



Biorefineries

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State of the art & current research activities

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Contents

- International status
 - biobased economy, definition, products, categories, objective, systems, points to be addressed
- Current research activities
 - Strategy NL, Bio2Value, biorefinery.nl, IEA 42, Biosynergy, Biocoup, Biopol



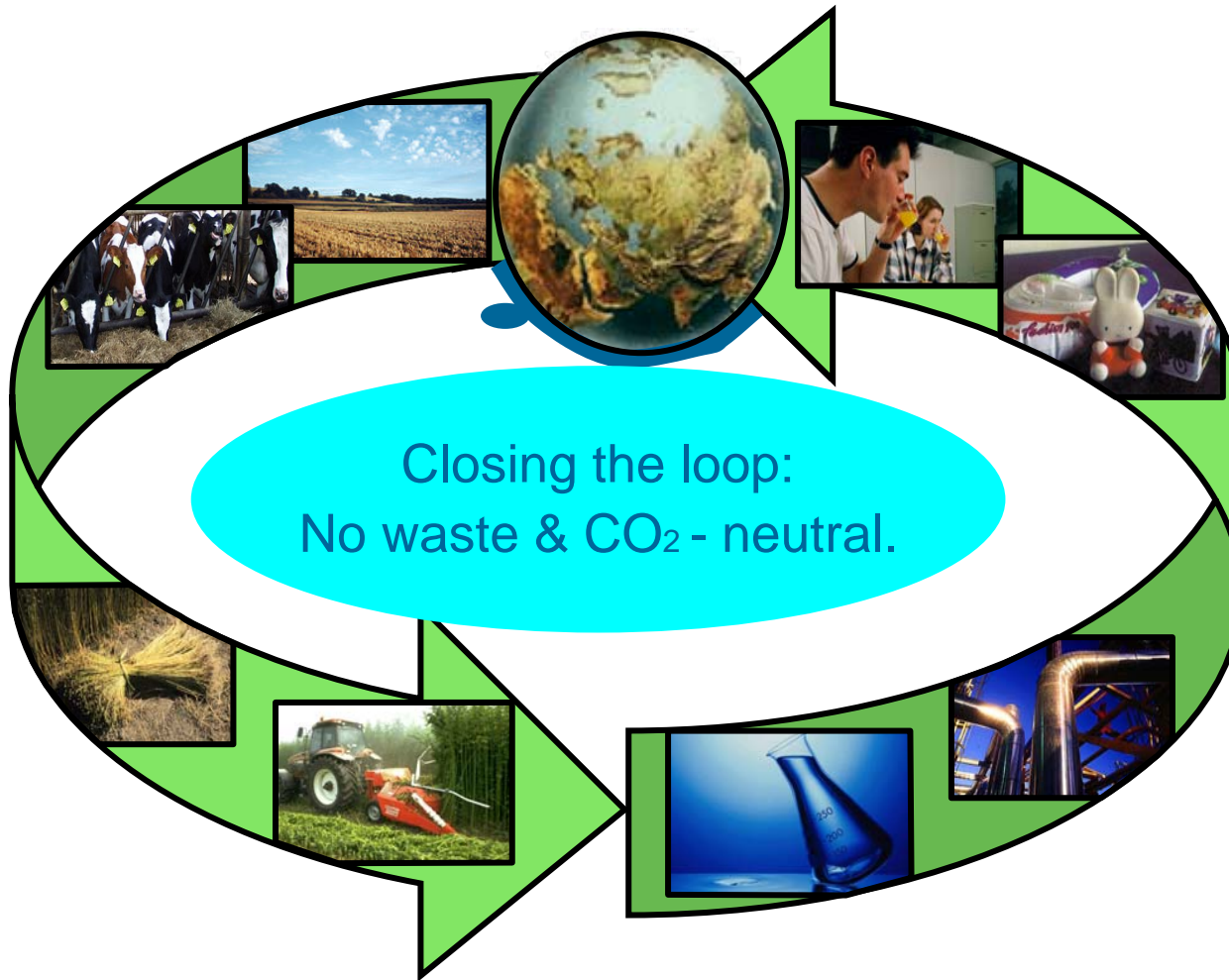
Biorefineries

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State of the art



The biobased economy



Drivers:

- Kyoto
- Security of supply
- Agricultural policies
- Sustainability
- Economics



World Biomass demand in 2050

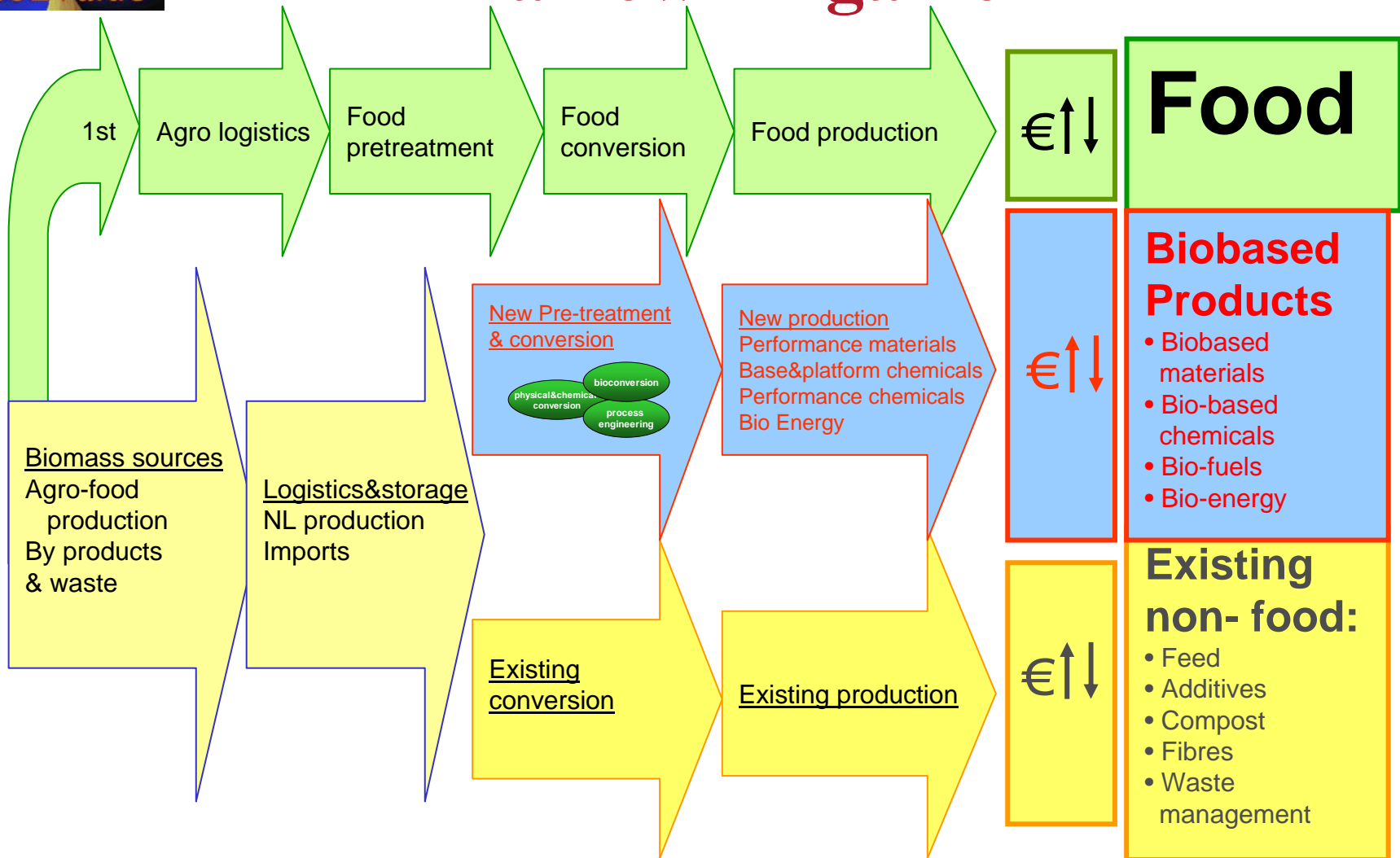
Food / Feed	10 billion ton biomass for 3 billion ton food
Energy	10 billion ton equivalent to 160 EJ
Chemical industry	1 billion ton for 0.3 billion ton product
Specialties	1 million ton
Wood and composites	2 to 3 billion ton

Current production 170 billion ton biomass of which 6 billion ton is used:

- 1,8 grains
- 2,2 other food (sugar, vegetables, starch, etc.)
- 2 wood
- 0,01 other non-food



