Will biorefineries develop into future chemical verbund sites?

Webinar October 19th, 2021

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- Who
- What
- Why
- How

Wageningen UR focus

Main global challenges

- Climate change
- Overpopulation urban centres
- Malnutrition
- Overconsumption nature & natural resources

Needed transitions

Circular agri-food systems

Eating proteins from more divers sources

A circular biobased economy

Technological disruptions & digital connectivity

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Campus ecosystem

University
- Students / scientists
- Education
- International
- Known worldwide
- Fundamental research
- High quality / high rankings

Research institutes
- Research employees
- Translation research from fundamental to applied
- Shared research facilities
- Pre-competitive & confidential projects

Startups
- StartLife
- Support & coaching starters
- Incubator
- Interaction & learning
- (Seed) capital

(Inter)national companies
- R&D departments
- Researchers
- Own & shared facilities
- Looking for interaction *and* confidential surrounding

Beyondte
Cleanlight
ClearDetections
Dyadic Nederland
Foodcase Imagination Lab
Food Solution Center

GreenFood50
GWFabs
Innosieve Diagnostics

Micreos
NGN
Nuplex Resins
Pectcof
SoilCares Research

Wageningen Food & Biobased Research

Fresh Food & Chains

- Healthy Foods
- Global Fresh Supply Chains
- Customised Food

BioBased Products

- Biorefinery
- Renewable chemicals
- Renewable materials

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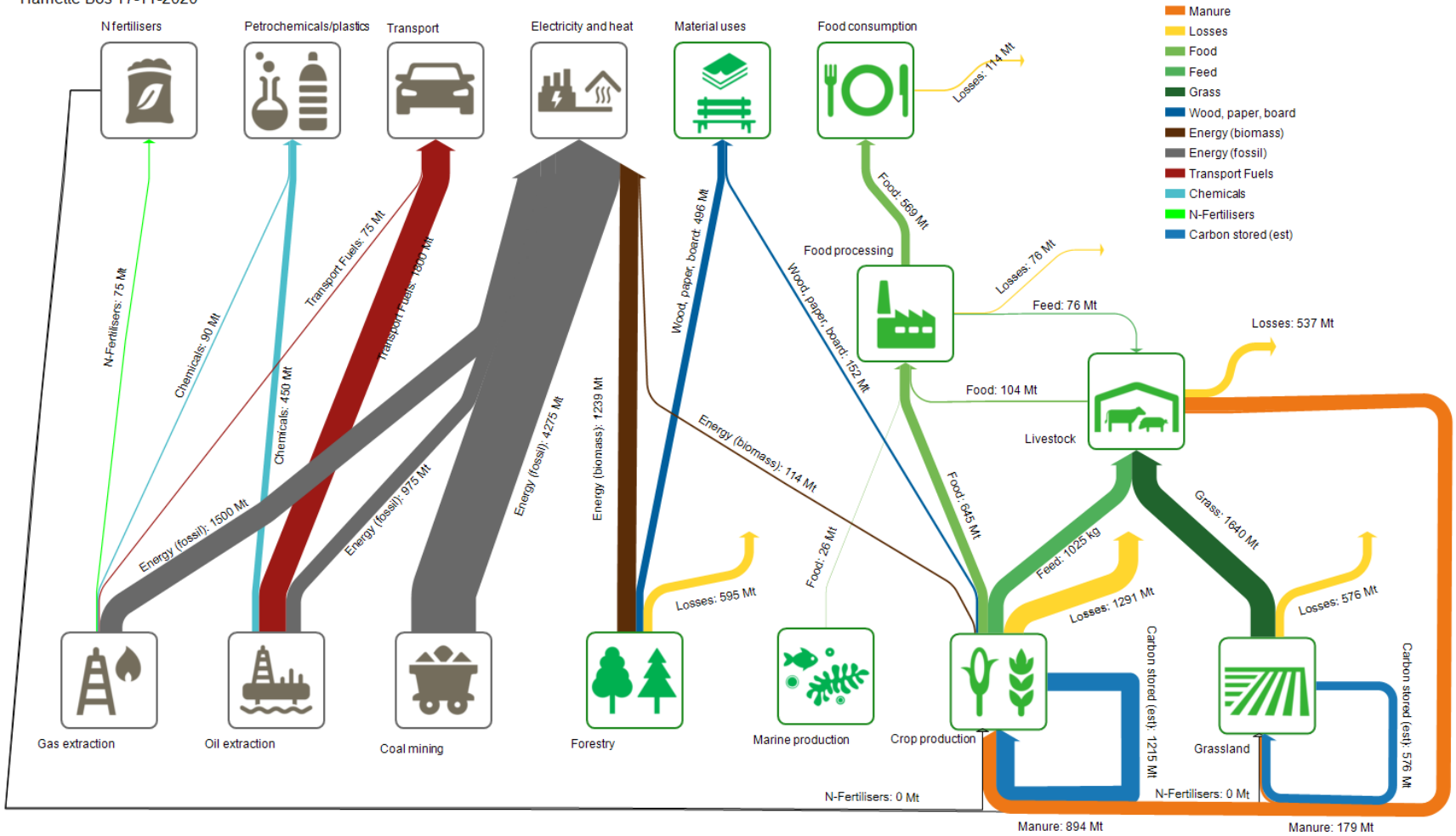
Some facilities

