Solvolysis of heteropolymers

An essential route in chemical recycling

Wouter Stuyck – Researcher @SPOT - VITO

12/03/2026

vito

vito.be

2025

+1,400
multidisciplinary experts

69
nationalities

39%
female talent

135
postdocs and phd’s

314
scientific publications

1,200
patents in portfolio

vito

2025

Lab to fab infrastructure

7

research sites in Flanders: Mol, Geel, Genk, Leuven, Antwerp, Ostend and Kortrijk

12,000 m²

of high-end laboratories

3,400 m²

of pilot halls

+40

cross-domain research areas

vito

2025

7

research sites in Flanders: **Mol**, Geel, Genk, Leuven, Antwerp, Ostend and Kortrijk

12,000 m²

of high-end laboratories

3,400 m²

of pilot halls

+40

cross-domain research areas

vito

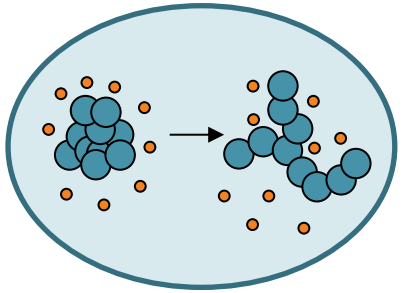
Design and development of
Sustainable **PO**lymer **T**echnologies
Renewable and/or Recyclable

