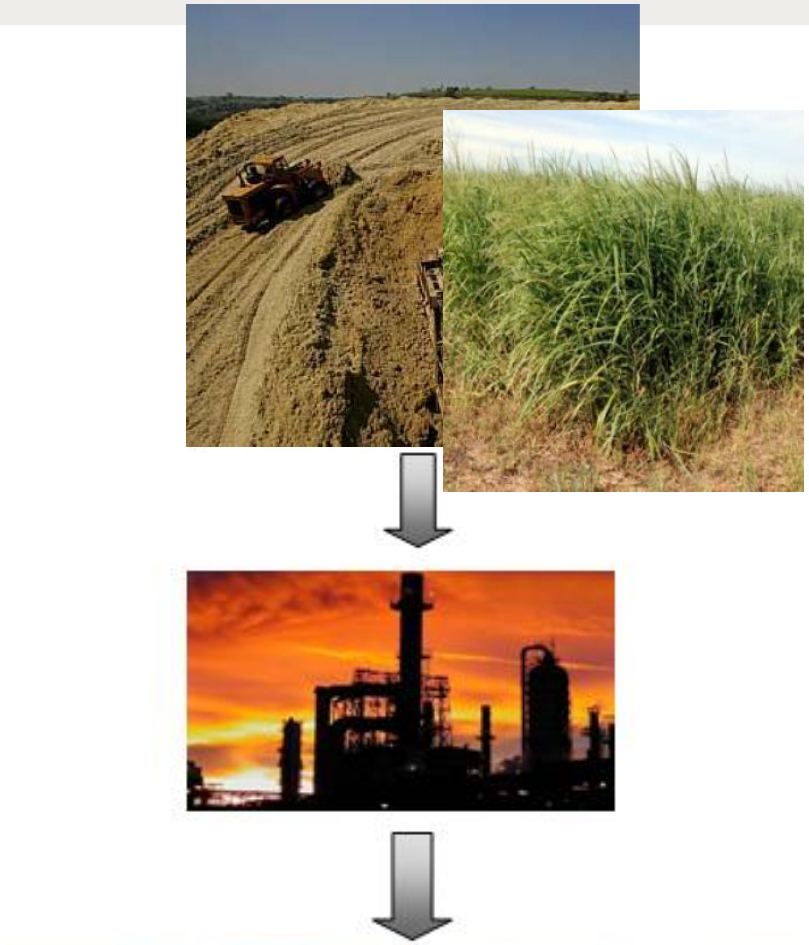

A Biorefinery approach to production of lignocellulosic ethanol and lignin chemicals from bagasse

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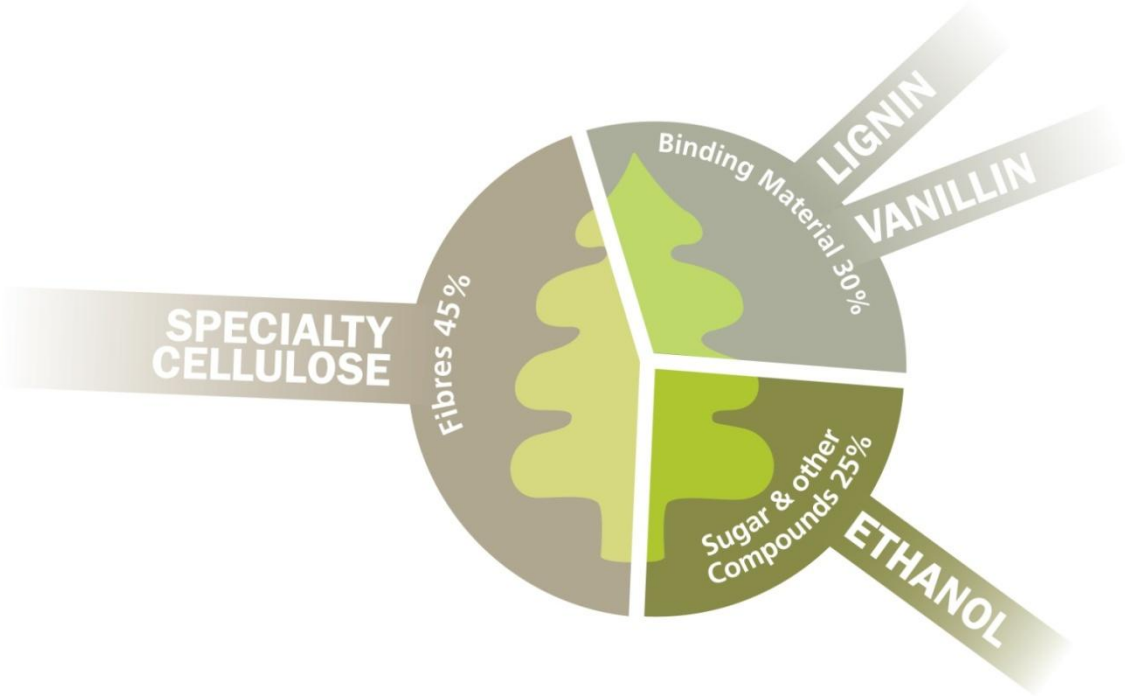
BBEST 2011
Campos do Jordao, Brazil 14-18. August 2011

