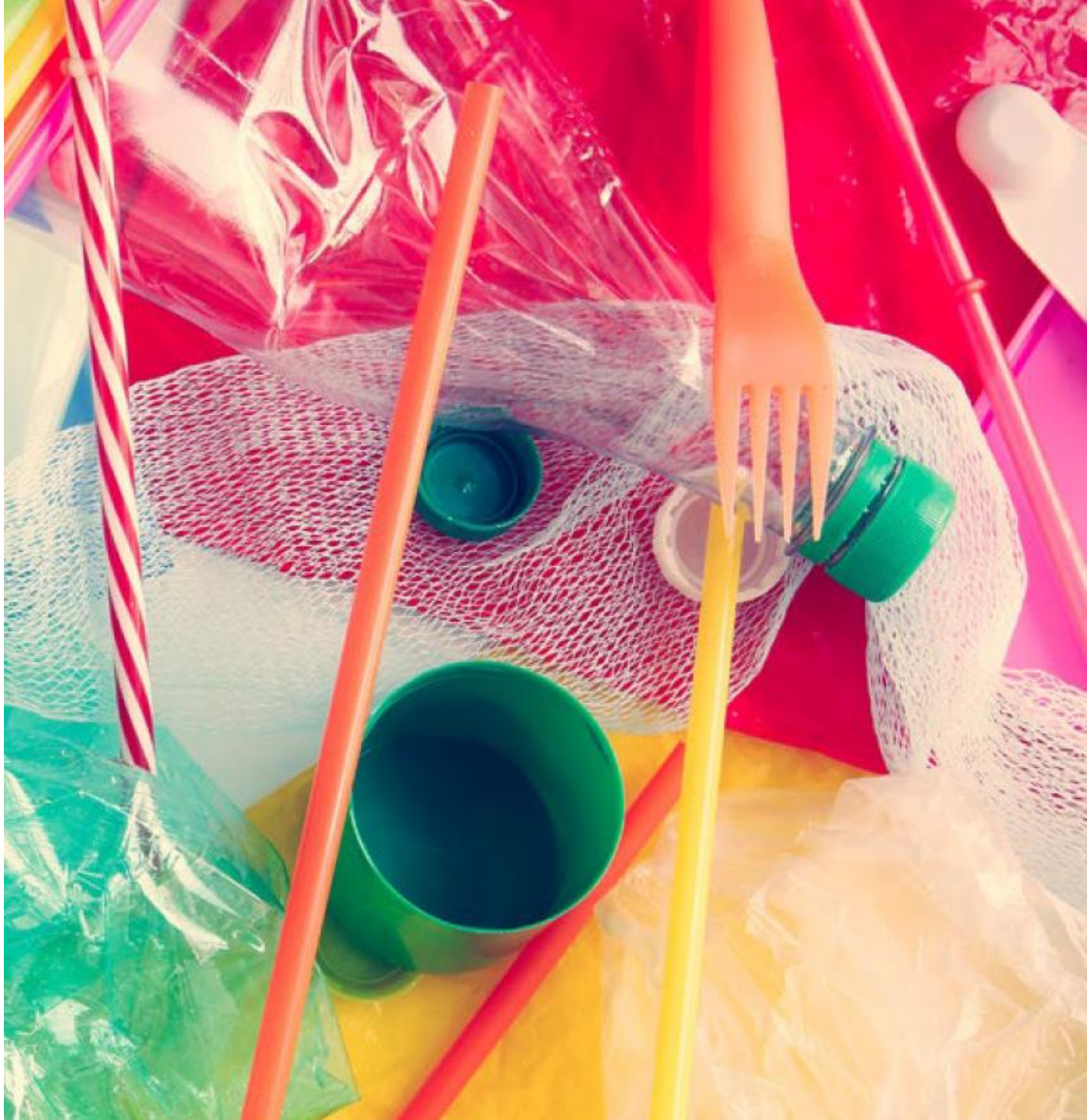
Webinar
“Chemical recycling projects in the Netherlands”

Versnellingstafel Chemische Recycling

27-06-2023



The Acceleration Table Chemical Recycling

- **The Acceleration Table Chemical Recycling of Plastics** (*Versnellingstafel Chemische Recycling van Kunststoffen – VTCR*) **is a public-private partnership between 13 Dutch industrial companies and the Dutch government.**
- **The Acceleration Table started from the joint ambition of the Dutch government and VNO-NCW to improve the investment climate for chemical recycling.**
- **In August 2020, the VTCR presented the Roadmap Chemical Recycling 2030. This Roadmap identifies several concrete action points to accelerate chemical recycling, based on three pillars: A) Ambition and potential, B) Feedstock, and C) Policy.**
- **→ Link to the Roadmap**

Program

Time	Topic	
11.00 – 11.05	Introduction	Sigrid, Luuk
11.05 – 11.20	Results of annual questionnaire of chemical recycling projects in the Netherlands (capacity, technology, risks)	Luuk van Gemert (Rebel)
11.20 – 11.40	Afvalfonds Verpakkingen, Nedvang, KIDV about chemical recycling and their own activities	Bianca Lambrechts (Nedvang), Chris Bruijnes (KIDV)
11.40 – 11.55	Project in the spotlight: OBBOTEC	Wouter van Neerbos (OBBOTEC)
11.55 – 12.20	Panel discussion: what ideas for actions does this evoke?	Xandra Weinbeck (Invest-NL), Michiel Brons (EZK), speakers
12.20 – 12.30	Conclusions and wrap-up	Sigrid, Luuk

Results of annual questionnaire of chemical recycling projects in the Netherlands

Luuk van Gemert (Rebel)

1. Context

Ambition in the Roadmap Chemical Recycling (August 2020):

500 Kton input capacity before 2025

1000 – 1500 Kton input capacity before 2030

Project Dashboard to track the development of projects.

- First version of this dashboard in 2021, second in 2022.
- Project Dashboard developed by Rebel for the Ministries of EZK and IenW, in collaboration with the members of the Acceleration Table.

Today, we summarize the most important findings for 2022. Where are we as a market?

1. Ambition: replace 10% of fossil virgin feedstock for plastics in the chemical cluster in NL with recycled feedstock. With an expected plastics production in 2030 of 5550 Kton this equals an ambition of about 550 Kton. This requires 1000 - 1500 Kton of gross feedstock for chemical recycling in 2030. (based Roadmap Chemical Recycling, 2020)

2. Method

Every year, we collect project-level information on several criteria.

- Information collected from projects through a questionnaire, which was shared within the Acceleration Table network, VNO-NCW, the Ministries of EZK and IenW, and Rebel.

