

# Environmental impact of food packaging in perspective

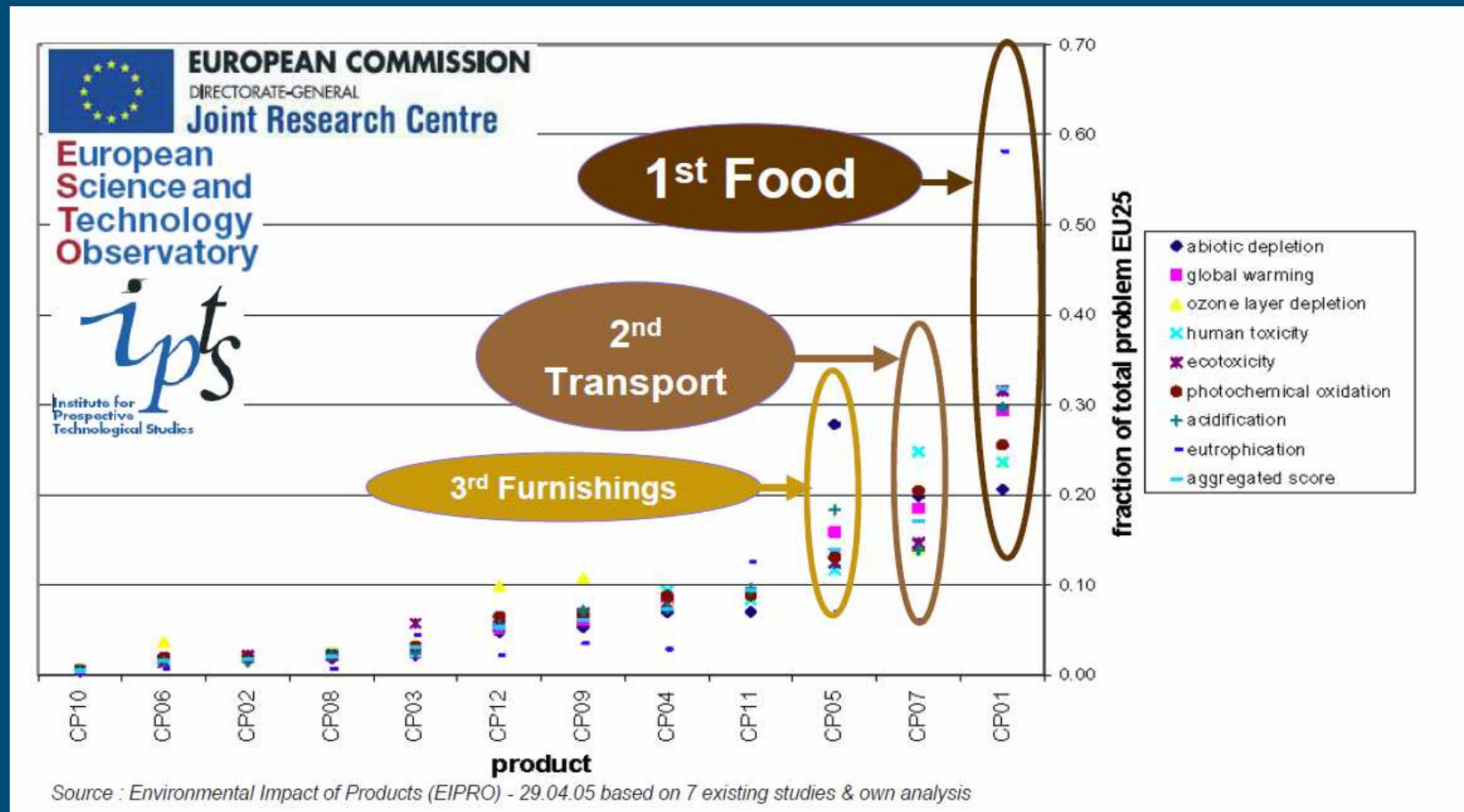
EU Thoden van Velzen

Nutrevent 18 June 2009



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# EU Food industry contributes most to environmental degradation of all EU industries....



# Generic routes to a more sustainable food industry

1. Raise energy efficiency of food processing
2. Replace ingredients
  1. Animal -> Vegetable based proteins
3. Reduce food wastage in the chain
  1. Improve temperature management
  2. More advanced prognosis-order systems
  3. Apply more protective packaging
4. Use by-products
5. Optimize packaging
6. ....