Borregaard
The Sustainable Biorefinery

Biorefinery – a Business Model Based on Biomass

Borregaard's biochemicals are sustainable and environmentally friendly substitutes to petrochemicals



Borregaard is a global leader in bio based chemicals.
Strong innovation efforts increase the value added to our customers.

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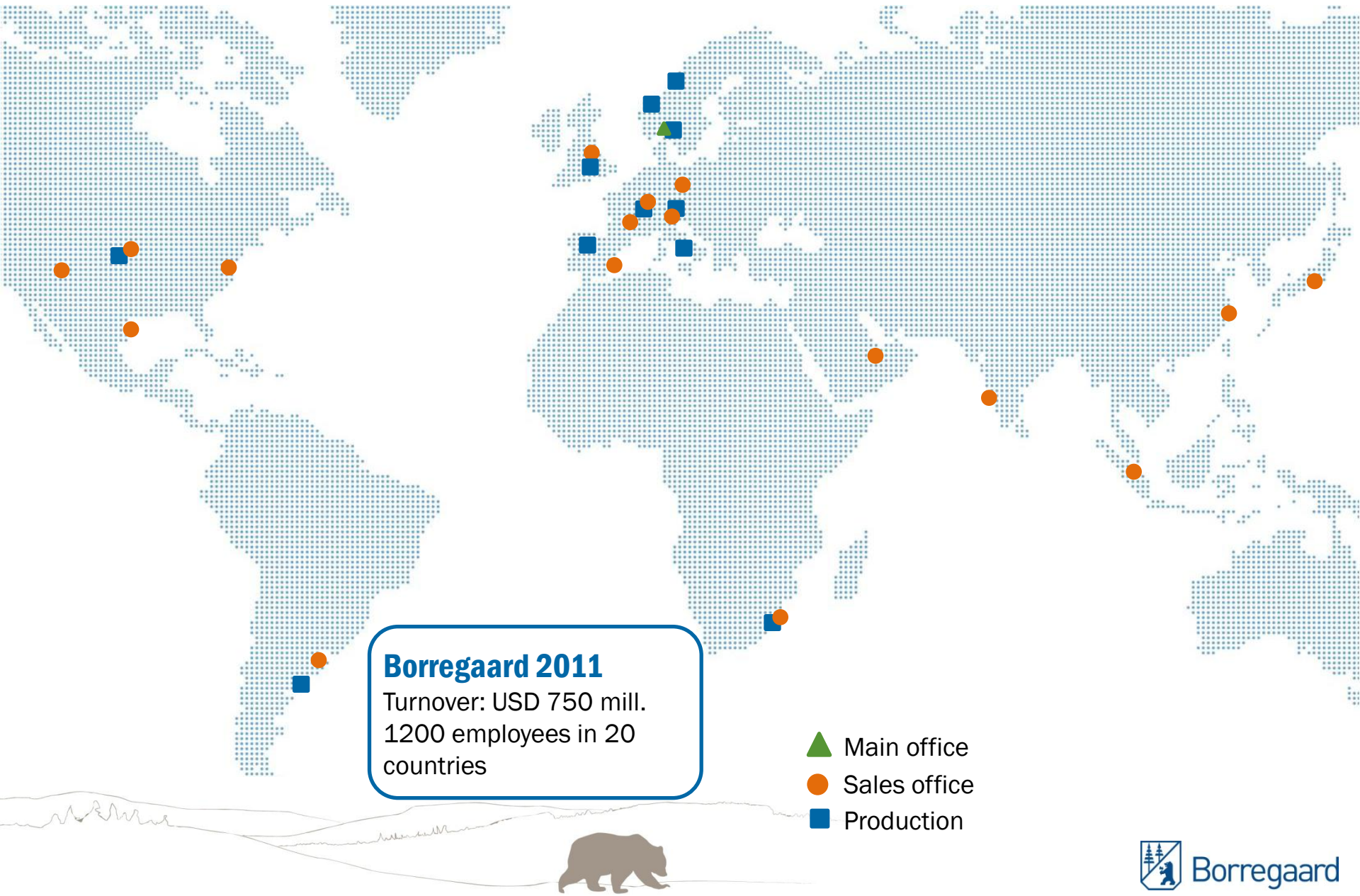
Global presence



