Green Biorefinery

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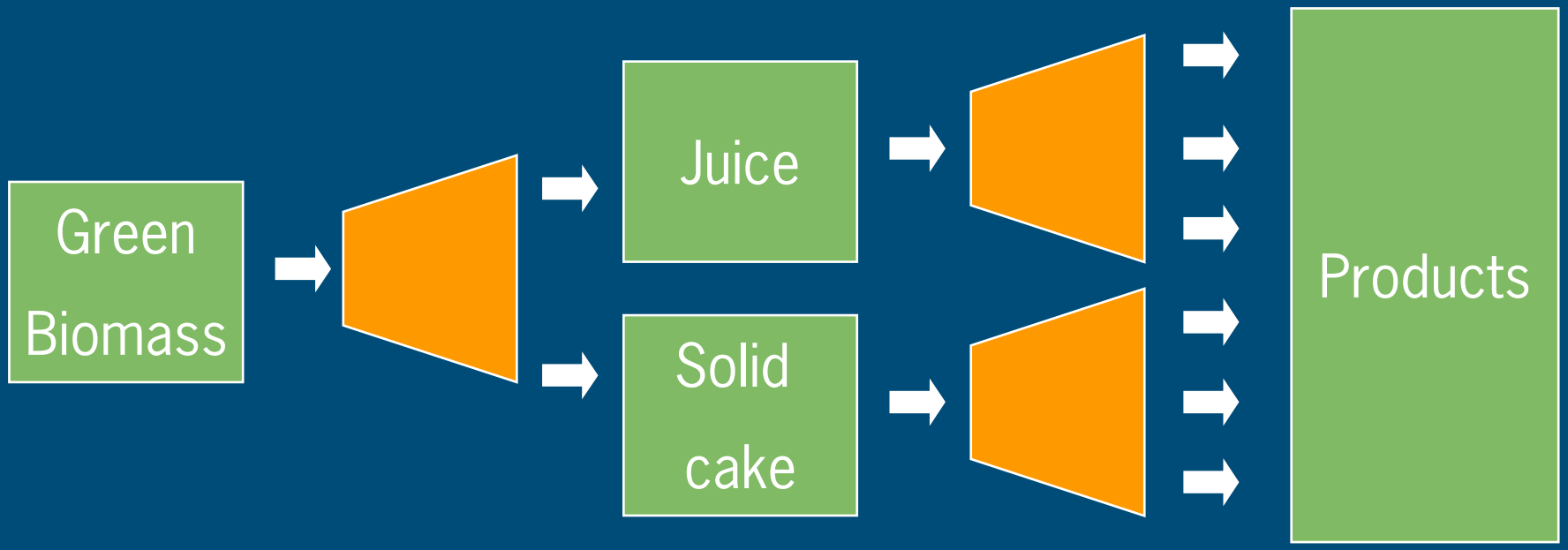
- Green Biorefinery overview
- Array of products and technologies
- Demo and Pilot initiatives across Europe
- Operation concepts and logistics
- Summary

Green Biorefinery overview

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



Green biomass

- Grass
  - Nature
  - Verge
  - Culture
- Clover
- Luzerne
- Sugar beet leaf

- Potato Leaf
- Green fertilizers
- Immature Cereals
- …..

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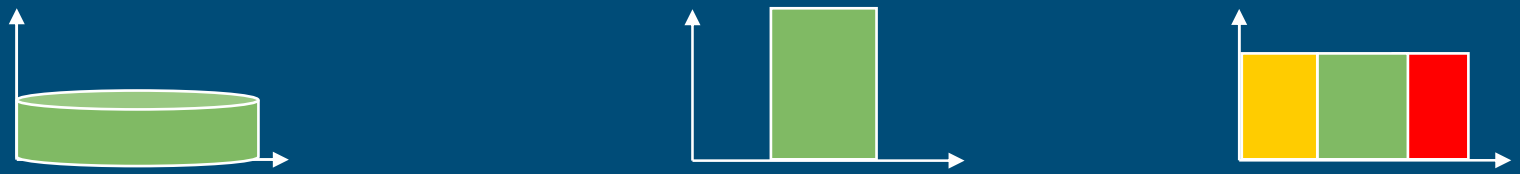
Motivation

