The ReBioCycle Approach

Advancing Chemical Recycling of Bioplastics
presented by Jan R. Pels (TORWASH)

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ReBioCycle

Circular Bio-based Europe Joint Undertaking

Bio-based Industries Consortium

Co-funded by the European Union

Motivation

ReBioCycle

- **Demonstrate biobased biodegradable plastics recycling**
- Increase the TRL to bring recycling closer to the market reality
- Generate critical data /evidence
- Inform policy development
- **Inform Recycling Industry and Society**

Innovation action

- Integration and scale up (Technology readiness level 6/7)
- Hub structure promoting integration

Consortium

ReBioCycle

Hubs

ReBioCycle

ReBioCycle consortium

UCD DUBLIN

COORDINATOR

ReBioCycle

Dutch HUB

torwash

TotalEnergies Corbion PAQUES biomaterials

NTCP Corbion

kaneka

Spanish HUB

AIMPLAS

UCD DUBLIN Trinity College Dublin AGRICULTORES DE LA VEGA DE VALENCIA

GlasPort Bio

CSIC CIB Margarita Salas NUI Galway Ollscoil na Gaillimhe

kaneka

Italian HUB

NOVAMONT

amiat Gruppo iren iren

I.BLU Gruppo iren

Horizontal Partners: ARAPAHA SULAPAC ARCHA europeanbioplastics Magfi

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ReBioCycle
Is taking a portfolio approach to biobased biodegradable plastics recycling

ReBioCycle hubs
Are a critical unit of activity and replication

Data
Will be gathered and used to prepare a blueprint to inform industry and policy

- Innovation Action
- Duration: 1 October 2024-30 September 2028
- Funding: 7.4 M Euro
- Provided by the CBE (Horizon Europe)

Three-step Approach

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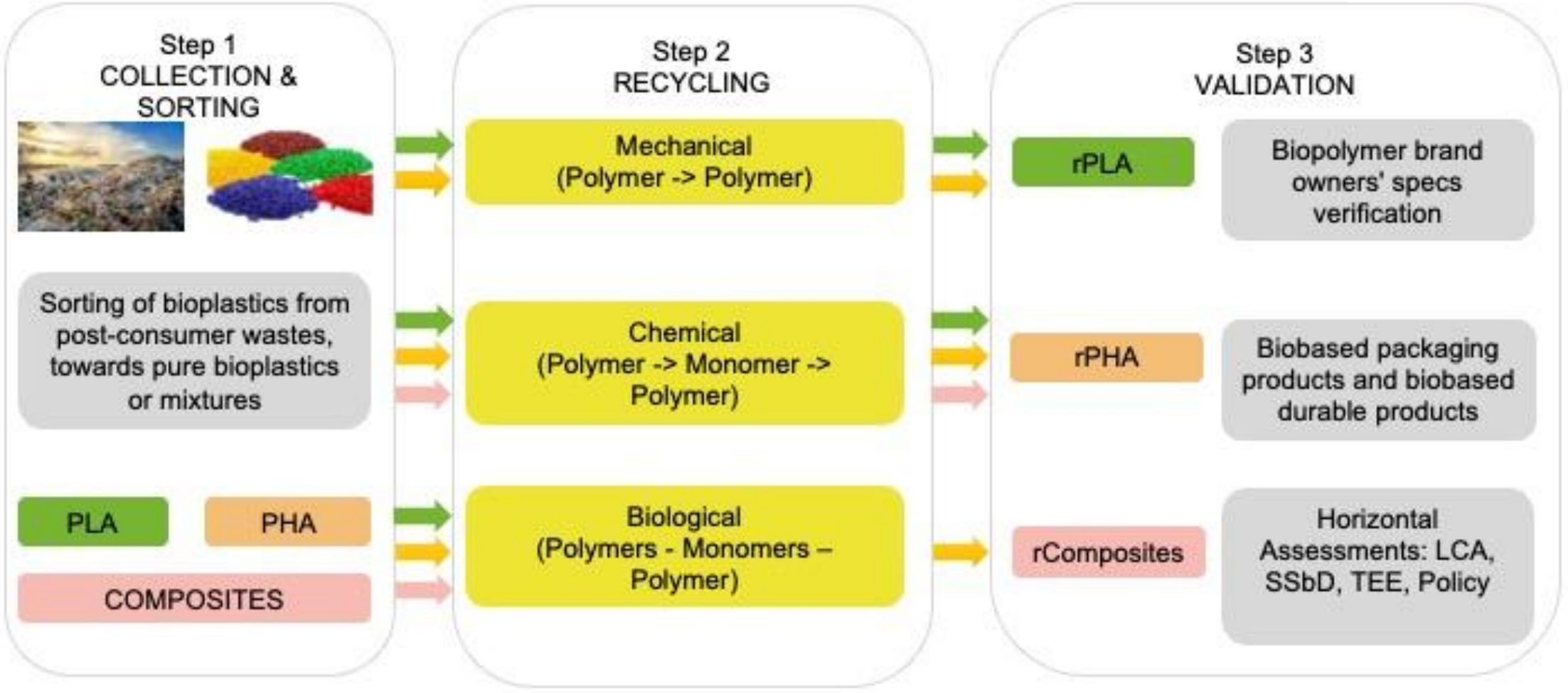

