

Circular economy: The challenge and possibilities of closing the system

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Climate Thursdays
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Waste management and a circular plastic system

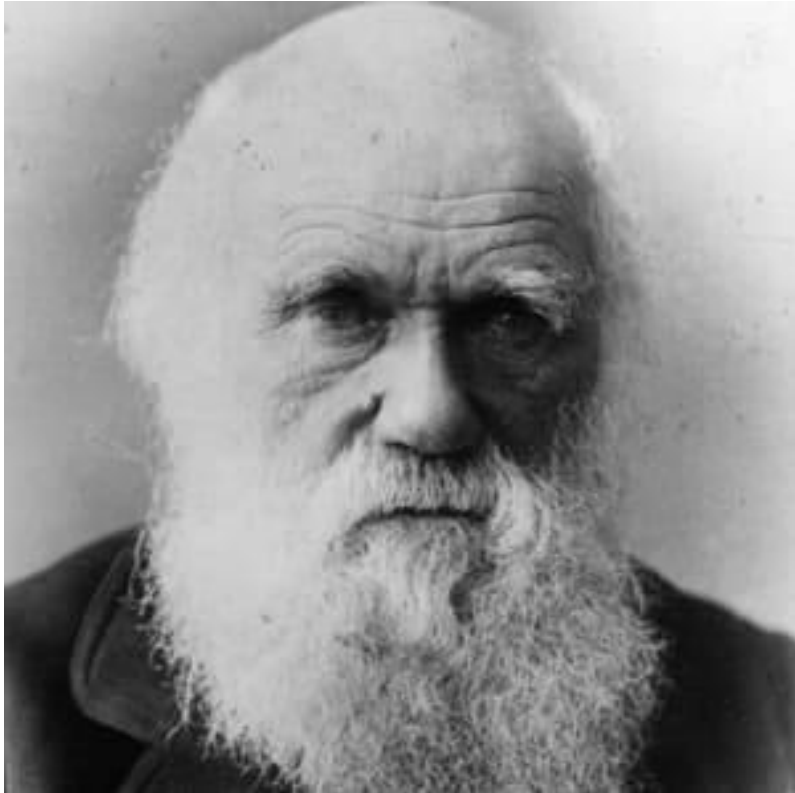
Presentation overview

- A helicopter perspective on framework conditions for waste management
- Recycled plastic quality
- Climate benefits
- The nature of the plastic system
- Experience from abroad
- The vision for the future waste and plastic system
- Q&A

