Chemical recycling and its CO_2 reduction potential

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Governments
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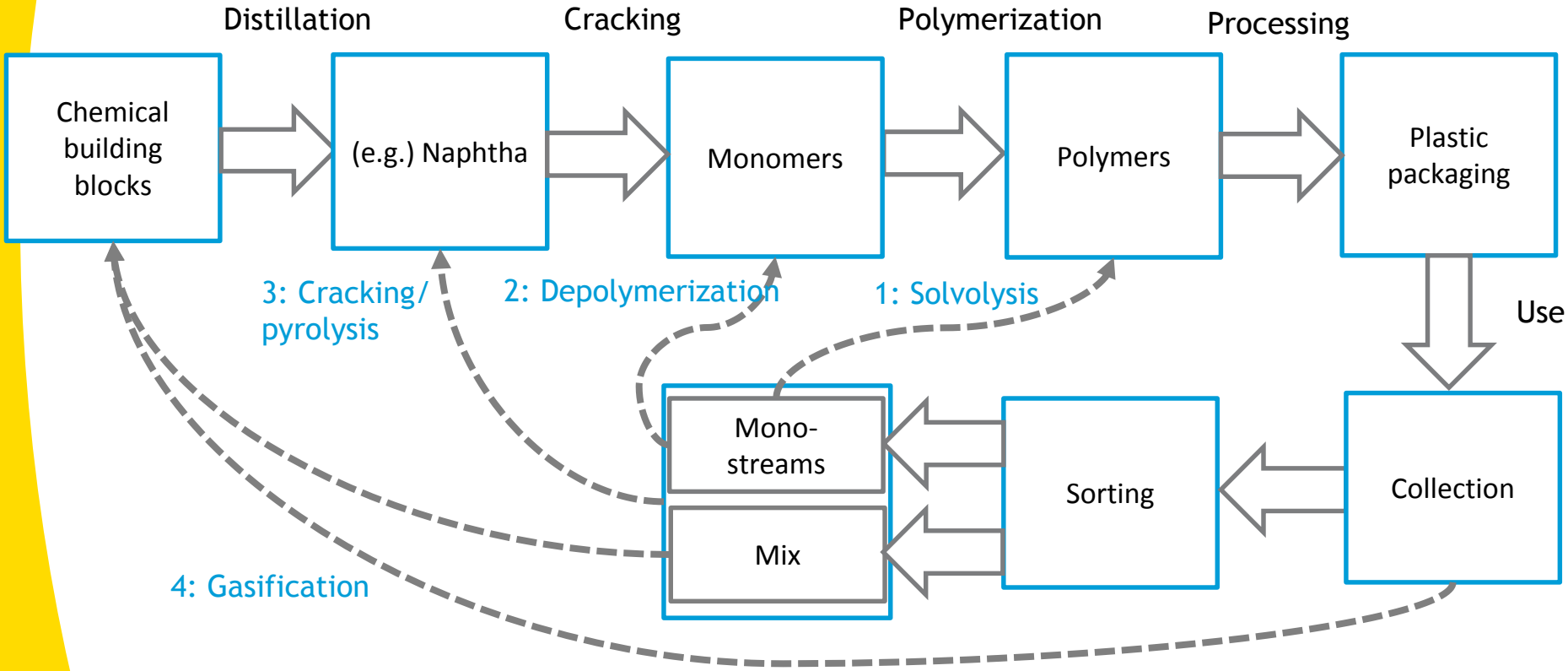
NGOs

Chemical recycling sounds great, but

- Is chemical recycling one technology or a group of technologies?
- Is it environmentally equal to mechanical recycling?
- How much climate change impact reduction could be achieved with chemical recycling (for example in the Netherlands)?
- How should policy makers deal with chemical recycling?

These questions are in the mind of companies and policy makers

4 main types of chemical recycling with different environmental performance



Research for Dutch Ministry of Economic Affairs

- Dutch ambitions:
  - Circular Economy transition agenda: 250 ktonne chemical recycling in 2030
  - Government target: 1 Mtonne CO_2 reduction by extra recycling in 2030

- Research question: how much feedstock is available and what CO_2 emissions reduction can be achieved?

