small scale biorefineries - opportunities and challenges

STATUS OF THE BIOECONOMY

Oslo, 2-3 September 2015

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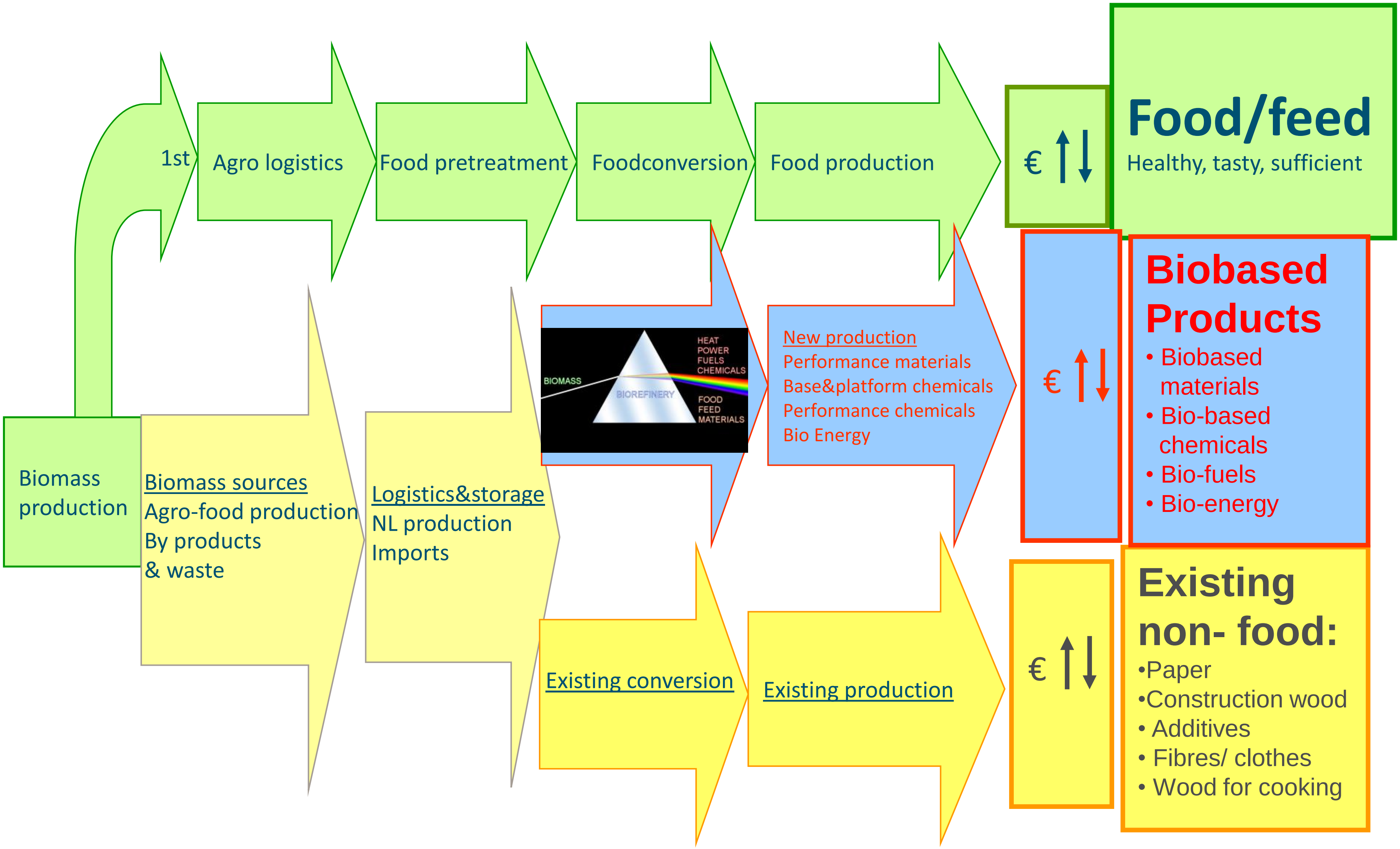
The new challenges in a biobased Economy:



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Many drivers for the Biobased Economy

- Shortage of cheap oil
- High energy prices
- Security of energy supply
- Climate change by green house gasses
- Rural development
- Developing countries
- Geo-political conditions

Different countries/groups are confident however that a BbE can contribute to their goals.

Design rules for a sustainable Bio-economy *People, Planet, Profit*

- *Improve our overall energy efficiency*
- Increase field yield but *keep components on the field that are required for soil fertility*
- Use all biomass components and *choose the right raw material*
- Use each component at its highest value:

  (molecular) structure is much better than caloric
- Reduce capital cost to speed up innovation and *to benefit from small scale without the disadvantages*

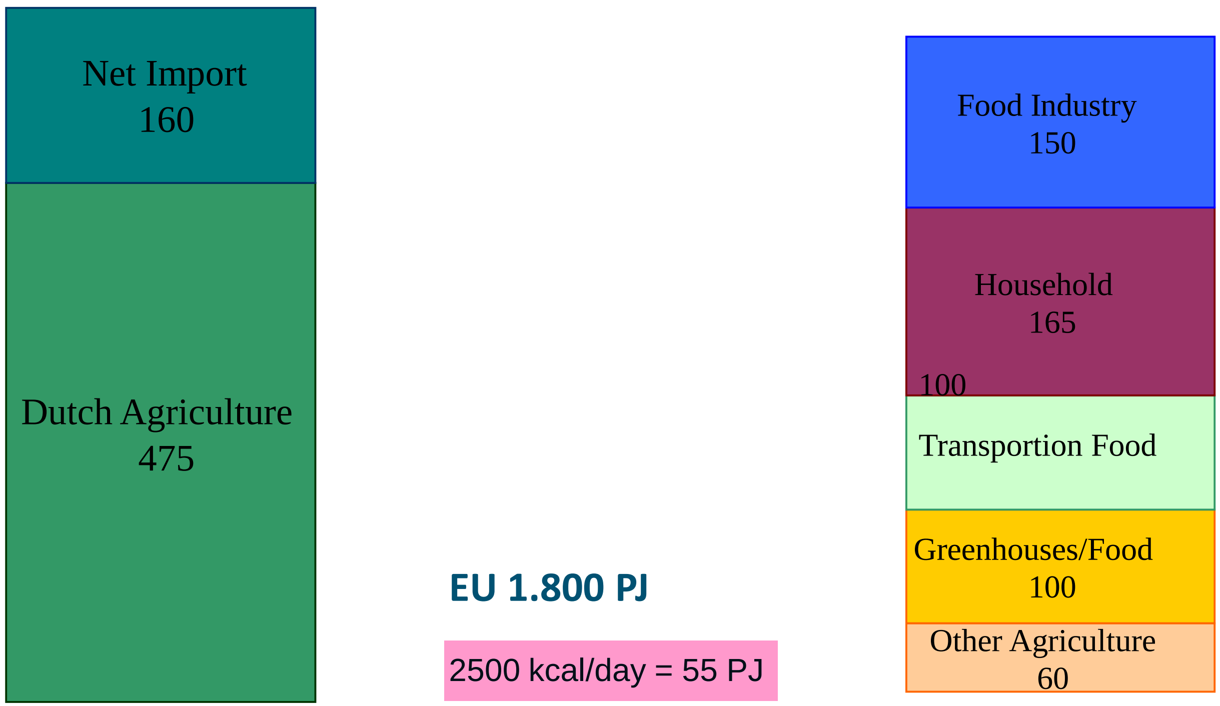
Following these rules, will we have enough resources?

Our daily food needs a 20-fold higher energy input

20 000PJ is more than 20% of our European energy bill!