The New Biomass value chain: a new €- game



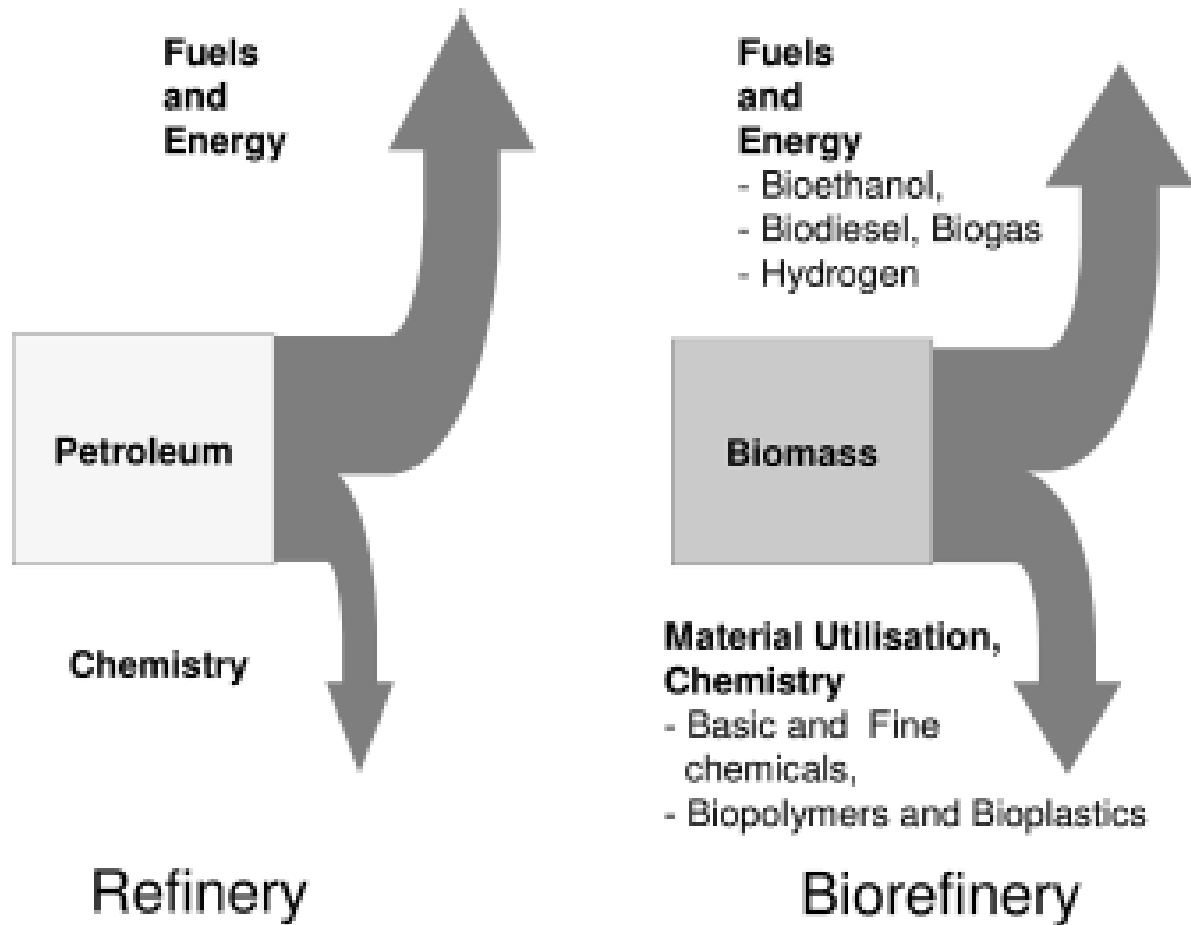


Biorefinery Definitions

- NREL: A biorefinery is a facility that integrates biomass conversion processes and equipment to produce fuels, power, and value-added chemicals from biomass. The biorefinery concept is analogous to today's petroleum refinery, which produce multiple fuels and products from petroleum
- IOWA State University: A cluster of biobased industries producing chemicals, fuels, power, products, and materials
- US-DOE: A biorefinery is an overall concept of a processing plant where biomass feedstocks are converted and extracted into a spectrum of valuable products
- NL: The separation of biomass into distinct components which can be individually brought to the market either directly after separation or after further (biological, thermochemical/chemical) treatment(s)
- (Shell: Addition of Pure Plant Oil into traditional oil refineries)

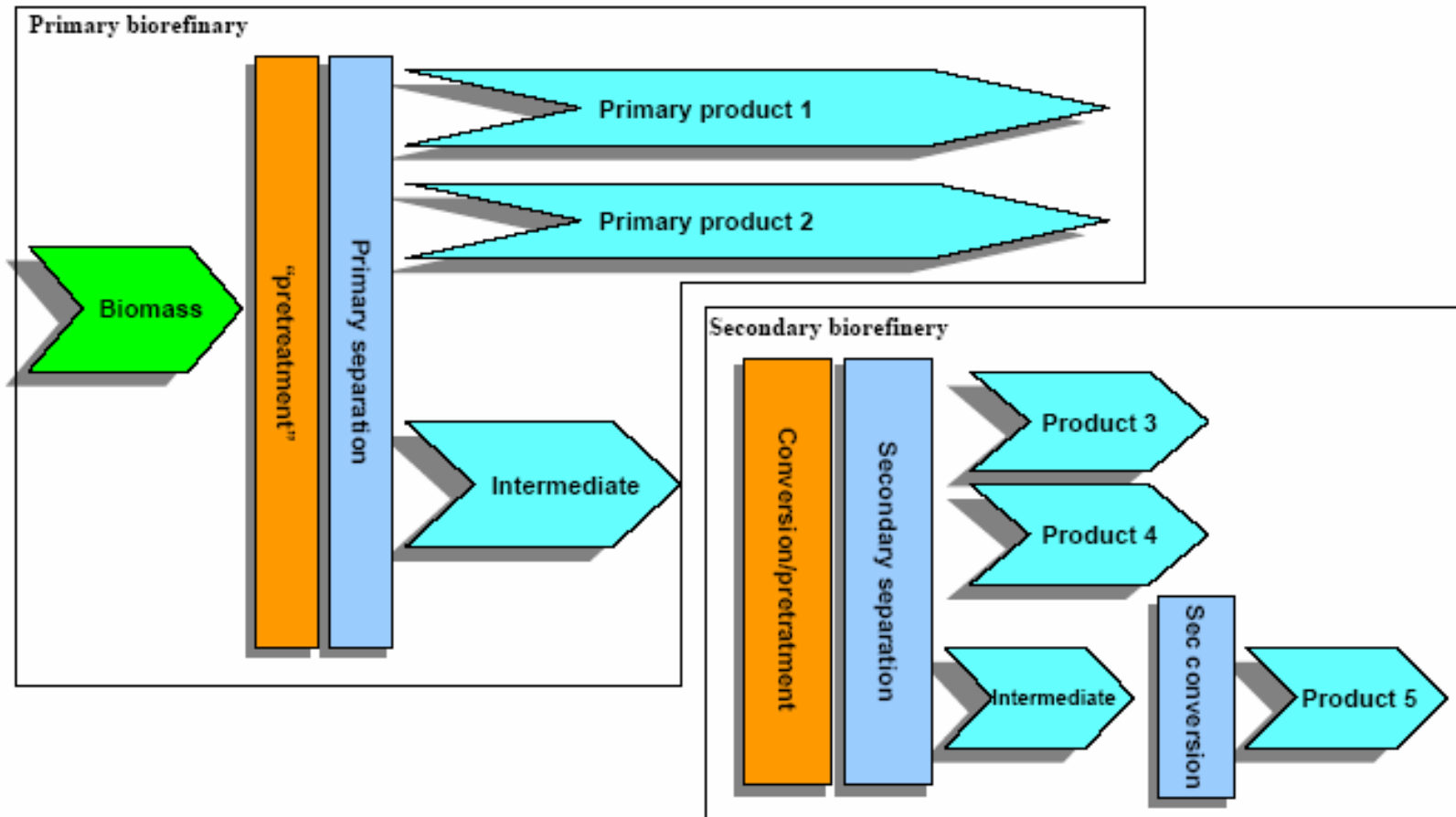


Comparison of the basic-principles of the petroleum refinery and the biorefinery





Schematic overview of a general Biorefinery concept





Which Products ?

