

# The revival of microbial PHA polymers – are PHA's back to stay?

Christiaan Bolck – Program manager materials

Food & Biobased Research Inspiration Day – 10 April 2014



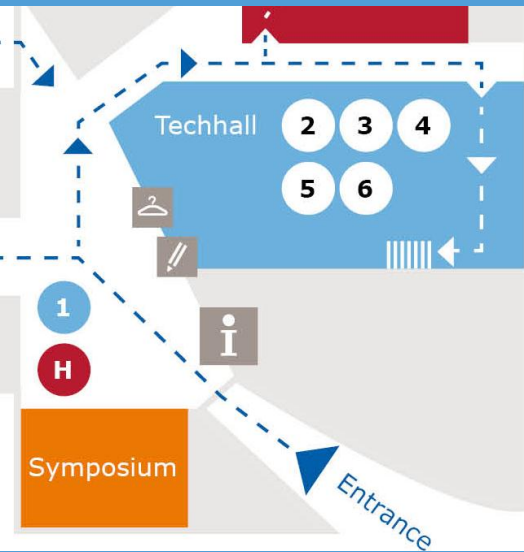
# Materials and products based on:

- Polymers made from biobased building blocks  
PolyLactic Acid (PLA), furans (FDCA/PEF) and isosorbide
- Natural polymers  
starch, cellulose, lignin and protein
- Polymers made by micro-organisms  
PHA's and polypeptides

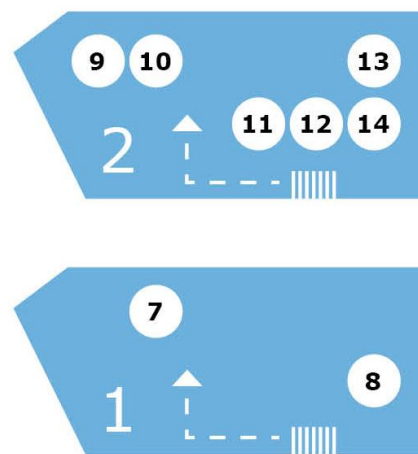


# Activities Materials :see demo's

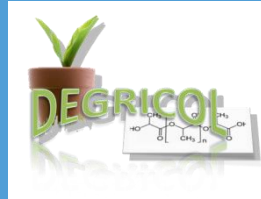
- New polymers and additives (11, 12, 13 & 14)
- Converting natural polymers into materials (2, 3, 4 & 6)
- New materials and products from bioplastics (1 & 7)
- Customised biobased polymers (see 8 & 9)
- Testing and normalisation (7)
- Education and knowledge transfer (see 1 & 5)



Techhall 1st and 2nd floor



# Highlights 2013



- Several EU projects
- Products from PLA



- BPM & TS Chemistry
- Tomato tray
- Education





# PolyHydroxyAlkanoates (PHA's): From waste to resource



# Current activities PHA's

## Global:

- Production on pilot scale in USA (Meridian, Metabolix) & Asia (Tianan, Ecomann, Kaneka)
- Resources: Fatty acids and sugars
- Price: 3-6 €/kg



Biopol  
shampoo  
flask,  
1991

## Netherlands:

- From waste to resource: heterogeneous biomass
- Focus on production PHA (Pacques, Anoxcalness, BIONND, Opure and others)
- Market / performance unknown = direct cause for programme



# Wageningen UR & PHA's (> 20 years)

Polymer chemistry and material technology meet environmental technology via biotechnology

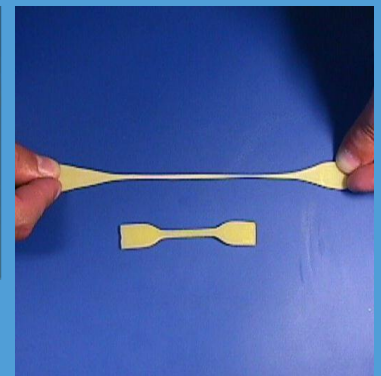
- Christiaan Bolck, program manager Biobased Materials
- Gerrit Eggink, professor industrial biotechnology
- Hardy Temmink, Researcher Environmental technology



And ...Hans Mooibroek, Gerald Schennink, Koen Meesters, Karin Molenveld, and many others

# PHA<sub>MCL</sub> Products Wageningen UR

- Intermediate product:
  - Solvent extracted PHA
  - PHA in latex form
  - Granular PHA
- Vulcanised to a rubber
- In melt processed
- As paint binder:
  - As high solid paints (low voc)
  - As latex (in water)