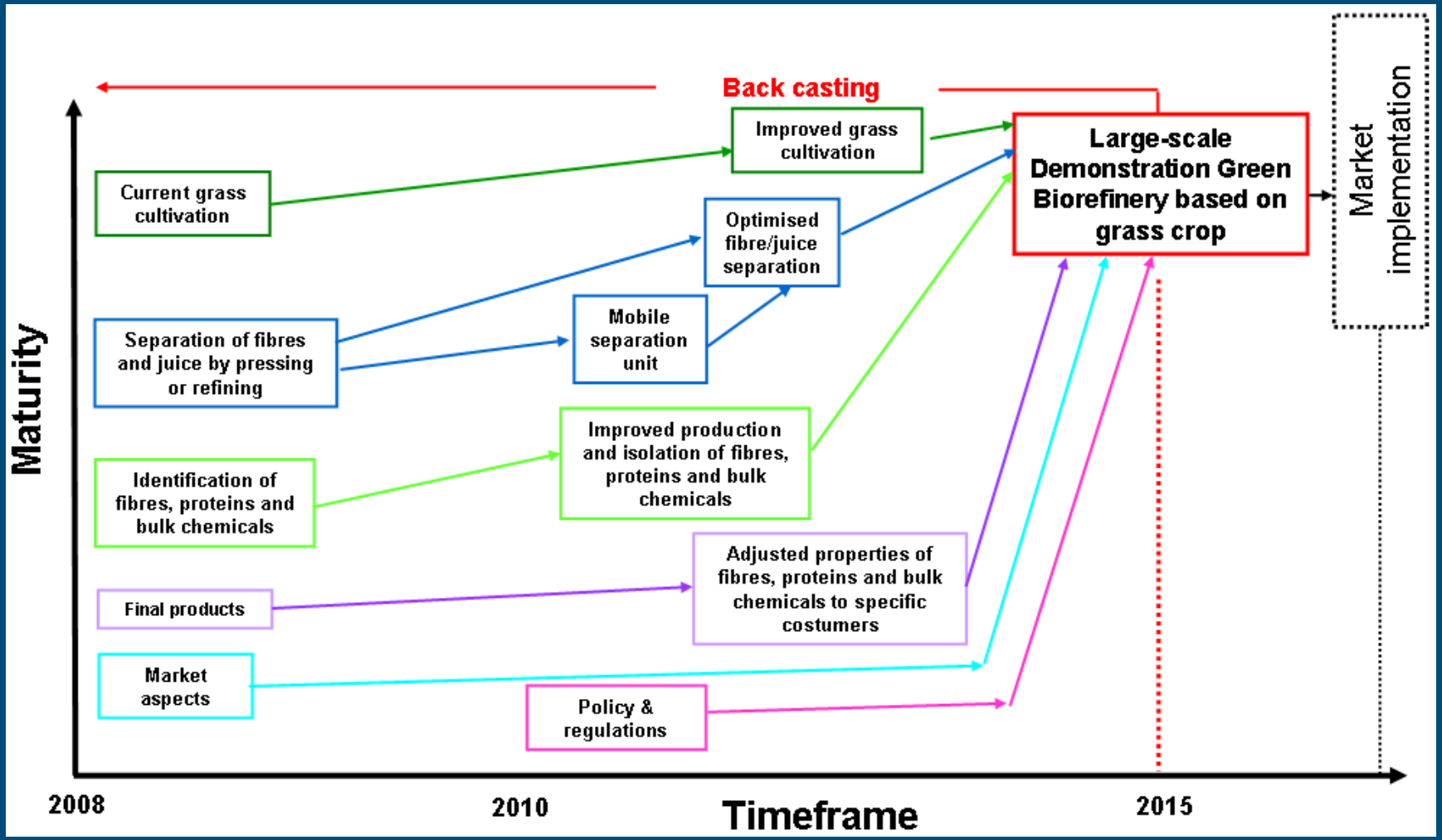
- Traditional use (dairy farming) of grasslands is decreasing
  - Grass is a surplus resources in many EU-regions
  - Green Biorefinery is an alternative concept for sustainable grassland utilisation
- Alternative cellulose sources are necessary
  - Demand for wood is increasing rapidly
- Alternative feed products
  - Soy import

