



Kemisk genanvendelse: Overvejelser vedrørende teknologier, værdikæder og bæredygtighed

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Søren Kristiansen
Soeren.kristiansen@LEGO.com



**Family owned
Danish**



Founded



**#1
Toy company**



**130+
countries**



**18,800
colleagues**



**#1
reputable brand**

Planet Promise

Positive impact on society & planet

- 2025 Sustainable packaging
- Plants from Plants one step to sustainable future



We want to remain
100%
renewable



Sustainable
materials by
2030

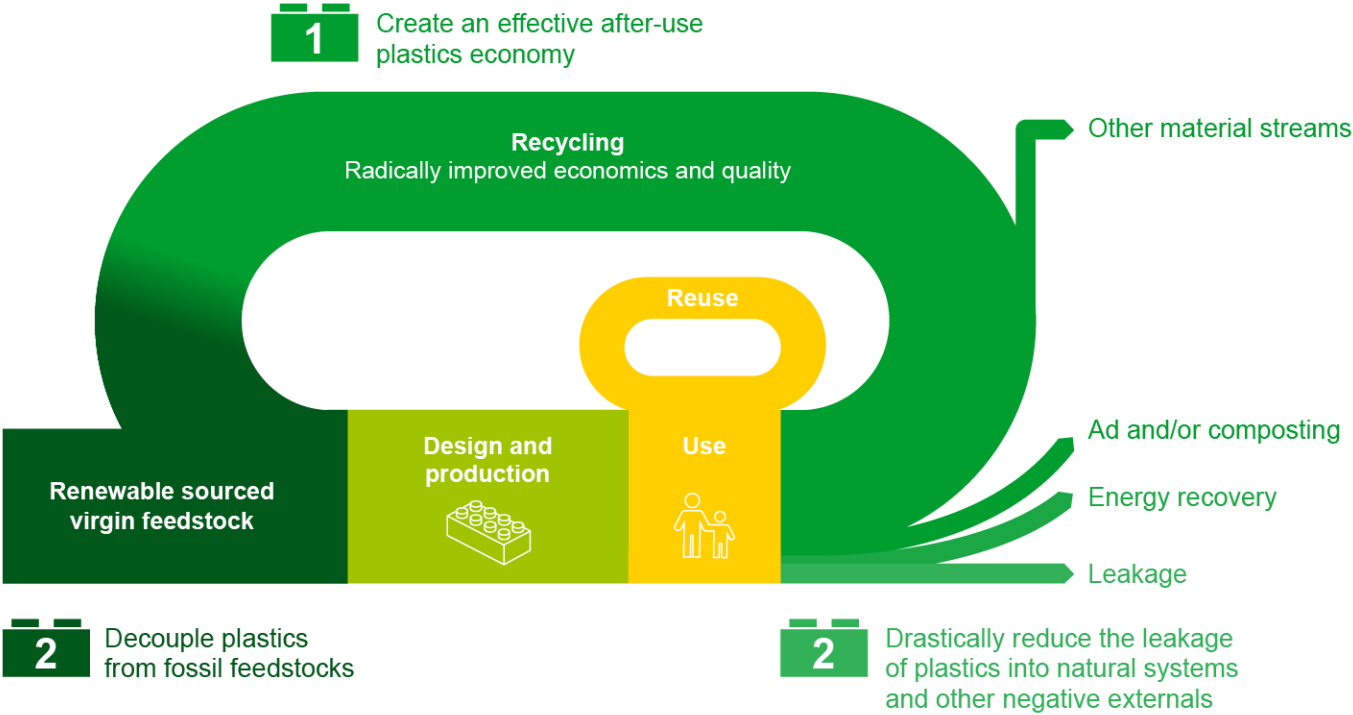
Bio Polyethylene



Bio HD-PE and bio LD-PE materials implemented.



Creating circularity for plastic



This model from the Ellen MacArthur Foundation, which illustrates our thinking about a circular plastic economy