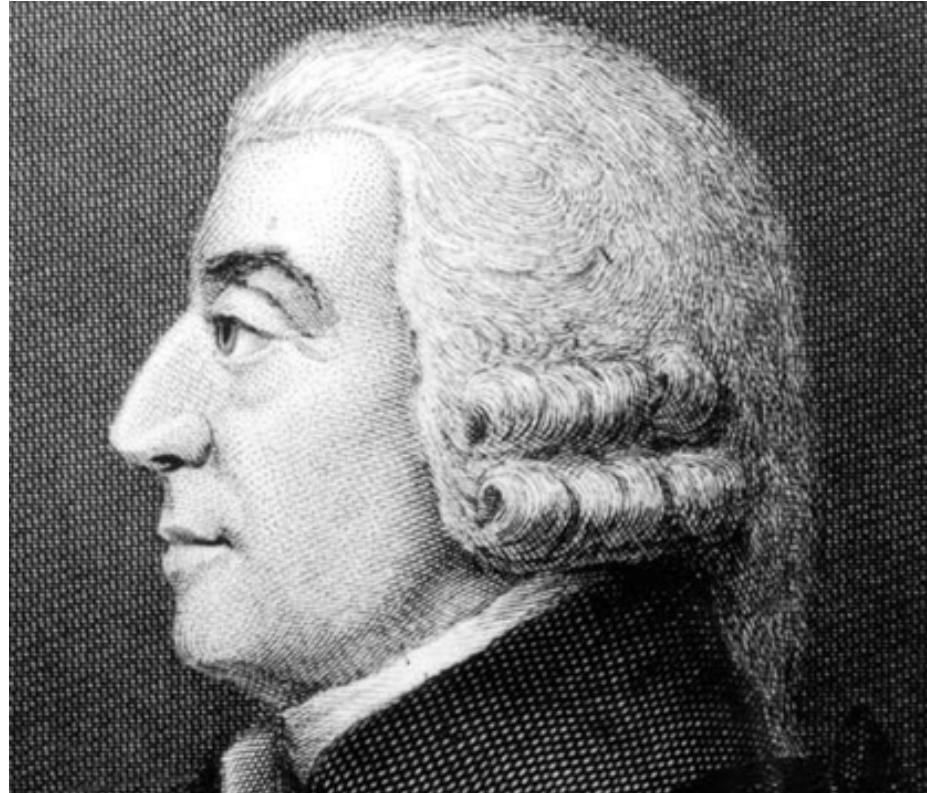
A helicopter perspective

- a 'socio-darwinistic' perspective on waste management

1859 Charles Darwin



1776 Adam Smith



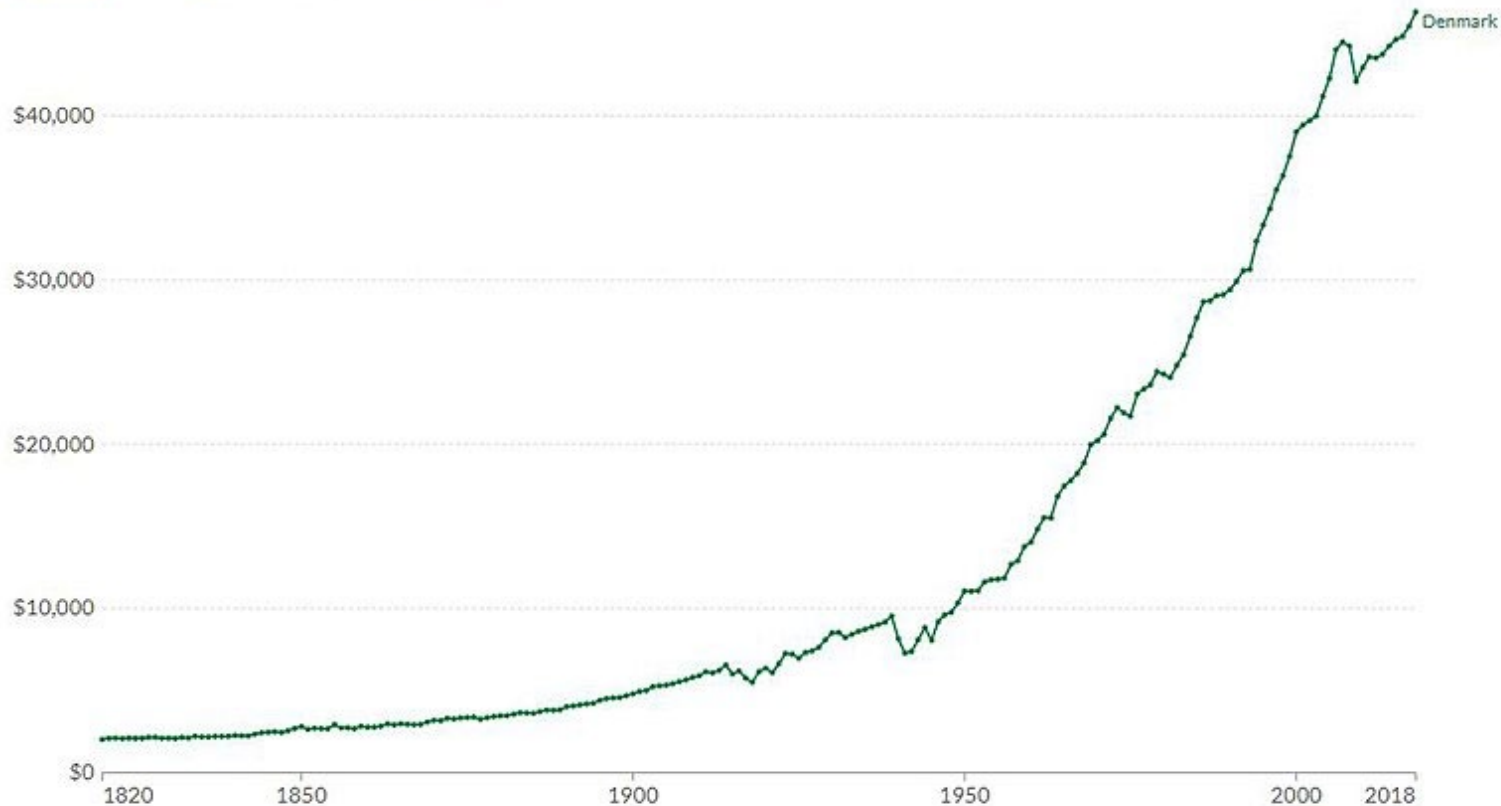
A helicopter perspective

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GDP per capita, 1820 to 2018