- Chemicals
- Fuels
- Power & heat
 - all Biorefineries should become heat and if possible power independent
- Materials (Fibres, Starch, Wood)
- Food and Feed
 - these two can be important (economic) products but are both outside the Biorefinery definition
- Ashes, CO₂, H₂O,

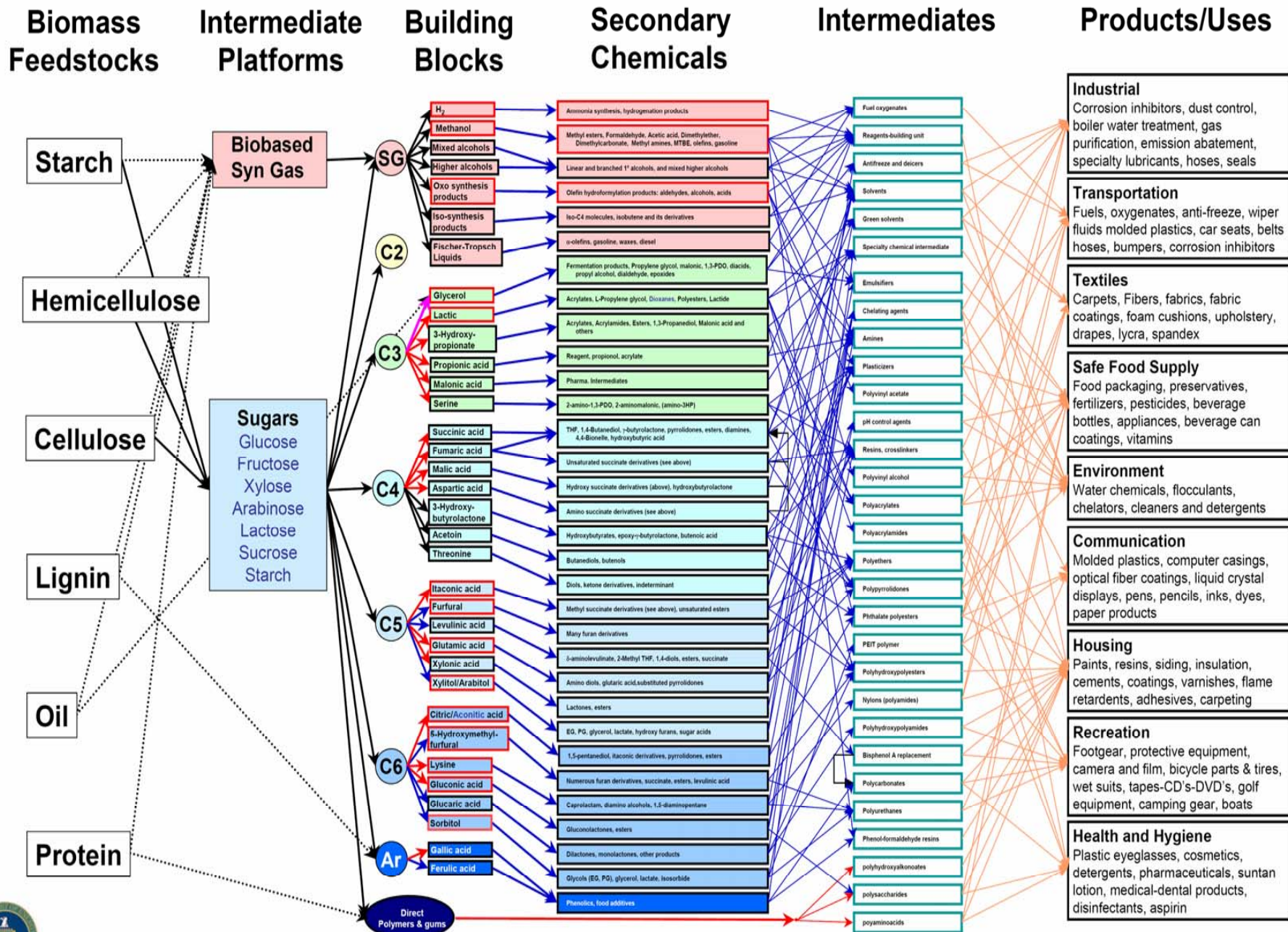


Figure 3 – Analogous Model of a Biobased Product Flow-chart for Biomass Feedstocks



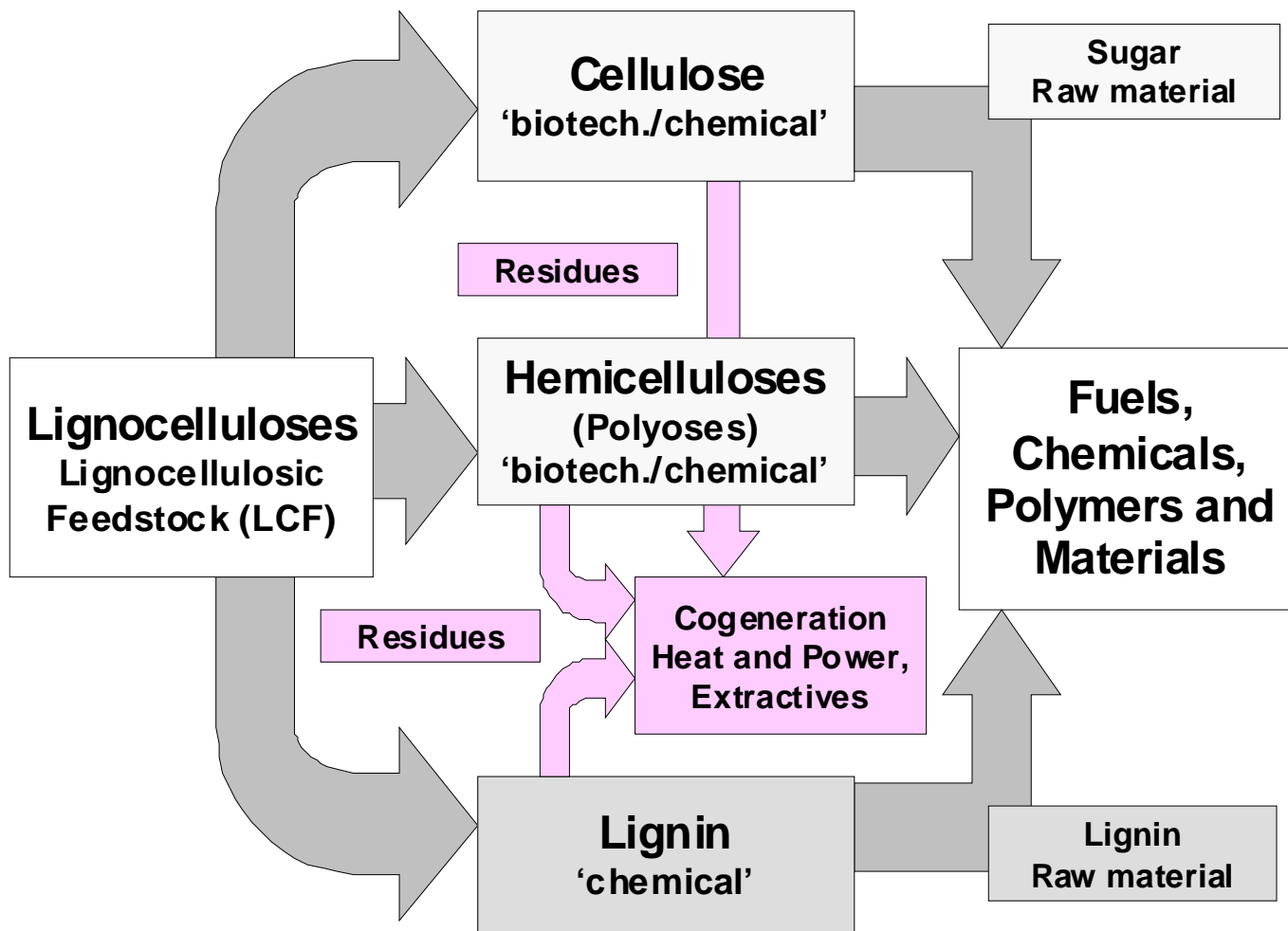


Biorefinery Systems

- “Lignocellulosic Feedstock Biorefinery” - uses “nature-dry” raw material
- “Whole Crop Biorefinery” - uses raw material such as cereals or maize
- “Green Biorefineries” - uses “nature-wet” biomasses such as green grass, alfalfa, clover, or immature cereal
- “Two Platforms Concept Biorefinery ” includes the sugar platform and the syngas platform

