THE FUTURE OF CELLULOSIC ETHANOL IS HERE

New technologies and research for industrial scale-up: the formula for a sustainable bioethanol

POUL RUBEN ANDERSEN, NOVOZYMES
3rd Bio-Ethanol Conference
Turin, Italy
March 2, 2010
NOVOZYMES IN BRIEF

GLOBAL PRESENCE

• Global leader in Industrial Enzymes & Microorganisms
• More than 700 products used in 130 countries within >30 different industries
• 5,200 employees worldwide

R&D

• Market leader in all main industries
• 47% global market share within industrial enzymes
• ~14% of sales invested in R&D
• >6,000 patents in place

PERFORMANCE

• 2009 global sales USD 1.6B (FY 2009)
• Operating profit margin 20% (FY2009)
• ROIC 20.3% (FY2009)
Largest supplier of enzymes to the existing biofuel industry
   Market share of more than 60% in this field
18% of total Novozymes sales in 2009
Continuously provide the enzymes giving the highest biofuel yields at the lowest total production cost and provide second-to-none customer support
Leading the way in development of 2nd generation / cellulosic ethanol in collaboration with industry leaders around the globe
   150 people working on this development
Enzymes for commercial production of cellulosic ethanol ready by 2010
CELLULOSIC ETHANOL MEANS ECONOMIC GROWTH AND JOB CREATION
CELLULOSIC ETHANOL MEANS SUSTAINABILITY
CELLULOSIC ETHANOL MEANS ENERGY INDEPENDENCE
Assumed 77% process conversion efficiency on all substrates utilizing C5 and C6 sugars.

Source cob:stover ratio used: 19.5: http://www.ars.usda.gov/research/publications/publications.htm?SEQ_NO_115=235194

LARGE POTENTIAL WITH MANY CELLULOSIC FEEDSTOCKS

Adjusted Feedstock

US
EU
Brazil
China
India

Estimated Production MLtr/Year based on Adjusted Feedstock

US
EU
Brazil
China
India

MLtr/Year

MMT/Year

Corn Stover
Corn Cobs
Wheat Straw
Sugarcane Bagasse
Wood

0 100 200 300 400 500

0 20,000 40,000 60,000 80,000 100,000 120,000 140,000 160,000
A CELLULOSIC ETHANOL INDUSTRY IS EMERGING

NOVOZYMES GLOBAL PARTNERS
NOVOZYMES CELLIC® CTEC2
DELIVERING ON OUR PROMISE

The first commercially viable enzyme for cellulosic ethanol
CTEC2 PROVIDES SIGNIFICANT PERFORMANCE IMPROVEMENT OVER CTEC

Hydrolysis of unwashed NREL PCS, 20% TS, 8-days

% Cellulose Conversion

Enzyme Dosage (ml/g-cellulose)
INCREASED PERFORMANCE
AT HIGHER SOLIDS

TARGET: 70% yield as glucose from unwashed NREL PCS in 5 days
CTEC2 PROVIDES SIGNIFICANT PERFORMANCE IMPROVEMENT OVER CTEC

- Hydrolysis of pretreated Arundo by Chemtex pretreatment at 7.5% DM after 48h with 80% of glucans conversion
CELLULOSIC ETHANOL PRODUCTION CAN BE BUILT TO COMMERCIAL SCALE IN A FEW YEARS

Roadmap for cellulosic ethanol deployment

**Phase 1**
2000-2009

- Lab-to-pilot scale
- Significant reduction in enzyme cost and overall ethanol production cost
- Pilot plants running using various feedstocks
- Demonstration-scale plants being built

**Phase 2**
2010-2011

- Demonstration-scale
- Enzyme for commercial-scale production launched and first processes ready for up-scaling
- Demonstration-scale plants operating
- Commercial-scale plants being built

**Phase 3**
2012-

- Commercial-scale
- First commercial-scale plants to-commence
- Large-scale demand for cellulosic bioethanol in the US and elsewhere

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NOVOZYMES IS LEADING THE WAY...

...TO A PROMISING FUTURE

• Novozymes Cellic® CTec2 is the first commercially viable product for cellulosic ethanol
• Our partners have proven technologies that they are scaling up to provide a viable liquid transport fuel – now
• Together, M&G and Novozymes is making cellulosic ethanol a commercial reality