Optimal use of Biomass addressing sustainability, supply security and CO2 avoidance

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DONG energy

DONG Energy group

Inbicon A/S

- 100% owned by DONG Energy
- Formed in 2004 as a share holders company
- Approx. 60 employees
- R&D in the field of biomass conversion (since mid 90')
- Sales of technology world wide
- R&D department in Skærbæk at the local power plant
- Industrial scale demonstration plant in Kalundborg

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Contents

- The fundamental idea
- Overview of the IBUS process
- IBUS and coal-biomass co-firing
- Summary

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How should biomass be used?

What is the Objective?

Basically people seem to agree:

- Biomass for electricity: Best environmental effect
- Biomass for heat: Lowest cost
- Biomass for fuel: Best employment & supply security impact

- Politics and Climate Change ?
- Easier to make a stand addressing supply security, employment and trade in agriculture, development of agricultural areas – climate change.

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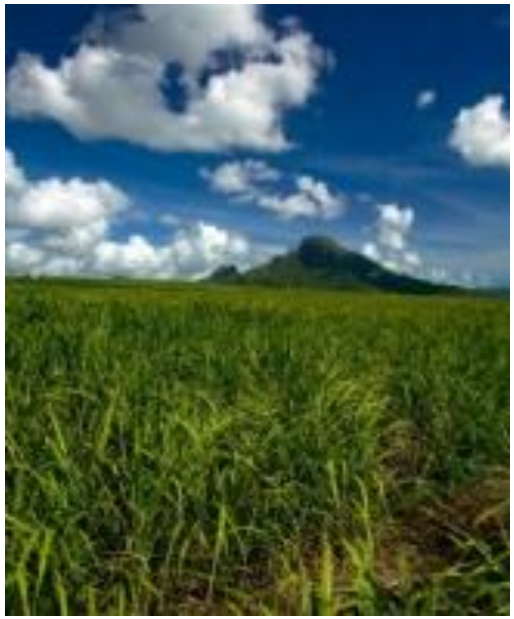
The Fundamental Idea

Solar Energy – Sustainable Energy

Thermal energy

Electric energy



Chemical energy

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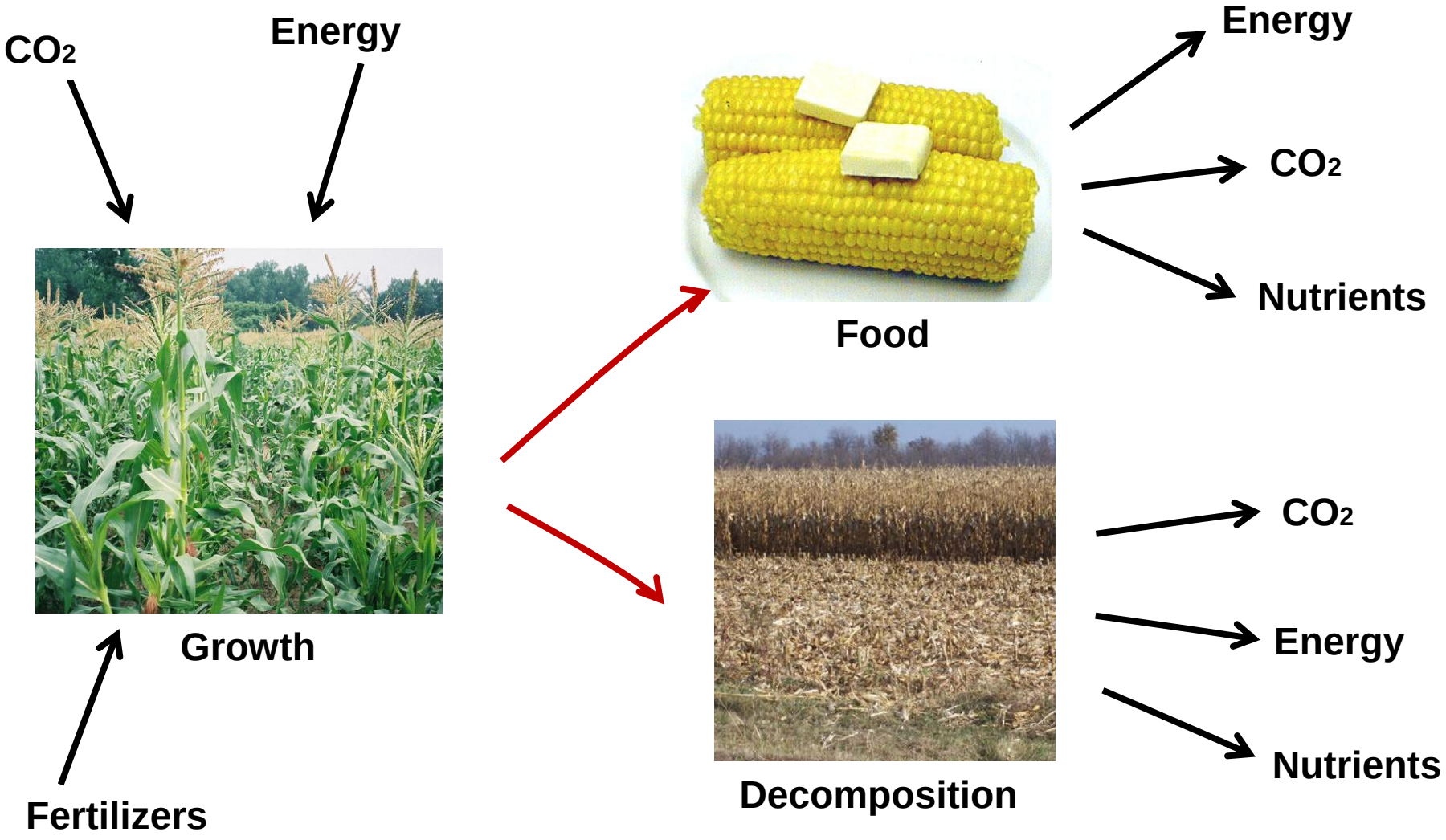
Solar Energy Conversion



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Our Goal is Optimal Use of Biomass

Cellulosic biomass (Waste)

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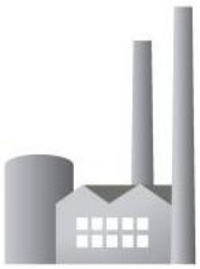
Ethanol

Ethanol replaces oil in transportation
84% reduction of CO2 emission

C5 molasses

C5 molasses increases food production
- or replaces more oil in transportation
- or produces bio-chemicals