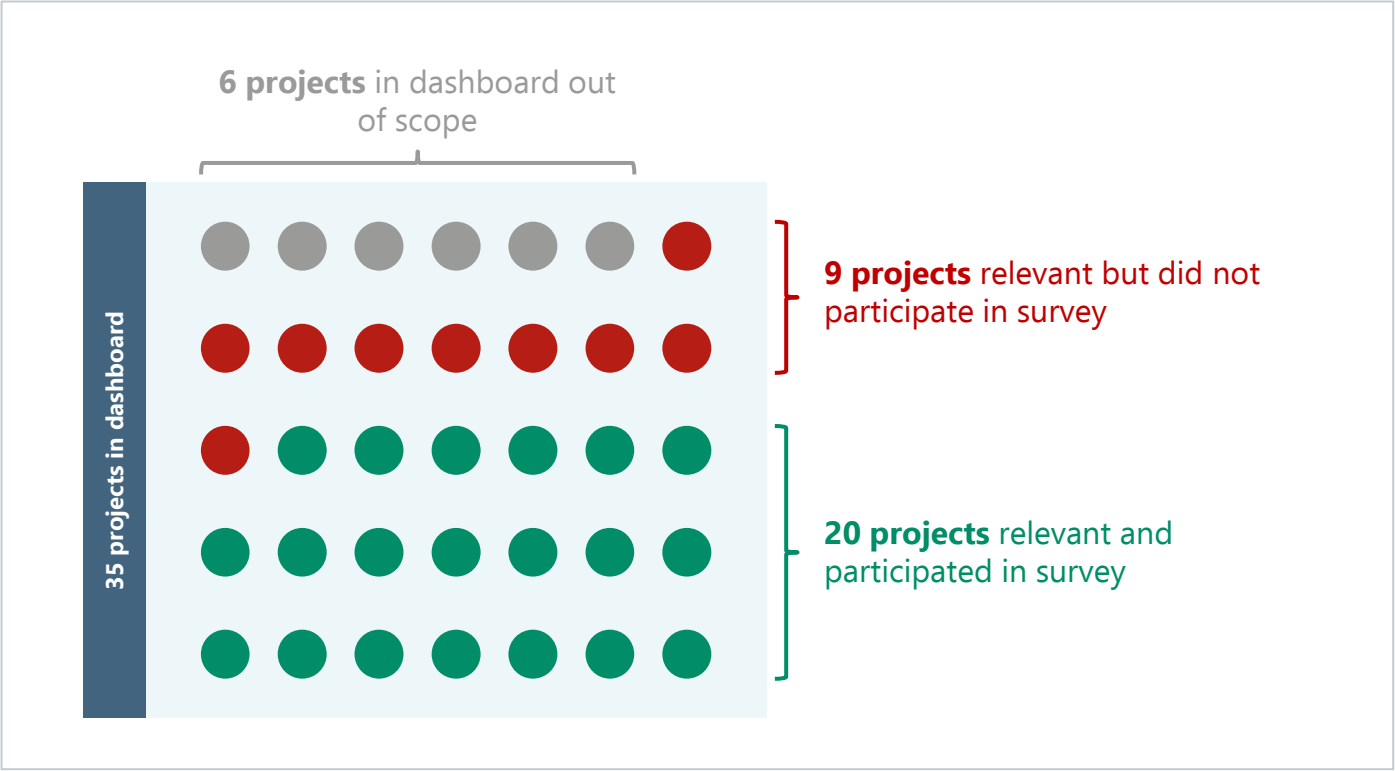
We asked these projects about, amongst others:

- Chemical recycling technique
- Input capacity
- Output capacity
- Intended timeline for capacity expansion by year
- Stage of development
- The proportion of (raw materials for) new plastics in the output product
- Risks perceived by projects around regulation, feedstock, market development and financing

2. Method

Scope:

- The dashboard lists **35 existing or planned chemical recycling projects in the Netherlands**
- Of the 35 projects, **29 have an output product that benefits or could potentially benefit the production of new plastics**
- Of these 29 projects, **20 projects completed the questionnaire**.



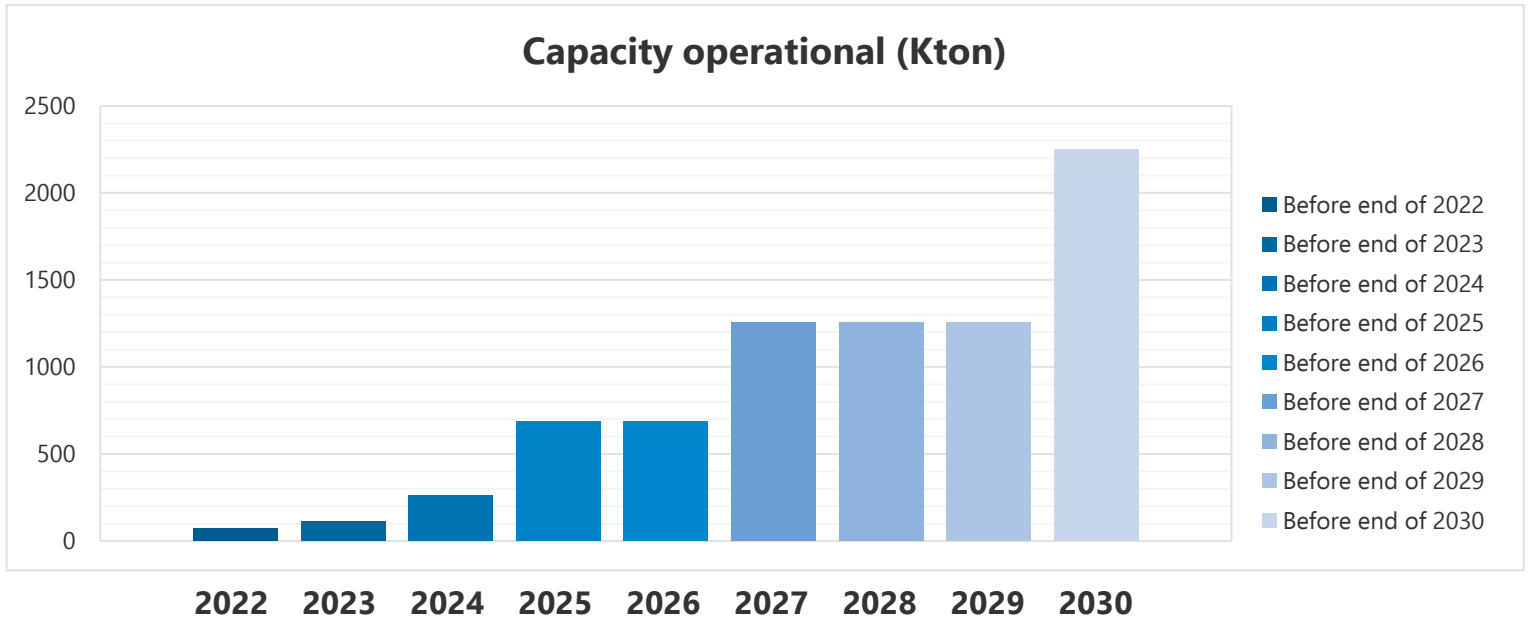
3. Results – input capacity

Operational in 2022: 55 Kton.

- Based on 5 operational projects. Of these projects, 2 have become operational during 2022 and 1 has expanded in capacity. Several projects are in the pilot phase.

Planned: 670 Kton in 2025, 2250 Kton in 2030.

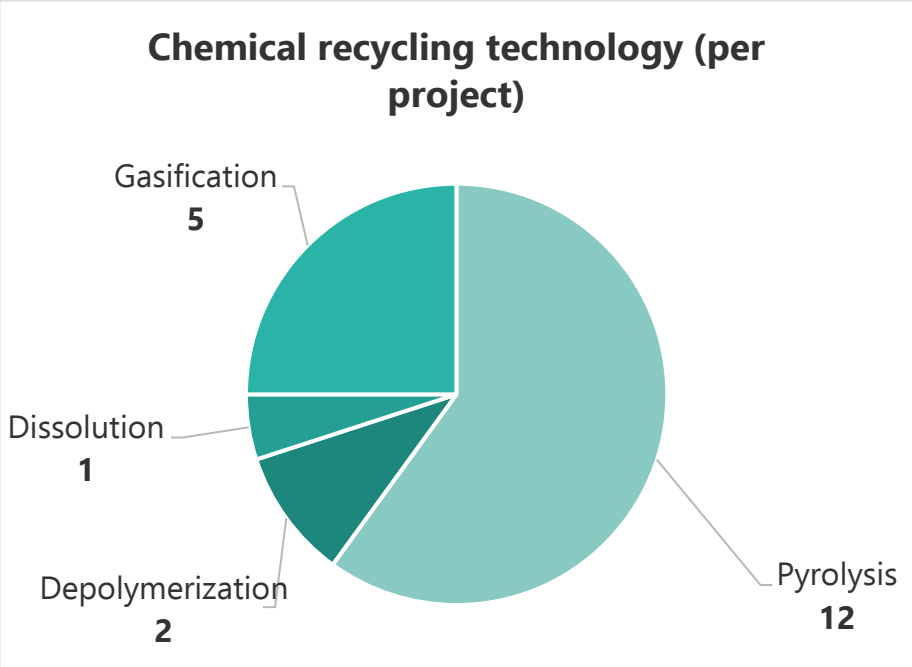
- Figures only include projects who participated in the survey. Actual planned capacity is estimated to be higher by 90 to 150 Kton.
- **Note**: still unclear what portion of the output capacity of these projects will benefit plastics production (this differs per technology)



Based on 20 projects:
20 Kton operational in 2022
670 Kton planned until 2025
2250 Kton planned until 2030

3. Results – technology mix

What we see in the dashboard: 12 pyrolysis projects, 5 gasification, 2 depolymerization, 1 dissolution.