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Borregaard Site in Sarpsborg, Norway

Head office - R&D - Production
800 employees, 280 mill EUR turnover

Specialty cellulose, lignin products, biovanillin, 2G bioethanol

Basic chemicals, energy, pharmaceutical intermediates

Borregaard operations in Brazil

Borregaard LignoTech Brazil

Borregaard operations in Brazil
LignoTech Brazil

- In 2006 Borregaard acquired the lignosulphonate company Melbar (established in 1969) from Melhoramentos/MI Drilling.
- One of eight production sites around the world for lignosulphonates.
- Market leader and only global supplier of lignin-based binding and dispersing agents.
- The most important market in Brazil is concrete additives.
- The plant is located in Cambará do Sul and the head office is in São Paulo/SP.
- 58 employees, of which 40 in the plant.
- Production and distribution with approx. 20% for the export market

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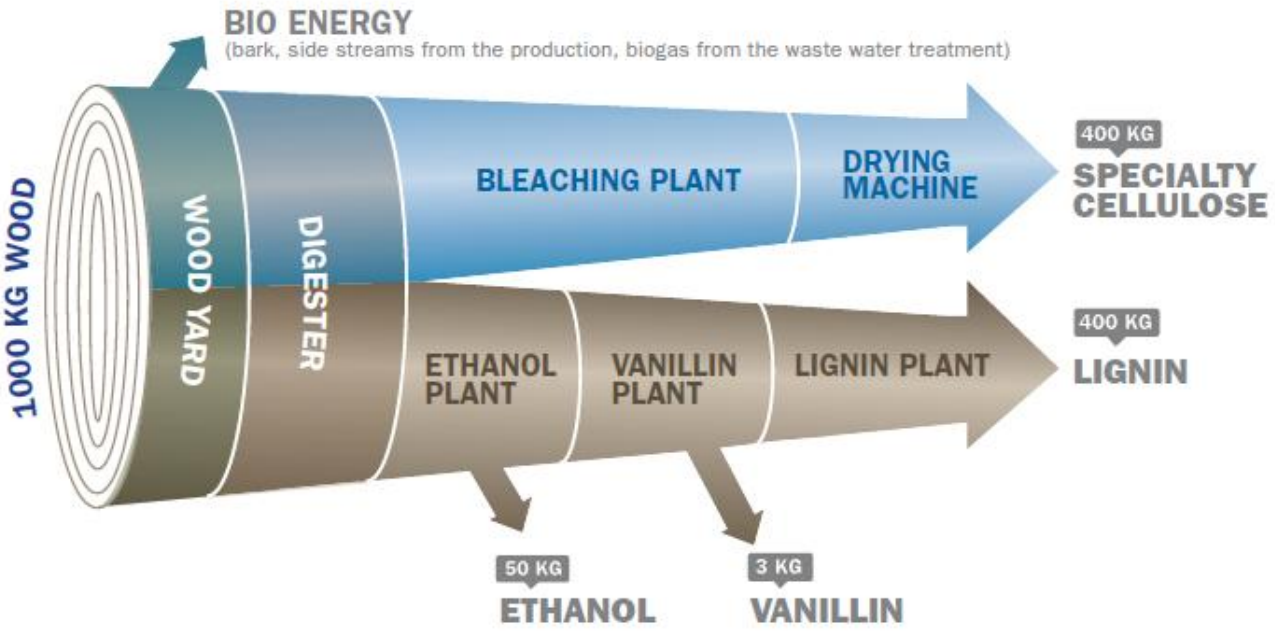
Wood Based Chemicals in an Integrated Concept



- Leading supplier of specialty **cellulose**
- Global leader in **lignin** performance chemicals, 50%+ market share
- Only producer of **vanillin** from lignocellulosics
- Production of lignocellulosic **bioethanol** since 1938 (20.000 m^3/y)
- 1500 GWh of **renewable** energy by 2013

