Integrated Biorefineries
Current Status and Developments

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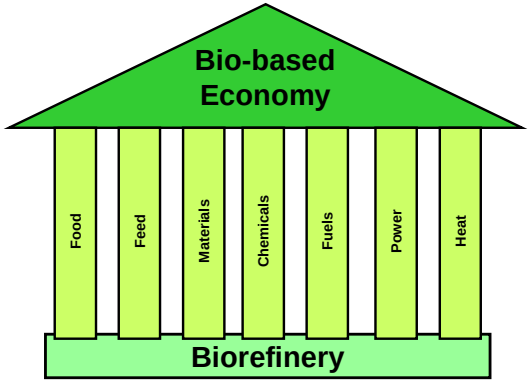
Task 42 – Biorefineries



Task co-ordinator: René van Ree

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Biorefinery Training Course @ International Biomass Valorisation Congress, Amsterdam, the Netherlands, 13 September 2010

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Content

1. IEA Bioenergy & Task 42 “Biorefining”
2. Definition Biorefining
3. Current Status & Developments Biorefineries
4. Market Implementation Scenario Biorefineries
5. Points for Discussion

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1. IEA Bioenergy

IEA Bioenergy is one of a number of Implementing Agreements (IAs) establised more than 30 years ago by the International Energy Agency (IEA)

Annual budget (2010): over 2 M US$

Aim is to provide platforms for international collaboration and information exchange in bioenergy research, development, and demonstration

23 contracting parties (member countries)
AUS, AT, BEL, BRA, CAN, CRO, DEN, EC, FIN, FRA, GER, IRE, IT, JP, NL, NZ, NOR, SA, SWE, SUI, TUR, UK, USA

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12 Tasks

Raw material related Tasks

Biomass Feedstocks for Energy Markets (43)
Energy Recovery Solid Waste Management (36)

Conversion process related Tasks

Combustion and Cofiring (32)
Thermal Gasification (33)
Pyrolysis (34)
Biogas & Landfill Gas (37)
Liquid Biofuels (39)

Assessment based Tasks

Socio-economic drivers (29)
AMF-cooperation (41)
Sustainable International Biomass Trade (40)
Greenhouse Gas Balances (38)

Task 42 Biorefinery
dealing with both raw materials, conversion processes and products in a Full Value Chain approach

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Task 42 Biorefineries

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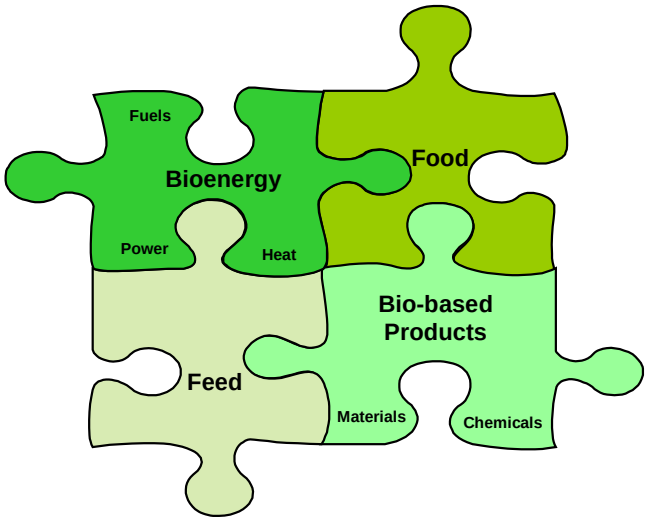
Task 42 Biorefinery

Framework Sustainable conversion of biomass into both Biobased Products and Bioenergy



Aims

1) Assess the worldwide position and potential for biorefineries

2) Gather new insights for the simultaneous production of food, feed, chemicals, materials, fuels, power and/or heat from biomass in a socially and environmentally acceptable and economically profitable way

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Task 42 Biorefineries

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Task 42 Biorefinery

13 Partners

Founding (2007) members (8):

Austria, Canada, Denmark, EU, France, Germany, Ireland, **the Netherlands**

New Members:

2009: Australia, Italy
2010: USA, United Kingdom, Turkey
(to be decided: Belgium)

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Task 42 Biorefineries

www.IEA-Bioenergy.Task42-Biorefineries.com

1. IEA Bioenergy

Task 42 Biorefinery

Results 2007 - 2009

- Common definition for biorefineries
- Common classification system for biorefineries
- Country reports on current processing potential and mapping of existing plants.
- Identification of biorefinery related RD&D programmes in participant countries
- Annual biorefinery seminar for stakeholders.
- Linking of ongoing international activities through joint events and new initiatives

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www.IEA-Bioenergy.Task42-Biorefineries.com

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Task 42 Biorefinery

Activities 2010 - 2012

1. Developing a Biorefinery Complexity Index
2. Identification most promising BBPs to be co-produced with Bioenergy
3. Assessing the current status and development potential of Energy-driven Biorefineries based on a Full Value Chain approach
4. Preparation of a Guidance document on Sustainability Assessment for BRs
5. Preparing a Summarising BR Paper
6. Bio-annual Task Meetings (internal know. diss.)
7. Workshops/website (external know. diss.)
8. Biorefinery Summer School

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Task 42 Biorefineries

2. Biorefining – Definition

Biorefining is the Sustainable Processing of Biomass into a Spectrum of Marketable Bio-based Products & Bioenergy

Sustainable: maximising €s, minimising environmental impact, socially acceptable, …

Processing: integrated mechanical, (thermo)chemical, biological, … conversion

Biomass: land/marine crops, primary/secondary residues

Spectrum: more than one

Marketable: current/future markets (volumes, prices)

Bio-based Products: human food, animal feed, chemicals, materials

Bioenergy: fuels, power, heat, CHP

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Task 42 Biorefineries

2. Biorefining – Definition

In general **Product-driven** and **Energy-driven Biorefineries** can be distinguished

Product-driven Biorefineries

Main goal is the production of one/more Bio-based Products (food, feed, chemicals, materials)
Process residues are used to produce Bioenergy for internal/external use to maximise the economic profitability of the overall biomass value chain

Energy-driven Biorefineries

Main goal is the production of one/more Energy Carriers (fuels, power and/or heat)
Process residues are valorised to BBPs to maximise the economic profitability of the overall biomass value chain

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3. BR – Current Status & Dev

"Biorefining" is not new !!!