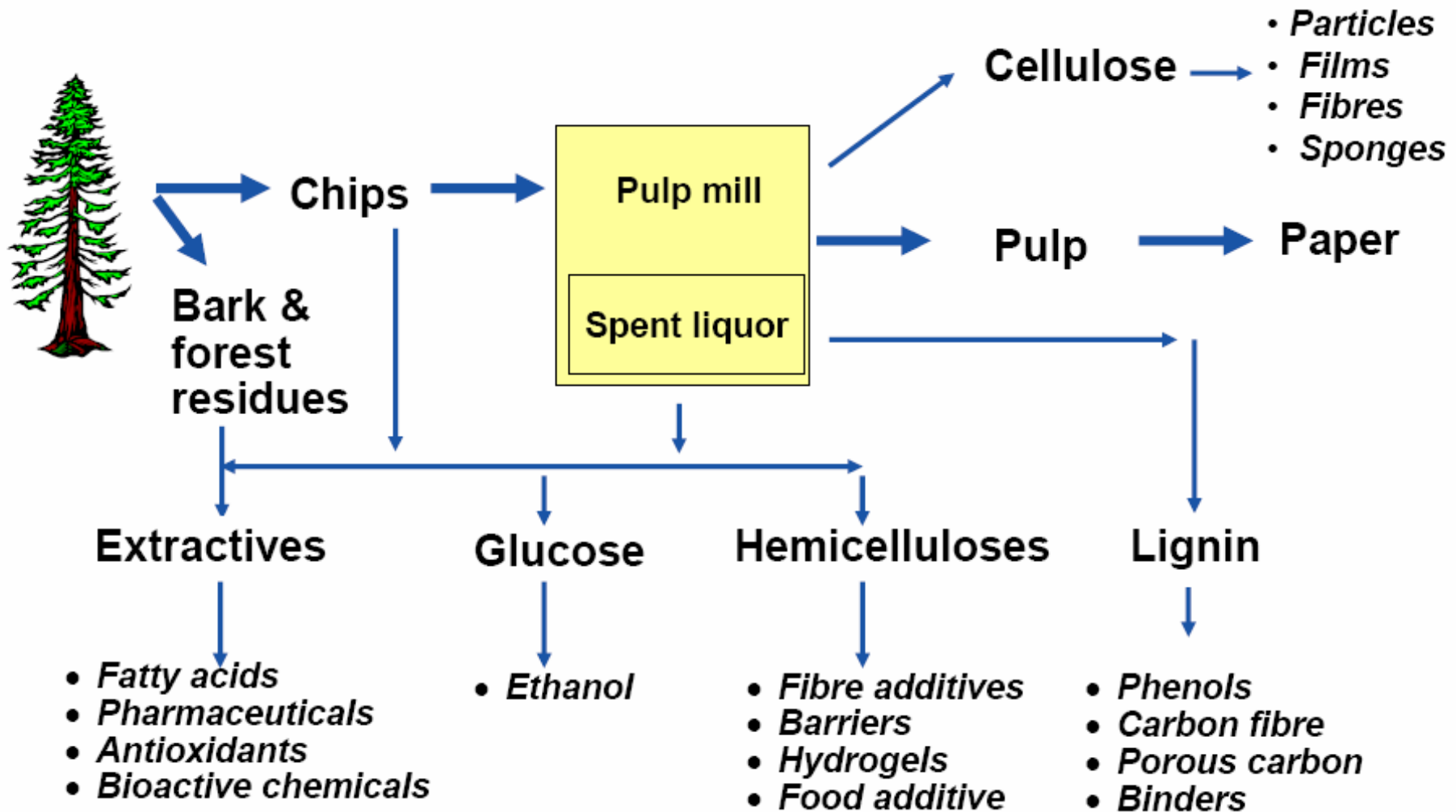


Lignocellulosic Feedstock Biorefinery



Source: Kamm et al.,
Wiley-VCH, 2006

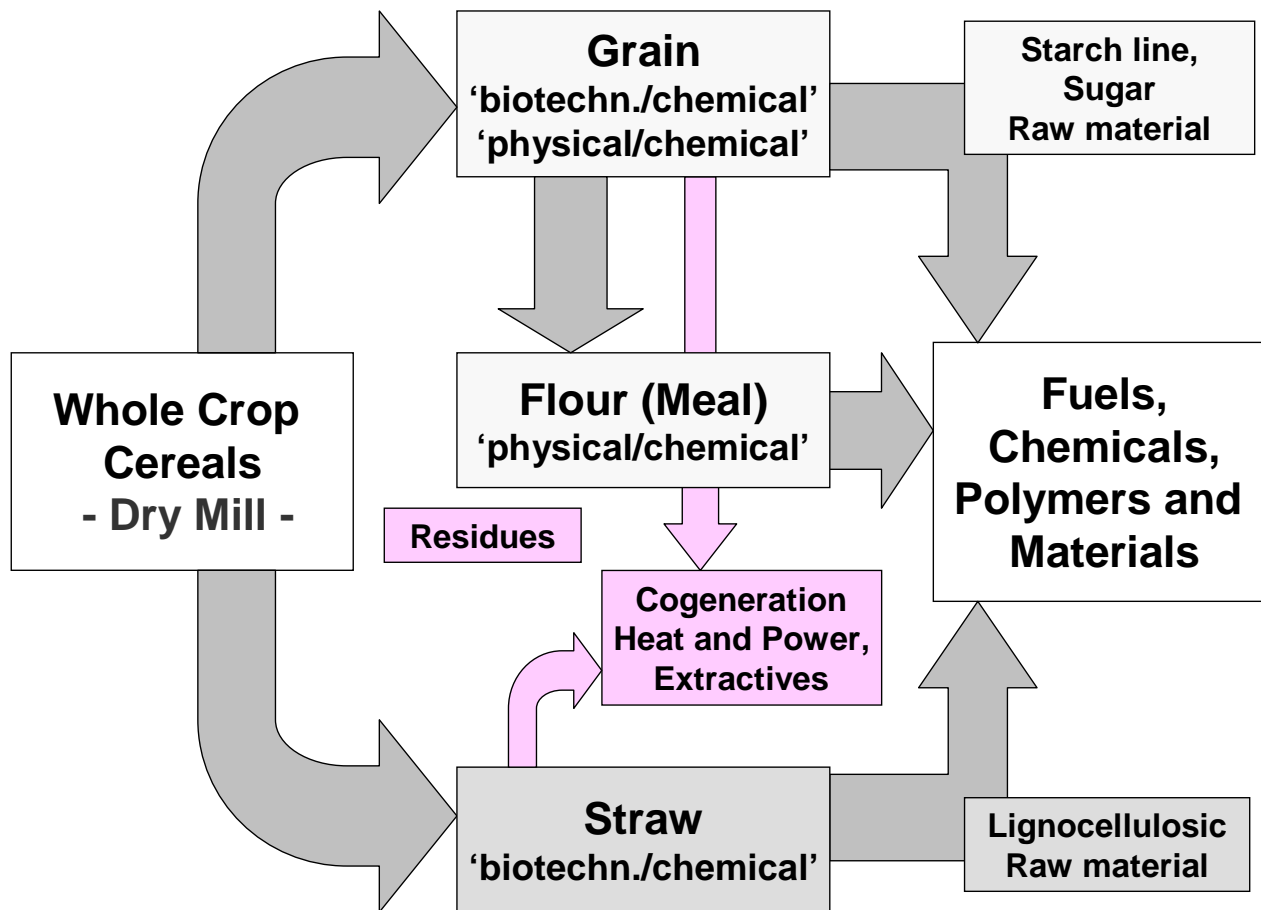
Layout (1) of a Wood Biorefinery



+ Solid fuel from lignin, bark and forest residues

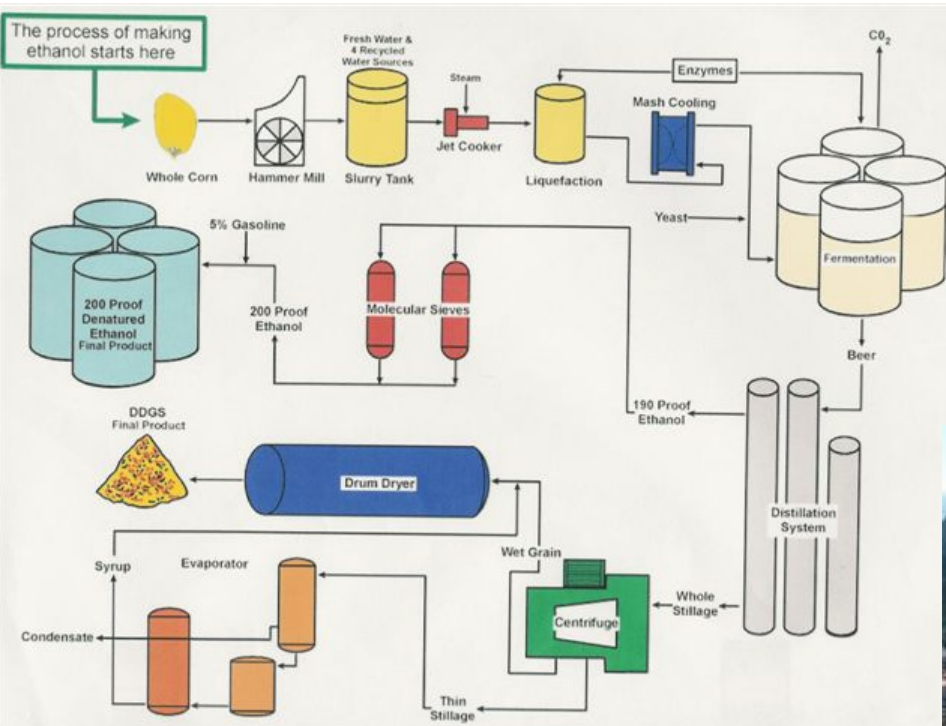
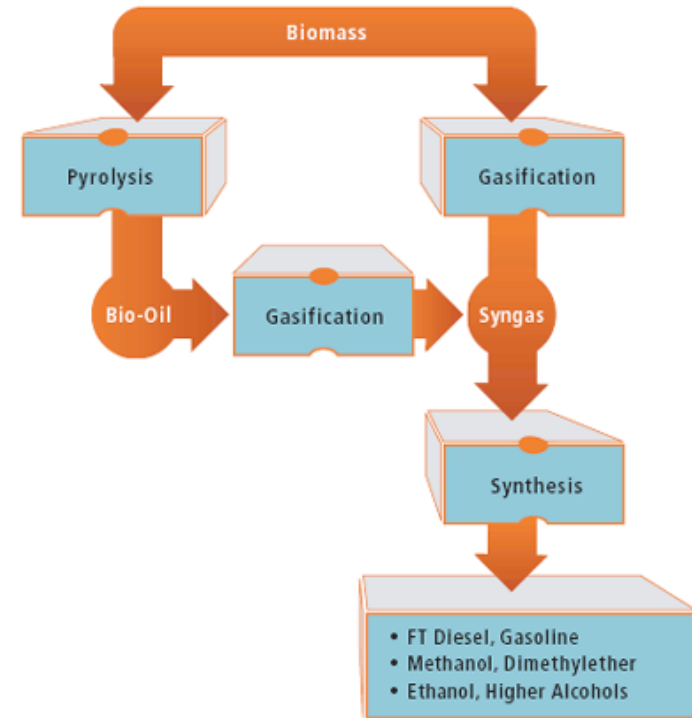


