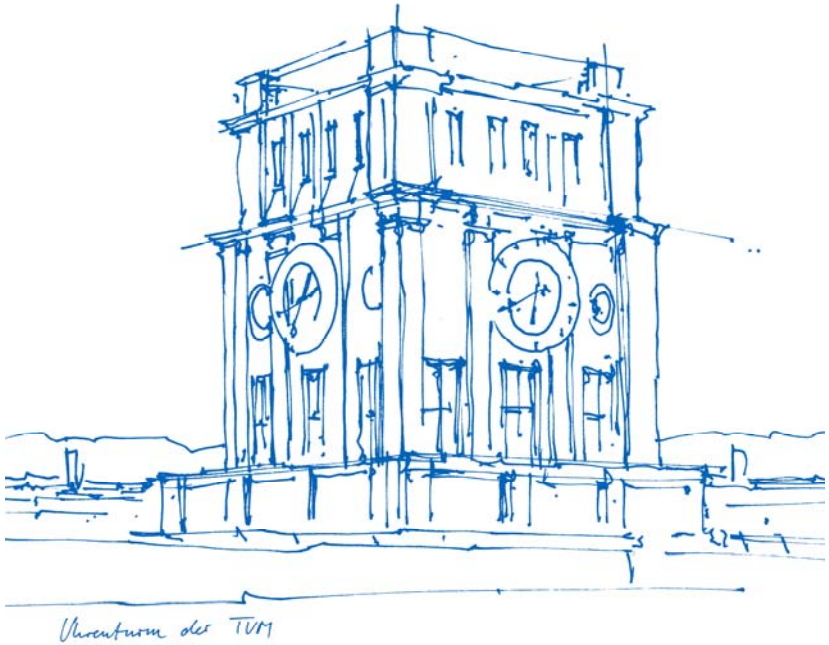
Joint KONARO project – Farmstead biorefinery

Prof. Dr. Volker Sieber



Farmstead biorefinery

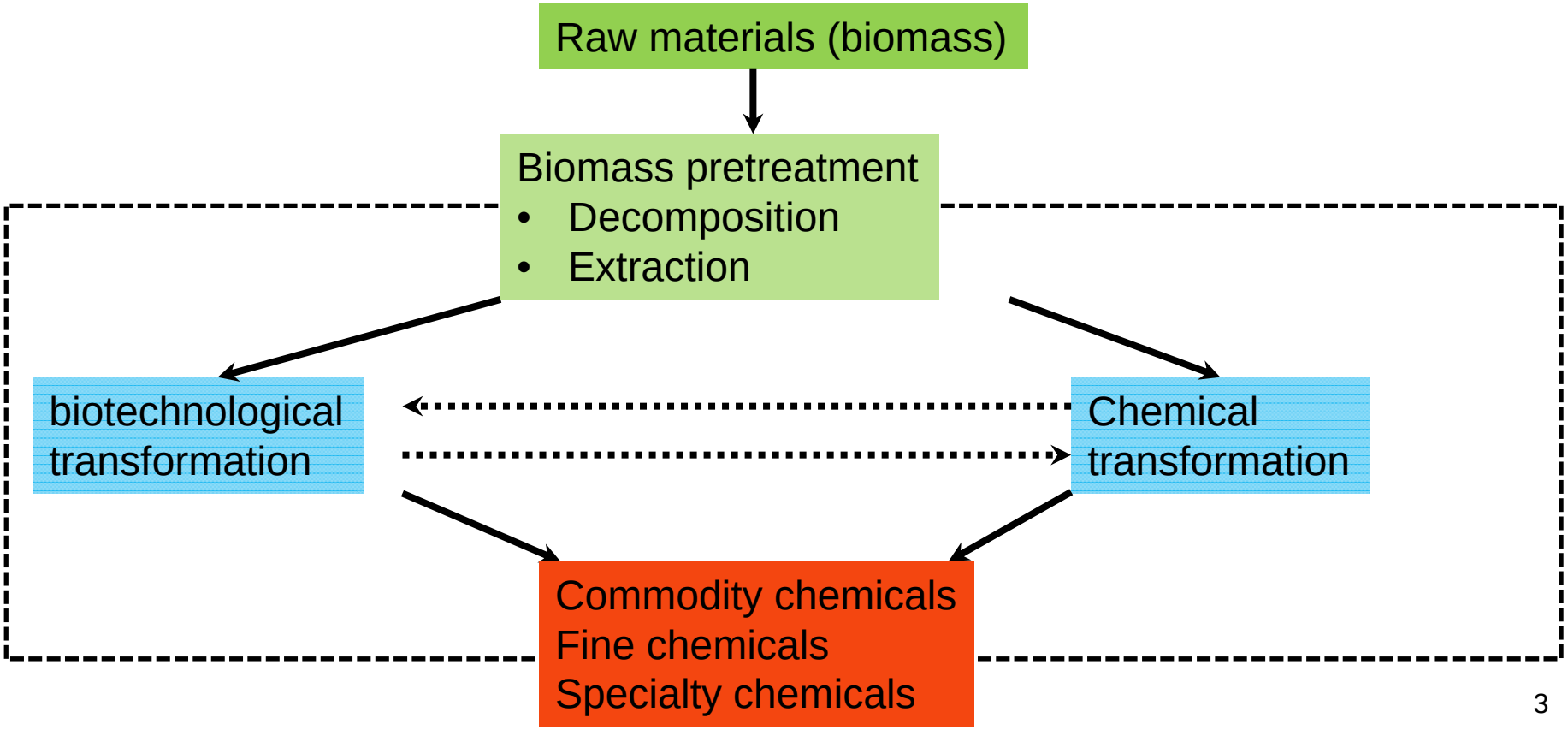
Overview

- Concept of Farmstaed Biorefinery
- Work packages
- Presentation of selected work packages
- Outlook
- Summary

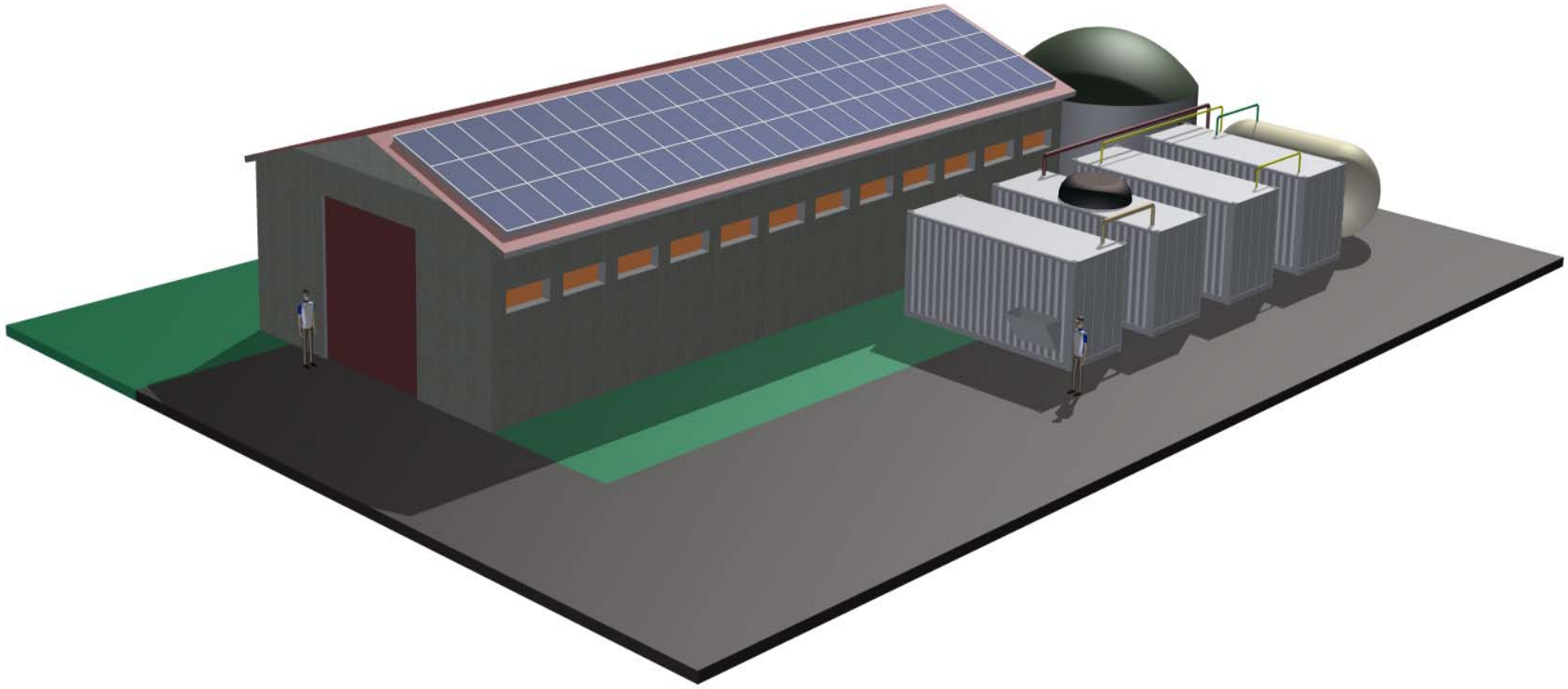
Biorefinery

"A biorefinery is a facility that integrates biomass conversion processes and equipment to produce fuels, power and chemicals from biomass"