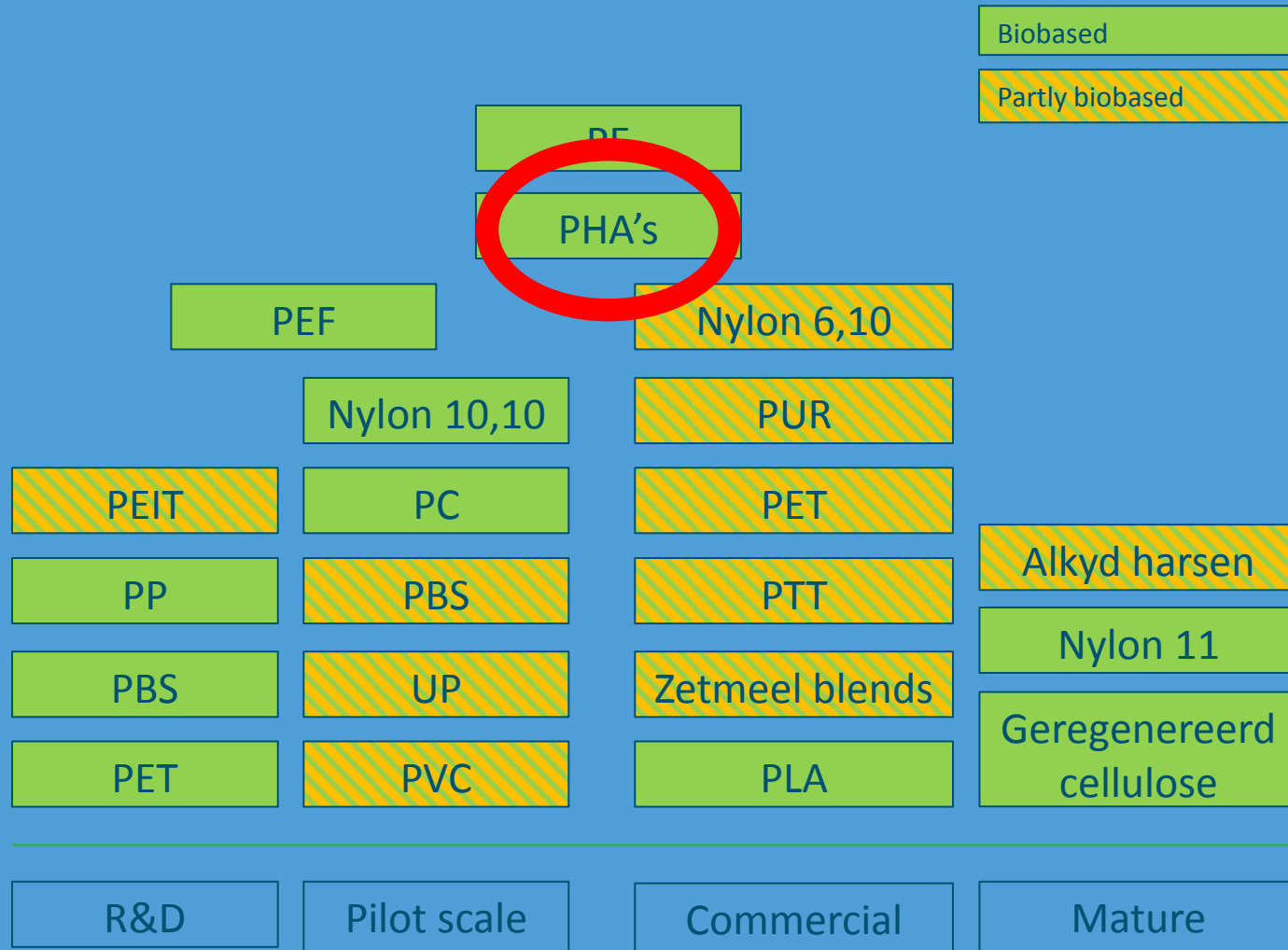


# State of the art: properties

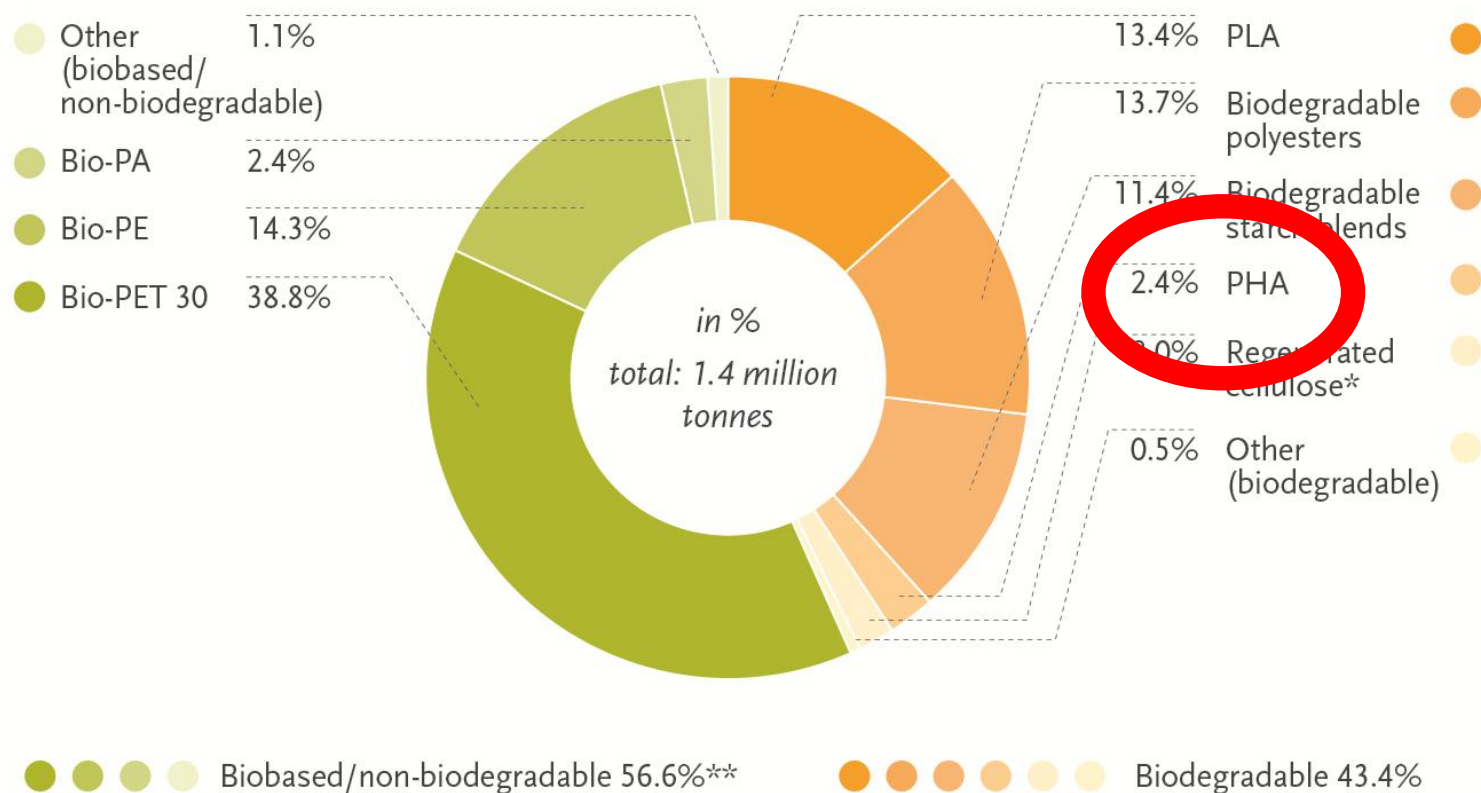
- PolyHydroxyButyraat (PHB): comparable with polypropylene and polyethylene
- PHA also applicable as rubber or latex for paints
- Biodegradable in almost all natural environments: compost facility, in the ocean, soil etc.



# Development stages biobased plastics



## Bioplastics production capacities 2012 (by material type)



Source: European Bioplastics / Institute for Bioplastics and Biocomposites (December 2013)

\* Only hydrated cellulose foils  
 \*\* Comprises drop-in solutions and  
 technical performance polymers

# Current vision on PHA's

PHA's showstoppers for success :

*Variable quality and relative high price in current market applications*

Goal: stabilizing quality and lower relative price by:

- Focus on market demand: wich application and wich specs?
- Cheap and sustainable DSP (extraction method)
- Join forces on biotech production of commodities
- Lower price : Biogas production 2.0