Specifically in the Food Industry "biorefining" is already applied for ages

however

Sustainable processing of biomass in both BBPs and BE (= Biorefining DEF) is new !

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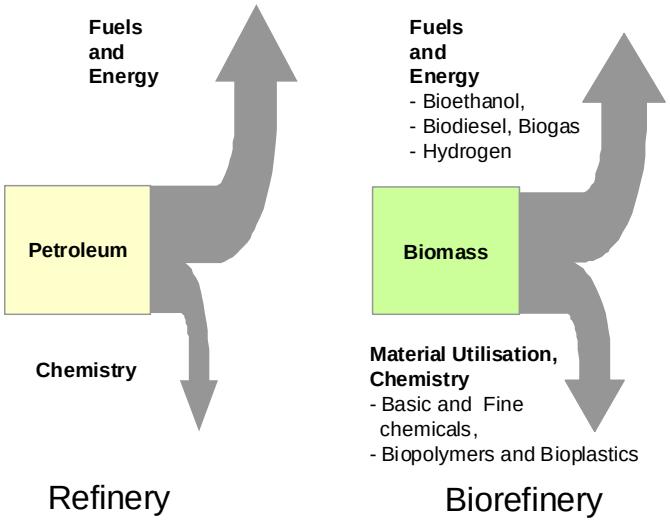
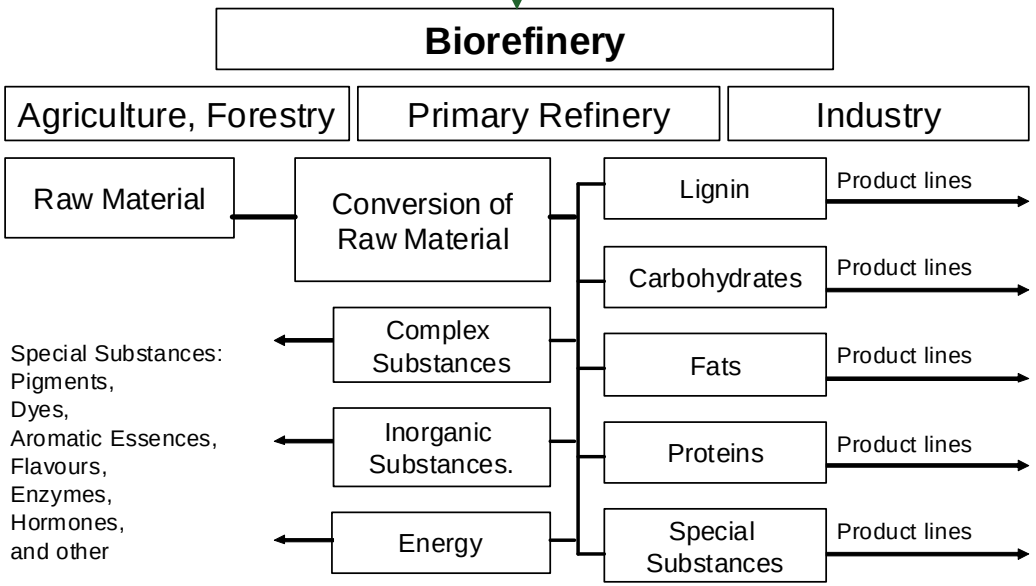
3. BR – Current Status & Dev

Oil Refinery vs Biorefinery



Source: Kamm, 2009



Source: Kamm, B. & Kamm, M.; Principles of Biorefineries. *Appl. Microbiol, Biotechnol., (AMB)*, 64 (2004) 137-145

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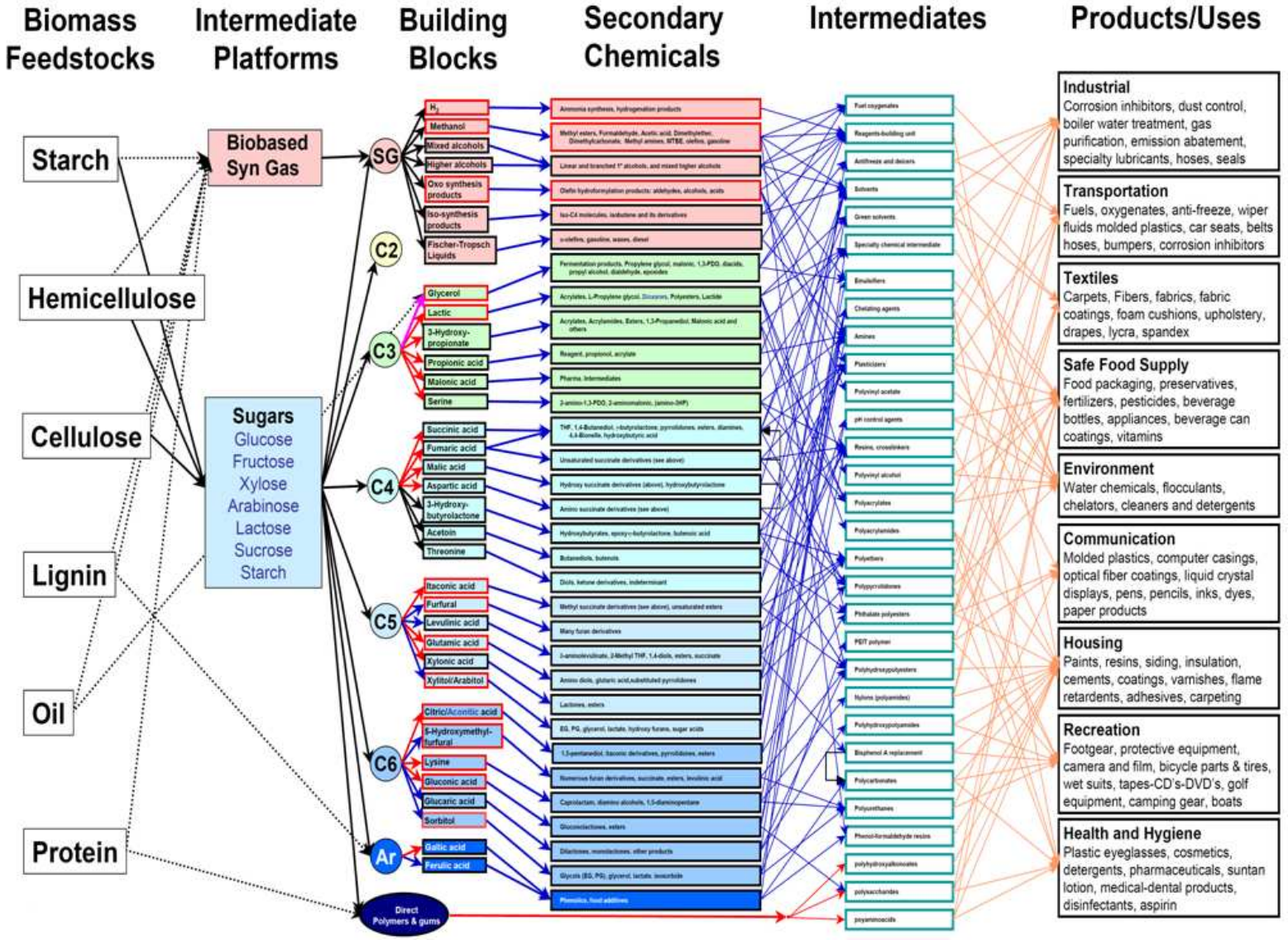
3. BR – Current Status & Dev