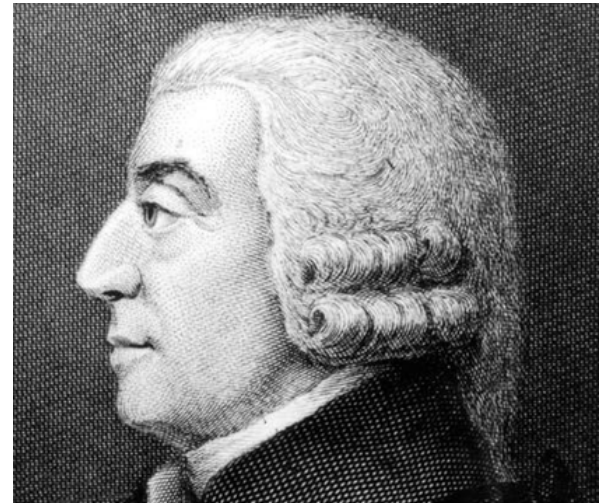
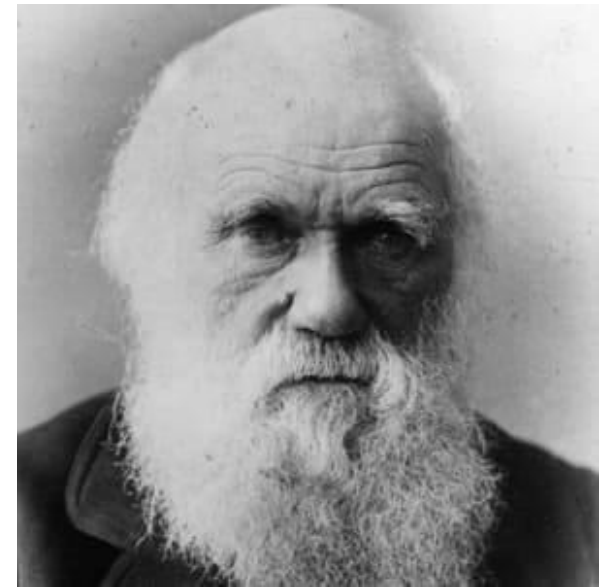
GDP per capita adjusted for price changes over time (inflation) and price differences between countries - it is measured in international-\$ in 2011 prices.