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Fermentation to Ethanol

glucose
mannose
galactose

xylose
arabinose

yeast

$2C_2H_5OH + 2CO_2$

Lignocellulosic ethanol produced since 1938

20 million liters yearly

Rawmaterial is monosaccharides from spruce hemicellulose

Yeast has been recycled since 1938

Increased focus from R&D since 2007 in optimization projects

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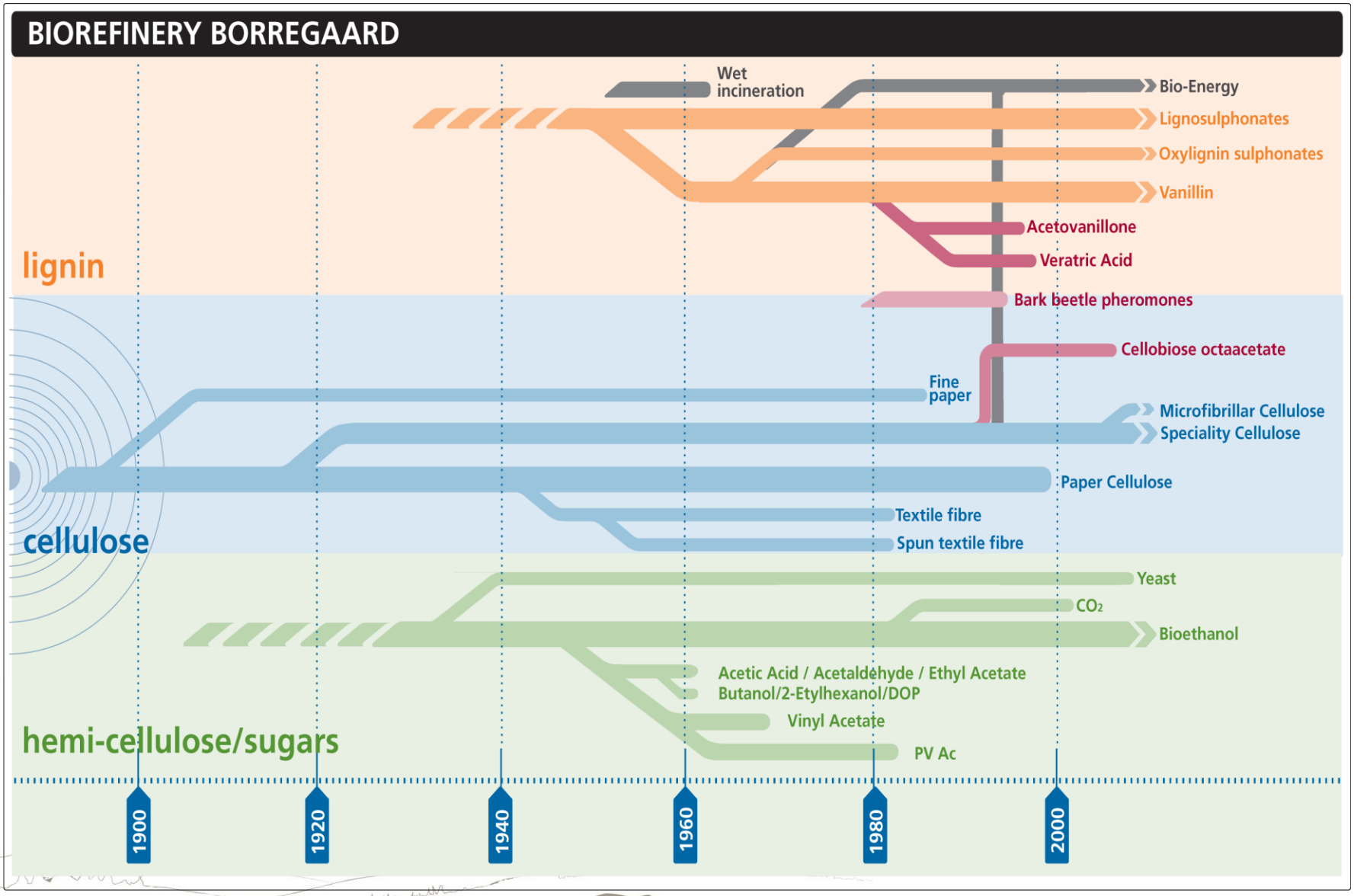
From Paper Mill to Biorefinery



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Oil or Biomass – “Green” or “Black” Carbon?

GREEN CARBON

Sustainable chemicals, materials, ingredients, biofuel

BLACK CARBON

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Biorefinery Options - Profit Considerations

High

Cost/price

Low

BIOR ERY

Preferred combination

BioMaterials
- *Polymers*
- *Composites*

BioChemicals
- *Flavours*
- *Monomers*
- *Proteins*
- *Fine chemicals*
- *Speciality chemicals*