Biorefinery, NREL (US)



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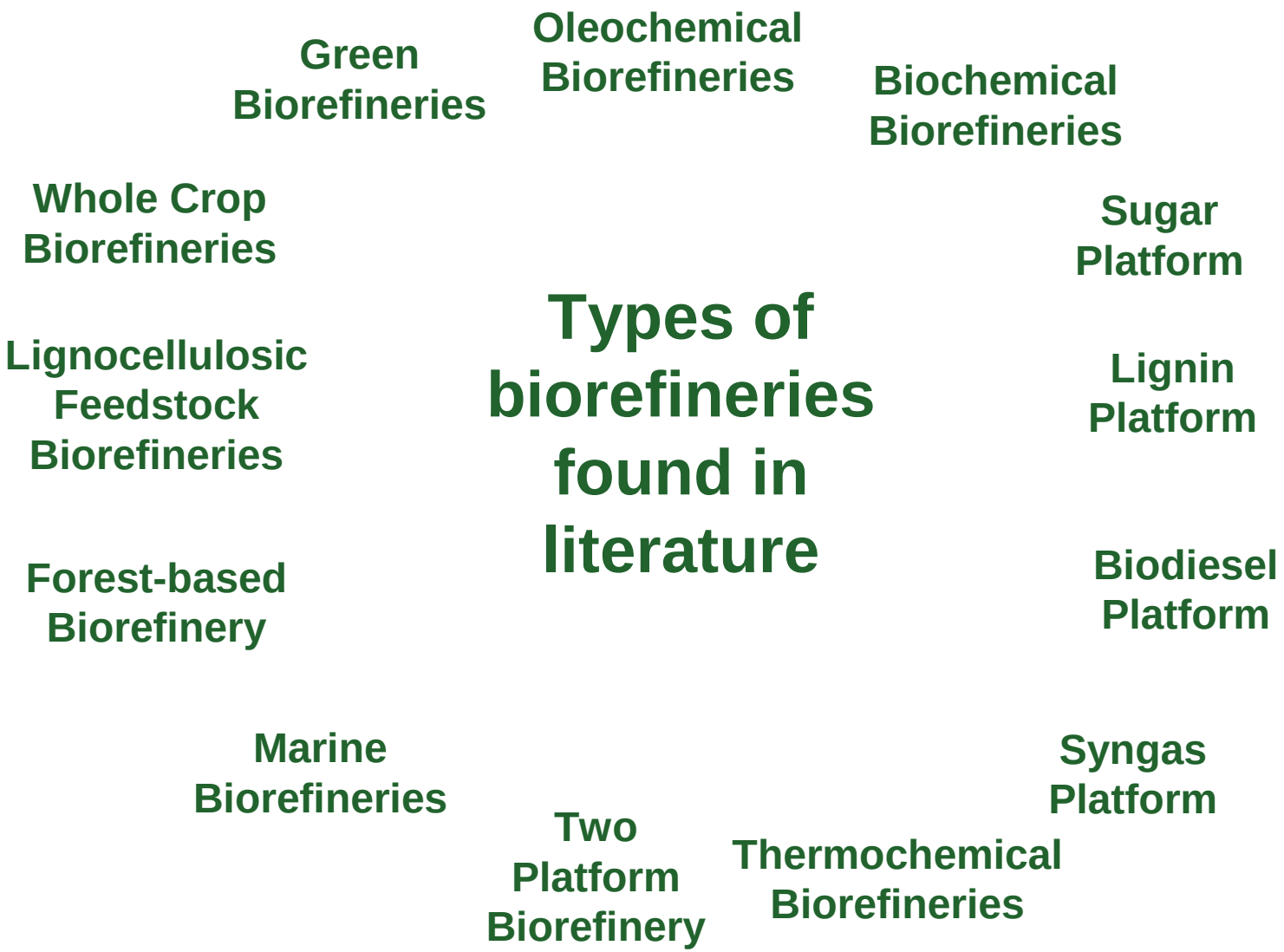
3. BR – CS&D / BR Types



