FUTURE PERSPECTIVES FOR SUSTAINABLE BIOFUELS

European Parliament

Kirsten Birkegaard Stær,

Director External Affairs, Europe

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NOVOZYMES IN BRIEF

- World leader in bio innovation and industrial biotechnology
- State-of-the-art expertise in microbiology, biotechnology and gene technology
- Strong global presence
- Sales of more than 700 different products to more than 130 countries
- Sales 2007: 7,438 mio DKK
- 13% of turnover spent on R&D
- 4933 employees in 30 countries

ENVIRONMENTAL IMPACT OF INDUSTRIAL ENZYMES -WHEN USED BY CUSTOMERS

CO_2 COST WHEN PRODUCING 1 KG ENZYME: 1-10 KG

SAVINGS IN TOTAL PER YEAR:

~20,000,000 T CO_2

CO_2 REDUCTION WHEN USING 1 KG ENZYME IN DIFFERENT INDUSTRIES :


30 KG
ANIMAL FEED


40 KG
LEATHER


100 KG
TEXTILES


150 KG
BIOETHANOL


150 KG
DETERGENT


200 KG
FOOD


UP TO 600 KG
PAPER


1,300 KG
OIL & FATS


3,400 KG
BIOCATALYSIS


3,800 KG
CEREAL

BIOFUELS - AN OPPORTUNITY ALSO FOR EUROPE

- **Biofuels are ONE of the tools that can help Europe**
  - **Reduce emissions of greenhouse gases in transportation**
  - **Reduce dependence on oil and ensure future energy supply**
  - **Provide economic opportunities and foster rural development**

ENERGY FOR TRANSPORTATION

- In the EU 98% of road transport depends on fossil fuels
- The transport sector is responsible for more than 20% of GHG emissions
- Emissions are growing faster in this sector than in others
- Alternatives are needed now

➢ **Bio-ethanol is a realistic alternative today to fossil based energy for the transportation sector**

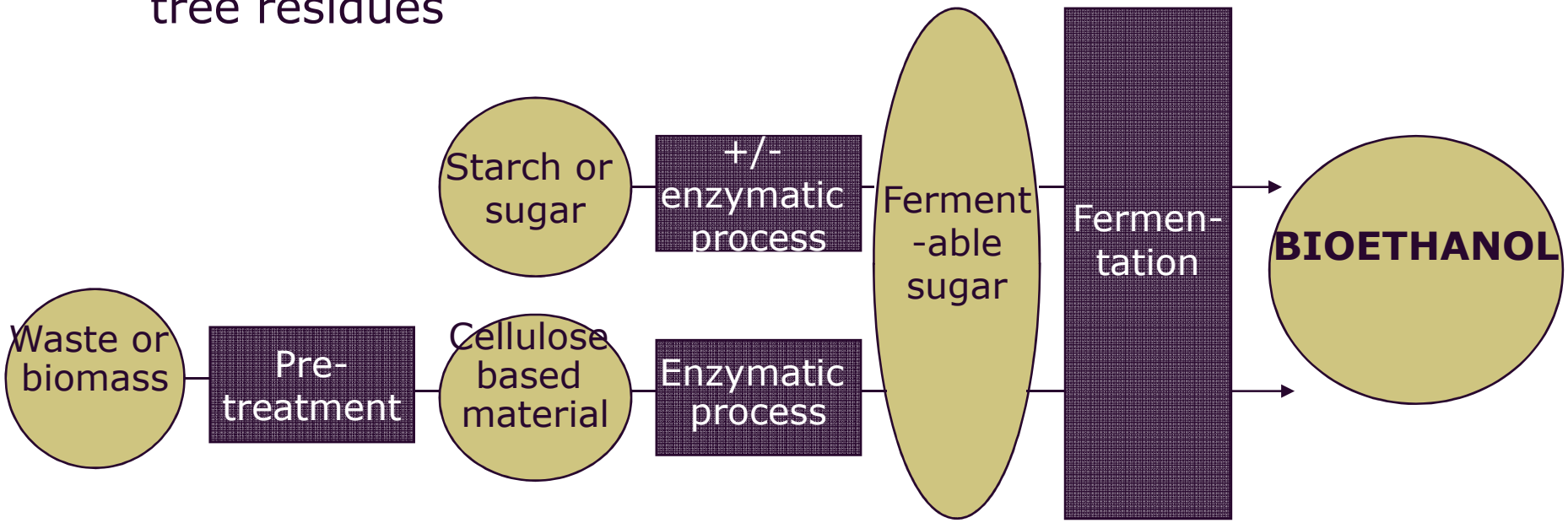
BIOETHANOL –FIRST AND SECOND GENERATION

FIRST GENERATION

- Produced from starch-based crops or sugar

SECOND GENERATION

- Produced from cellulose based material: industrial waste, municipal waste, wheat/rice straw, corn stover, bagasse, tree residues