Our World
in Data



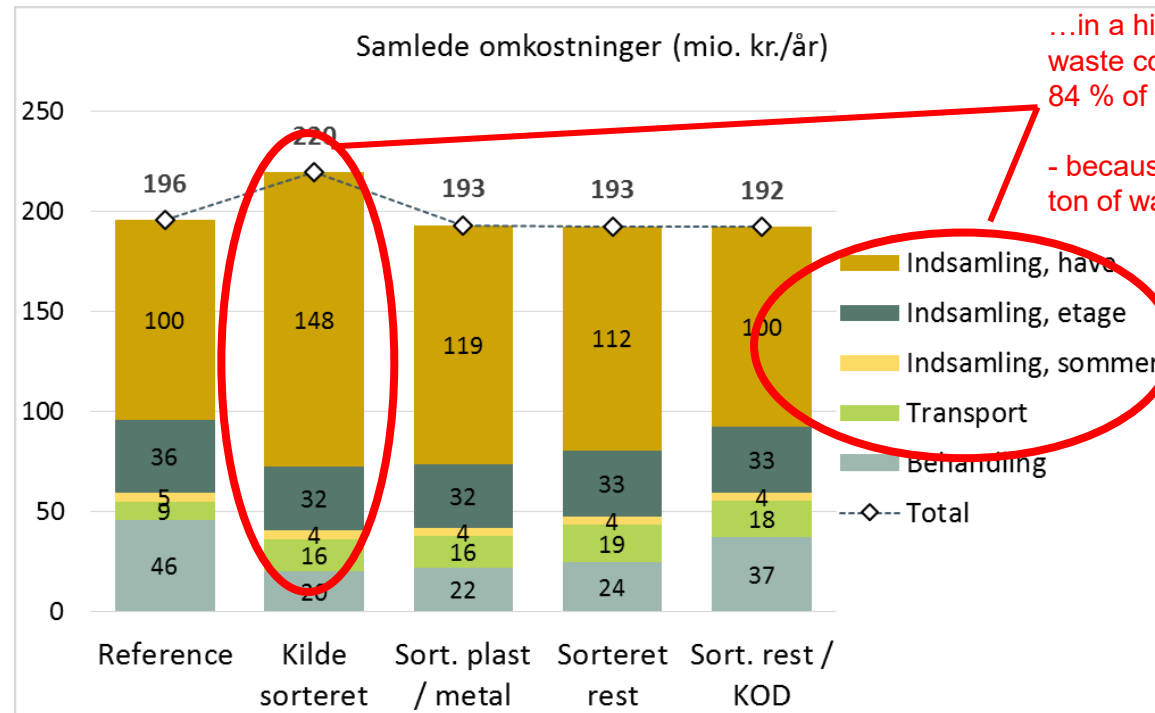
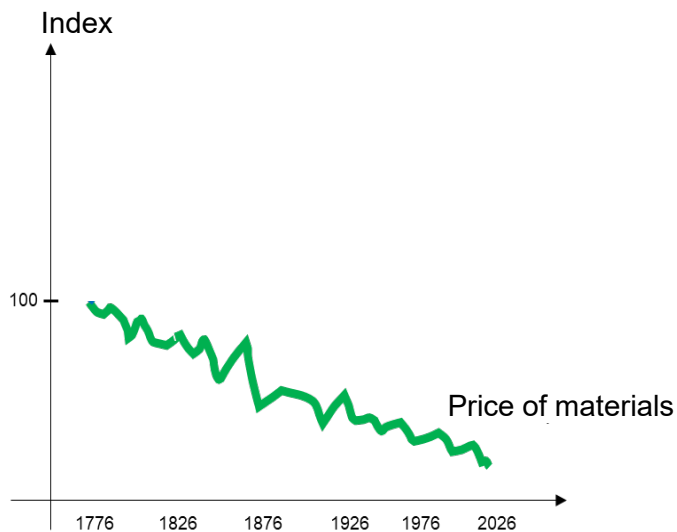
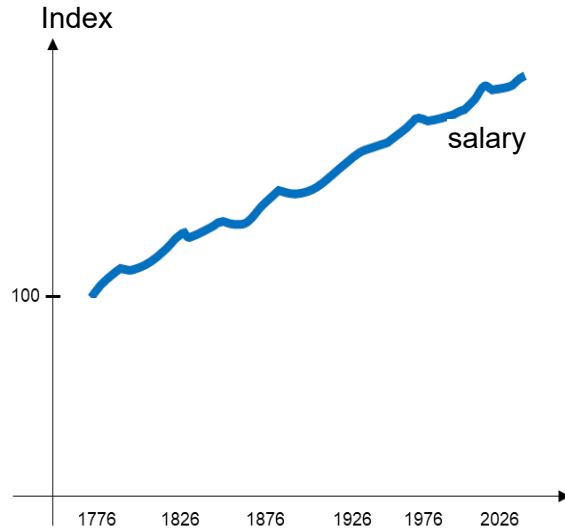
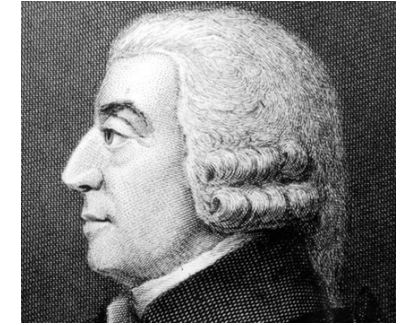
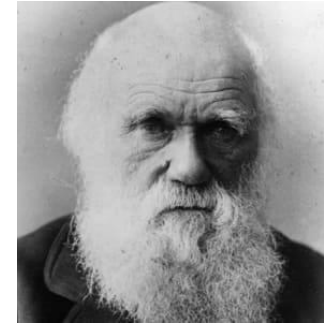
Source: Maddison Project Database 2020 (Bolt and van Zanden (2020))

