take agreement with Getty Oil (provides natural hedge against commodity fluctuations)
- $22M in grants and loans from State of Pennsylvania
- Closed $205M debt financing with WestLB, TD Banknorth & Stern Brothers Feb ’08
- Design underway for co-location of pilot plant

www.bioenergyllc.com
Lake Providence, Louisiana

- 110Mgpy expandable to 220Mgpy
- Key permits in hand
- $20M in grants
- Site lease executed with Port Authority
- Mississippi River location provides logistics options for diverse feedstocks and product output
Led by Dr. Mohammed Moniruzzaman and a world-renowned team of molecular biologists, engineers, and chemists, BioEnergy uses its proprietary technology to advance the development of its cheap sugar platform.
Innovative, Integrated Cellulosic Platform
site as important as technology

The road to low cost fuels is in the feedstock…

1st wave technology: Grain based

2nd wave technology: Organic waste based

< Different technologies, different strategies

The gap is closing fast

Site and Business plan as important as technology >

Today 2009

www.bioenergyllc.com
BioEnergy’s Biorefinery Technology

The source
- Bagasse
- Rice straw
- Wood chips
- Paper Sludge

The feedstock
- C6 sugars
- C5 sugars

The technology
- Metabolic Engineering
- Directed Evolution
- Process Integration

The product
- High value fuels & chemicals:
  - Lactic acid
  - Succinic acid
  - Butanol
  - Butanediol

BioEnergy’s “software” will convert Today’s “hardware” into Tomorrow’s biorefineries.
Revolutionary technology - BioEnergy’s “software” will convert today’s “hardware” into tomorrow’s biorefineries

Sugar feedstock
- Bagasse
- Rice straw
- Wood chips
- Municipal waste

Cellulosic technology

Biocatalyst Fermentation “The Cell Factory”

Products
- Biochemicals
- Bioplastics
- Biofuels

BioEnergy’s flexible microbial technology platform allows specified selection of chemicals to produce

- 3-HP
- Ethanol
- Adipic acid
- Microorganism
- Lactic acid
- Propanediol
- Succinic acid
- Butanol
- Butanol
Business Overview
Novel Biocatalysts

Through the development of novel biocatalysts for use in state-of-the-art biorefineries, BioEnergy has pioneered a progressive, sustainable, and economically viable alternative to the traditional petroleum-based production of renewable fuels and high-value bio-based intermediates and polymer precursors.
Commercial D-lactic acid

- BioEnergy broke the D-lactic acid code
- Product already in the market

**BIOPLASTIC**

**PURAC PDLA**

**BENEFITS**

- PLA plastics with HDT B (0.45MPa) values > 100°C possible
- New applications with better heat stability possible
- More efficient in injection molded PLA
- Bulk density of PLA unchanged

**IMPROVING HEAT-RESISTANCE OF PLA USING POLY(D-LACTIDE)**

PLA (Poly L-Lactide) is a bioplastic derived from annually renewable carbohydrate resources. PLA has conquered a promising market volume and is growing fast. The semi-crystalline biopolymer has mechanical properties comparable to polyethylene and is being used as an eco-friendly packaging material. However, the adoption and growth of PLA is currently limited by a number of technical challenges. The most prominent material property of PLA that needs improvement is the poor heat resistance. Heat deformation of PLA already takes place at temperatures below 50°C. This poses major issues in storage, transport and use of pallets and finished articles. A solution for the low heat-stability while maintaining transparency would accelerate the acceptance of PLA and widen the application window.

Six years of innovative research and development at PURAC have resulted in the commercial availability of D- and L-lactic acid. The monomer that enables large-scale utilization of PDLA (Poly D-Lactide). Melt-mixing PLA in the presence of PDLA produces in-situ so-PLA crystallites, which act as heterogeneous nuclei for PLA, resulting in faster crystallization and higher crystallinity upon cooling from the melt. Consequently, the material exhibits better mechanical and thermal properties, like lower shrinkage and improved heat resistance (HDT). A 50/50 mixture of PLLA and PDLA, the homopolymers of L(+)- and D(-)-lactic acid, produces a semi-crystalline polymer with a melting temperature of 215-230°C, i.e., 50-60°C higher than PLA packaging grades. This so-PLA (semi-crystalline PLA) is a suitable biopolymer for melt-spun fibers and biokially stretched film.

**About PURAC**

- Global presence
- Efficient and secure supply chain
- Natural products with high quality standards
- Dedicated application expertise for customers
BioEnergy’s Novel Biocatalyst Platform
Game Changer

1,4 Butanediol

35 % THF

29 % PBT (polyester)

16% GBL

14% TPU

4% COPO

BioEnergy product
Transforming the fuels, chemicals and energy industries with biotechnical advantage to push down cost and increase value
Status Quo of Oil is Unsustainable

Basic Chemicals
- ethylene
- propylene
- Benzene etc.

Plastics
- PET
- Polyester
- Polyols
- Polyurethanes
- Nylon

Fuels
- gasoline
- diesel
- jet fuel

CUSTOMERS

D-Lactic acid
- Succinic acid
- Propanediol
- Butanediol
- Adipic acid
- HPA

ETHANOL
- Butanol

PLA
- Polyester
- Polyols
- Polyurethanes
- Nylon

CUSTOMERS
Thank You

Corinne Young, Director of Government Affairs

BioEnergy International, LLC