General challenges in biomass processing

- Economy of scale
  - Transportation costs
  - Wet vs. dry products
- Central vs. decentral
  - Mobile units
- Storage vs. campaign



Dutch roadmap Biorefinery: Grass



Products

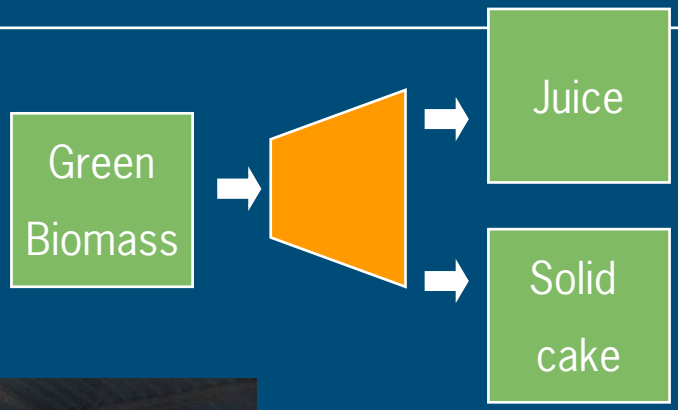
Main focus current Green Biorefinery technology

- Proteins (amino acid)
- Soluble sugars
- Ligno- cellulose fractions (fibres)
- Special fine chemical