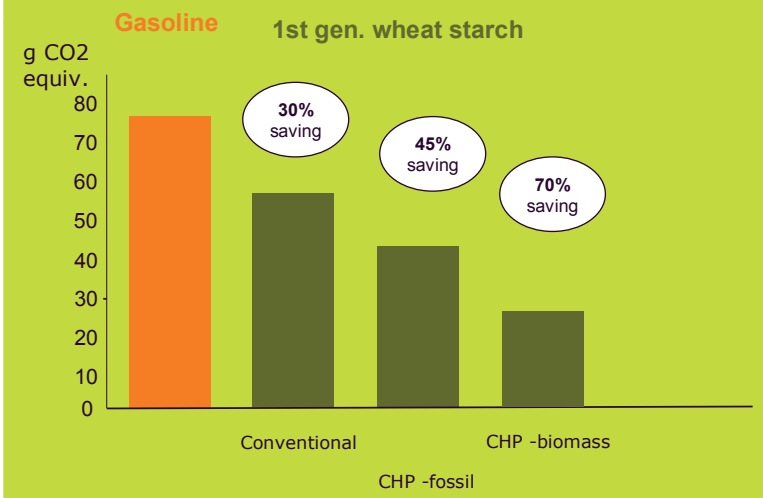


A FEW WORDS ON FIRST GENERATION BIOETHANOL

LCA classic

The potential for improving the present technology is significant

EU, wheat starch, Well to Wheel, JRI (2006)