	Operational in 2022	Planned until 2025	Planned until 2030
Depolymerization	8 Kton	32.6 Kton	32.6 Kton
Gasification	0 Kton	308 Kton	1807 Kton
Pyrolysis	47 Kton	327 Kton	387 Kton
Dissolution	0 Kton	20 Kton	20 Kton
	55 Kton	**670 Kton**	**2250 Kton**

Towards 2025 and 2030, pyrolysis remains the dominant technology in terms of the number of (planned) projects. In terms of input capacity, gasification becomes most dominant.

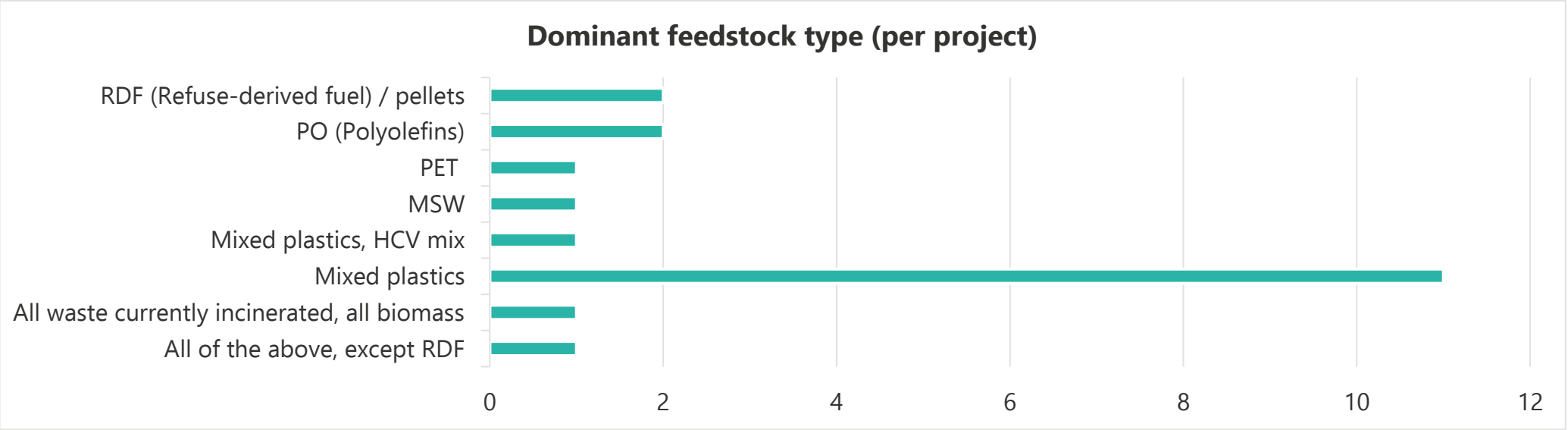
3. Results – feedstock type

The projects use different types of feedstock.

- Dissolution and Depolymerization generally use purer waste streams than Pyrolysis and Gasification.
- This is in line with the existing picture that not all feedstock types are equally suitable for all techniques.

Most projects indicate mix plastic streams as the dominant input stream.

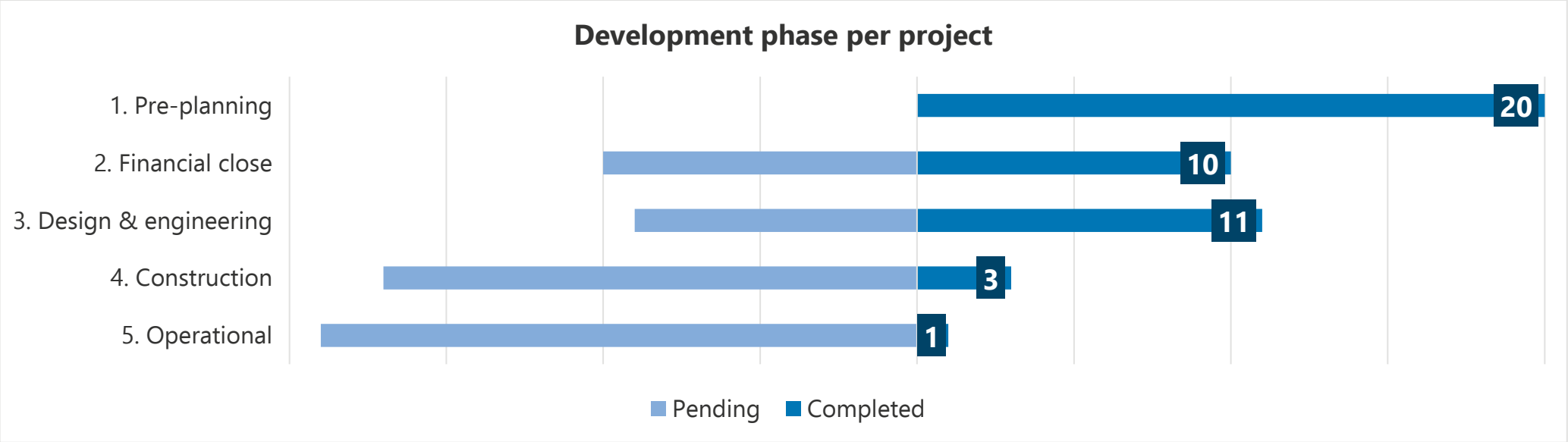
- Mix streams do vary widely in composition.
- Often mentioned are films (e.g., PE, PP), mix streams with high percentages of Polyolefins, and DKR 350.



4. Results – development stage per project

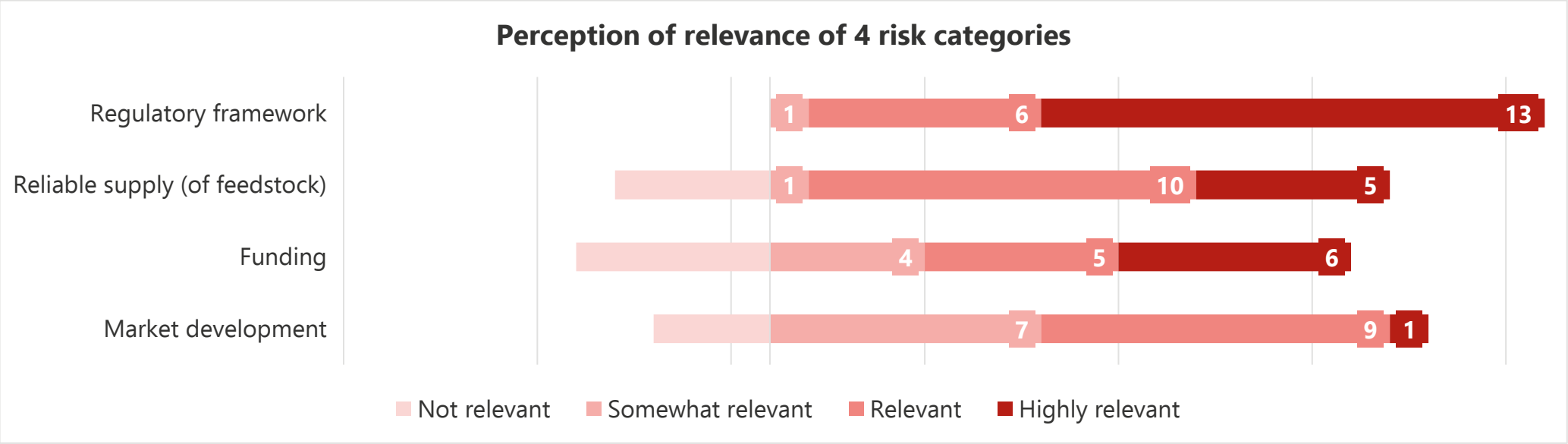
Initial planning stage completed for all 20 projects, but only 1 project fully operational.

