

# Industrial development: Biofuels for transportation

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# Overview presentation

- Biofuels: what are they?
- Why using biofuels?
- Current biofuel production in the world
- Opportunities for rice straw
- Conclusions



*gasoline/ethanol pump (Sweden)*

# Biofuels: transportation fuels from biomass

- Legislation leads to higher demand for biofuels
- Large scale production: Brazil, U.S.A., China
- Various producers in EU
- Current raw materials for biofuels:
  - Sugarcane
  - Maize
  - Wheat, Barley
  - Sugarbeets
  - Rapeseed, Sunflower, Palm oil
- Current use of raw materials leads to discussion:
  - “food versus fuel”
  - Sustainability of current biofuel production



*Ethanol fermentor*

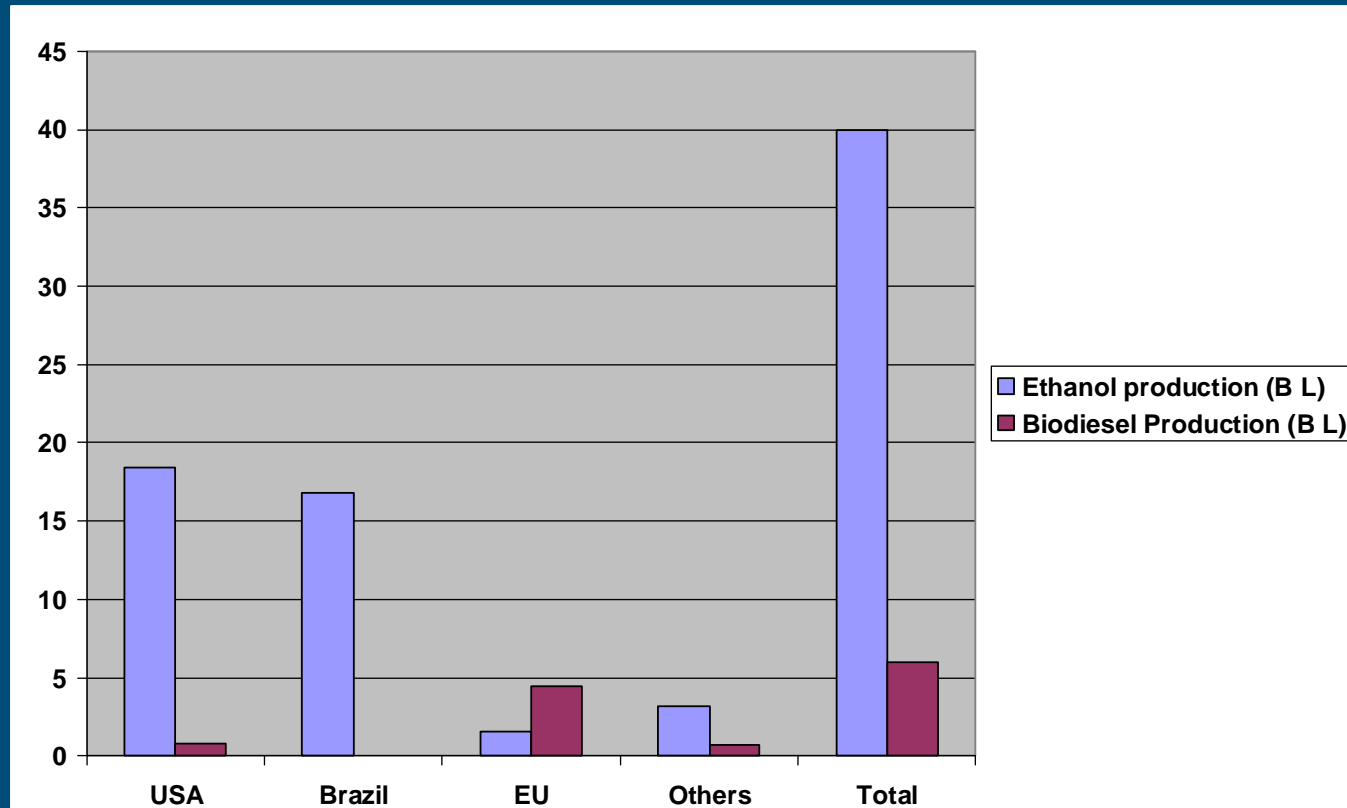
## Why use biofuels? Drivers are:

- Reducing dependency on imported oil
- Kyoto: reduce CO<sub>2</sub> emissions of transport sector
- Reduce Environmental pollution
- Economic development of agriculture, agri-industry
- Add value to by-products



# Current biofuel Production in the World

- Bioethanol (alcohol fuel): replacement of petrol
- Biodiesel: replacement of regular diesel







## Opportunities for Rice Straw conversion to Biofuel:

- “2<sup>nd</sup> generation biofuels”
- Based on using lignocellulose as raw material for production of bio (transportation) fuels
- Advantages of 2<sup>nd</sup> generation biofuels:
  - No competition with use of food crops
  - Higher Carbon benefits/Greenhouse gas emissions reduction
  - Will lead to a diversity of fuels, and other (bio-based) products
- However, technology not yet fully developed!
  - Production costs not yet competitive with 1<sup>st</sup> generation biofuels

# Lignocellulose: what is it?



- Fibreous plant material
  - Hardwood, softwood, grasses, **straw**, pulp, etc.
  - Both woody crops as well as residues can be used
- Main production methods:
  - Thermochemical pathway
    - Fuels: FischerTropsch Diesel/BTL
  - Biochemical pathway
    - Bioethanol, Butanol
- Technology for conversion of lignocellulose
  - In various stages of development