- Input from previous screening LCA studies for:
  - AkzoNobel
  - Enerkem
  - Ioniqa
  - City of Rotterdam
  - KIDV (Dutch Institute for Sustainable Packaging, funded by EPR system)

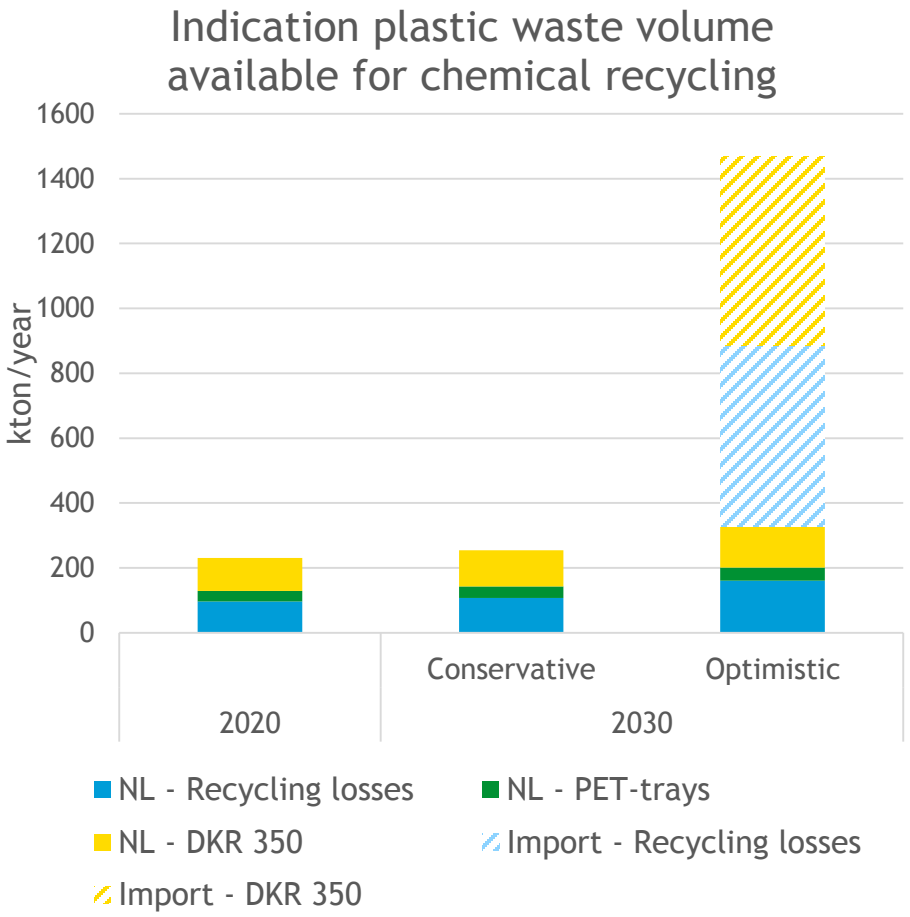
Availability of plastic feedstock for chemical recycling in the Netherlands

Waste streams currently not recycled or with low value recycling:

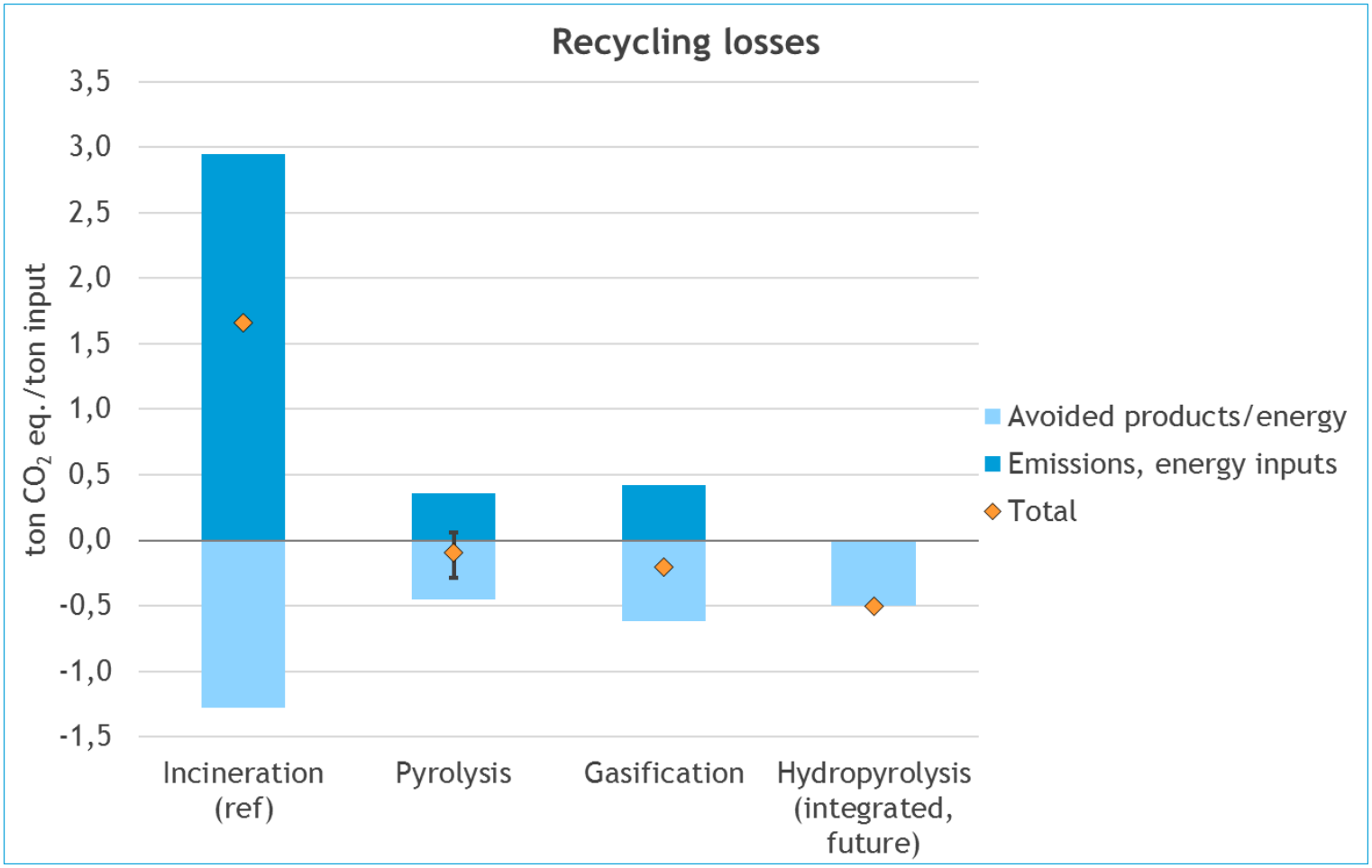
- Losses from the recycling sector
- PET-trays
- Mixed plastics (DKR 350)

Estimated quantities (2030):