Biobased Innovation Pilot

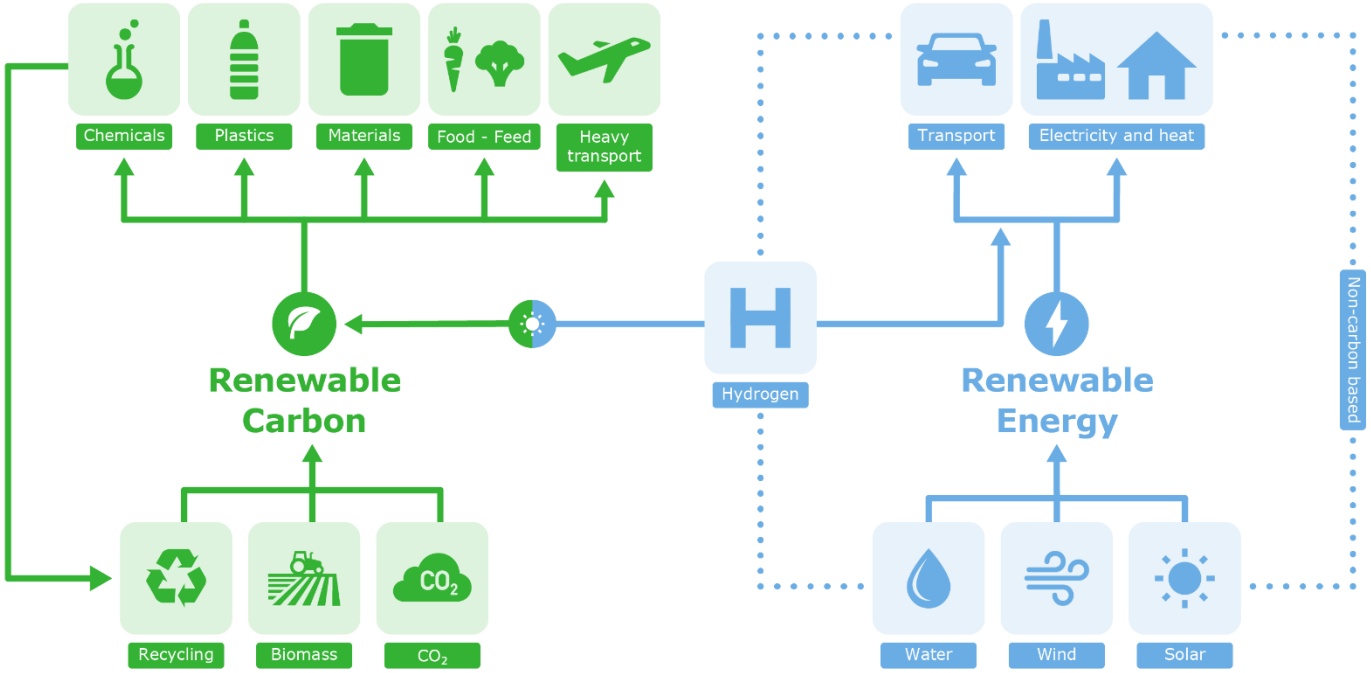
According to WUR

World-wide carbon flows expressed in MTon C atoms

Harriëtte Bos 17-11-2020



Renewable Carbon for a Fossil Free society



WUR transition pathways

Source: NOVA Institute

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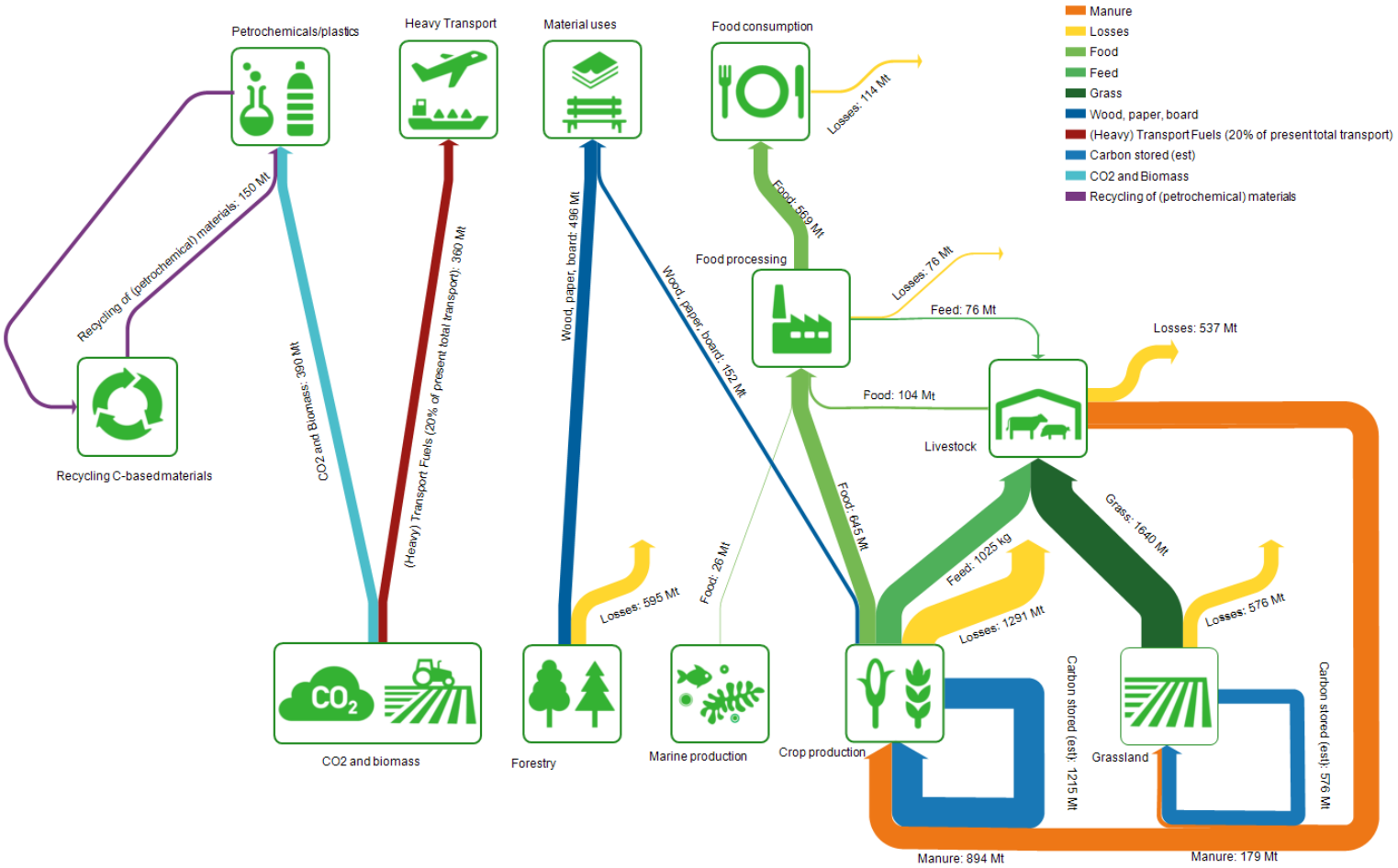
DRAFT Renewable carbon challenge. Present carbon (C) use world wide, (excluding energy) DRAFT