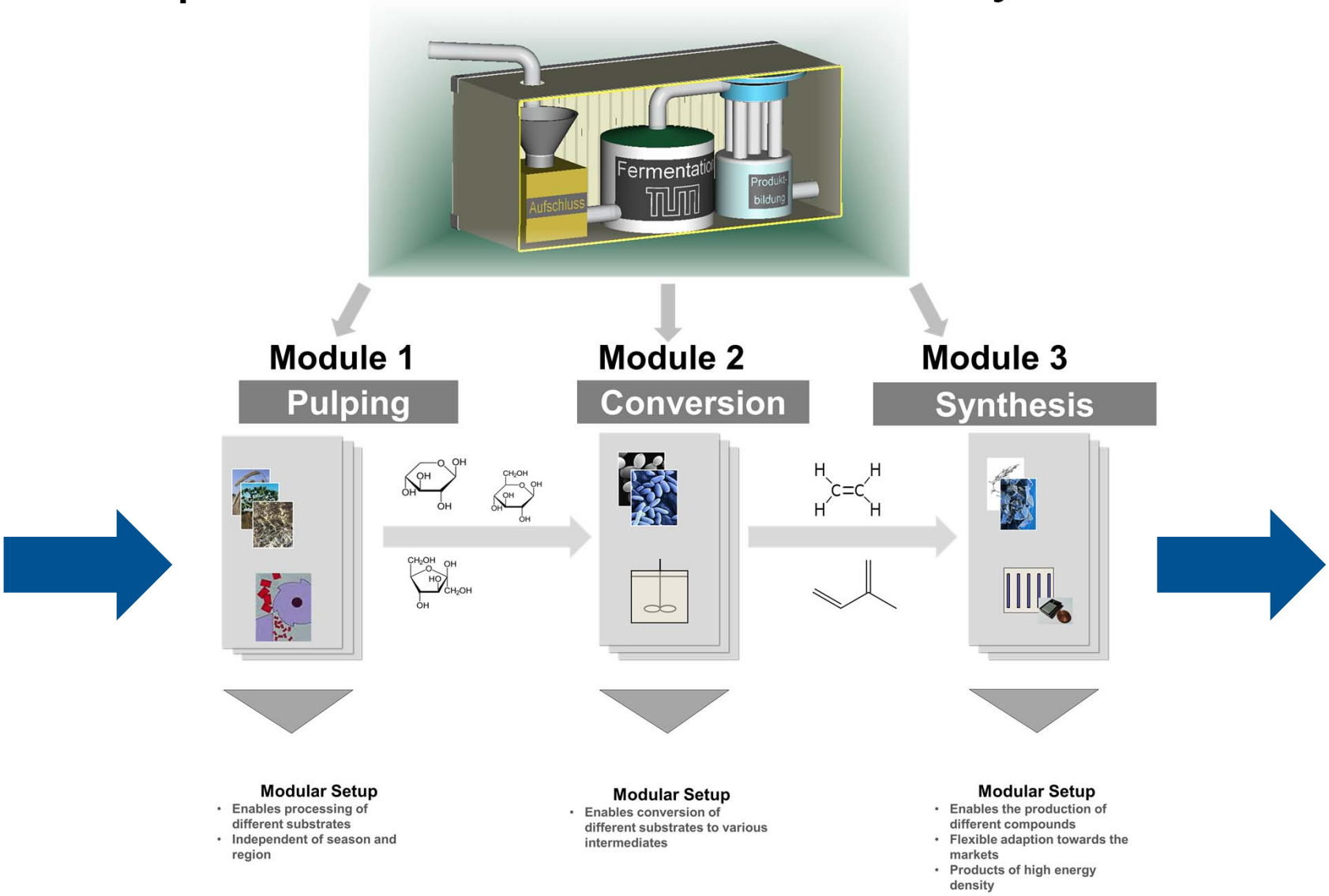
American National Renewable Energy Laboratory



Concept of the farmstead Biorefinery



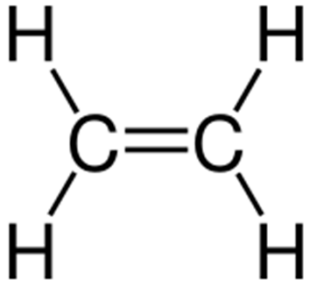
Concept of the farmstead Biorefinery

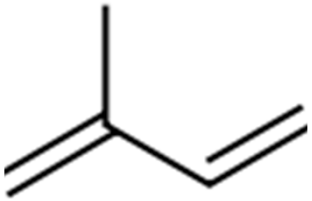


Substrate- & Product spectra

Substrates

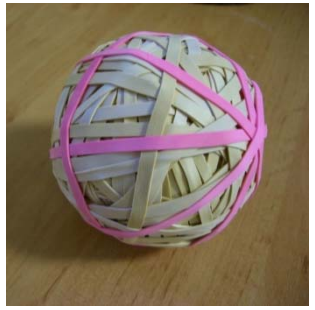
Products





...

veredelte Produkte



Work packages

Fraunhofer

Prof. Dr. Volker Sieber

Universität Regensburg

Lehrstuhl für Organische Chemie und Mikroreaktionssysteme

Prof. Dr. Olga Garcia Mancheño

HOCHSCHULE WEIHENSTEPHAN-TRIESDORF UNIVERSITY OF APPLIED SCIENCES

Fachgebiet für Bioinformatik

Prof. Dr. Dominik Heider

Technologie- und Förderzentrum im Kompetenzzentrum für Nachwachsende Rohstoffe

Technologie- und Förder-zentrum

Dr. Bernhard Widmann

HOCHSCHULE WEIHENSTEPHAN-TRIESDORF UNIVERSITY OF APPLIED SCIENCES

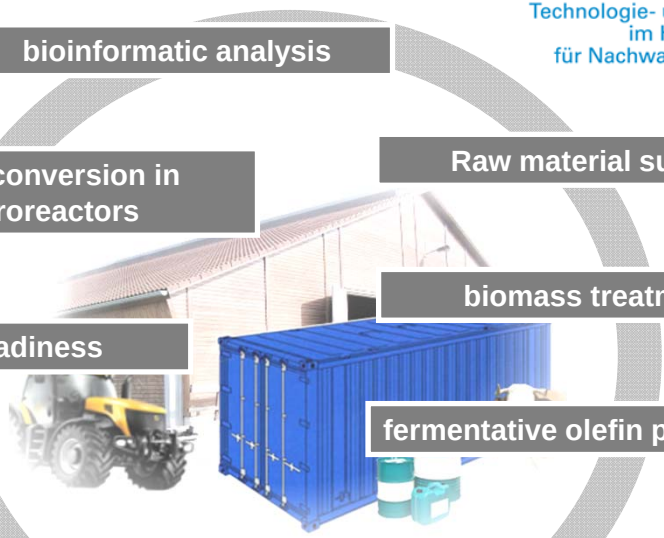
Fachgebiet für Marketing und Management Biogener Rohstoffe

Prof. Dr. Klaus Menrad

Technische Universität München

Lehrstuhl für Chemie Biogener Rohstoffe

Prof. Dr. Volker Sieber



Technische Universität München

Lehrstuhl Biogene Polymere

Prof. Dr. Cordt Zollfrank

C.A.R.M.E.N.