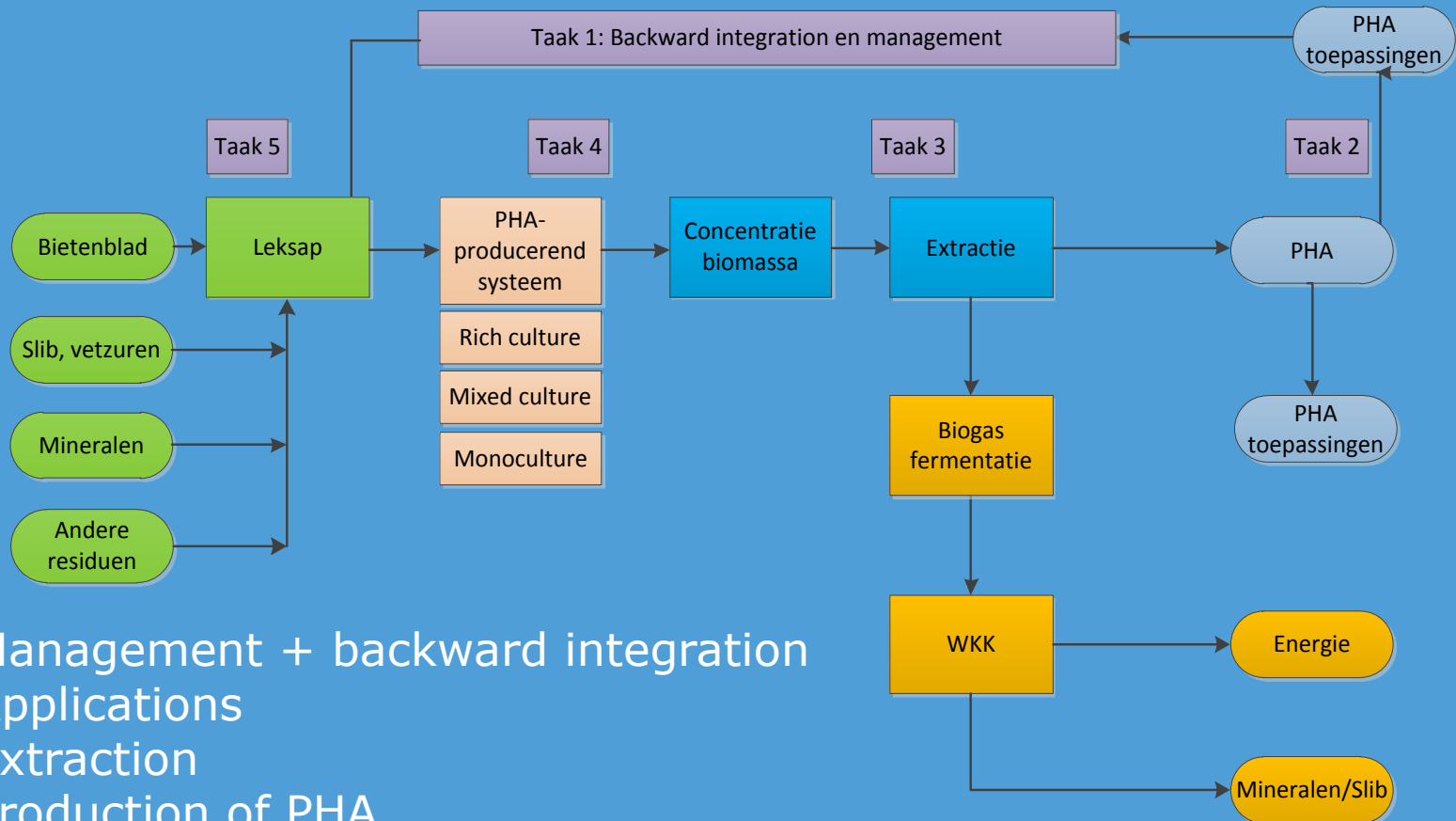


# Integral research programme

- Objective: Large scale commercial production and application of PHA's from biomass
- Approach:
  - Backward integration
  - Connect knowledge on material, polymer- , bio-, and environmental technology
  - Focus on bottlenecks
- Major challenge: cost effective production of PHA's with added value from a mixture of fatty acids



# Backward integration: end-user in the lead



1. Management + backward integration
2. Applications
3. Extraction
4. Production of PHA
5. Resources and fatty acid production



# Now: start PPS

## Finance:

- Contribution in kind and in cash
- Public Private Partnership : Topsector A&F
- Pilot production and application: regions

## Organisation:

- Consortium
- Partners from whole value chain
- Fundamental, precompetative and applied research
- Backward integration