Technology platforms in SPOT

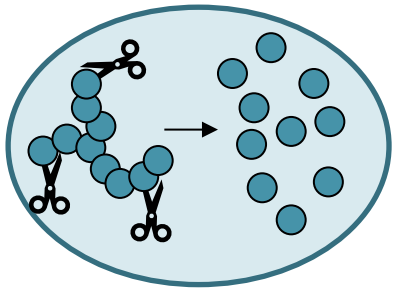
Sustainable carbon

Biomass, Lignin & Plastics as a feedstock

Dissolution



Depolymerization



Material development

Polymers & additives
Design from and for recycling

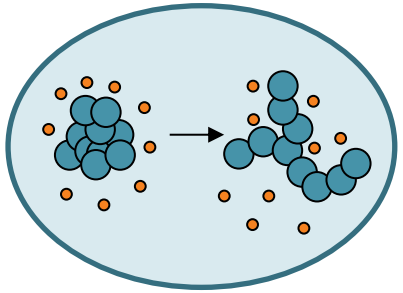
Polymerization

Technology development in SPOT

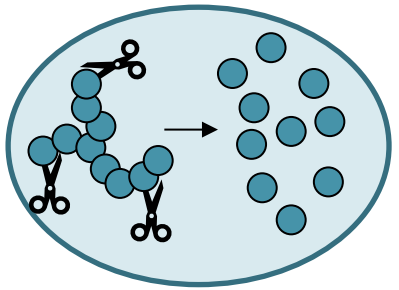
Sustainable carbon

Biomass, Lignin & Plastics as a feedstock

Dissolution



Depolymerization



Material development

Polymers & additives

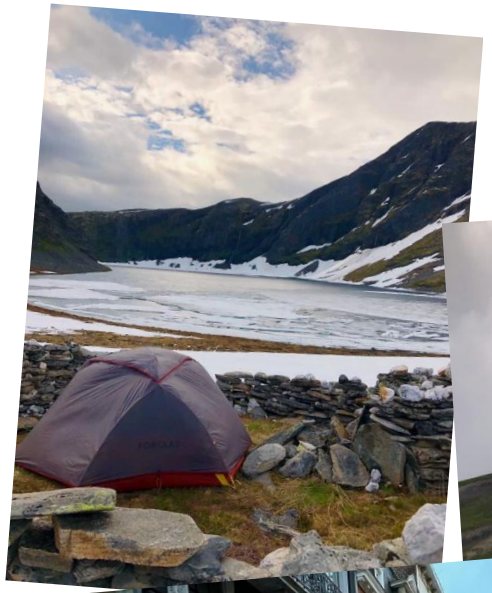
Design from and for recycling