Centrales-Agrar-Rohstoff-Marketing-Entwicklungs-Netzwerk

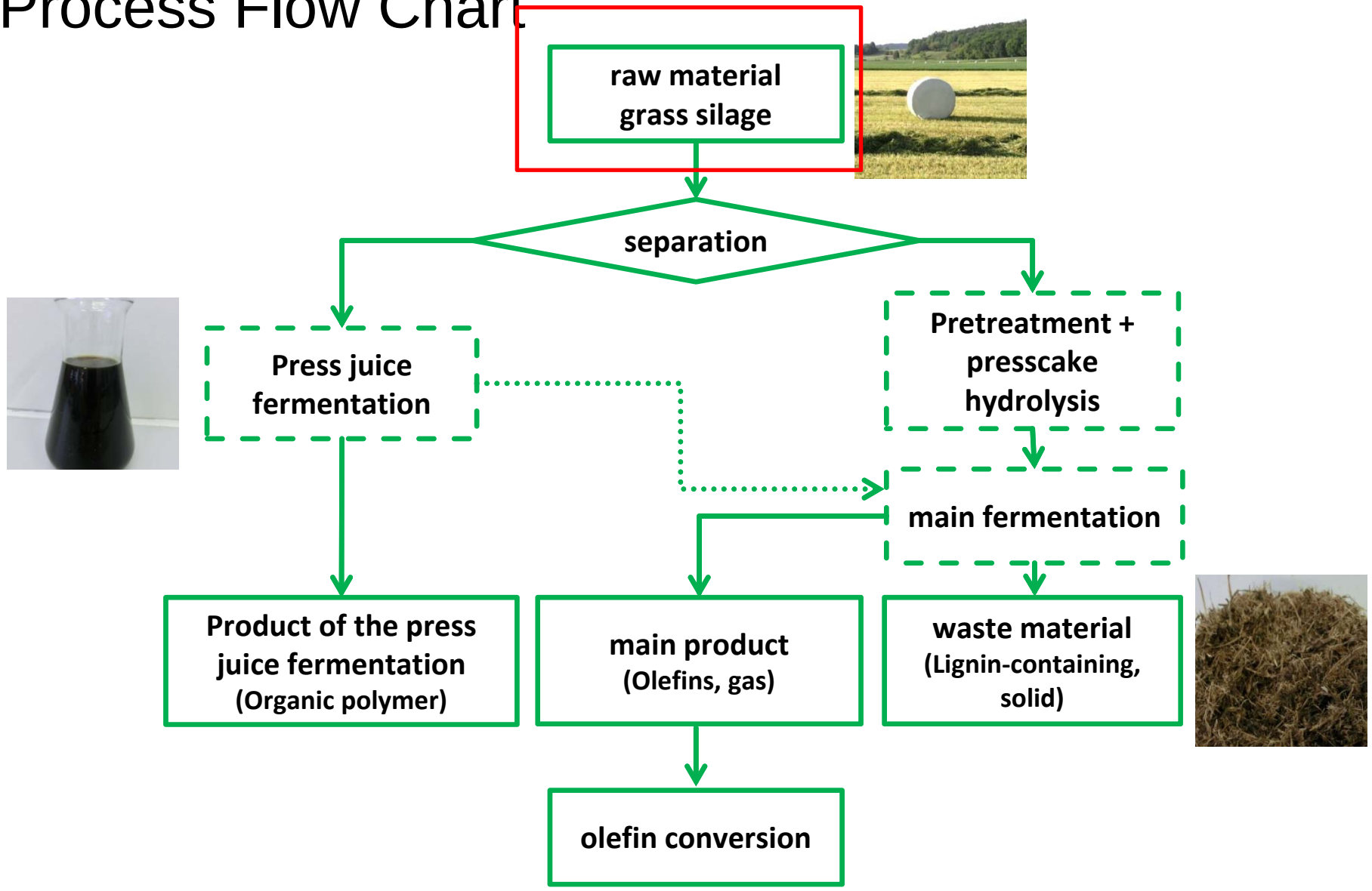
Dipl.-Wi.-Ing. Edmund Langer

HOCHSCHULE WEIHENSTEPHAN-TRIESDORF UNIVERSITY OF APPLIED SCIENCES

Fachgebiet für Organische und Analytische Chemie

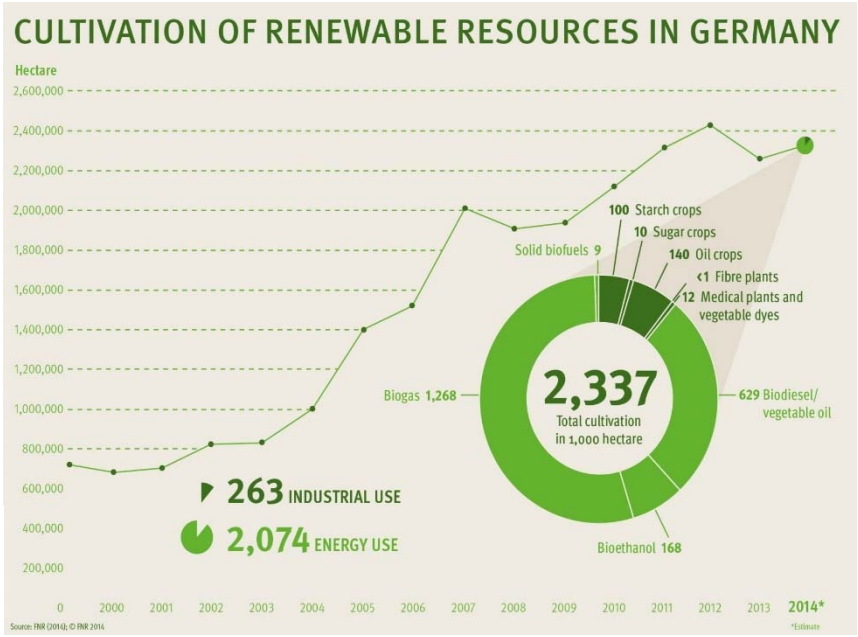
Prof. Dr. Herbert Riepl

Process Flow Chart



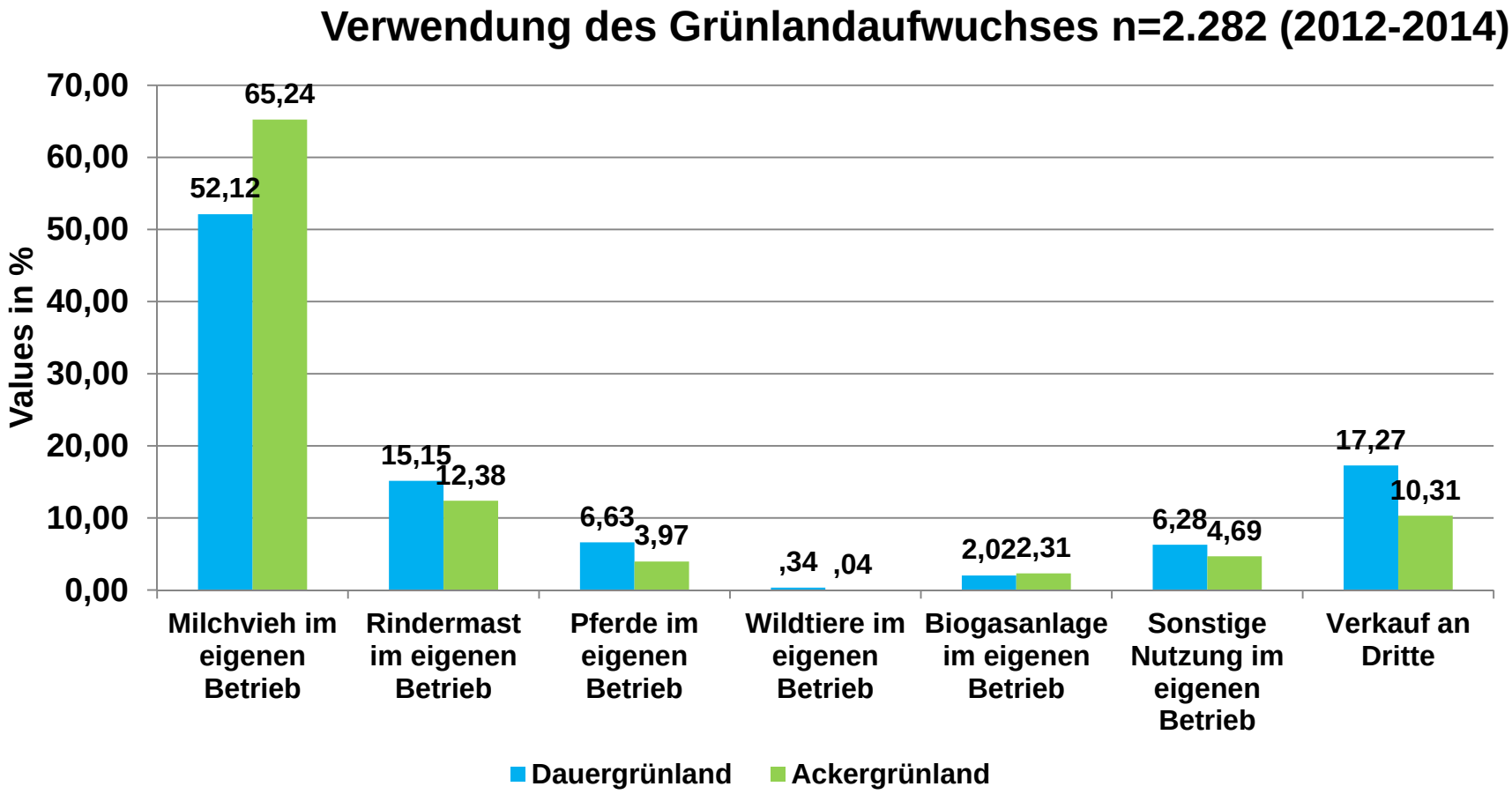
Substrate – grass silage

- EU Regulation: 1/5 of arable land to grassland
- No or little interference with food crops
- High annual production of biomass per hectare
- Simple logistics and storage
- Mostly *Poaceae*
- Low industrial use

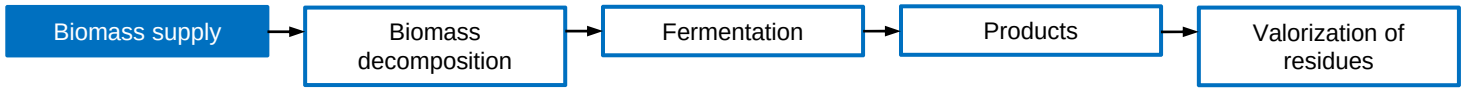


FNR
Fachagentur Nachwachsende Rohstoffe e.V.