# Thank you for the attention

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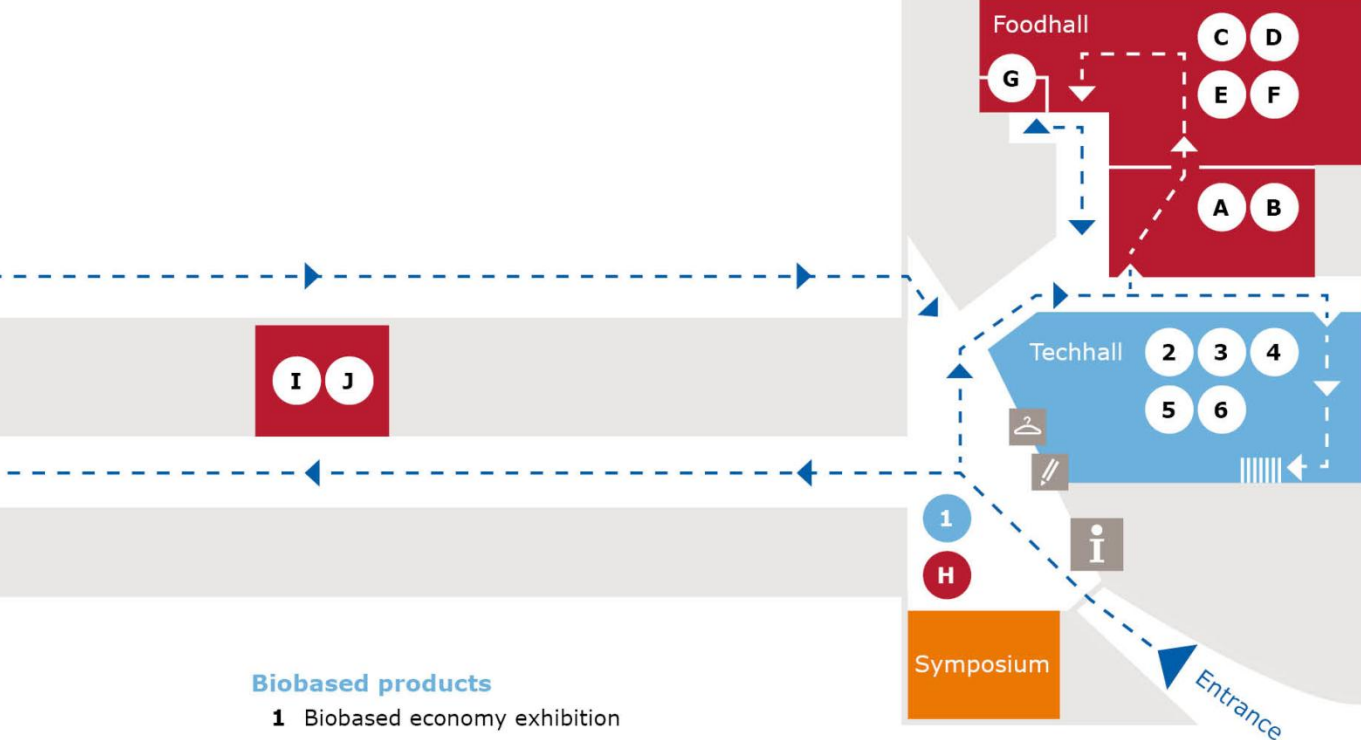
[www.wageningenur.nl/fbr](http://www.wageningenur.nl/fbr)

[www.biobasedperformancematerials.nl](http://www.biobasedperformancematerials.nl)

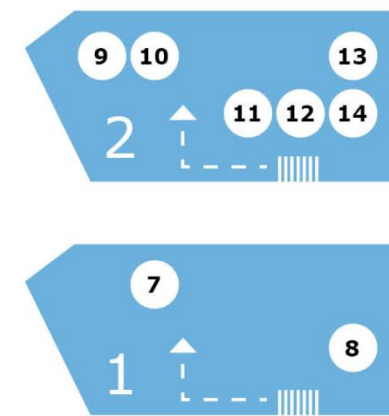


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*For quality of life*





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## Biobased products

- 1 Biobased economy exhibition

## Techhall

- 2 Exotic feedstocks for biorefinery
- 3 Grass refinery
- 4 Seaweed refinery
- 5 Chain design and policy advice for the Biobased Economy
- 6 Lignocellulose biorefinery to carbohydrates
- 7 PLA processing
- 8 Microbial cell factories: microbe selection and improvement
- 9 Fermentation: biomass to chemicals and fuels
- 10 Micro array tests for rapid and simple diagnostics
- 11 Polymerisation of biobased monomers
- 12 From carbohydrates to PEF, the biobased alternative to PET
- 13 Lignin isolation and conversion to aromatic products
- 14 From carbohydrates to bioaromatics

