

The background of the slide is a close-up photograph of vibrant green grass blades, slightly out of focus, creating a natural and fresh aesthetic.

Green Biorefining grass for generating products and energy

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What is a Green Biorefinery

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

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

Motivation green biorefinery

- ▶ **Traditional grass utilisation has been changing... due to strong restructuring of diary/ beef sector**
- ▶ **→ grassland biomass has become a surplus resources in some areas available for alternative use**
- ▶ **Green biorefinery is seen as new utilisation pathway to enter future markets (food/feed, biochemical, material and biofuels sector)**
- ▶ **Biorefinery are expected to support rural development and agricultural sector respectively**

Alternative grass utilisation

From grass for cattle towards grass for bio-industry



food products
milk & beef,
and manure



bio-products
food/feed, materials,
bulk and fine chemicals,
biofuels and energy...

„..from cow
to
„technical cow“



Grassland in Europe

Table 1: Distribution of grassland and forage crops by EU Member States, and intensity indicators in 2007. Source: Eurostat 2010 (Farm Structural Survey 2007), Lutter (2009), own calculations.

EU member state	Code	perm. grassland Share of UAA (%)	forage crops (%)	forage area share of EU-27 total (%)	grazing livestock per forage area LU ha ⁻¹	cow milk production kg ha ⁻¹
EU-15						
Austria	AT	54	8	2.6	0.77	1568
Belgium	BE	37	18	1.0	2.63	3911
Germany	DE	29	12	9.2	1.41	4087
Denmark	DK	8	18	0.9	1.75	6751
Spain	ES	35	3	12.4	0.71	698
Finland	FI	2	29	0.9	0.97	3172
France	FR	29	17	16.8	1.26	1918
Greece	GR	20	6	1.4	1.79	744
Ireland	IE	76	17	5.1	1.43	1344
Italy	IT	27	14	6.9	1.06	2161
Luxemburg	LU	52	18	0.1	1.61	2834
The Netherlands	NL	43	22	1.6	2.25	9301
Portugal	PT	51	10	2.8	0.61	747
Sweden	SE	16	36	2.1	0.77	1885
United Kingdom	UK	62	8	15.1	0.91	1228
EU-12						
Cyprus	CY	1	29	0.1	2.04	3175
Czech Republic	CZ	26	12	1.7	0.82	2138
Estonia	EE	30	24	0.7	0.42	1356
Hungary	HU	12	6	1.0	0.95	2390
Lithuania	LT	31	15	1.6	0.55	1645
Latvia	LV	36	22	1.4	0.31	829
Malta	MT	0	45	0.0	3.50	8655
Poland	PL	21	5	5.4	1.17	3004
Slovenia	SI	59	11	0.4	1.07	1561
Slovakia	SK	28	13	1.1	0.51	1225
Bulgaria	BG	9	3	0.5	2.11	3359
Romania	RO	33	6	7.0	0.75	992
EU-15		36	12	79	1.11	2005
EU-12		25	8	21	0.85	1780
EU-27		33	11	100	1.06	1958

In EU 27:
33% of utilized
arable area is
perm.
grassland

Reference: Osterburg B et al; Impact of economic and political drivers on grassland use in the EU, Grassland Science in Europe, Vol 15