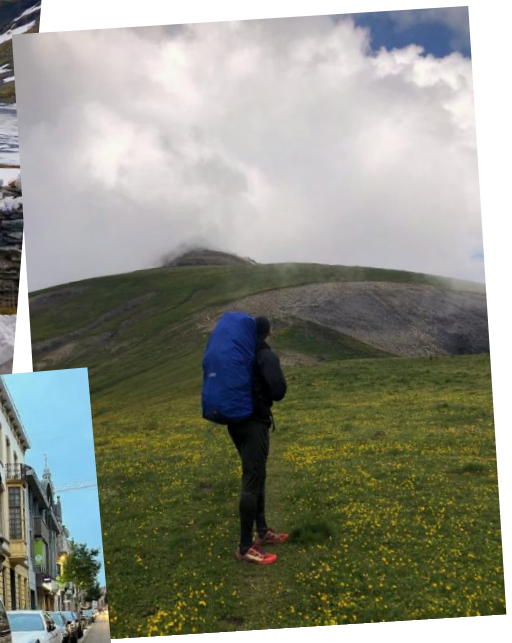
Polymerization

vito

vito.be

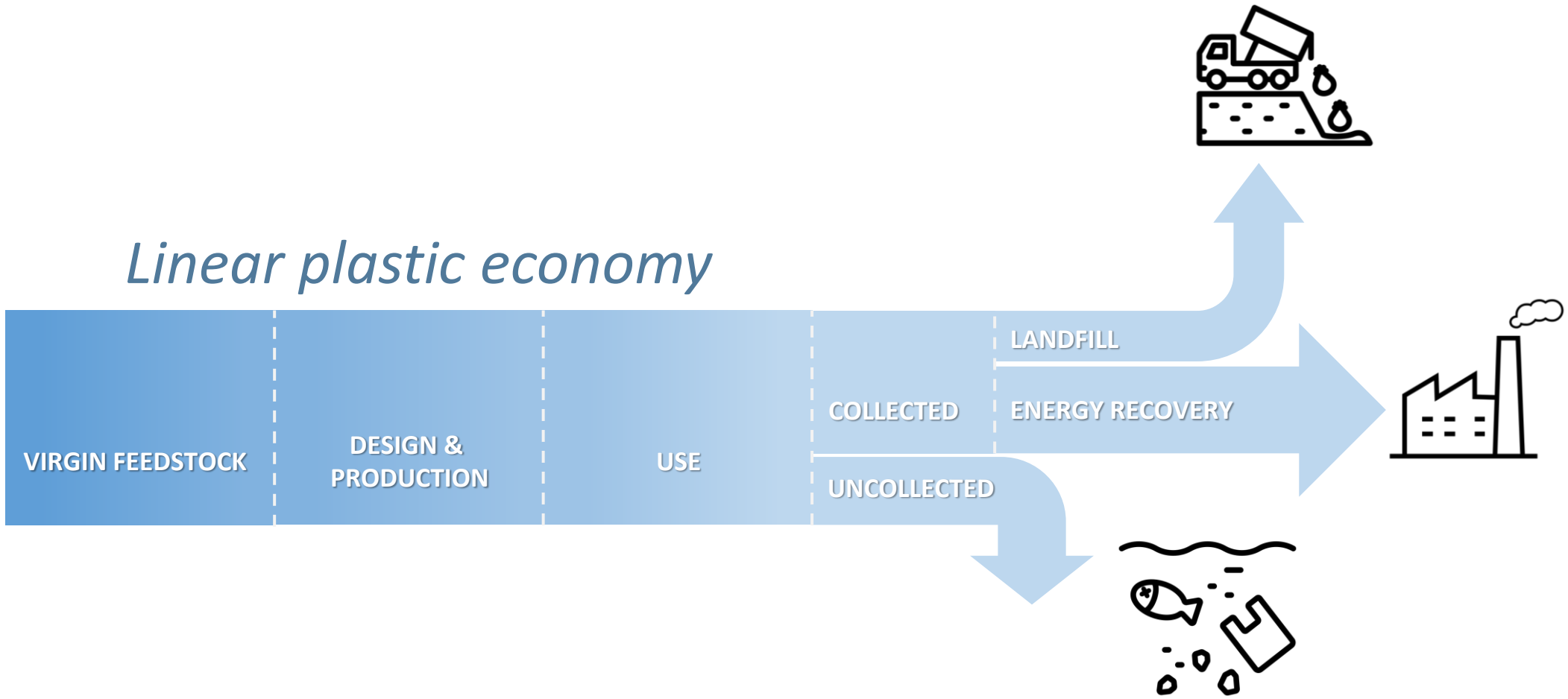
Plastic



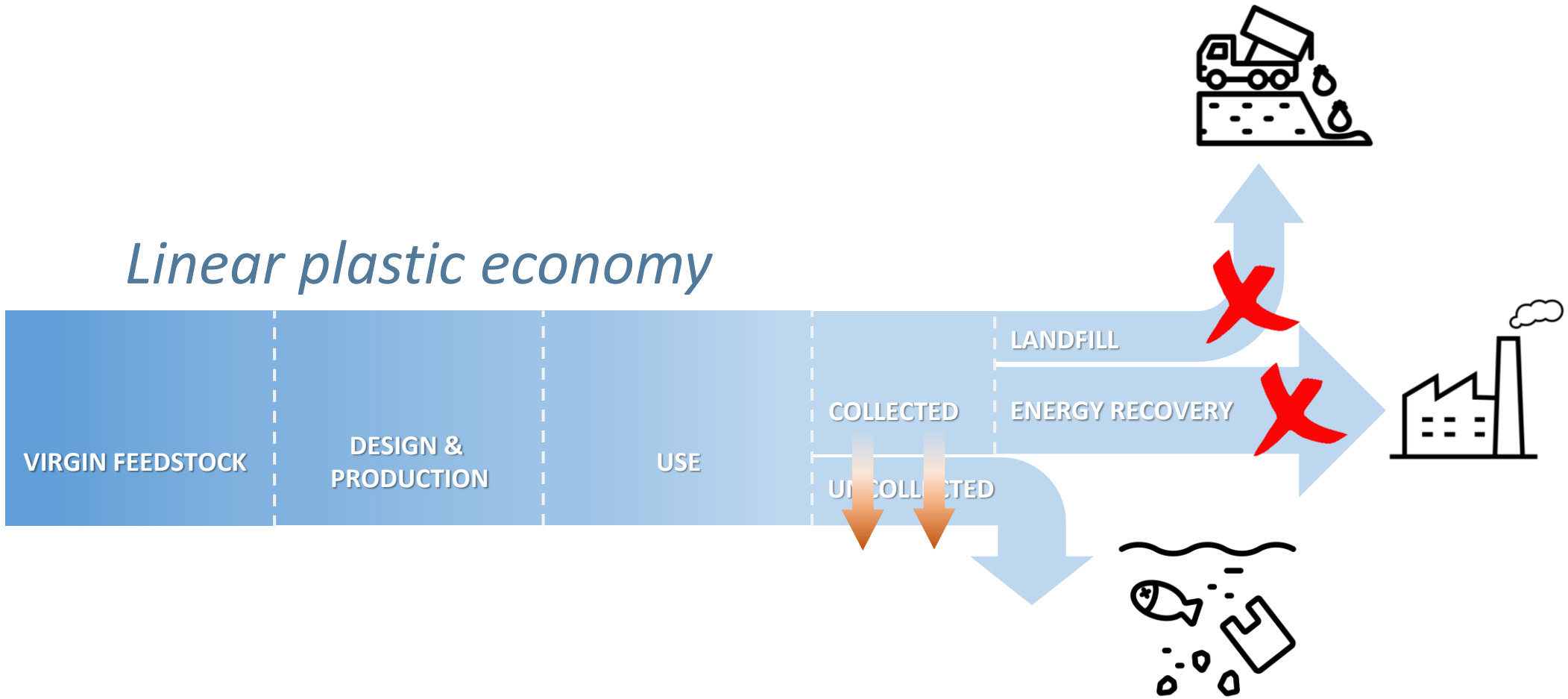


Plastic

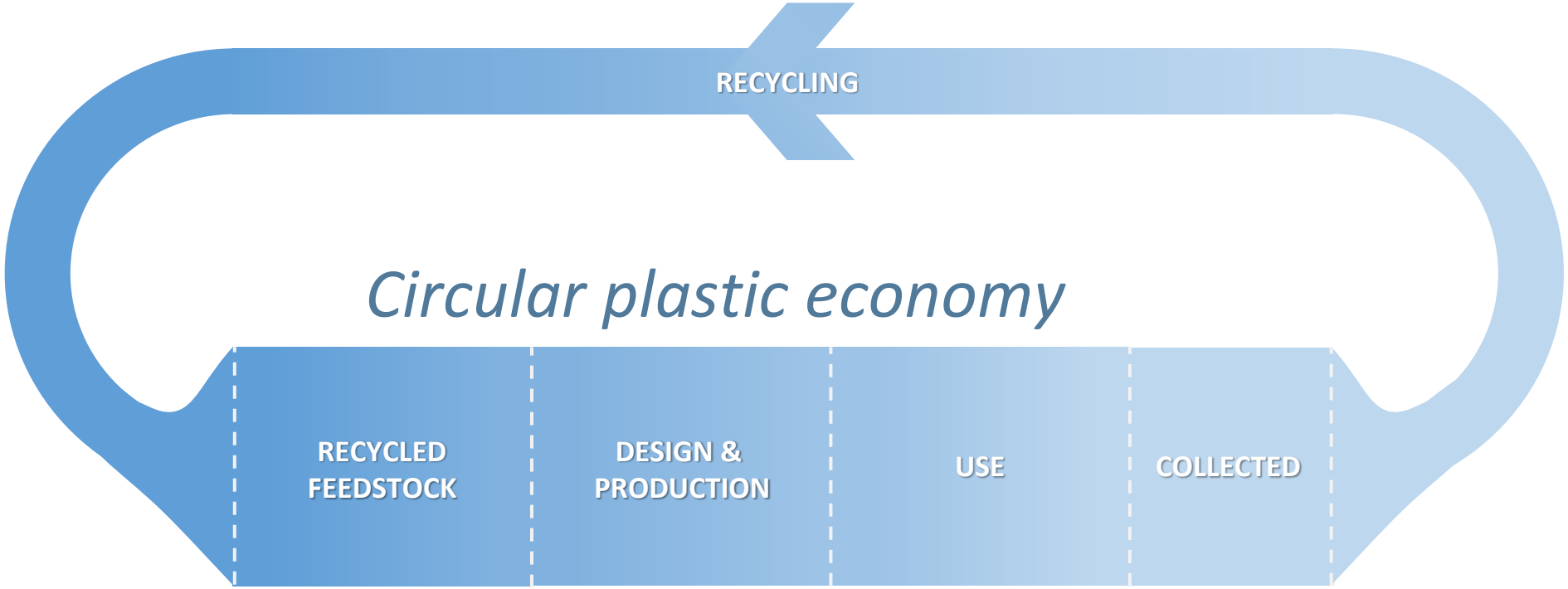
Plastic economy



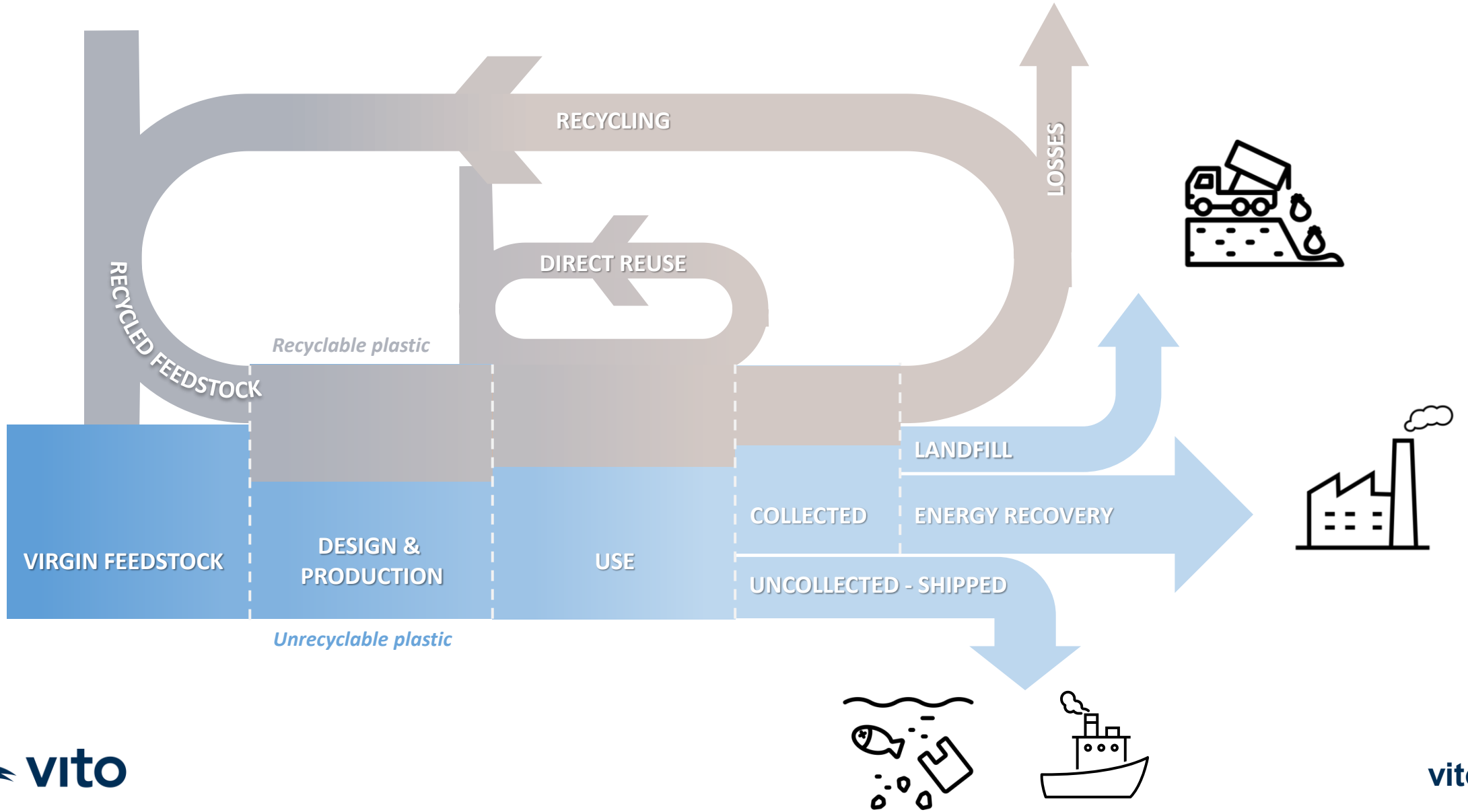
Plastic economy



Plastic economy

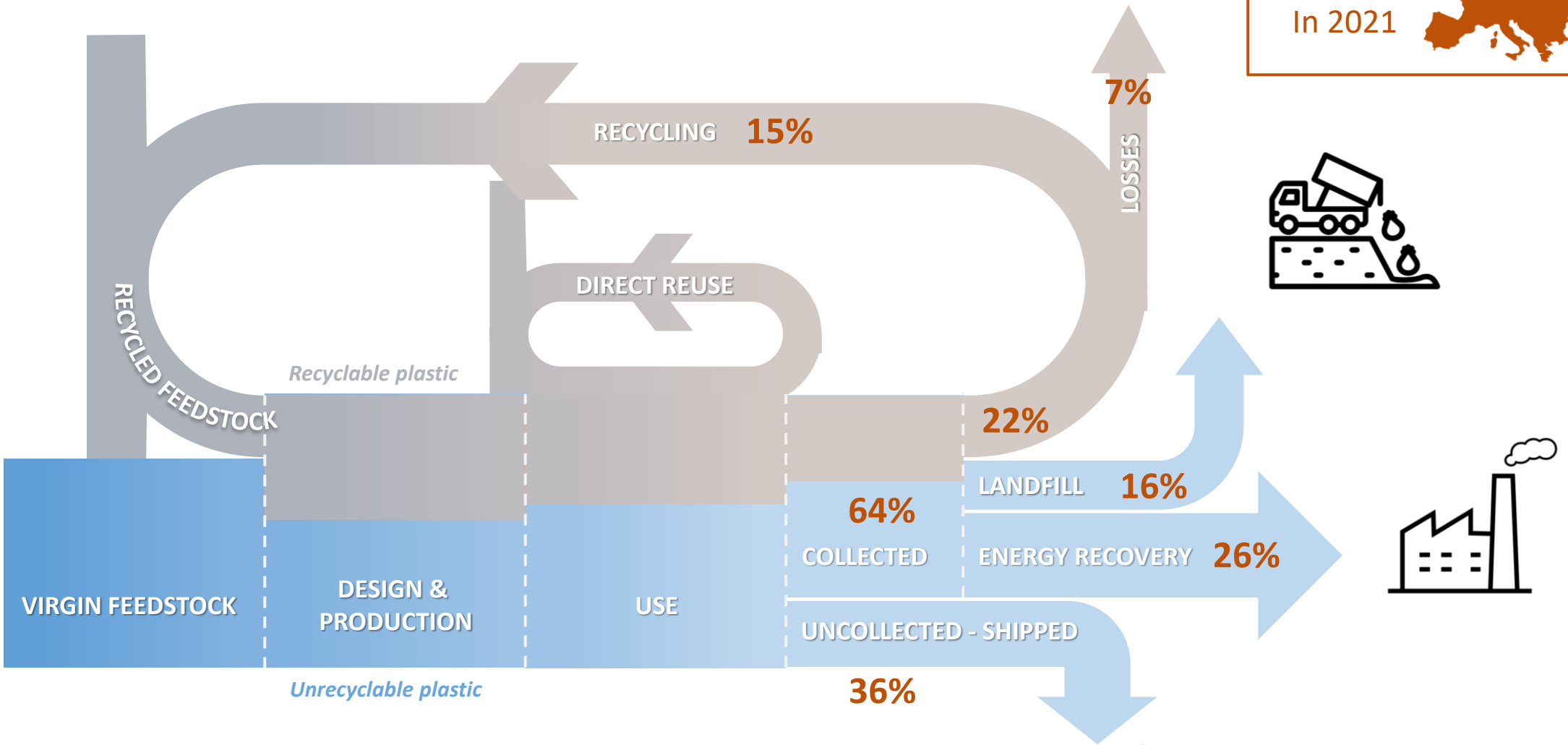


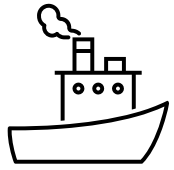
Plastic economy



Plastic economy

45 Mt
Plastic waste
In 2021





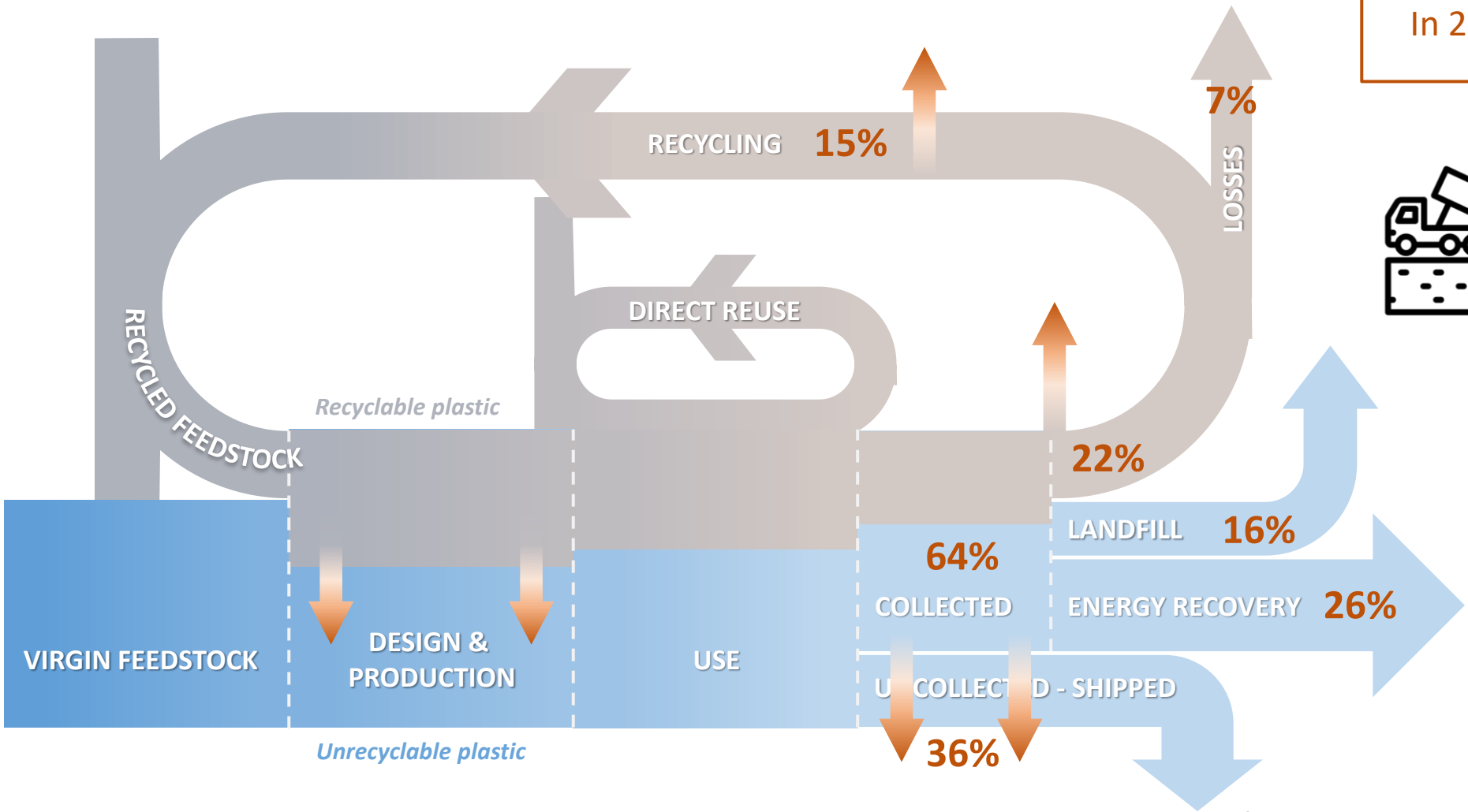
vito

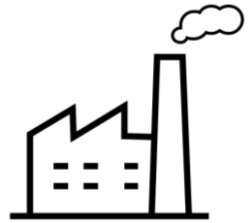
Europe's Missing Plastics, Material Economics; March 2022