Whole Crop Biorefinery Concept





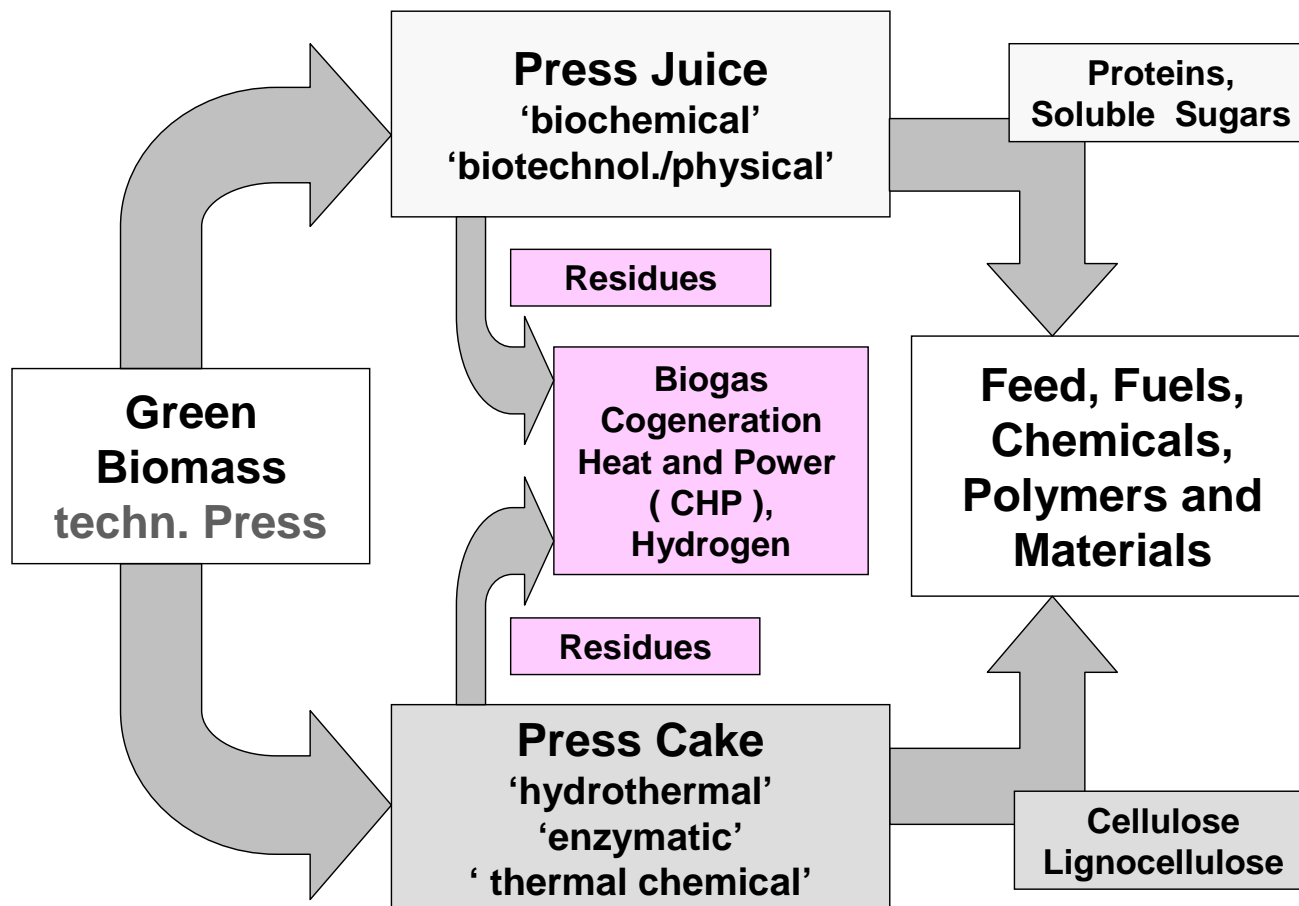
Abengoa Bioenergy



**Dry-milling => Whole crop
=> Thermochemical**

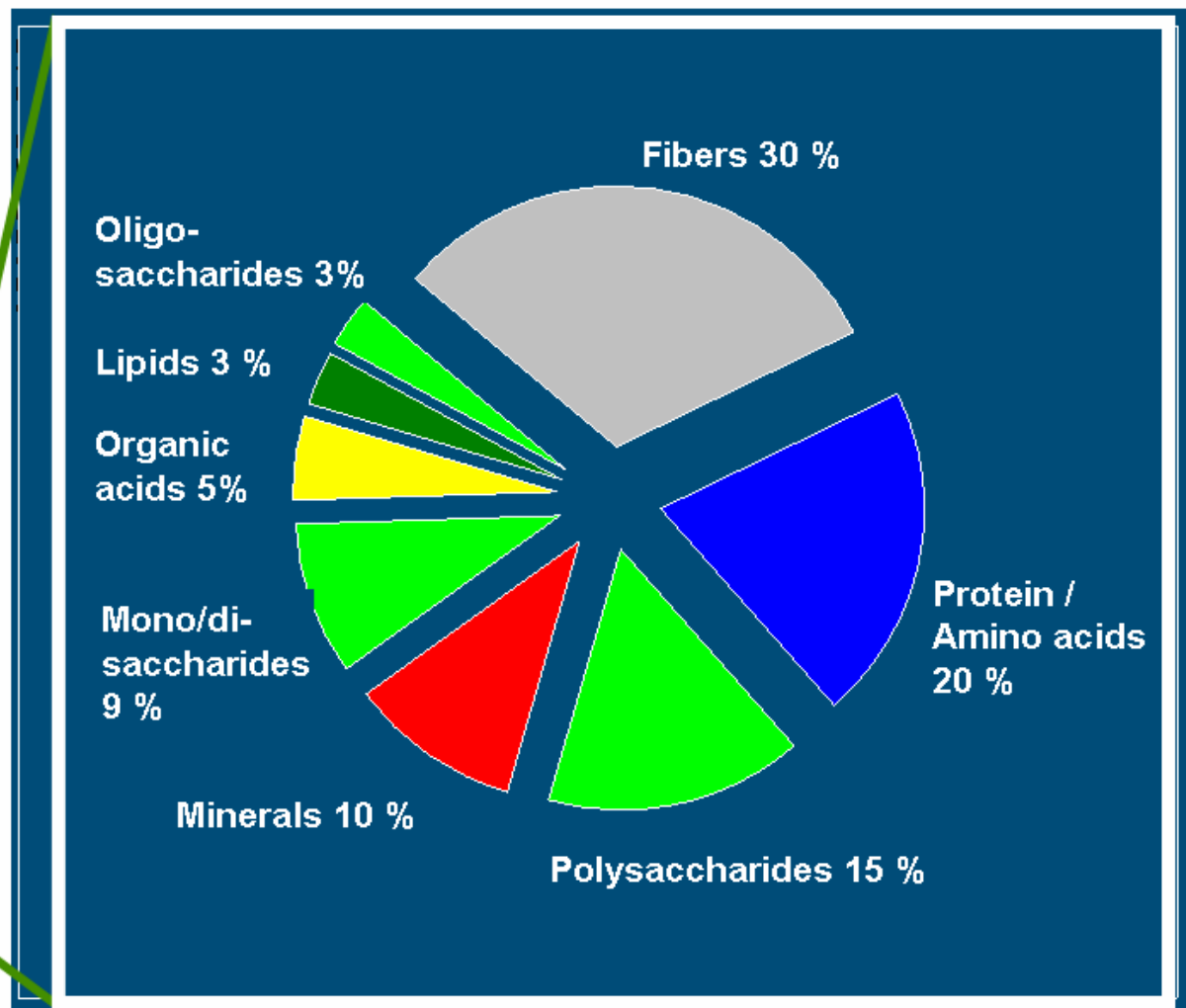


Green Biorefinery Concept



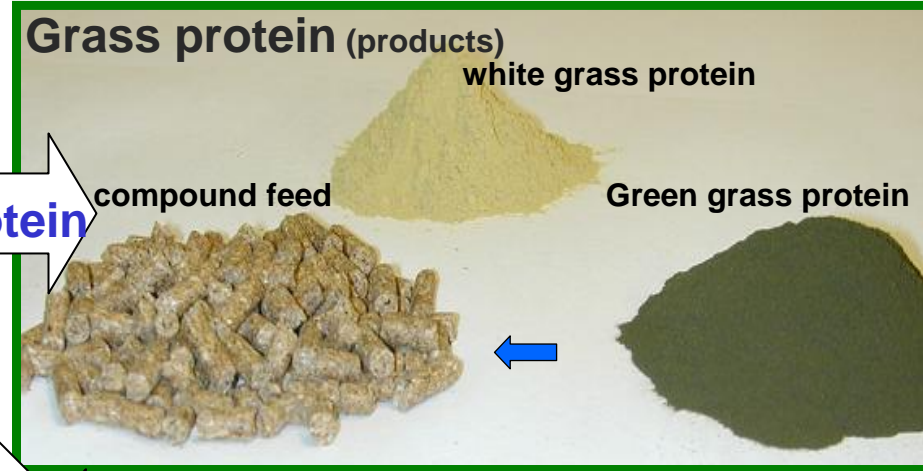
Composition of Grass

Fresh grass





Pilot biorefinery line Foxhol (Prograss consortium)



Grass juice

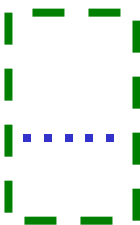


compound feed



Ethanol

+



Fibers



Potting soil



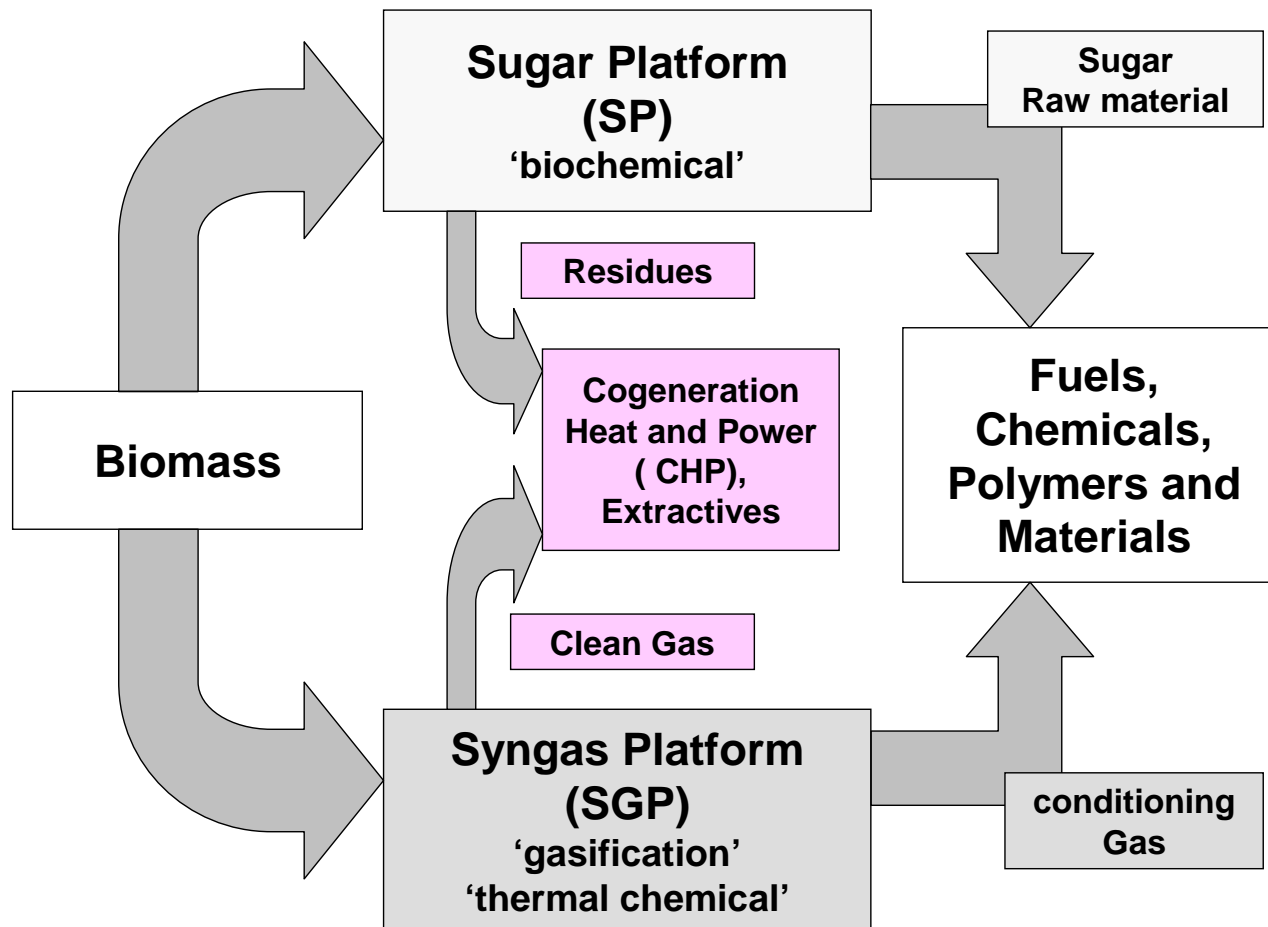
Construction material + paper



Polymer extrusion products



Biorefinery two platforms concept





Biorefineries

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Current research activities
(with emphasis on Dutch involvement)



Biorefinery development strategy for the Netherlands

- Identification and analysis international SOTA (a.o. IPs, IEA)
- Identification and analysis interests major stakeholders (industry, agro-sector, NGOs, government, R&D-institutes, universities, ...)
- Identification and analysis national strengths (technological and agricultural knowledge-base, existing infrastructure, harbours, ...)
- Development of a common national Biorefinery Vision
- Development and implementation of a national Strategic Research and Agenda and Implementation Strategy

*This Strategy should be worked out by a joint effort of all stakeholders facilitated by the Dutch Network on Biorefineries
(biorefinery.nl)*