Lignin biofuel

Biofuel replaces coal in power and heat generation

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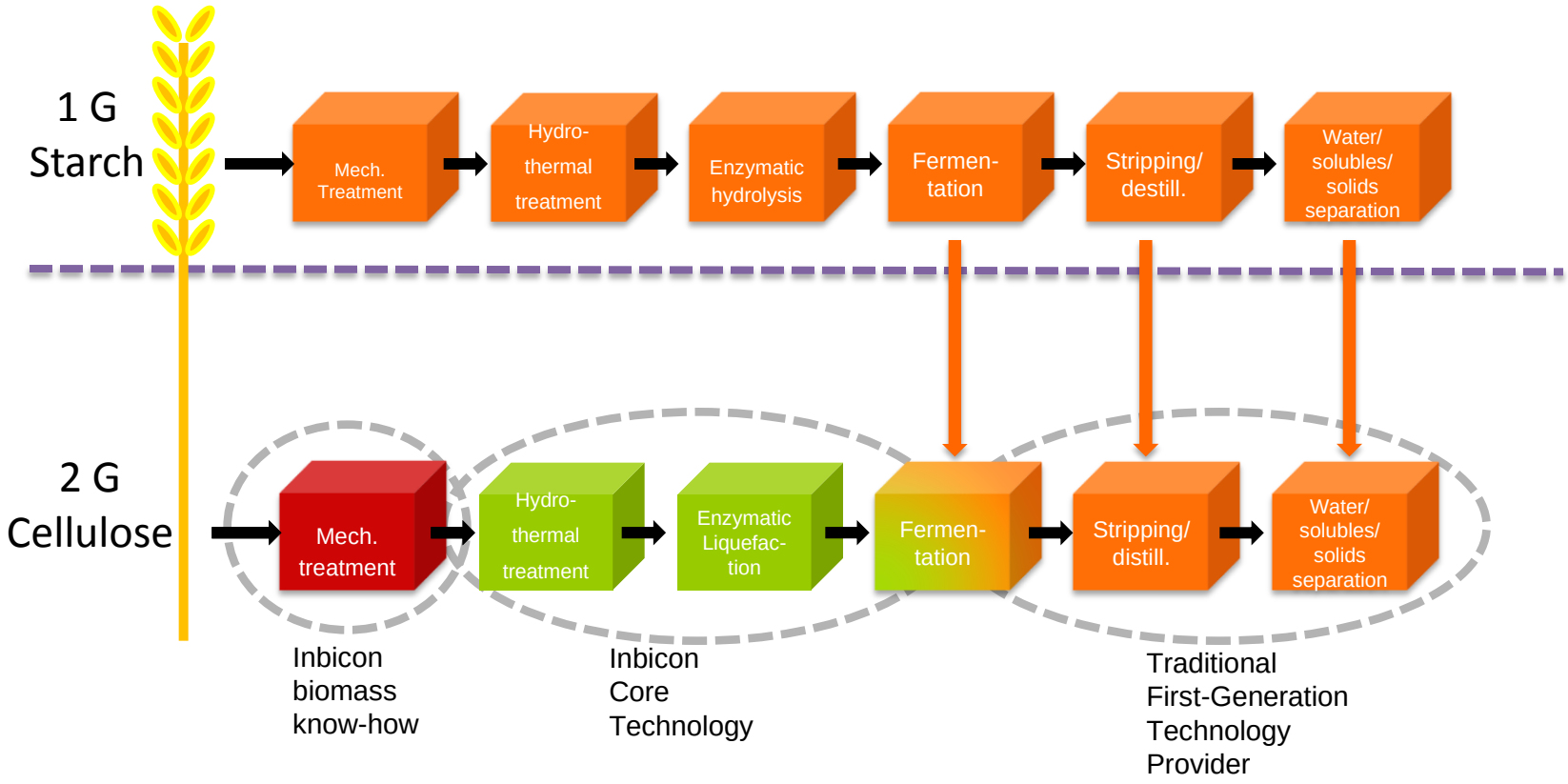
Core Technology



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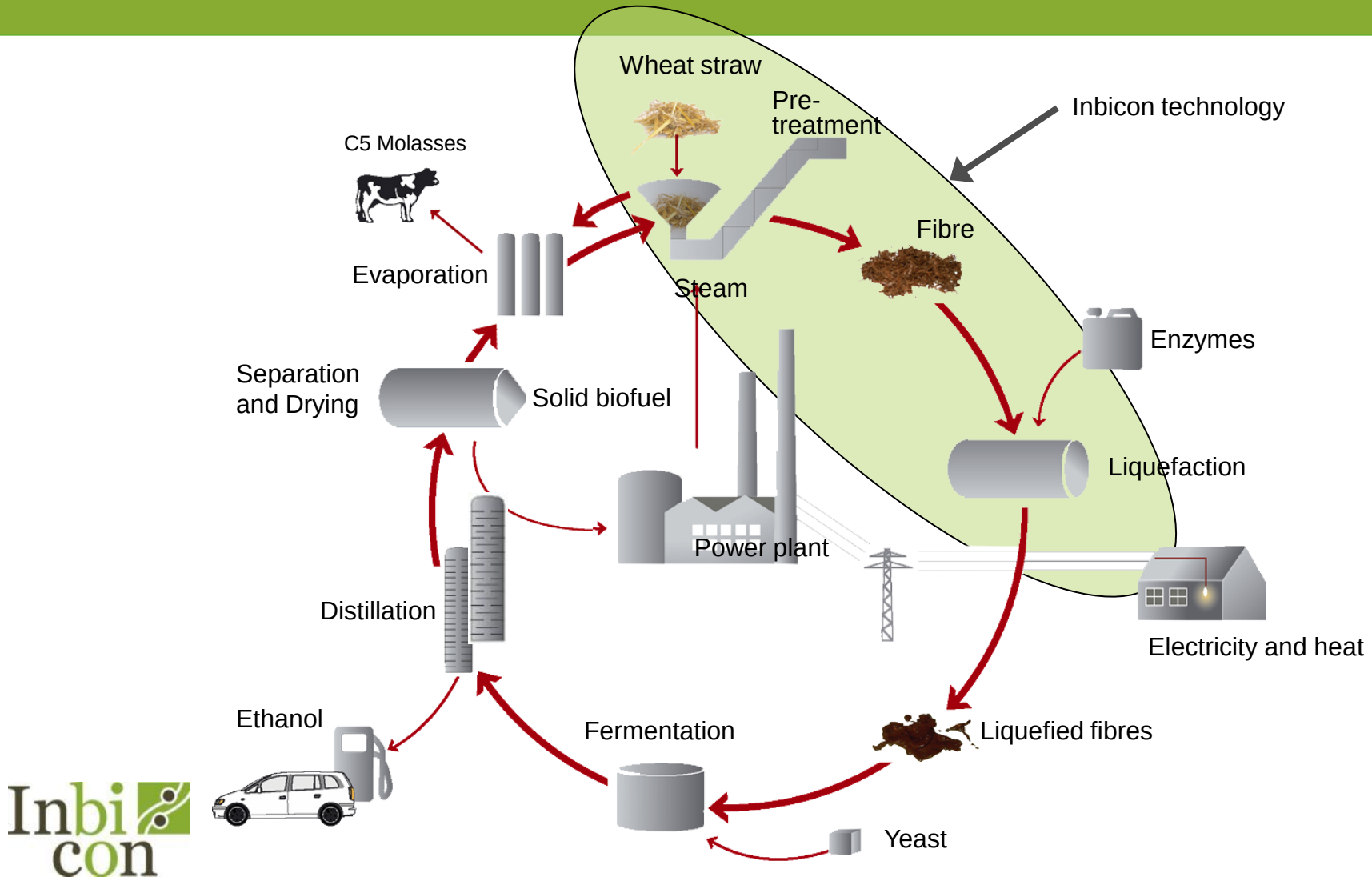
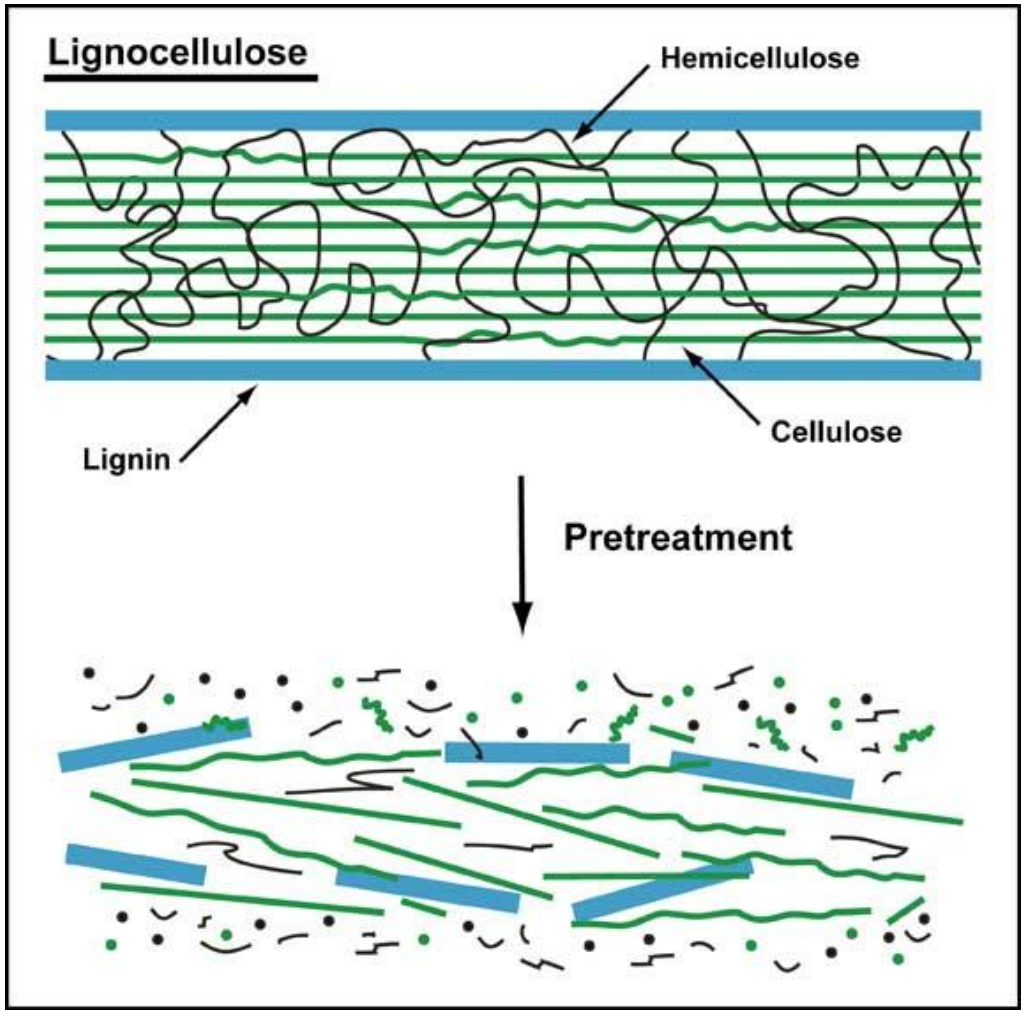
The Inbicon 2 ethanol process