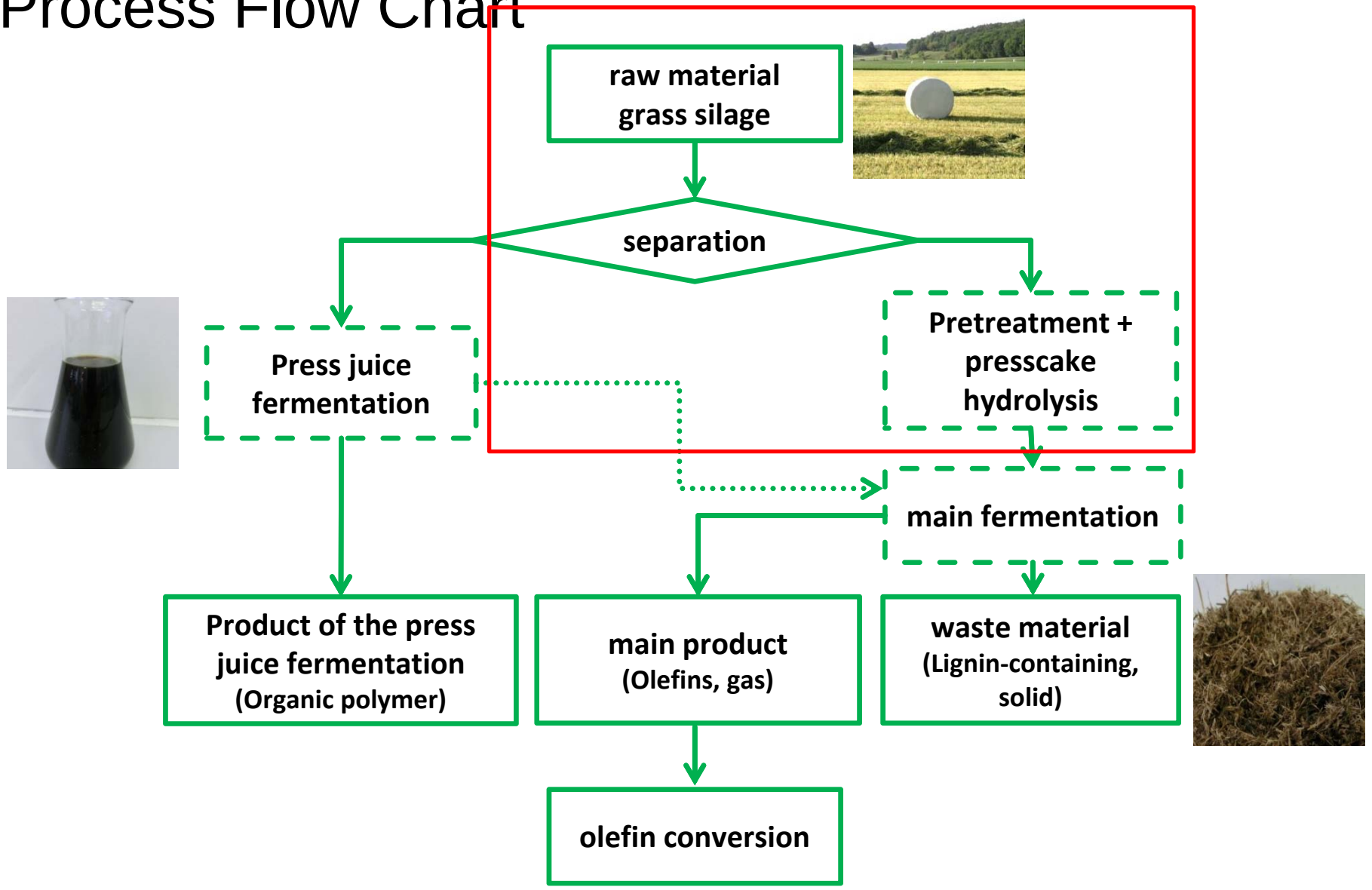
Delivery readiness



→ Verkauf je nach Preis

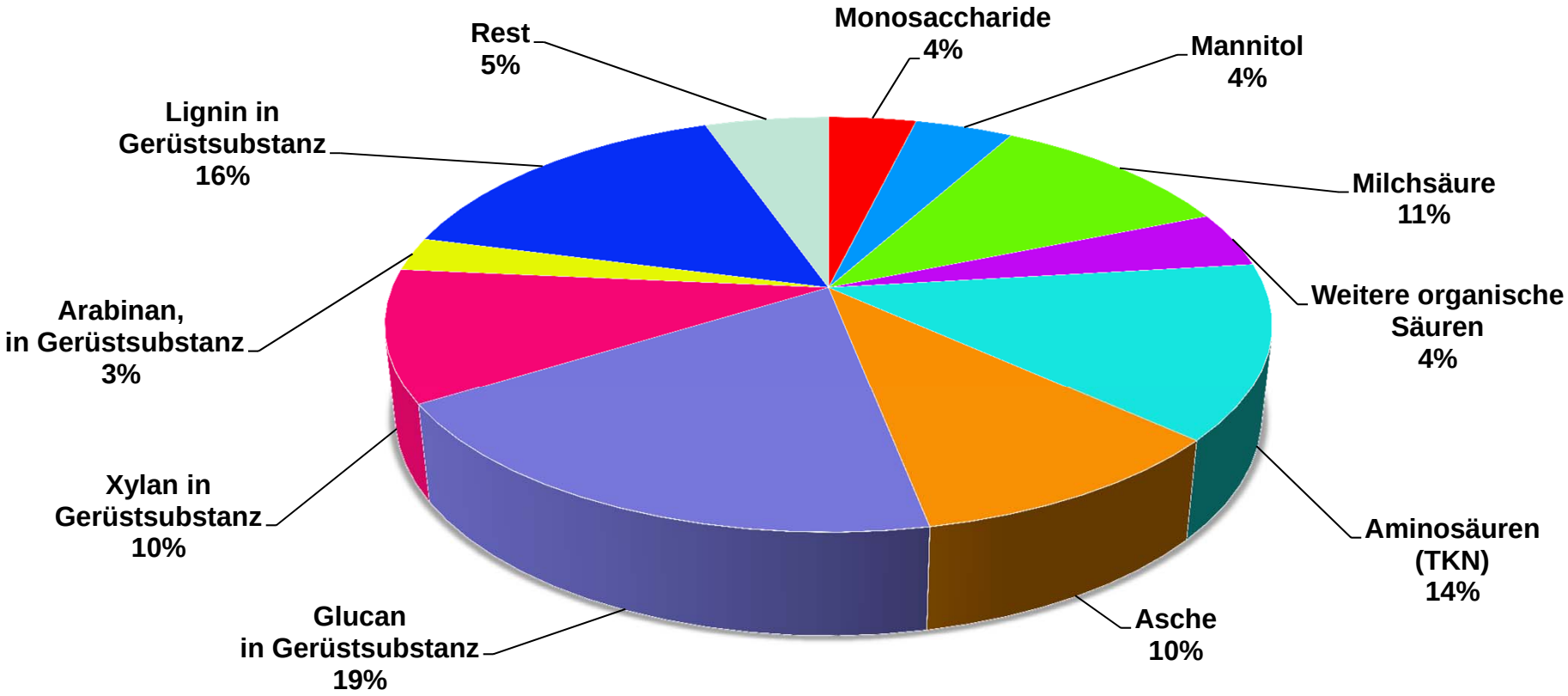


Process Flow Chart

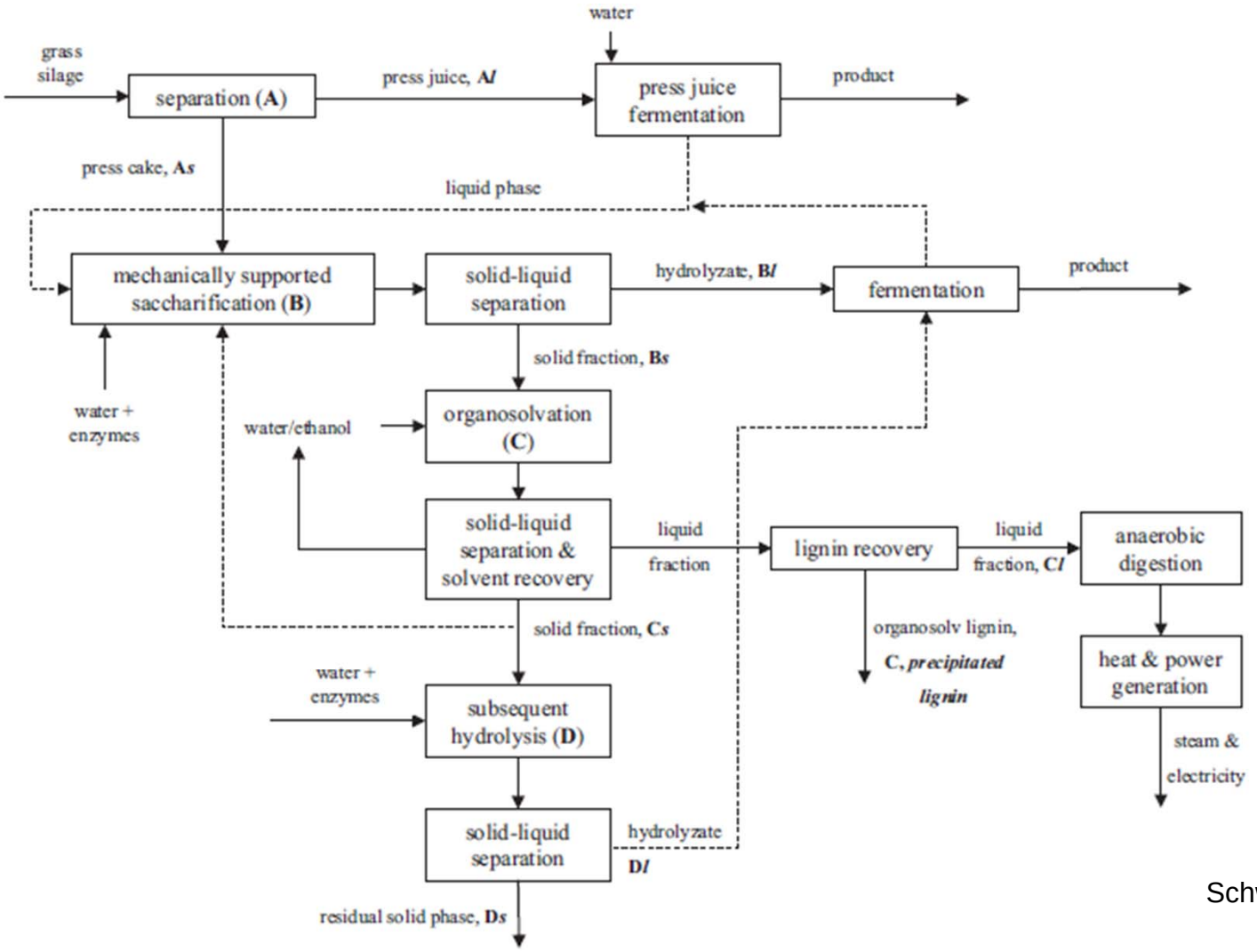


Biomass treatment - silage

dry matter Silage press juice



Dominik Schwarz

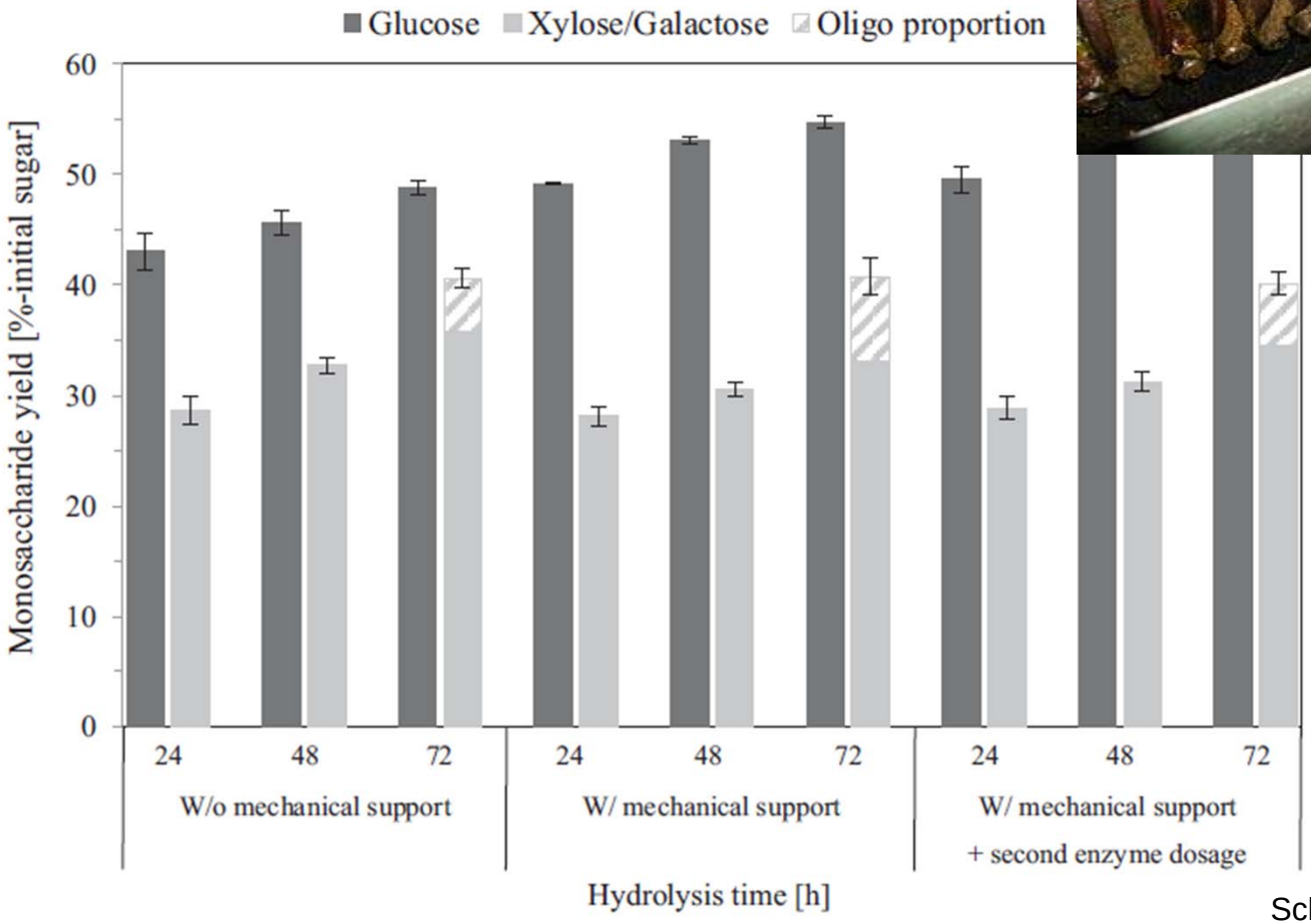


Schwarz *et al*. 2016

Fig. 1. Overview of the combined pulping process conceptualized for a green biorefinery. X*s* and X*l* refer to the solid and liquid fractions after process step X, respectively.