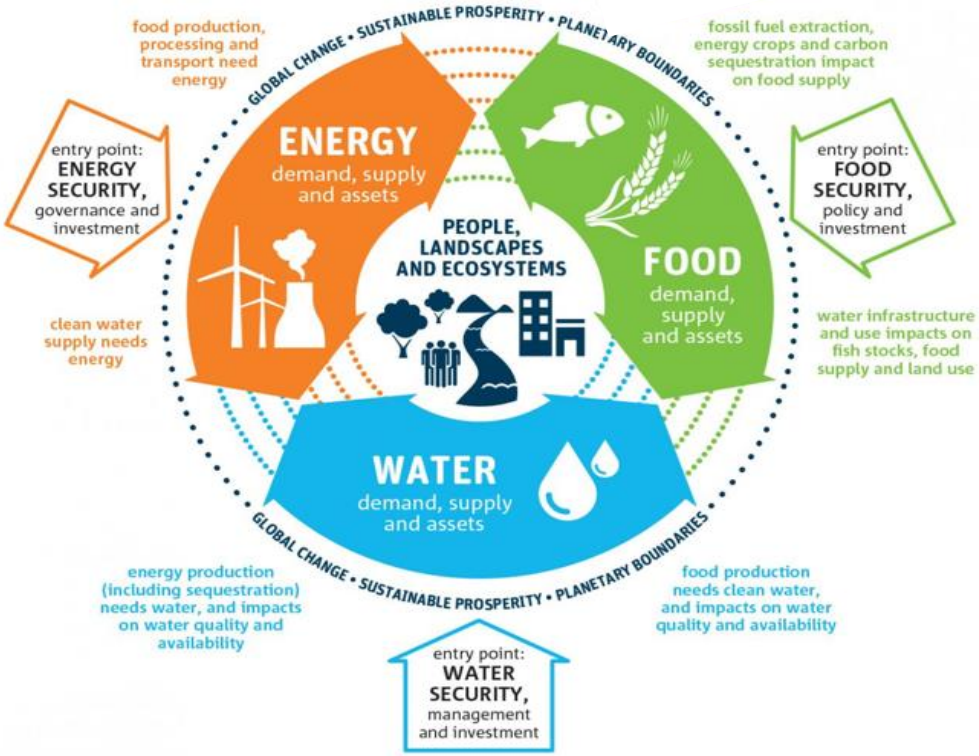
Harriëtte Bos 3-12--2020 Units are Mton C content



Materials transition:

part of greater challenge

- Additional entry point to the water-food-energy nexus
- Renewable carbon resource security



Source:
IWA, 2018
Sluijsmans, 2020

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Growth in demand biobased products

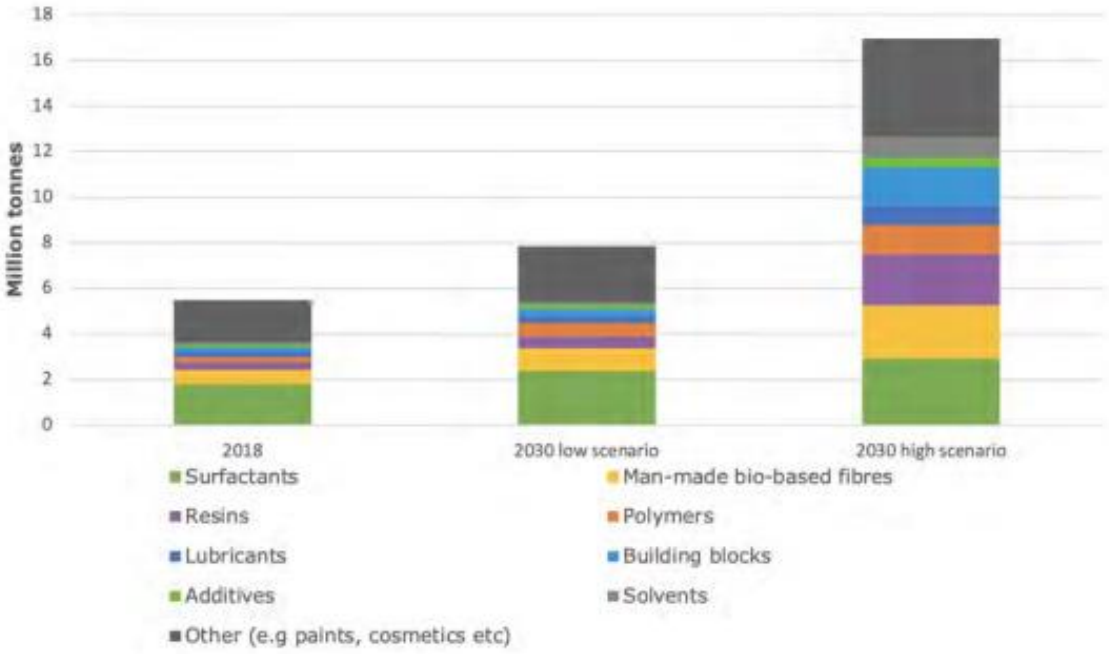

Figure 2. Demand for bio-based products 2019, and 2030 low- and high scenario[14]

Source: EU Biorefinery Outlook, Final Report 2021

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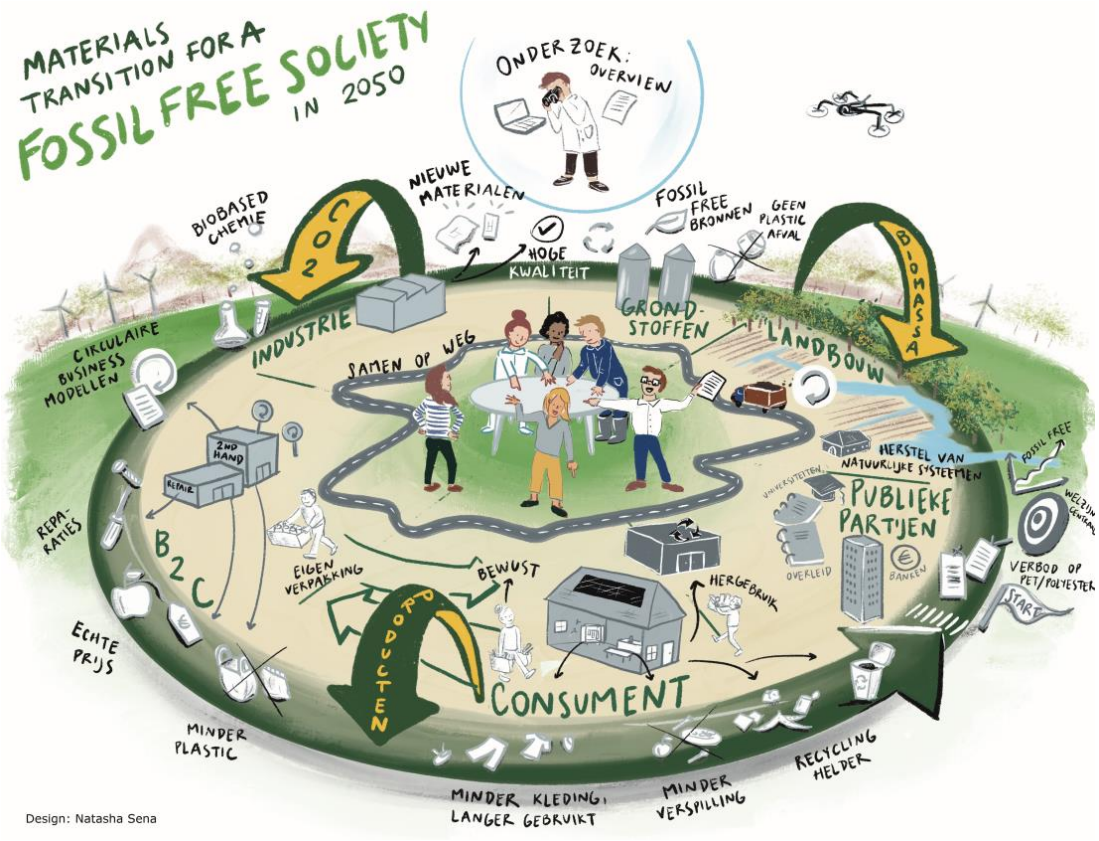
Materials transition for a Fossil Free Society

