



# Green Biorefinery

a current status

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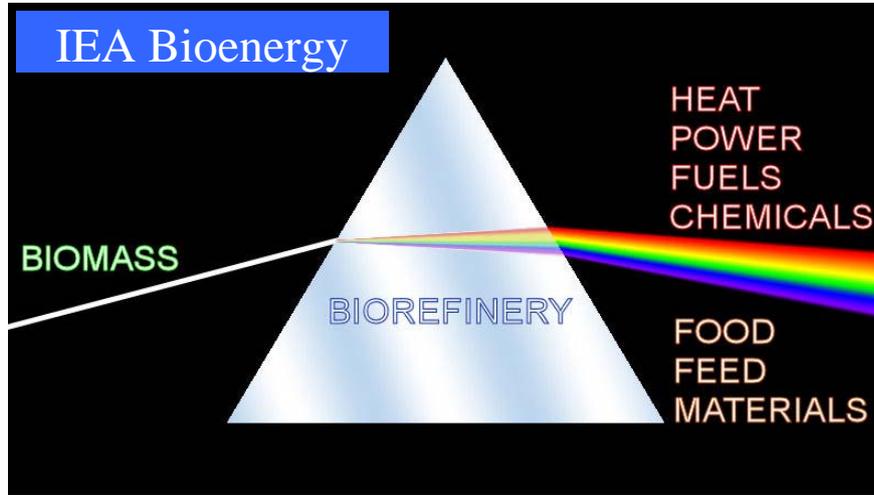
## What can you expect

- **Biorefinery overview**
- **Green Biorefinery: Array of possible Products and processes technologies**
- **Examples of some Demo/ Pilot initiatives across Europe**
- **Operation concepts and logistics**
- **Summary**

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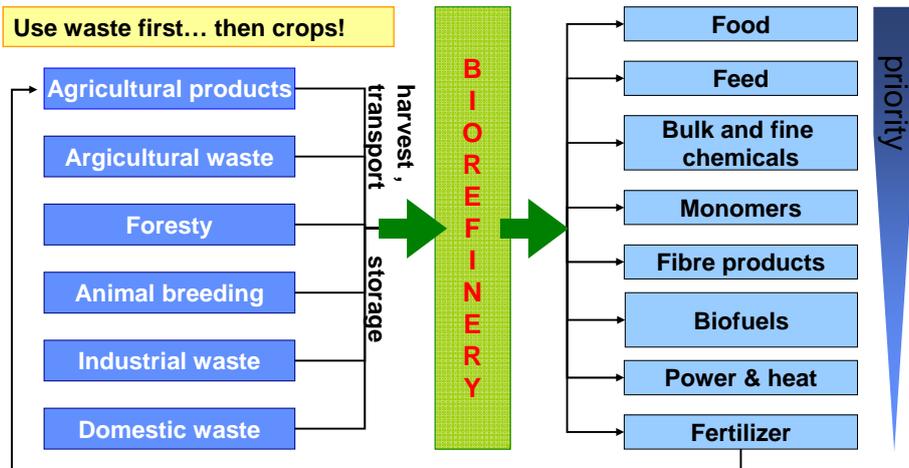
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## Was ist eine "Bioraffinerie"?



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## Overview resources and products



Modified from Janis Gravitis; A Biochemical Approach to Attributing Value to Biodiversity – The Concept of the Zero Emissions Biorefinery

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## Types of biorefinery



- Whole Crop Biorefinerie
- Sugar based Biorefinery
- Lignocelluloses Biorefinery
- Green Biorefinery

According to Kamm et al 2005

..but also names according to uses feedstock or applied processes:

e.g. starch biorefinery, pulp meal biorefinery..

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## What is a Green Biorefinery

**A Green Biorefinery processes (fresh) green biomass to an array of products**

Feedstock options are manifold such as **Grass, Clover, Lucerne...**  
**immature cereals etc.**

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## Motivation

### Traditional use (dairy farming) of grasslands is decreasing

→ Grass is a surplus resources in many regions and countries within EU

e.g. Austria 100.000-150.000 ha (source BAL Gupenstein)

→ Green Biorefinery is an alternative concept for sustainable grassland utilisation

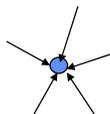
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## General challenges in biomass processing

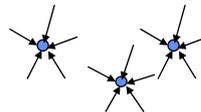


### size optimisation

Balancing of feedstock logistics and economy of scale !