Biomass
NL 635 PJ
EU 20.000 PJ

Fossil
NL 575 PJ
EU 20.000 PJ



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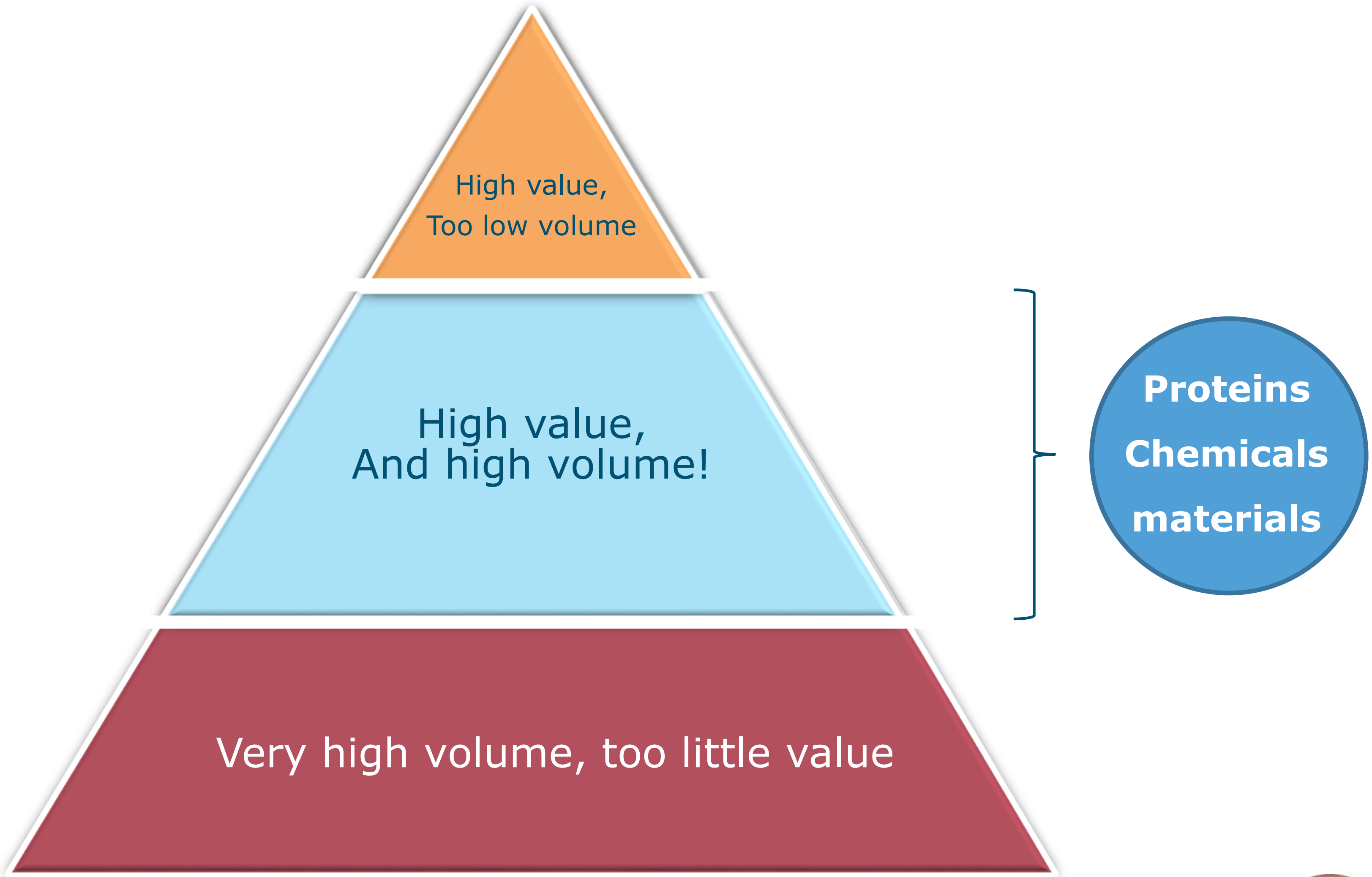
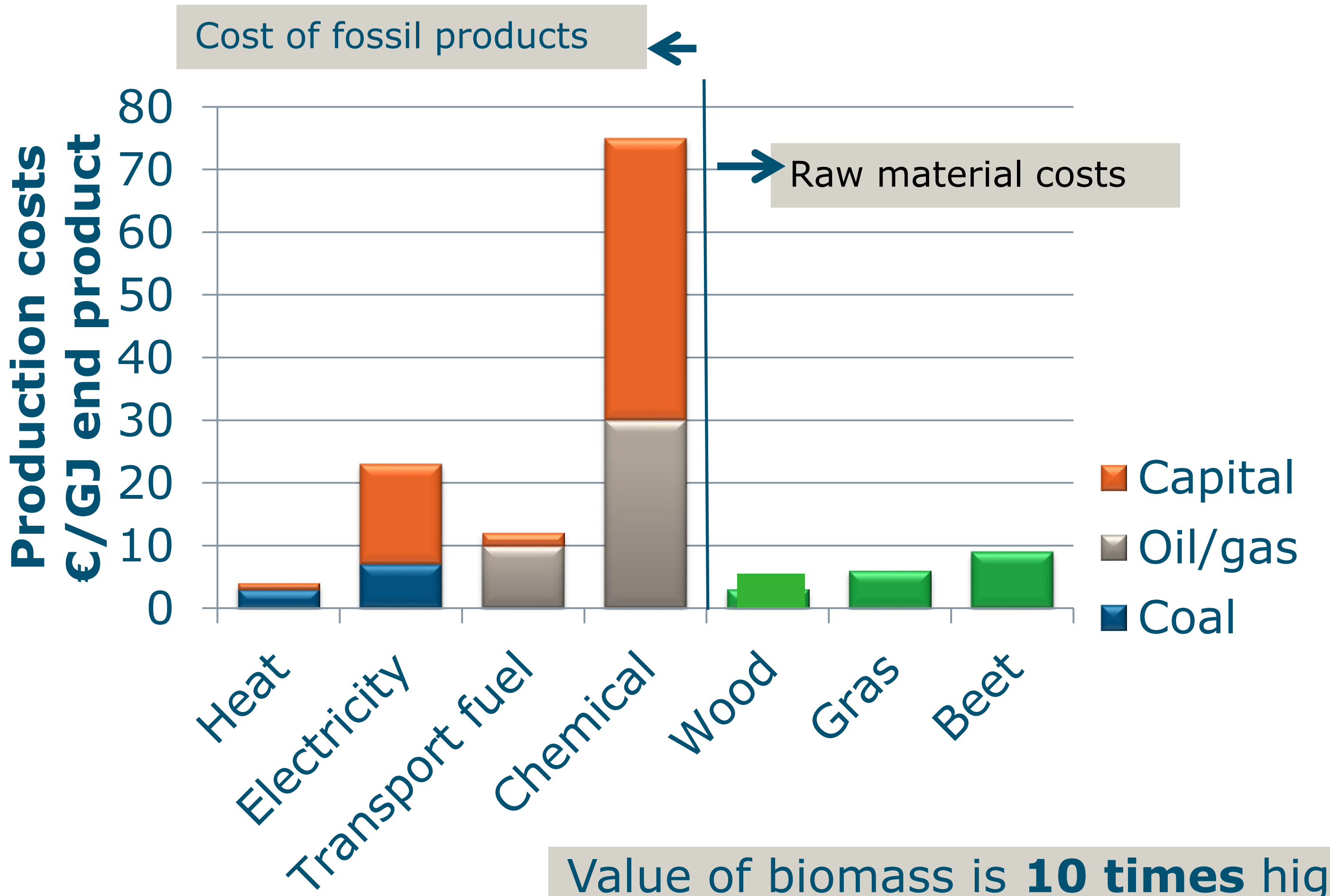
Economic carriers in the BioEconomy