(Too) Many Tech Options

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- 3 biodegradable plastics: PLA, PHA and composites
- 4 technologies: mechanical, chemical, enzymatic, microbial
- 3 hubs: Dutch, Italian, Spanish
- 3 x 4 x 3 = 36 combinations

Hub	NL			IT			ES / IE		
	PLA	PHA	Composites	PLA	PHA	Composites	PLA	PHA	Composites
Mechanical							x	x	
Chemical	x	x	o		o	x		o	
Bio-enzymatic							o	x	o
Bio-microbial	x	x	o				x		x

x = full recycle in the same hub o = interaction between hubs

(*) Composites=mixed bio-based biodegradable plastics including blends of different biopolymers

Where are we now?

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- ES Hub
  - Sorting tests with PHA and PLA completed
  - First batch of mechanically recycled PLA produced – Milestone 4
- IT hub
  - Sorting tests with composites and other bioplastics completed
  - Chemical recycling of composites at lab-scale into pure components
- NL hub
  - Sorting tests with PLA and PHA completed
  - First lab-tests of waste PLA shows no bottlenecks for purification/recycling
  - Up-scaling under way

NL HUB map

Heerenveen:
PLA+PHA from TEC & Kaneka
used plastic waste from OMRIN
sorting at NTCP, then TORWASH

Balk:
HA (+ some LA) to
Paques Biomaterials

Emmen:
PHA bacteria to
Paques Biomaterials

Gorinchem:
LA to Corbion and further to
TotalEnergies Corbion

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Before sorting, we’re making a blend

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Figure 8 Spiked lightweight packaging waste processed on the sorting line at NTCP

Figure 9 Sorted PLA+PHA fraction, which was subsequently split into separate streams of PLA and PHA

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Composition of stream 10% bioplastics