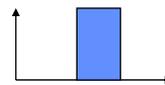
Central vs. decentral



Why not bring the process to the raw material?



Storage vs. campaign



Adapt the process to the raw material?

M. Narodslawsky 2007

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## ...some answers to build on

- Feedstock logistics strongly determine the size of Green Biorefinery (not “economy of scale” factors)  
→ regional embedding of technology
- Mobile processing is hardly developed at present
- Local production of raw material generates stimulation of rural area (import of feedstock ??)
- Ensiling feedstock enables continues operation
- From the long term perspective security of raw material supply requires sustainable agriculture!

## Product options

**Green Biorefinery technology at present mainly focuses on**

- Proteins (amino acid)
- soluble sugars
- ligno- cellulose fractions (fibres)
- special fine chemical

**As product or valuable intermediate**

## Primary processing

Basic processing is a mechanical fractionation (screw press, refiner etc..) to generate a **juice and solid fraction**



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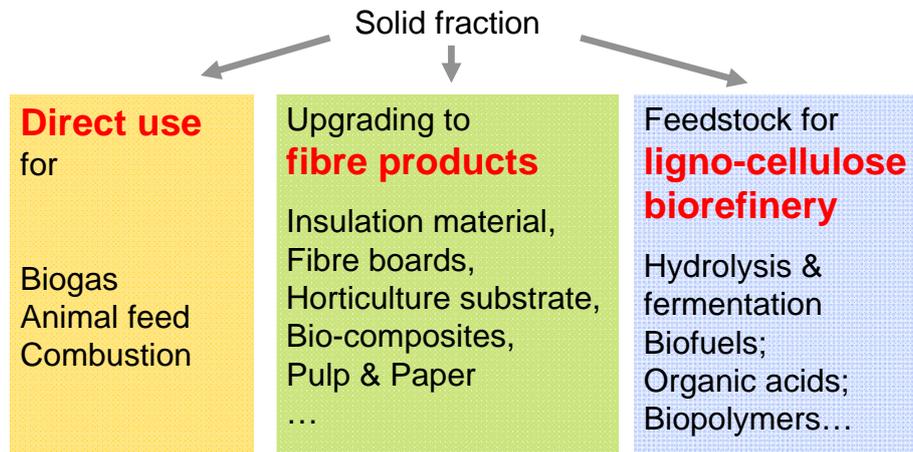
## Processing grass juice

Process technology	Product or intermediate	Application	Market size
Agglomeration membrane technology	Protein recovery	animal feed	+++
<b>Separation technology</b> e.g. nanofiltration electro dialysis/ chromatography	Amino acids mixtures	High grade, e.g nutrition supplement, body care	+
	Lactic acid	Bulk chemical food/ feed/ drinks/ PLA, Ethyllactat...	++
Direct fermentation	e.g. lactic acid ...		++
Biogas generation	Bio-methane	CHP or gas-grid biofuel	++(+)

+ small ++ medium +++ big

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## Processing fibre fraction



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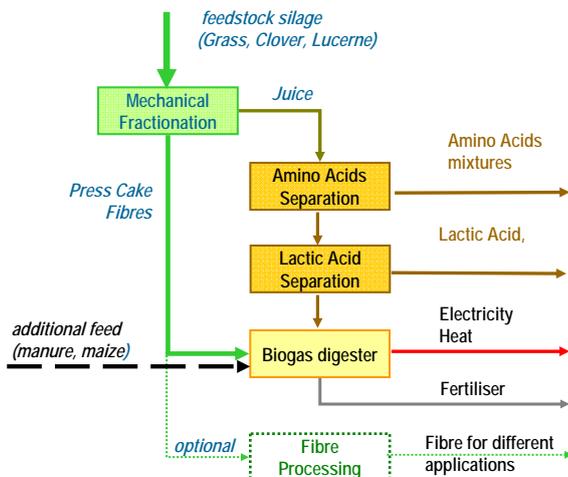
**Some fibre product samples**