10 of the 20 projects have already been closed financially; the remaining projects are still awaiting funding.



4. Results – risks for development and scaling up

We asked about four types of risks: regulatory framework, feedstock, funding and market development.



The regulatory framework is seen as the most important risk, followed by feedstock supply.

4. Results

Regarding regulatory framework, the main risks mentioned are:

- End-of-waste status for output products
- Food grade/food safety regulations
- Recognition of chemical recycling as a recycling method
- The absence of a Mass Balance system
- Implementation of the Waste Framework Directive
- Obtaining permits

Regarding feedstock, the main risks mentioned are:

- Availability and stable supply
- Quality of feedstock and high costs to get feedstock to the right specifications
- Availability of mix streams
- Waste collection and sorting market focus on mechanical recycling - potentially suitable streams for chemical recycling are lost
- Current EPR system lacks incentives on quality of recycled streams
- Feedstock-and-financing problem ("chicken-and-egg")

4. Results

Regarding funding, the main risks mentioned are:

- Difficult to secure funding for first plant ("proof of concept")
- Debt financing (bank loans or investment funds) often not possible due to high risk profile of new technologies
- Risk profiles too high for private investors
- Increasing CAPEX (Capital Expenditures) due to inflation
- Uncertain investment climate due to geopolitical tensions

Regarding market development, the main risks mentioned are:

- Level-playing-field
- Development of collection and sorting capacity of plastic waste streams
- Rising and fluctuating energy prices

5. In summary…

Operational chemical recycling input capacity of 55 Kton in 2022, based on 5 operational projects.

Most existing and planned projects and largest volumes involve pyrolysis and gasification.

Planned input capacity is:
→ 670 Kton in 2025
→ 2250 Kton in 2030

Ambition Roadmap Chemical Recycling:
→ 500 Kton before 2025
→ 1000 – 1500 Kton before 2030

So, are we on track? This depends on several questions:

- Will all the output of these installations benefit the production of new plastics?
- Will there be sufficient feedstock available? → Link to Webinar 6 July 2022 – "Waar is de feedstock"
- **Will these projects all manage to successfully scale up – despite the various risks?**
- **How can we mitigate risks?**

Afvalfonds Verpakkingen, Nedvang, KIDV about theme and projects

Bianca Lambrechts (Nedvang), Chris Bruijnes (KIDV)

afvalfonds verpakkingen

Nedvang b.v. registers the collection and recycling, and maintains the contact with municipalities and waste companies. And takes care of the sorting and recycling of (plastic) packaging by contracting post-separation facilities, sorters, recyclers, transporters and storage- and transhipment stations.

NederlandSchoon
Fighting and preventing litter together with municipalities, companies, governments, societal organisations and concerned citizens.

The **Knowledge Institute of Sustainable Packaging** ('KIDV') helps companies with concrete knowledge and advise with making their packaging policies more sustainable.

Statiegeld Nederland coordinates the implementation and the practical execution of the deposit obligation, for the small and large plastic soda- waterbottles and cans.

Chemical Recycling of Plastic Packaging

10 Vision Statements & Current Practices

by

afvalfonds verpakkingen

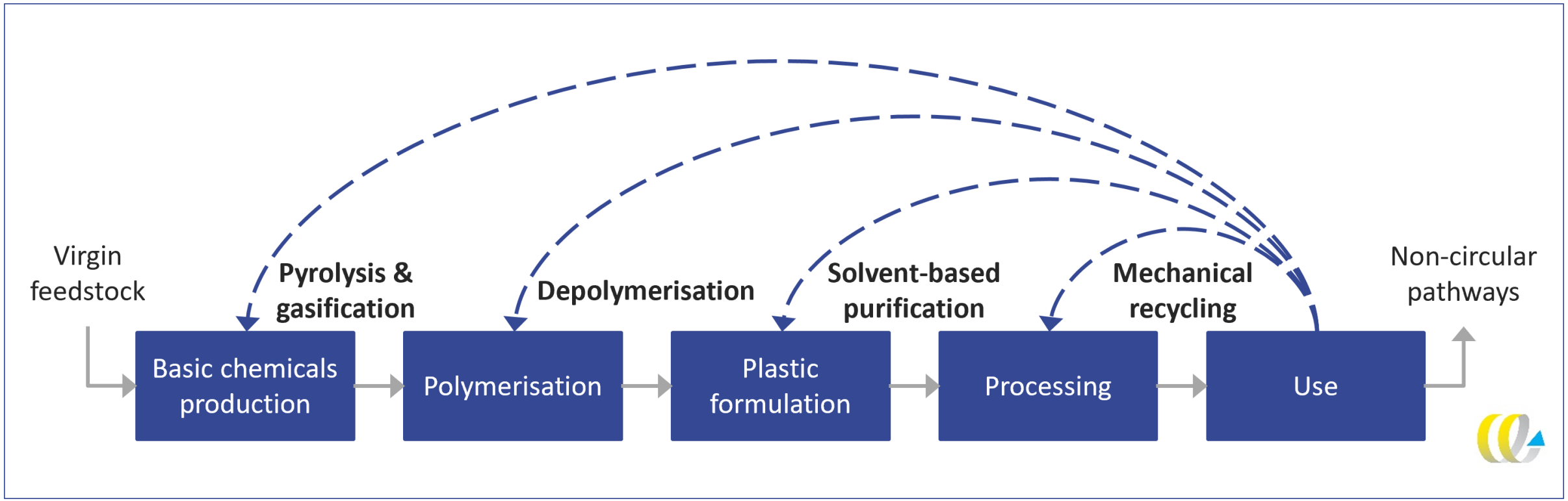
nedvang b.v.

Kennisinstituut Duurzaam Verpakken

Chris Bruijnes, Netherlands Institute of Sustainable Packaging (KIDV)
Bianca Lambrechts, Nedvang

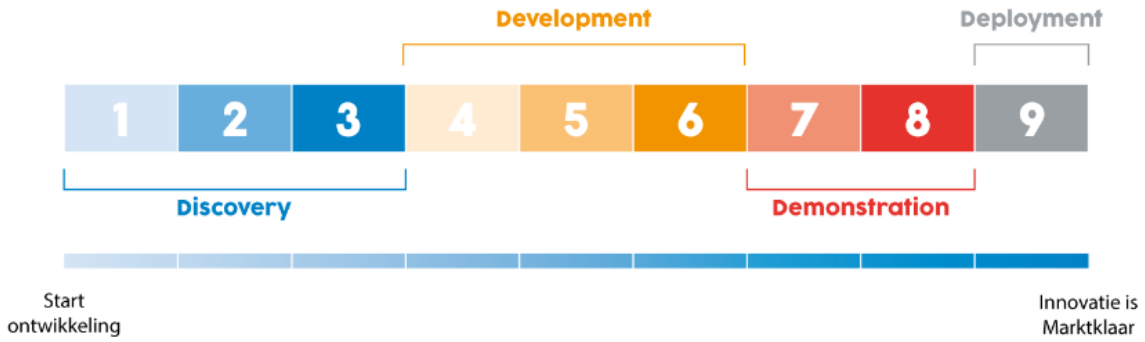
Vision Statement 1

Chemical recycling will become part of the technology mix for recycling plastic (packaging) waste.



Vision Statement 2

Absolute technology choices have not yet been made yet



Recycling technology	TRL-value
Short-loop technologies:	
Mechanical recycling (all plastics)	9
Dissolution (PP/PE)	4-6/7-8
Depolymerization (PET)	4-6/7-8*
Long-loop technologies:	
Pyrolyses (PP/PE)	4-6/7-8*
Degassing	4-6

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Vision Statement 3

Chemical recycling is complementary to mechanical recycling

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Vision Statement 4

As long as there are only quantitative obligations, Afvalfonds Verpakkingen cannot commit itself to the delivery of large quantities of feedstock.

