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A biorefinery model

Borregaard
The Sustainable Biorefinery

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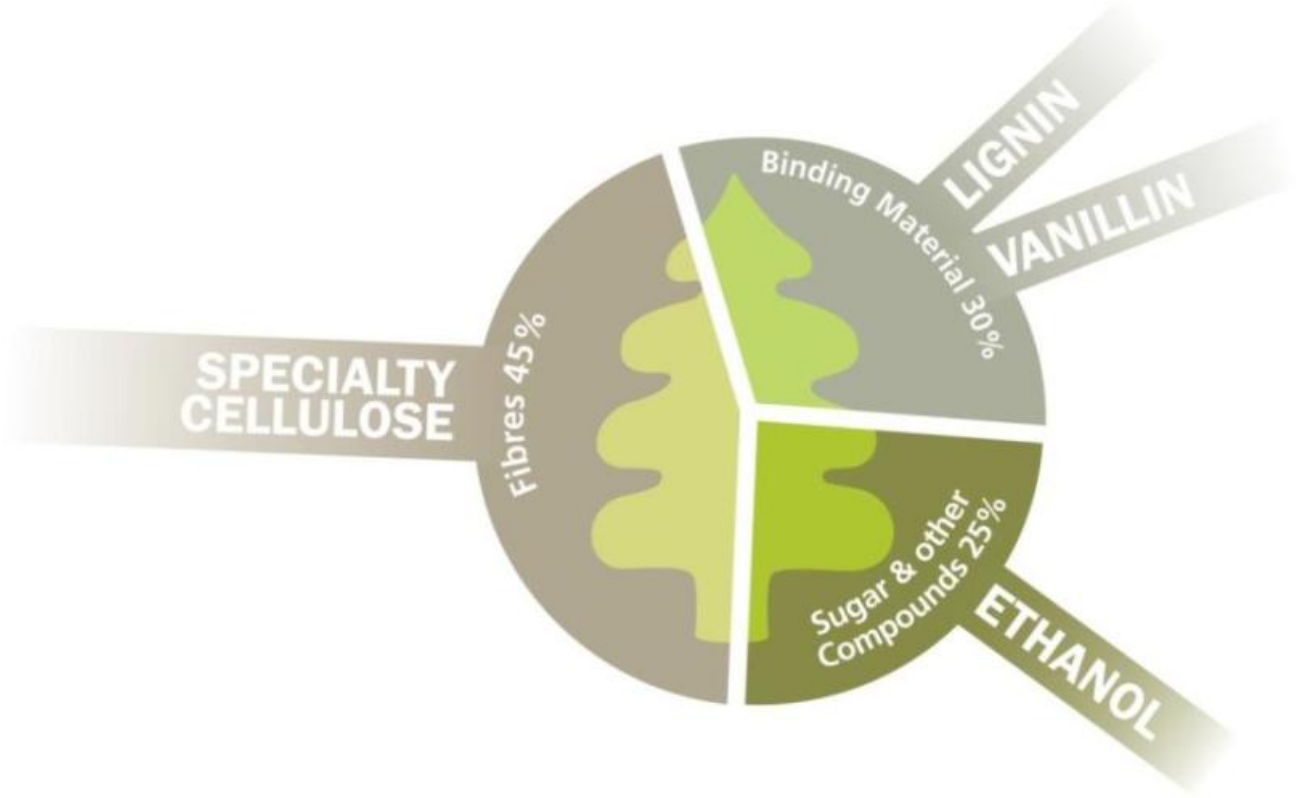
Borregaard is the global leader in biobased chemicals

High value added through full raw material utilisation



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

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A biorefinery model

A biorefinery is a facility that integrates biomass conversion processes and equipment to produce fuels, power, heat, and value-added chemicals from biomass.

IEA Task 42:
Biorefining is the sustainable processing of biomass into a spectrum of bio-based products (food, feed, chemicals, materials) and bioenergy (biofuels, power and/or heat).

Borregaard Sarpsborg

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- Cellulose
- Ethanol
- Lignin
- Vanillin