As product or valuable intermediate

Primary processing

- Mechanical Fractionation
  - Screw Press
  - Refiner



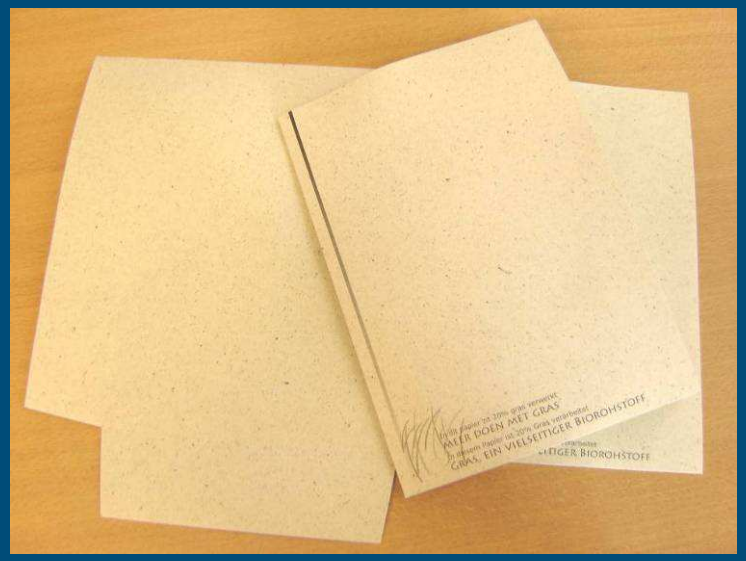
Secondary processing: Juice

Secondary processing: Juice

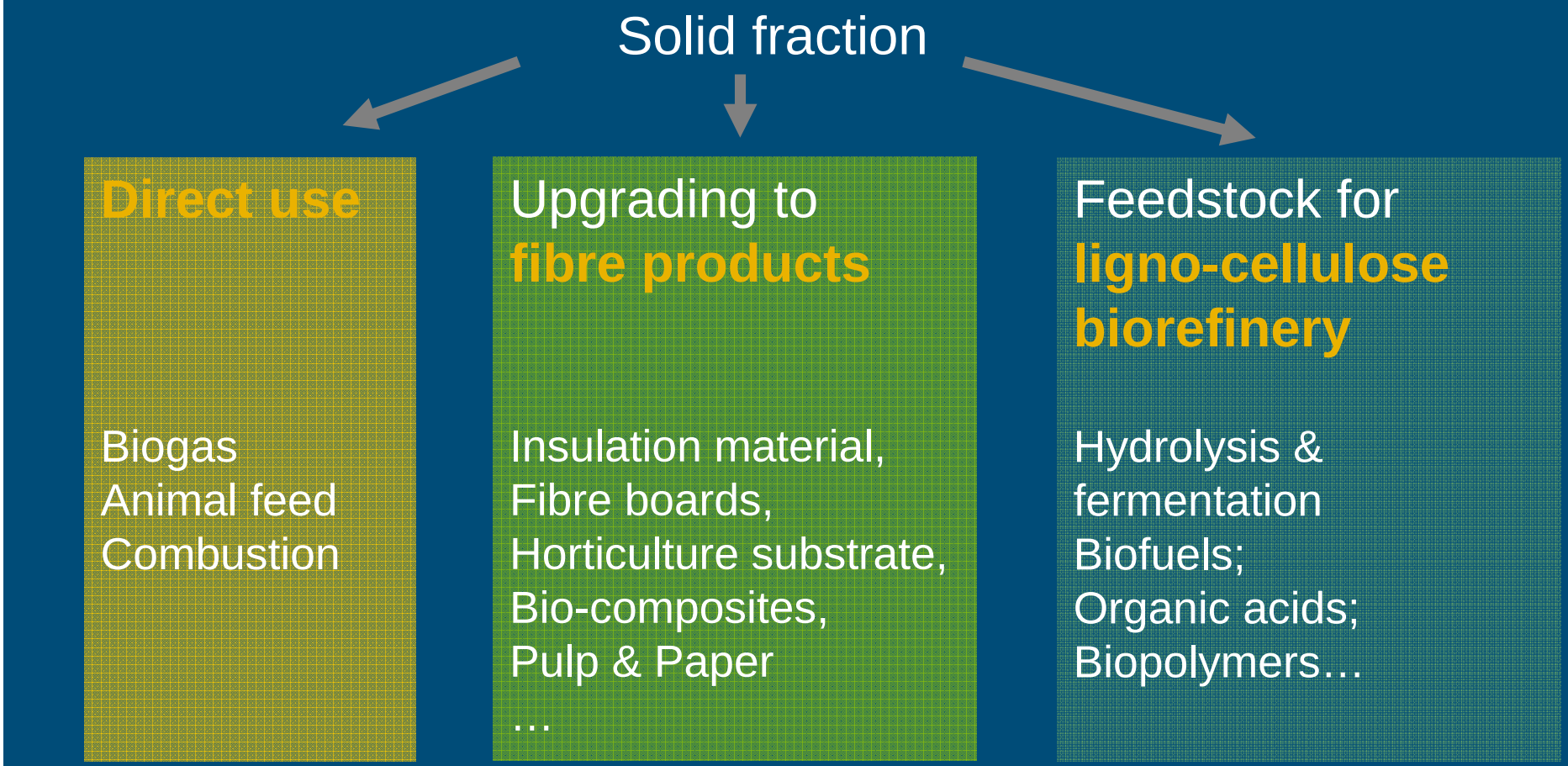
Process technology	Product or intermediate	Application	Market size
Agglomeration membrane technology	**Protein recovery**	**animal feed**	**+++**
Separation technology e.g. nanofiltration electro dialysis/ chromatography	**Amino acids mixtures**	**High grade, e.g nutrition supplement, body care**	**+**
	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