Complex of technical and non-technical actions by multiple stakeholders

Diverse combination of solutions



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Chemical verbund sites

"Chemical verbund" sites are integrated chemical complexes co-producing range of fuels and chemicals by refining fossil based resources

Typical examples include

- The Ludwigshafen BASF integrated chemical complex is the archetype "chemical verbund site"
- Port of Antwerp
- Port of Rotterdam

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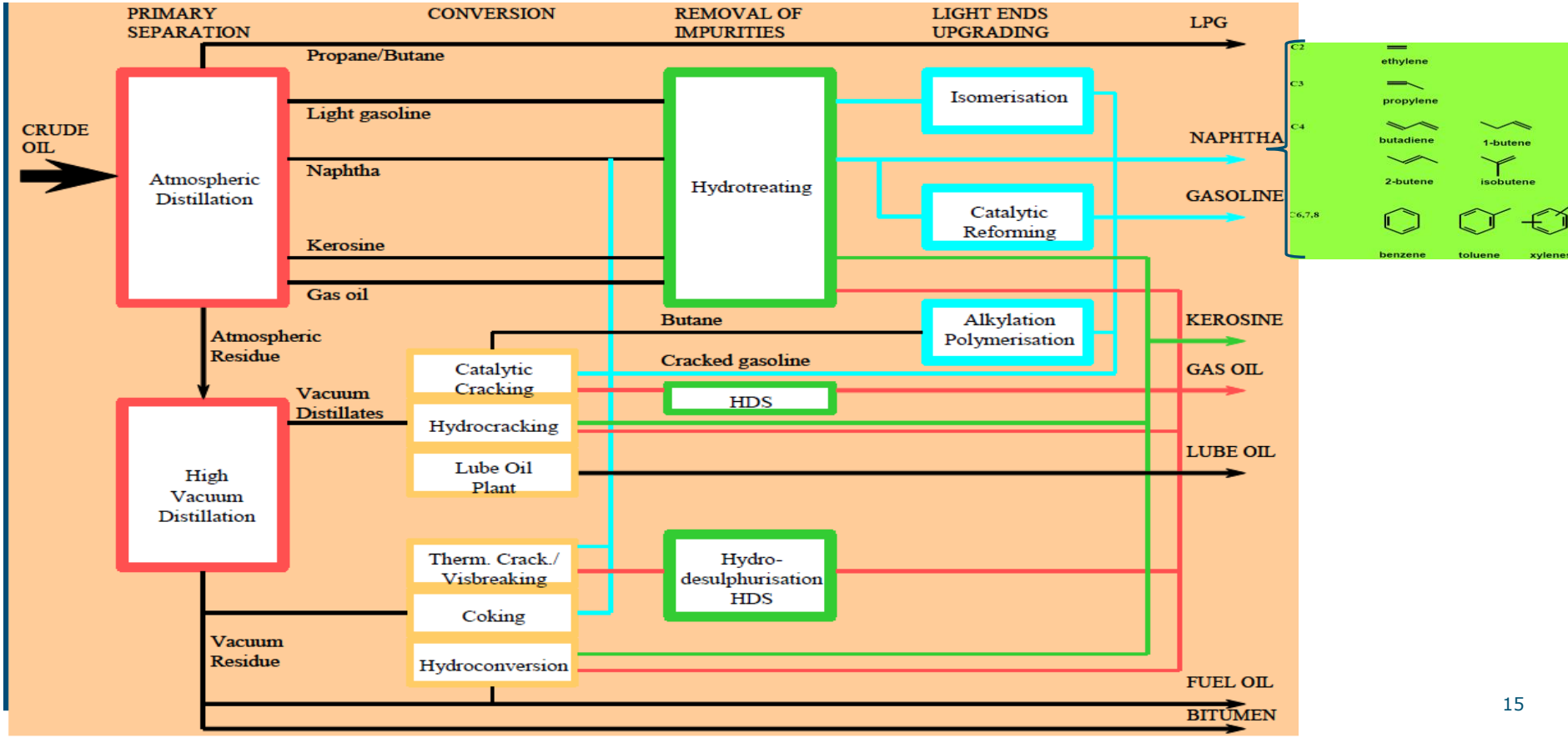
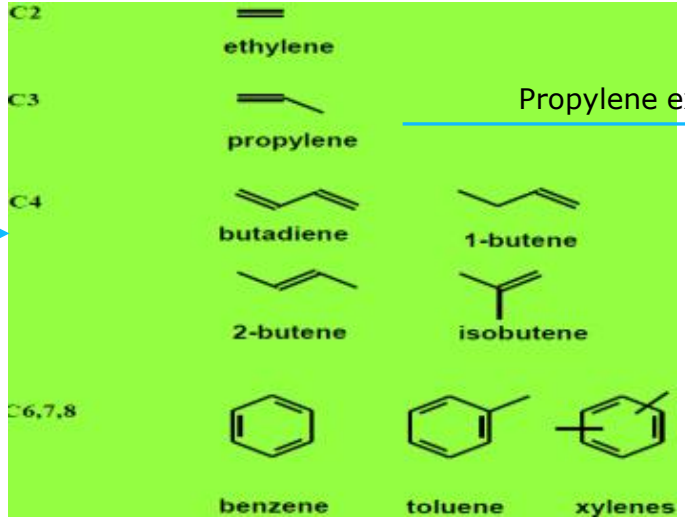
Fossil oil as feedstock for chemical verbund sites