Biomass supply → **Biomass decomposition** → Fermentation → Products → Valorization of residues

Biomass decomposition

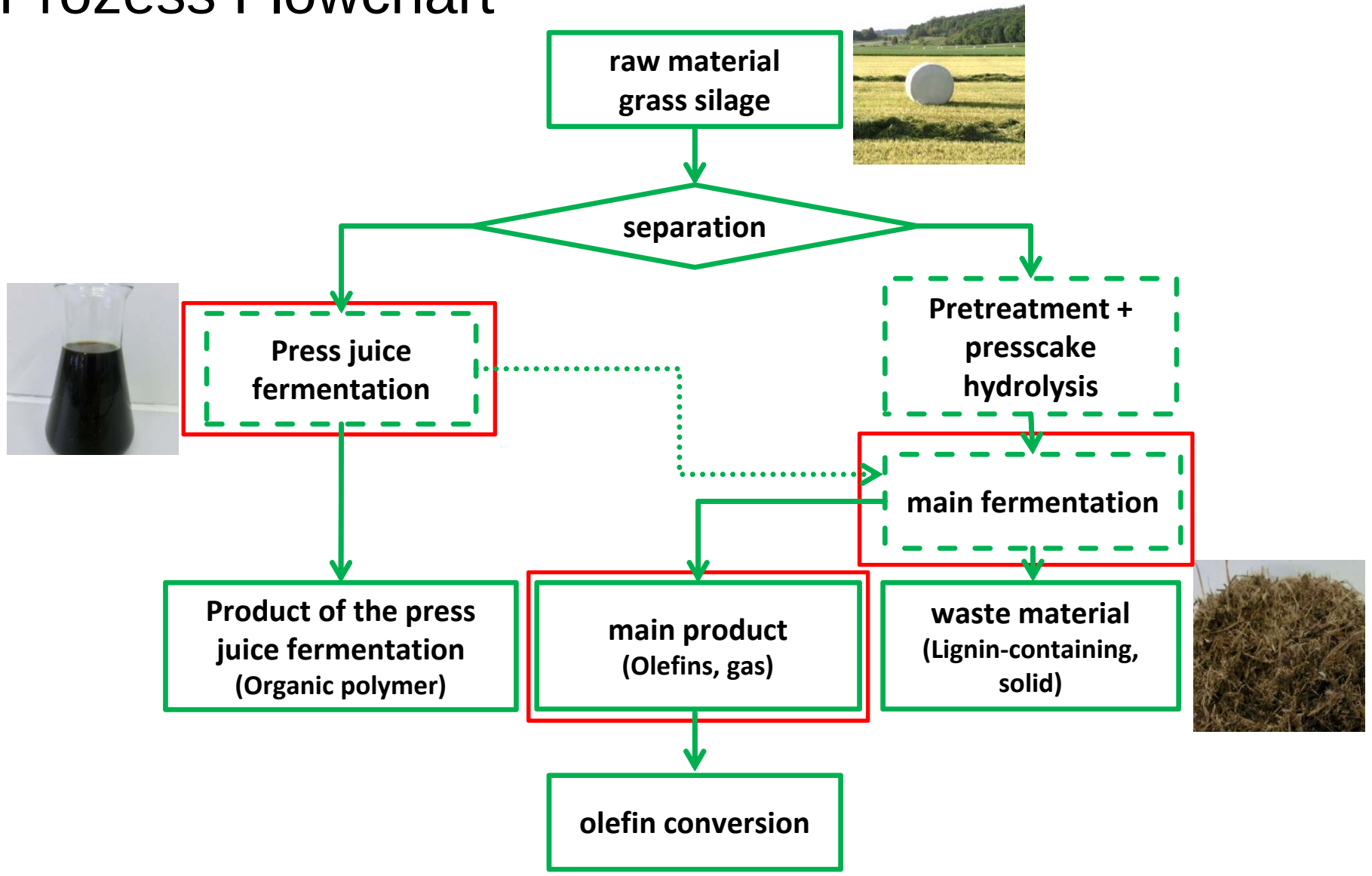


Schwarz *et al*. 2016

Fig. 4. Saccharide yields in the high total solid load saccharification of PC, with (W/) or without (W/o) secondary mechanical support and secondary enzyme dosage. Parameters were obtained by calculation 2 (see Table 2), although the hydrolysis time was corrected to 72 h; $n = 2$.

