Environmental assessment of pyrolysis and gasification

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CE Delft

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Governments
(European Commission, European Parliament, regional and local governments)

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Why LCA studies on chemical recycling?

Policy makers at state and local level have several questions:

- Do chemical recycling technologies not need too much energy?
- Are chemical recycling technologies equal from an environmental point of view?
- How does chemical recycling compare environmentally with mechanical recycling?
- How much CO_2 emission reduction can chemical recycling achieve in the Netherlands?

Initiatives chemical recycling in the Netherlands:

- Sabic/Plastic energy, Enerkem/Nouryon, Ioniqa/Indorama, Cure/Cumapol, IGE solutions, AMA (Amsterdam), Shell, etc.

But many others all over the world:

- BASF/Quantafuel (D/N), Eastman (USA), Total/PureCycle (F), APK Newcycling (D), Clariter (SA/P), Renasci (B), BP (UK), etc.

Exploratory study on chemical recycling

Commissioned by Dutch ministry of Economic Affairs

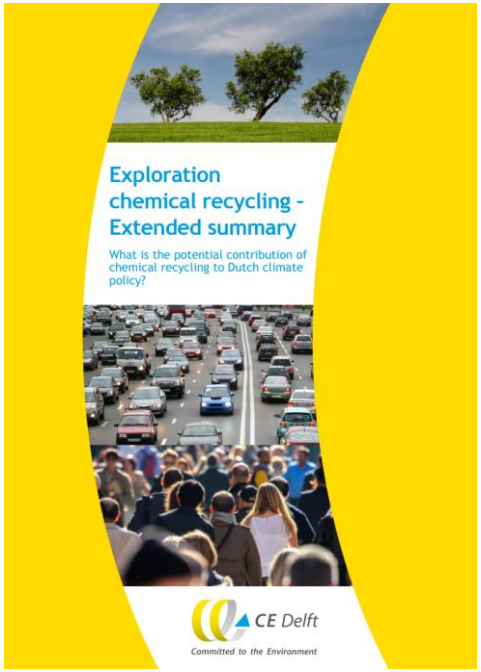
(In Dutch with extended English summary)

Research questions

- Can chemical recycling lower greenhouse gas (GHG) emissions?
- What is the potential for GHG reduction?
- What policies should be used to support chemical recycling?

Methods

- Estimated plastic waste volumes
  (not suitable for mechanical recycling)
- Screening LCA studies



An English extended summary of the report is available online: https://www.cedelft.eu/en/publications/download/2832

Exploratory study on chemical recycling

Some findings

- Chemical recycling can lower GHG emissions
- Environmental benefits differ per technology and waste stream
- Estimated GHG emission reduction potential in 2030:
  - Using only Dutch waste: 0.26 Mtonne CO_2 eq./yr
  - Including imported waste: 1.5 Mtonne CO_2 eq./yr

Main policy suggestions

- EPR schemes should include chemical recycling as an option
- Dutch waste law: update position of chemical recycling in waste hierarchy
- Government support can differentiate based on environmental performance
  - For example: 100% for depolymerisation/dissolution and 50% for pyrolysis and gasification

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Main types of chemical recycling with different environmental performance

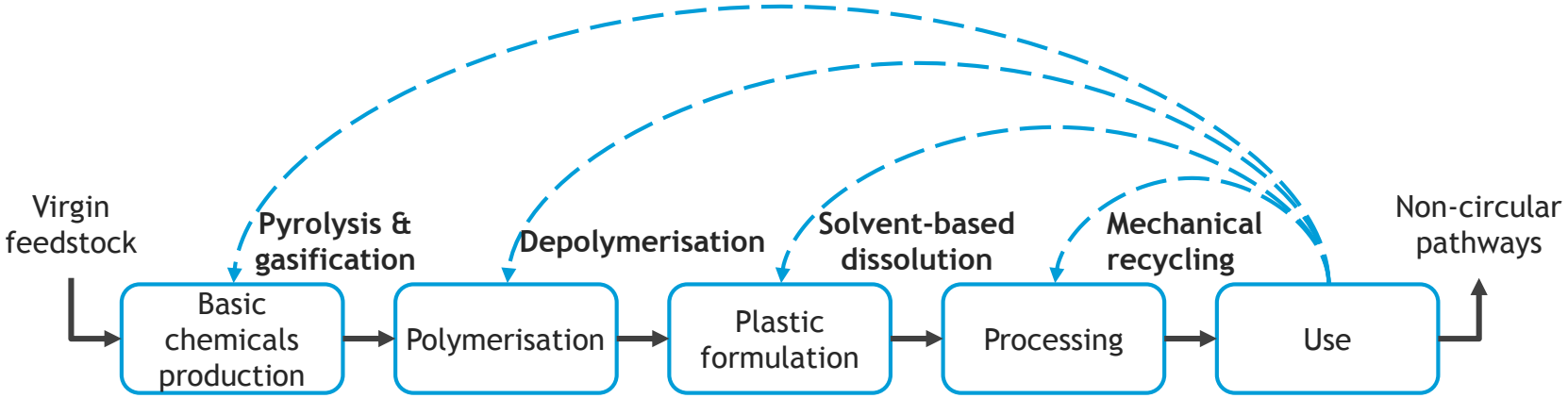
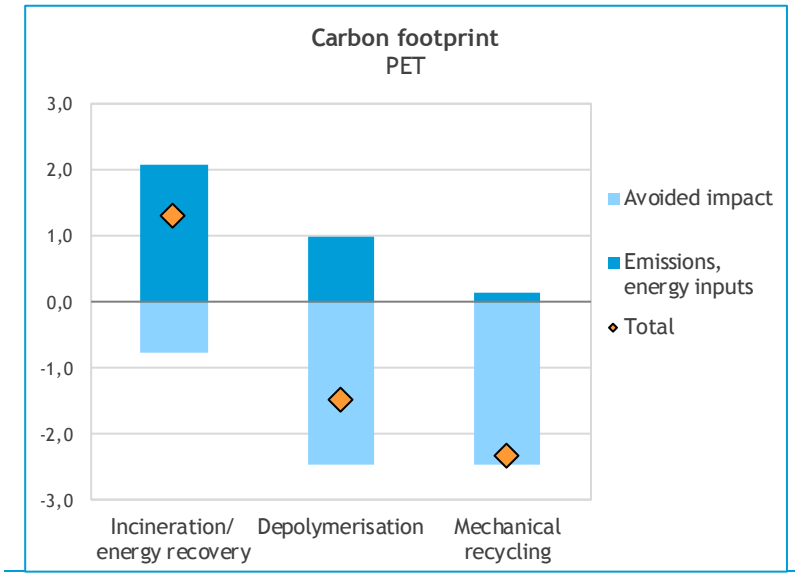