BioFuel
- *Bioethanol*
- *Biodiesel*
- *Biogas*

BioEnergy
- *Electricity/Heat*
- *Liquid Fuels*
- *Pellets*

High

Creating values

Low

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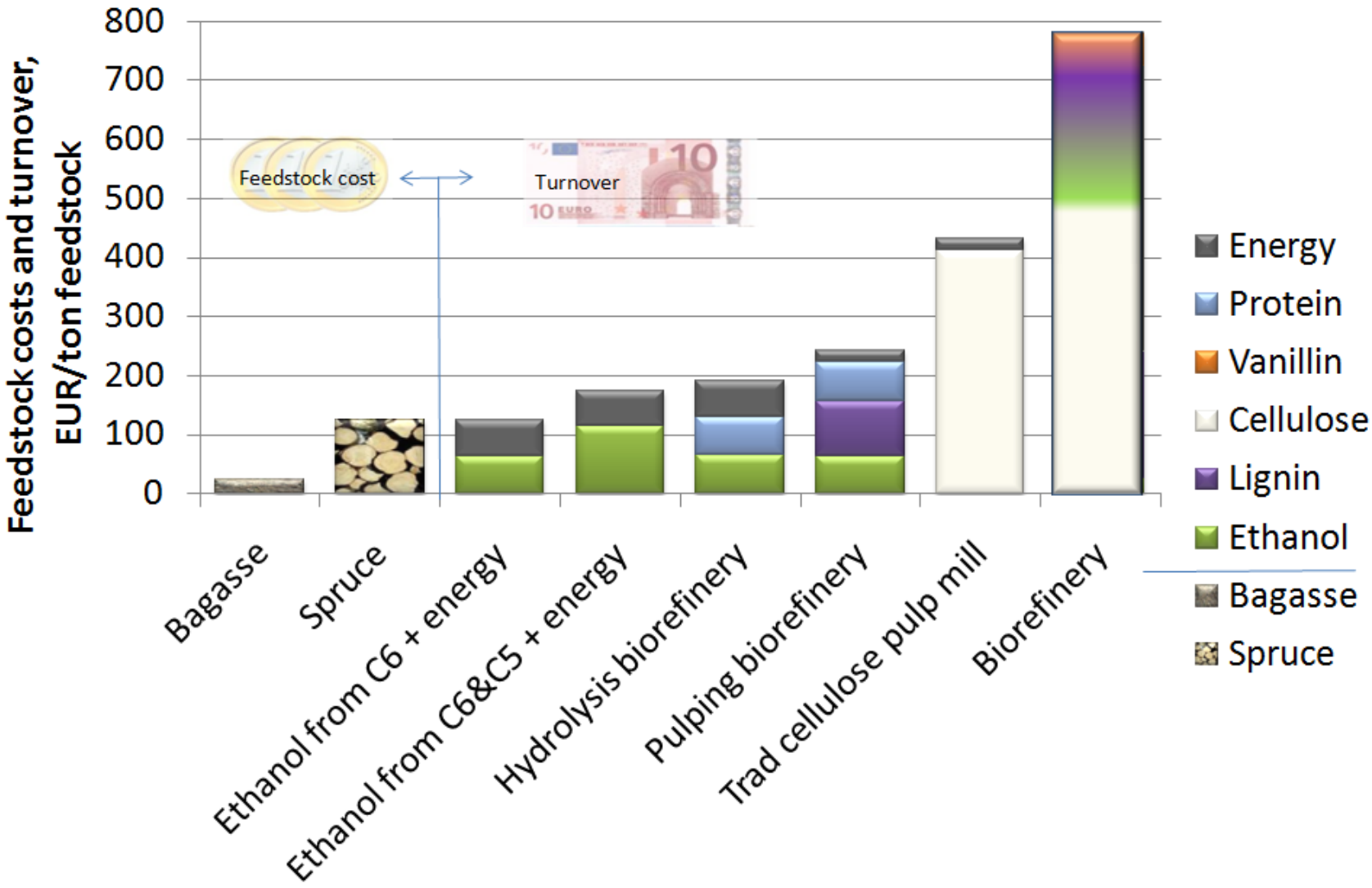
Turnover for Ethanol Production and Biorefineries