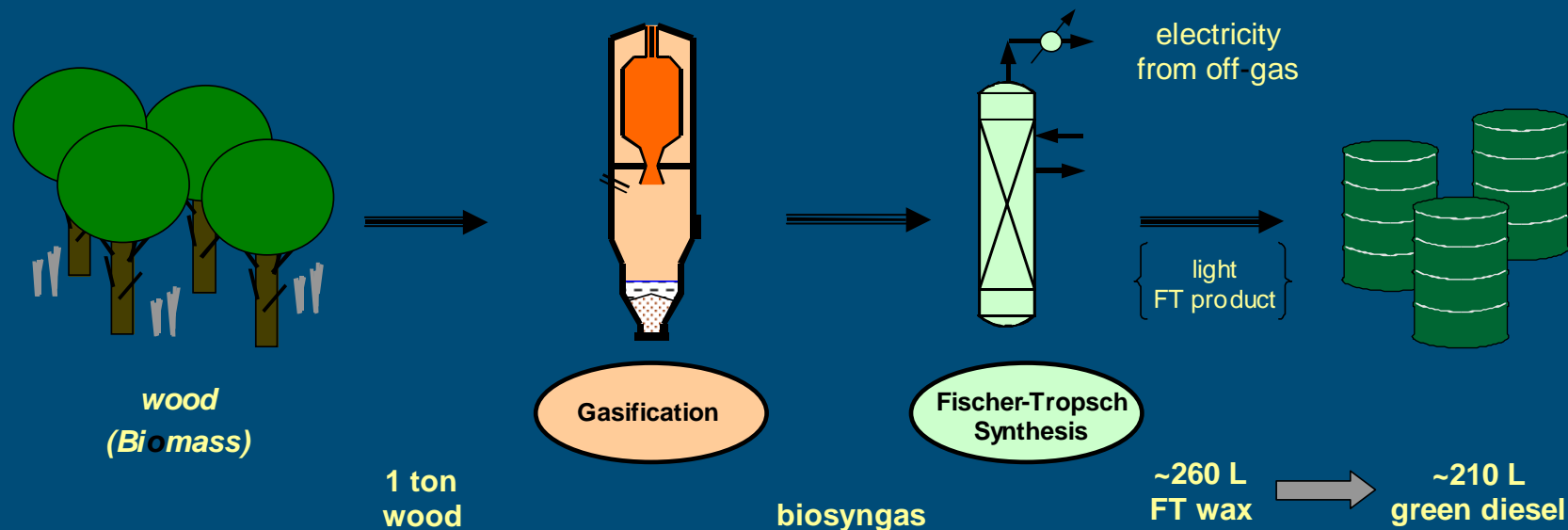


*Straw fibres (1000X)*



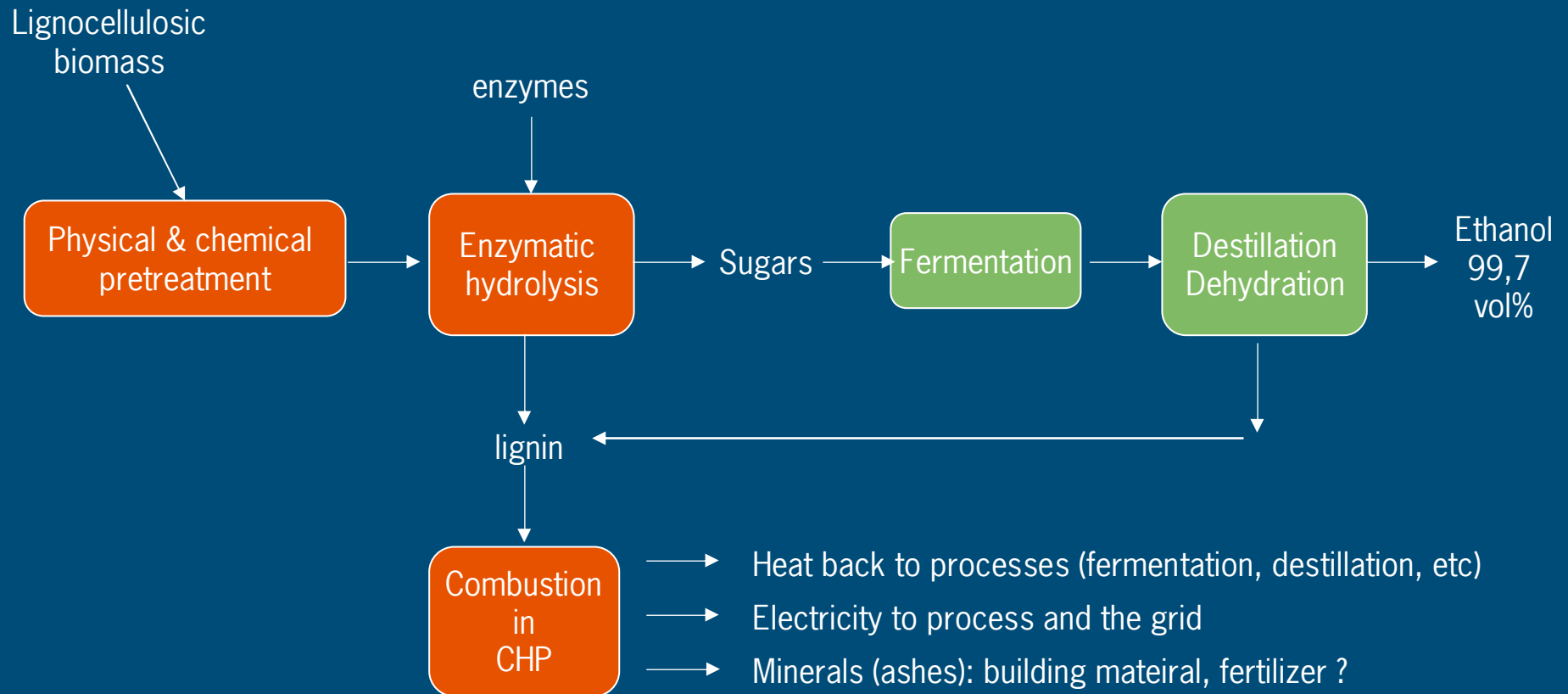
# Example 1: Synthetic diesel from lignocellulose (BTL)

Yield from tree-to-barrel



Energy efficiency from wood to diesel = ~44%, light products: 11%, power: 14% ->  
**total energetic efficiency: 69%**

# Example 2: Bioethanol from lignocellulose



# Biomass to Liquids: developments

Reader - [CHOREN\_ChK\_Start\_up\_Beta\_Valencia.pdf]

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Source : [www.choren.de](http://www.choren.de)

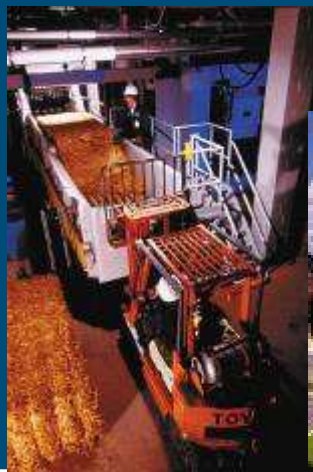
# Ethanol from lignocellulose: developments