# Focus on the role of food packaging

- More protective packaging to avoid food wastage
  - Lost energy
  - GHG emissions on landfills
- Optimize the packaging itself
  - Packaging contains about 10% of the embodied energy
  - 1,7 EJ embodied energy in packaging plastics in EU+NO/CH
- Because packaging (waste) is visible



# Sustainable packaging



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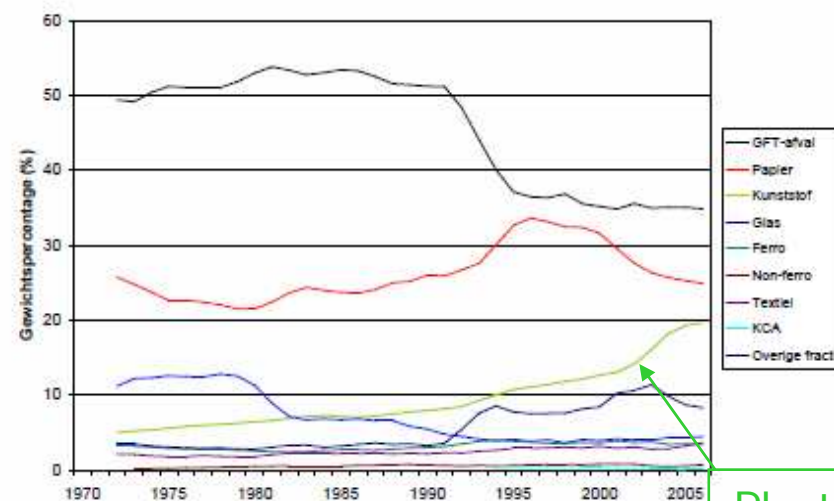
# Waste management perspective on plastic food packaging

- Annual Global production was 260 Mton in 2007
  - 65 Mton in EU+NO/CH
  - 24.6 Mton in packaging
    - ~16 Mton in food packaging

- Growth rate in 2007
  - +9% Global
  - +3% EU+NO/CH

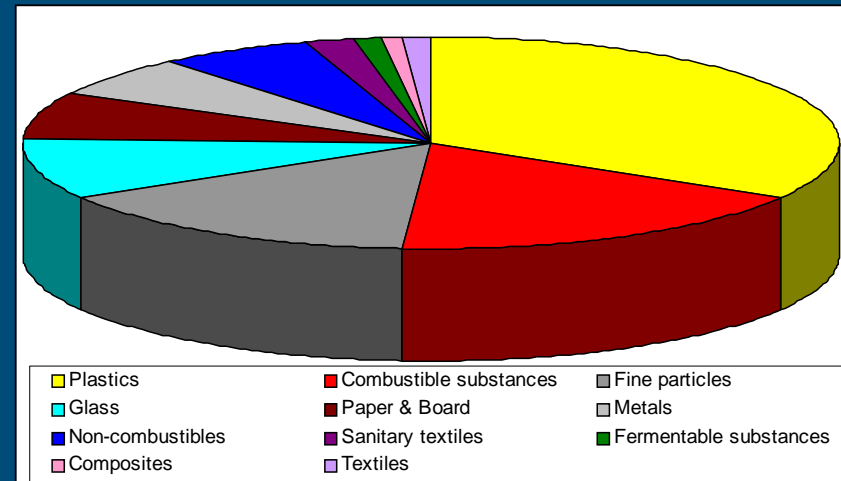
- Fraction of waste plastic in MSW grows similarly
  - 2007: 0.65 Mton plastics in Dutch MSW

## Composition of MSW in NL



# Waste management perspective 2

- Heavy metal and organic contaminants in MSW
  - Make waste management expensive
  - Restrict the use of compost made from MSW
  
- 33% of the metals originates from plastic
  - WEEE
  - Food packaging



Combined origin of  
As, Cd, Cr, Cu, Hg, Ni, Pb, Se and Zn  
found in compost made from MSW  
France 2009, ASTEE



# Waste management perspective 3

- Landfilling Biowaste and not recycling plastic waste in the EU is a major source of GHG
  - 20-30% of the CO<sub>2</sub> reduction targets can be met by 2020 by diverting biowaste from landfill and recovering plastics
  - 150-250 Mton CO<sub>2</sub> eq. reduction potential!  
→Large direct investments in Central European waste industries!