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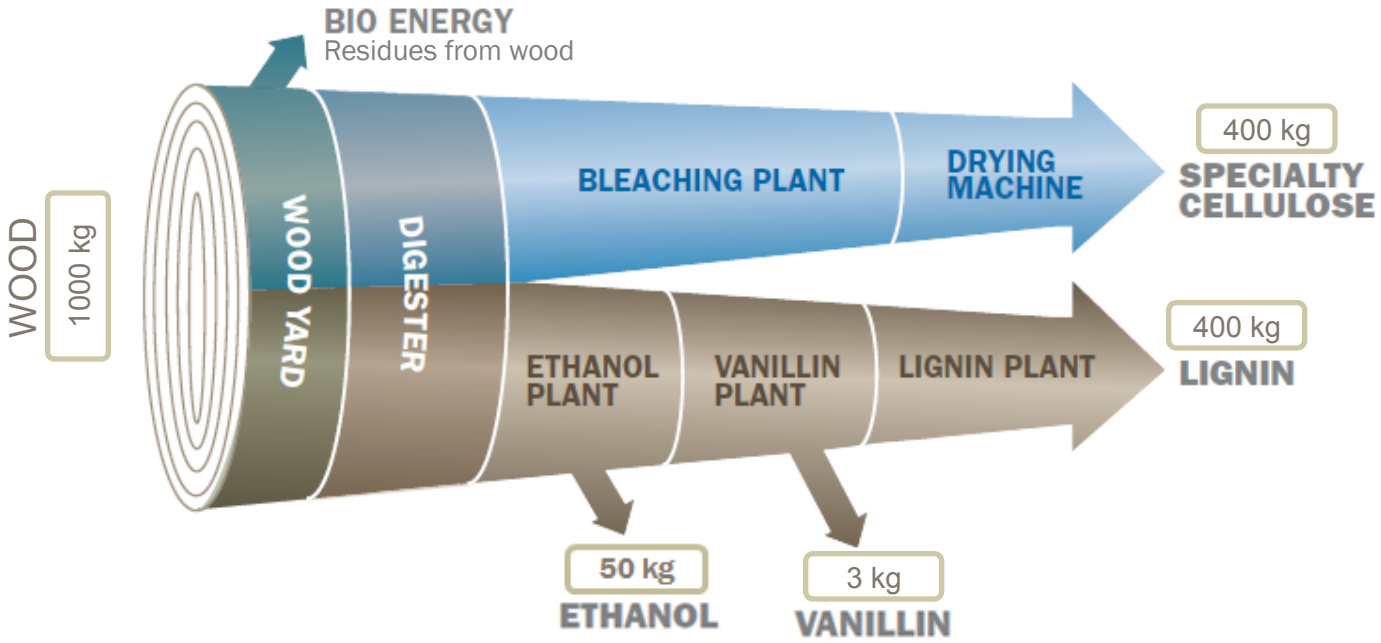
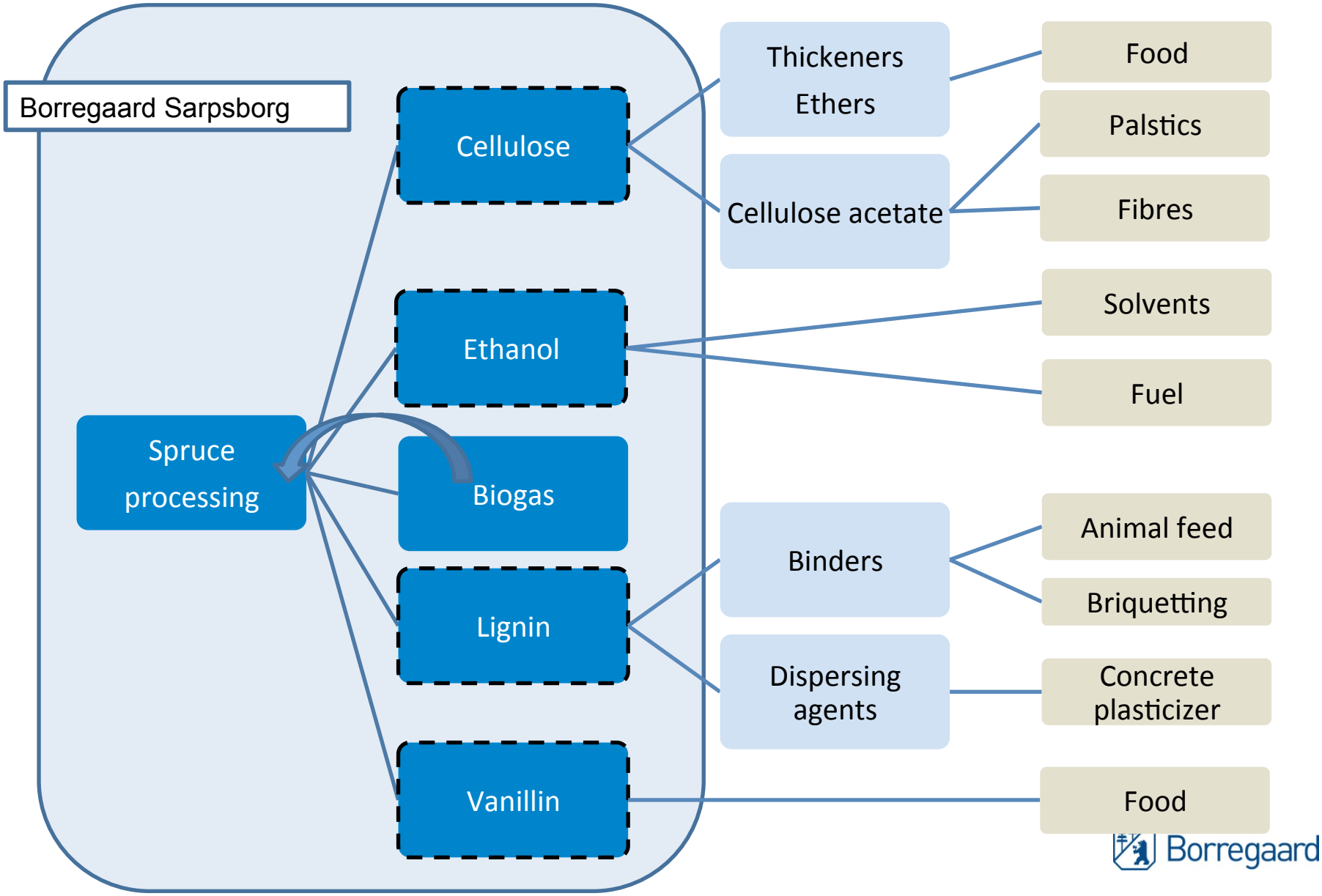
Borregaard is the world's most advanced biorefinery