Programmatic biorefinery-based co-operation

Upstream and
(bio)chemical
expertise



www.bio2value.nl

Downstream and
(thermo)chemical
expertise

Dutch Knowledge
Network on
Biorefinery

IEA Bioenergy
Task 42
Biorefineries

National and
EU-funded
projects

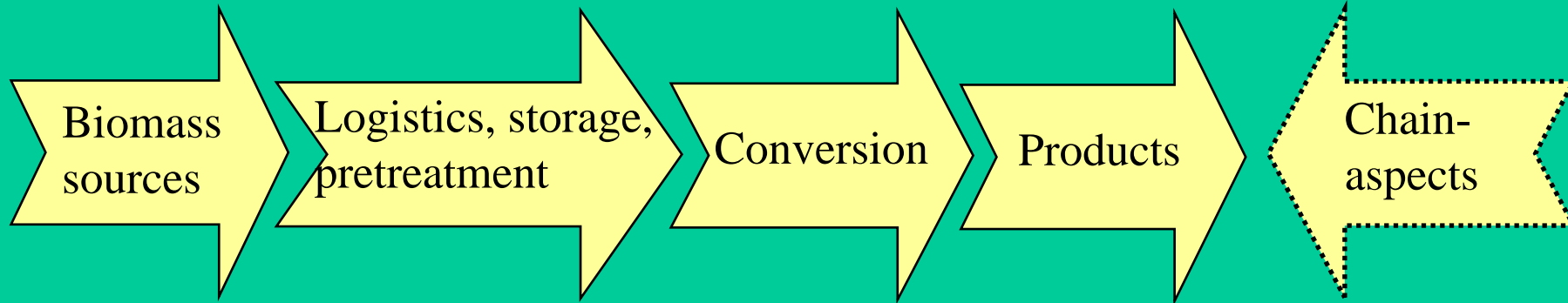
Biorefinery.nl

www.biorefinery.nl

EU IP BIOSYNERGY
EU SSP BIOPOL



Bio2Value



Biomass import	Torrefaction, pyrolysis	Thermo-chemical conversion: co-firing, torrefaction, pyrolysis, gasification	Elektricity, heat, SNG, FT-diesel chemicals
Side products and aquatic biomass	Logistics, planning, drying	Combined thermo-/biochemical processes, incl. biorefinery concepts	Co-production range of "products"
Multifunctional land use, biomass growth, agro-residues	(Bio)chemical pretreatment, storage aspects	(Bio)chemical conversion: fermentation, biogas, ...	Materials, chemicals, bioethanol, biodiesel, biol.-H ₂ , ...

Integral chain analysis/-optimization,
Beta/gamma-aspects,
Policy aspects,
Process design
Sustainability...

Dutch knowledge network

Biorefinery.nl

A close co-operation of different stakeholders (industry, universities, institutes, NGOs, GOs) with a broad variety of disciplines working together in research, development and demonstration of (innovative) biorefinery concepts for implementation in the Dutch economy and abroad

- Knowledge import and dissemination (www.biorefinery.nl, newsletters, national workshops, ...)
- Definition of a national Biorefinery Vision within an European and global framework
- Develop a Technology Roadmap, incl. SRA and Technology Deployment Plan



IEA Task 42 Biorefineries

IEA Bioenergy

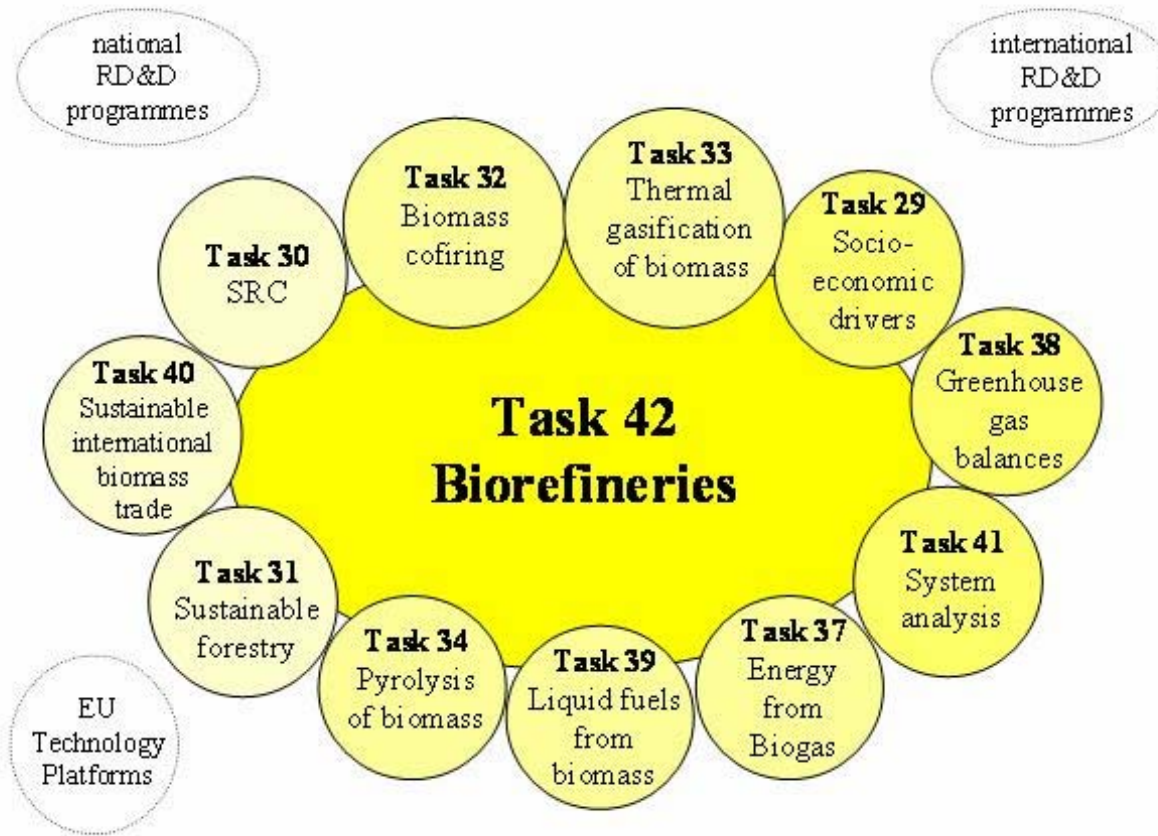
Integrated biorefinery concepts convert a variety of feedstocks, including residues, into a portfolio of products with improved energetic chain efficiency, economy and environmental effects, compared to stand-alone processes often producing only one or two products.

The methodology of integrated system approach – optimising the overall added-value of the portfolio of biomass-derived products, within an acceptable overall ecological framework – is one of the major aspects in which this Task distinguishes from the other IEA Bioenergy Tasks.



IEA Task 42 Biorefineries - Links

IEA Bioenergy





IEA Task 42 Biorefineries - Tasks

IEA Bioenergy

0. Task web-site.
1. Common definition and classification system on Biorefineries.
2. Mapping of existing biorefineries in participating countries.
3. Identification of biorefinery (related) RD&D programmes in participating countries.
4. Financial-economic and ecological advantages and disadvantages of biorefinery-based co-production over single product processes.
5. Fostering multi-disciplinary partnerships of key stakeholders (platform function).
6. Co-production of chemicals and secondary energy carriers, addressing a.o. favourable functionalised chemicals and platform chemicals (building blocks) to be co-produced, incl. market compatibility aspects.
7. Co-operation with ongoing international activities, a.o. other IEA Bioenergy Tasks and EU Technology Platforms.
8. Dissemination of knowledge, including teaching.



EU IP BIOSYNERGY (1)

BIOmass for the market competitive and environmentally friendly **SYN**thesis of bioproducts – chemicals and/or materials – together with the production of secondary **enERGY** carriers – transportation fuels, power and/or CHP – through the biorefinery approach

(Bio)chemical and thermo-chemical pathways are combined.
Process development from lab-scale to demonstration at pilot-scale.