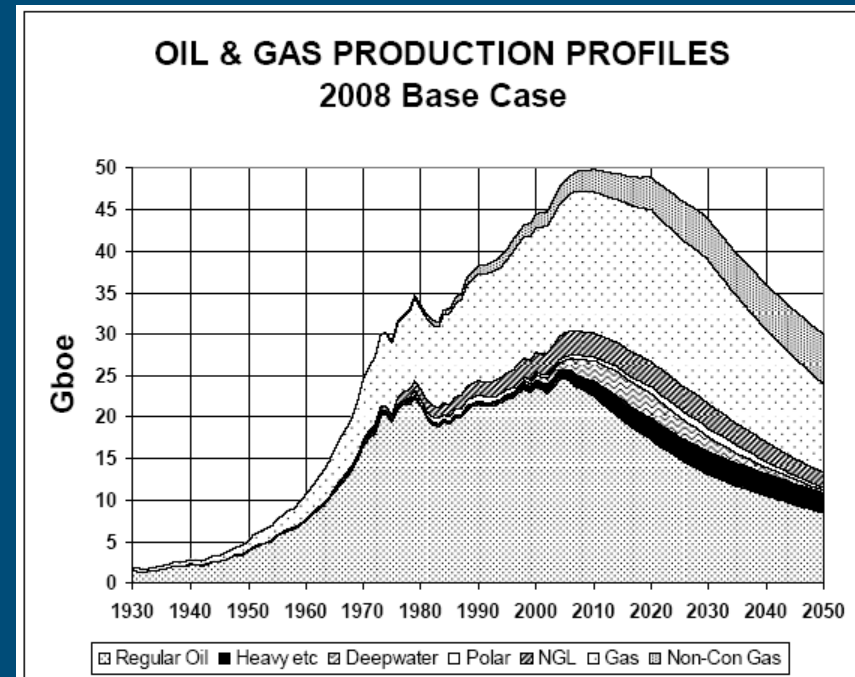
- Source: Prognos, IFEU, INFU, Oct. 2008





# Resource management perspective

- Critical resources for our global economy
  - Fossil fuels: crude oil, gas, coal, uranium
    - Prices ↑ : demand ↑ & supply ↓
      - 7% of crude oil is used for plastic packaging: prices ↑
  - Precious metals (Ag, **Sb**, Au, Zn, Sn, In....)
  - Land, water, phosphates



# Politics

- Landfill directive 99/31/EC
- Waste framework directive 08/98/EC
- Packaging waste directive 94/62/EU
  - Recycling and recovery targets per material / member
  - Not always reduction of environmental impact
- Pack waste is visible



# What is sustainable food packaging?

- Optimised packages
- Recycled packages
- Biodegradable / renewable packages
- Oxodegradable packages



# Packaging optimisation and reduction



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# Packaging reduction and optimisation

- Many opportunities



# History of meat packaging in NL

- 60's
  - Supermarkets expand
  - Meat is pre-packed
    - White styrofoam tray
    - PVC stretch
- 1964 first tests MAP
- 1975 Begin MAP
- 2000 Break through MAP
  - Large retailers start
- 2005: 50 % MAP