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**



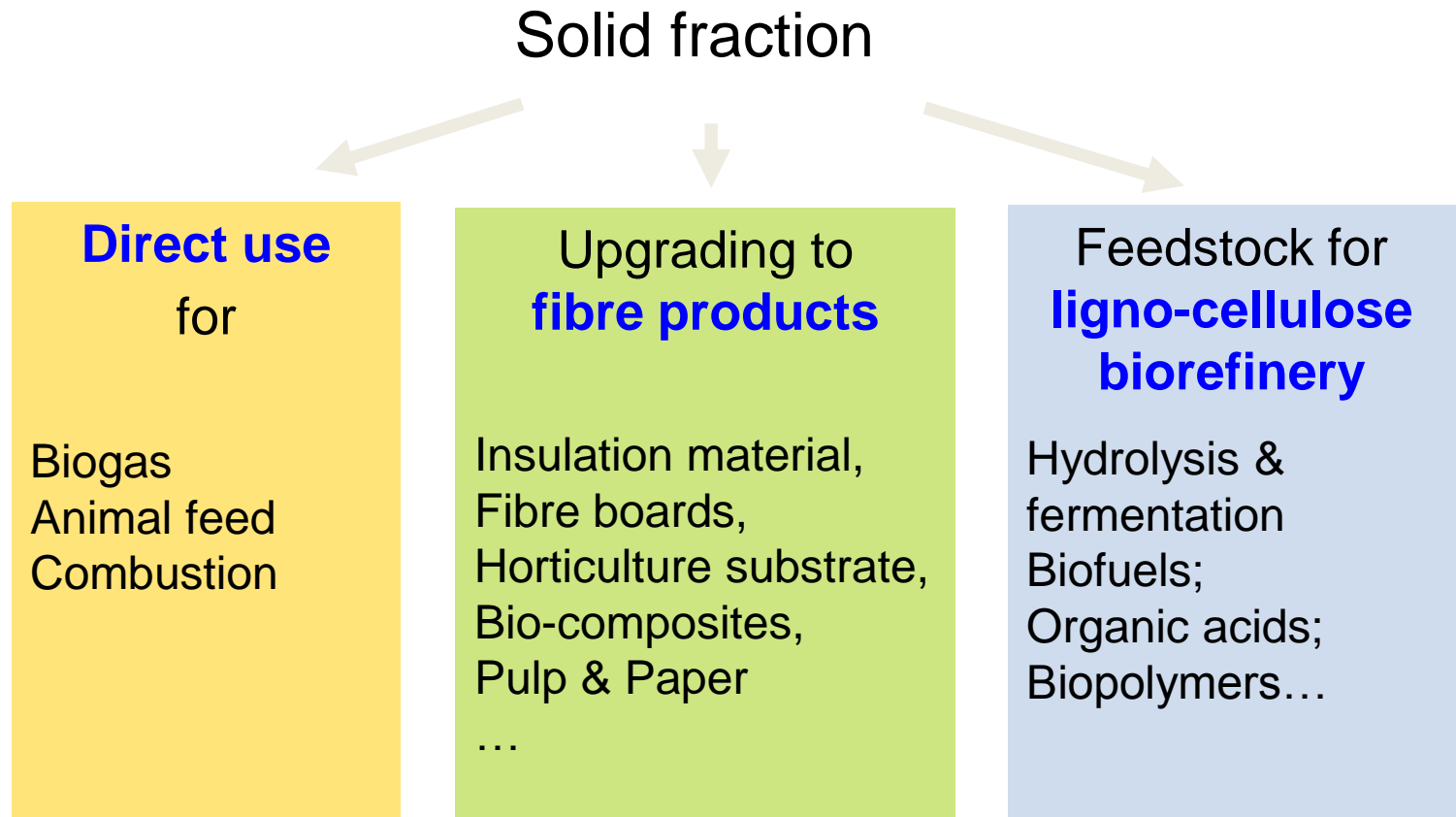
Quelle: E Keijsers

Processing grass juice

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

+ small ++ medium +++ big

Processing fibre fraction





Some fibre product samples

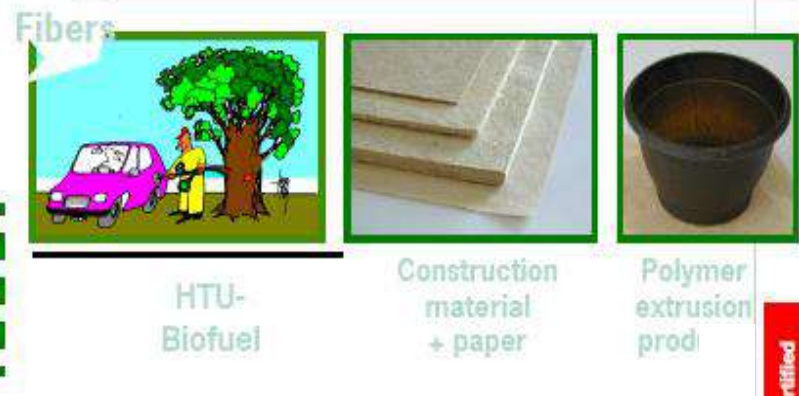
Some examples for Green Biorefinery initiatives in Europe (Demo / Pilot plants)

state	Current Status	Products	Remarks
A	Pilot plant (Utzenaich)	Lactic acid, Amino acids, Biogas	LA + AA separation out of silage juice; fibres to biogas
GER	Pilot Plant Brandenburg Demo „Biowert“	Lactic acid Biogas, feed , fibre	Fermentation of fresh green juice +starch hydrolysis Mainly biogas
IRE	Concept		Biogas + Insulation
DK	Pilot , Demo	Protein, Lysin-feed	Integrated to green pellets production
NL	„closed“ pilot plant; new facilities planed	Feed product focus, fibre utilisation	fibres for pulp and paper and various fibre products... „mobile“ operation concepts
CH	Demoplant	Grass insulation product (biogas a. feed options)	Commercial business for insulation material; biogas & feed not jet integrated

Prograss Initiative

Grass pilot plant (NL)

Plant not existing any more!



