BluCon-P:
A Consolidated Bioprocess for Lignocellulose Conversion

International Fuel Ethanol Workshop & Expo (FEW), Minneapolis

June 4-7, 2012

Albrecht Laeufer, VP Business Unit Lignocellulosic Technologies
What do we do?

- Developing proprietary bio-based solutions in fast industry growing segments
- Focusing on biomass conversion to high value fuels and chemicals
- Executed by a skilled and experienced technical and commercial team of 30+
- Advanced product portfolio targeting hundred billion dollar market areas
We build on a decade of proven capabilities

Tailor-made enzymes, strains and bio-processes

- Microbiology
- Molecular genetics
- Assay development
- UHTS Screening
- Process development
Our Product Pipeline

Phytase (thermostable)

Mannanase (thermostable)

Value enhanced DDGS

Lignocellulose Conversion

Laboratory → Pilot / Demo → market

Genencor

BASF

BluZy-D

BluCon-P
Direvo’s enzyme based solution to improve the value of Distiller’s Grain, the key co-product of the US bio-ethanol industry.
US Biofuel production is corn-based

- Over 60% of global BioEthanol production is US based
- Corn is the main feedstock
- Profitability depends on co-product sale
- Main co-product (DDGS) amounts to over 35M tons annually ($7+ bn market value)
- Feeding of DDGS to poultry and hogs is very limited due to anti-nutritional constituents

Source: Renewable Fuels Association
Conversion of Corn to Ethanol and Distillers Grain (DDGS)

1 bu corn

17.5 lbs DDGS

+ 2.8 ga ethanol

Source: Renewable Fuels Association
BluZy-D treated DDGS replaces corn and soy meal in poultry diets

DDY MILL ETHANOL PROCESS

BluZy-D DDGS can be fed at high inclusion rates

Source: Renewable Fuels Association
Improving economics along DDGS value chain

Efficient processing
- Reducing viscosity
- Improved dewatering & de-oiling
- Less energy consumption

High DDGS quality
- Low soluble fibers
- Improved drying
- Constant quality

Premium Feed
- High true metabolizable energy
- High amino acid digestability
- High Inclusion Rates

Reduced production cost
Higher value DDGS
Lower Feed Cost
Direvo’s proprietary solution for the cost-efficient conversion of lignocellulose to bio-fuels and chemicals
Really Great Products are made from Oil
Bio-Economies new currency: Sugar

Crude Oil

Hydro carbons
CH₃(CH₂)ₙ-CH₃.

Fuel
Chemical

Biomass

Sugar

Fuel
Chemical
The challenge to introduce a bio-currency

Key Drivers

Sustainable Reduction of Green house gas emission

Unrestricted Feedstock Availability
- Easy storage
- Secured supply 365 / 7 / 24
- Stable pricing

Stable and low COGS
- Low feedstock price
- CAPEX (Steel + Mortar)
- OPEX
So we need lots of sugar

..... we need it cheap

Today

- sugar crops
- grain starch

Tomorrow

- wood
- grasses

€ 400 / t

€ 150 / t
How to get there?

Our hi-temp consolidated bioprocess offers many benefits:

- One-vessel conversion technology
- Hydrolysis enzymes produced in process
- Simultaneous fermentation of C5 and C6 sugars
- Evaporation of ethanol during fermentation
But you need the right bug to do it all

Sample from 250+ extreme and smelly locations

Selection at 160° F on poplar as sole C source

Purification of 30+ isolates

Identification of 15 proprietary microbe strains
What do our microbe's have to offer

- Geographic and seasonal flexibility through a feedstock agnostic process
- Broad range of conversion products from ethanol, lactate, succinate, H2 to acetate
- Reduced CAPEX and OPEX through a consolidated process
- Robust process through high temperature fermentation (> 70 Degrees C)
- *in-process* ethanol removal
One platform –
Two products under development

Biofuels

Bioplastics
Feedstock agnostic process

**Grasses**
- straw / stover
- bagasse
- miscanthus / switchgrass
- sorghum

**Wood**
- Poplar
- Spruce
- Cotton stalk

**Industrial / waste**
- DDGS
- Beet pulp
- De-inking mud

Many substrates from around the globe tested

→ 90 to 100 % conversion
BluCon-P development goals

- Production cost per liter EtOH

- 2012: $3.5
- 2014: $2.0
- 2016: $0.45

- Process Optimization
- Strain Optimization
- Metabolic Engineering (by-product elimination)
Conclusion

- Developing bio-based solutions for a Green Economy
  - Strong foundation build from 12 years of experience
    - Focusing on fast growing market segments
      - Several proprietary products in the pipeline
    - Excellent partnership opportunity
Contact Information

DIREVO Industrial Biotechnology GmbH
Nattermannallee 1
D – 50829 Köln (Cologne)
Germany

Phone  +49 221-47448-101
Fax    +49 221-47448-111

E-Mail  albrecht.laeufer@direvo.com
Internet www.direvo.com