ADVANCES IN THE BIOLOGICAL CONVERSION PATHWAY
THE ENZYMES ARE READY

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European Biofuels Technology Platform
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**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)
NOVOZYMES IS A LEADING ENZYME DEVELOPER AND SUPPLIER TO THE GLOBAL FUEL ETHANOL INDUSTRY

- Leading provider of enzymes for ethanol in all regions where we operate
- Broad insight into cellulosic ethanol – we are working on many feedstocks and technologies
- Global R&D focus on cellulosic ethanol
- Unprecedented effort with more than 150 people dedicated to Novozymes' cellulosic ethanol work
ENZYMES ENABLE PRODUCTION OF ETHANOL AND OTHER PRODUCTS FROM STARCH AND CELLULOSE

**Pre-treatment**
- Starch
- Cellulose & Hemi-cellulose
  - Enzyme process
  - Sugar
  - Fermentable sugar
  - Fermentation
- Ethanol & higher alcohols
- Renewable chemicals

**Synthetic biology:**
Metabolic engineering enabling better yields and new products
NOVOZYMES PROVIDES THE ENZYMES THAT PLAY A CRUCIAL ROLE IN CELLULOSIC ETHANOL PRODUCTION

Technology overview

- Logistics
- Pre-treatment
- Hydrolysis
- Fermentation
- Distribution

Enzymes

Cellulosic biomass

Vehicles
We have delivered on our 2010 promise by further reducing the enzyme dose by up to 50% resulting in an enzyme use cost of as low as EUR 0.10/liter.
...IS KEY TO DELIVERING COMMERCIALITY RELEVANT CELLULOSIC ETHANOL
BUT MOST IMPORTANT IS AN INTEGRATED VIEW ON ENZYMES, PROCESS STEPS AND PROCESS INTEGRATION

Highly interrelated technology and process choices
Novozymes leverages advanced R&D tools and enzyme application know-how

Pre-treatment
- Open fiber
- Increase water access
- Enzyme accessibility
- Minimize sugar loss
- Minimize inhibitors formed
- Catalyst/auto-hydrolysis
- Temp/time/technology

Hydrolysis
- Degrade polymers
- Substrate viscosity/energy
- Avoid effect of inhibitors
- Solid load
- Liquid displacement
- Find superior enzymes/novel cocktails
- Temperature/pH/fed batch
- Understand synergy effects

Fermentation
- Avoid effect of inhibitors
- Avoid infection
- Conversion of sugars
- C5 fermenting organism
- Handling of residual fibers
- Yeast dosage/ cost

Applied discovery
Reduce process costs via holistic innovation
THIS IS ALSO WHY PARTNERSHIPS AND SCALE-UP ACTIVITIES ARE CRUCIAL

Examples of Novozymes’ cellulosic ethanol partners
SCALE-UP IS TAKING PLACE ACROSS THE WORLD

Cellulosic ethanol plants – status as of February 2010

[Map showing the status of cellulosic ethanol plants around the world as of February 2010. The map includes symbols for different stages of development (Proposed or Planned, Construction, Operational) and capacities (0.0, 20.0, 40.0, 60.0, 80.0, 100.0, 110.0 MGY).]
Read more about how Novozymes is developing fuel ethanol technologies together with our partners at:

www.bioenergy.novozymes.com