Recycling-resultaten 2021

	Wettelijke doelstelling incl. circulaire verpakkingen NL 2021	Recycling incl. circulaire verpakkingen 2021	Wettelijke doelstelling recycling EU 2025
Glas	86%	89%	EU 70%
Papier/karton	85%	90%	EU 75%
Plastic	40%	49%	EU 50%
Ferrometaal	94%	95%	EU 70%
Aluminium	73%	74%	EU 50%
Hout	55%	66%	EU 25%
Totaal	71%	80%	EU 65%

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Vision Statement 5

To meet the upcoming regulations and the goals of the Plastic Guide, chemical recycling technologies must produce high quality and high yields of recyclate.

Our goal for 2050 is that all products will be packaged completely fossil-free and circular.

- 100% fossil-free: we only use recyclate and biobased raw materials
- 0% litter and microplastics from packaging
- 0% damage to people and the environment

plastic wijzer

Our commitment for 2030:

- 100% collection and reuse systems in NL are of high quality and uniform
- 100% of the P/I's get their share of recyclate back
- 100% of the packaging is recyclable
- where possible, packaging is reusable
- plastic use packaging goes down without negative substitution

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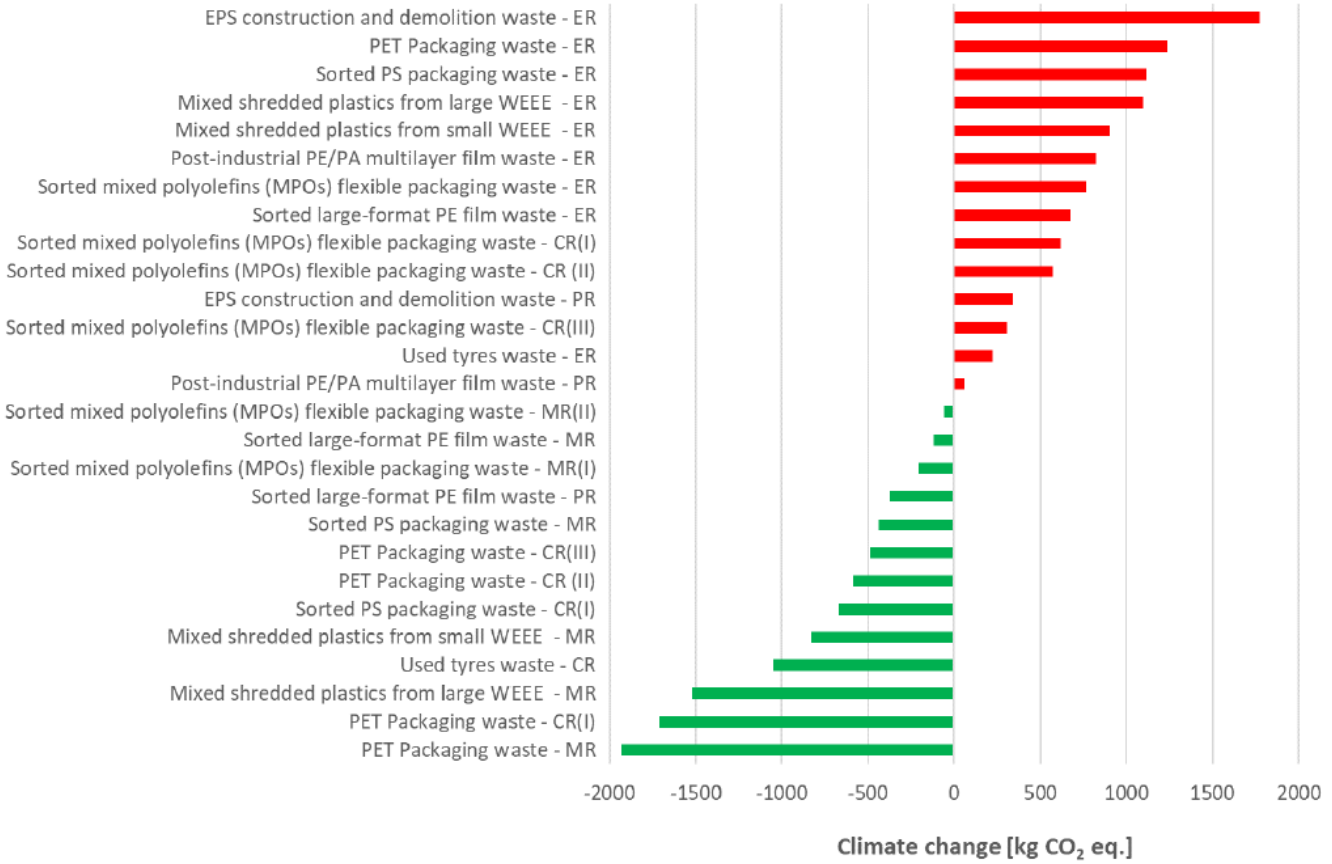
Vision Statement 6

From an environmental point of view, so-called short-loop technologies are currently preferred over long-loop technologies



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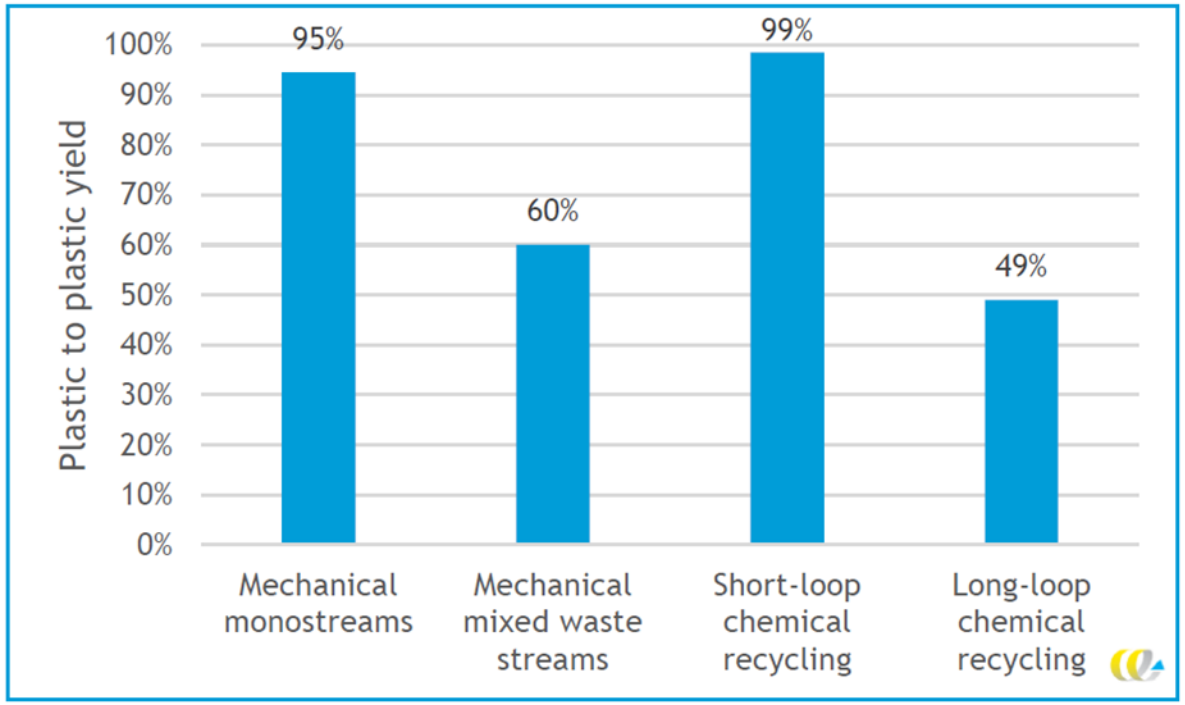
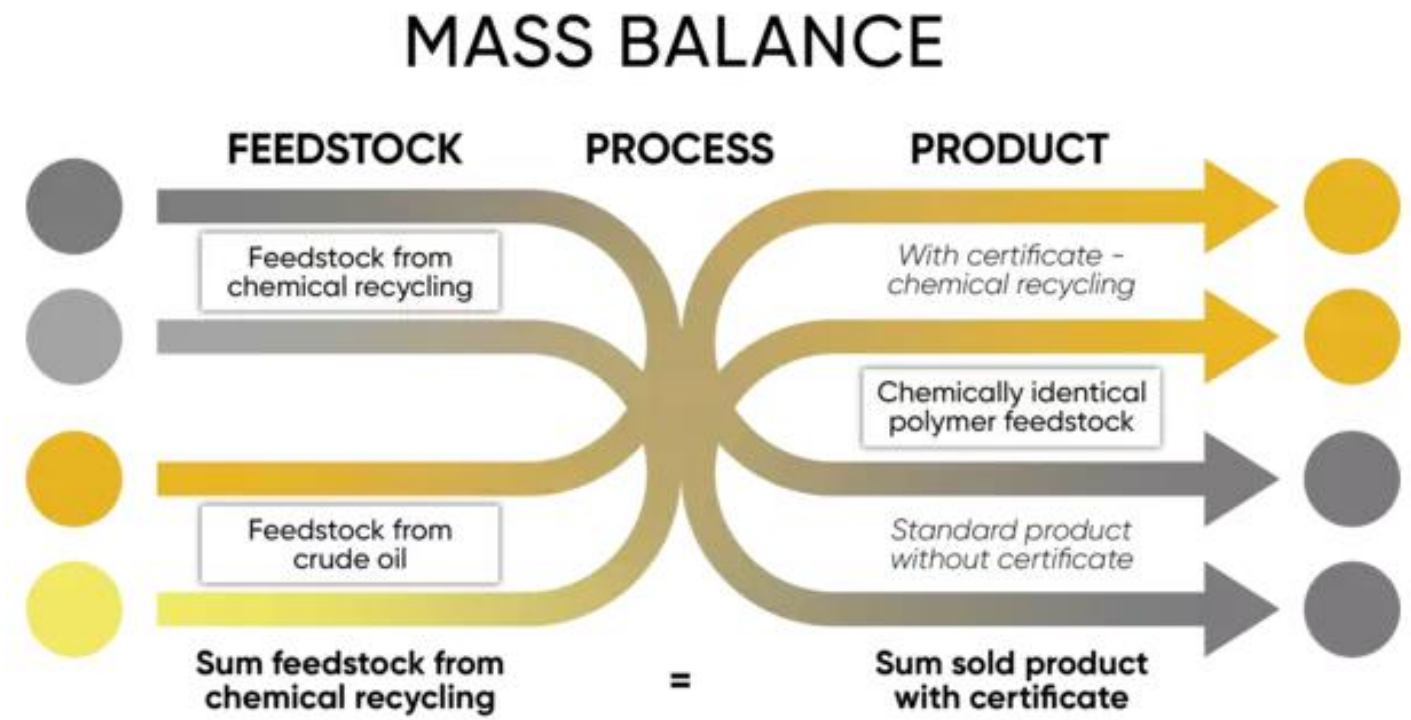
Vision Statement 7