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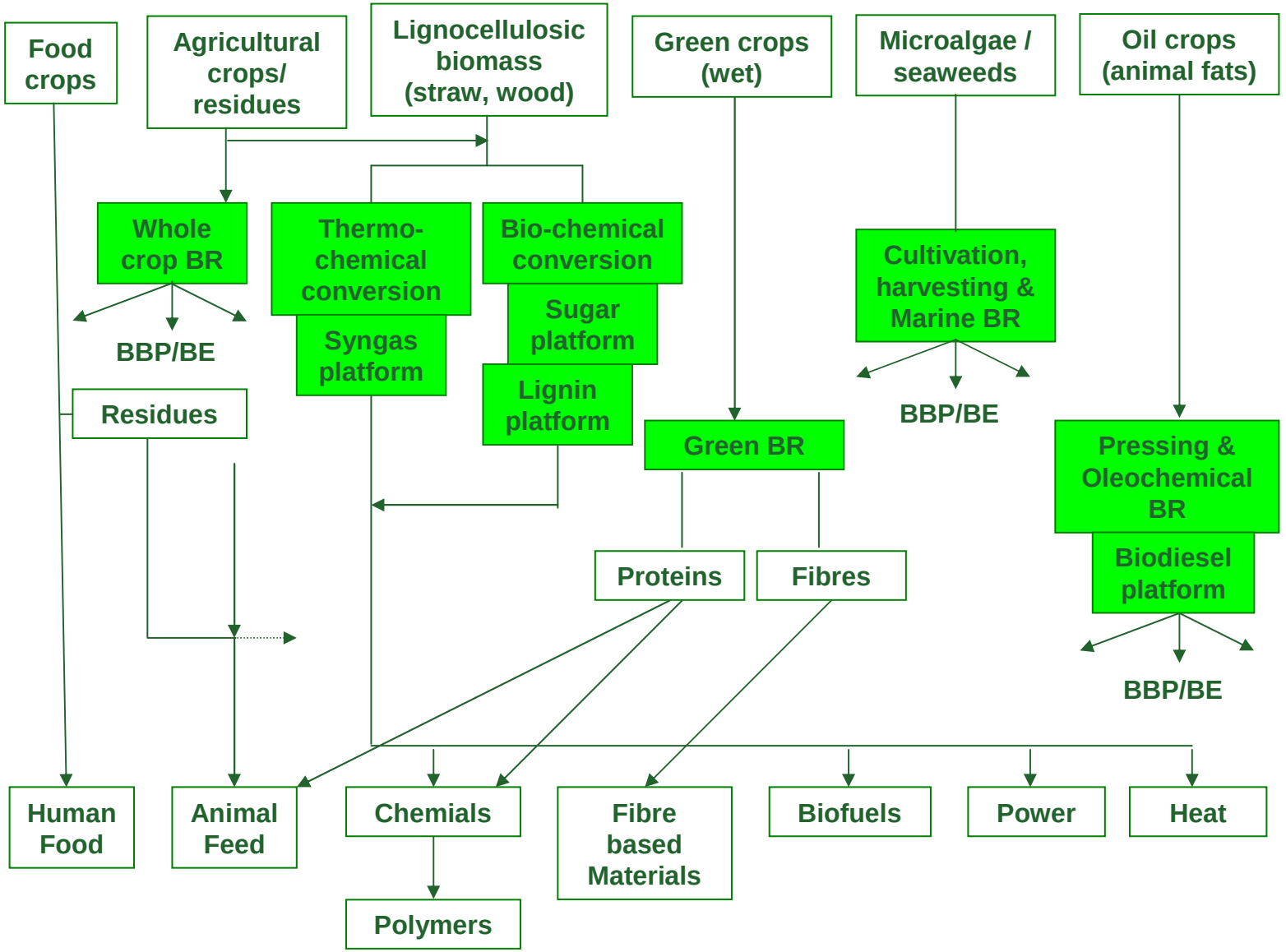
3. BR – CS&D / Simplified BR Schemes



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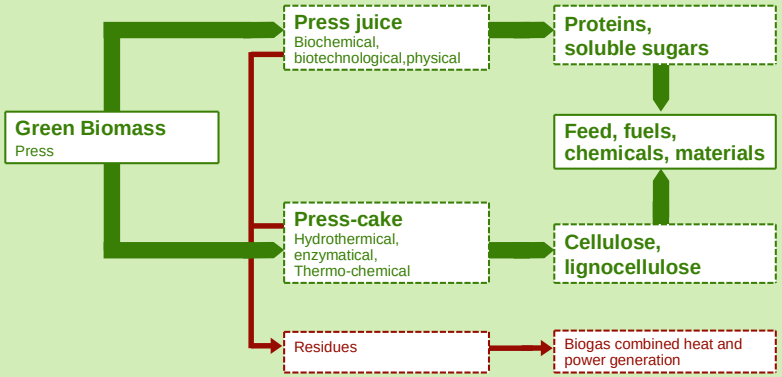
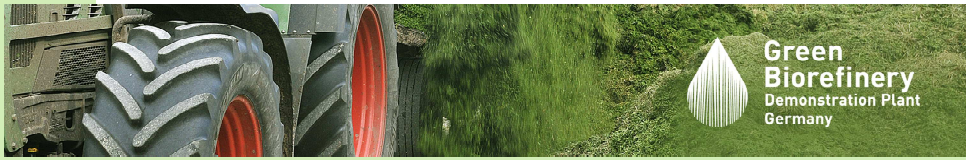
3. Example / Green BR