Integrated production system serving diverse markets



Specialty cellulose	Lignin	Vanillin	Bioetanol
Construction materials	Concrete additive	Food	Car care
Cosmetics	Animal feed	Perfumes	Paint/varnish
Food	Dyestuff	Pharmaceuticals	Pharmaceutical industry
Tablets	Batteries		Bio fuel
Textiles	Briquetting		
Filters	Mining		
Paint/varnish	Soil conditioning		

Borregaard Sarpsborg today
Worlds most advanced biorefinery in operation



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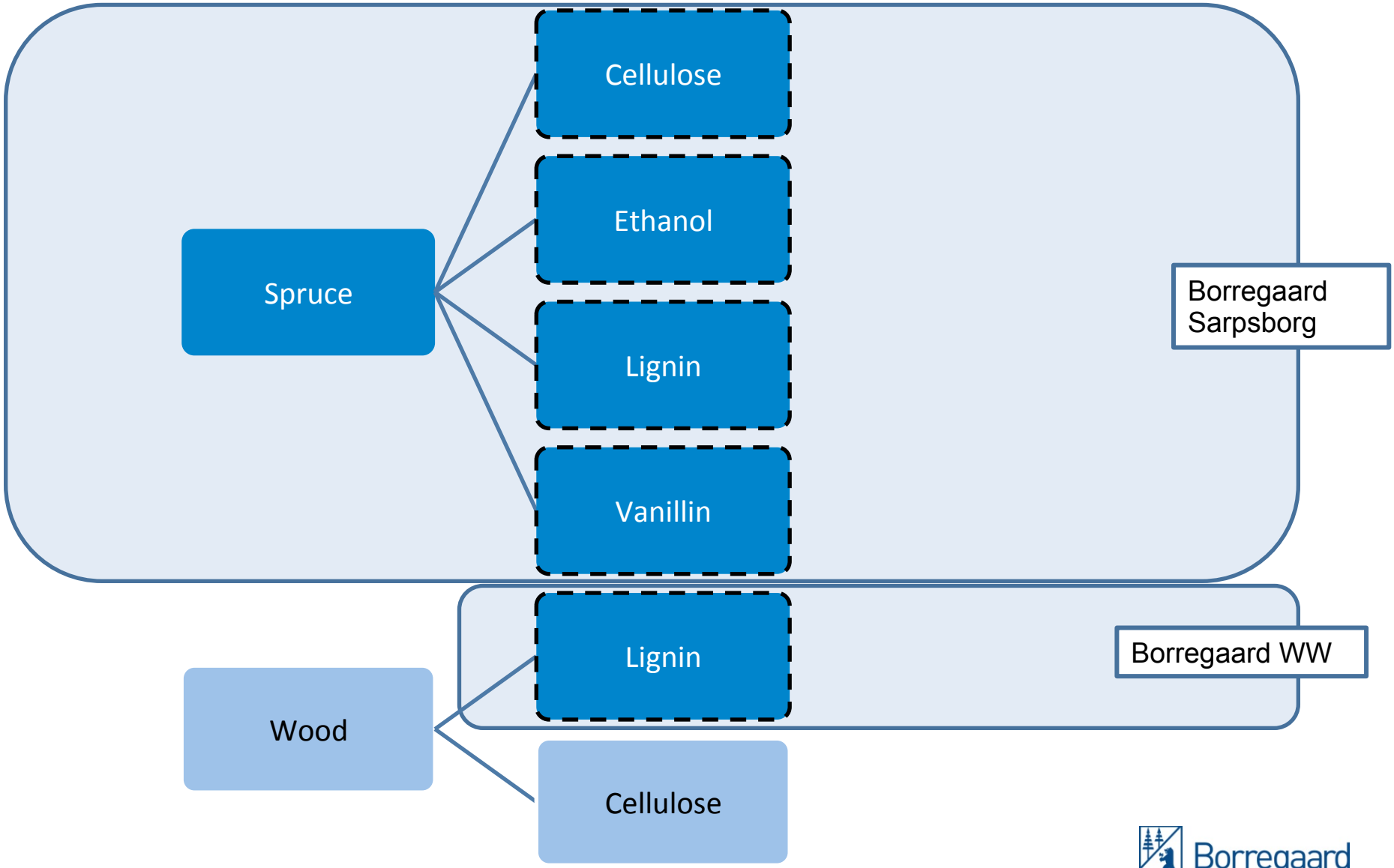
Global presence