Why pretreatment?

Hemicellulose	Cellulose	Lignin
C5-sugars	C6-sugar	
20-25%	35-40%	15-20%



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Core Technology

Hydro-thermal treatment → Enzymatic Liquefaction

High Solids 20-40%
Inhibitor control
Yields 8%+wt Beer

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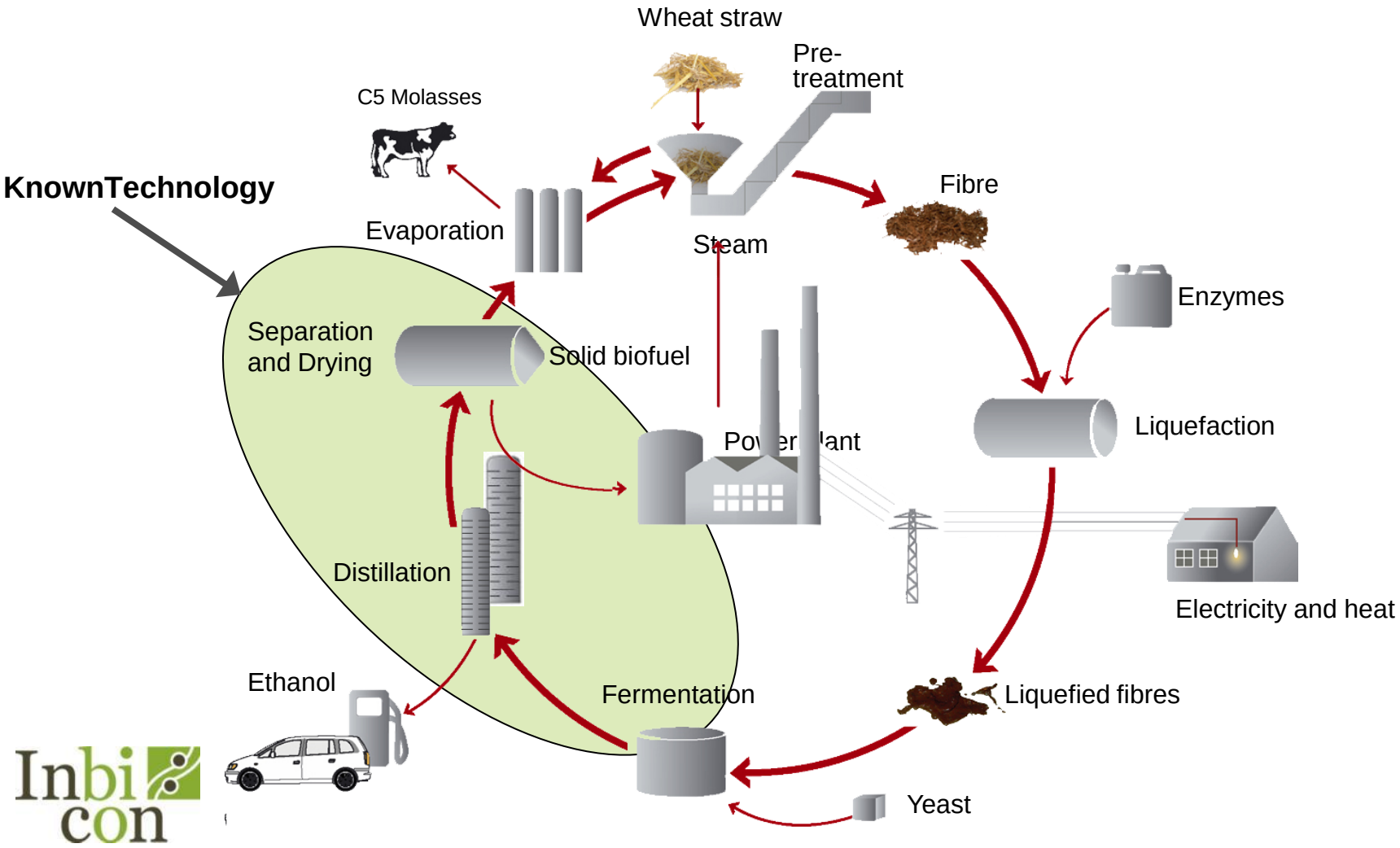
The Inbicon 2 ethanol process