How biomass can best compete with fossil feedstocks



Value of biomass is **10 times** higher as chemical building block than to use it for biogas or bio-electricity

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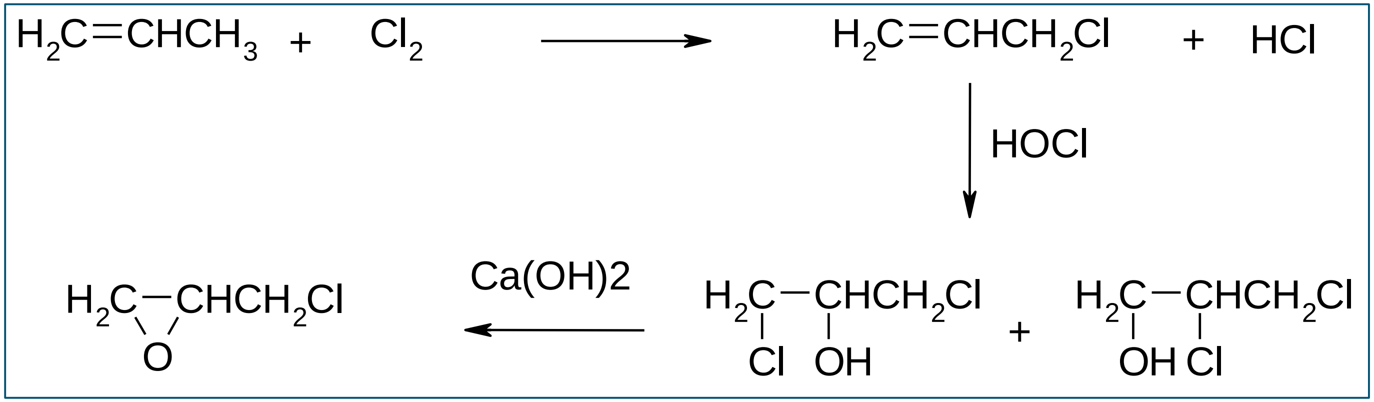
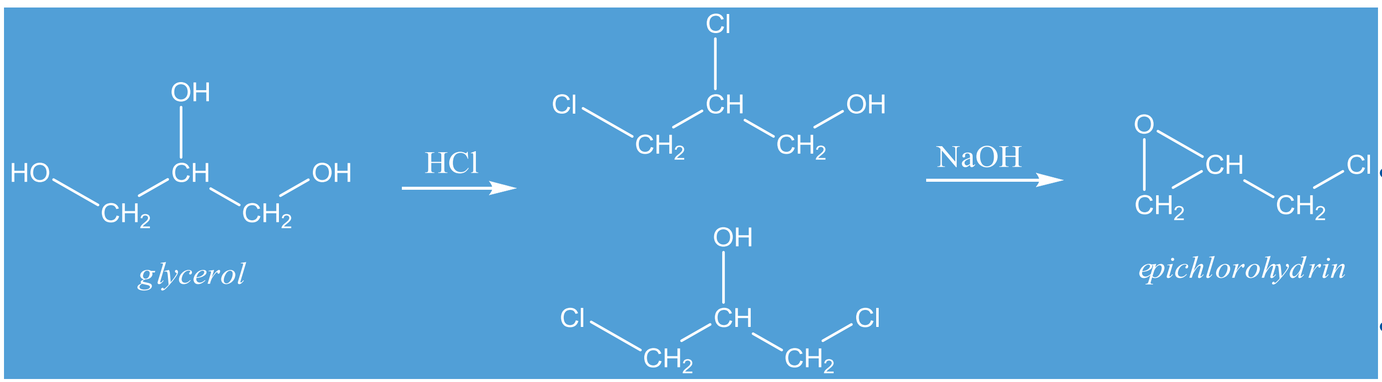
Epichlorohydrin a good example of using biomass functionality





- Solvay 'Epicerol' process: glycerol to epichlorohydrin

- Price:

  € 1300 - 1500 per tonne

- Volume:

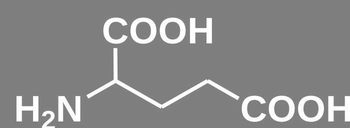
  0.5 mln tonnes per annum

- Capital required: 300€/ tonne ?
- Raw material cost: glycerol, HCl, NaOH

Margin??

Use of plant molecular structures leads to *little heat exchange and valuable product*

N-Vinylpyrrolidone

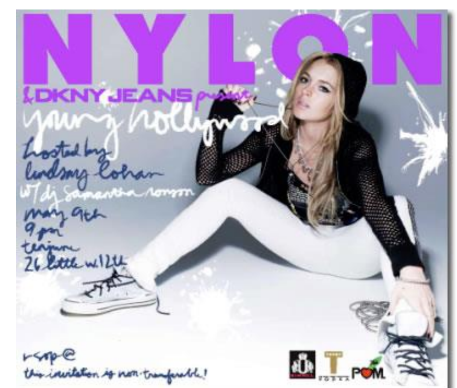


Glutamic acid

Acrylonitrile

N-Methylpyrrolidone

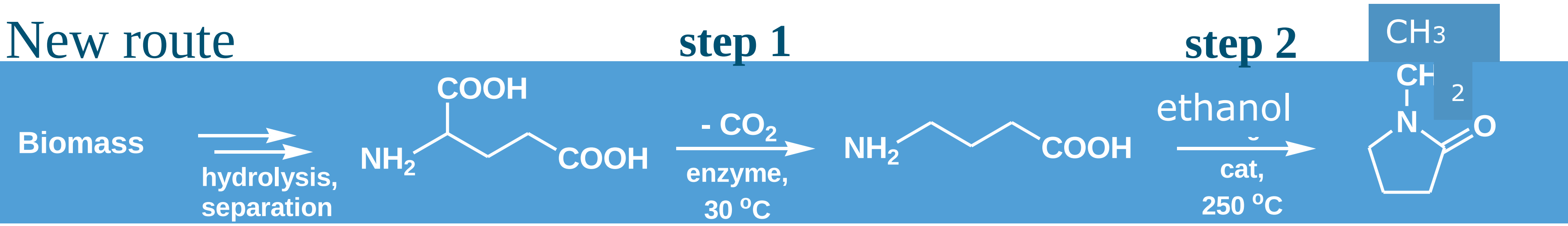
Diaminobutane



The route to NEP, new vs conventional NMP

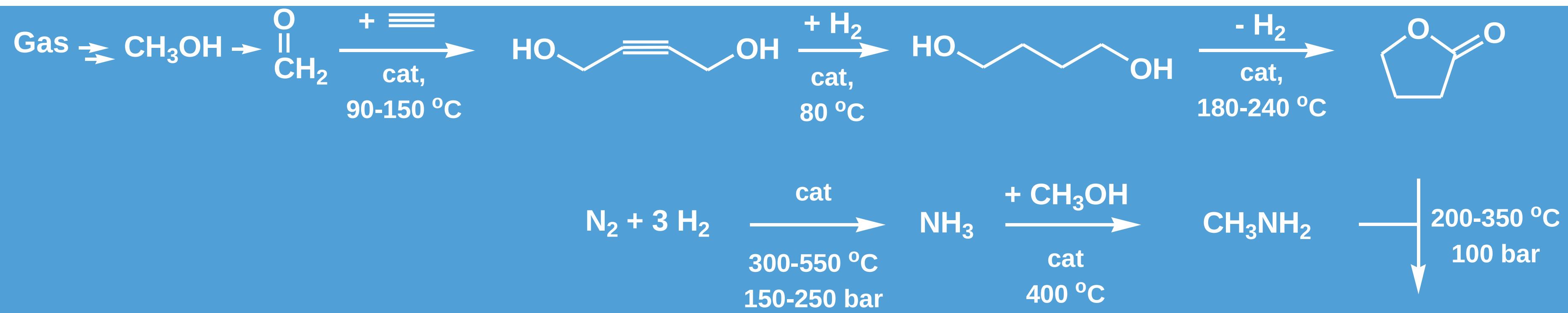
New route

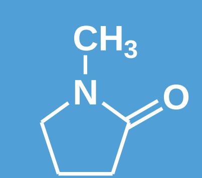
step 1 **step 2**



Glutamic acid *NEP*

Conventional route





Amino acids contain N and O.