An international business with global customers

Borregaard
Turnover: NOK 3,6 bill
1050 employees in
17 countries

Borregaard

Borregaard ww concepts today



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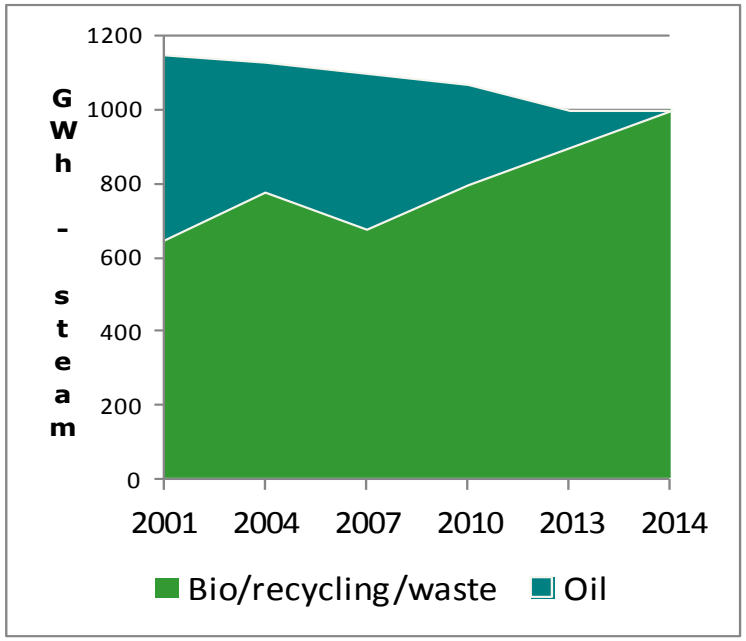
Not all biorefineries are sustainable or have a low CO2 footprint.

Significant environmental investments at Borregaard:

NOK 2 billion during the last 20 years



- Reduced emissions to air and water
  - New technology
  - New operations
  - Cleaning measures
- More renewable energy
  - Oil is being phased out, replaced by biofuel and waste

Independent of heavy oil for all purposes by the end of 2013

Reduced energy costs and greener products

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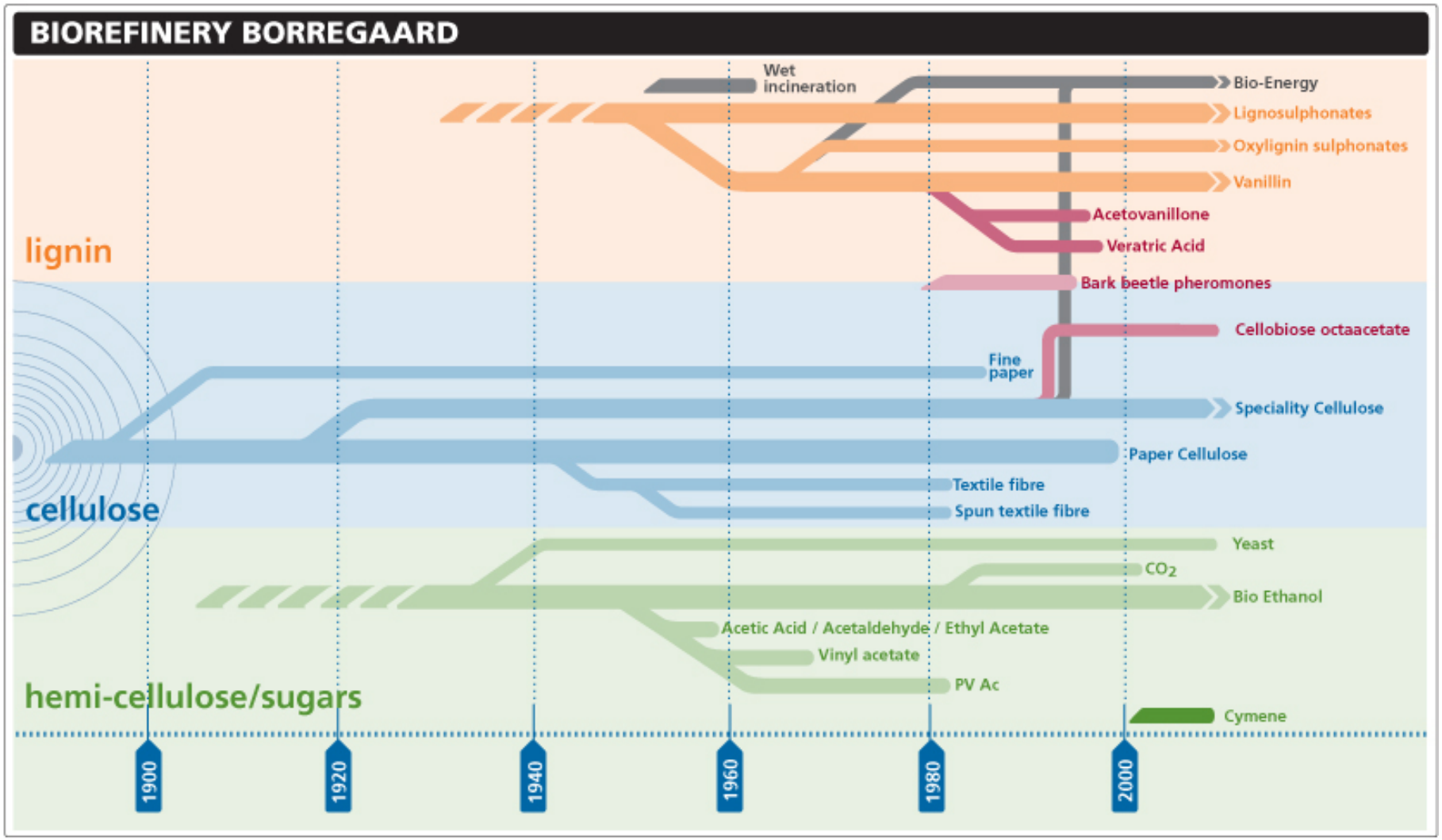
From paper mill to biorefinery