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Waste Biomass converted into three high value products

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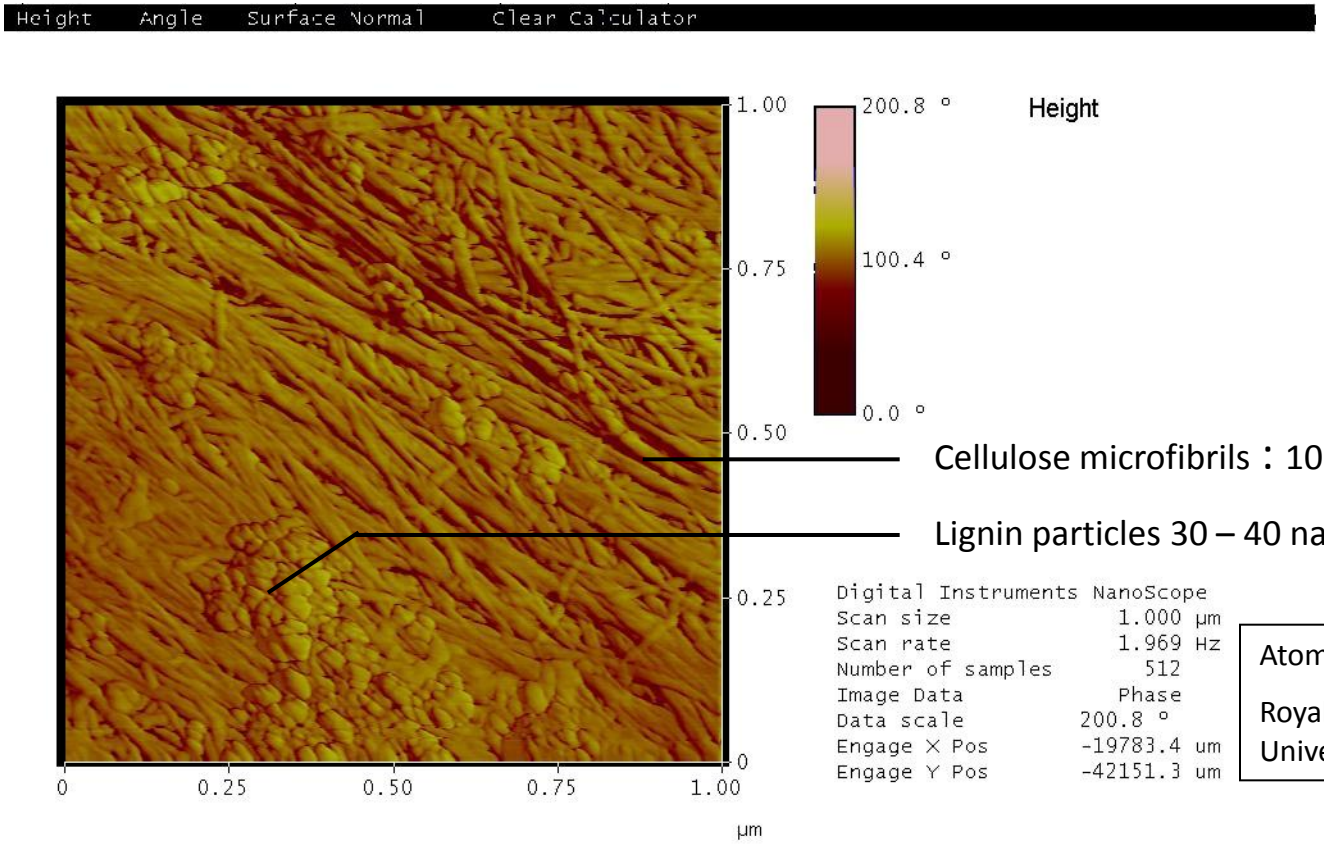
Lignin



Atomic Force Microscope:

Royal Veterinary and Agricultural University

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Utilisation of biomass

Biomass CHP	Co-fired CHP	Co-fired Power Plant	Co-fired Power ethanol plant
•Ash Utilisation ↓	•Ash Utilisation ↑	•Ash Utilisation ↑	•Ash Utilisation ↑
•Wet biomass ↓	•Wet biomass ↓	•Wet biomass ↓	•Wet biomass ↑
•Grid balancing ↓	•Grid balancing ↑	•Grid balancing ↑	•Grid balancing ↑
•Flexibility ↓	•Flexibility ↓	•Flexibility ↑	•Flexibility ↑
•"Hot" Countries ↓	•"Hot" Countries ↓	•"Hot" Countries ↓	•"Hot" Countries ↑
•Efficiency ↑	•Efficiency ↑	•Efficiency ↓	•Efficiency ↑