*Sekab, Zweden*



*Abengoa, Spanje*



*Iogen, Canada*



# Public-private partnerships: Bioethanol from lignocellulose

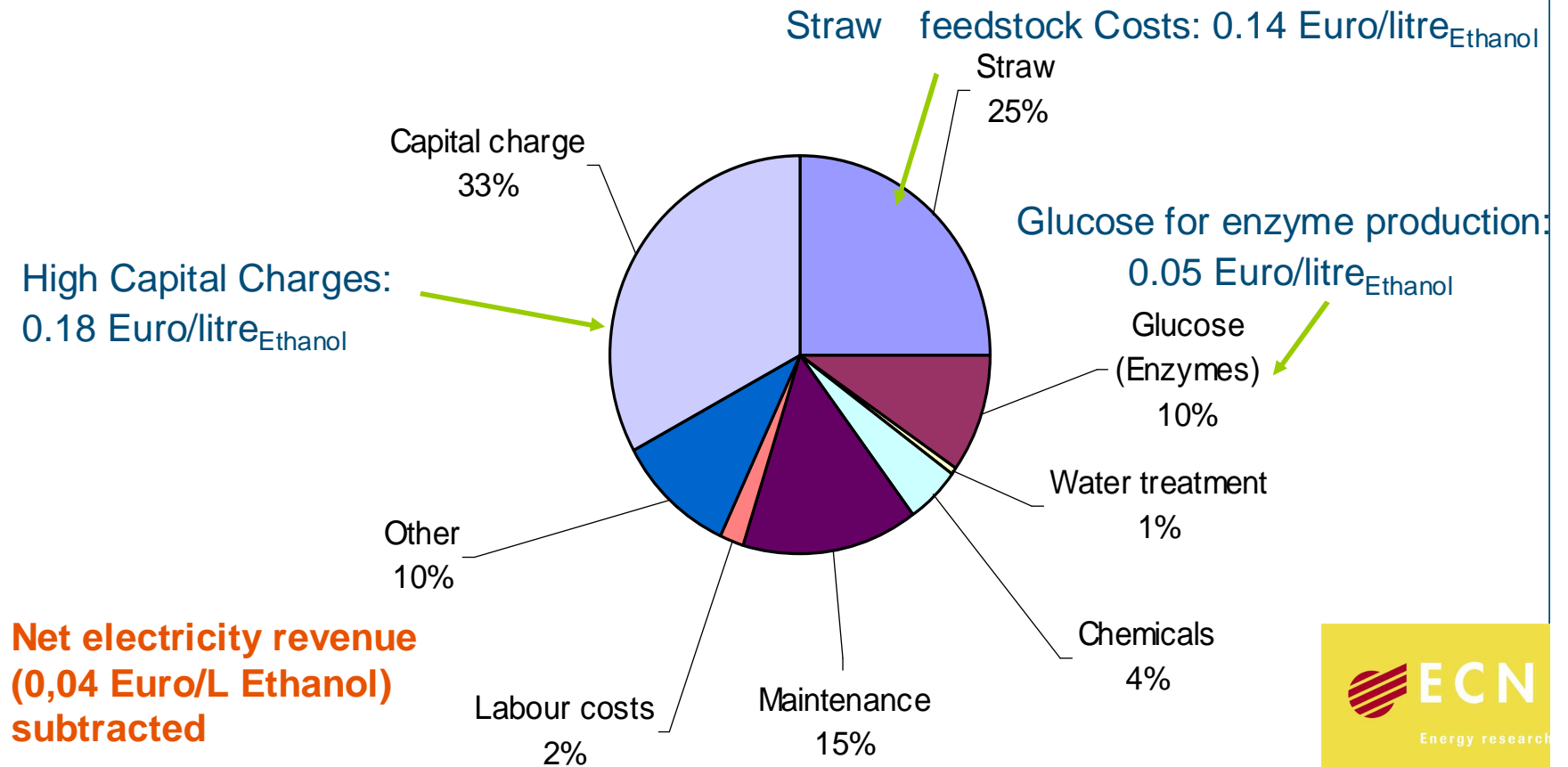
- “Co-productie van hernieuwbare transportbrandstoffen, groene chemicalien, electriciteit en warmte uit biomassa(rest)stromen”
- EET programme
- 2002-2006
- Participants
  - Private sector: Nedalco, Purac, Shell
  - Institutes: A&F, ECN, TNO
  - University: Wageningen U