OurWorldInData.org/economic-growth • CC BY



A helicopter perspective

- a 'socio-darwinistic' perspective on waste management



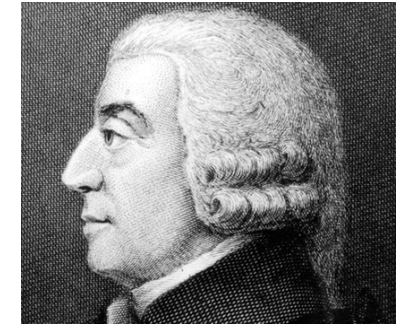
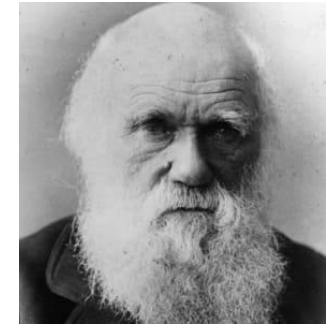
...in a high source separation situation, waste collection and transport represent 84 % of total waste management costs

- because this is where manual labour per ton of waste is by far the highest

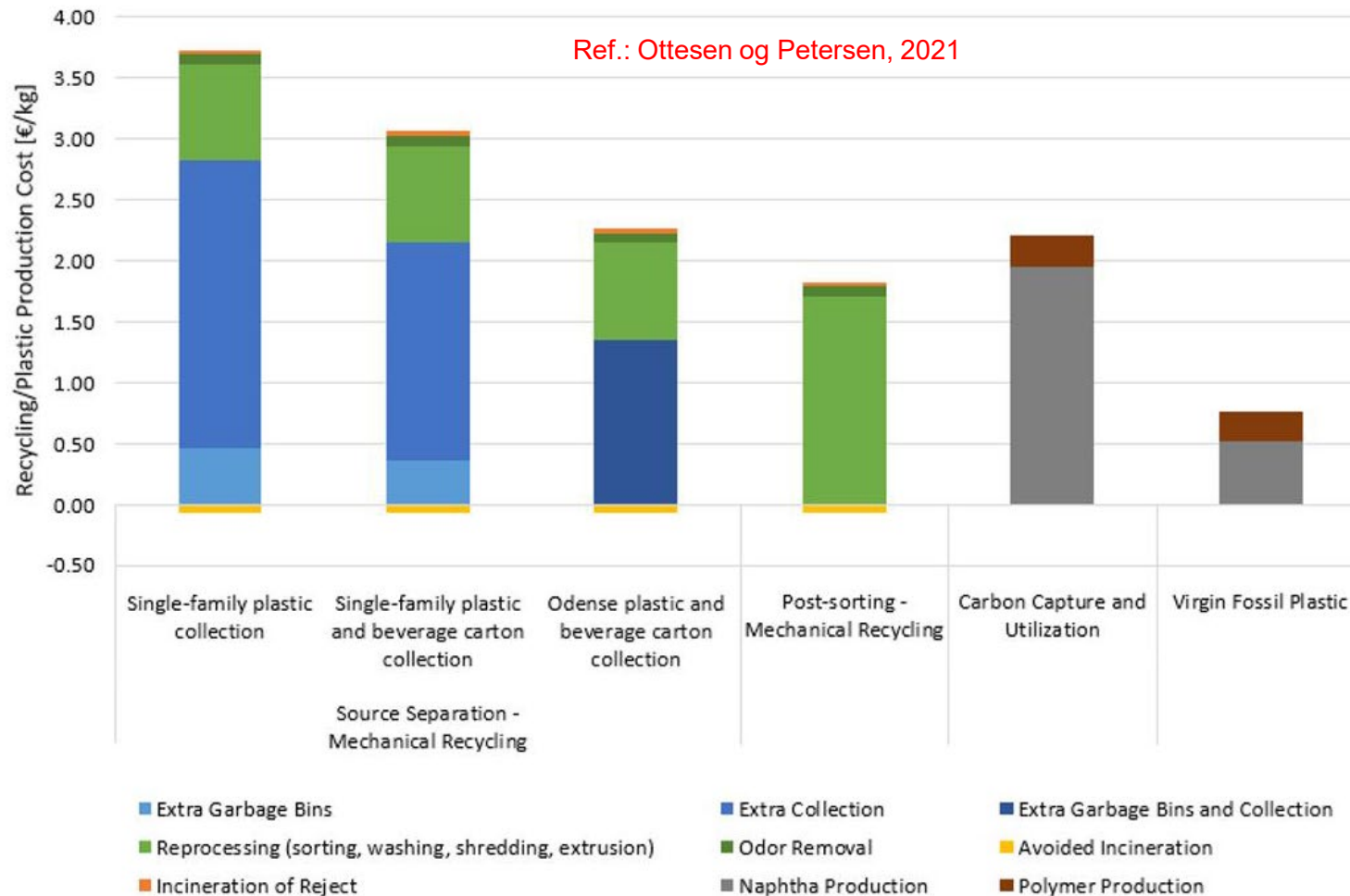
Ref.: SYFRE II, slutrapport, SDU & COWI, september 2017

A helicopter perspective

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Cost of plastic recycling/recovery



Mid-way conclusions

- Post sorting is cheaper than source separation
- Plastic made from flue gas CO2 and hydrogen is cheaper than or equal to source separation
- ... so why source separate?
- ... maybe plastic quality is better when source separating?
- ... and maybe climate benefits and other environmental benefits are higher from source separation?

Ref.: ProCES-Fyn, 2022

Recycled plastic quality

Ottesen og Petersen (2021)



Recycled plastic quality

Comparison before and after wash...

Odense – foil plastic from residual waste



Copenhagen – foil plastic from source separated waste



Ottesen og Petersen (2021)