Source:JP Sanders, WUR

Pilot Plant in Orbe (CH)

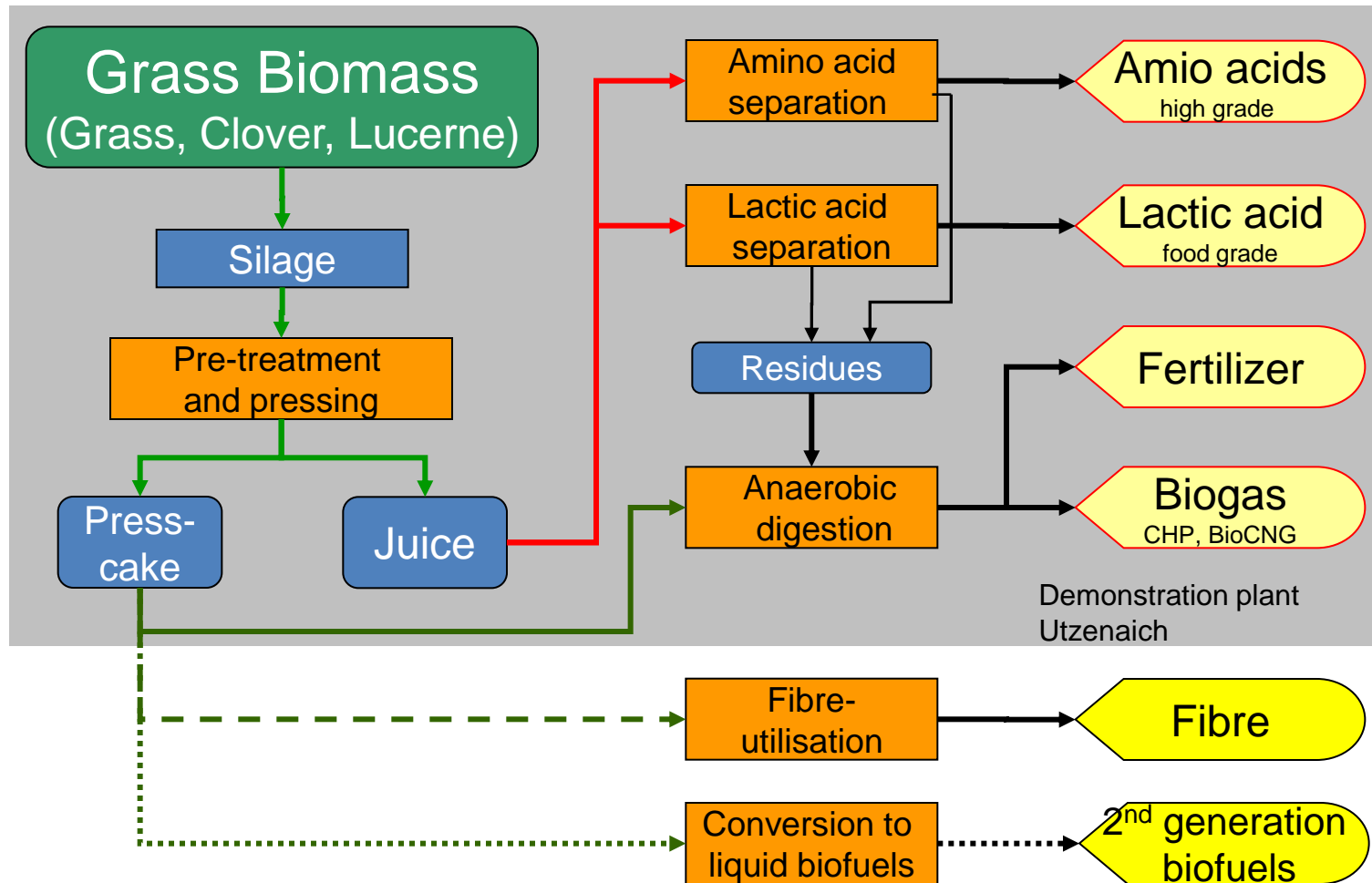
**Biomass Process Solution (BPS)
upgrades grass fibre to insulation products**