Energy perspective on green chemistry



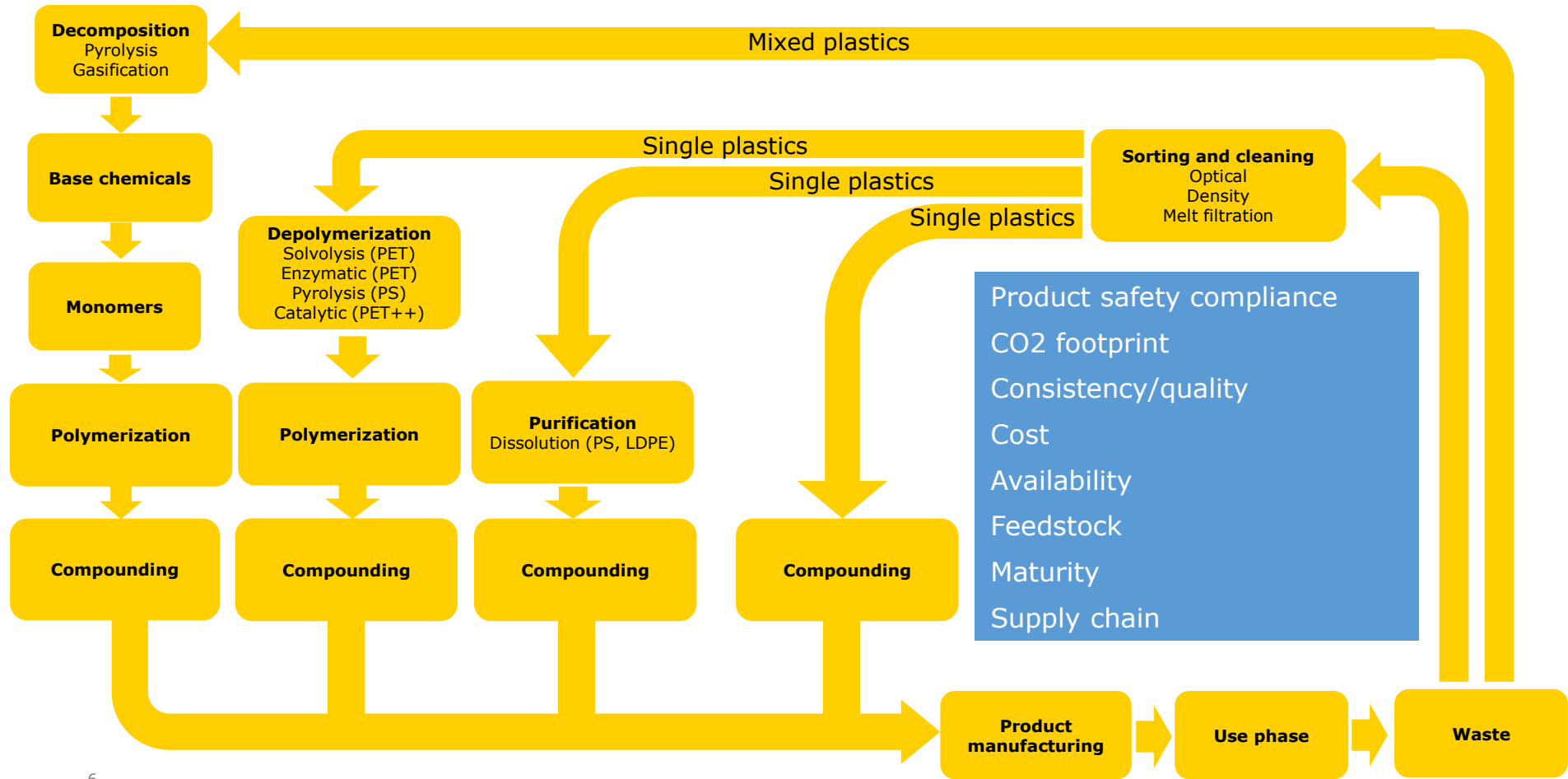
IPCC has estimated the global amount of biomass is equivalent to 100 – 300 EJ/year. *)

In 2050 the global production estimate of plastics 1.2 Gt/year equivalent to 120 EJ/year. **)

Total need for energy by 2050: 1000 EJ/year.

Biomass, recycling and sustainable energy must all be parts of the solution.

- *)The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change. Chum et al., 2011. **)Energy equivalence of plastics production is 80 – 120 GJ/t.





Sustainability

- For sure **mechanical recycling** is the most sustainable way to recycle plastics, but product requirements and legal requirements make it difficult to work.
- **Dissolution** is a refinement of the mechanical recycling. Environmental impact of dissolution depends on type and consumption of solvents. Energy usage for solvent reuse. Adding of lost additives, such as antioxidants is also a production step to take into account.
- **Depolymerization** is a very good concept, but only some materials are suitable. It will be possible to produce materials with virgin properties. The monomers will most likely go into a mass balance solution. Careful about energy usage.
- **Pyrolysis** can take care of the potential 'land fill' or energy recovery fractions. Pyrolysis is reality most suitable for polyolefins. Some processes are very energy consuming. Pyrolysis oil must undergo cracking and chemical steps in order to end up as new plastics. The full energy usage for the full chain must be investigated. Mass balance concept is unavoidable. Be aware of certifications.