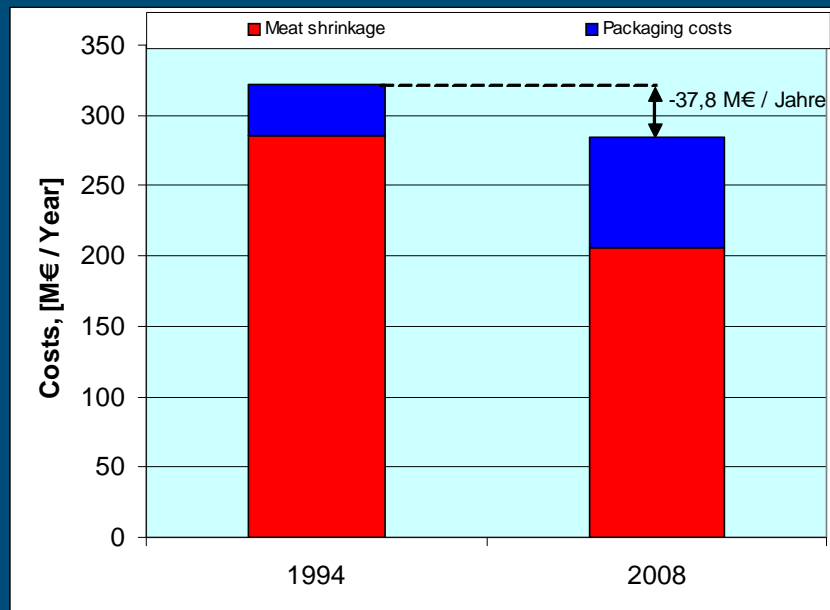


# Modified atmosphere packaging for meat

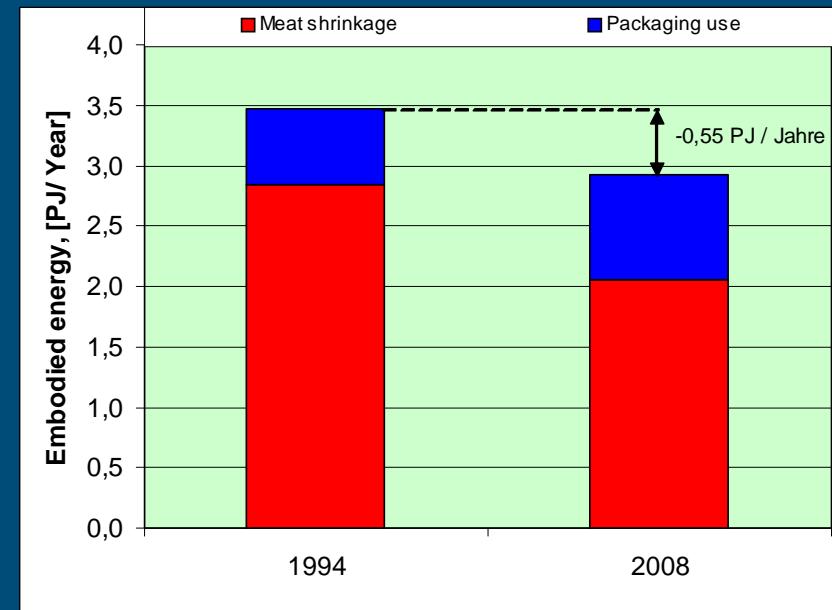
- Higher direct costs +0,07 €/pack
  - Packages
  - Gasses, machines...
  
- Lower indirect costs -0,10 €/pack
  - Longer shelf life
    - Less shrinkage in shops (8 -> 5%)
    - Less night shifts
    - Lower delivery frequency ....



# Balances



Financial: -37.8 M€ / Year



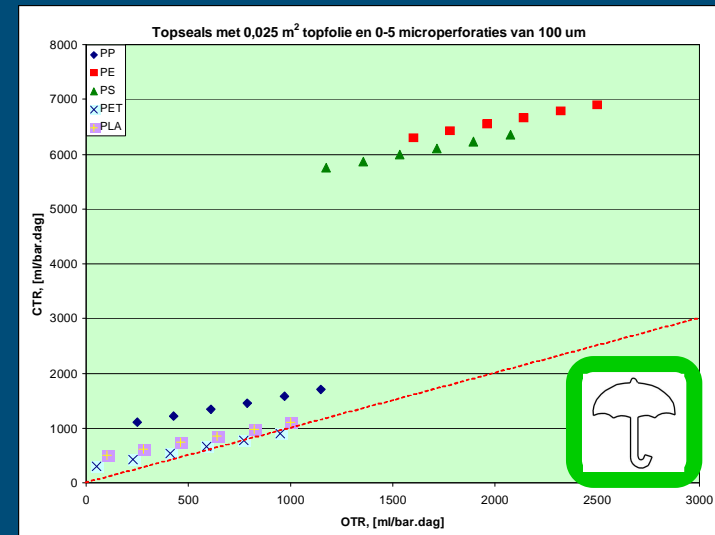
Environment: -0.55 PJ / Year





# Top-seals for cut fruits and veggies

- Marketing:
  - PET > cla.-PP, PS > PP
- Product quality
  - PS > PP > PET
- Costs
  - PET vs PP = +0,04 €/tray