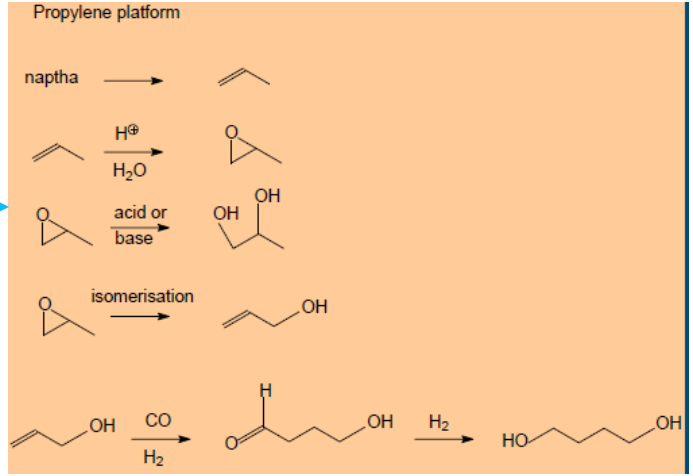


From naphtha to platform chemicals

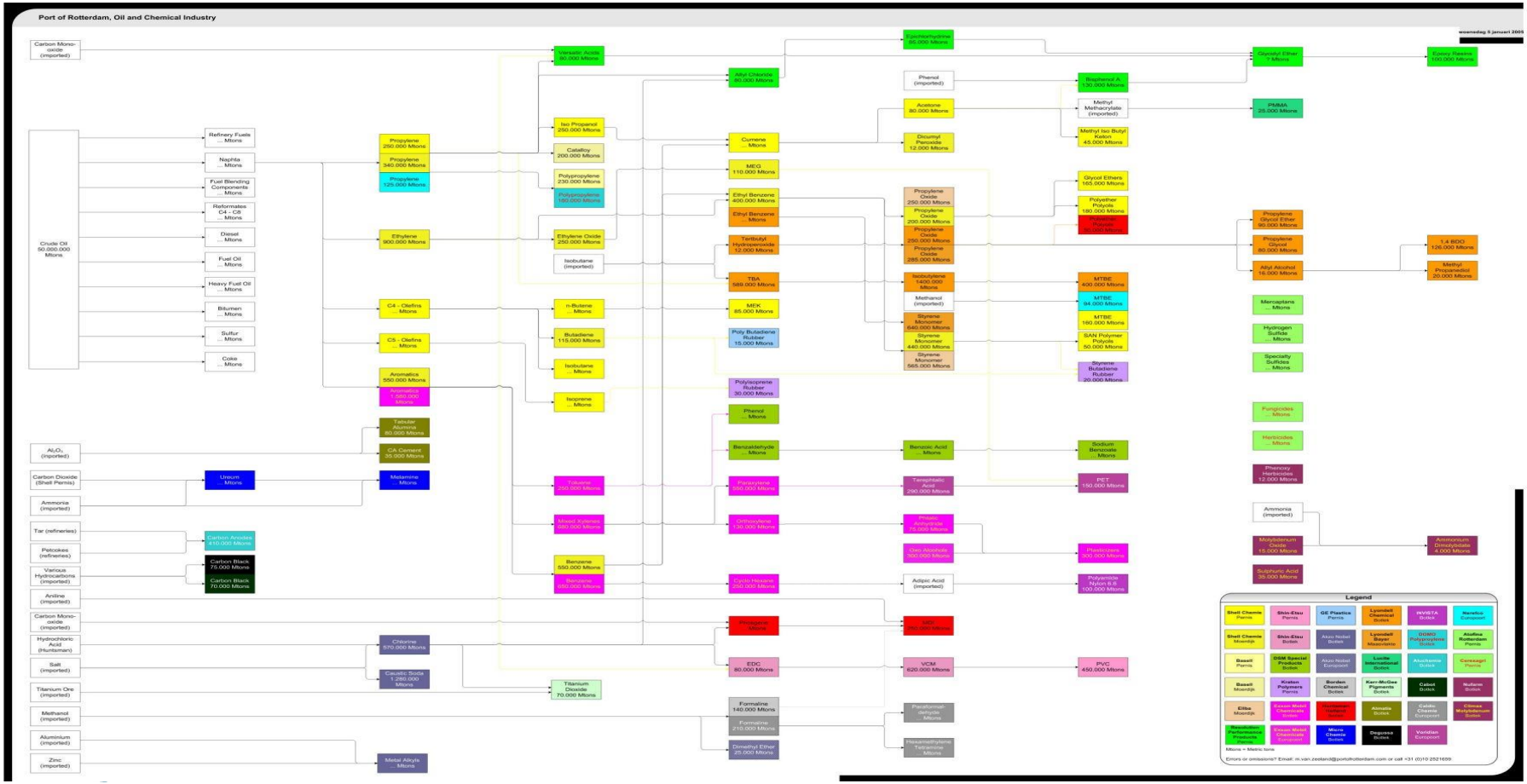
Naphtha



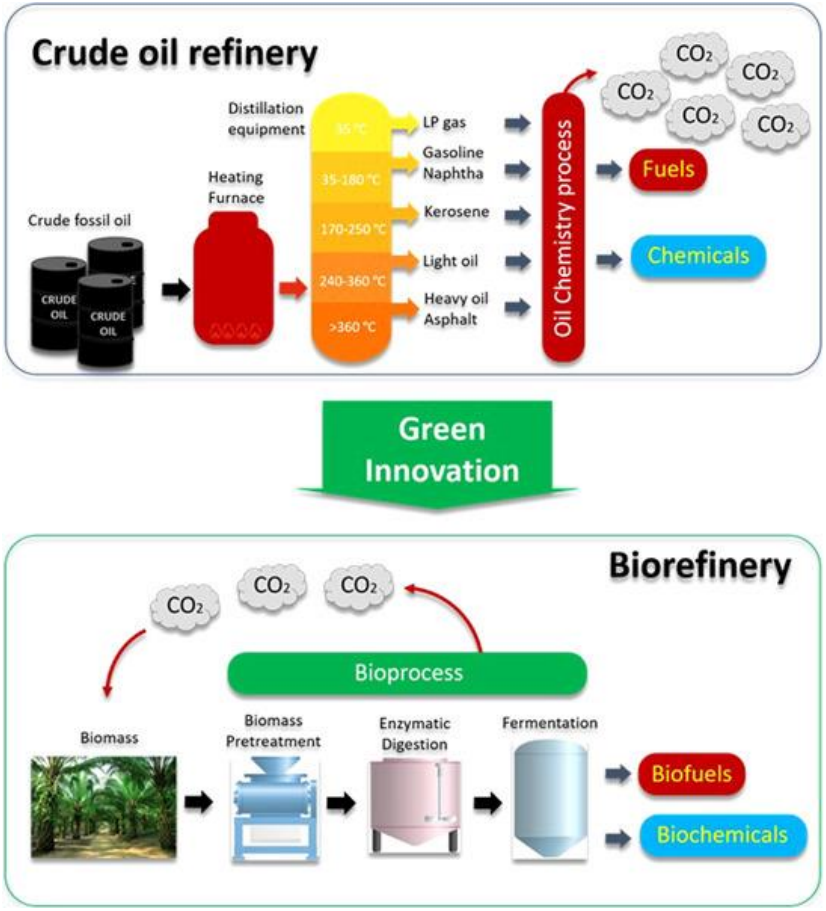
Propylene example



The Chemical Products of the Port of Rotterdam



From from fossil refinery to biorefinery



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BioNaphtha as new drop-in feedstock for chemicals

Co-feeding bioNaphtha to naphtha crackers has huge **advantages**:

- makes use of currently available infrastructure
- creates drop-in chemicals with known market potential
- using the mass balance approach *"all chemicals can be made biobased"*