Use of liquid phase for biogas generation

Source: Stefan Grass, BPS

Set-up of Green Biorefinery Utzenaich



Down stream processing silage juice in green biorefinery Utzenaich

Combination of different separation processes:

- ▶ **Ultra & nano filtration**
- ▶ **Electro dialysis**
- ▶ **Reversed osmosis**
- ▶ **Ion exchange**



Results Green Biorefinery

› Economy

- › Economic feasibility of processing is possible at moderate scales (app. 10.000 DM/a feedstock)
- › Required revenue for Amino acid mixture > 4 €/kg
- › AA product from grass is new and needs to be introduced
- › Green power tariffs (biogas CHP) have strong effect on the economics

› Implementation

- › A production plant for grass utilisation is currently in evaluation; access to AA market is important

Green Biorefining for Ireland?

- ▶ Feedstock is there but currently animal feed?
- ▶ Cost prize grass silage: (80) - 150€/tdm

(1) Grass → protein concentrate + Biogas/CHP

(2) Grass → high value protein + Biogas/CHP

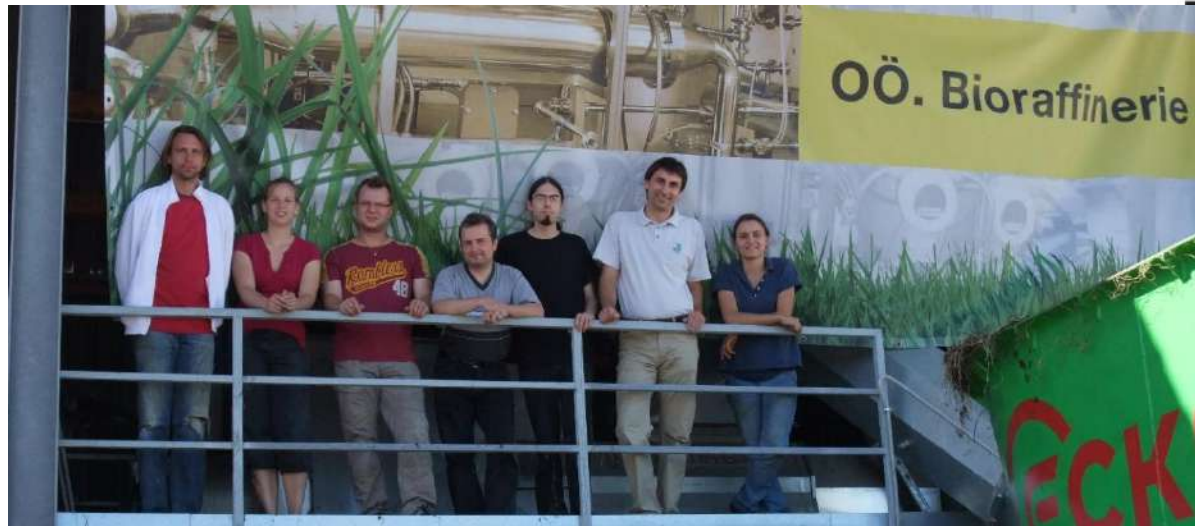
(3) Grass → AAs + Biogas/CHP

(4) Grass → AAs + press cake for feed

(5) Grass → AAs + press cake for fibre product

Conclusions Green Biorefinery

- ▶ **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**



We proudly acknowledge our funders and partners



Amino acid product

% of 100g spray dried powder

Aminosäure	Eigenanalyse	Analyse AGES ³	Schwankungsbereich AGES
Asparaginsäure	11,5	11,3	1,19
Threonin	2,08	2,31	0,23
Serin	1,63	1,57	0,16
Glutaminsäure	4,15	3,93	0,39
Asparagin	0,00		
Prolin	6,92	6,48	0,65
Glycin	3,88	4,04	0,40
Alanin	13,0	13,5	1,35
Cystein	2,50	4,34	0,65
Valin	8,34	8,37	0,84
Methionin	1,95	1,27	0,19
Isoleucin	5,76	5,73	0,57
Leucin	9,14	9,24	0,92
Tyrosin	1,42	1,22	0,12
Phenylalanin	3,09	3,32	0,33
GABA	3,49	n.a.	
Ammonium	0,16	n.a.	
Lysin	0,00	n.n.	
Histidin	0,00	n.a.	
Tryptophan	0,00	0,21	0,0206
Arginin	0,00	n.n.	
Summe AA	78,8	76,8	

Quelle: Eigene Messungen, bzw. Analyseergebnisse der AGES