Biomass supply → **Biomass decomposition** → Fermentation → Products → Valorization of residues

Prozess Flowchart

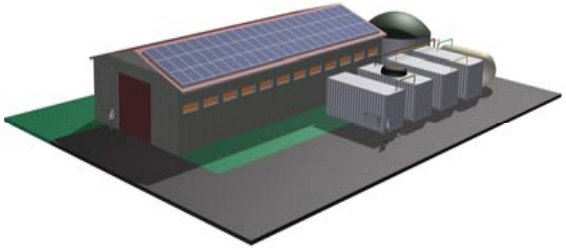


Fermentation

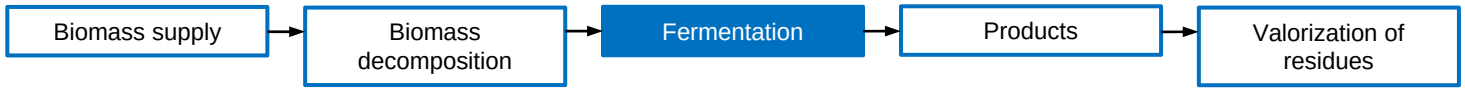
Petroleum $\xrightarrow{30\text{-}180°C}$ Naphtha $\xrightarrow{1050°C}$ **Ethylen** (Olefine)

- solvents
- 200 bar
- High temperatures

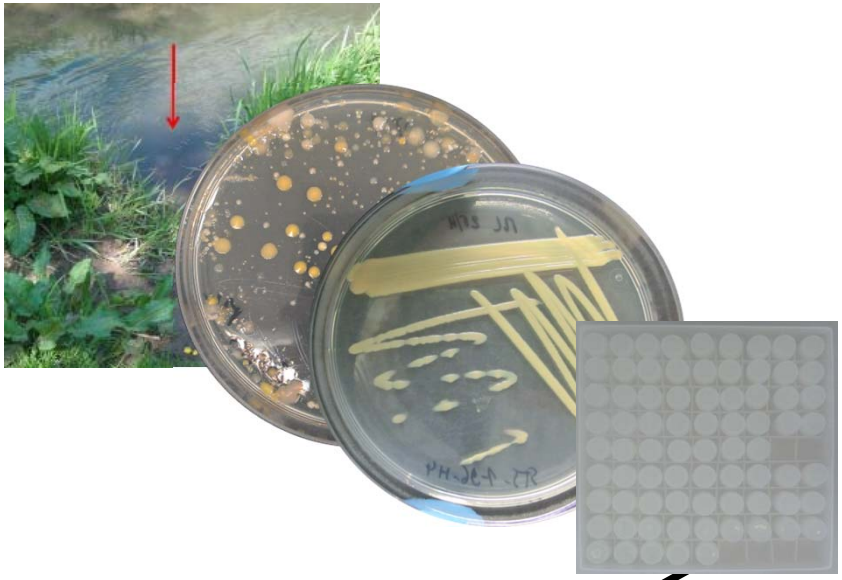
Glucose / Lactat → Ethanol $\xrightarrow{-H_2}$ **Ethylen**



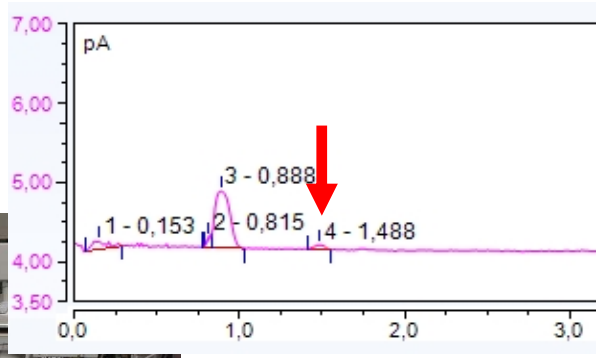
- aqueous
- 1 bar
- Ca. 30°C

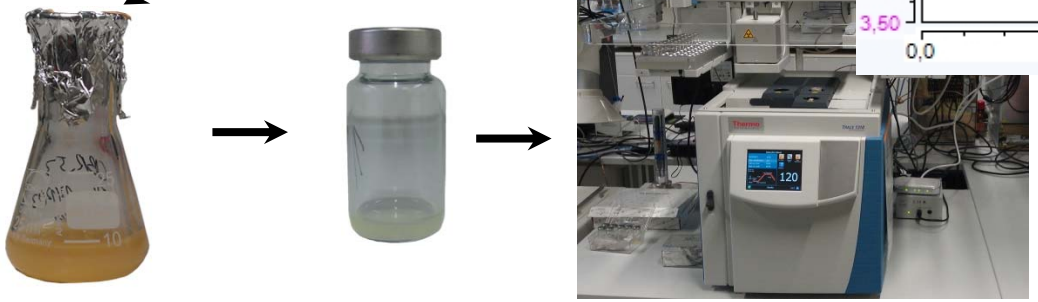


Fermentation



~30 Ethylen building organisms
(ppm-Bereich)
Of ca. 500 tested organisms

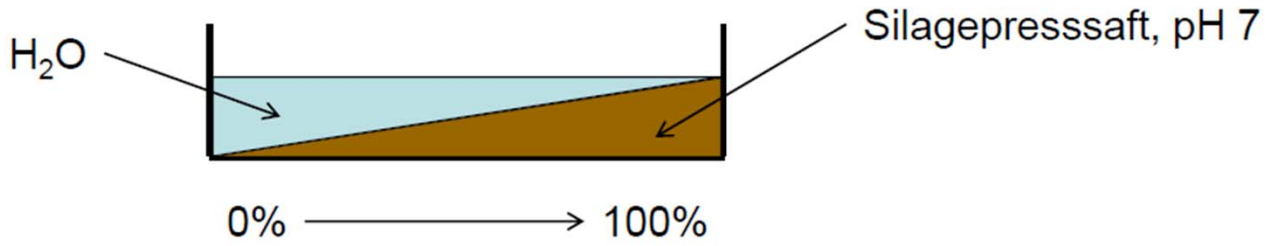




Biomass supply → Biomass decomposition → **Fermentation** → Products → Valorization of residues

Fermentation

Gradienten Platten

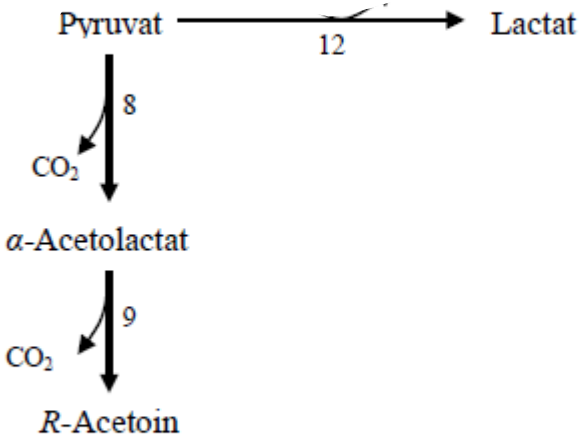


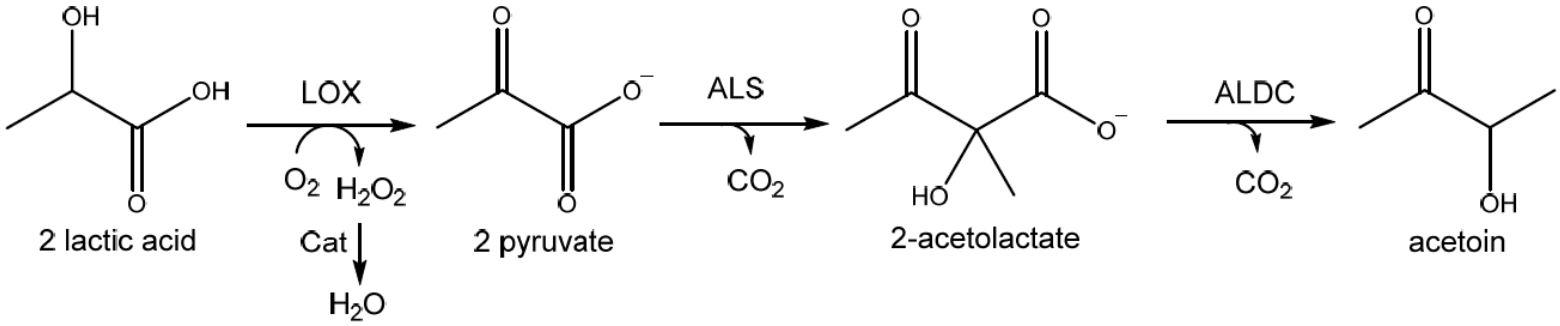
Pichia fermentans *Cupriavidus necator* *Bacillus* sp. *Lysinibacillus xylanilyticus*

Biomasselieferung → Biomasseaufschluss → **Fermentation** → Produktveredelung → Reststoffverwertung

De-acidification of press juice

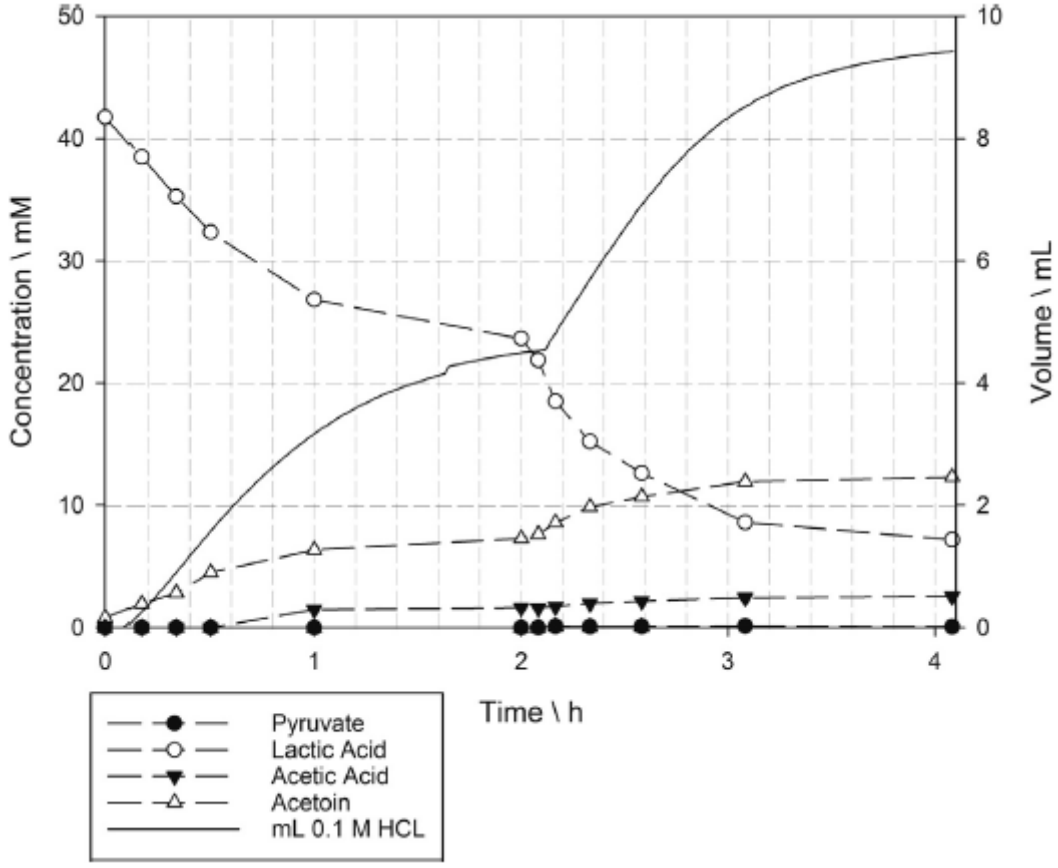
- Removal of lactate => Increase of pH
- Production of value added compound