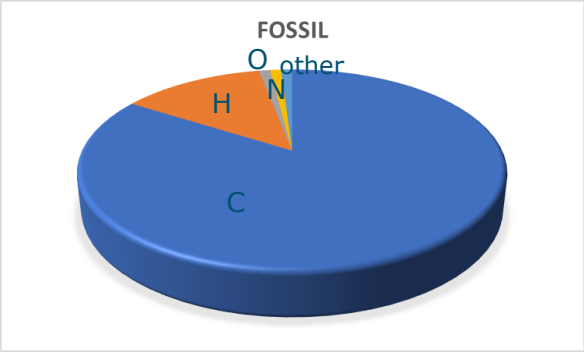
But, it has a number of **disadvantages** as well:

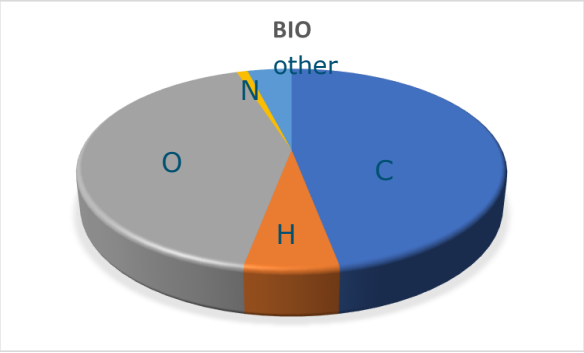
- suitable sources for bionaphtha are **limited**; e.g. waste cooking oils, HVO and compete with other high value non-food applications, conversion of lignocellulosic biomass into pyrolysis oil is still economically challenging and
- **takes out** all the **functionality** from biomass that subsequently needs to be reintroduced
- it creates drop in products that where **not** designed to be **circular** (difficult to recycle, non-biodegradable)
- It does not create the potential for new products with **new properties**
- Breaking down to base molecules and rebuilding to products require substantial **energy consumption**

Fossil vs. Biomass composition

Ultimate composition:

C
H
O
N
Other





Different types of feedstock require different type of processing leading to different type of processes, products and properties.

Mild biorefinery vs. bionaphta refinery

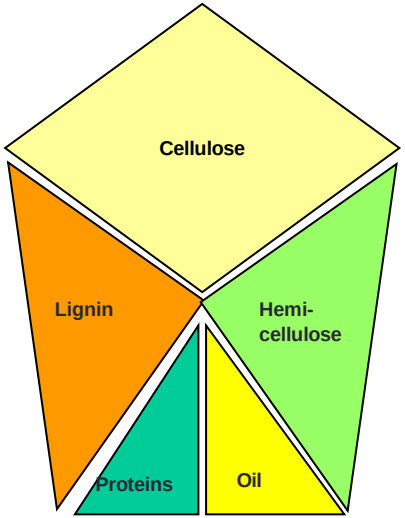
Because

- Uses inherent functionality and composition of the plant
- Less energy usage
- Biodegradable
- New properties
- Chance to include circular design

But

- Requires different infrastructures and markets
- Very heterogeneous biomass (still) too difficult and more suited for bionaphta?

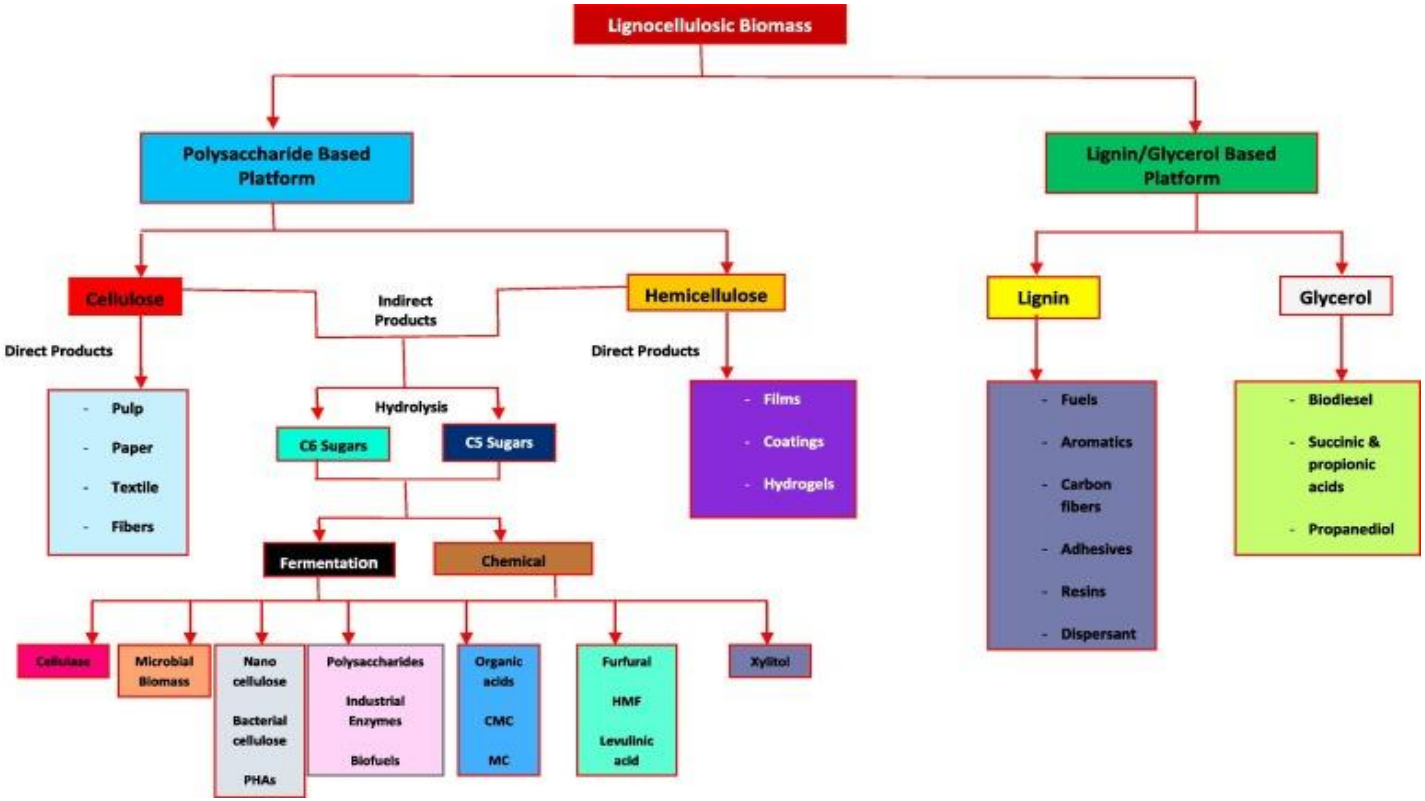
General composition of biomass



Cellulose (40-50%)
Hemi-cellulose (20-25%)
Lignin (20-25%)
Proteins (up to 10%):
Oil (up to 10%):
(Tr)ash (sand, metals, plastics, ...)