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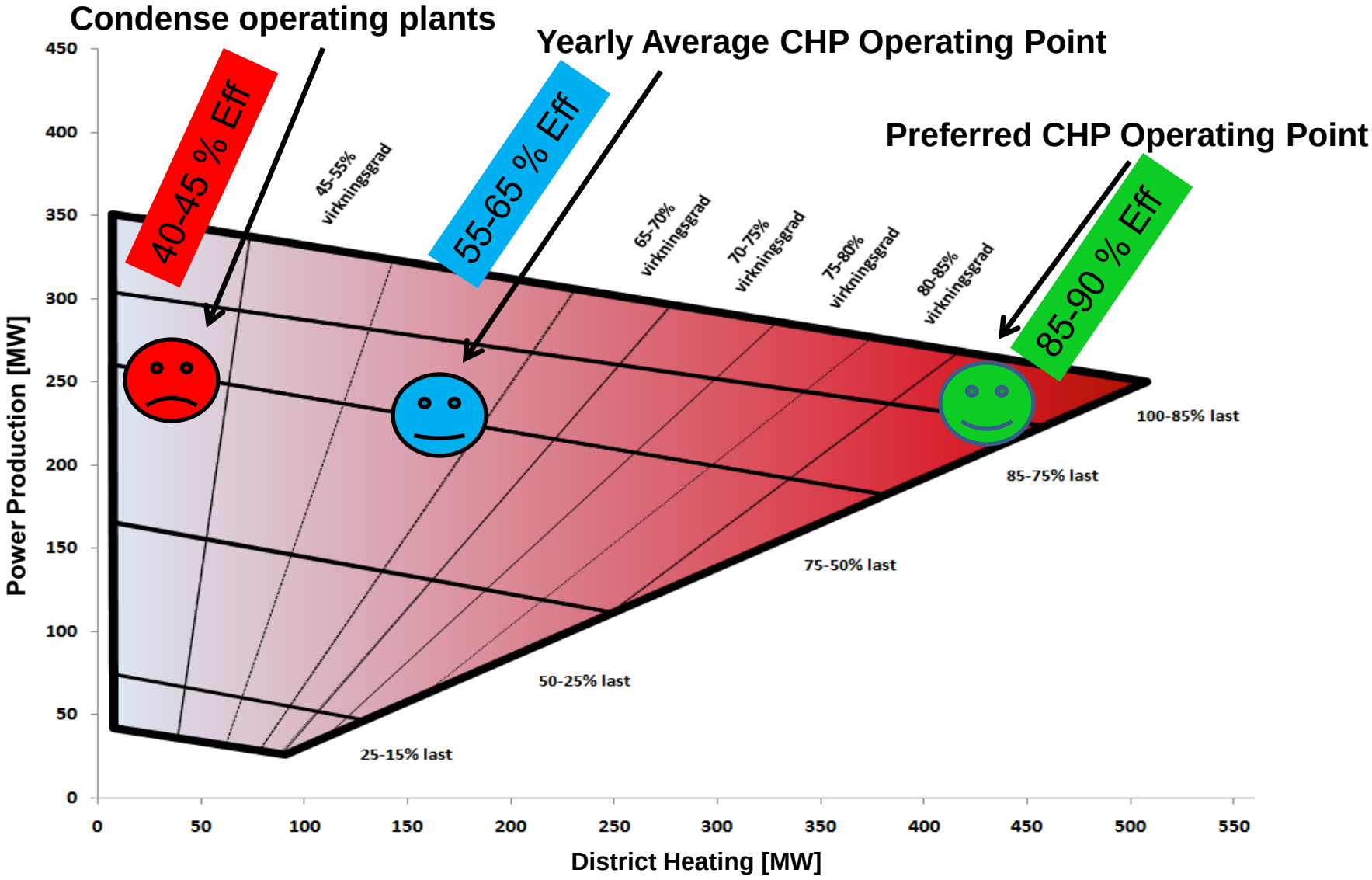
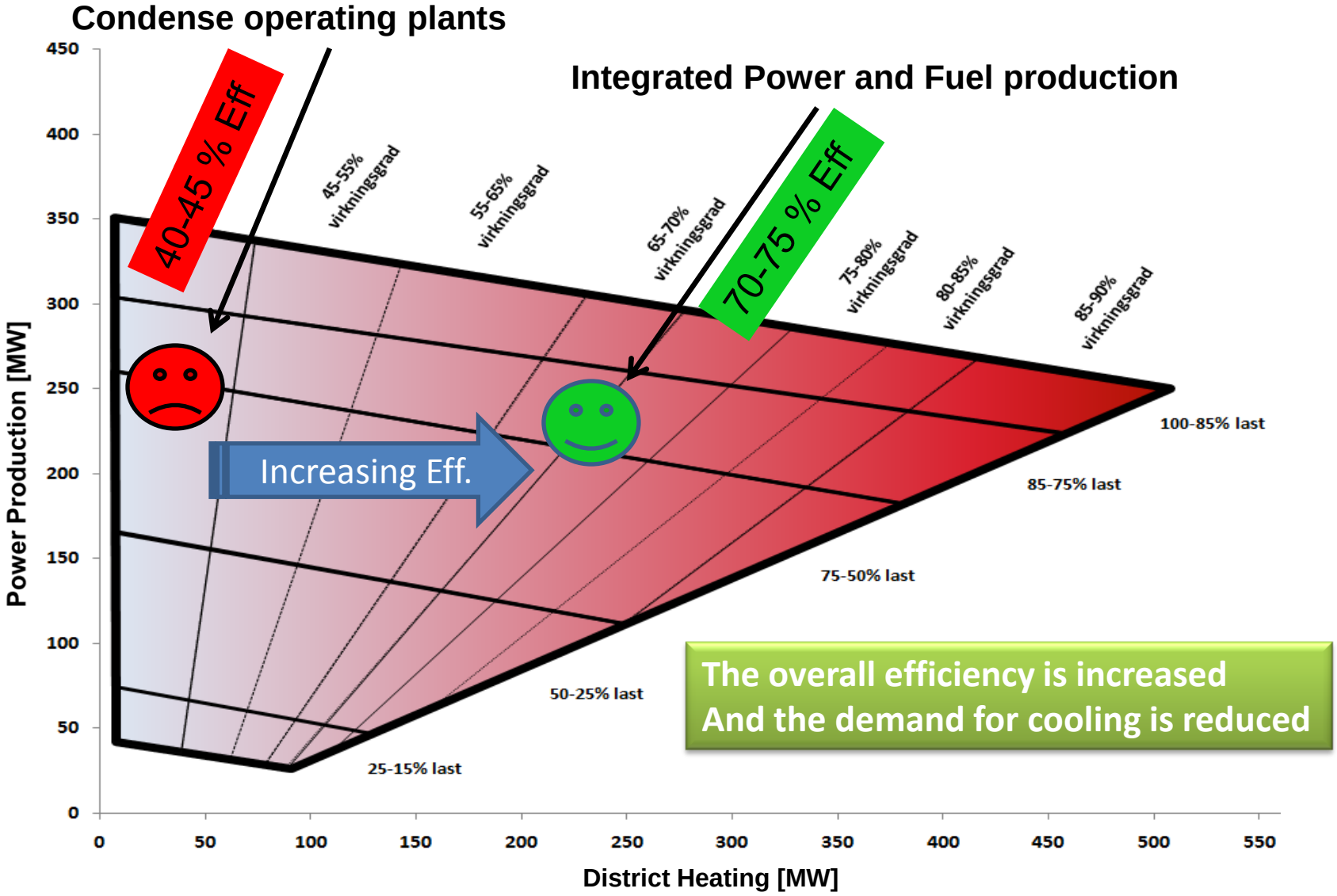
Note: "Hot" Countries = Regions where district heating makes no sense