Supply chain

- Feedstock availability now and in the future
 - Clean fractions can be limited.
 - Pull from packaging industry is significant.
 - Uncertain feedstock prices. In some cases negative price.
- Fit between output fraction and requirements for input.
- Maturity of technologies. When will the full chain be up and running?
- How to ensure volumes for offtake.



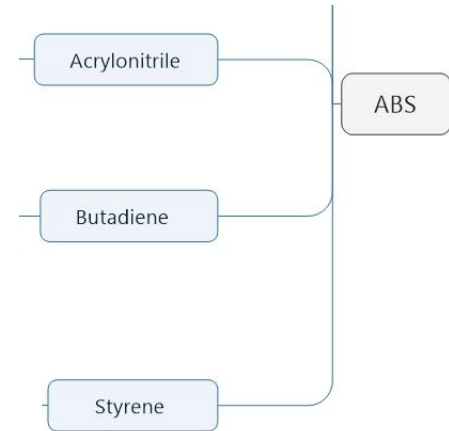
Depolymerization

- Reversing the polymerization process.
- Not all polymers are suitable for depolymerization.

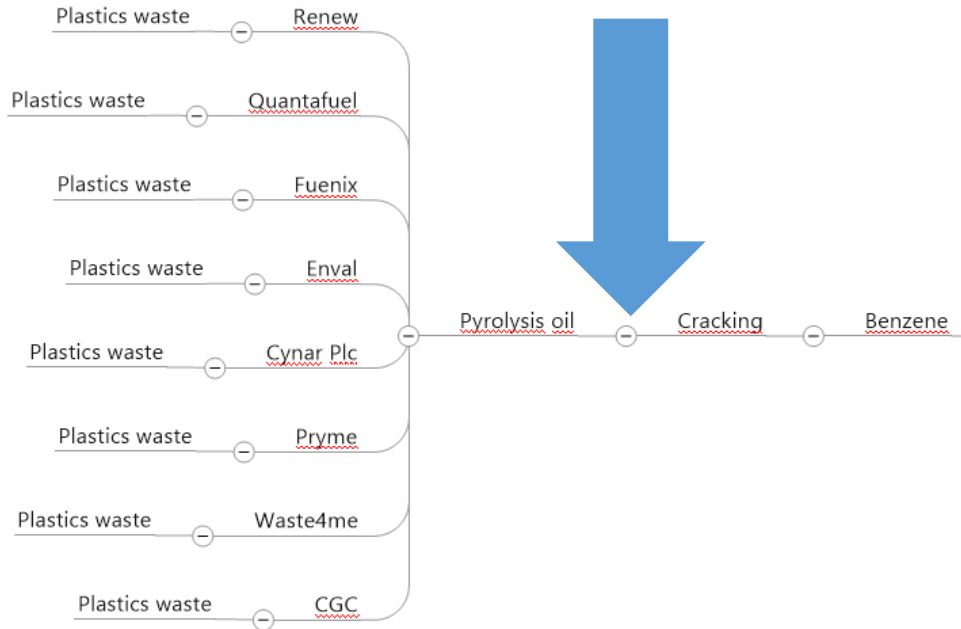
- **polyamide 6 -> caprolactam**
- **Polystyrene -> Styrene**
- **PET -> MEG + PTA**
- **PMMA -> MMA**
- Polyethylene -> WAX/Diesel/naphtha...
- Polyacrylonitrile -> Carbon fibers



Case: How could supply chains for ABS look?



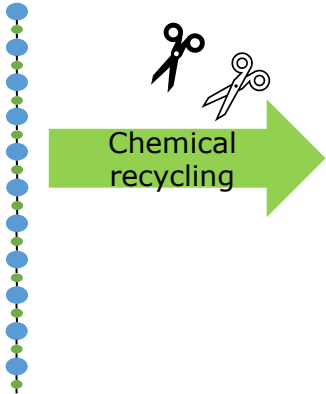
Different technologies and match



Case: PET



PET polymer



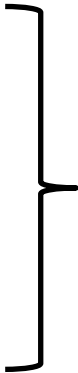
Hydrolysis



Methanolysis

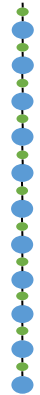


Glycolysis



Purification of monomers/intermediates
Repolymerization

PET polymer





Summing up

- Chemical recycling technologies are key contributors to achieve a higher degree of circularity.
- You cannot having evaluate a technology without having an idea of the fit to the supply chain.
- If you are a material user, you have to be sure that there is a material supplier willing to implement new technologies and upstream suppliers.
- Many promising technologies are under development. In which future supply chains will the technology fit, and what are the competitive technologies?
- Output and input must match.