4. Biorefinery-System

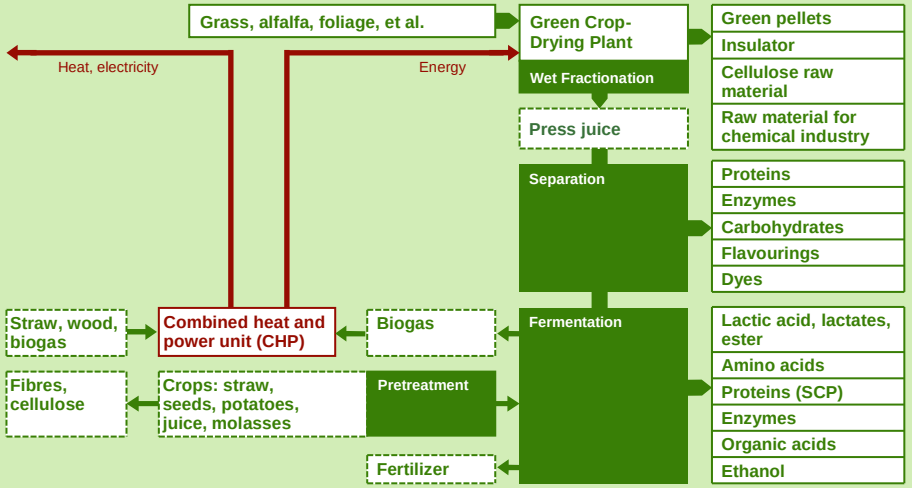


Kamm, B.; Gruber, P.R.; Kamm, M.; Biorefineries, Industrial Processes and Products, Wiley-VCH, 2006

More detailed info presentation Edwin Keijsers



Biorefinery-Systems



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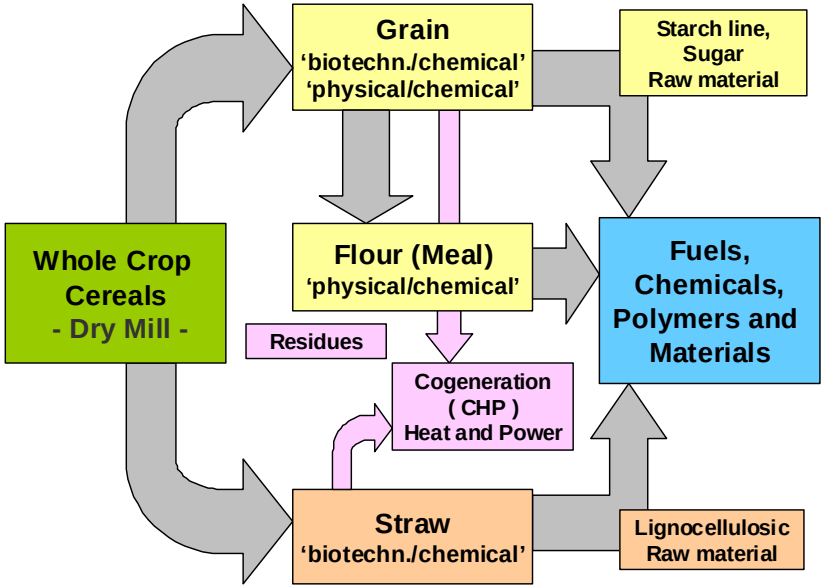
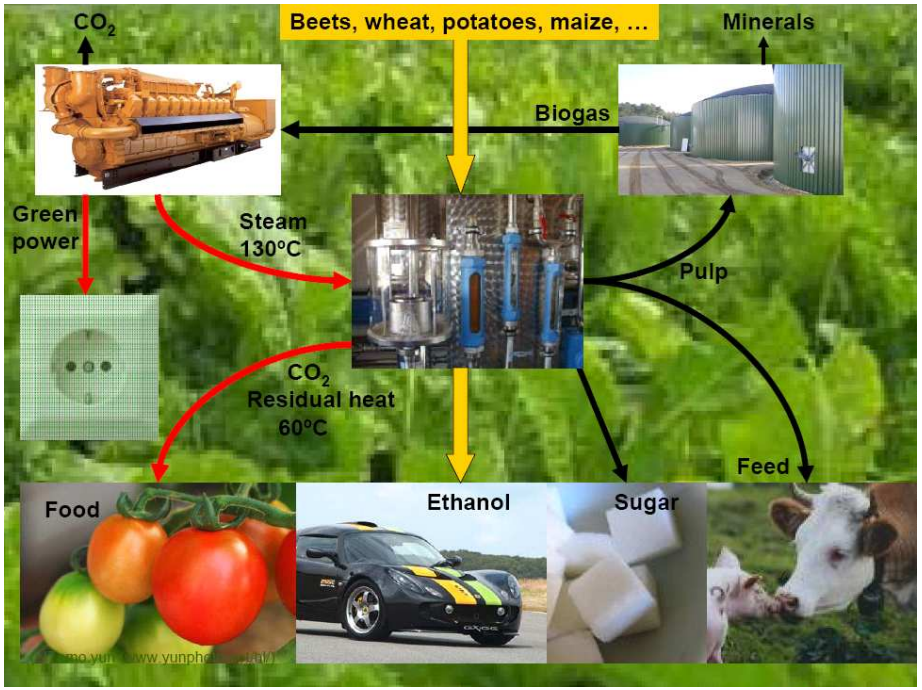
3. Example / Whole Crop BR



Source: Kamm, Gruber & Kamm, 2006

Use of raw materials such as cereals or maize



Source: Beethanol, NL

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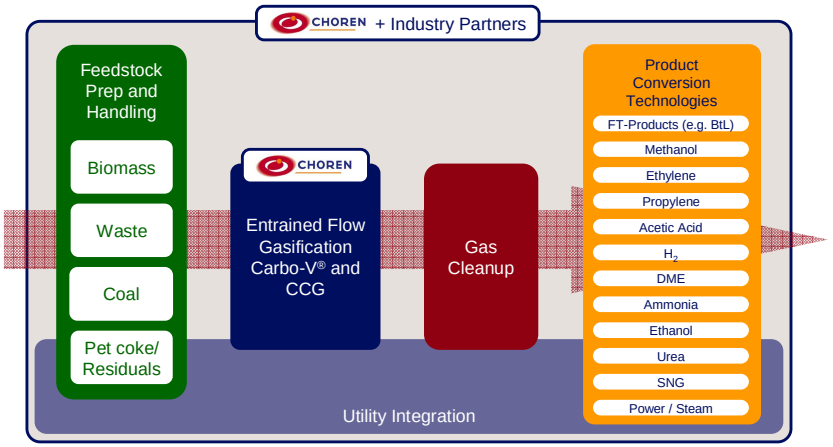
3. Example / LCF BR