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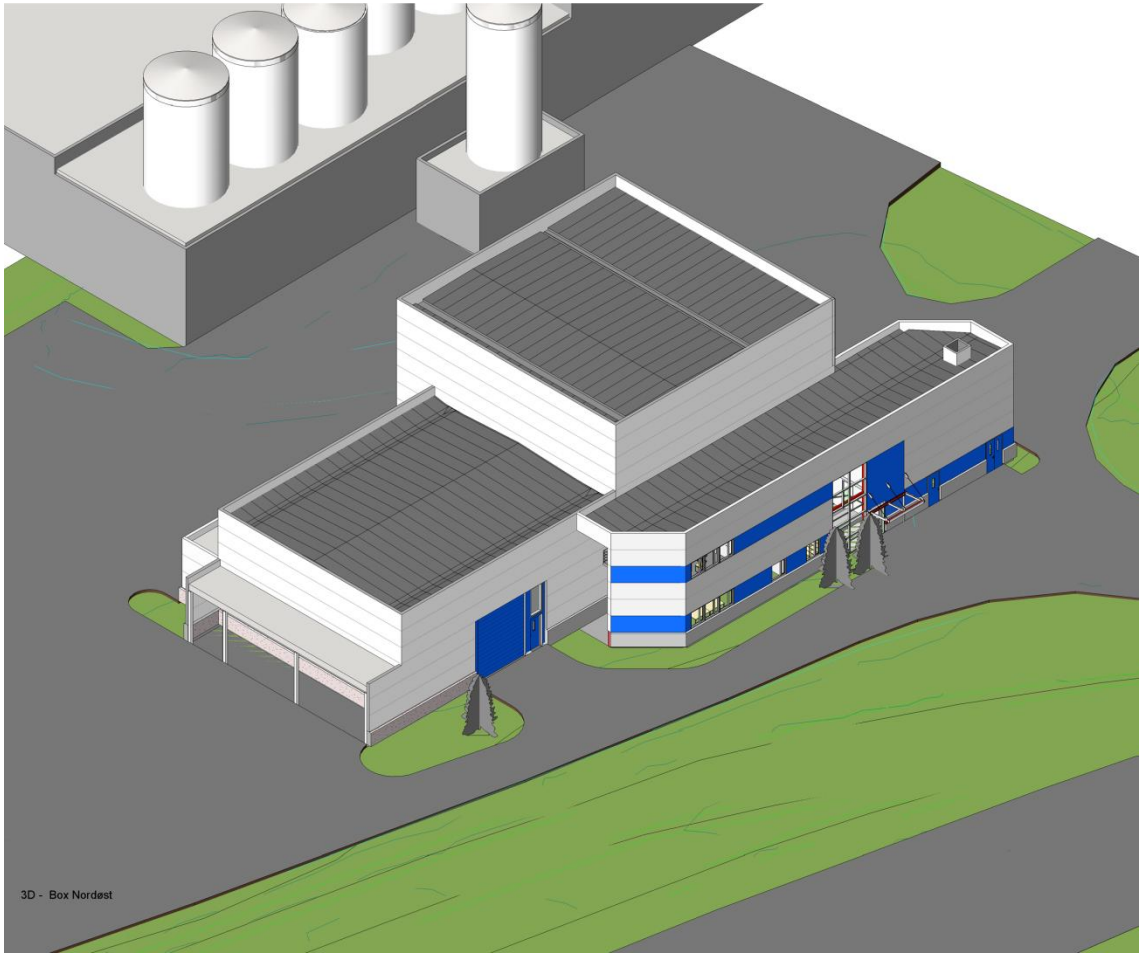
Pilot Plant: Ethanol and Biobased Chemicals



BALI

Bioethanol **Lignin**

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BALI Process in a Nutshell

Bagasse

Pretreated and **”reactive”** pulp

Water soluble lignin

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Lignin Based Chemicals – Applications

New lignin application:
Soil conditioner – plant growth improvement

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2G lignocellulosic ethanol: BALI process is unique

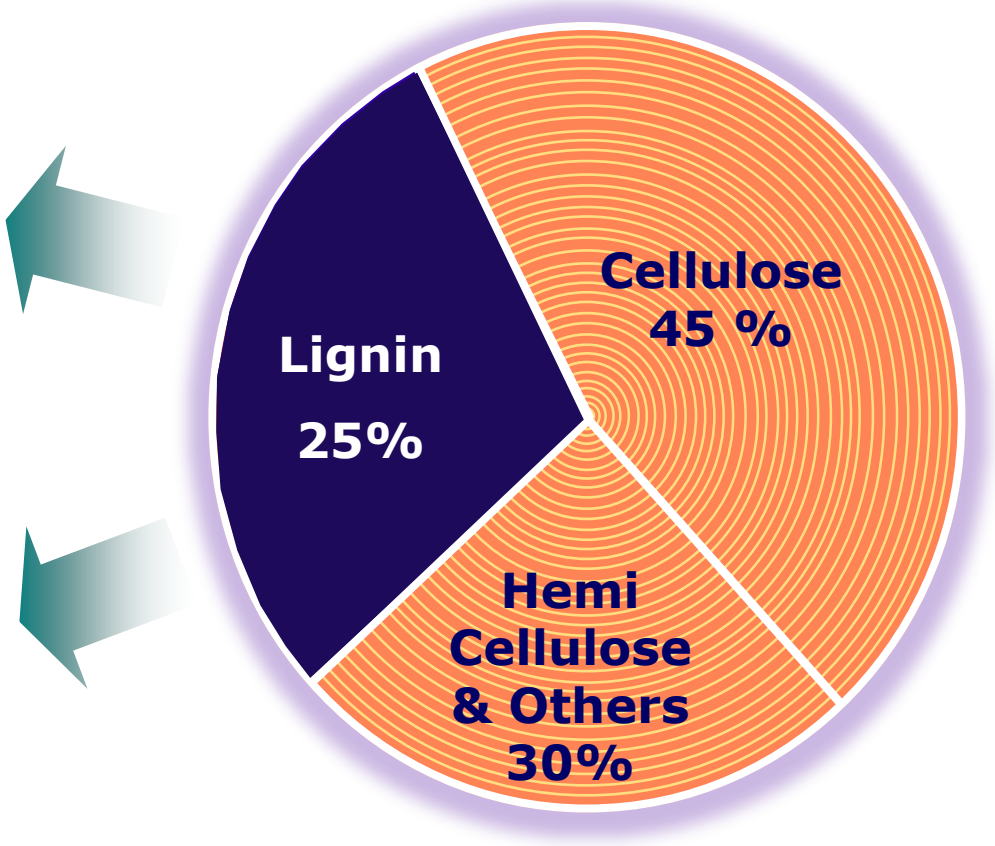
Borregaard BALI process:

Lignin

specialty chemicals

Competing processes:

Energy – heat and power



Borregaard has confirmed that our lignin products based on bagasse performs equal to similar products from wood

BALI Process in a Nutshell – Sugar Platform

Pretreated and ”reactive” pulp is hydrolyzed using cellulase enzymes

Hydrolyzate = monomeric sugar in solution

Fermentation of C5 and C6 sugars

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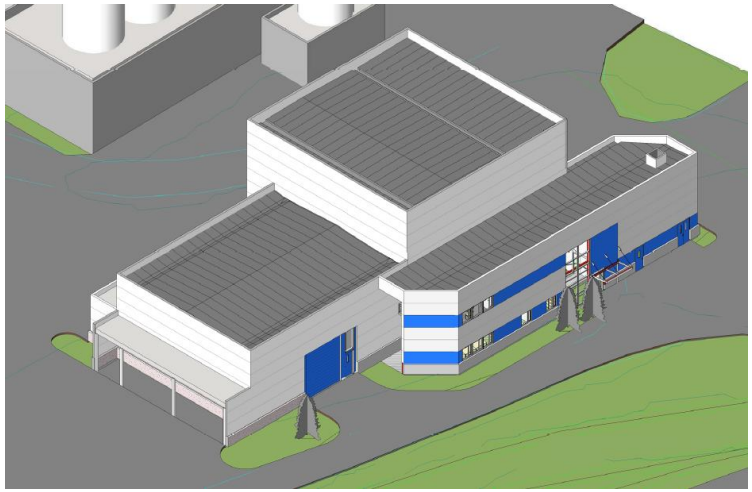
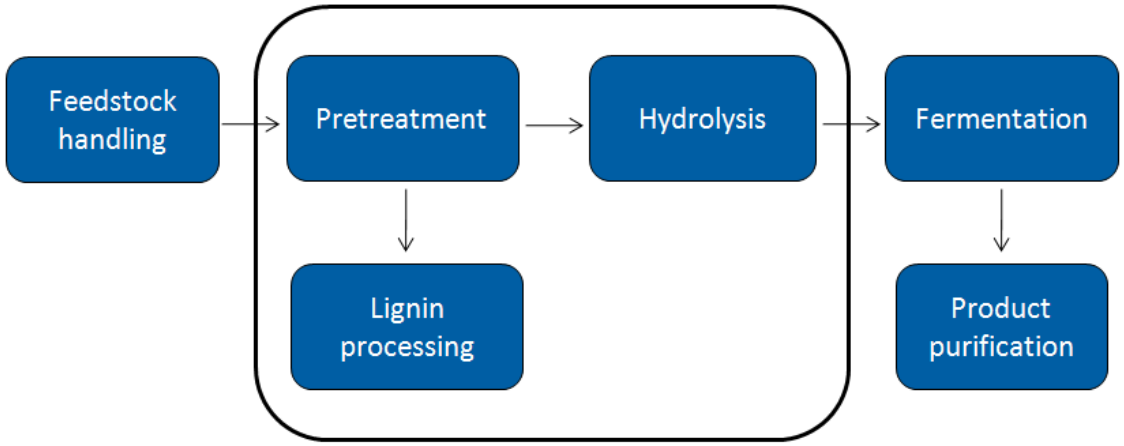
BALI Pilot Plant