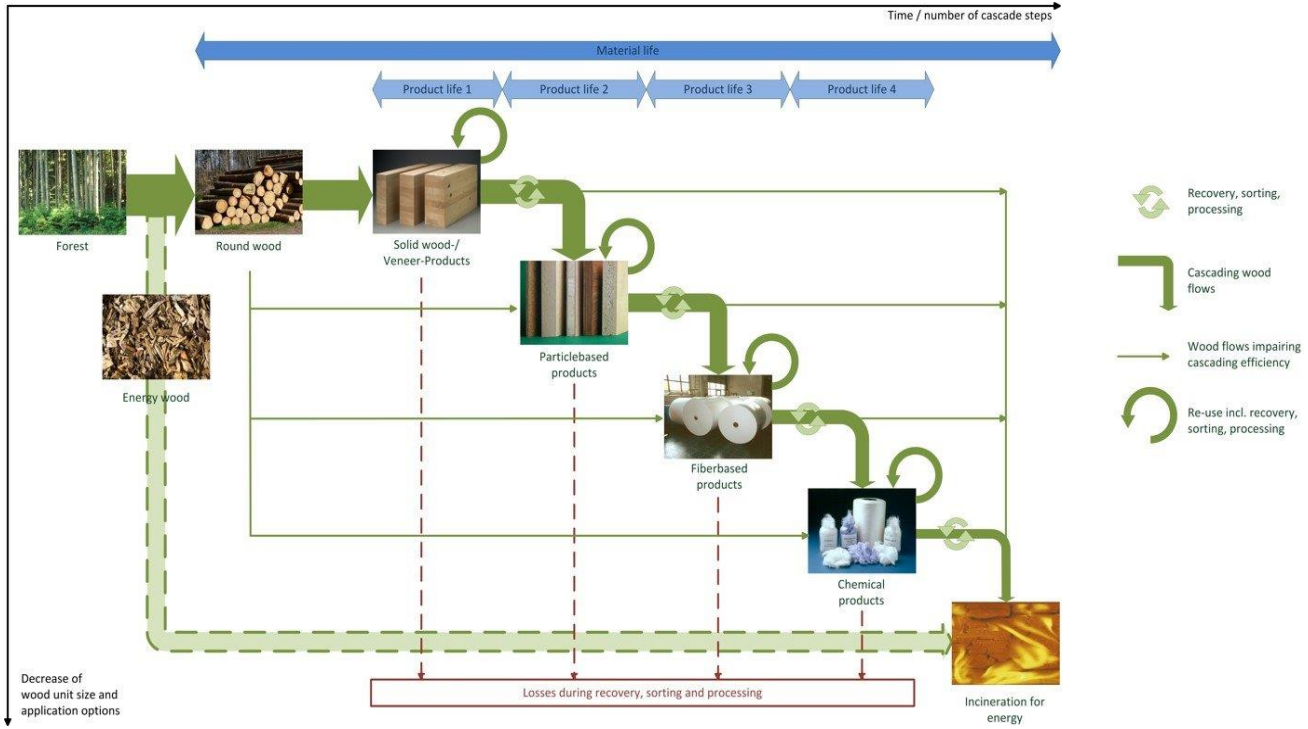
Mild biorefining uses 'non-destructive' processes so that maximum value can be derived from plant-based resources following principles of cascading and total-biomass use

Mild biorefinery vs. bionaphta refinery



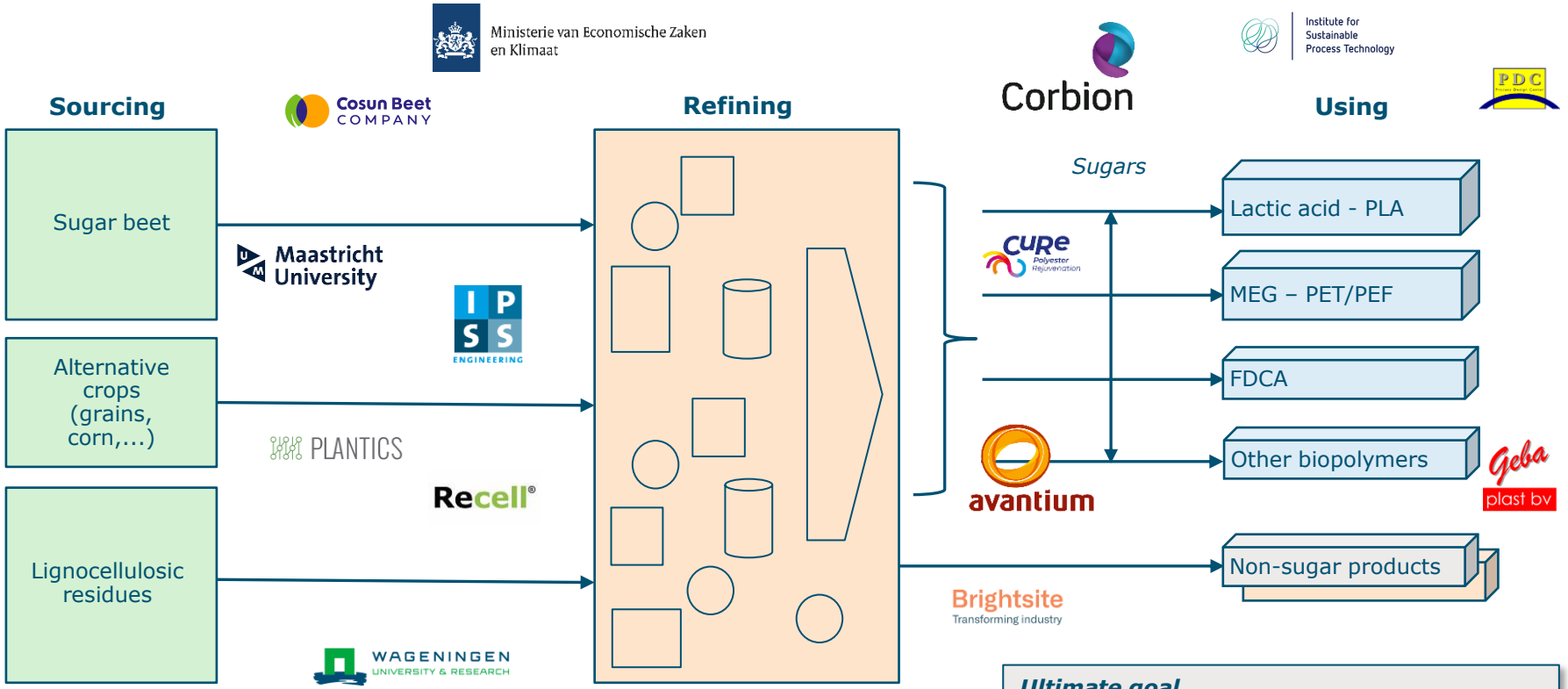
Cascading: example of wood

Cascading leads to 14% less wood usage and 7% less CO_2 emission



The sugarbeet biorefinery

Dutch consortium: sugars to biopolymers Biorefinery



Ultimate goal
Multiple biorefineries producing 3 million tons sugars for biopolymers in NL in 2050