De-acidification of press juice

Pure lactic acid



De-acidification of press juice

Enzyme immobilization, utilization of press juice

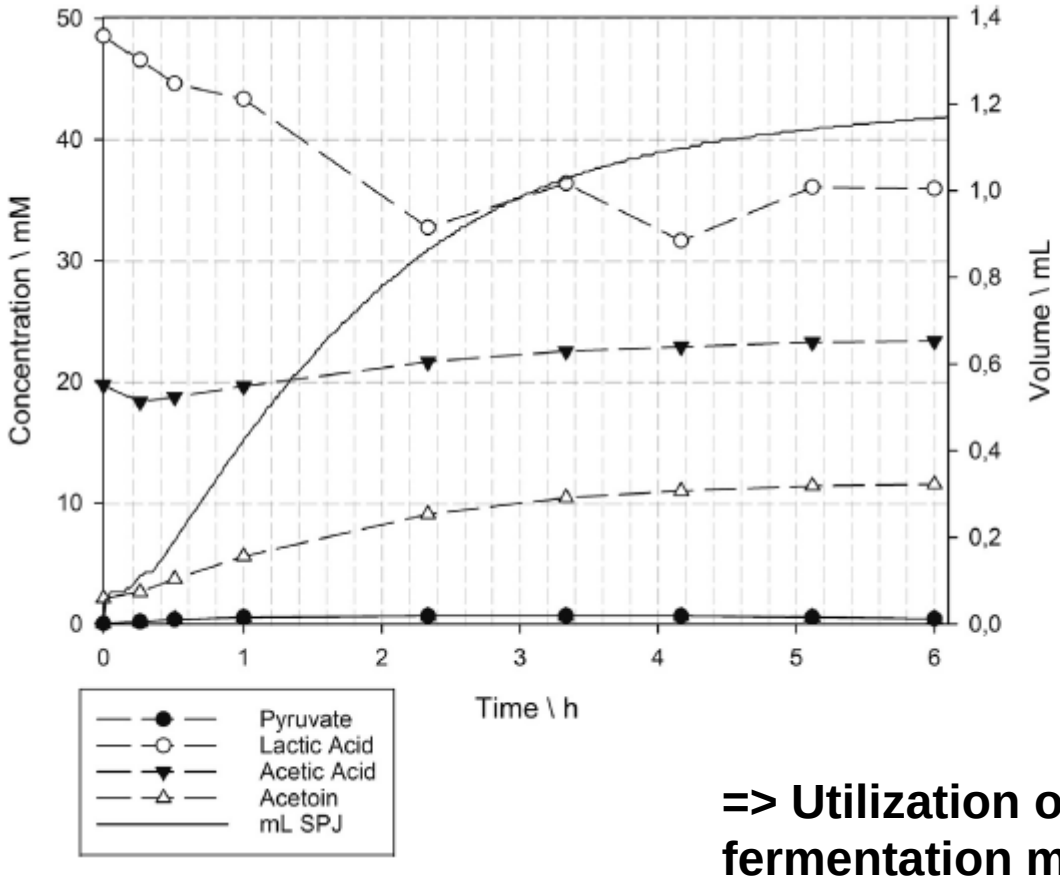
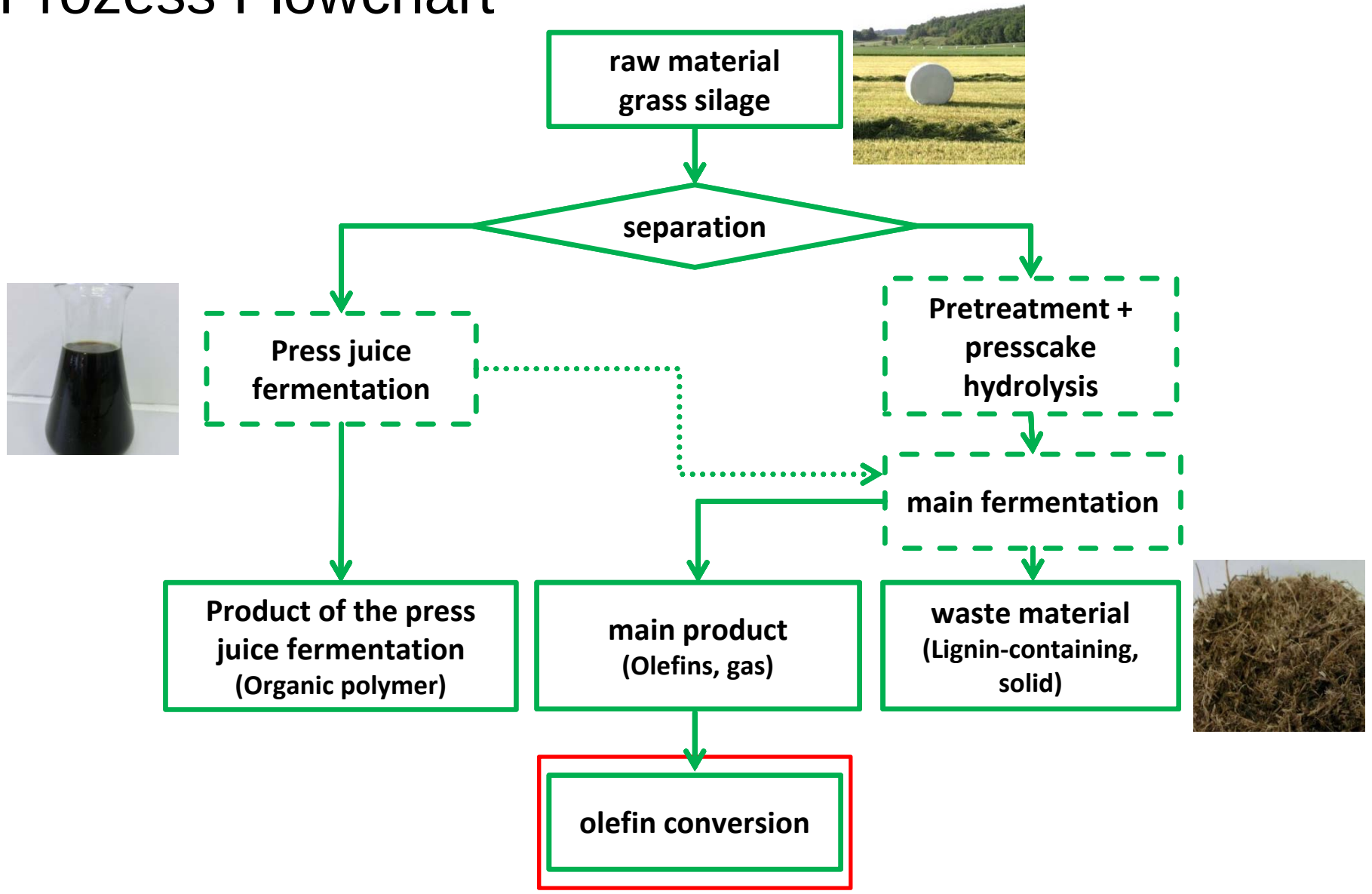


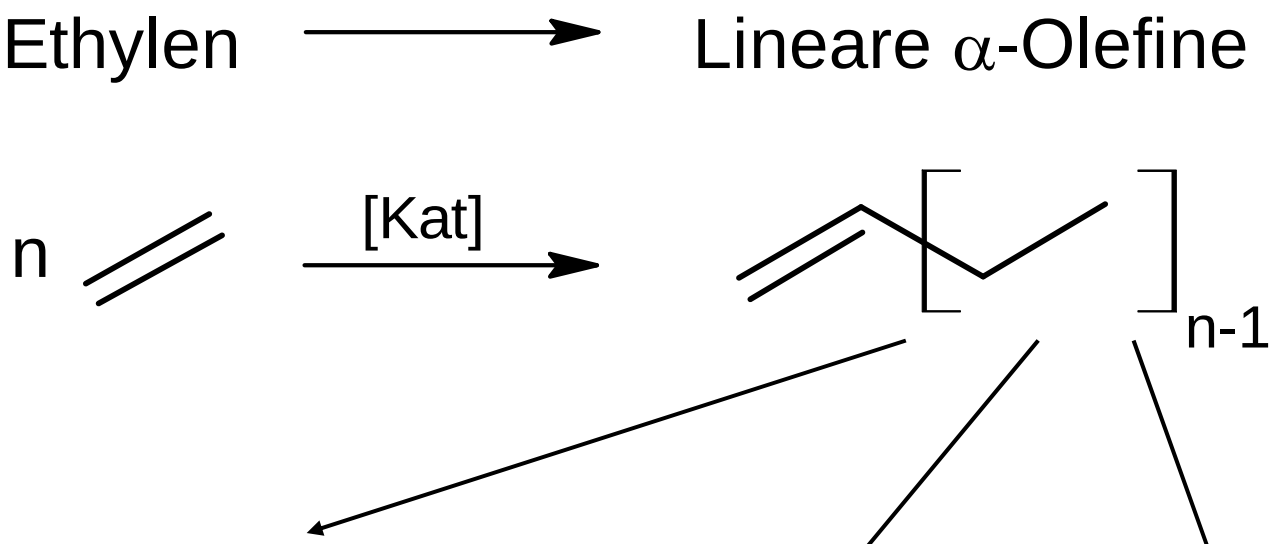
Fig. 5. Production of acetoin via encapsulated enzymatic reaction cascade using diluted SPJ (50 mM lactic acid) as initial mixture. The reaction was run at 40 °C and kept at pH 6.5 by titration of undiluted SPJ.