From a maximum yield point of view, short-loop technologies are also currently preferred over long-loop technologies.



Vision Statement 8

A harmonized mass balance method at European level is necessary for an unequivocal determination of the recycled plastic used in products that are produced partly via long-loop technologies. For the short term, work can be done on a national working agreement.



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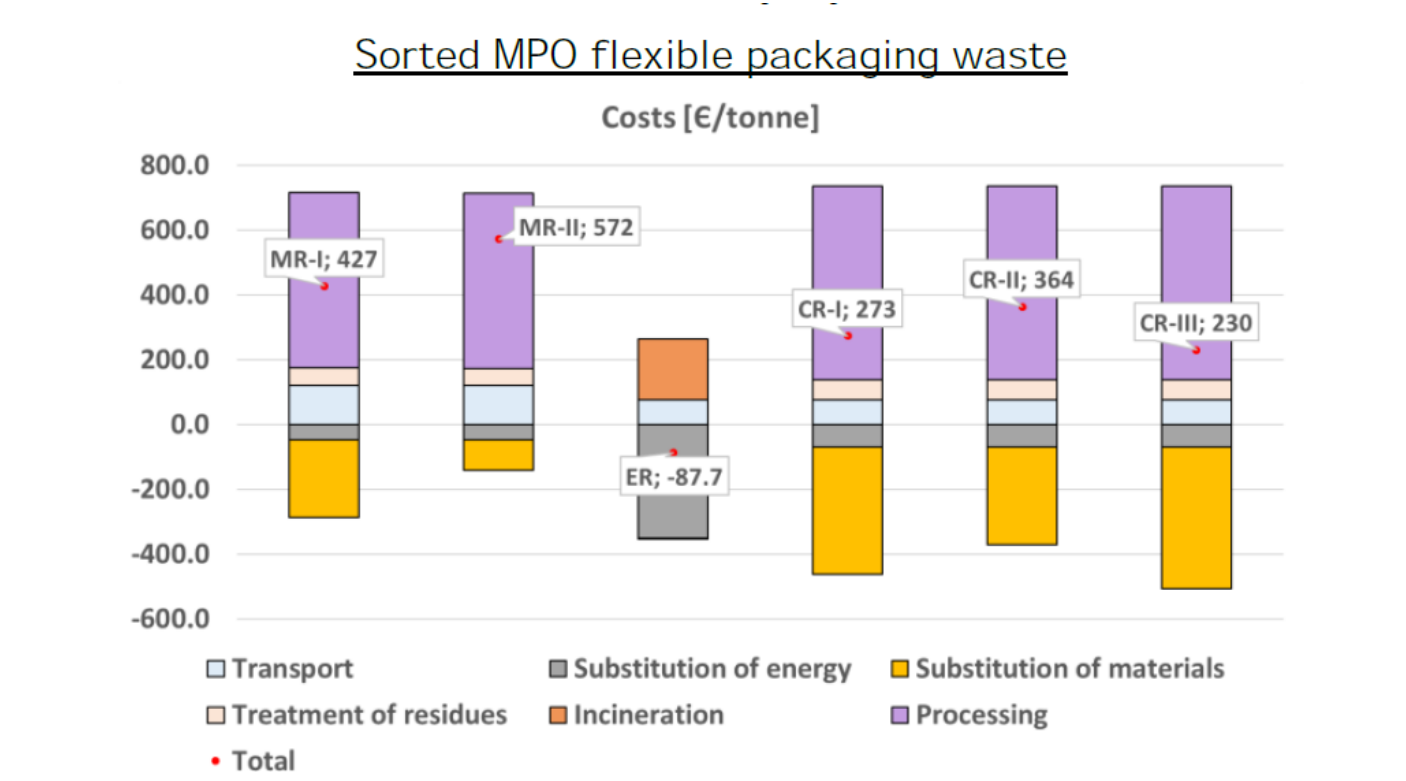
Vision Statement 9

The financial-economic future of chemical recycling technologies is still so unpredictable that it is not yet possible to determine a preferred technology on that basis. A look ahead at the future (social) costs and benefits will form part of the Assessment Framework.



MR-I: MPO, PP and HDPE regranulate production; MR-II: MPO agglomerate production; ER: incineration; CR-I: conventional pyrolysis; CR-II: conventional pyrolysis; CR-III hydrothermal pyrolysis

Vision Statement 10

The cooperation with market parties developing chemical recycling technology will be accompanied by a limited availability of plastic packaging waste, because practical experience must first be gained.