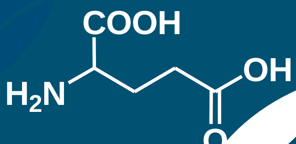
□ Less steps (= factories) & energy for the same product!

Biobased NMP, makes an ethanol plant profitable

500 Million liters bioethanol

(~ 400 kton) =200M€

360 kton DDGS (~130 € / ton) =46M€



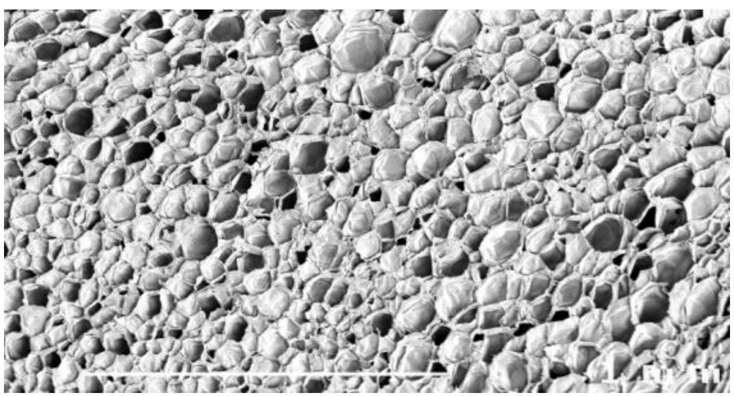
23 kton NMP

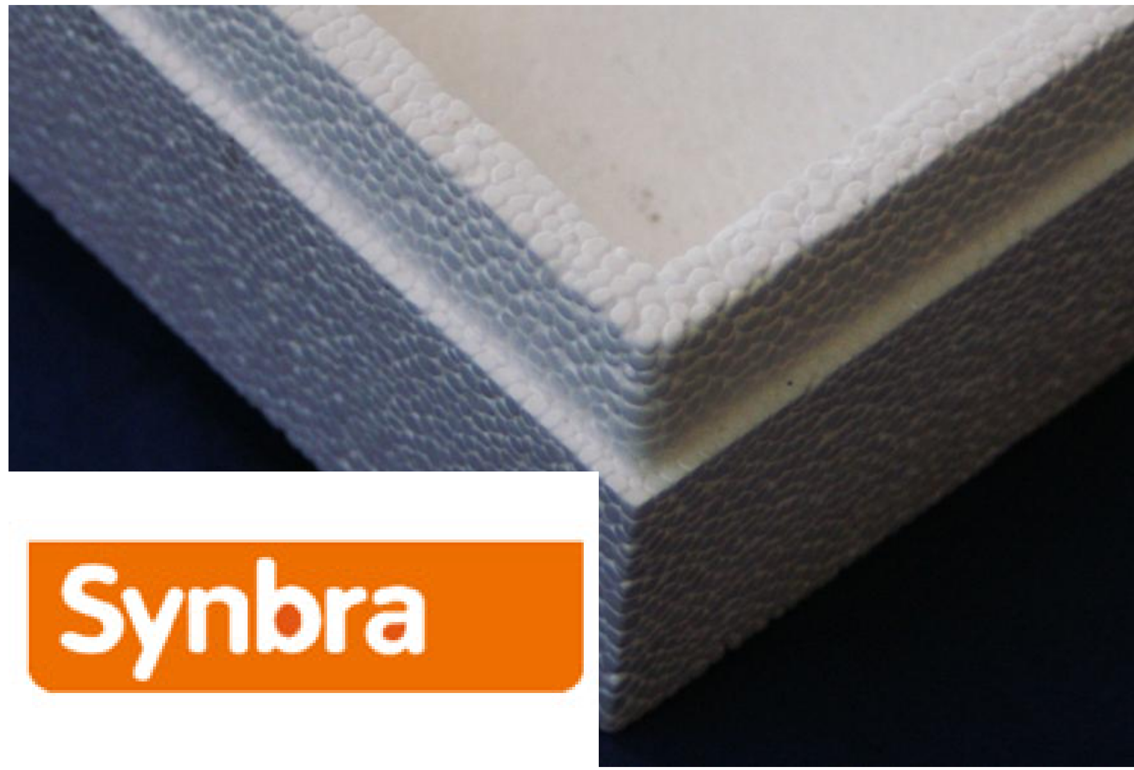
(~2500 € / ton)

=58 M€/y

3D-foamed polylactic structures (Wageningen UR)

- Expandable bead technique
  - Good cell structure
  - Density <30 g/l





Synbra

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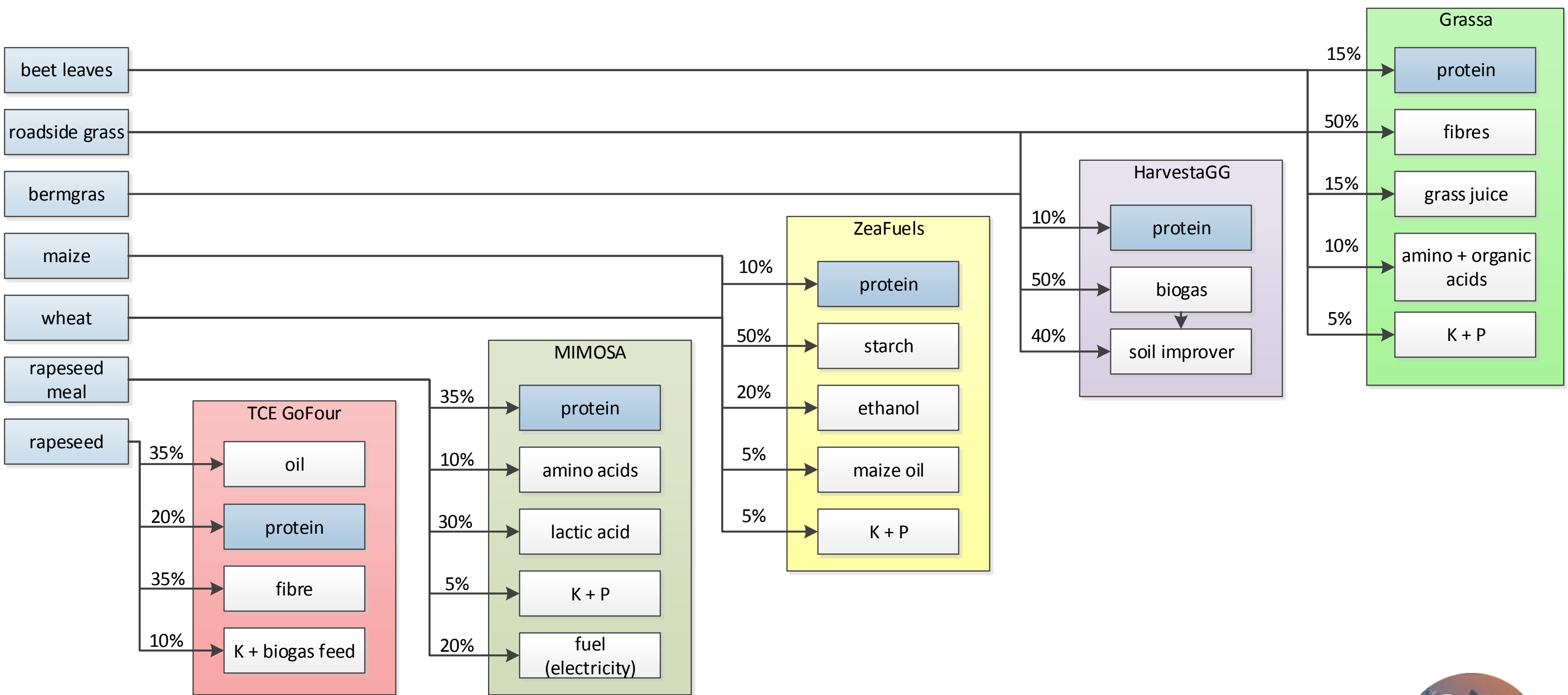
Sheet: Karin Molenveld