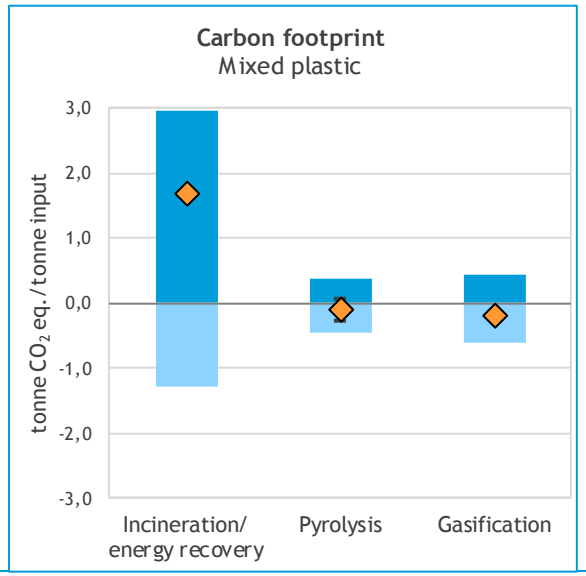
Image based on Crippa et al., 2019, *A circular economy for plastics - Insights from research and innovation to inform policy and funding decisions*, European Commission

Mechanical and chemical recycling compared environmentally

Compared to incineration with energy recovery:

- GHG reduction of depolymerisation is similar to that of mechanical recycling
- GHG reduction of pyrolysis and gasification is about half that of mechanical recycling
- GHG reductions depend on energy recovery efficiency of incineration





Note: indicative results from screening LCAs representing environmental performance of technologies in development in the Netherlands. Carbon footprint results depend on specific technology, plastic waste composition and reference technology (e.g. energy recovery efficiency). Please refer to the extended summary for further details.

Chemical recycling and policy

Transitioning towards circular and sustainable plastics requires:

- Mechanical recycling (?40% for all plastic not only packaging)
- Chemical recycling (both short loop (?15%) and longer loop (?25%)
- Biobased plastics (?20%)

To reach this we need a good combination of policies:

- Treat monomer recycling and dissolution as similar to mechanical recycling
- Treat pyrolysis and gasification as roughly half as good as mechanical recycling
- Increase the plastic recycling targets
  (*Most interesting would be an input target of recycled or biobased plastic for all plastic use in the EU)*
- Stimulate innovation in sorting, mechanical recycling and chemical recycling
- Prevent that governmental support for plastic-to-fuels results in less recycling

Plastic-to-plastic vs plastic-to-fuel

- Today, plastic-to-fuel and plastic-to-feedstock (pyrolysis/gasification) result in similar GHG reductions

- On the longer term (2030-2040), transport will require less diesel, while the chemical sector will still require carbon, so a preference for material is logical.

- Large-scale stimulation of plastic-to-fuel (through RED obligations) could attract materials which could otherwise be mechanically recycled

Policy solution:

- A balanced target for recycled and/or bioplastic in plastic input in Europe like the target for renewable fuel (RED) in diesel and petrol could create a level playing field.

Conclusions

- A combination of more mechanical recycling, short loop chemical recycling and longer loop chemical recycling (pyrolysis and gasification) could make all plastics more circular and sustainable.

- Pyrolysis or gasification for materials or for fuels is more interesting than incineration but mechanical recycling and monomer recycling and dissolution have to be the priority.

- Policy suggestions:
  - Increase recycling targets for plastic preferable for the input
  - Preference for mechanical recycling, monomer recycling and dissolution
  - 50% score for pyrolysis for materials or fuel
  - A preference for material when less necessary in the fuel sector (2030)