## Some examples for Green Biorefinery initiatives in Europe (Demo / Pilot plants)

Country	Current Status	Products	Remarks
Austria	Pilot plant (Utzenaich)	Lactic acid, Amino acids, Biogas	LA + AA separation out of silage juice; fibres to biogas
Germany	Pilot Plant Brandenburg Demo „Biowert“	Lactic acid Biogas, feed, fibre	Fermentation of fresh green juice + starch hydrolysis Mainly biogas
Ireland	Concept		Biogas + Insulation
Netherlands	„closed“ pilot plant; new facilities planned	Feed product focus, fibre utilisation	fibres for pulp and paper and various fibre products... „mobile“ operation concepts
Switzerland	Demoplant	Grass fibre insulation product biogas and feed options	Commercial business for insulation material; biogas and feed not yet fully integrated

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## Green Biorefinery Utzenaich, Austria



**Upgrading  
grass silage to  
lactic acid,  
amino acids and  
biogas**

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## Green Biorefinery Pilot Plant Utzenaich



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## Lactic acid



- **~85% recovery of lactic acid from silage feedstock**
- **Application: bulk chemical, solvent, bio-polymer (PLA)**
- **Combination of separation technologies**
- **Market perspective for LA promising**

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## Amino Acids



- Silage: hydrolyzed proteins
- ~60% rel. recovery rate of amino acids from Silage
- All essential amino acids are contained
- from nutrition ...personal care is feasible
- Complex juice composition !

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## Pilot Plant Brandenburg, Germany

### Use of fresh grass juices for lactic acid fermentation

- Pre-treatment of plant substrates for microbial conversion processes
- Kinetics of cell growth and product processing of lactic acid bacteria
- Development of continuous processes for the production of basic chemicals, valuable products and biomass



*Pilot plant facility for biotechnological manufacture of valuable products based on renewable resources*

Source: Joachim Venus, ATB

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## Pilot Plant in Obere, Switzerland

### Biomass Process Solution (BPS) upgrades grass fibre to insulation products



### Use of liquid phase for biogas generation

Source: Stefan Grass, BPS

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## Pilot Plant in Obere, Switzerland cont.

### Benchmarking grass insulation properties

Product	Heat conductivity [W/m,K]	Greenhouse potential [kg CO <sub>2</sub> -aequiv./kg]	Sound absorption	Sommer heat protection
Stonewool	0.035	1,4	good	medium
Polystyrene	0.035	3,2	poor	medium
Flax	0.04	0,4	good	good
<b>Gramitherm®</b>	<b>0.035</b>	<b>-0,9 (!)</b>	<b>good</b>	<b>good</b>

Source: BPS, S. Grass

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## Products



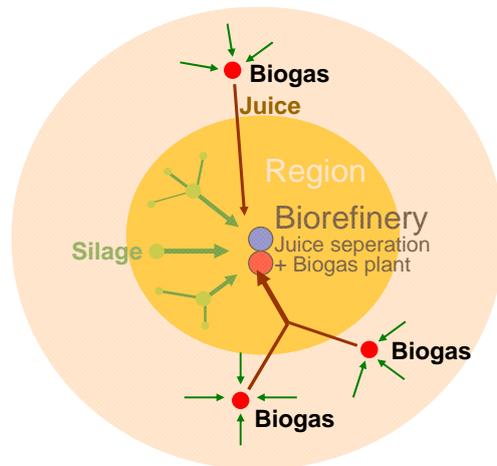
Source: Johan Sanders, WUR

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## Examples Green Biorefinery integration

Grass Biorefinery in the center of a supply area (r =15-20km)

Possible Integration of surrounding region



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### “Take home message...”

- **Economic feasibility: 2-3 product outlet is required**
- **incentives for biogas generation (green power legislation) could boost Green Biorefinery**
- **Grass protein for animal feed products is a economically challenging but offers a very big market for big scale implementation**
- **Grass is good in crop rotation and has proven to be a sustainable long term resource**

### “Take home message...”

- **Logistics are part of the process setup which lead to regional adopted biorefinery solutions**
- **Lack of funding for pilot activities is a major bottleneck for stepping into the market**
- **Linking Green Biorefinery with Ligno-Cellulose Refinery pathway is an attractive concept  
→ further R&D needed!**