Protein as economic carrier in BioEconomy in North Netherlands / Weser Ems area

	rapeseed	rapeseed meal	maize	grass	grass
max. area (kha)	60	not applic.	465	70	620
yield (€/ha)	1800		3000	5200	2500
inv. / unit (M€)	0.1	20	3	50	1.2



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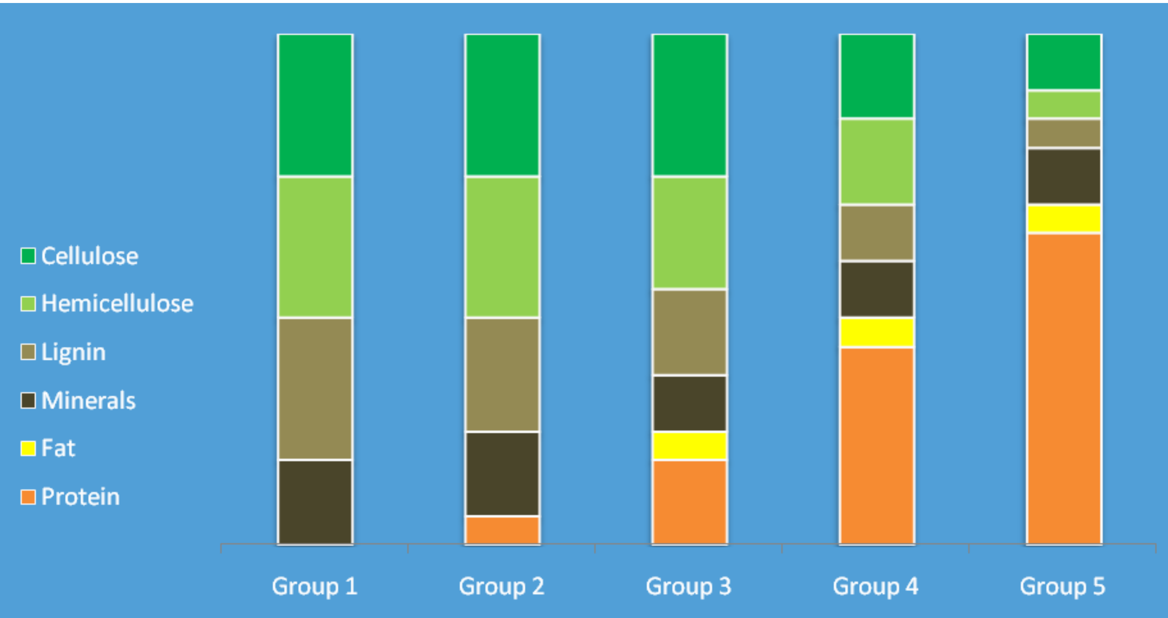
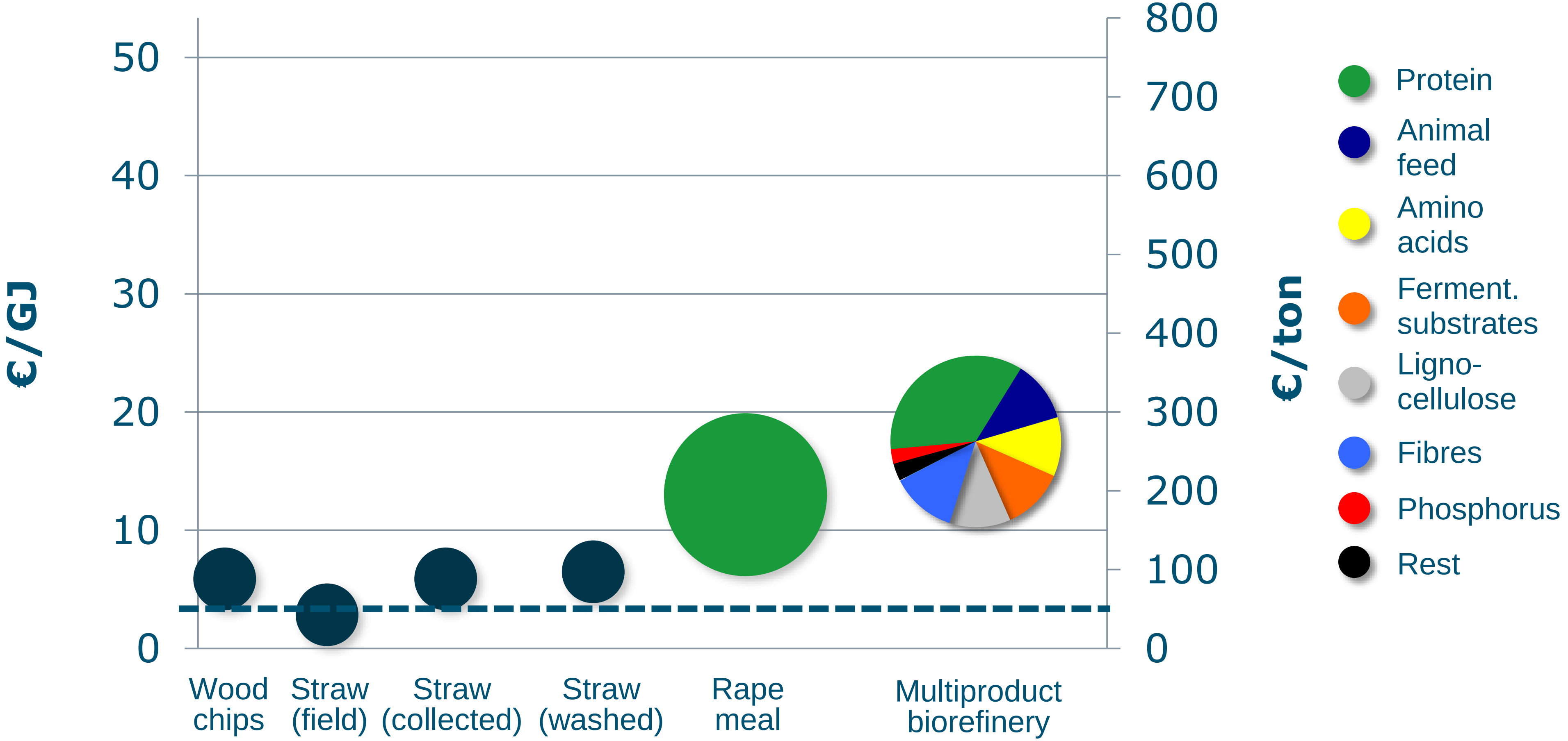
Biorefining of agricultural residues ..