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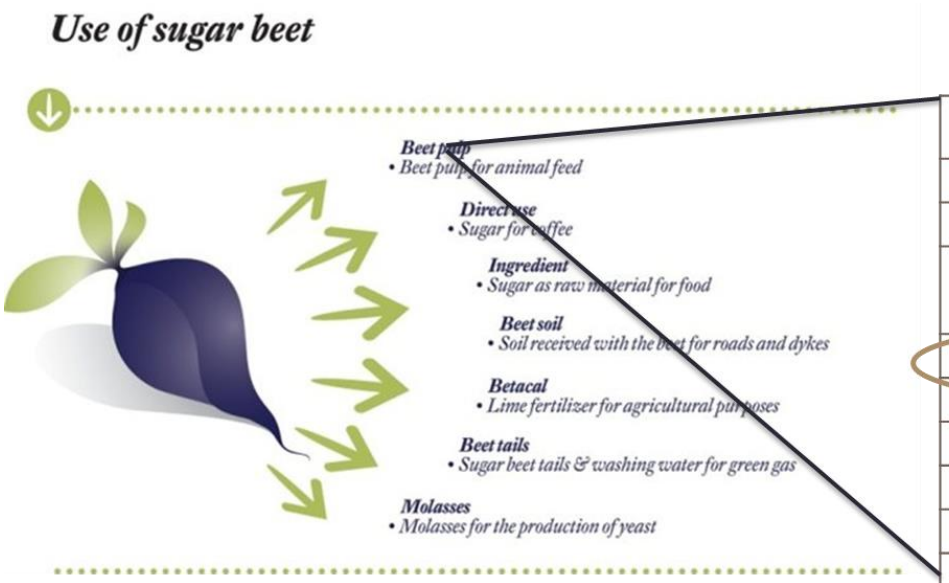
DSD
BETA PROCESS bioenergy
NewFoss Biobased products and techniques
HAN BioCentre

Biorefinery of sugar beet pulp: process development

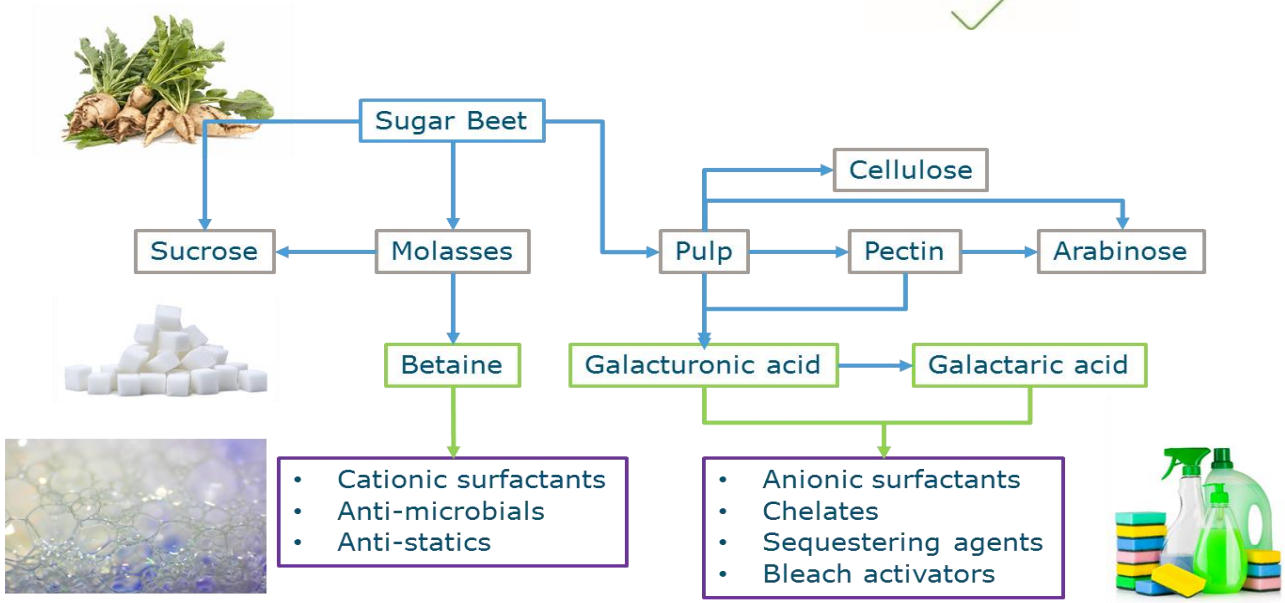


Component	Amount (% w/w)
Water	4-8
Cellulose	22-26
Hemi-cellulose (arabanes)	22-26
Pectin	**21-25**
(Raw) proteins	6-10
Residuals	7-13
Soluble sugars	1-3
Lignin	0-3
Other	6-12

- Cosun SBP volume: 1200 kT/annum
  - Currently sold as cattle feed (low contribution)
- Potential pectin volume: 60 kT/annum
  - Find high value products (high contribution)

Biorefinery of sugar beet pulp: process development

- Pectin valorisation



Biorefinery of sugar beet leaf: multiple products

Leafs
40 ton/ha

Sugar beets
80 ton/ha

Protein (Rubisco)

Protein (feed)

Biopolymers

Biogas

Paper

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Biorefinery of sugar beet leaf: process development

Shredding

Pressing

Decantation

Centrifugation

Membrane filtration

Adsorption

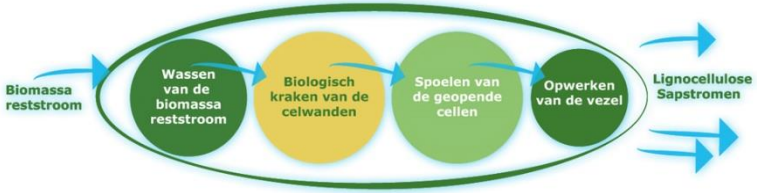
Spray drying

The Protein powder

Grass refining

Mild refining of lignocellulose biomass: grass, agri-food residues towards

- Products based on inert fibers
- Juice containing minerals, salts and sugars



Advantages

- ✓ Turns costly residue into multiple valuable products
- ✓ Year round production
- ✓ Small scale (10.000 tons/year DM)
- ✓ Simple robust production process without chemicals and low water and energy footprint

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Challenges in bioresidue valorization

Availibility

- Year round supply
- Conservation, stability and preservation
- From heterogeneous resource to homogeneous feedstock
- Removal of polluting components and substances
- Quality control
- Economy of scale
- Logistics: central vs. decentral or combination

Thank you for your attention

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