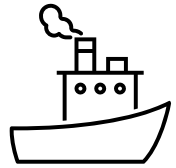
vito.be

Plastic economy

45 Mt
Plastic waste
In 2021





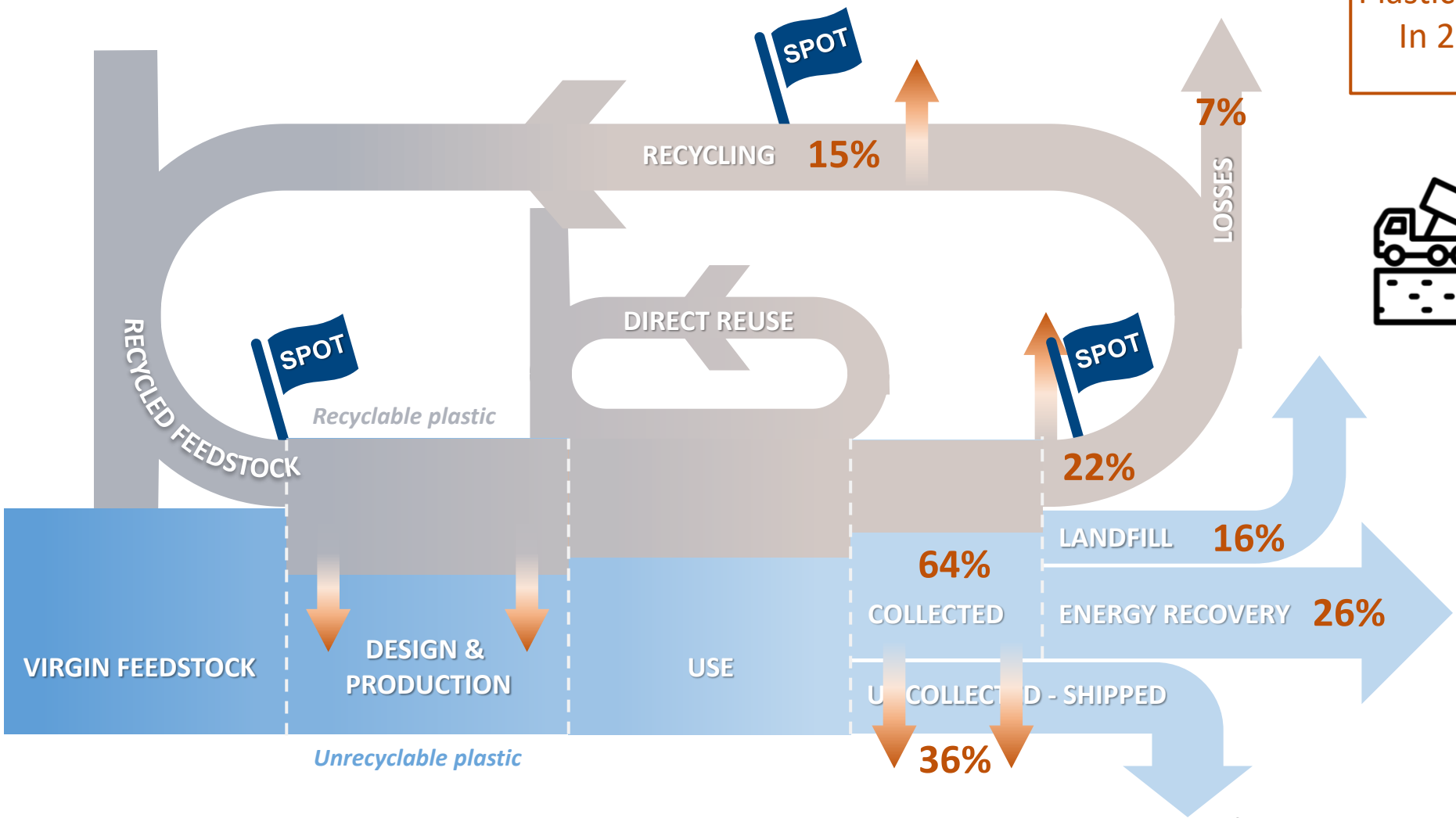


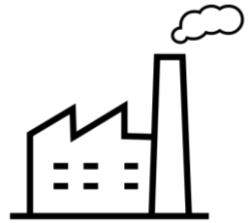
vito

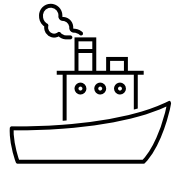
vito.be

Plastic economy

45 Mt
Plastic waste
In 2021







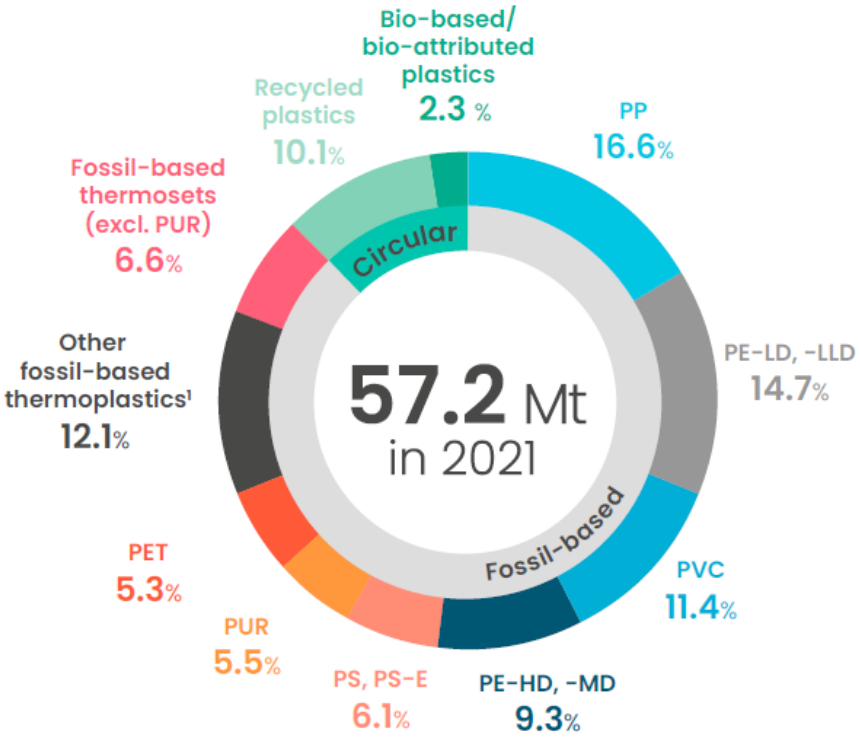
SPOT

1. **Design for recyclability**
2. **Plastic recycling technologies**

vito

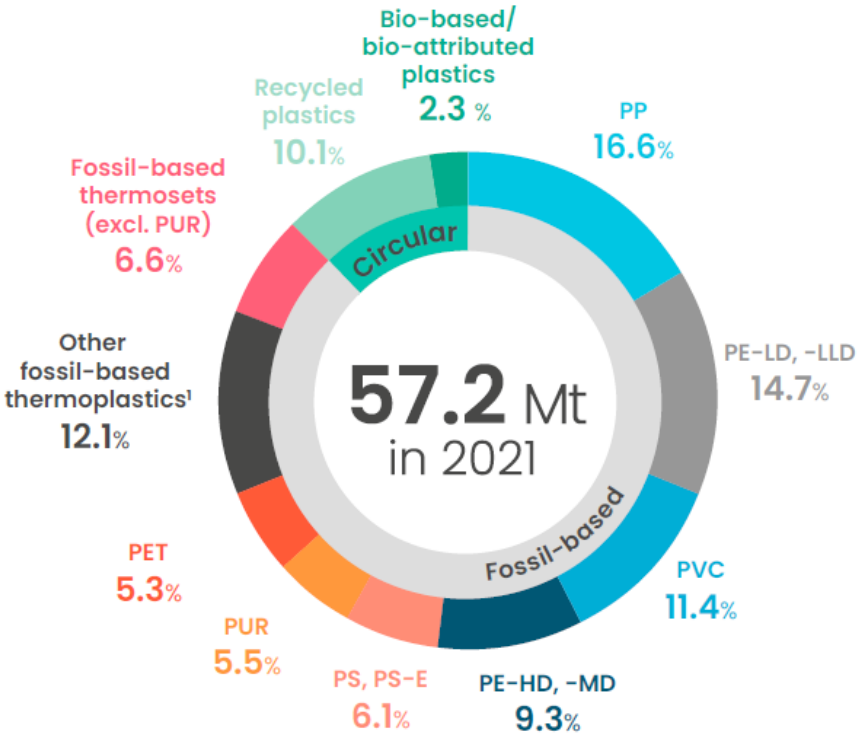
vito.be

Recycling technologies – Polymer types



Plastics Europe – Plastics – The Facts, 2022

Recycling technologies – Polymer types



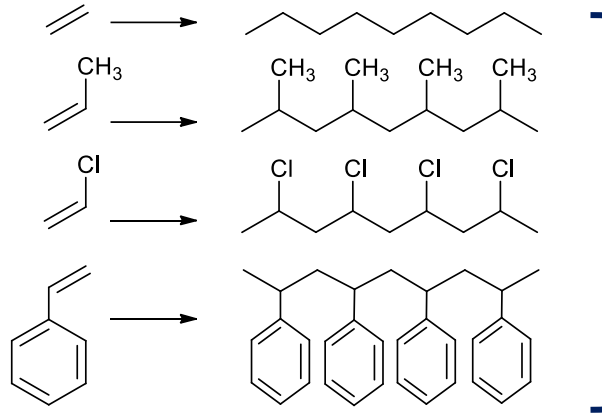
Homopolymers – One monomer type → Polymer

Polyethylene (PE)

Polypropylene (PP)

Polyvinylchloride (PVC)

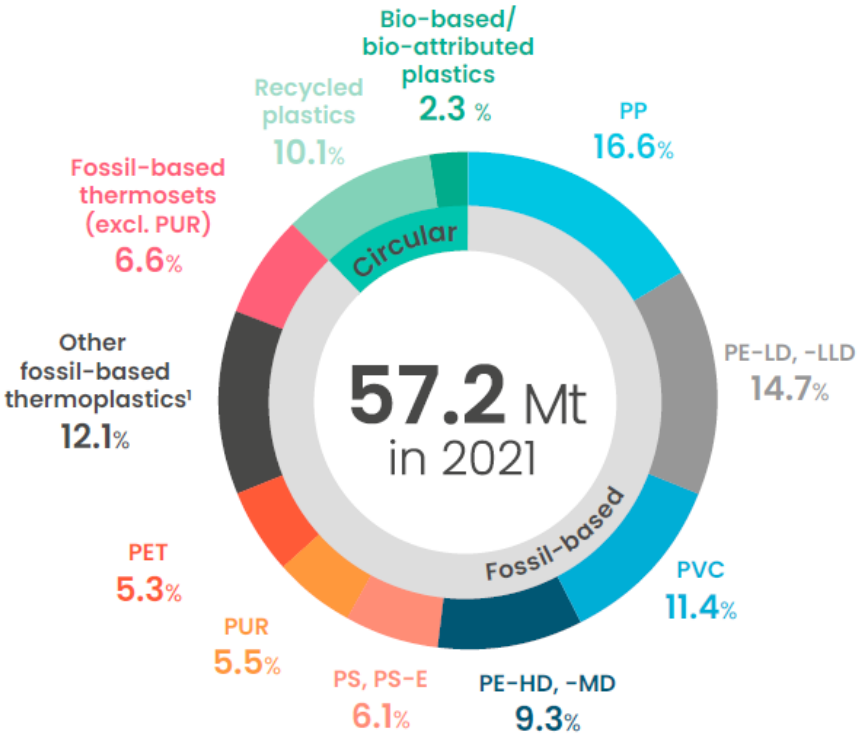
Polystyrene (PS



C-backbone

Plastics Europe – Plastics – The Facts, 2022

Recycling technologies – Polymer types



Plastics Europe – Plastics – The Facts, 2022

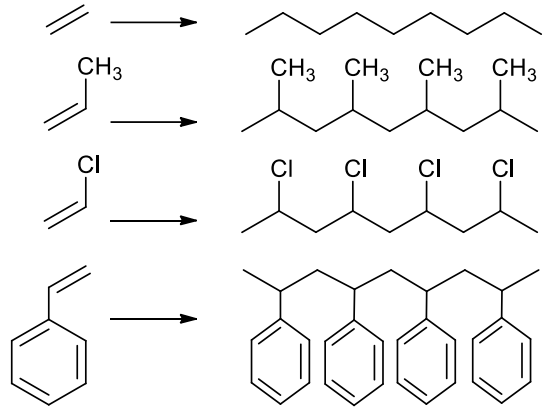
Homopolymers – One monomer type → Polymer

Polyethylene (PE)

Polypropylene (PP)

Polyvinylchloride (PVC)

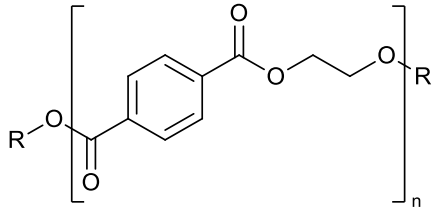
Polystyrene (PS



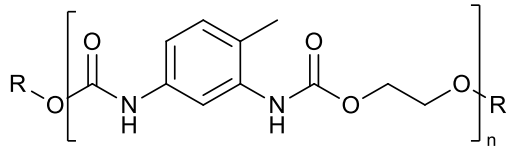
C-backbone

Heteropolymer – More than one monomer type → Polymer

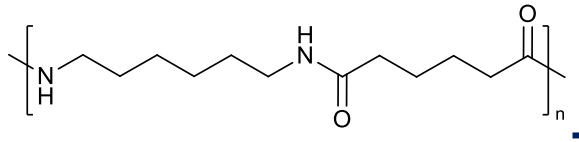
Polyethylene terephthalate (PET)



Polyurethane (PUR)



Polyamide (PA)



Often Hetero-atom Linkage

vito.be

Recycling technologies – Recycling technologies

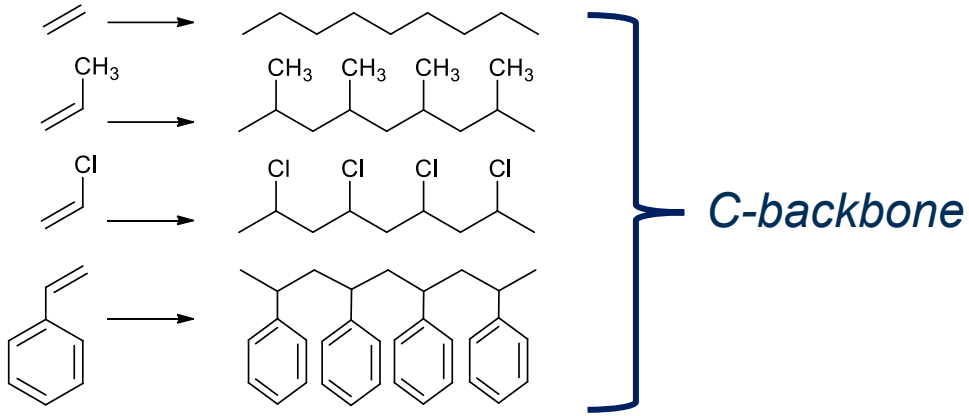
Homopolymers *– One monomer type → Polymer*

Polyethylene (PE)

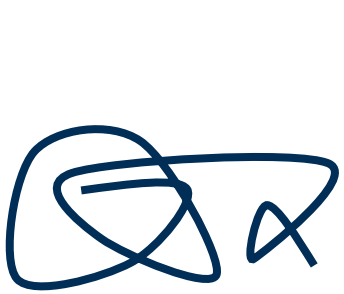
Polypropylene (PP)

Polyvinylchloride (PVC)