## Symposium

The latest developments in biorefinery, biobased materials & chemicals



Welcome & information



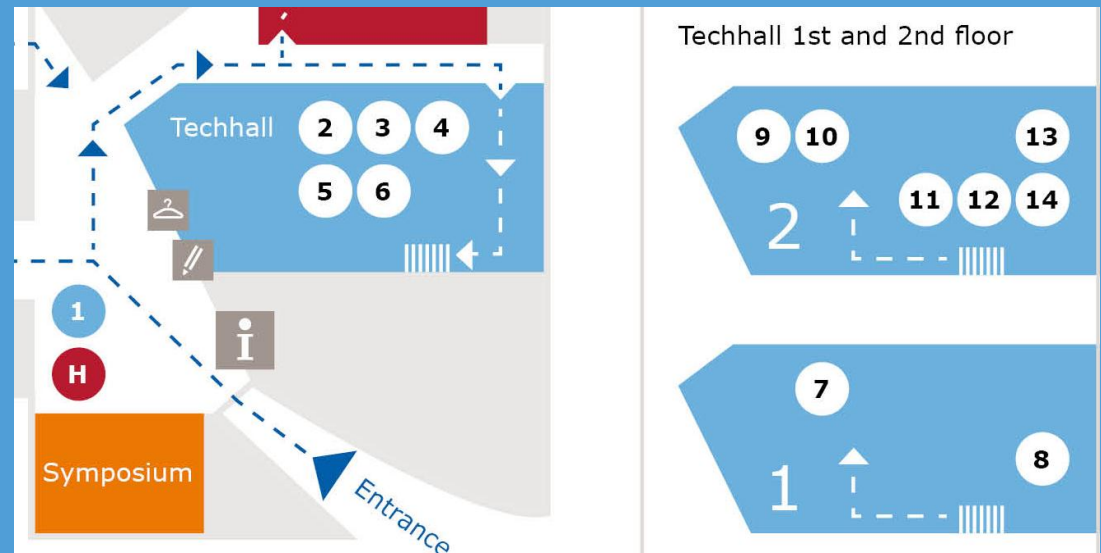
Registration & badges



Wardrobe