Secondary processing: Solid cake



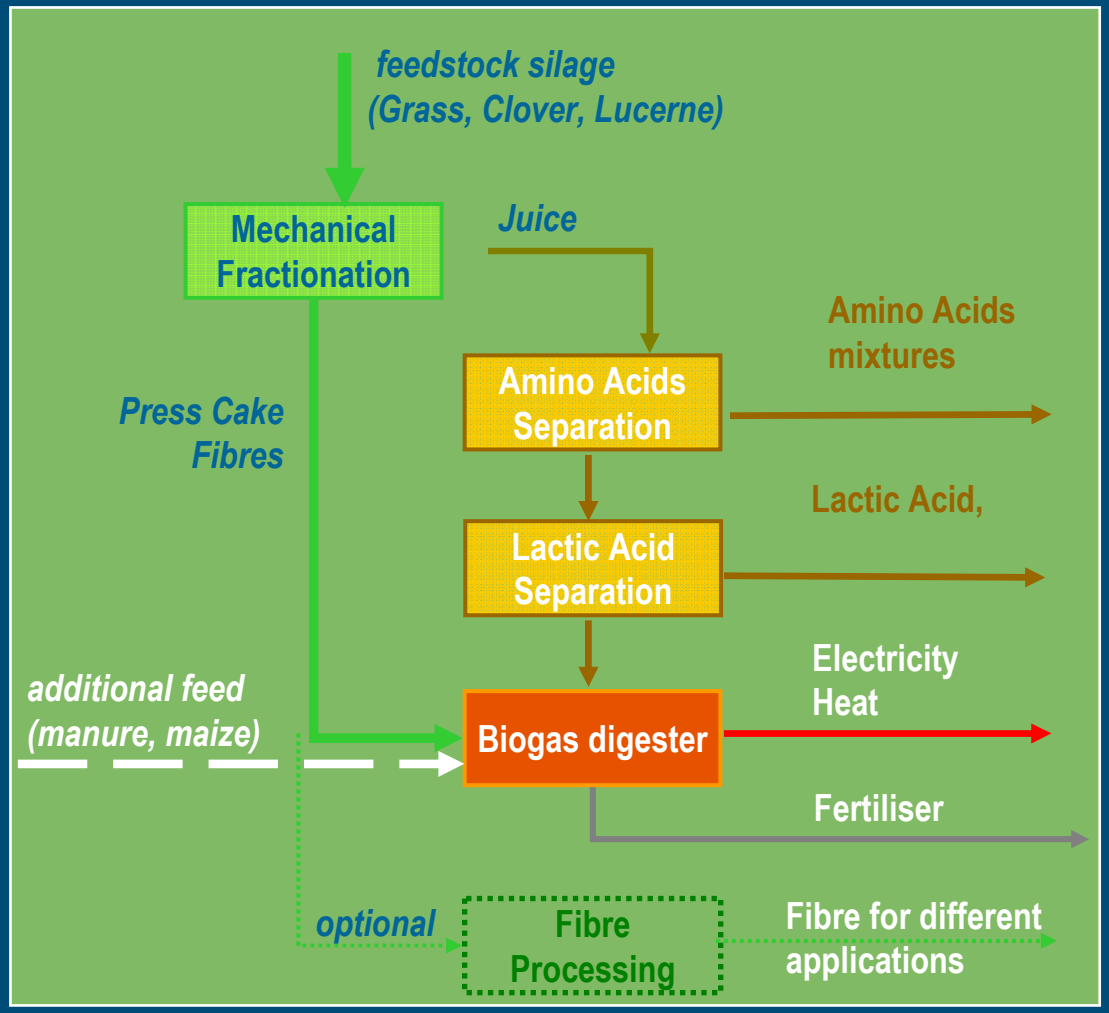
Secondary processing: Solid cake



Demo and Pilot plants in Europe

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	Pilot plant Grassa! 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

Green Biorefinery Utzenaich, Austria



Upgrading grass silage to lactic acid, amino acids and biogas

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Green biorefinery Netherlands

1998

Grass

Prograss
- central

Courage/
de Haan
- mobile unit

GRASSA!