- Location: Borregaard Sarpsborg, Norway
- Flexible feedstock
- 1 metric ton dry matter/day
- Break ground May 2011
- Commissioning Q2 2012
- 800 m^2 total area
- Budget cost: EUR 17 mill (1 EUR = 2,2 RS)





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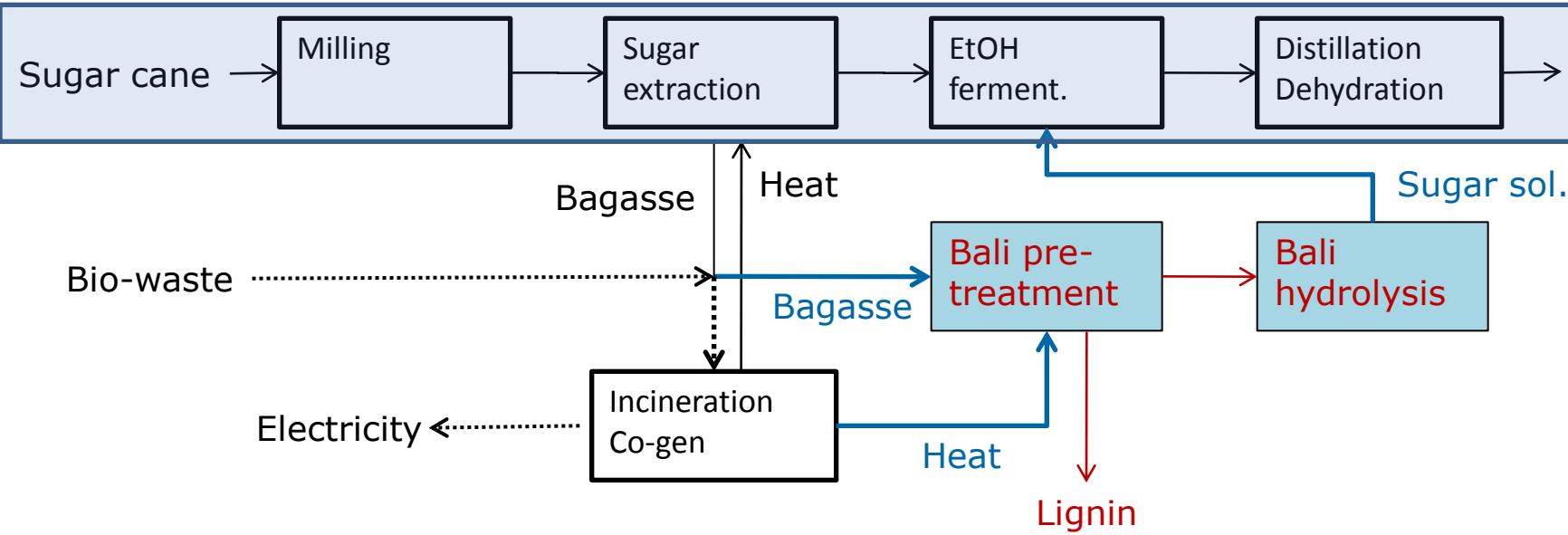
Process flow:
Integration into 1. generation Bioethanol Process

Illustrative



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Summary BALI Pretreatment Process

- BALI pretreatment process enables good economy in a biorefinery
- New large potentials for lignins under development - will expand usefulness of the technology
- Excellent for add on to 1st generation bioethanol
- Preferably industrialized in coop with strategic partner to reduce country, feedstock and/or market risks

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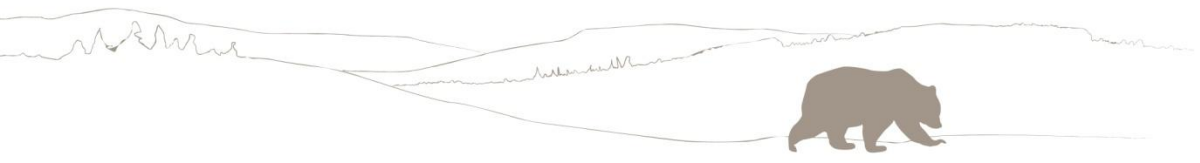
Funding

- EuroBioRef
  - Borregaard granted EUR 3.0 mill funding (2010 – 2013)
  - BALI pretreatment & enzymatic hydrolysis

- Biomass2Products – B2P
  - Borregaard granted 2,3 mill EUR from the Norwegian Research Council (2009 – 2012)

- BALI·PILOT
  - Borregaard granted EUR 7,5 mill from Innovation Norway (2011-2012)
  - Covering 45% of investment costs



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