# Comparison PET vs. PP top-sealed trays

## ■ Environmental impact:

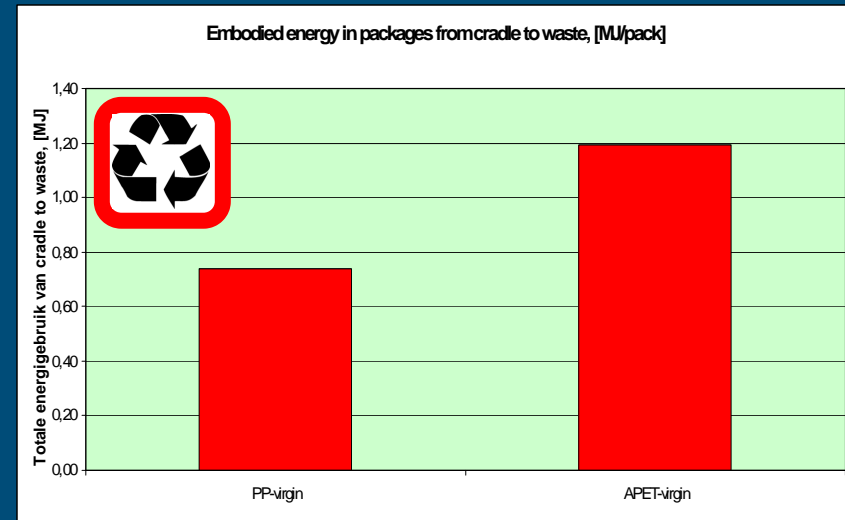
- PS, PP < PET

- PP vs PET

- $\Delta EI = 0,45 \text{ MJ/pack.}$

## ■ A change from PET to PP top-seals would in NL:

- Reduce costs: 0,2 M€
- Improve shelf life
- Reduce energy use: 1,8 TJ EI



# Packaging recycling



# Packaging recycling

- Recycling polymers is sustainable
  - Virgin polymers: 85-110 MJ/kg
  - Collecting, sorting, reprocessing: 5-25 MJ/kg
- But currently the total societal costs of recycling are often larger than the costs of virgin polymers
  - Mostly policy driven
  - Material or Energy recovery
  - Tendency for down-cycling
- Bright future
  - Rising virgin polymer prices
  - Steadily improving technologies for sorting and reprocessing
  - Food industries will demand recycled packaging



# Deposit refund systems

- Suitable for few types of packaging: 4-5%
  - Large PET soda bottles
  - Large HDPE washing liquid bottles
- High (hidden) costs
  - Labour, floorspace, RVM's
  - Costs are 2500-3000 €/ton
- B2B recycling rate just 17%



# Source separation of plastic packaging



- Most European countries source separate plastic packaging waste from the households
  - High responses are claimed, but actual recovery is lower
  - 20-30% is impurity
  - Substantial costs are made for collection, sorting and reprocessing
  - High impact of logistics in costs and emissions
- Recycling plastic packaging is good, but should be done as efficient as possible