Reduction in GHG emission from substituting gasoline on a MJ basis

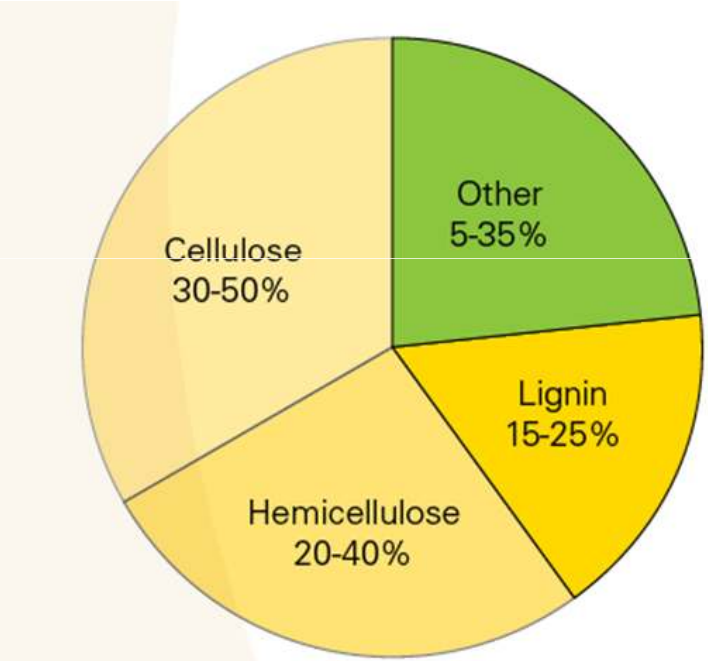
Europe, wheat

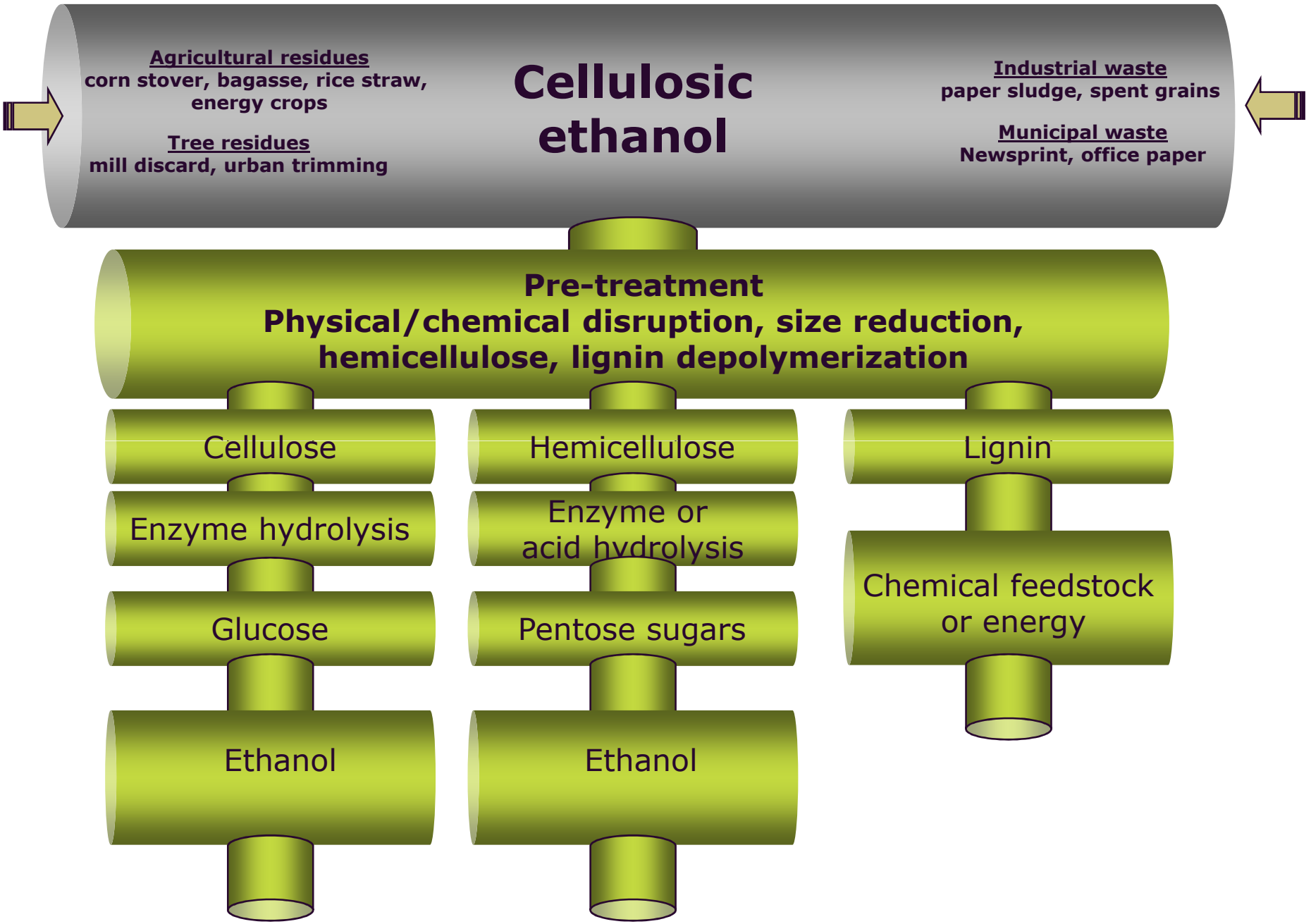
- Collaboration with US customers shows that further development of enzymes have enabled process improvements such as reducing temperature during fermentation and thereby further reducing CO2 emissions compared to gasoline/petrol

WHY SECOND GENERATION BIOFUELS ?

- Sustainability: CO2 emission savings more than 90%
- Sustainability: Turns waste to value
- Sustainability: No impact on the food chain
- Makes sense

CELLULOSIC MATERIAL: A COMPLEX SUBSTRATE AND A TECHNOLOGICAL CHALLENGE




Agricultural residues
corn stover, bagasse, rice straw, energy crops
Tree residues
mill discard, urban trimming
Cellulosic ethanol
Industrial waste
paper sludge, spent grains
Municipal waste
Newsprint, office paper
Pre-treatment
Physical/chemical disruption, size reduction, hemicellulose, lignin depolymerization
Cellulose
Hemicellulose
Lignin
Enzyme hydrolysis
Enzyme or acid hydrolysis
Chemical feedstock or energy
Glucose
Pentose sugars
Ethanol
Ethanol