Thermochemical BR – Syngas Platform

Gasification Application Overview

CHOREN

CHOREN technology is the core for a broad universe of utilizations



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Main RTD issues in general

Feeding of biomass

Gasification behaviour

Gas clean-up

Beta plant in Freiberg (Saxony/Germany)

CHOREN

World first commercial BtL facility

- 45 MW thermal
- 65,000 t/a feedstock
- 18m l/a BtL

6

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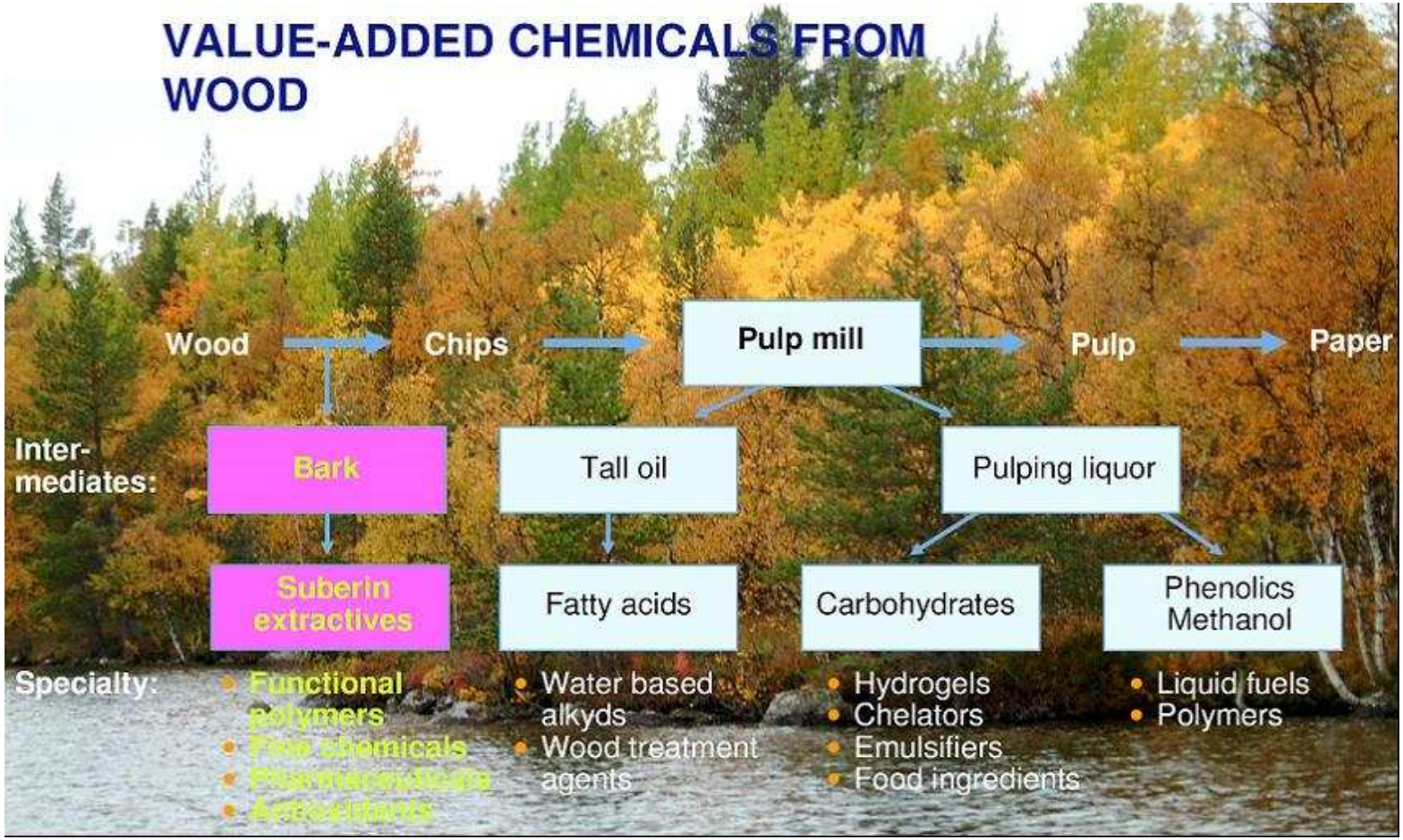
3. Example / LCF BR

Forest-based BR



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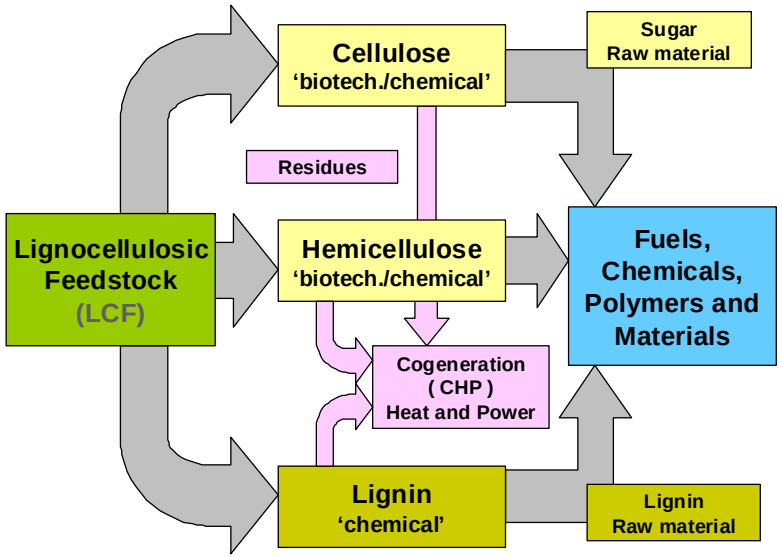
3. Example – LCF BR

Biochemical BR – Sugar / Lignin Platform



Source: Kamm, Gruber & Kamm, 2006

BCyL cellulose ethanol demo plant AB, Salamanca, 5 Million L EtOH/yr from 25,000 ton straw. ***Operational since Oct. 2009****.*

More detailed info presentation Hans Reith

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3. Example / Oleochemical BR