2003

2006

2008

2010

GRASSA!!

Sugar beet leaf

CSM
- digester

Suikerunie
- Fibre
- Protein

Pilot Plant Brandenburg, Germany

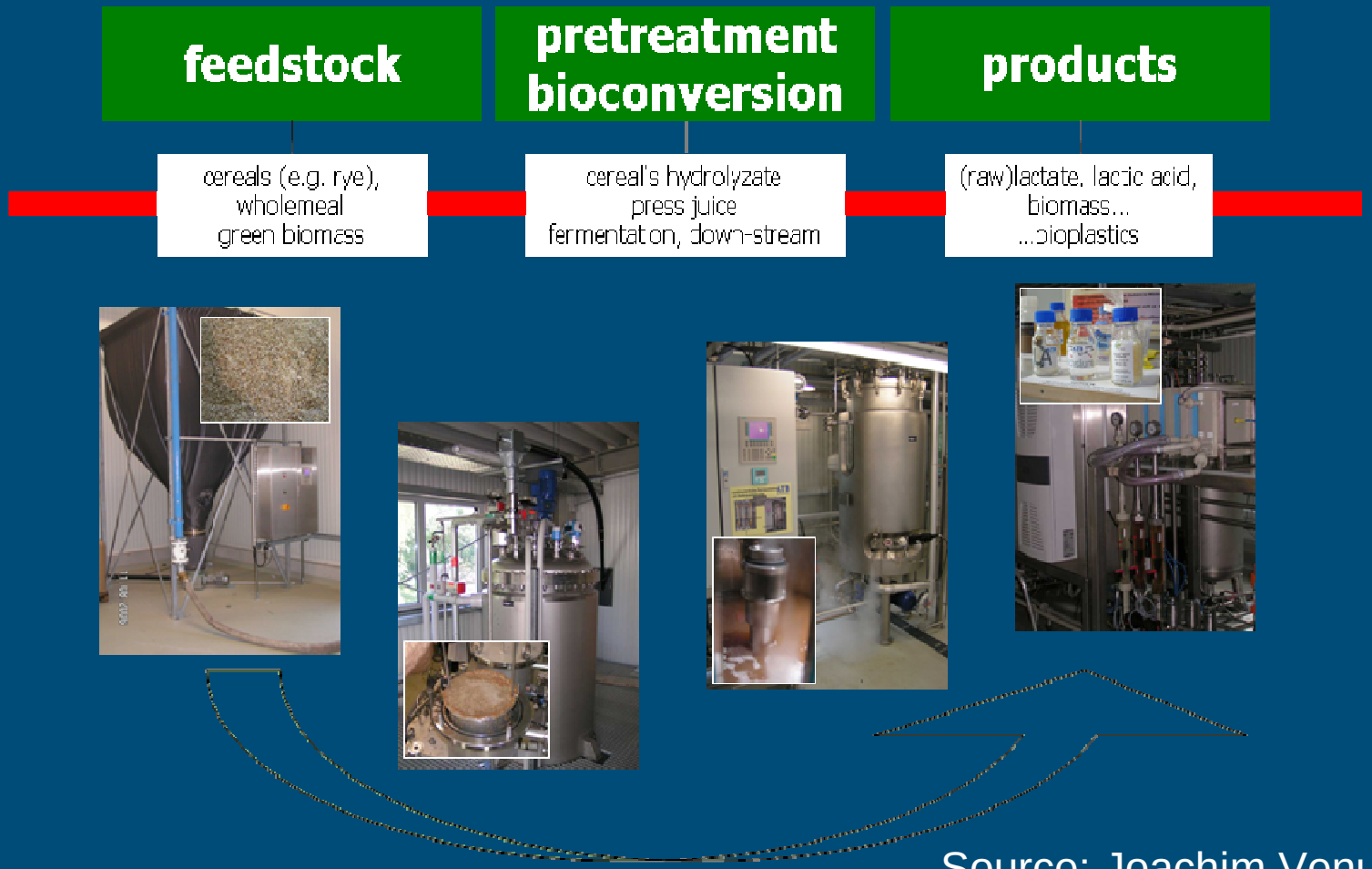
Use of fresh grass juices for lactic acid fermentation

- 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

Pilot Plant Brandenburg, Germany cont.