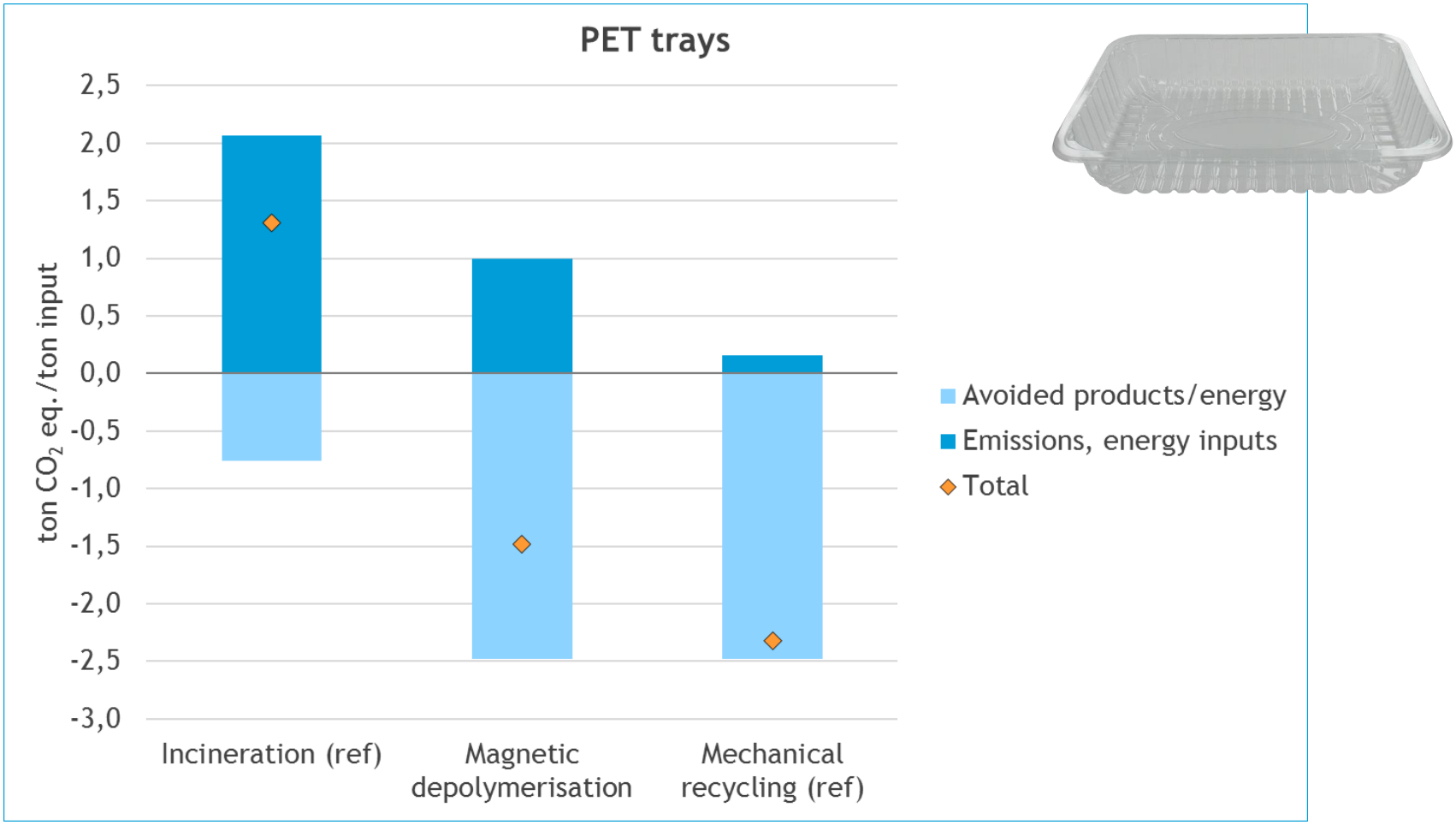
- Conservative: 260 kton/yr
- Optimistic: 1500 kton/yr, including imports from UK/BE/DE