Polystyrene (PS



C-backbone



Melting - Extrusion

- ✓ Simple/cheap recycling method
- ✓ Similar polymer obtained
- ✗ Requires ‘clean’ polymer

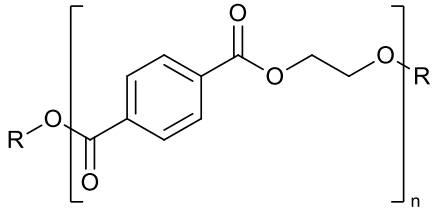
Splitting

- ✓ More expensive recycling technique
- ✓ Can handle ‘dirty’ streams
- ✗ Broad range of products
- ✗ Monomers difficult to obtain

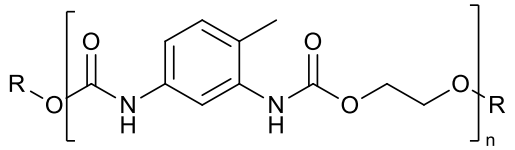
Recycling technologies – Recycling technologies

***Heteropolymer** – More than one monomer type → Polymer*

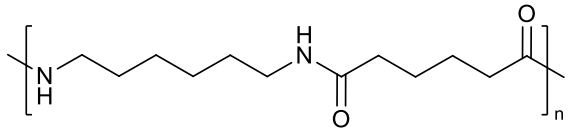
Polyethylene terephthalate (PET)



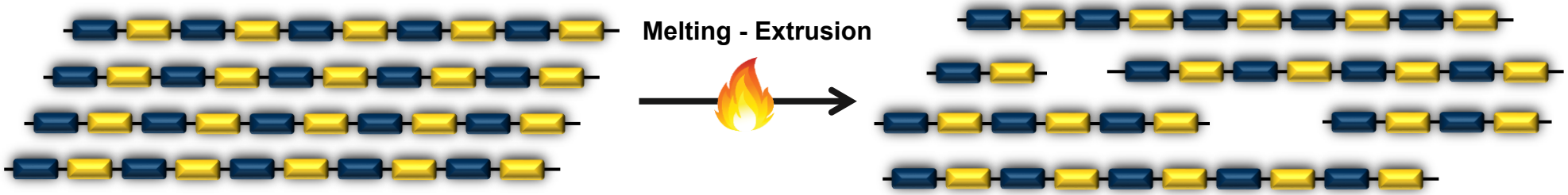
Polyurethane (PUR)



Polyamide (PA)



Often Hetero-atom Linkage

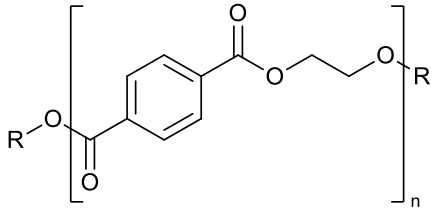


- ✓ Simple recycling method
- ✗ Undesired chain scission
- ✗ Loss properties - Downcycling

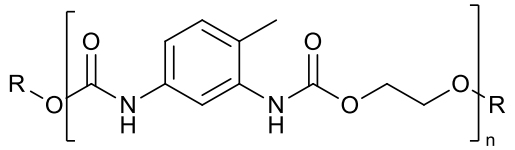
Recycling technologies – Recycling technologies

Heteropolymer *– More than one monomer type → Polymer*

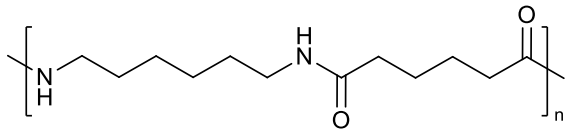
Polyethylene terephthalate (PET)



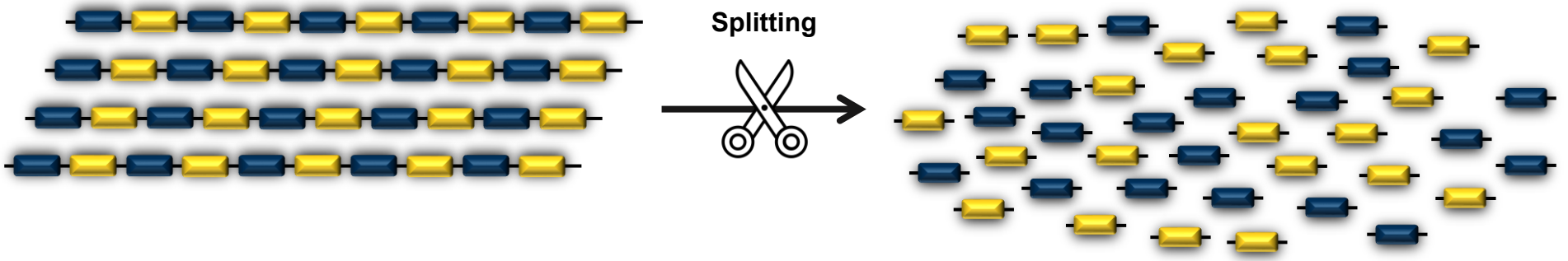
Polyurethane (PUR)



Polyamide (PA)



Often Hetero-atom Linkage

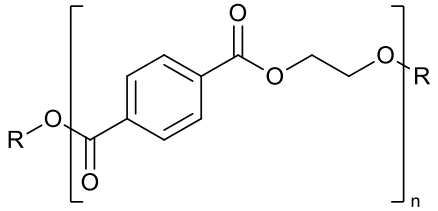


- ✗ Often more challenging
- ✓ Monomers reused in new synthesis
- ✓ No loss of mechanical properties

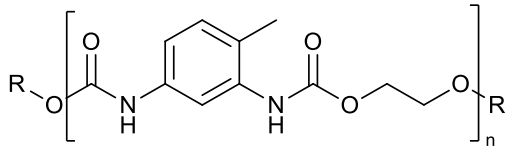
Recycling technologies – Recycling technologies

Heteropolymer *– More than one monomer type → Polymer*

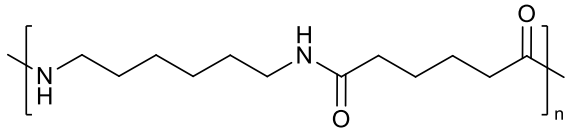
Polyethylene terephthalate (PET)



Polyurethane (PUR)

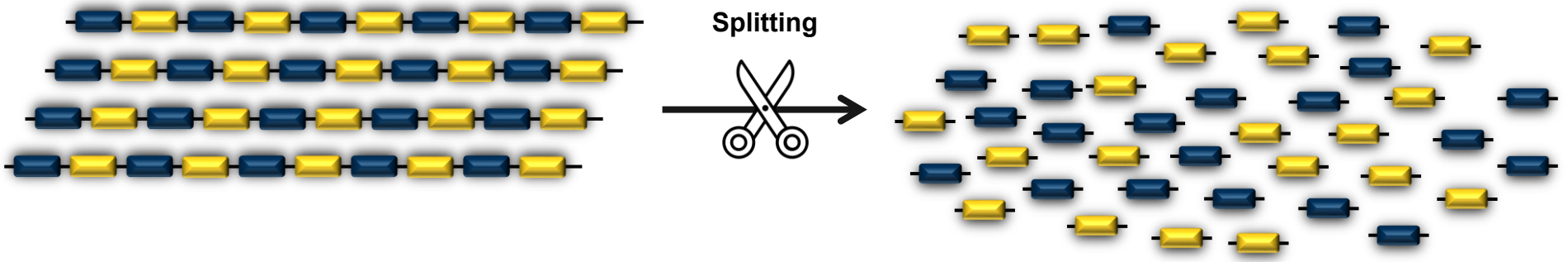


Polyamide (PA)



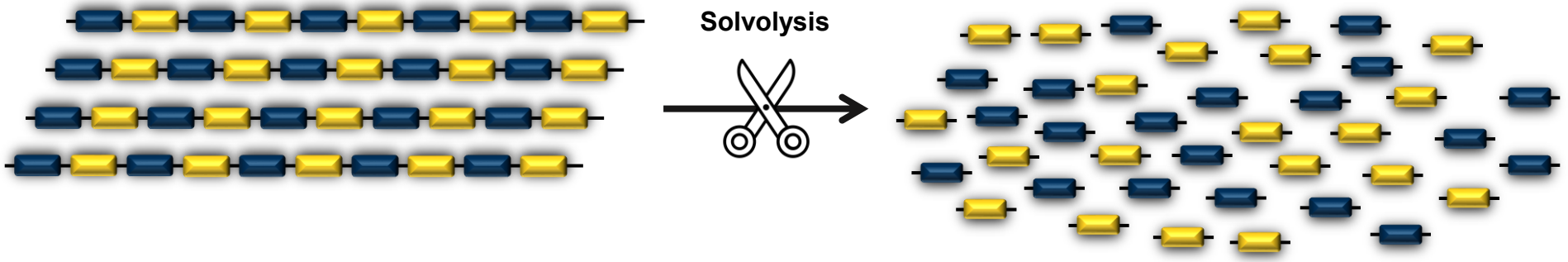
Often Hetero-atom Linkage

SPOT



- ✗ Often more challenging
- ✓ Monomers reused in new synthesis
- ✓ No loss of mechanical properties

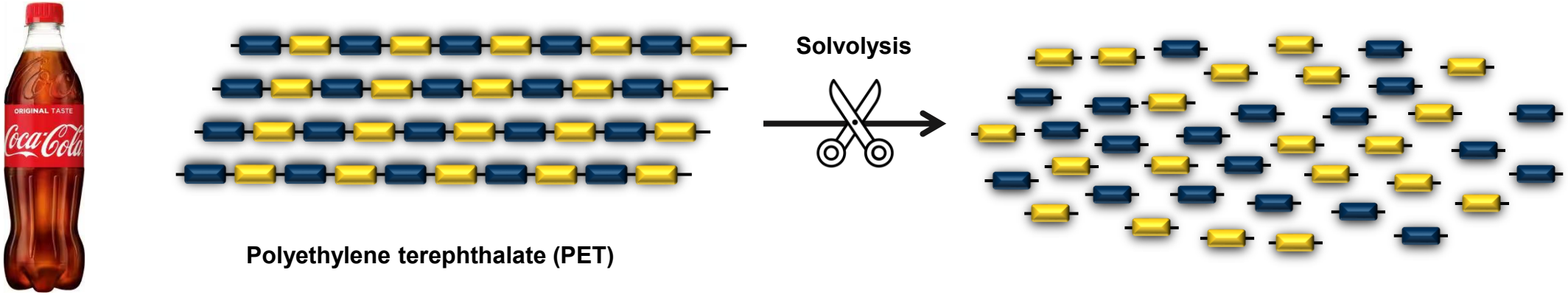
Recycling technologies – Solvolysis for heteropolymers