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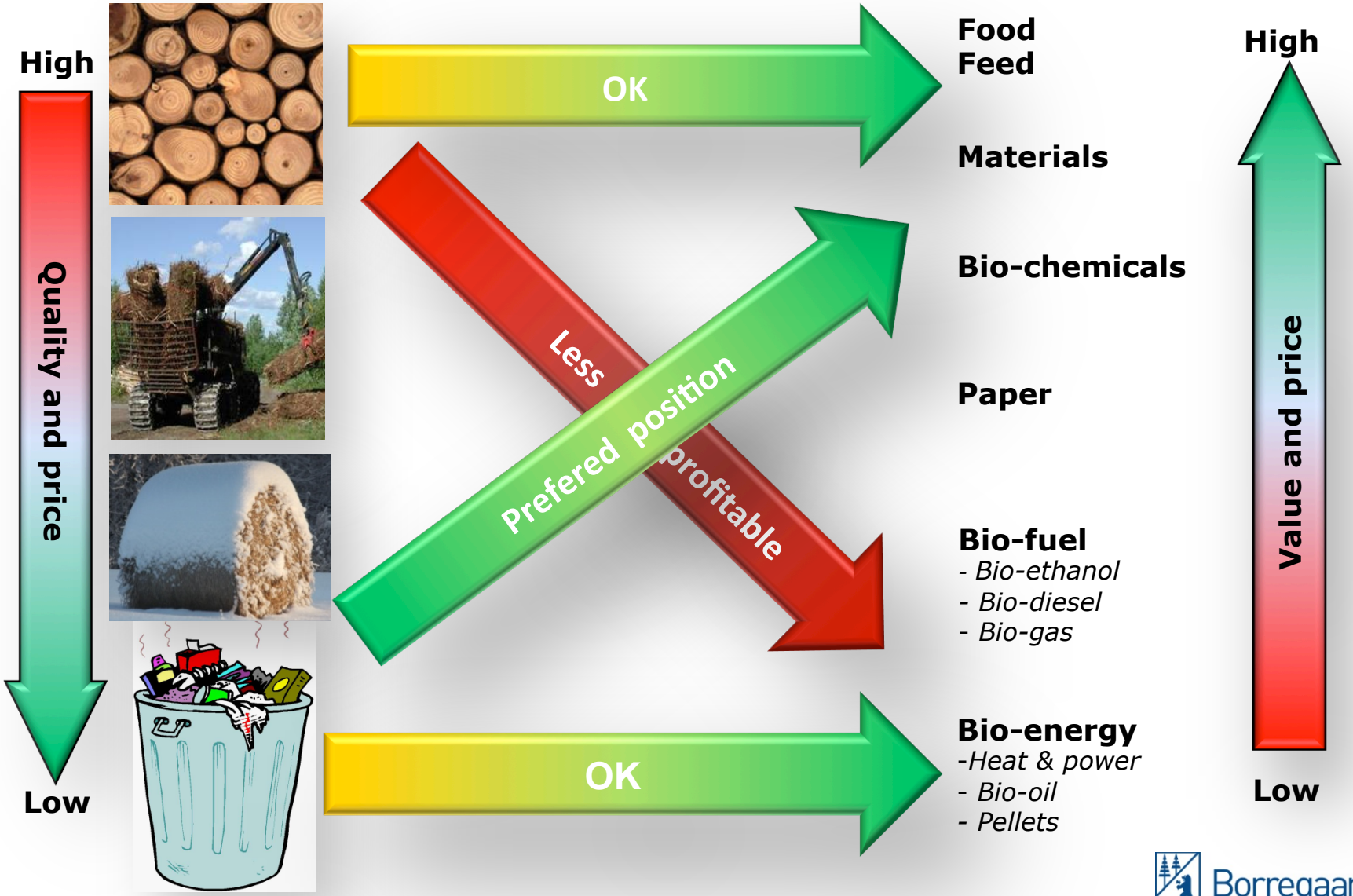
Optimal use of biomass - differentiation



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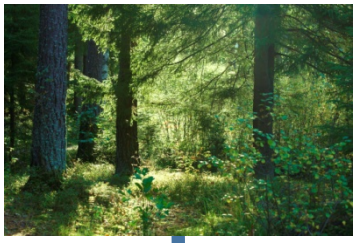
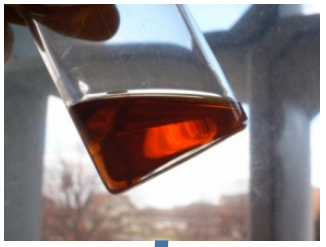
BALI™ process in a nutshell





Mechanical biomass handling

Chemical pretreatment

cellulose

Enzymatic hydrolysis

sugar

Fermen-tation

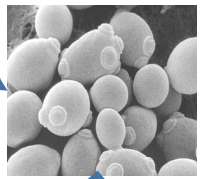
Ethanol, Chemicals Yeast

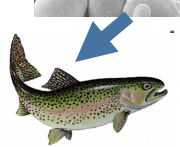
lignin

Chemical lignin processing

Chemical processing

BALI™ process





Borregaard BALI™ Demo Plant

- Location: Borregaard: Sarpsborg, Norway
- Feed: 1-1.5 metric ton DM/day
- Construction started May 2011
- Ready end 2012
- 800 m^2 total area
- Budget cost: NOK 130 mill (EUR 16.5 mill)
- 45% cash support from Innovation Norway
- Currently exploring partnership opportunities for full scale production plant