Protein content	0	5 %	15 %	35 %	50 %
Examples	Wheatsstra w	cocoahulls Corncobs Sugarcane leaf	Coffee pulp Rape straw Beet leaf	Rape meal	Soy meal
Cost (€/ton)	50-80	50-110	100-140	150-180	300-350

Biorefinery enables power generation at 45€/ton and high quality 2nd generation fermentation raw materials for 200€/ ton ***at reasonable small scale***



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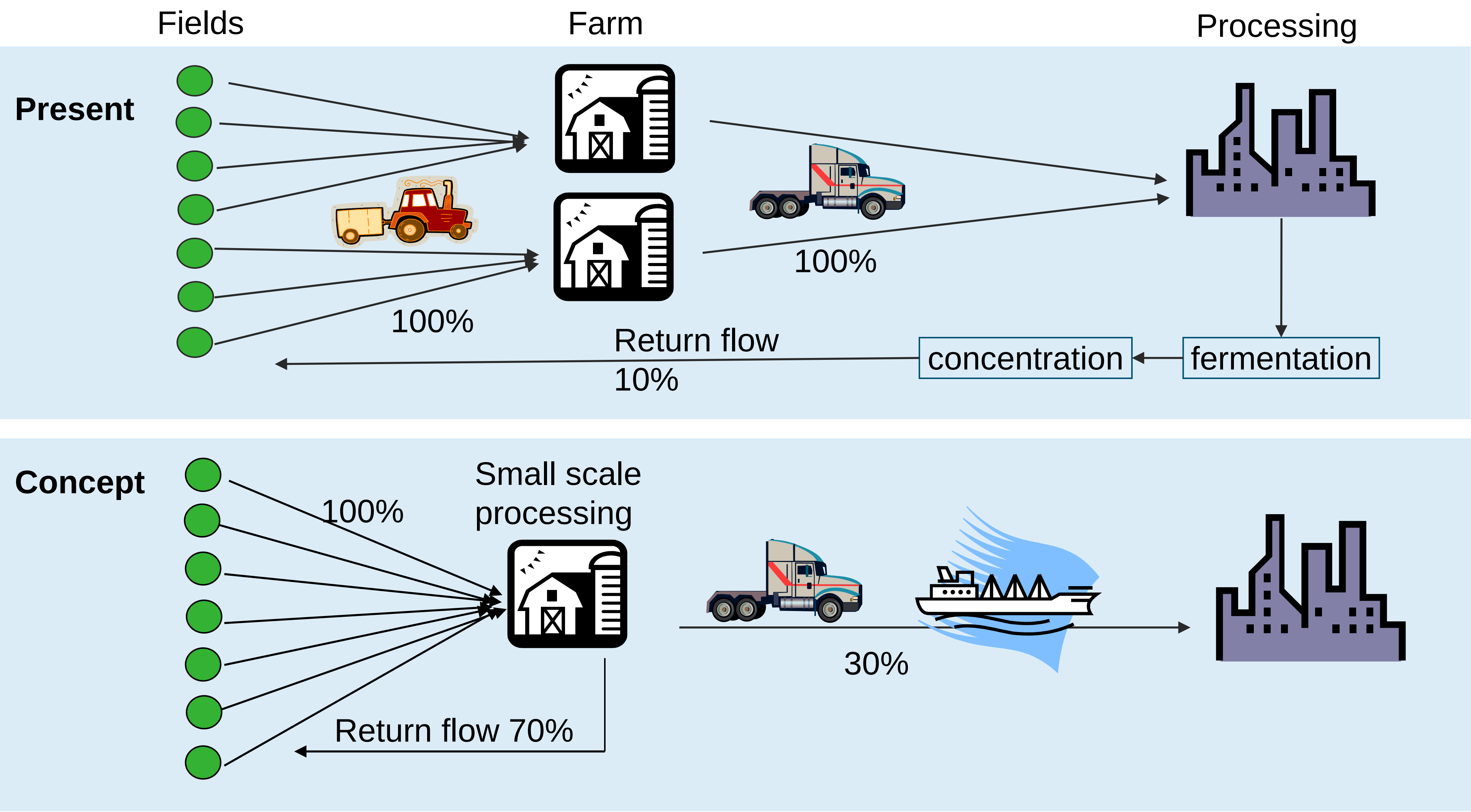
Small scale biorefinery reduces transport cost and seasonality



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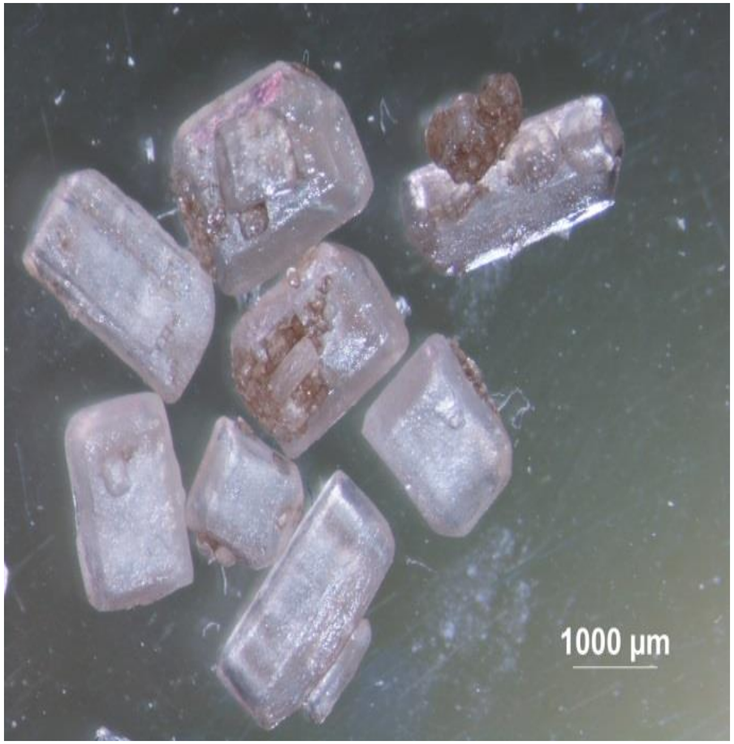
small scale beet sugar production(2-500ha) can beat large scale factories !

Less energy
Less transport
Minerals recycled to field



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Kolfschoten et al

Anaerobic fermentation of bulkchemicals

Yield: 0.95 g/g or J/J

→ Little heat produced

→ Low capital required!