Current practices

Nedvang

- Operational organization of Afvalfonds Verpakkingen
- Taking care of collection, sorting & recycling of plastic packaging waste in NL
- Contracts with public and private parties

- Gaining practical experience
- Opportunities of chemical recycling
- Complementary to mechanical recycling
- All technologies of chemical recycling included

- In contact with most initiatives and pilots on chemical recycling in NL

Current practices

- Limited volumes available for pilot-projects
- Due to challenging recycling targets
- Search for alternative volumes
  - Volumes difficult/hard to recycle mechanically
  - Rest-streams of mechanical recycling-processes
  - Other than packaging waste (textile, electronics, etc.)
- Yield
- Quality
- Recycled content for new packaging material

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Hout	55%	66%	EU 25%
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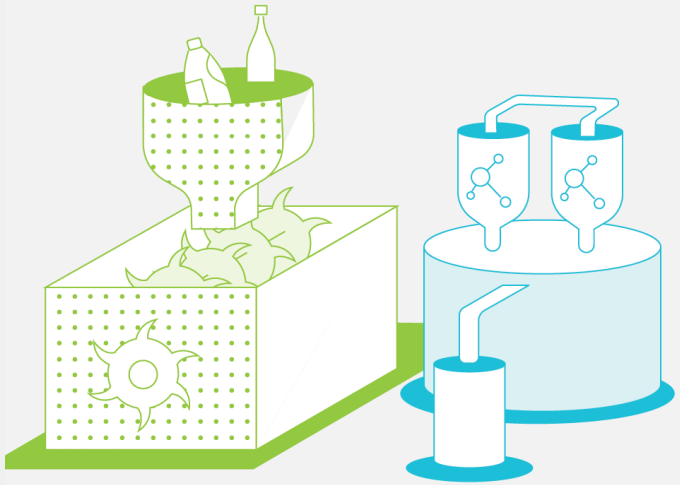
Current practices

- Pilot Pyrolysis

- Foil from post-separation (household residual waste)
- Supplemented with / Replaced by alternative streams

- Pre-Treatment, contracted by Nedvang
- KPI’s on quality and quantity
- Optimisations over the postconsumer recycling-chain
- Optimisations over the whole packaging-chain

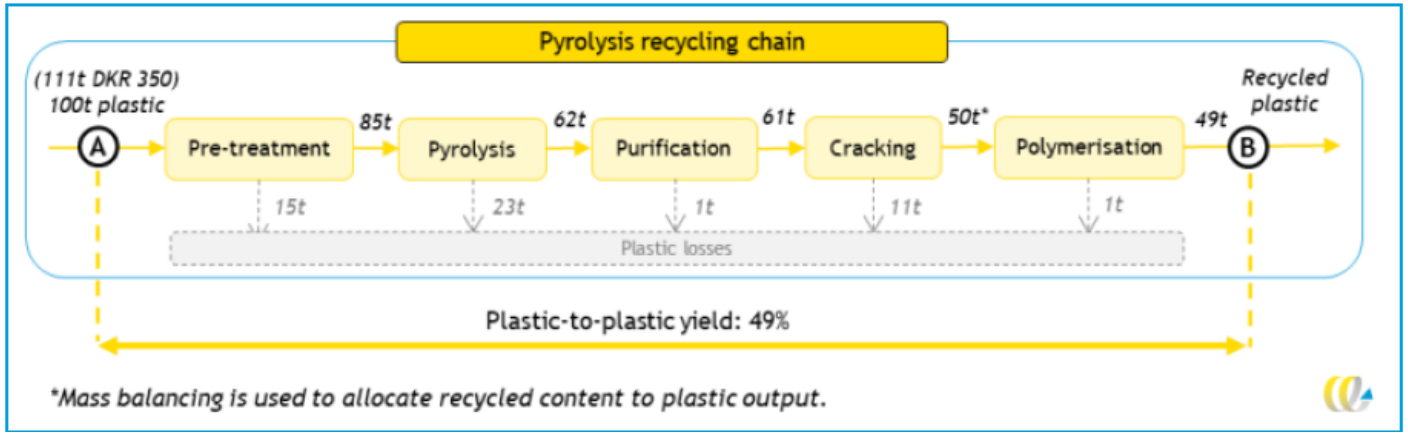


Current practices

- Output pre-treatment available for Pyrolysis plant
- KPI's on quantity & quality
- Up to and including the intended new measuring point

- Purification up to and including polymerization
  => based on Mass Balance Approach
- Evaluation after 9 months

- Gaining practical experience
- Opportunities of chemical recycling
- More pilots on other technologies

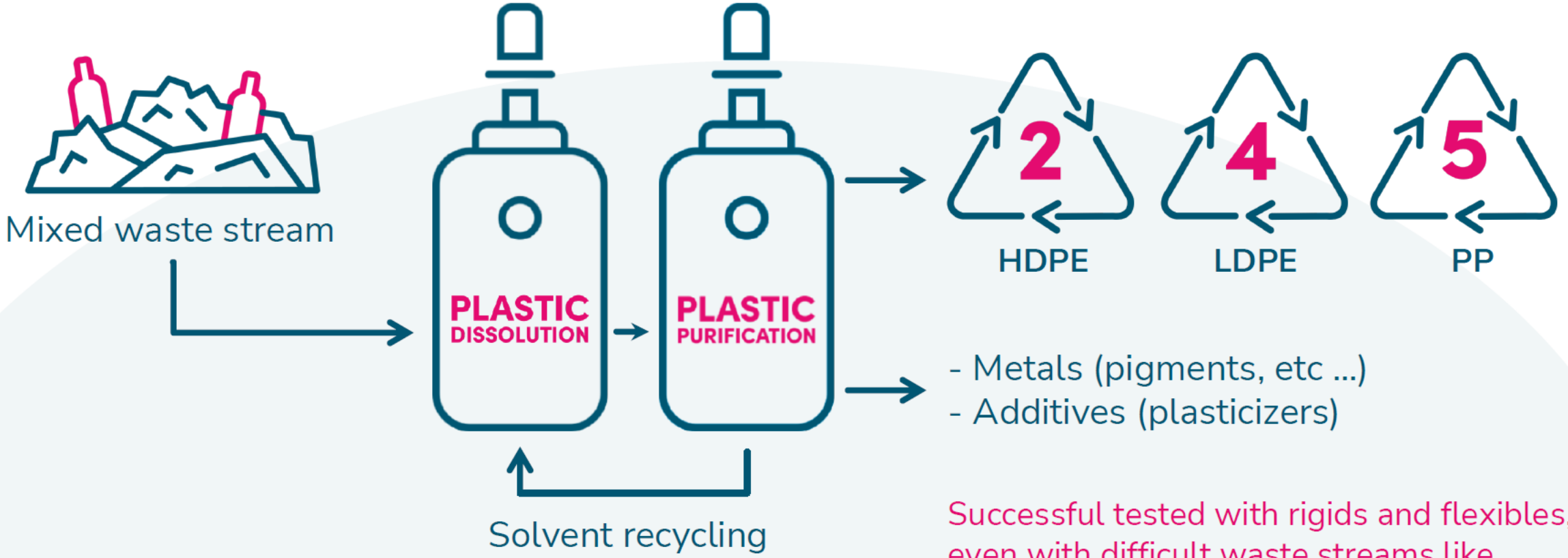


Project in the spotlight: OBBOTEC

Wouter van Neerbos (OBBOTEC)


OBBOTEC
SPEX Technology

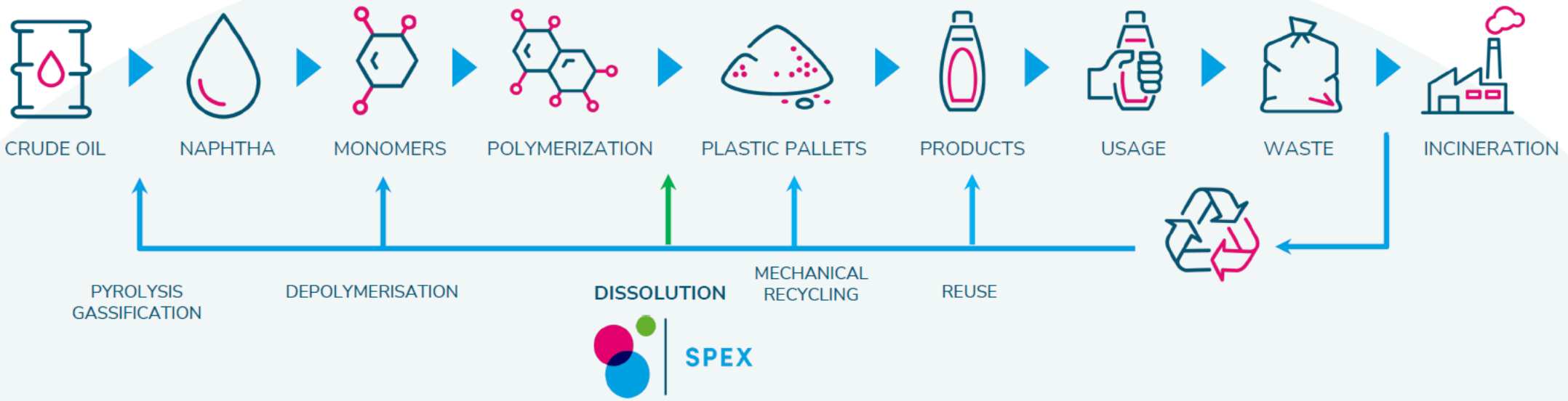
Selective Plastic EXtraction (SPEX) plastic dissolution process