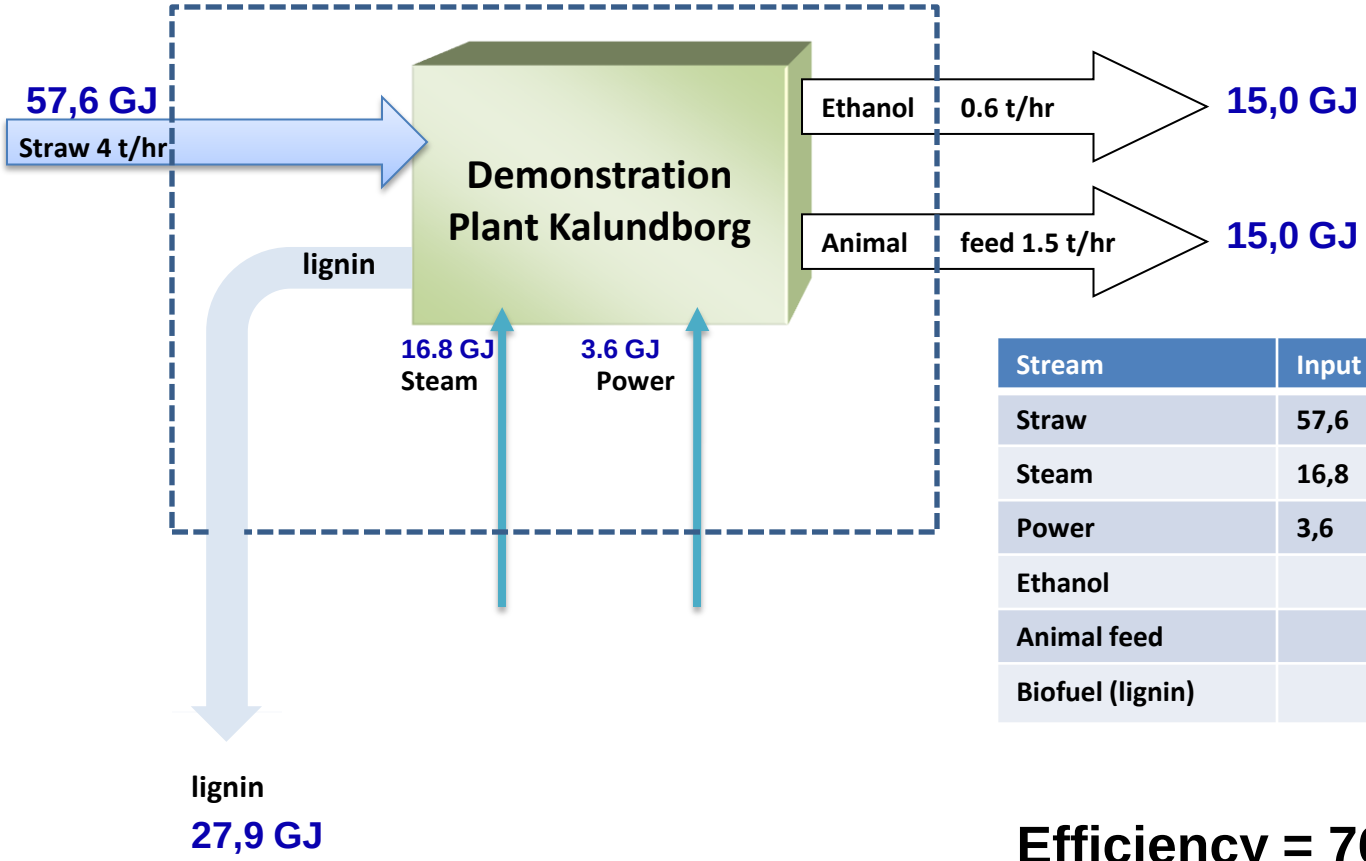
Co-firing of biomass does not take place with 90% efficiency !



Adding bio-ethanol plants to Condense Operating Plants increases overall efficiency



Efficiency model 1



Stream	Input [GJ]	Output [GJ]
Straw	57,6	
Steam	16,8	
Power	3,6	
Ethanol		15,0
Animal feed		15,0
Biofuel (lignin)		28,9

Efficiency = 76% !

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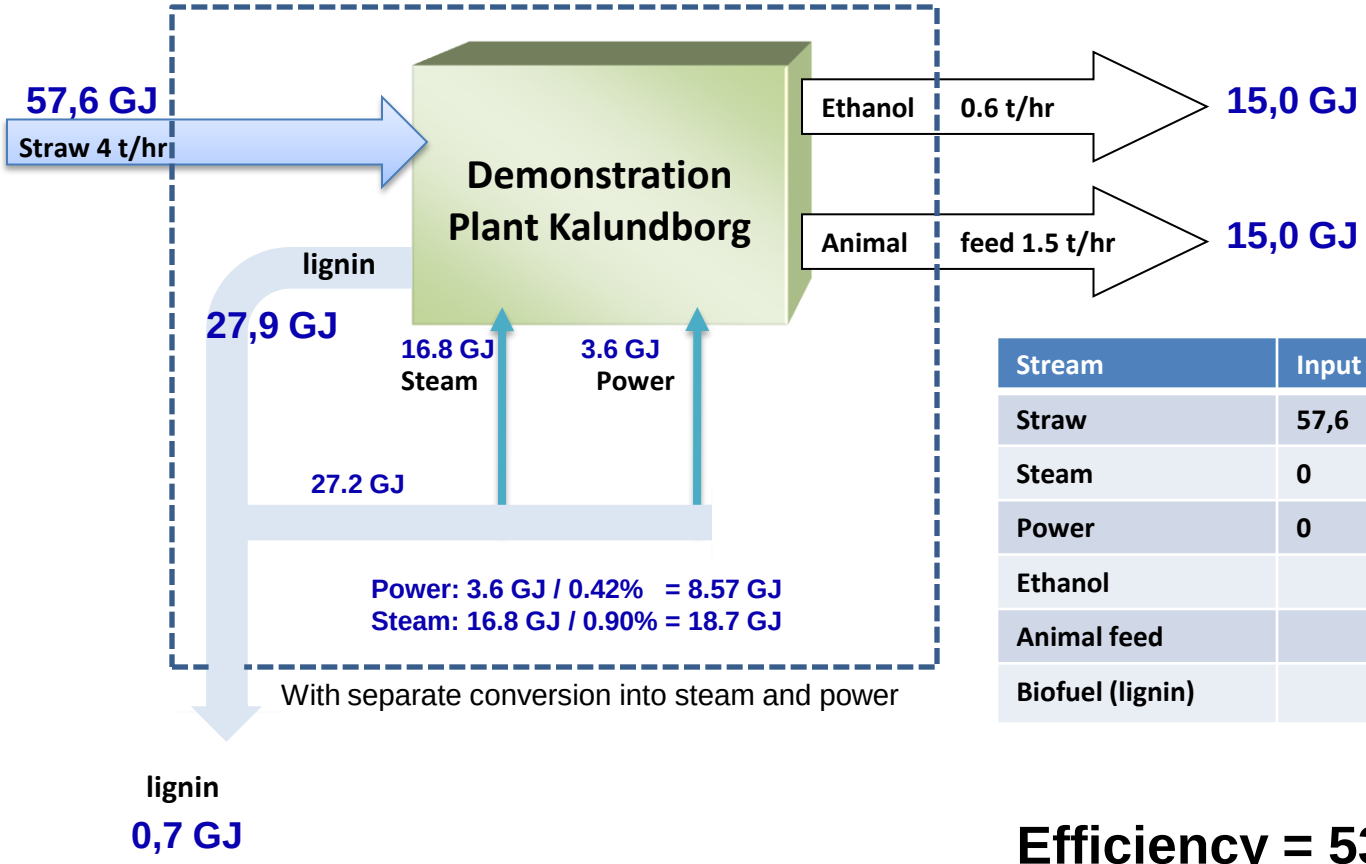
Efficiency model 2



Stream	Input [GJ]	Output [GJ]
Straw	57,6	
Steam	0	
Power	0	
Ethanol		15,0
Animal feed		15,0
Biofuel (lignin)		0,7

Efficiency = 53% !