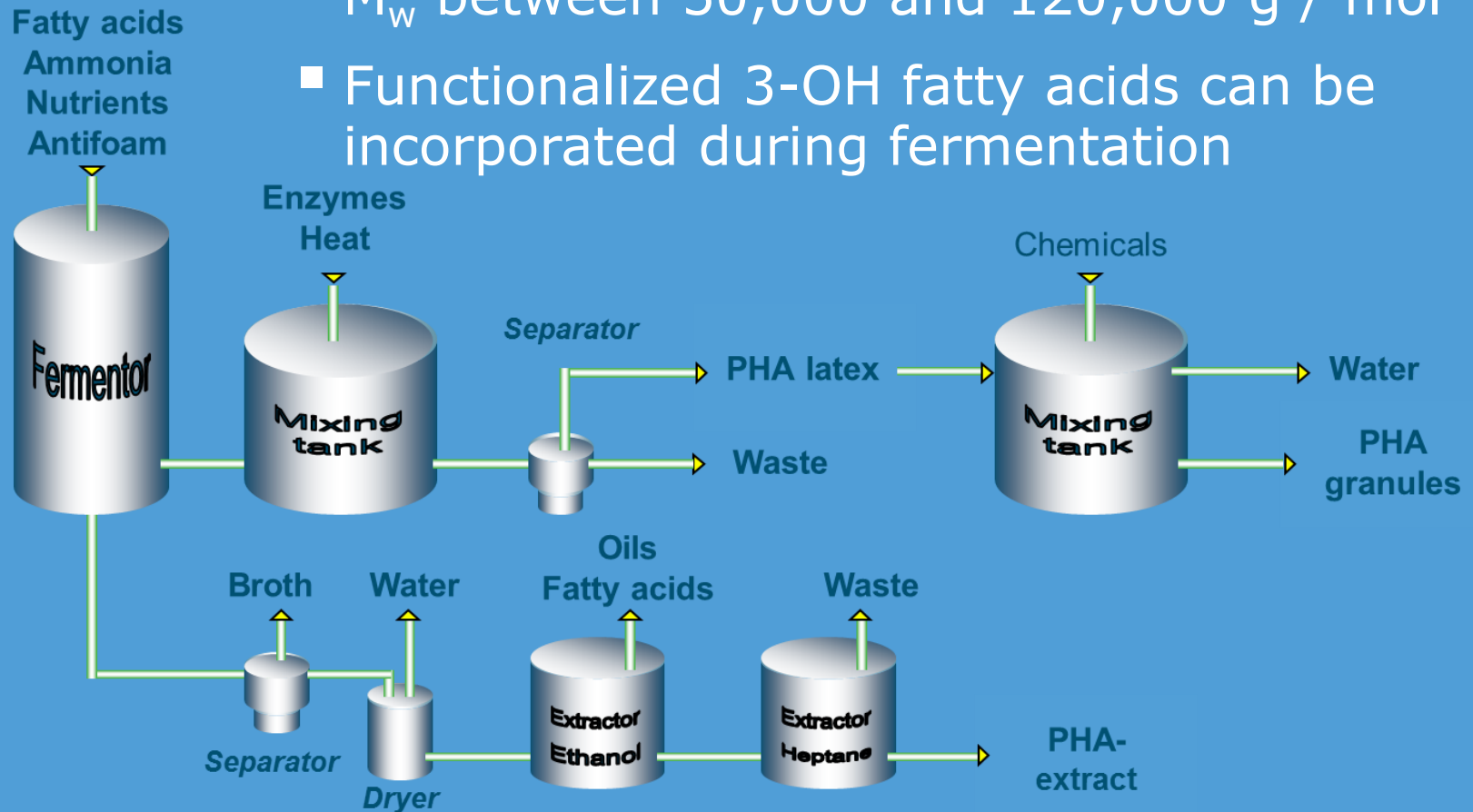
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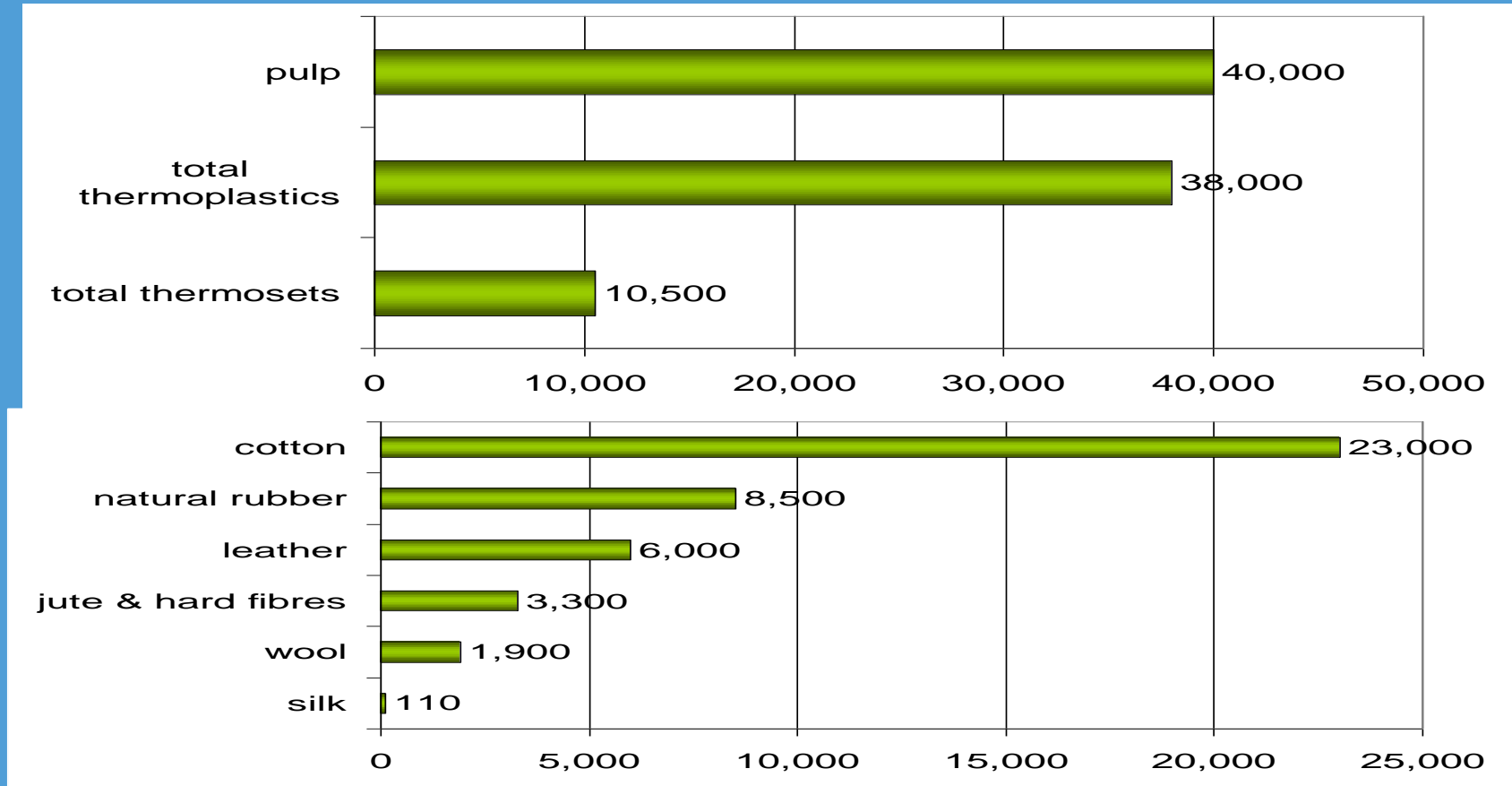
# PHA<sub>MCL</sub>: Hydrophobic polyester, water insoluble, biodegradable, biocompatible