Successful tested with rigids and flexibles, even with difficult waste streams like mixed plastics, multi-layers, laminates, foils

Recycling technology overview

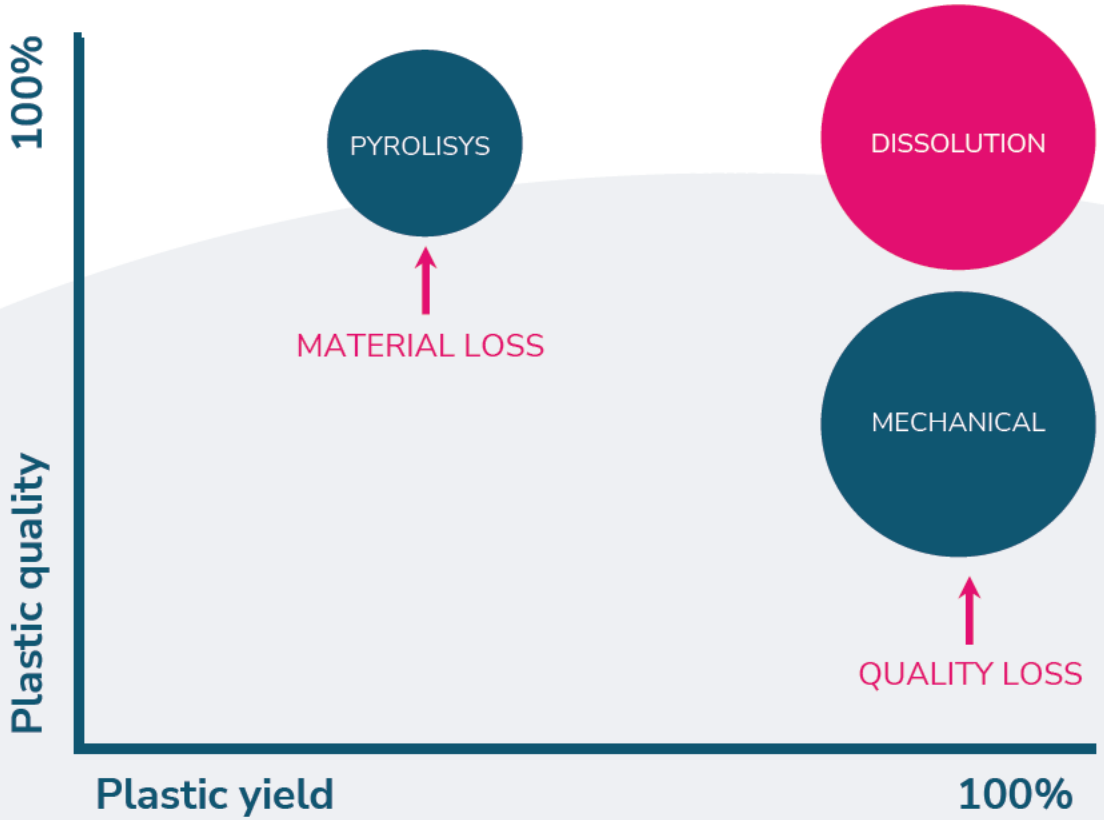
Dissolution and Mechanical recycling and are the shortest loop after reuse



Chemical recycling

Mechanical recycling

Comparison plastic-to-plastic recycling technologies



Advantages of dissolution:

1. High Yield
2. High Quality
3. Good LCA (mass/energy basis)

Business development model

2018 - 2020:

- Company founded
- Successful lab tests with a variety of PE and PE waste streams for multiple customers and suppliers
- Proven that it can even recycle difficult waste (2D&3D) like mixed, multi-layers, laminates, and foils

2021 - 2022:

- Pilot unit built and commissioned to demonstrate scalability, business case and LCA

2023 - 2024:

- Build and commission first commercial demo plant in NL
- Apply for food grade application with ESFA and FDA

2025+:

- Operate and commercialise the commercial demo plant
- Build additional commercial plants in other regions: AM, APME, EU
- Continue R&D activities to improve technology and application for other plastics (PET, PVC, PS, ...)
- Exploring partnerships to accelerate scaling and growth for impact

Lessons Learnt, Challenges

1. **Market development**
   - Complex chain with petrochemicals and waste industries as opposites who need to marry in order to close the loop
   - Collaboration: variety of parallel (siloed)and competing initiatives
   - Small steps are needed for a giant leap

2. **Challenging valley of death for a SME;**
   - Size; creating change in industrial environment (impact, location)
   - Wide because it takes up to 10 years
   - Deep decease of the heavy investment

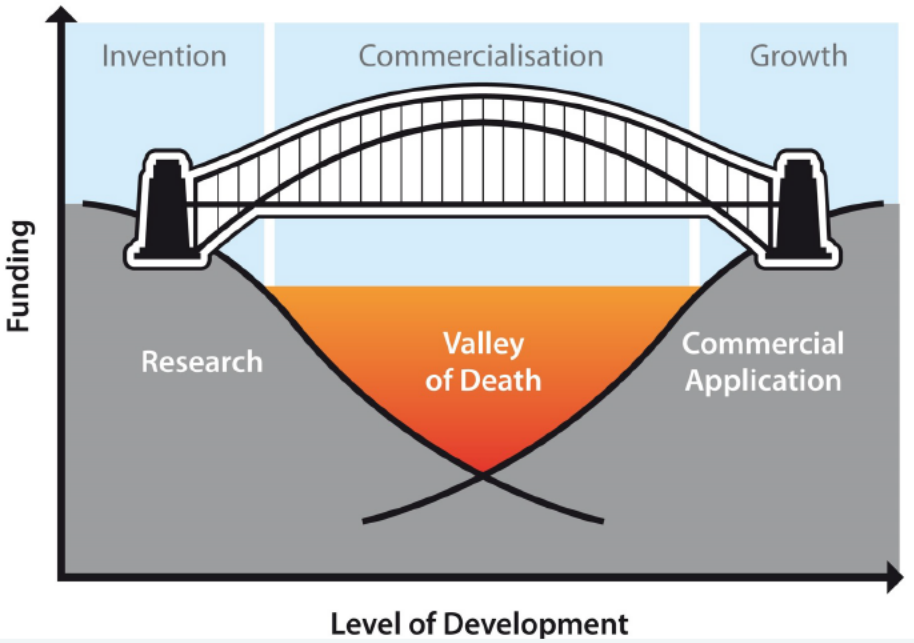
3. **Funding:**
   - Difficult to secure funding for first plant
   - Risk profiles too high for private investors

4. **Feedstock:**
   - Availability and stable supply
   - Competition between mechanical and chemical recycling

5. **Regulatory framework :**
   - End-of-waste status for output products
   - Food grade/food safety regulations
   - Obtaining permits for a suitable location

Long and complex value chain

Valley of death



Help requested

- Acknowledge and embrace our overall vision regarding the positioning of dissolution versus mechanical and chemical recycling

- Support us crossing the valley of death by;
  1. **Funding:** financial support in broadest sense
  2. **Location for 1st commercial plant:** with appropriate permits in an industrial area (co-location)
  3. **Feedstock:** availability in general, stimulate the most effective routes, and avoid cannibalization
  4. **Regulatory framework:**
     - Get a fast track to obtain EFSA approval for dissolution
     - Get clarity on the end of waste status, both a process and a product basis


plastic
paradox
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Q&A

Panel discussion

What ideas for actions does this evoke?

Thank you for your attention!