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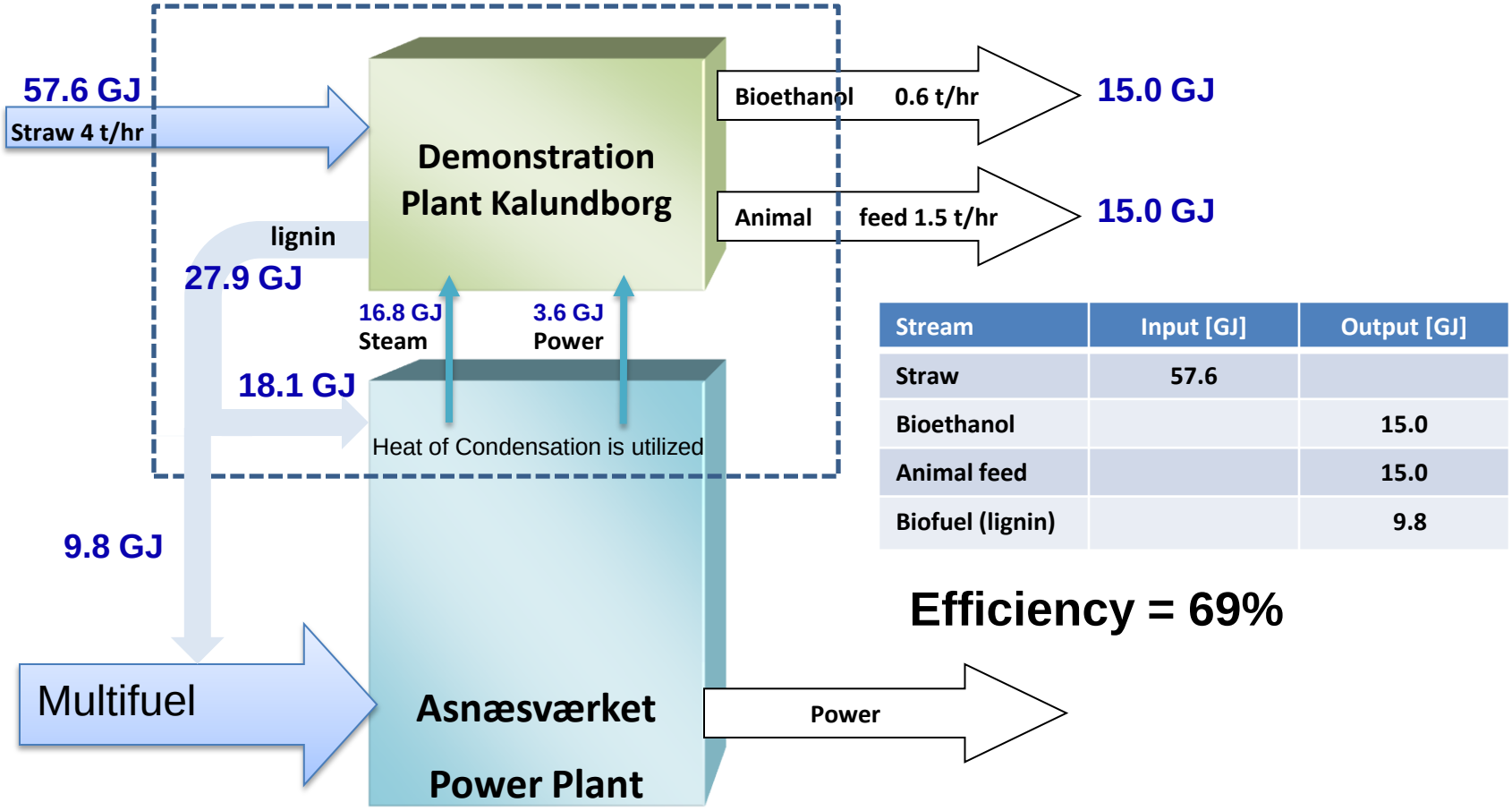
Efficiency model 3 (used by DONG Energy)



Stream	Input [GJ]	Output [GJ]
Straw	57.6	
Bioethanol		15.0
Animal feed		15.0
Biofuel (lignin)		9.8

Efficiency = 69%

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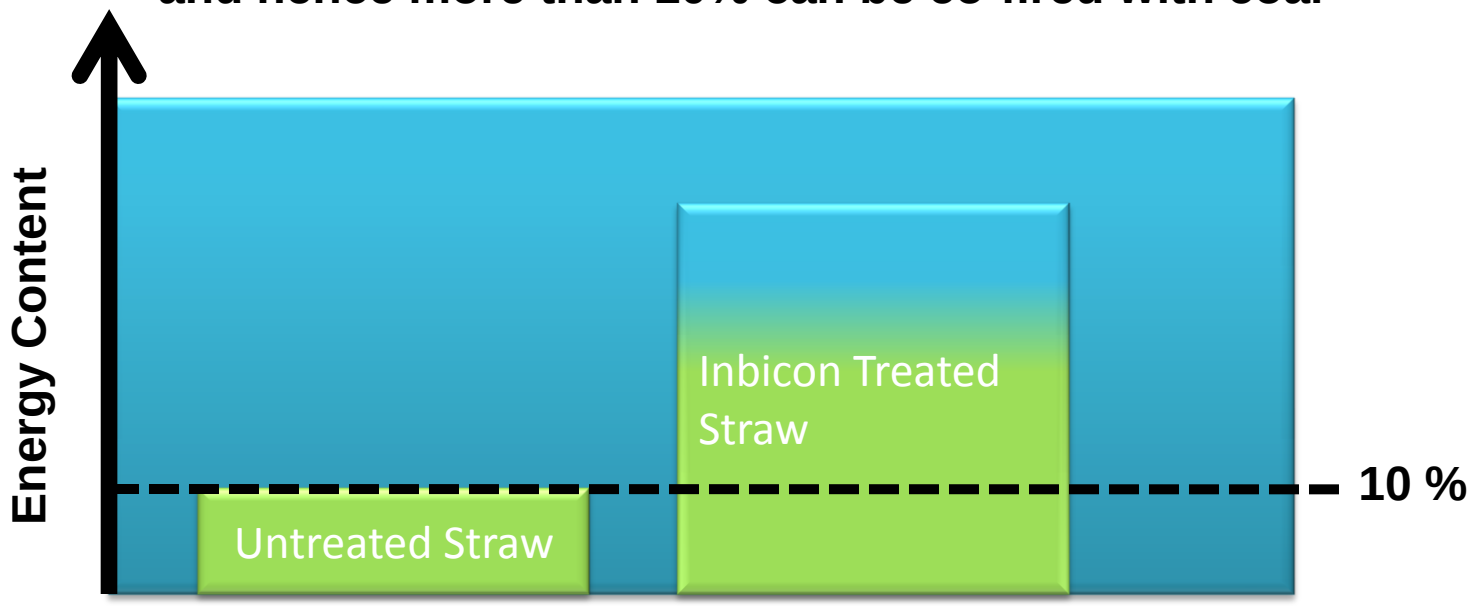
By utilization of the integration advantage:
Additional **1.5 kg CO_2 per litre ethanol can be saved !**

Direct Co-firing of Biomass is good

- but not without IBUS !