=> Utilization of residual sugars in fermentation made possible

Prozess Flowchart



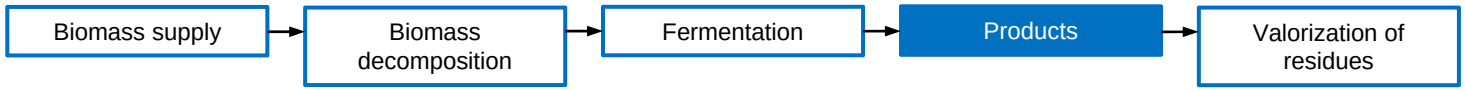
Olefin Conversion



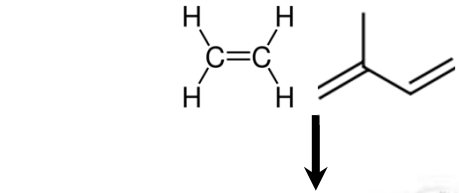
Bio fuel
Comonomers for production of PE (HDPE und LLDPE)

Tensides

Lubricants, plasticisers, etc.

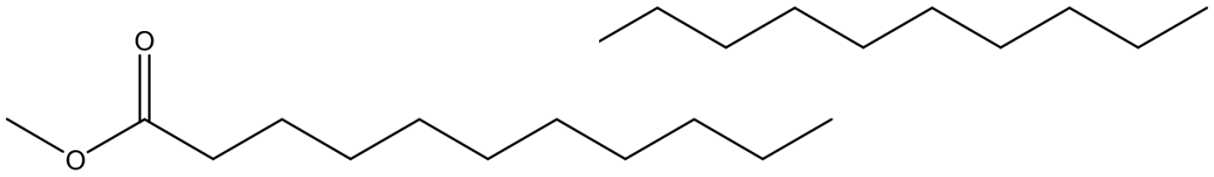


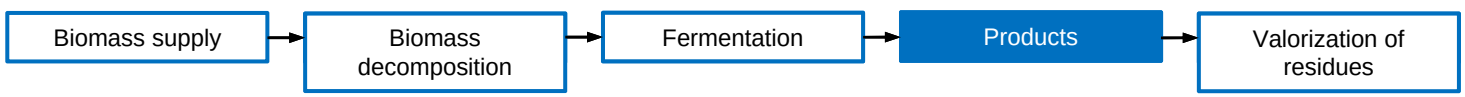
Microreactor



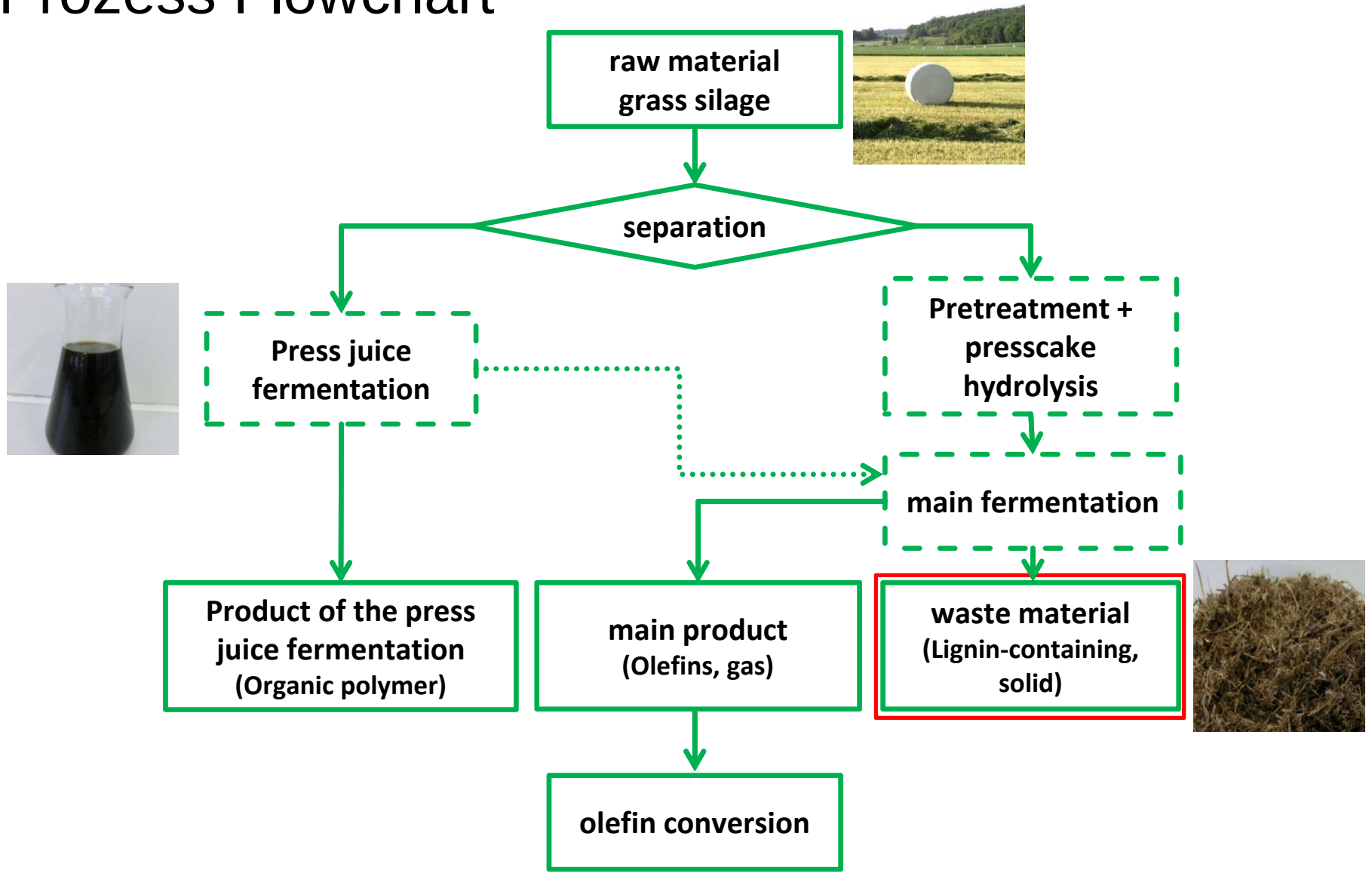
Mirkoreaktor-System

- Säulen
- Katalysatoren





Prozess Flowchart



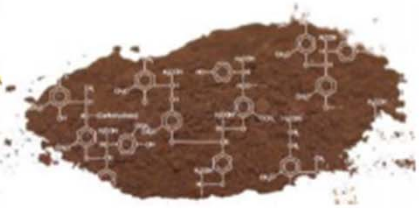
Residues

Rohstoffe

Poaceae - Silage

Reststoffe

Faserstoffe



Lignin

Additivierung / Kompostierbarkeit

Biopolymer-Fiber-Composites (BFC)

Formkörperherstellung

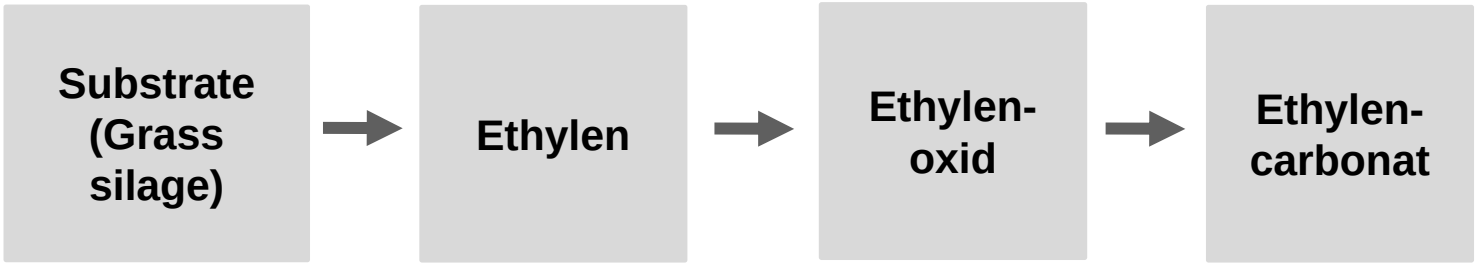
Spritzguß / mech. Charakterisierung

5

Biomass supply → Biomass decomposition → Fermentation → Products → Valorization of residues

Economics

Capacity: 1.000 t/a



Investment (1st Plant)	-	1.000.000 €	780.000 €	780.000 €
Running cost (p.a.)	54.000 €	13.000 €	8.000 €	15.000 €
Personell and others (p.a.)		10.000 €		

Summary

- Substrates are available, farmers are interested
- Flexibility on Substrate is important
- Mechanical processing supports enzymes
- Ethylene or Isoprene are possible intermediates
- Polymers and composit material as side product important for economics
- Decentralized vs. Centralized = „Economy of scale“ vs. „Economy of numbers“

The Farmstead Biorefinery Team