# Commingled collection and centralised recovery

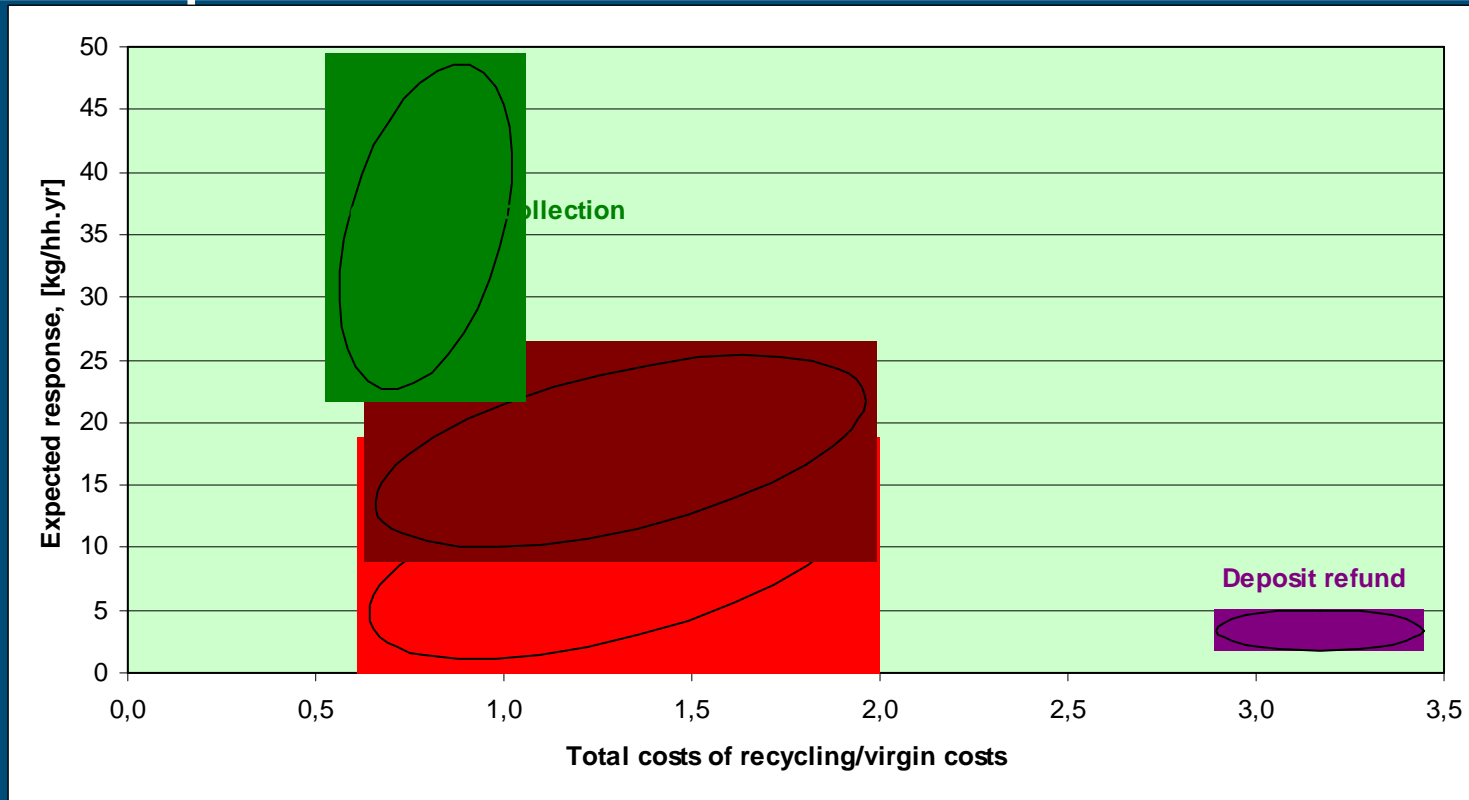
- Plastics can also be automatically separated from MSW with MRF
  - High investments
  - Low market prices for recovered plastics
  - Rigid and Flexible packaging recovered

- But:

- Few waste companies can add MRF to their incinerator
- Flexibles
  - New methods of material recovery necessary
  - Or energy recovery
- New recycling processes needed