The IBUS proces removes the alkali from the straw, and hence more than 10% can be co-fired with coal



Today a maximum of 10% untreated straw can be co-fired with coal, due to alkali poisoning of the mandatory SCR Units, corrosion of superheaters and utilisation of fly ash.

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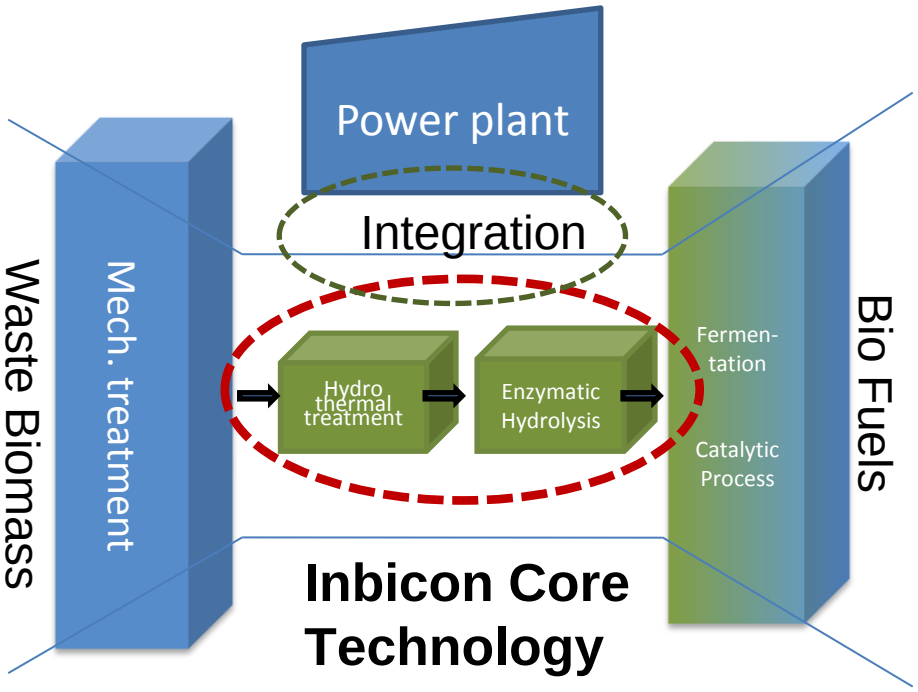
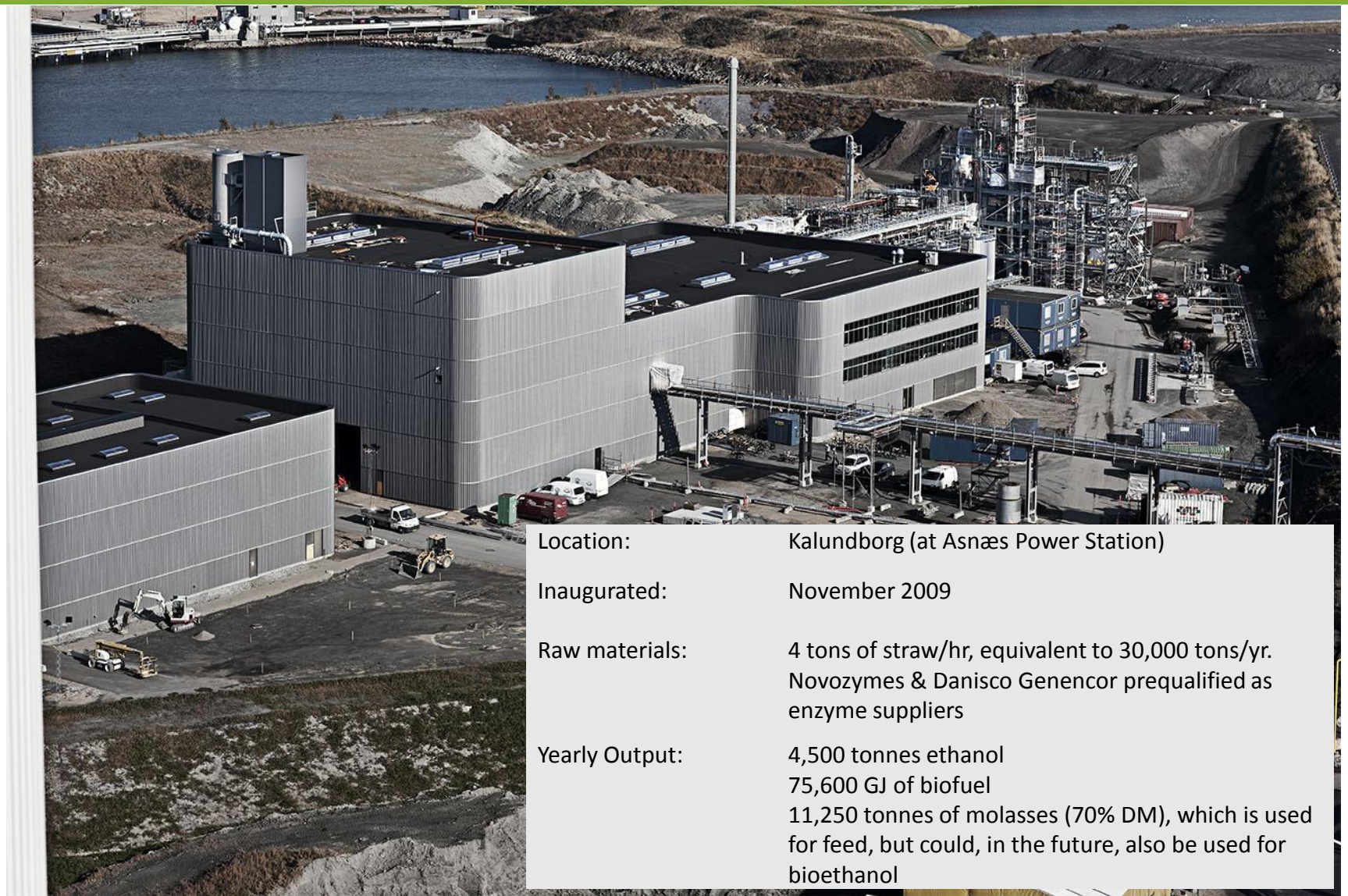
Summary

- **2G Technology based on soft waste biomass**
- **Simple and fast process**
  - **uses only water, enzymes and yeast**
  - **process time < 100 hr**
  - **Scalable technology**
  - **Integrated contamination control**
- **Energy efficient**
  - **No milling required**
  - **High dry matter process**
  - **Power Plant Integration**
  - **Self-sustained (energy consumption)**
- **Flexible Biomass Refinery**



Kalundborg Large Scale Demonstration plant



Location:	Kalundborg (at Asnæs Power Station)
Inaugurated:	November 2009
Raw materials:	4 tons of straw/hr, equivalent to 30,000 tons/yr. Novozymes & Danisco Genencor prequalified as enzyme suppliers
Yearly Output:	4,500 tonnes ethanol 75,600 GJ of biofuel 11,250 tonnes of molasses (70% DM), which is used for feed, but could, in the future, also be used for bioethanol

Questions ?