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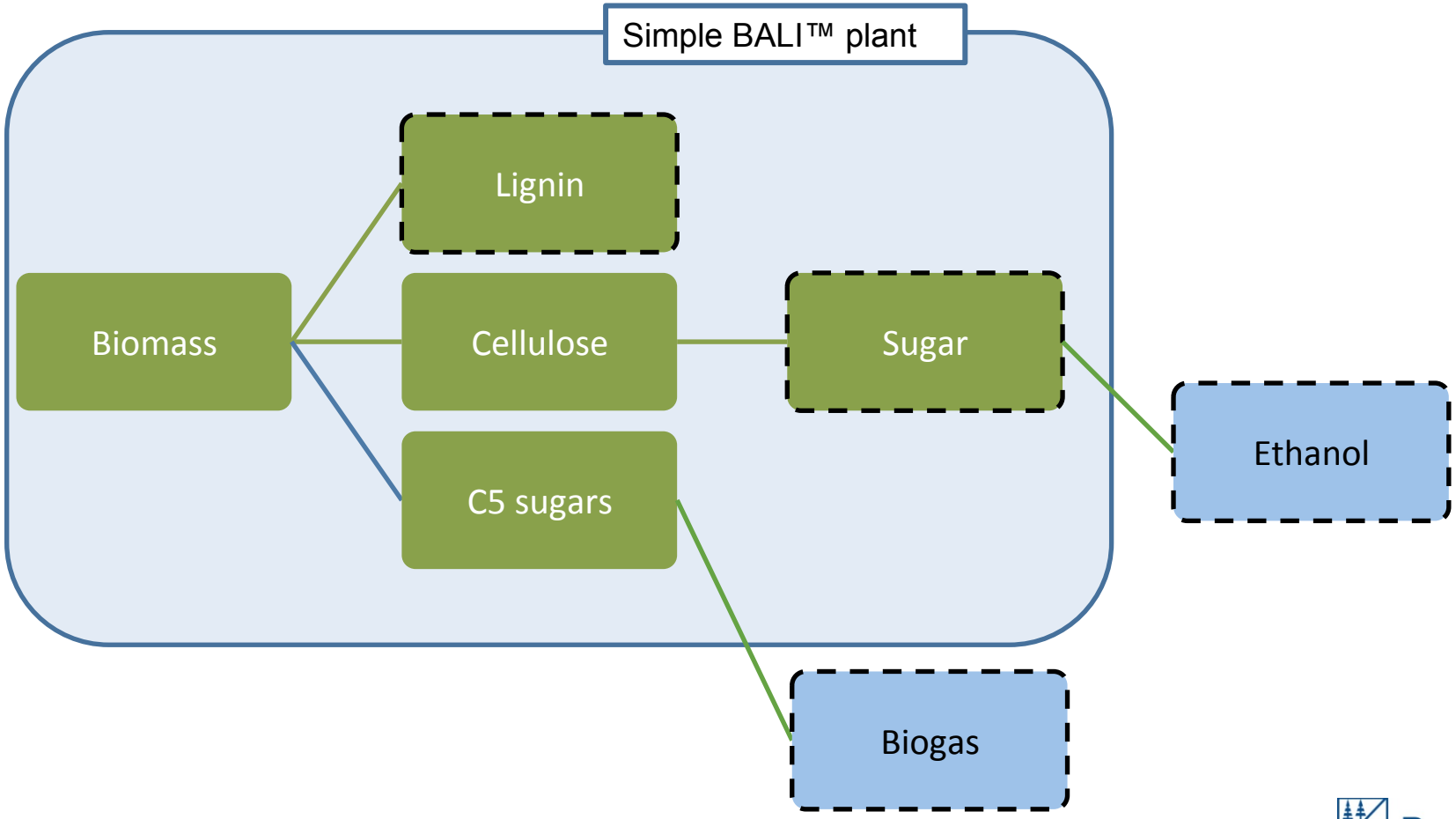
Borregaard biorefinery extended with BALI™ technology