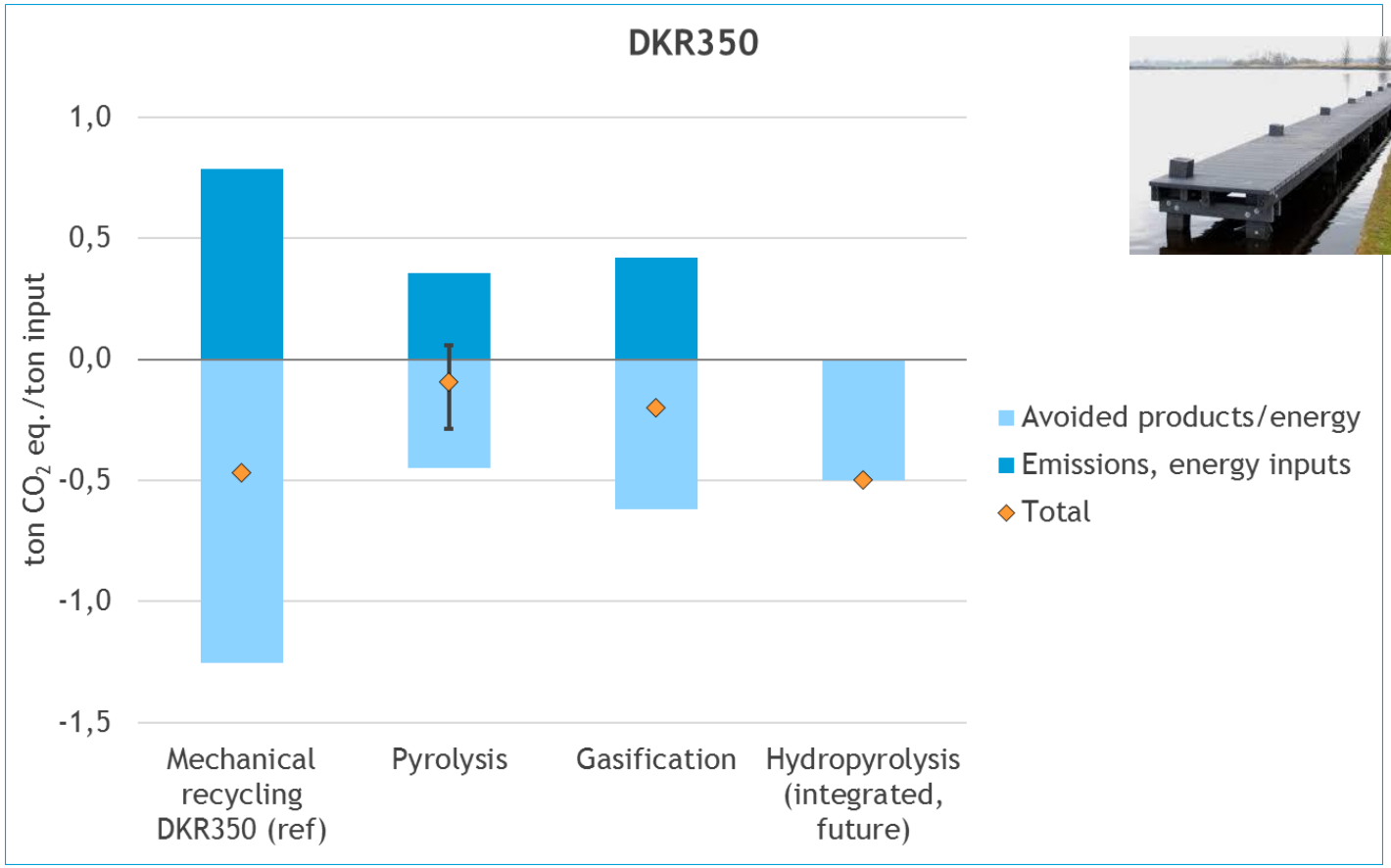
Climate change impact per technology
Example: recycling losses



Climate change impact per technology: PET trays



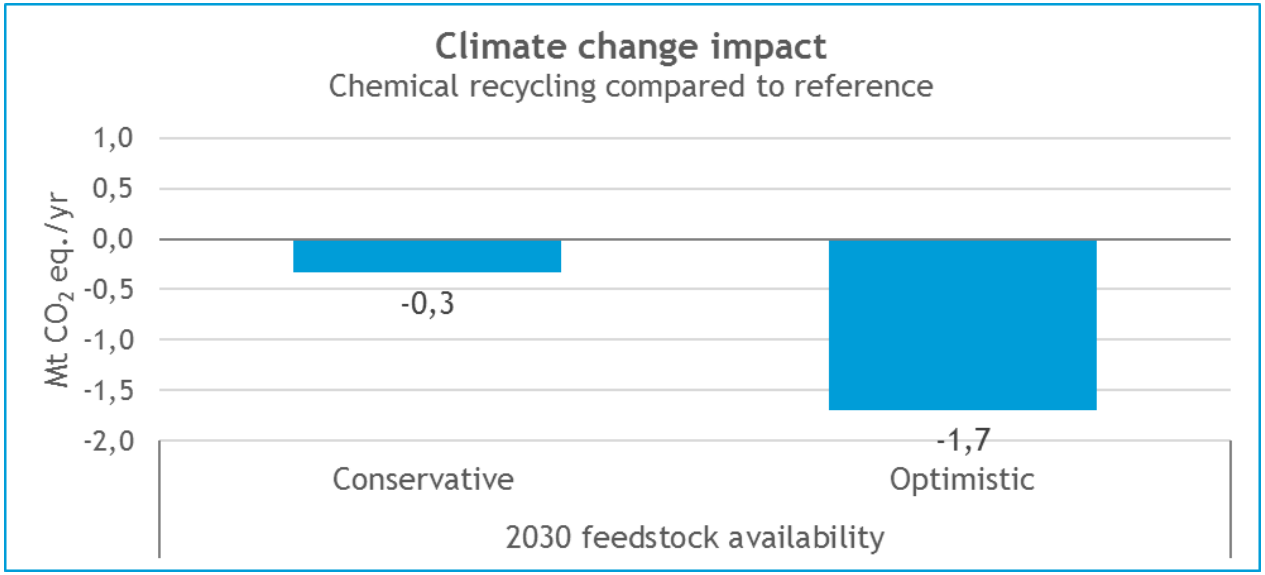
Climate change impact per technology: DKR350 mixed plastic