Current chemical industry mainly based on:
Raw oil -> fuels (95%) + Naphta (5%) ->
ethylene, propylene, butadiene, aromatics ->
chemical conversion (+ O,N) -> functionalised products

Biomass is already functionalised (O, N) ->
chemical conversions generally defunctionalisation

Exception oils/fats (contain less oxygen) ->
already applied for chemicals for years (oleochemistry)

More detailed info presentation Sofie Dobbelaere

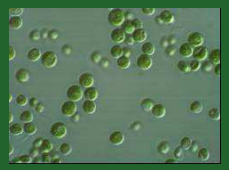
Consumption oils/fats (2009)

Food: 78%

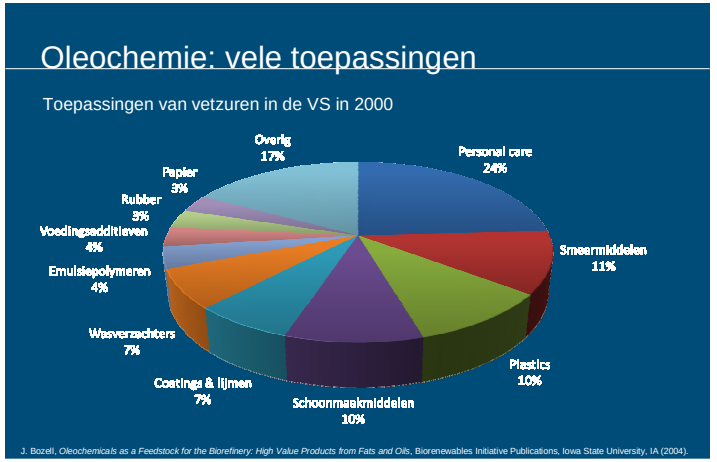
Feed: 4%

Fuels: 10%

Chemicals: 8%



Main RTD issues:
press cake valorisation,
valorisation glycerol,
application new crops (jatropha, algae)



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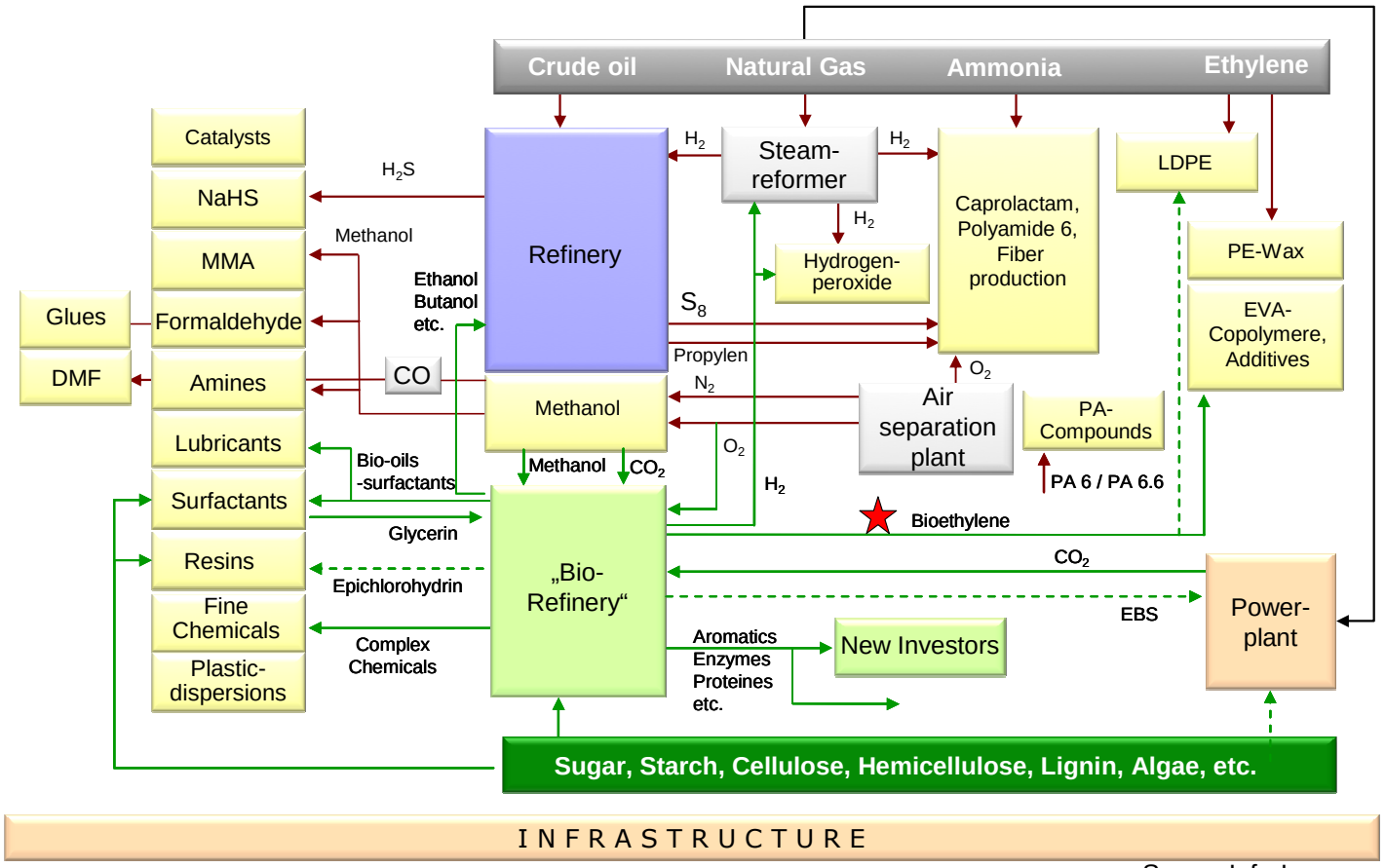
3. Example / Integration into conventional oil refineries