After wash

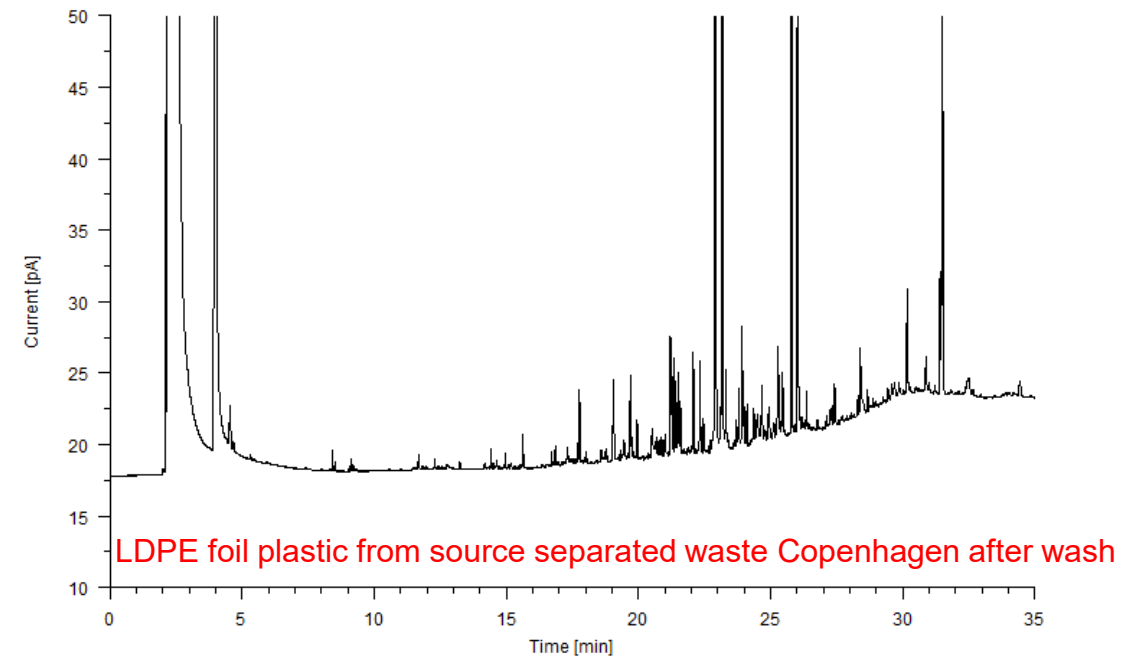
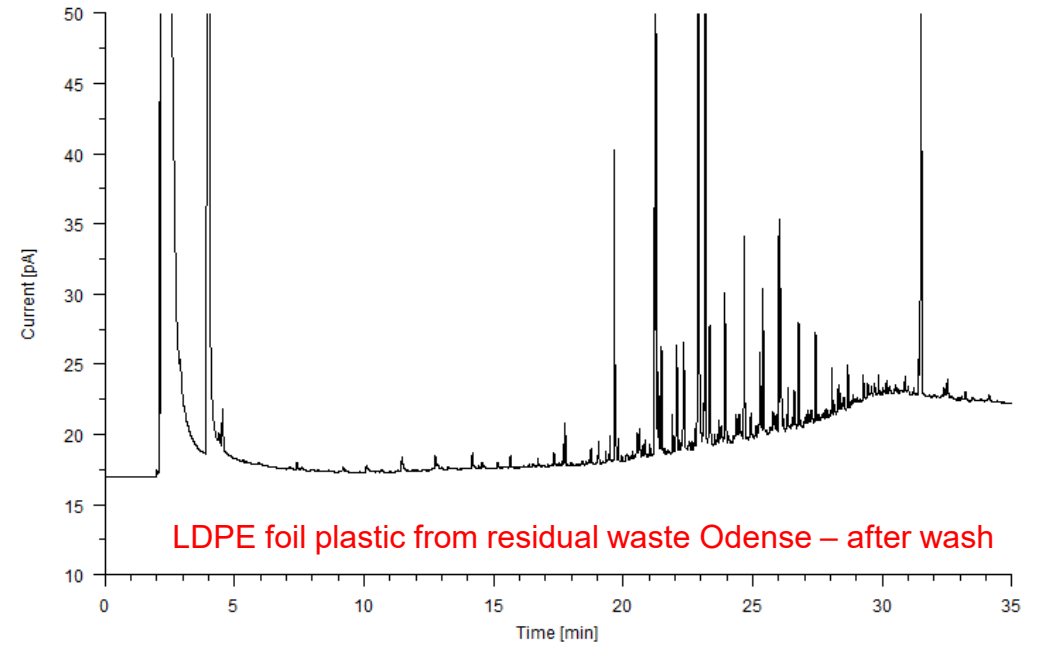
Recycled plastic quality

Chemical analysis of molecular contamination...