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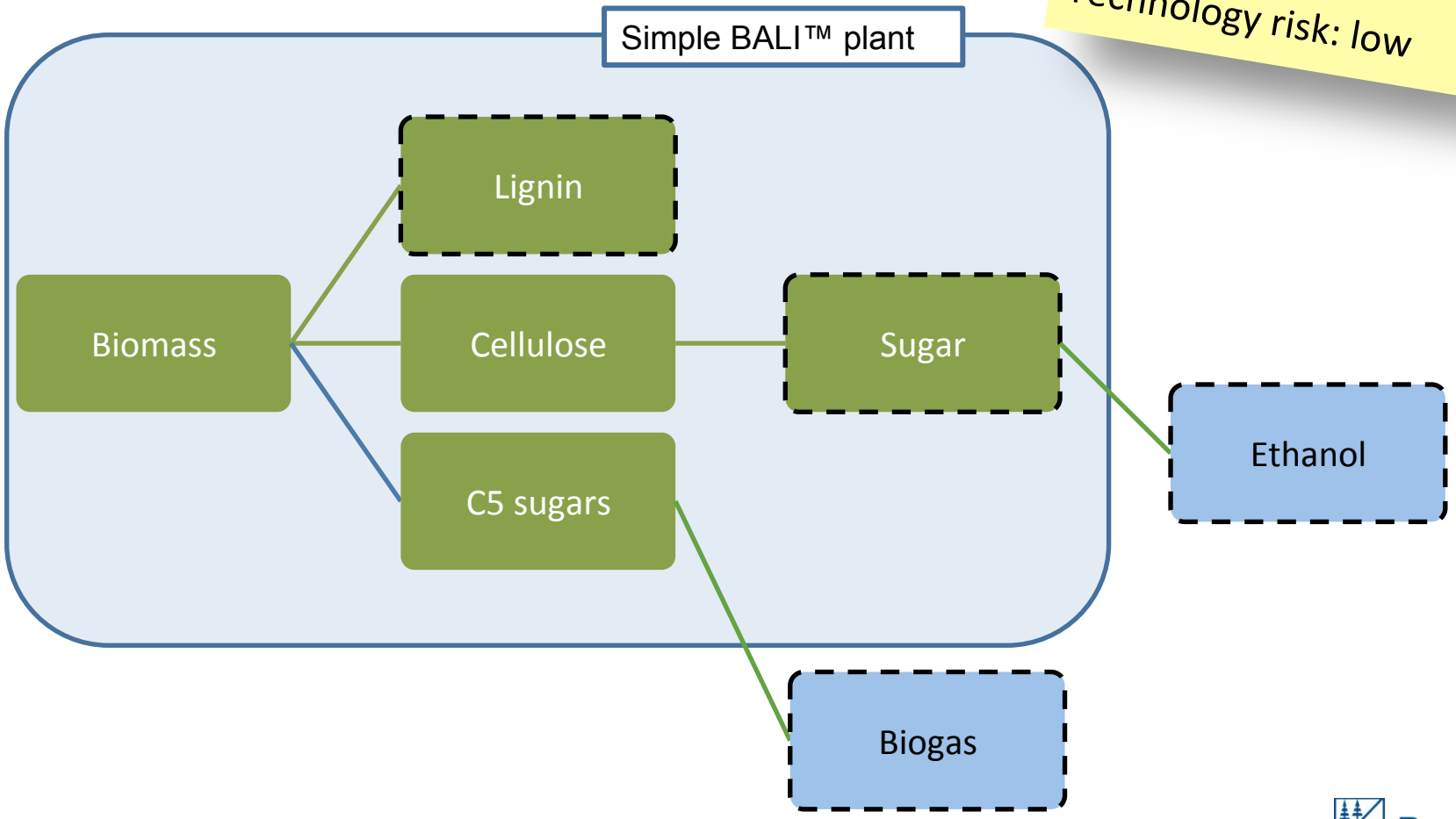
Borregaard biorefinery extended with BALI™ technology

Concept: simple
Value creation: not very high
Site: Where conditions are very good
Technology risk: low



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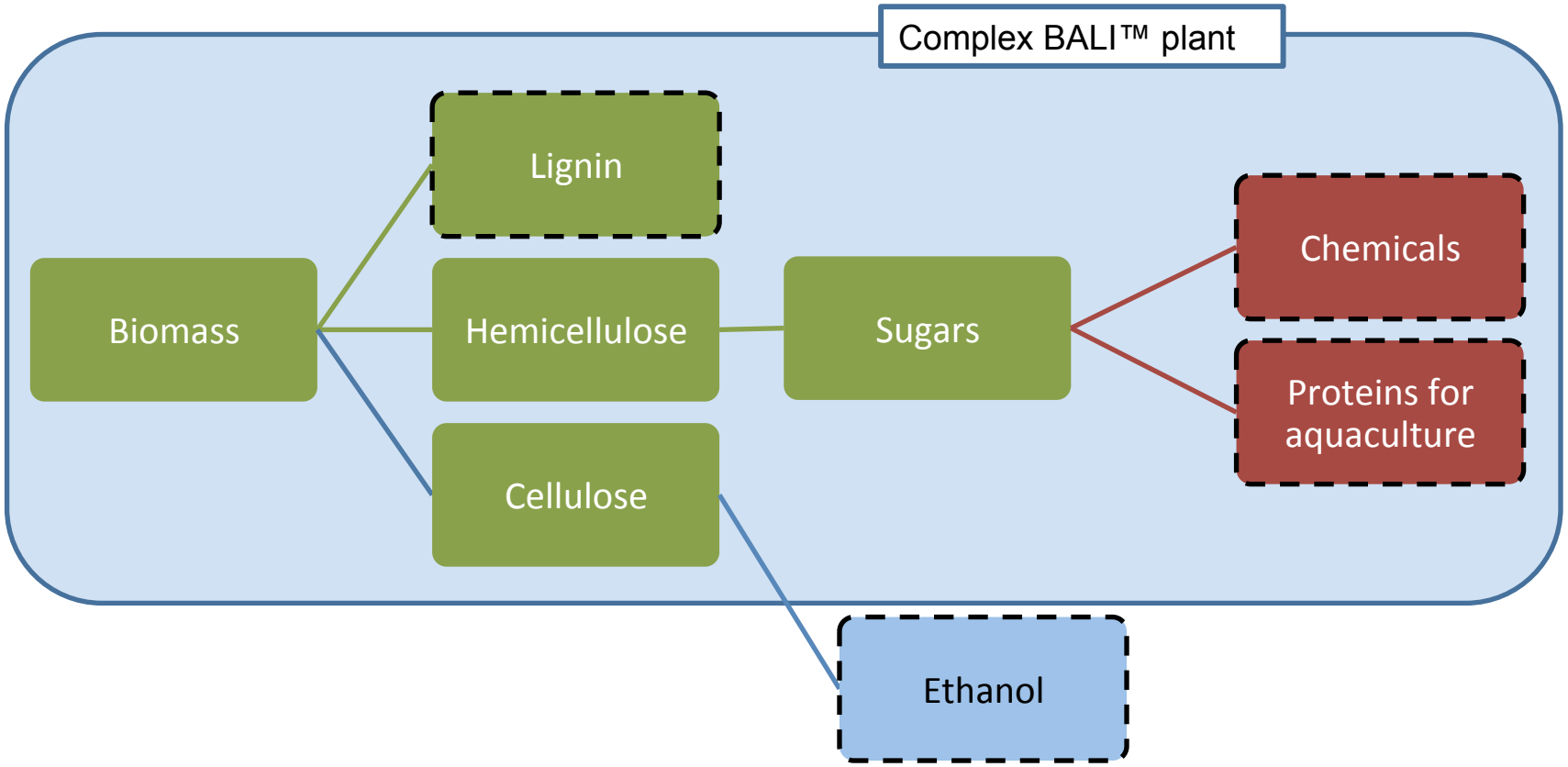
Increased value creation