Productivity: up to 5 times higher

→ Low capital required

5 projects running

Mobile Cassava starch refinery in Africa, *small scale started > 10 years ago*

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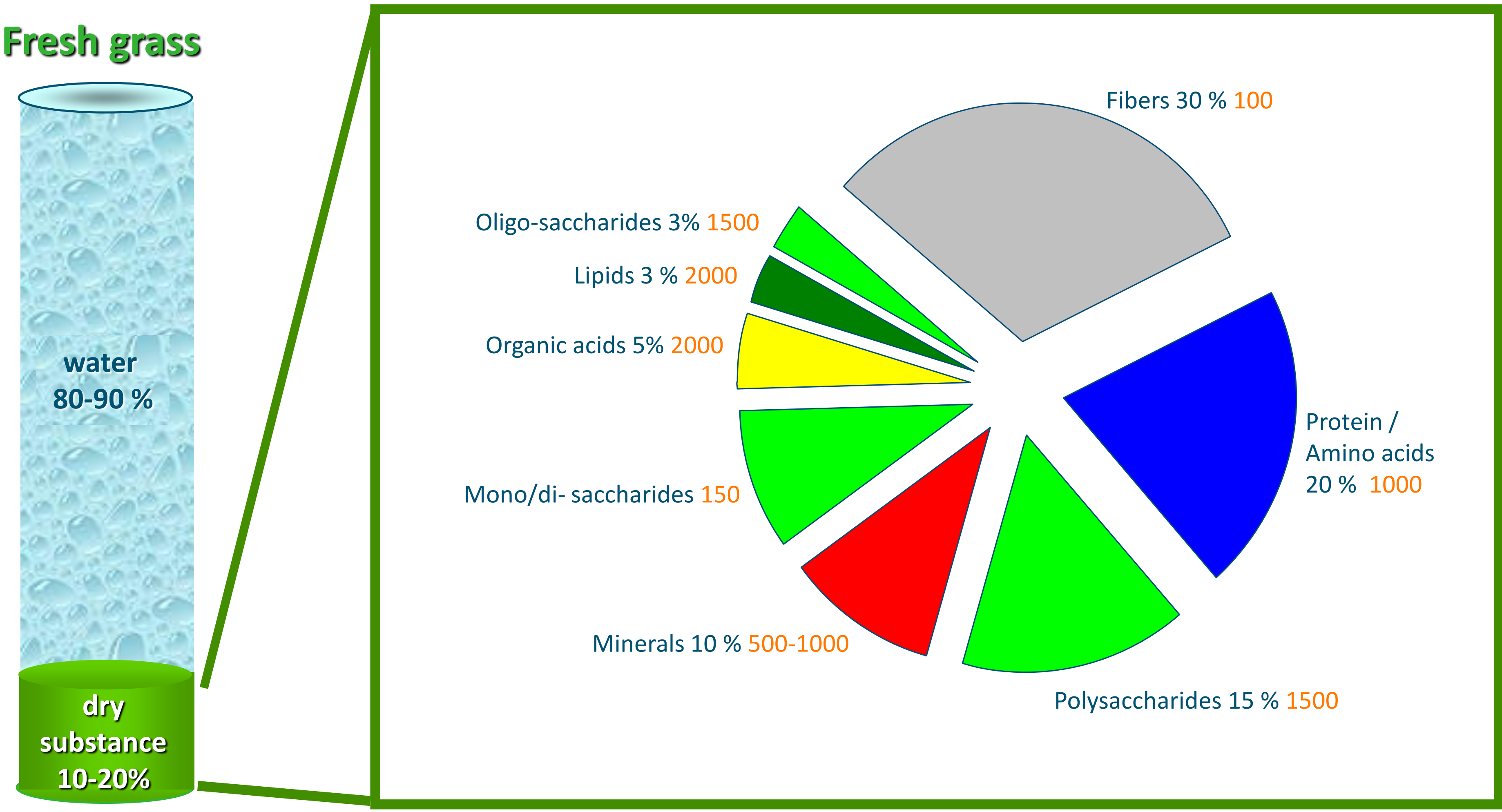
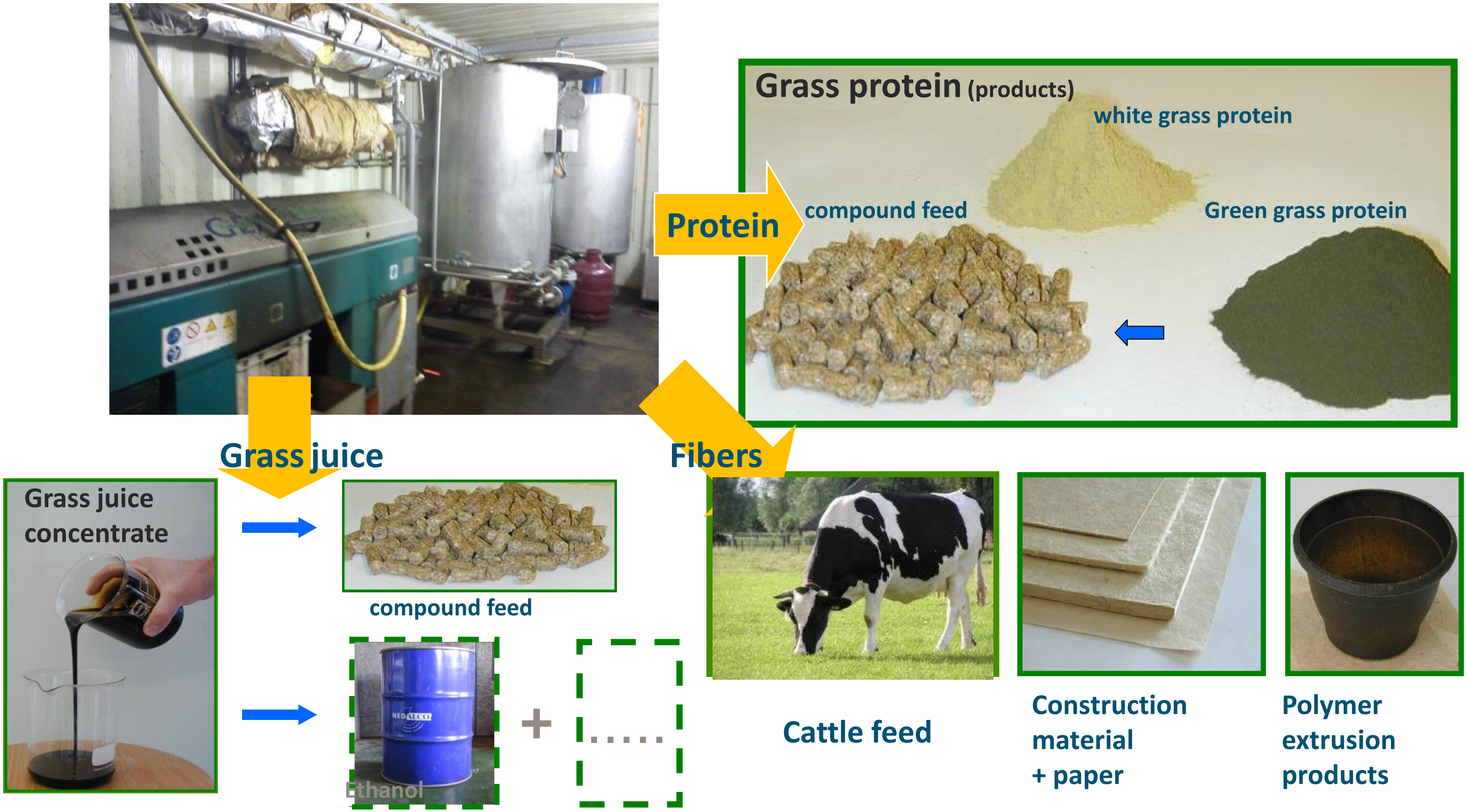
The separated components of grass value 700 – 800 €/ton as compared to 60€/ton raw materials



Mobile grass refinery unit Grassa (the Netherlands)