# System performance





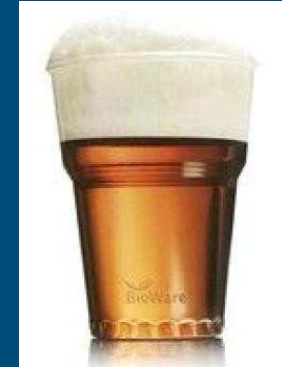
# Biodegradable / renewable packaging



# Bio-degradable / renewable packaging

## ■ Current applications

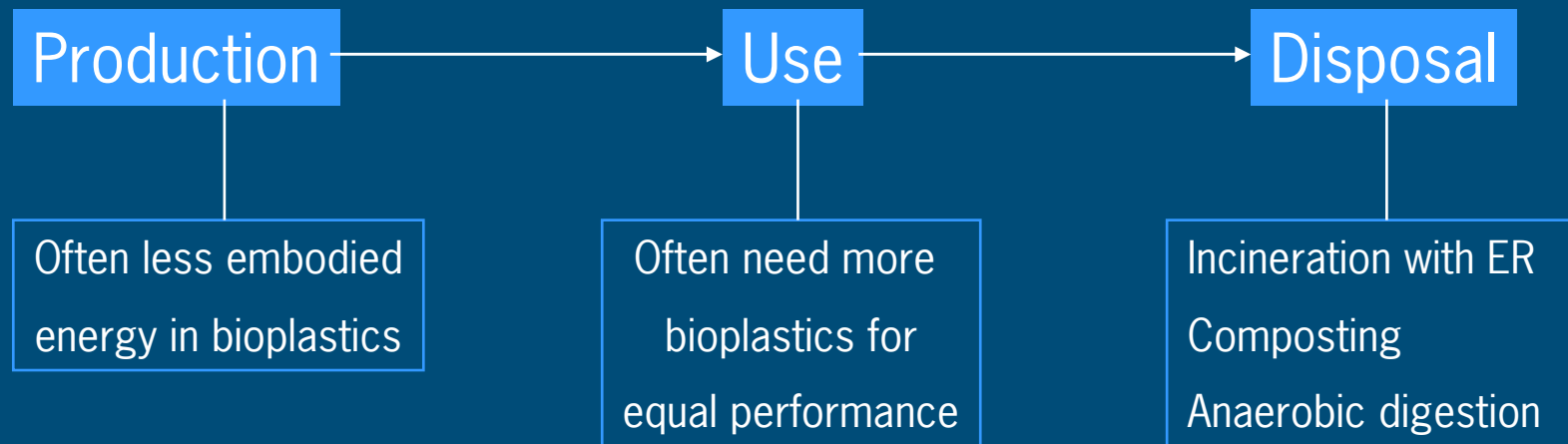
- Beer cups for outdoor events
  - PLA does not break up into sharp splinters
- Organic foods (fruit, vegetables and yoghurt cups)
  - Do not upset heavy users of organic foods
  - Most cost efficient activity to promote its image of sustainability



- Other applications are technical difficult, but much more is expected in the coming years



# Environmental impact packages



- Bioplastics can be better, especially when there are few technical (permeability) constraints.
  - Incineration or anaerobic digestion with energy recovery improve the energy balance
  - Composting: conservation of soil nutrients



## Example: replacement of PP by PLA yoghurt cups

### ■ Cradle to bin (production and use)

- PP cup =  $(8,5 \text{ g} + 0,01 \text{ g}) \times 95 \text{ MJ/kg} = 0,842 \text{ MJ/pack}$
- PLA cup =  $(10,2 \text{ g} + 0,02 \text{ g}) \times 57 \text{ MJ/kg} = 0,593 \text{ MJ/pack}$