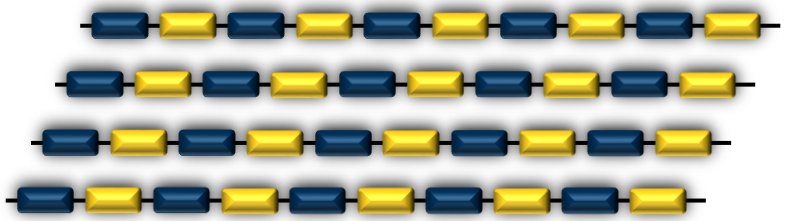
Solvolysis *– Using a solvent to depolymerize a heteropolymer*

- Broad class of molecules can be used to break a linkage:
  - *Methanolysis (Methanol), hydrolysis (water), glycolysis (glycol), aminolysis (amines)*
- In addition to solvent, temperature and stirring (agitation) important factor
- Also catalysts can accelerate the reaction
  - *Depending on which solvolysis method – different catalysts may be effective*

Solvolysis for heteropolymers – PET case

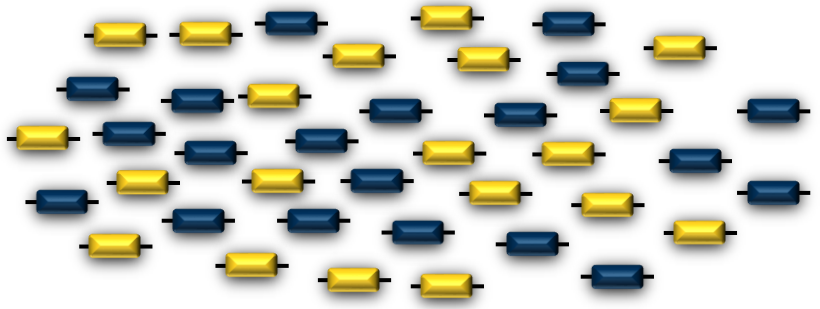


Solvolysis for heteropolymers – PET case

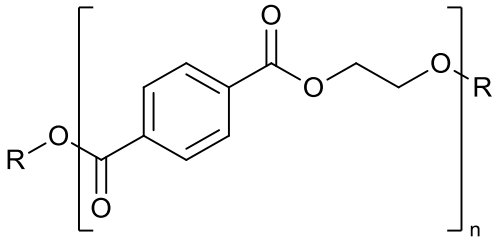


Polyethylene terephthalate (PET)

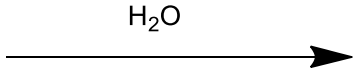
Solvolysis

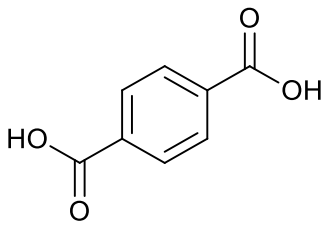


Monomeric units



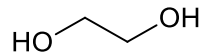
Polyethylene terephthalate (PET)



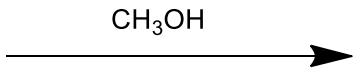


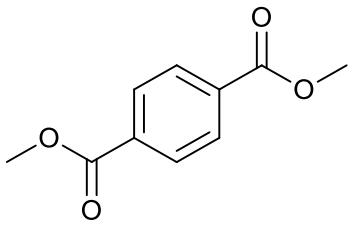
Terephthalic acid

\+



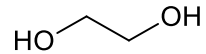
Ethylene glycol





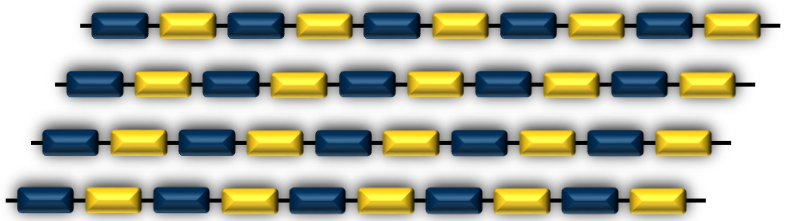
Dimethyl terephthalate

\+



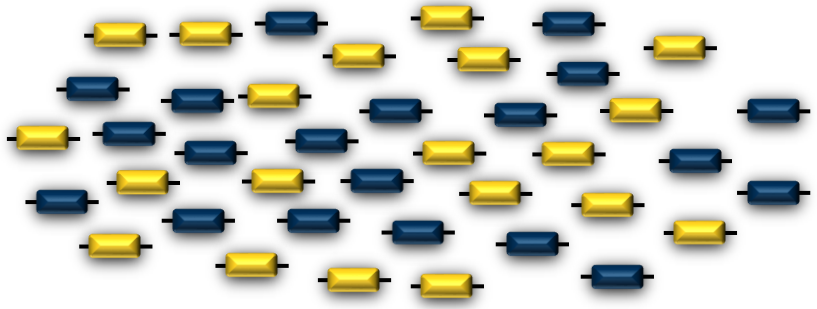
Ethylene glycol

Solvolysis for heteropolymers – PET case



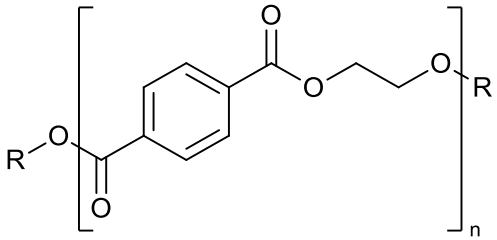
Polyethylene terephthalate (PET)

Solvolysis



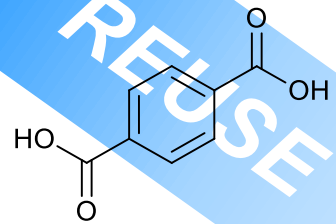
Monomeric units

REUSE



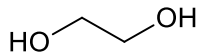
Polyethylene terephthalate (PET)

H_2O



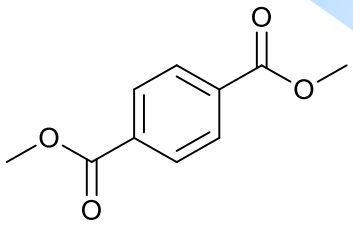
Terephthalic acid

\+



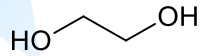
Ethylene glycol

CH_3OH



Dimethyl terephthalate

\+



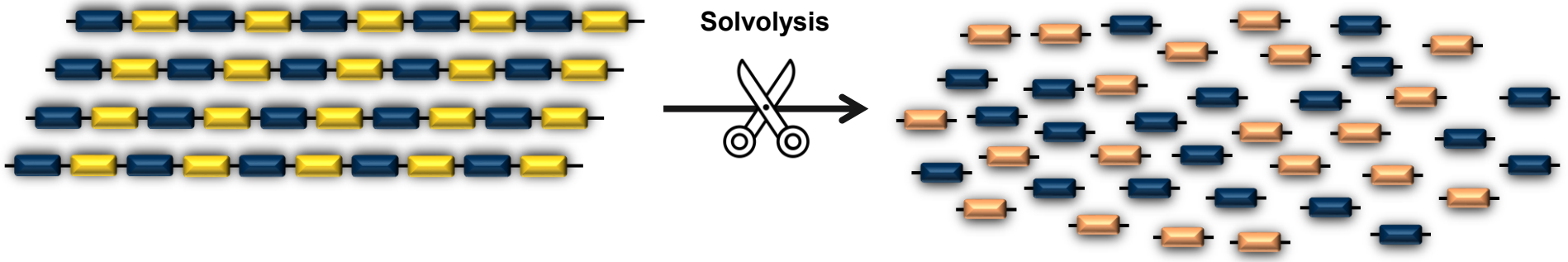
Ethylene glycol

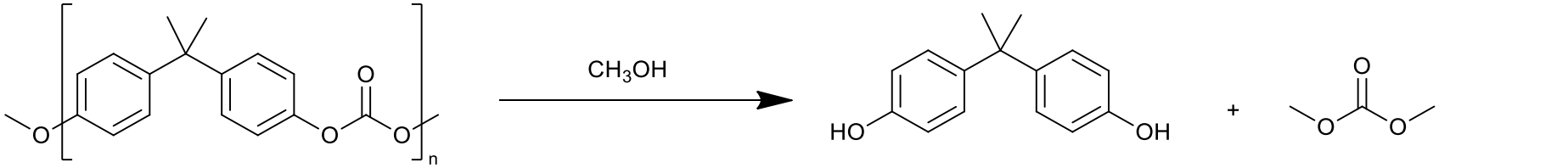
- ✓ 50% - 80% reduction CO_2 eq.
- ✗ 2.2 x more expensive vs. virgin