Source: Joachim Venus, ATB

Pilot Plant in Obre, Switzerland

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

Use of liquid phase for biogas generation

Source: Stefan Grass, BPS

Pilot Plant in Obre, Switzerland cont.

Benchmarking grass insulation properties

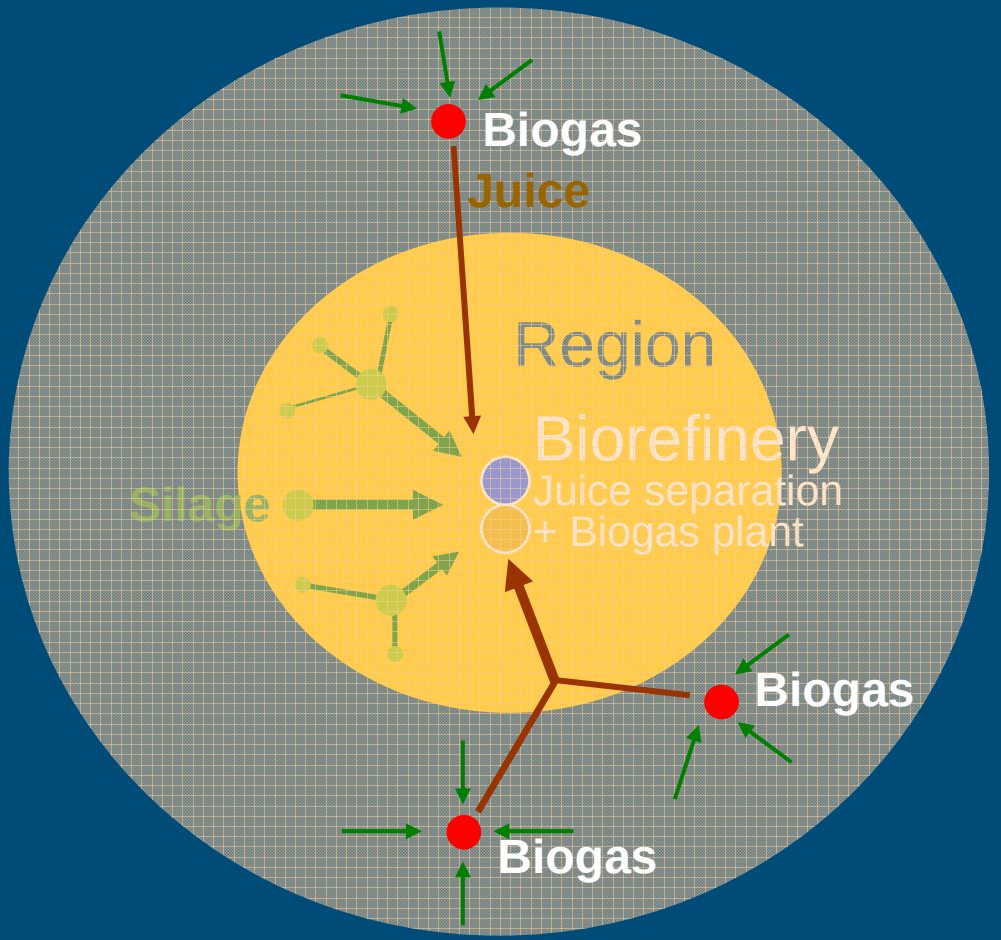
Product	Heat conductivity [W/m,K]	Greenhouse potential [kg CO_2-aequiv./kg]	Sound absorption	Sommer heat protection
Stonewool	0.035	1,4	good	medium
Polystyrene	0.035	3,2	poor	medium
Flax	0.04	0,4	good	good
Gramitherm®	0.035	-0,9 (!)	good	good