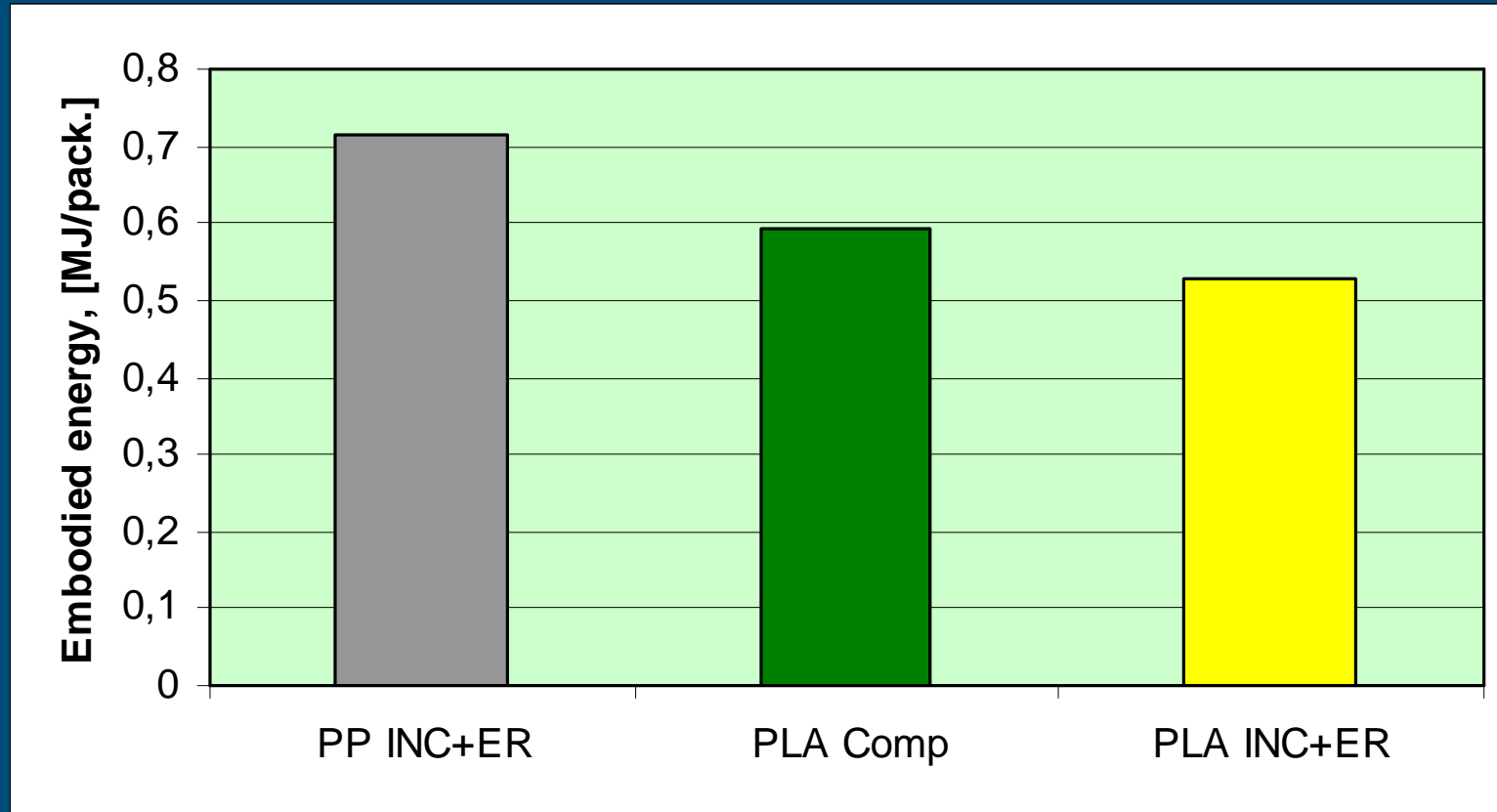
### ■ Incineration with energy recovery yields:

- PP cup =  $(8,5 \text{ g} + 0,01 \text{ g}) \times \alpha \times 45 \text{ MJ/kg} = -0,126 \text{ MJ/pack}$
- PLA cup =  $(10,2 \text{ g} + 0,02 \text{ g}) \times \alpha \times 18 \text{ MJ/kg} = -0,063 \text{ MJ/pack}$

### ■ Hence Cradle to end-of-life:

- PP cup = 0,842 MJ/pack landfilled or 0,716 MJ/pack Inc.+ER
- PLA cup = 0,593 MJ/pack composted or 0,529 MJ/pack Inc.+ER

# Energy balance for yoghurt cups



Take care: different for every application, do not generalise!



# Bio-barriers

- Various bio-barriers are under development
  - PLA-SiO<sub>x</sub>-PLA
  - PLA-PVOH+nanoclay
  - Starch laminates
  - PLA-EVOH-PLA
- Still problems with
  - Machinability
  - Permeability (CO<sub>2</sub>)
- MAP packaging applications with hard cheese, cured meats and fresh meats are improving, but not as good as traditional, yet.



# Bio-degradable / renewable packaging

- Price: always (a bit) more expensive
- Performance: sometimes equal, often less, but improving.
- Environment: sometimes better, sometimes not
- Much innovation and improvement expected



# Oxo-degradable packaging

- Magic “self disappearing” plastic
- Normal plastic packaging with strong oxidative catalyst
  
- Not compatible with recycling, yet
- Loss of energy
- Degradation routes not known
  - Toxicity?
  - Bio accumulation of fragments?





# Environmental priorities and possibilities

- Many initiatives for a more sustainable food industry are meaningful
- 1 raise the energy efficiency of food production
- 2 diverse from landfill in EU
- 3 reduce food wastage and optimise packaging
- 4 recycle plastics
- 5 biodegradable and renewable packages



# Thanks

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