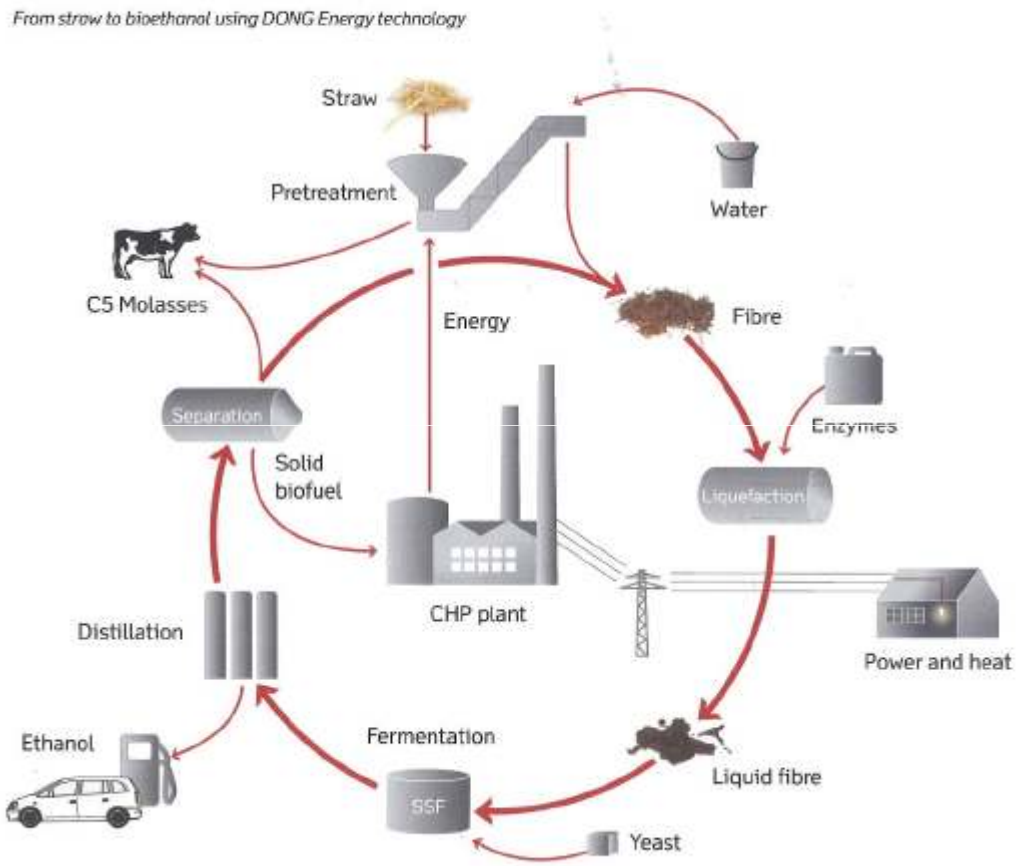
SECOND GENERATION BIOETHANOL- WHEN WILL IT HAPPEN?

- Enzyme technology for second generation bioethanol is already available for testing at pilot- and demonstration scale
- Novozymes expects enzyme technology at a commercial scale for making second generation bioethanol to be available by 2010
- Optimization of technology to increase the cost-performance will continue
- Full scale commercialization depends on incentives and price of oil, and looks likely to happen in 2011-2012

SECOND GENERATION BIOETHANOL-CURRENT DEVELOPMENTS IN EUROPE

- **Pilot plant projects and/or demonstration plants are starting up in:**
  - **France**
  - **the UK**
  - **Denmark**
  - **Italy**
  - **The Netherlands**
  - **Sweden**
  - **Spain**
- **Main feed-stock: wheat straw**
- **But other feedstocks will follow**

FROM STRAW TO BIOETHANOL- A PROCESS SET-UP



DONG/INBICON, DK

BIOFUELS IN THE EU – THE PROPOSAL FOR A RENEWABLE ENERGY DIRECTIVE

-Novozymes welcomes the Commission proposal for a directive on the promotion of renewable energy sources

-10% biofuel in 2020 is appropriate and achievable without jeopardising sustainability

-Sustainability criteria and certification schemes must be established

-Innovation and environmental improvements must be encouraged

NOVOZYMES POSITION ON SUSTAINABILITY CRITERIA

- Novozymes strongly supports the establishment of ambitious and credible sustainability criteria
- The use of renewable raw materials for fuel purposes should not jeopardize food supply
- Use of land with high biodiversity value and with high carbon stocks to be excluded and land use changes to be taken into account
- The introduction of a step wise increase in the GHG saving percentage is a sensible way to ensure progress
- The introduction of social sustainability criteria are welcomed
- Sustainability calculation methods should be clear and based on scientific evidence
- Measures to amend and up-date the calculation methods including must be ensured
- Monitoring of impact on land use must be established

LAND USE AND SUSTAINABILITY

- ”LCA classic” (technical data): assumes that land and crude oil is available
- Includes agricultural and crude oil extraction processes

- ”Direct land use change” (biological data): specific known changes in land use

- ”Indirect land use change” (market considerations): market driven land use changes

LAND USE IN EUROPE

Commissioner Mariann Fischer Boel:

-In 2020, 80% of our biofuels usage target could be met by domestically produced raw material grown on about 15% per cent of European Union arable land

-At present less than 1% of EU cereal production is used for ethanol

-The 10% biofuel target can be achieved without putting excessive strain on our land resources and our food and feed markets

-Developments will take place: yield increase, abolition of set- aside land,second generation fuels and 20% imports