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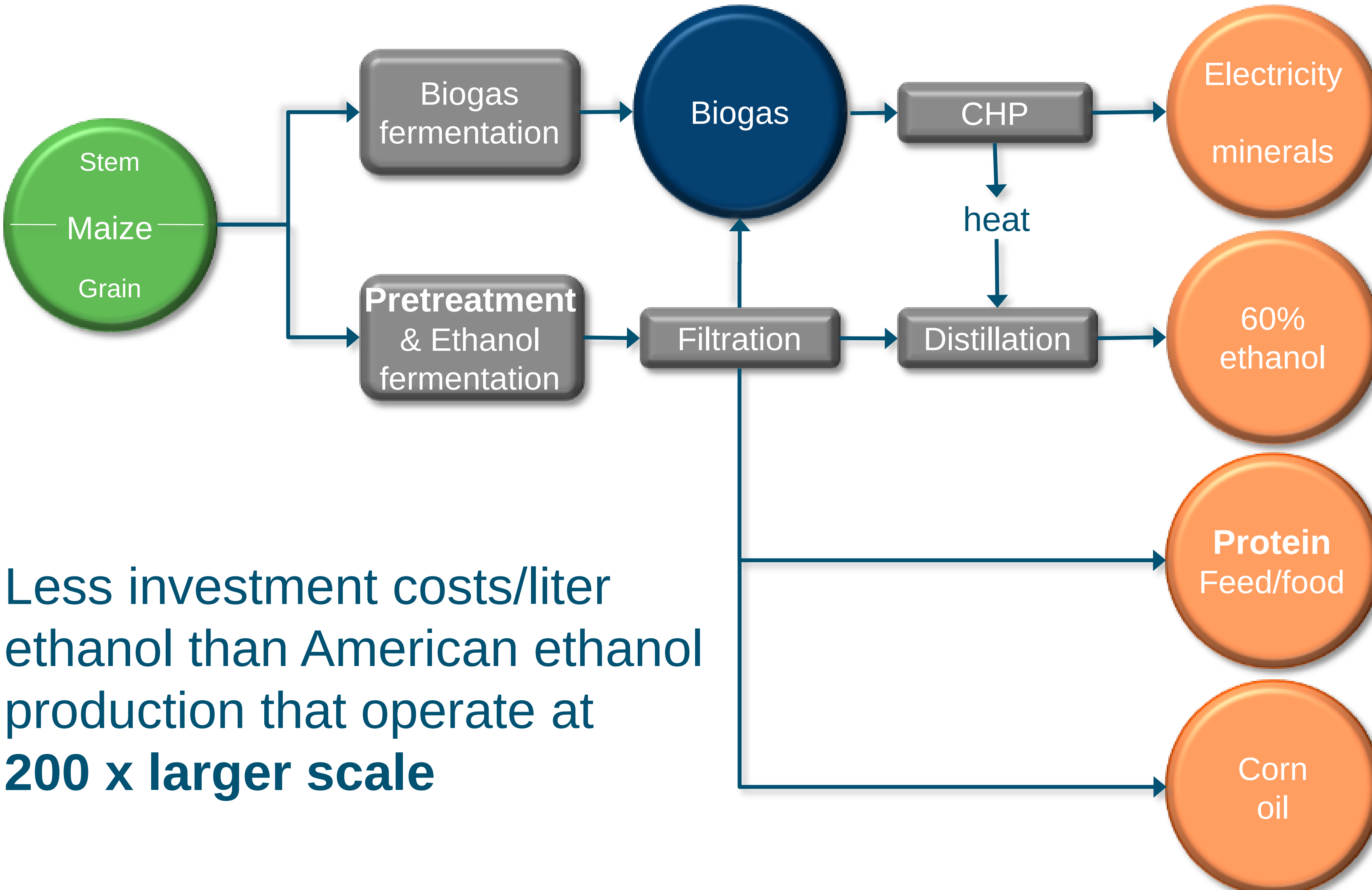
Just protein is not sufficient to cover the costs

bioraffinery	**-------**	**3 products**	**--------**	**8 products**	
	income	costs	**Norway income**	income	costs
Grass costs		60			60
Process costs		120			440
protein	120		160	120	
fibers	30		35	30	
Juice components	55		60		
minerals				75	
Organ. acids				60	
Amino acids				75	
sugars				12	
sugarpolymeren				225	
fat				60	
totaal	**205**	**180**	**255**	**657**	**500**

Grass processing on very small scale (500kg/h)

protein/oil/ethanol/biogas from small scale corn-biorefinery



Less investment costs/liter ethanol than American ethanol production that operate at **200 x larger scale**

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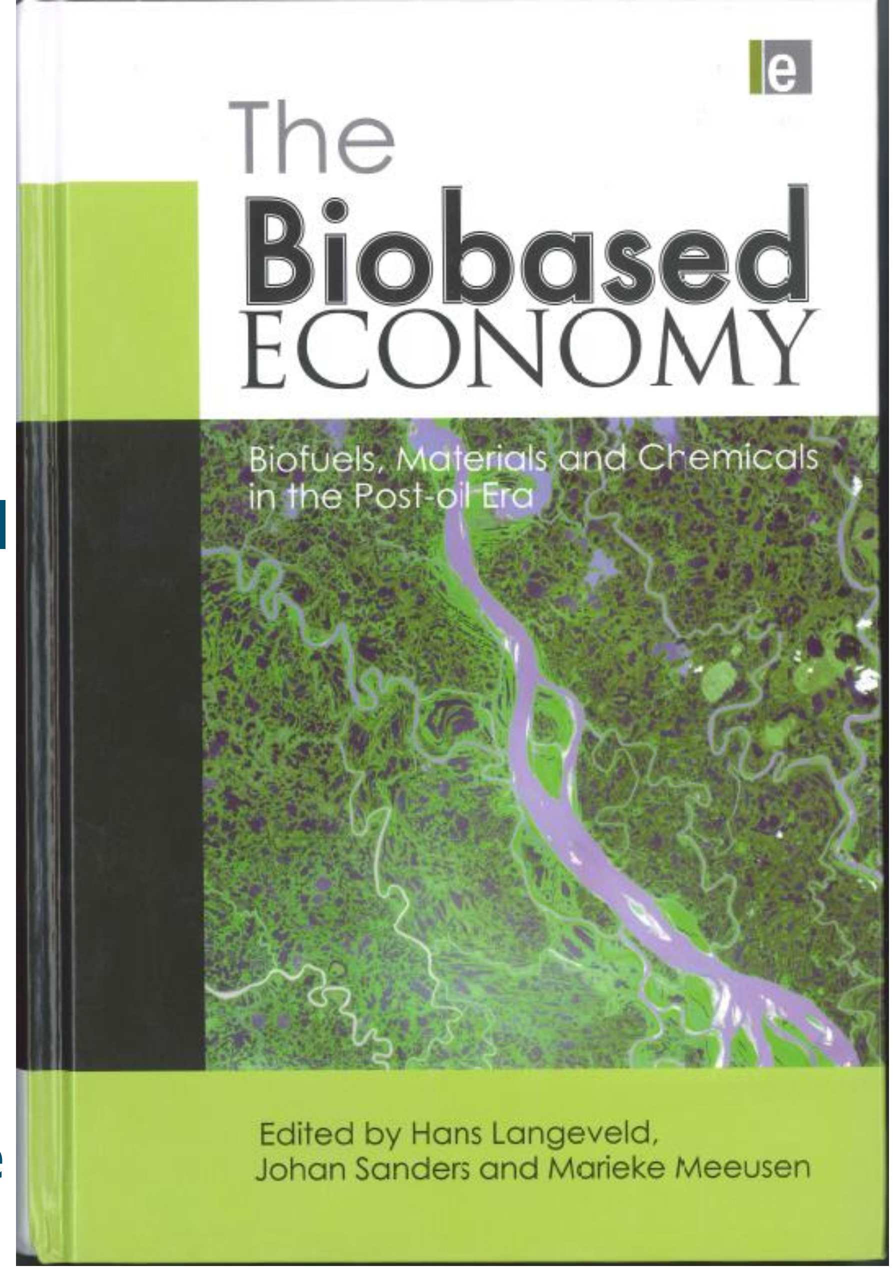
Byosis (Lelystad, Netherlands)






Conclusions

- Biorefinery for feed, materials and chemicals will create good income for agriculture and enables even to compete with coal, natural gas and Brasilian feedstocks!
- Small scale processing reduces capital as well as costs for energy and transportation and
- will lead to higher employment
- Biorefining is not easy because we have to collaborate



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