Use of liquid phase for biogas generation

Source: BPS, S. Grass

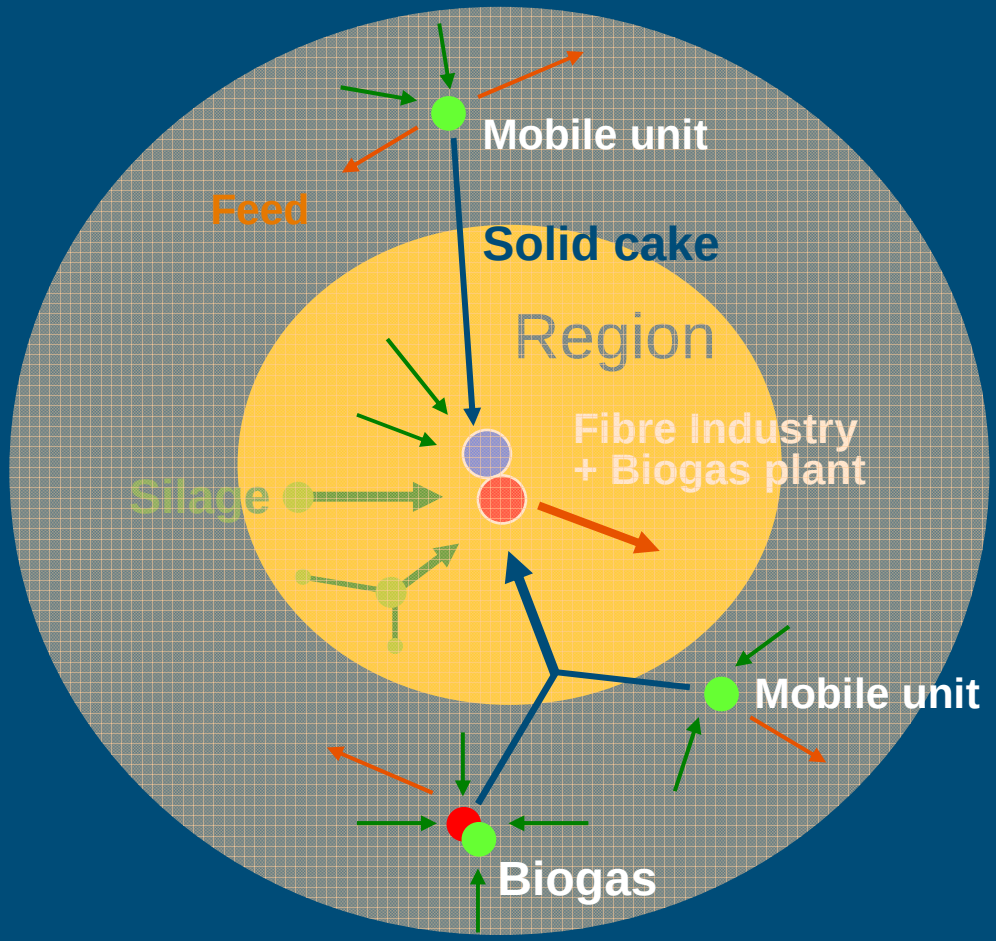
Green Biorefinery integration: Austria

- Grass Biorefinery in the centre of a supply area (r =10-20km)
- Possible Integration of surrounding region



Green Biorefinery integration: Netherlands

- Fibre Industry in the centre of a supply area
- Integration of surrounding region



…some answers to build on

- Feedstock logistics strongly determine the size of Green Biorefinery (not “economy of scale” factors)
  → regional embedding of technology
- Regional circumstances determine biorefinery setup and product array
- Ensiling feedstock enables continues operation
- From the long term perspective security of raw material supply requires sustainable agriculture!

“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!

Thank you for your attention

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