Vision „Biorefinery Leuna“– Integration of Bioethylene in the value chain

THE LINDE GROUP



Source: InfraLeuna

More detailed info presentations Gabriella Fogassy and Ruben M. Gutierrez

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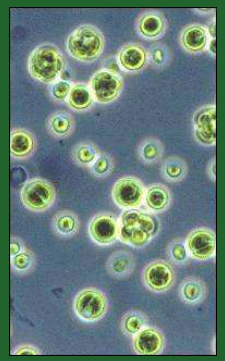
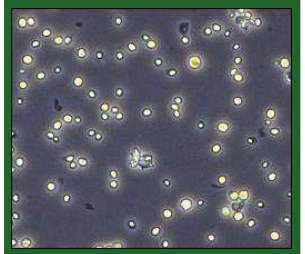
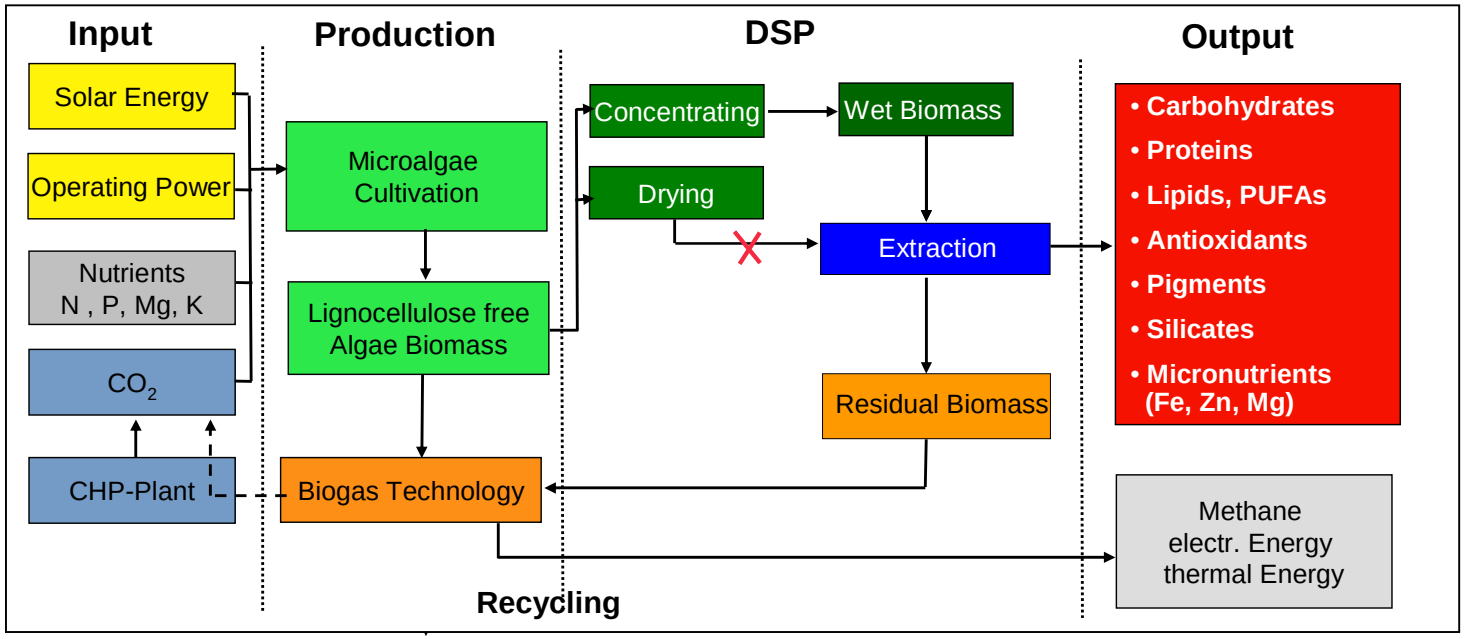
3. Example / Marine BR

Microalgae





Sustainable Algae-based Processes



More detailed info presentation Maria Barbosa

Fraunhofer IGB

schmid-staiger@igb.fraunhofer.de

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3. Example / Marine BR

Macroalgae / Seaweeds

East Asia seaweeds used as vegetables for ages

Now annually 7- 8 Mt are harvested for both food and chemicals

Special composition + potential cultivation at large-scale with high yields ->
potential feedstocks for chemicals (plastics, resins), fuels (ethanol, ABE, H_2) and energy (CHP)

Major RTD Issues:

Selection of right high-productive site-specific weeds; cultivation/harvesting concepts, refinery and downstream processing, sustainability aspects

More detailed info presentation Maria Barbosa

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4. Market Implementation Scenario BRs

Short-term: Upgrading of existing industrial infrastructures to high-efficient biorefinery facilities by i) using process (chain) residues and/or ii) making process modifications for the production of added-value bio-based products and/or bioenergy.

Examples: conventional ethanol + ddgs valorisation, biodiesel + cake and/or glycerol valorisation, upstream integration of biomass pyrolysis/gasification units within conventional oil refineries, …

More detailed info presentation Hamid Mozaffarian et al.

Long-term: Development of fully new sustainable biorefinery facilities for the high-efficient co-production of human food, animal feed, chemicals, materials, fuels, power and/or heat.

Examples: Green BRs, Whole Crop BRs, Lignocellulosic Feedstock BRs, Marine BRs, …

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5. Points for Discussion

For a transition to a Biobased Economy biomass use should be economically profitable, environmentally friendly and socially acceptable

Sustainable Biorefining is the only right approach?

Biomass is composed of a portfolio of unique functionalised structures – (mild) fractionation and separation to extract these components is inevitable to maximise the full economic value of biomass conversion chains

Product-driven BR is the way to go?

(quality of use must be taken into account (food > feed > chemicals/materials > fuels > power > heat)

If the answer is yes

New international policy goals on the quality of biomass use are required?

Thank you for your attention

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Task 42 Biorefineries

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Further information

René van Ree (rene.vanree@wur.nl)
www.fbr.wur.nl

www.IEA-Bioenergy.Task42-Biorefineries.com

International Conference on Polygeneration Strategies (ICPS)
Leipzig, Germany, 7 - 9 September 2010