vito

vito.be

Solvolysis for heteropolymers – Spot case 1: PC methanolysis

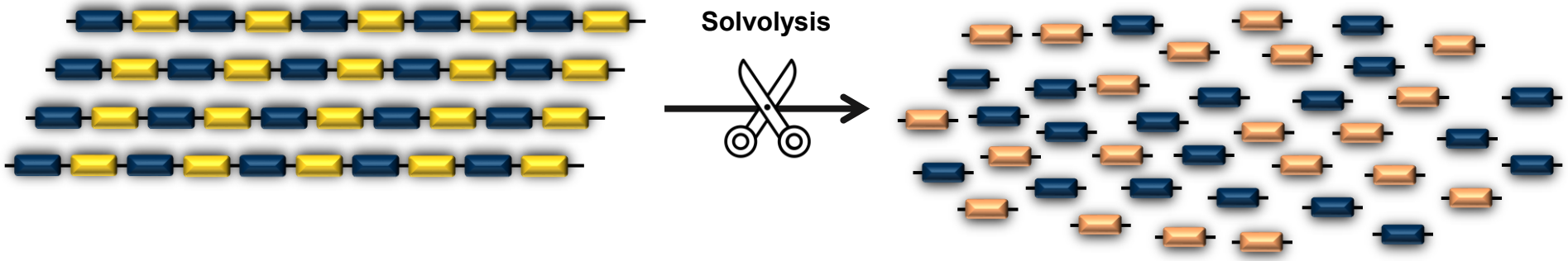


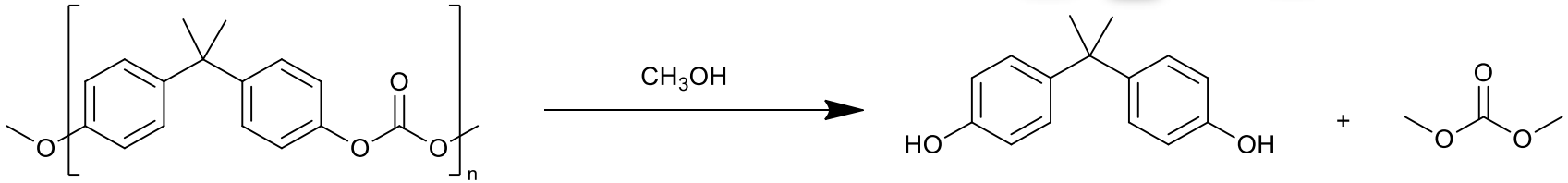


Polycarbonate (PC) **Bisphenol A (BPA)** **Dimethylcarbonate (DMC)**

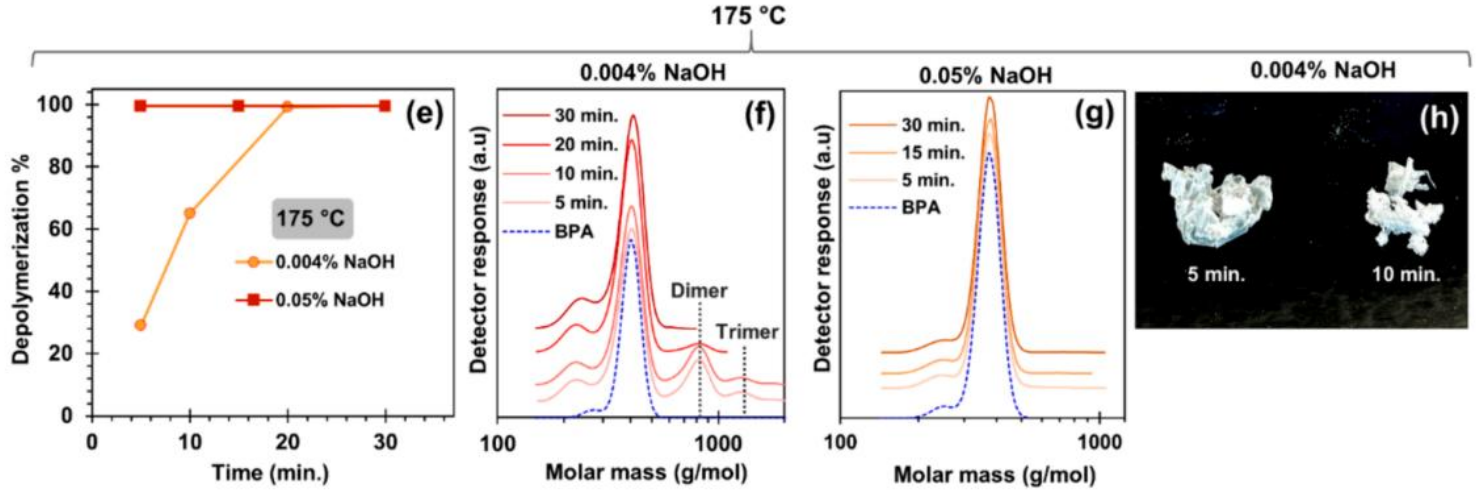
Chemical Engineering Journal 497 (2024), 154390

Solvolysis for heteropolymers – Spot case 1: PC methanolysis





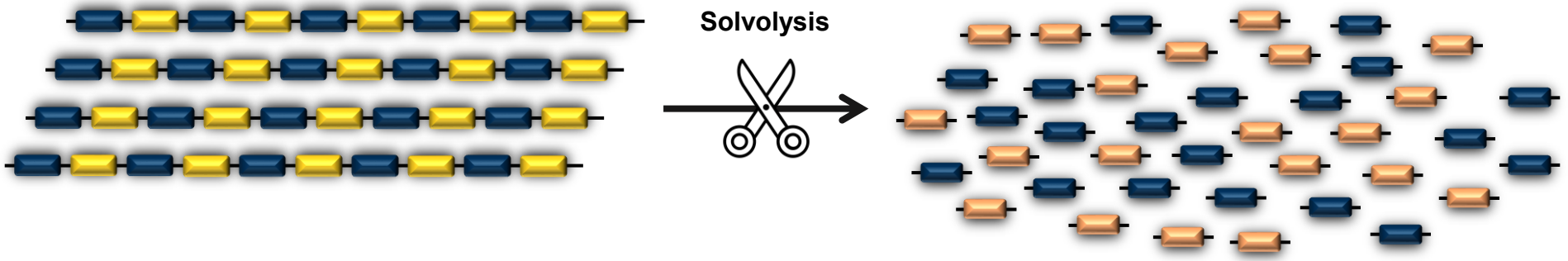
Polycarbonate (PC) **Bisphenol A (BPA)** **Dimethylcarbonate (DMC)**

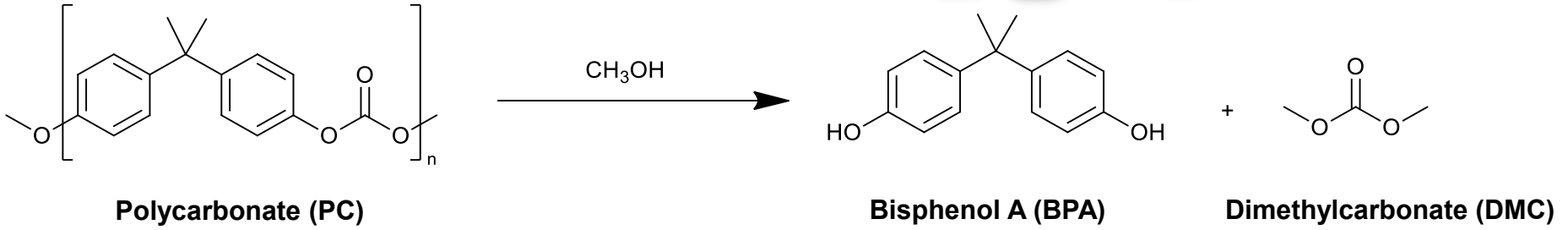


Chemical Engineering Journal 497 (2024), 154390

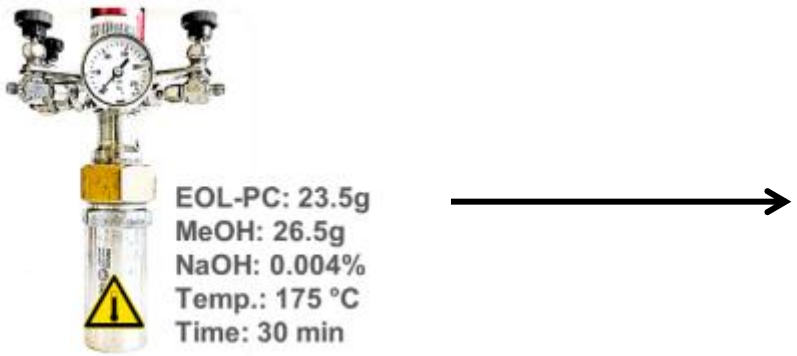
vito.be

Solvolysis for heteropolymers – Spot case 1: PC methanolysis



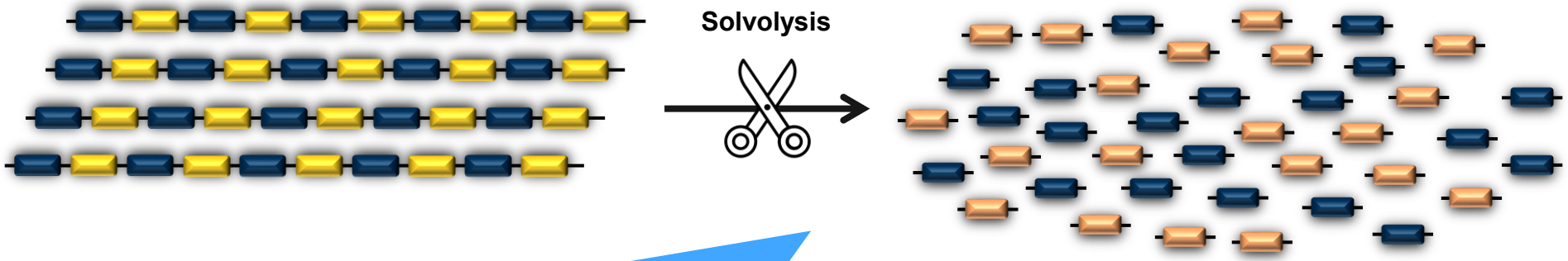


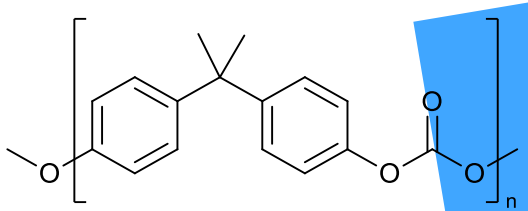
Polycarbonate (PC) **Bisphenol A (BPA)** **Dimethylcarbonate (DMC)**



Chemical Engineering Journal 497 (2024), 154390

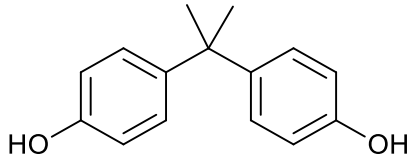
Solvolysis for heteropolymers – Spot case 1: PC methanolysis





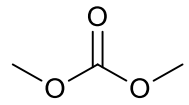
Polycarbonate (PC)

CH_3OH



Bisphenol A (BPA)

+



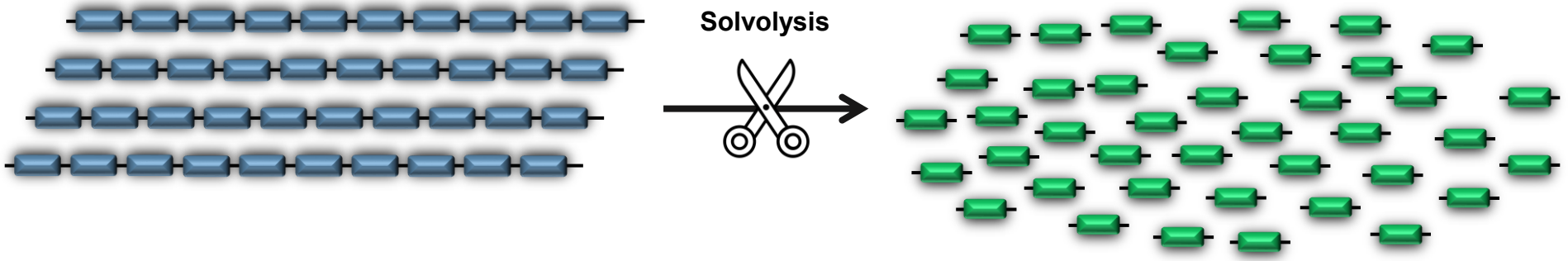
Dimethylcarbonate (DMC)