- Note: mechanical recycling products may replace tropical wood
  - Impacts of (avoided) land use and land use change not included

Climate change impact reduction for 2030

- Assumption for all studied plastic waste streams in NL:
  - Best chemical recycling option instead of reference treatments
- Estimated reduction in (global) climate change:
  - Conservative (260 kt feedstock/yr): -0.3 Mt CO_2 eq./yr
  - Optimistic (1500 kt feedstock/yr): -1.7 Mt CO_2 eq./yr



Conclusions exploratory study for Dutch Ministry of Economic Affairs

- Plastic feedstock availability for chemical recycling in NL in 2030
  - Conservative: 260 kt/yr
  - Optimistic, with import: up to 1500 kt/yr

- Technologies offer different trade-offs
  - Depolymerisation and solvolysis: more climate change benefits (similar to mechanical recycling), but require rather clean feedstock
  - Gasification and pyrolysis: more flexible in feedstocks, but lower climate change benefits (~50% of mechanical recycling)

- Climate change reduction potential: up to 1.7 Mt CO_2 eq./yr in 2030

Chemical recycling in policy

Waste policies

- EPR systems for packaging do now not consider chemical recycling as recycling, so collection for chemical recycling is not funded
- Dutch waste policies view chemical recycling as low-value recycling
  - However, environmental analyses show that chemical recycling can be beneficial and can be considered moderate to high-value recycling
- Dilemma: Should all chemical recycling be seen as equal, or should different categories be distinguished?
  - For example, categories for high and low CO_2 reductions

Energy policy

- Plastic pyrolysis is better than incineration but can also disturb the recycling market. Be careful with stimulation.

Final conclusions

- Chemical recycling can be an interesting addition to mechanical recycling
  - Options that retain chemical structures (solvolysis, depolymerisation) offer highest CO_2 reductions that can rival mechanical recycling
  - Gasification and pyrolysis offer lower CO_2 reductions and should be used when other options are not feasible (e.g. mixed plastic waste)

- Chemical recycling can produce food grade plastic for packaging which is interesting for the transition towards circular packaging

- Chemical recycling installations become more economical with a larger scale. A common European policy on chemical recycling could make import and export for efficient chemical recycling easier.

More information:

- Contact Geert Bergsma: bergsma@ce.nl

- Dutch report: Exploratory study on chemical recycling https://www.cedelft.eu/en/publications/2173/exploratory-study-on-chemical-recycling

- Screening LCA summary Ioniqa (English) https://www.cedelft.eu/en/publications/2154/summary-of-ioniqa-lca-screening-carbon-footprint-analysis