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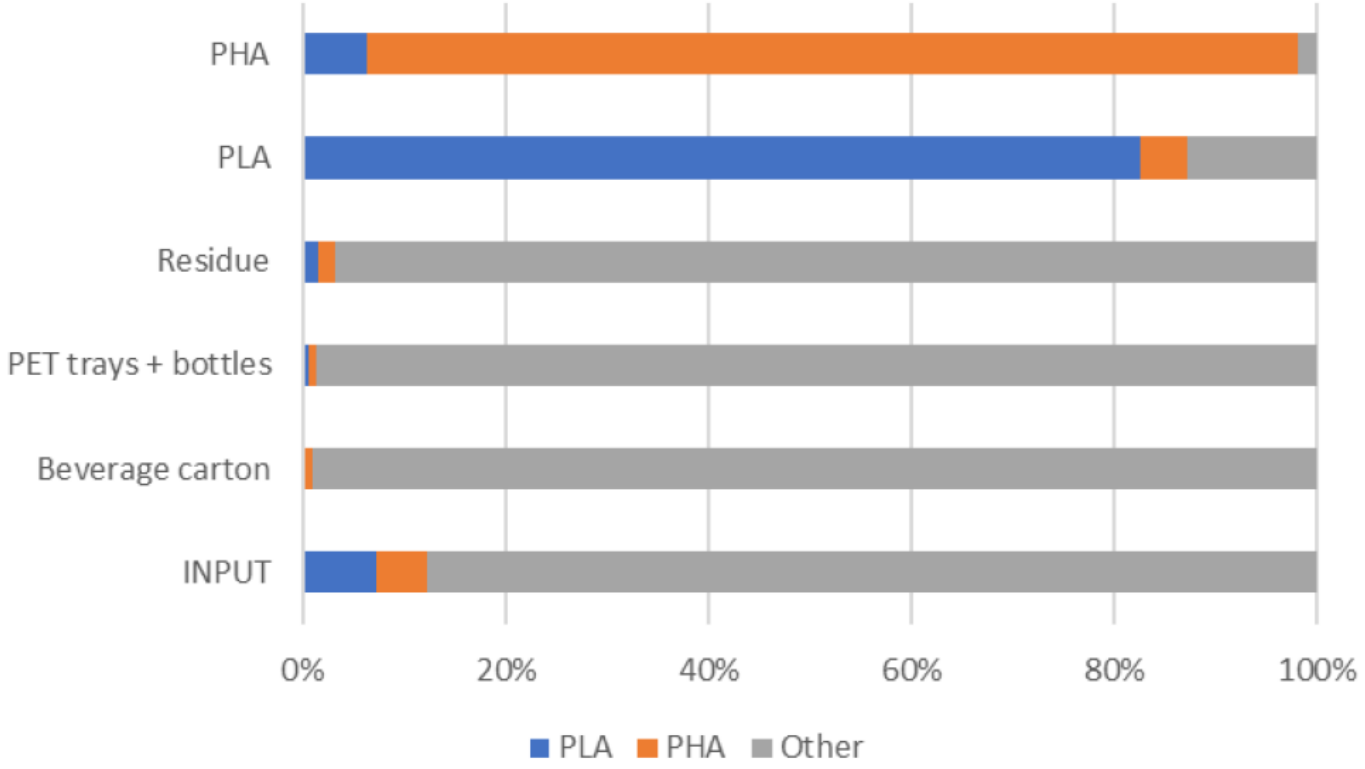

Sorting with smallest commercially available NIR-based machinery

Manual Characterisation

- PLA - blue
- PHA - orange
- Others - grey

Positive separation of PHA leaves ‘others’ in PLA fraction; can be reversed, i.e. ‘others in PHA fraction’

Conclusion of three HUBs: existing equipment can sort PLA, PHA, composites as good as PE, PET, etc.

TORWASH

TORWASH = hydrolysis of PLA and PHA

- PLA → Lactic Acid at 175°C (patent of DuPont, 1993)
- PHA → Hydroxy Butyrate and Hydroxy Valerate

TORWASH can separate materials

Selective removal from complex objects and compounds

Sequential removal of polymers by manipulating reaction conditions

- PLA, PHBV, PEF, PET, PA, etc. all have specific temperatures
- remaining after treatment: PE, PP, PS, steel, glass, etc.

“Designed-for-Recycling-by-TORWASH”

- Recycling must become integral part of Product Design

Before

After

TNO innovation for life

torwash

Scaling Up

Mobile TORWASH installation for sludge

- **Scale-up to mobile unit**
  - Mobile system with 1 m^3 batch reactor
  - → 0.5 – 1 ton per day of shredded plastics: PLA, PHA, etc.
  - operational in 2026

- **Full Scale** Lactic Acid production from PLA
  - continuous reactor with heat integration
  - → 50.000 ton Lactic Acid per year

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Challenges ReBioCycle addresses

- Technical: real contaminations
- Practical: transporting waste materials
- Legal: recycled material of food grade quality
- Societal: microplastics, food/feed etc.
- Commercial: transition of brand owners

Thank you!

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ReBioCycle

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