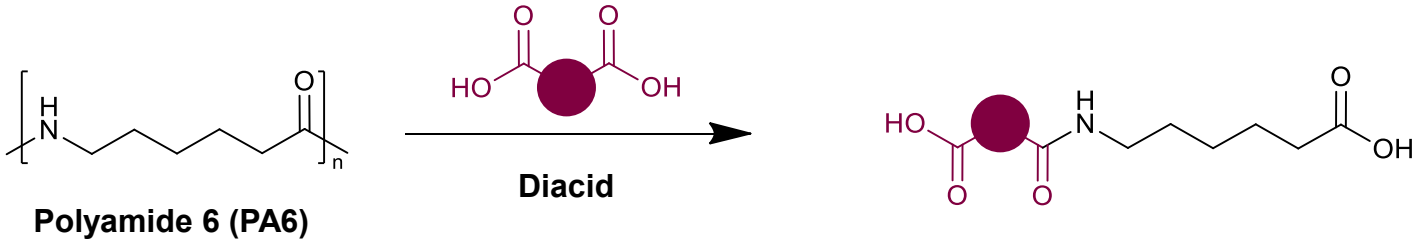
REUSE

EOL-PC: 23.5g
MeOH: 26.5g
NaOH: 0.004%
Temp.: 175 °C
Time: 30 min

Chemical Engineering Journal 497 (2024), 154390

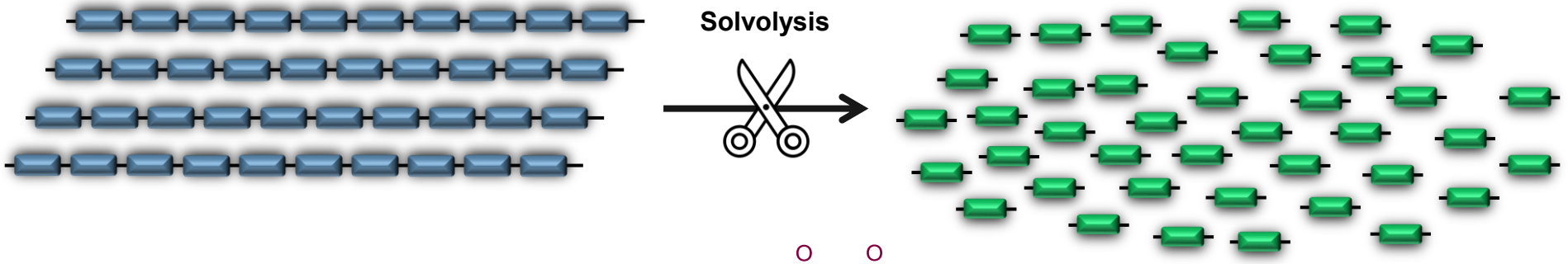
Solvolysis for heteropolymers – Spot case 2: PA6 acidolysis

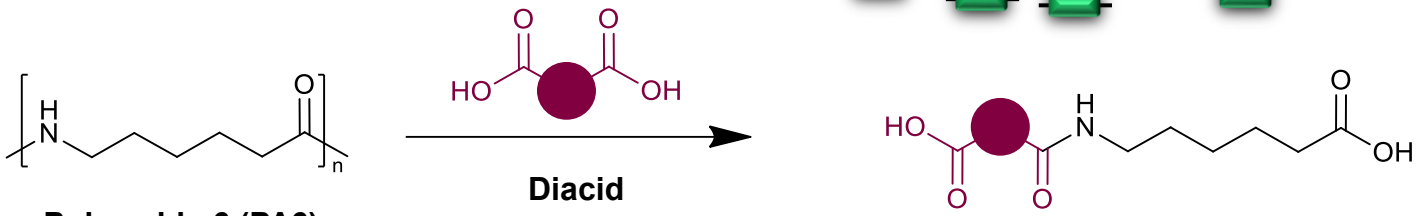




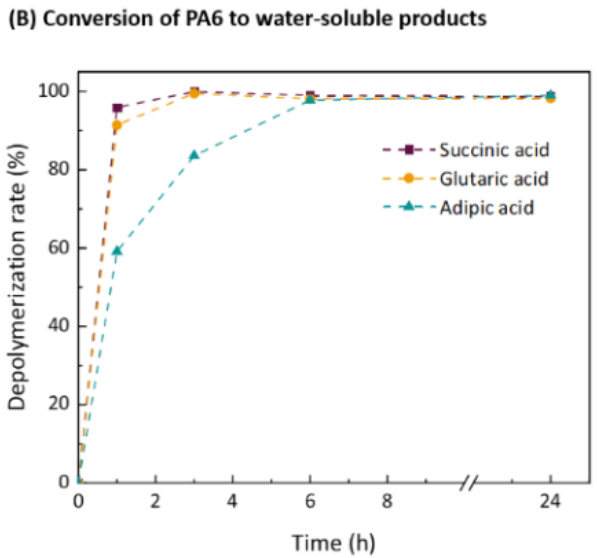
Polyamide 6 (PA6)

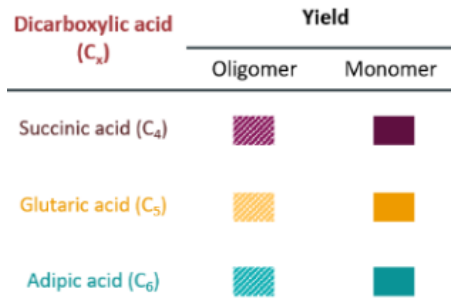
Solvolysis for heteropolymers – Spot case 2: PA6 acidolysis

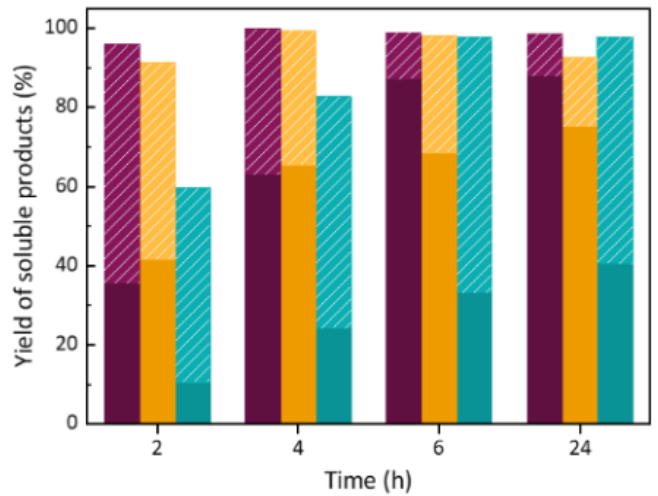




Polyamide 6 (PA6)

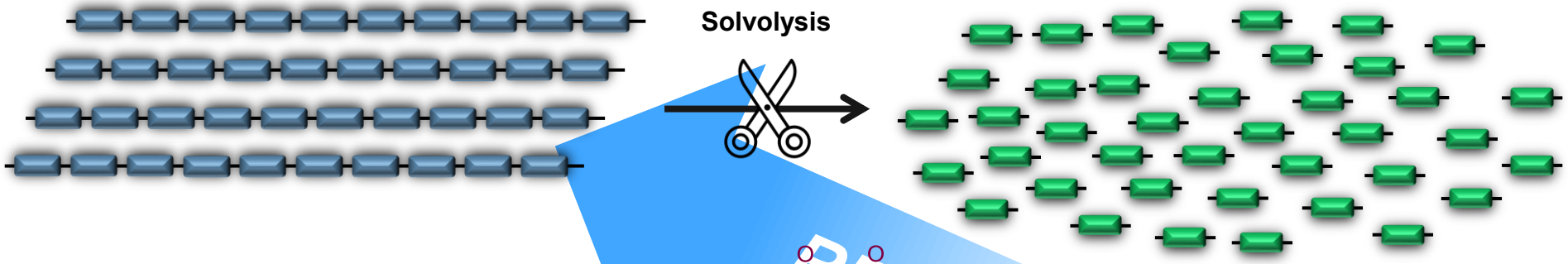


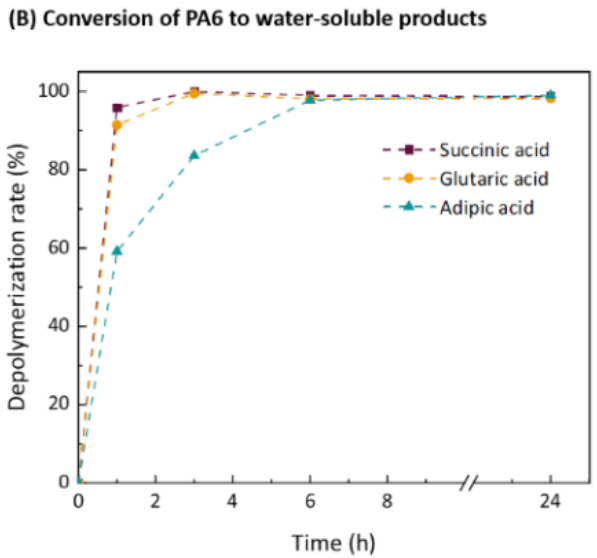


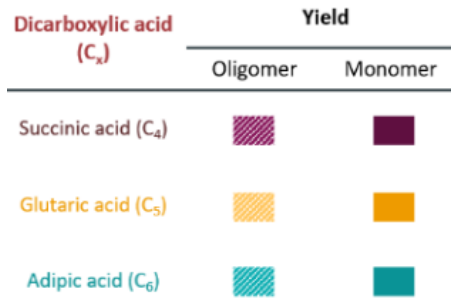


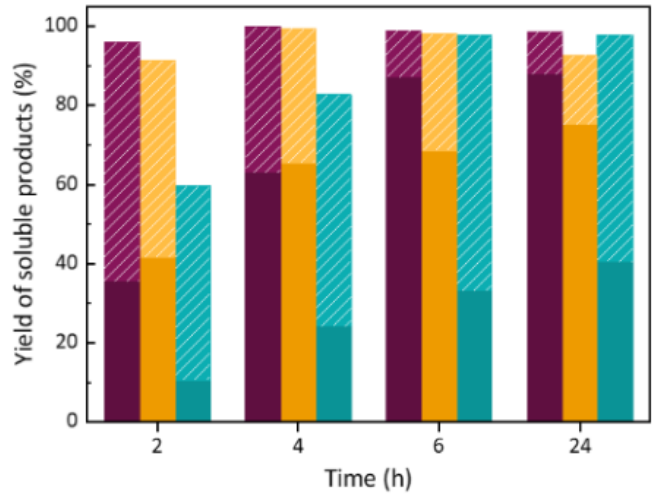
vito

Solvolysis for heteropolymers – Spot case 2: PA6 acidolysis









Questions?

Time for a workshop?