*Straw harvest K01116*



# Bioethanol: prospective production cost

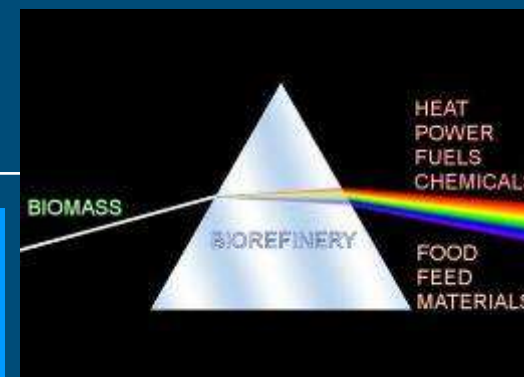


Total Production Costs: ~ 0.52 Euro/litre<sub>Ethanol</sub> (IRR 3.3%)

Minimum selling price (IRR 15%) ~ 0.75 Euro/litre<sub>Ethanol</sub>

# The future: Biorefinery

Biorefinery is the sustainable processing of biomass into a spectrum of marketable products



[concept definition, IEA Bioenergy Task 42 on Biorefineries]

Biorefinery: concepts, facilities, plants, processes, cluster of industries

Sustainable: maximising economics and minimising environmental aspects, fossil fuel replacement

Processing: upstream processing, transformation, fractionation, thermo-chemical and/or biochemical conversion, extraction, separation, downstream processing

Biomass: crops, organic residues, forest residues, aquatic biomass, ...

Spectrum: more than one (excl. heat & power)

Marketable products: both intermediates and final products (i.e. fuels, power, heat, food, feed, chemicals, materials)

See also: [www.biorefinery.nl](http://www.biorefinery.nl)

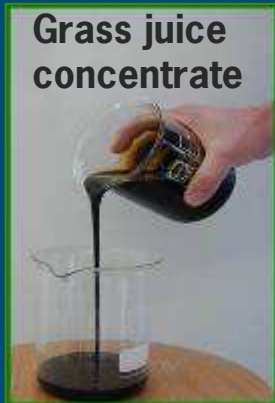
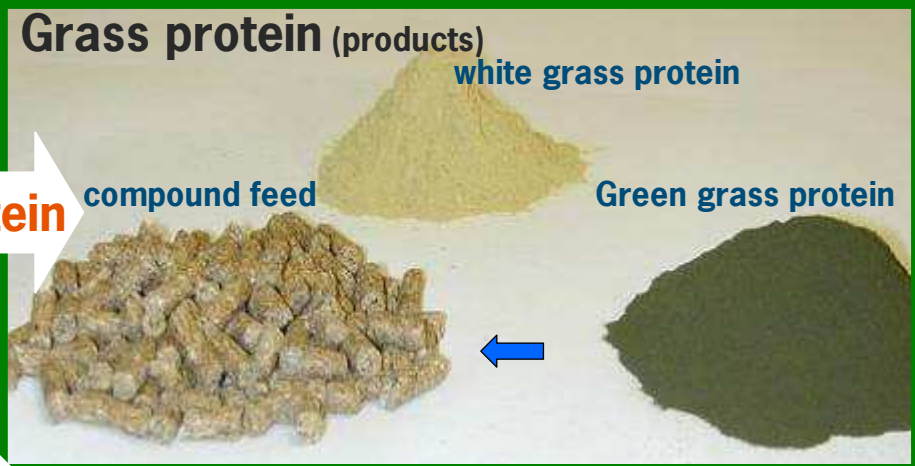
# Pilot biorefinery line Foxhol (Groningen) (Prograss Consortium)



**Grass juice**

**Protein**

**Fibers**



**Grass juice concentrate**



**compound feed**



**Ethanol**



**Biofuel**



**Construction material + paper**



**Polymer extrusion products**



# Conclusions

- Important improvements have been realised in recent years
  - particular role for innovations in Industrial Biotechnology, Process technology
- Outlook for coming years:
  - Transfer of technology to the industry
  - Important role for public-private partnerships!
- Technology for conversion of lignocellulose, including rice straw, is applicable:
  - For a broad range of raw materials
  - For a broad range of fuels and products
- Active support for Research and Development by governments remains crucial
- Role for Egypt:
  - Join international consortia for further development of 2<sup>nd</sup> generation biofuels, including straw

# Questions?



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