Partners: ECN (NL), Greencell (ES), Cepsa (ES), DOW (NL), VTT (FIN), Aston (UK), WUR-A&F (NL), ARD (F), IFP (F), CRES (GR), BTG (NL), JR (AT), Bioref (D), GIG (P), JRC (B), Chimar (GR), TUD (NL)

Duration: 2006 – 2010 (four years), Budget: 13 M€(grant: 7 M€)



EU IP BIOSYNERGY (2)

Base-case

Existing conventional bioethanol production plant of Greencell in Salamanca (ES): cereals -> 295 MI/a bioethanol, DDGS, CHP

Advanced cellulosic bioethanol production plant: straw
-> 5 MI/a cellulosic ethanol

BIOSYNERGY

Maximising the overall plant economics by the co-production of chemicals with cellulosic ethanol

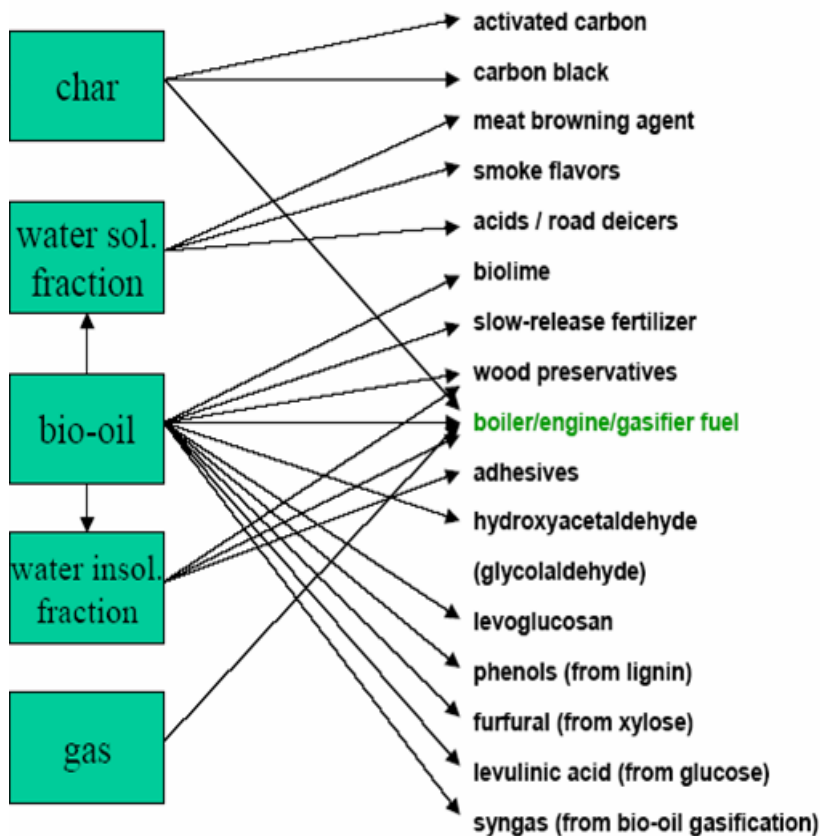
Lab-scale development and pilot-scale demonstration advanced physical/chemical fractionation, thermo-chemical conversion, biochemical and chemical conversion and synthesis technologies. Integral chain ass./optimisation

Conceptual design integrated Biorefinery facility for Greencell

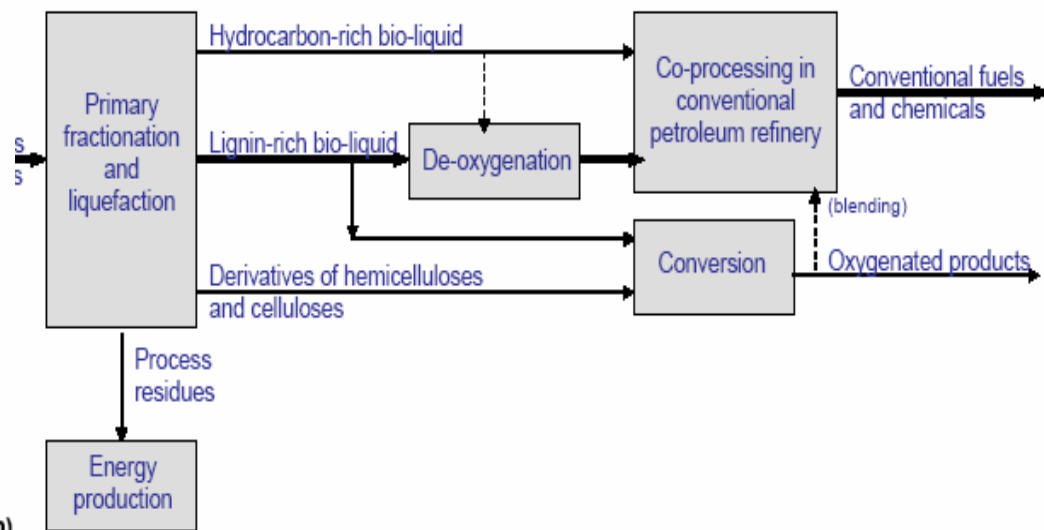


EU IP BIOCOUP

Co-processing of upgraded bio-liquids in standard refinery units



incorporating fractionation with liquefaction



BIOCOUP is an Integrated Project coordinated by VTT (Fi), involving 17 partners from 7 countries. It started on 1st May 2006



EU SSP BIOPOL (1)

Assessment of BIOrefinery concepts and the implications for agricultural and forestry POLicy

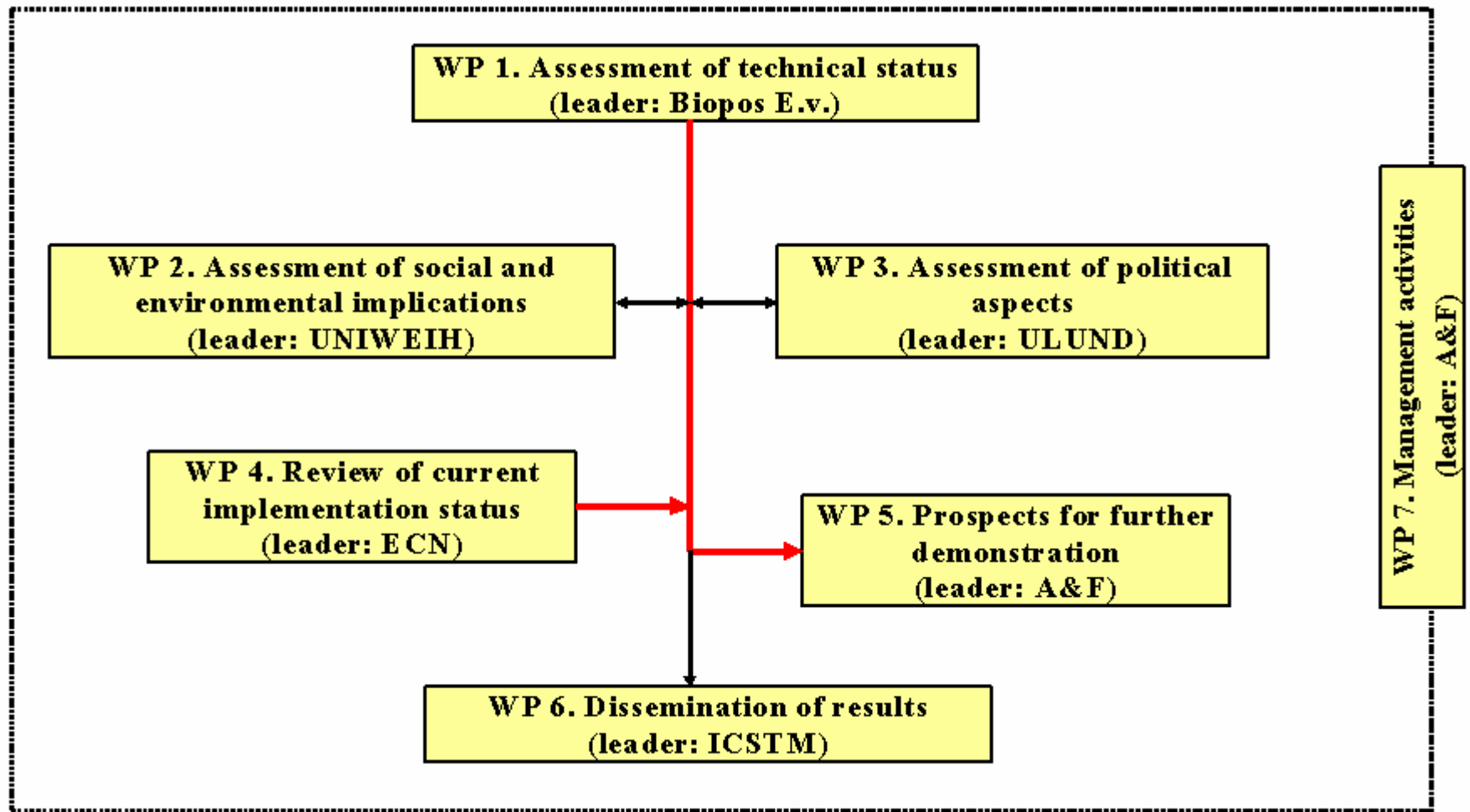
Partners: WUR-A&F (NL), Biopos e.V. (D), Imperial College (UK), Lund University (S), EC-BREC (PL), ECN (NL), University Weihenstephan (D), Technical University of Athens (GR)

Duration: 2007 – 2008 (two years)

Budget: about € 700,000 (grant: about: € 550,000)



EU SSP BIOPOL (2)





Thank you for your attention !!!

www.biorefinery.nl

www.biobasedproducts.nl

www.ecn.nl