- CE Delft, material department https://www.cedelft.eu/en/raw-material-chains

Backup slides

Study approach

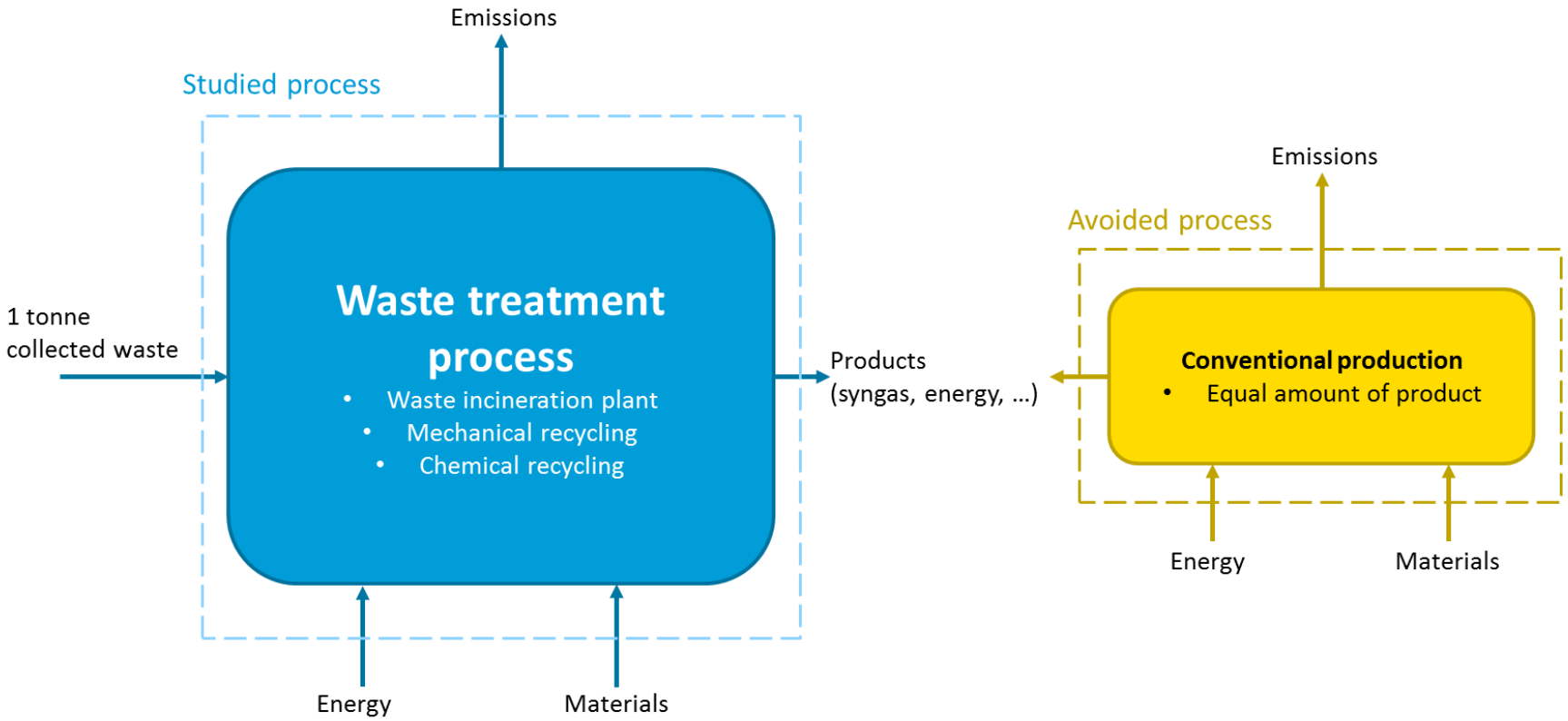
1. Analysis of availability of plastic waste up to 2030, focusing on:
   - Difficult to recycle mechanically
   - Available in the Netherlands and part of waste in UK, Belgium and Germany

2. Several chemical recycling technologies
   - Including different carbon footprints per technology

3. CO_2 reduction potential for the Netherlands for 2020 and 2030

4. Policy suggestions

Screening LCA methodology



Carbon footprint waste treatment = (impact studied process) – (impact avoided process)

- Expressed in tonne CO_2 eq. per tonne treated waste
- Direct emissions
- Used energy/materials
- Treatment of residues
- Same products made via conventional production process

LCA results: details