- $M_w$  between 50,000 and 120,000 g / mol
- Functionalized 3-OH fatty acids can be incorporated during fermentation



# Current production of (bio)polymers

Annual world production in kton (FAO 2004, APME 2003, CEPI 2004)



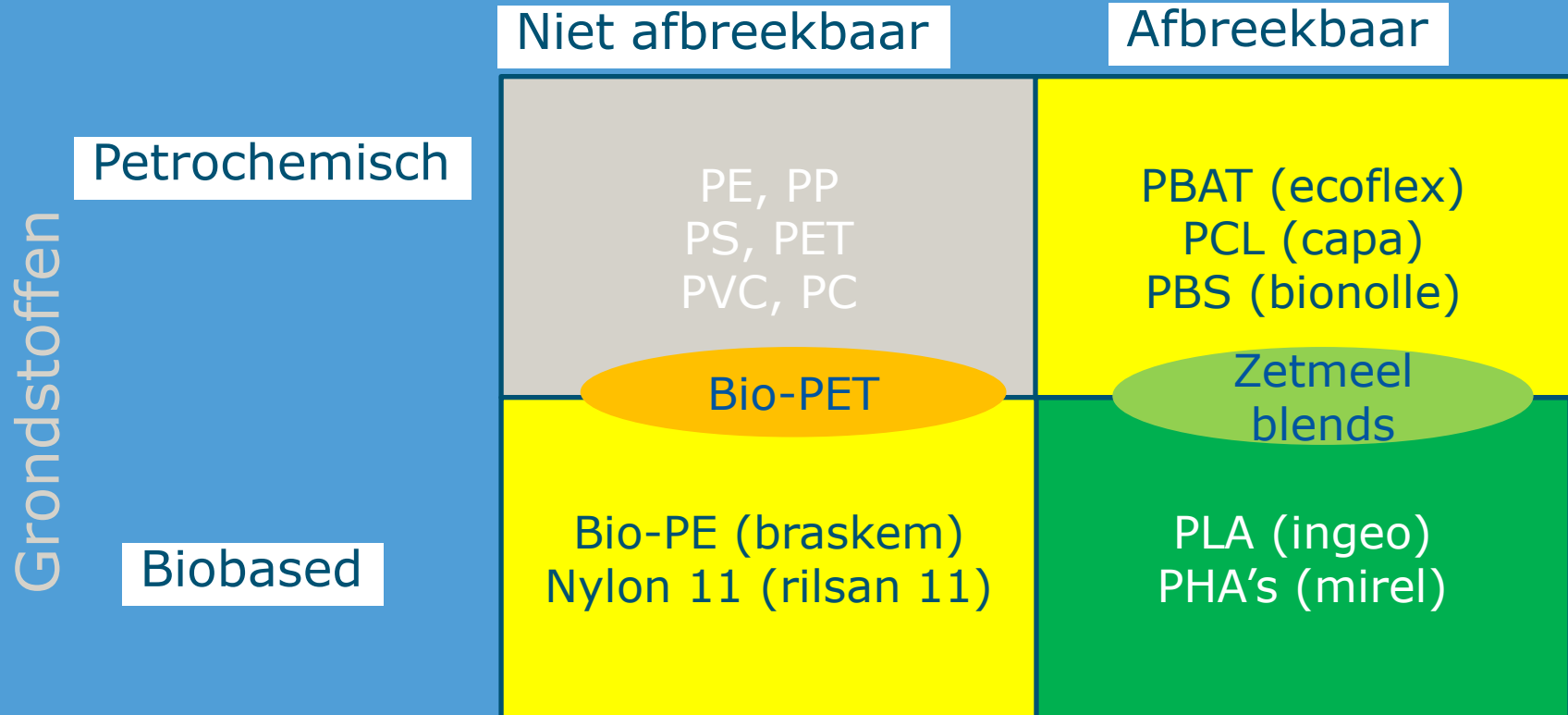
Biopolymers are big; biobased thermoplastic polymers not yet!





# Bioafbreekbaar en/of biobased?

Eindproducten



# Bioplastics



# Verduurzaamd hout



# Bioethanol



Bensin 95	9,53
Bensin 96	9,69
Bensin 98	9,83
Diesel	7,97
Etanol E5	9,43
Etanol E85	7,41

# Groene weekmakers



# Agrovezel composieten



# Composteerbare verpakkingen



# Bouw materialen



# Verven, coatings en kleurstoffen



# Isolatie



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# Ketenpartners