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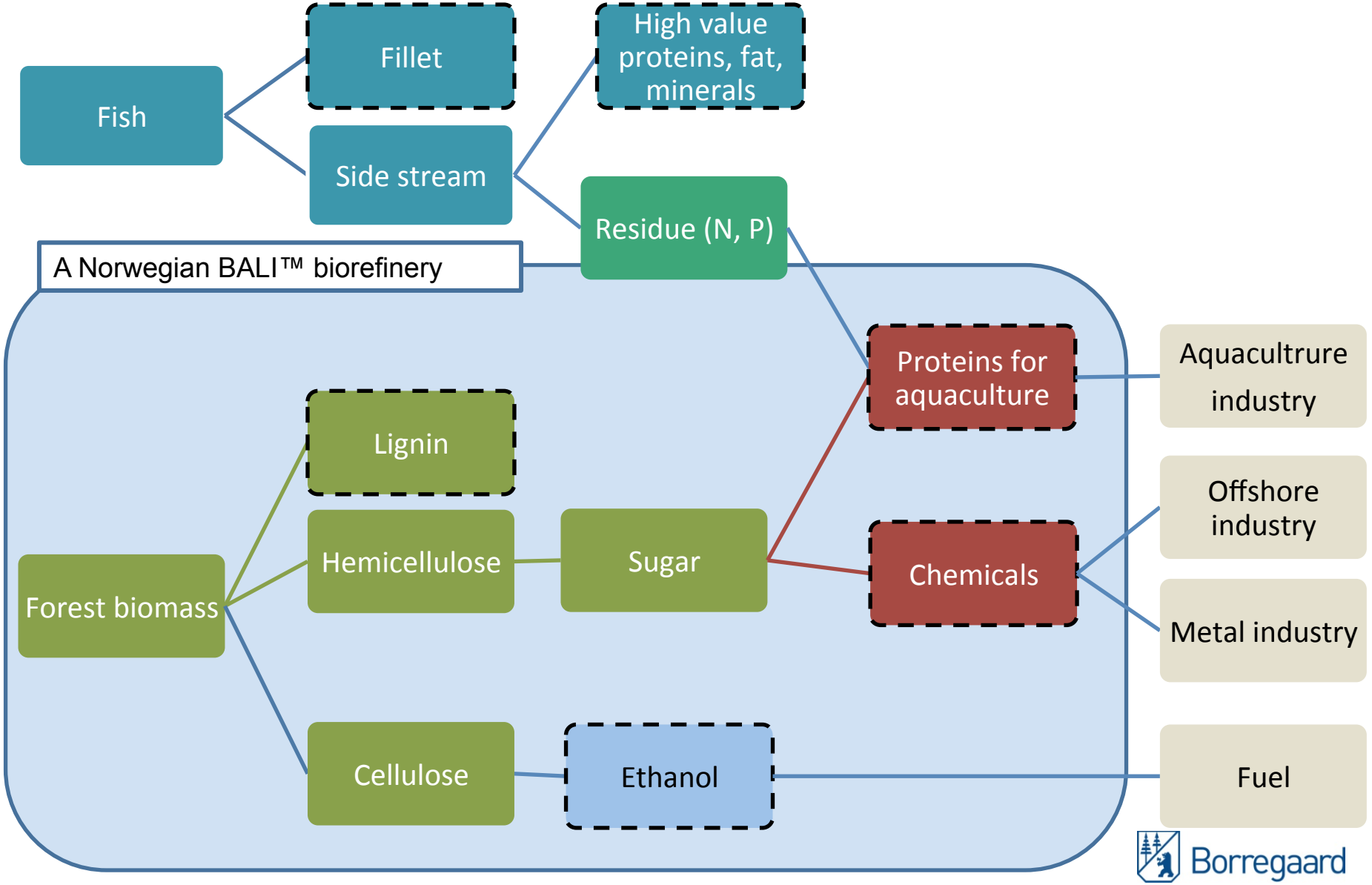
A biorefinery model adapted to a Norwegian environment



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Conclusions

- Norway have lots of unused biomass (wood, fish) and potentials for more (straw, macro algae, energy crops)
- Biomass is expensive in Norway
- There are opportunities to build biorefineries that are particularly adapted to local conditions
- Biorefineries need to be flexible and have the option to develop further to cope with changes in market demand
- Focus on high value creation is needed, high volume commodity products whenever there is no better option.

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