Ottesen og Petersen (2021)

Gaschromatography

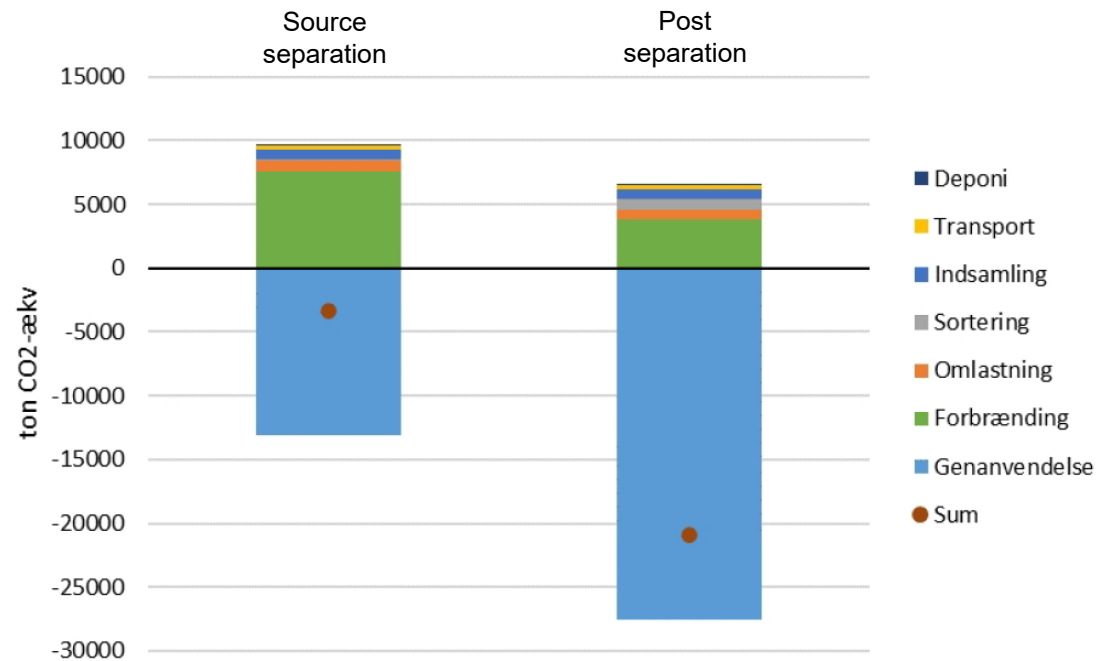


Recycled plastic quality

- all known analytical comparisons

Plastic property	Plast type	Conclusion on quality	Year	Country	Reference
Polymer purity	Plastic in general	No difference	2022	Norway	Mepex Consult AS, 2022
		In several cases best for post sorted plastic	2021	The Netherl.	van Velzen, Smeding, Brouwer & Maaskant-Reilink, 2021
		No difference	2014	The Netherl.	Luijsterburg & Goossens, 2014
Particle contamination	PET bottles	Least contaminated for post sorted plastic	2021	The Netherl.	van Velzen, Smeding, Brouwer & Maaskant-Reilink, 2021
Chemical contamination - organic	LDPE bags	No significant difference	2020	The Netherl.	Maaskant-Reilink, van Velzen & Smeding, 2020
	Plastic in general	No significant difference	2021	Denmark	Ottesen & Petersen, 2021
Chemical contamin. - brom. flame retard.	Plastic in general	No significant difference	2017	Denmark	Pivnenko, Granby, Eriksson & Astrup, 2017
Chemical contamin. - heavy metals	PET, PE, PP and PS	Insignificant difference	2018	Denmark	Eriksen, Pivnenko, Olsson, & Astrup, 2018
Odor	LDPE bags	Difference in odor character No difference in odor intensity	2020	The Netherl.	Maaskant-Reilink, van Velzen & Smeding, 2020
	Yellow bin vs. grey bin	The washing process means more than the collection method	2020	Spain	Cabanes, Strangl, Ortner, Fullana & Buettner, 2020
	Plastic in general	Difference in odor character No difference in odor intensity	2021	Denmark	Ottesen & Petersen, 2021
Physical properties	HDPE, PP	No difference (smelteindeks, flydespænding, brudstyrke, brudforlængelse, elasticitet, slagsejhed)	2020	Denmark & Norway	Mortensen & Raussen, 2020
	PE, film, PP, MP	No difference (trækstyrke, brudforlængelse)	2014	The Netherl.	Luijsterburg & Goossens, 2014

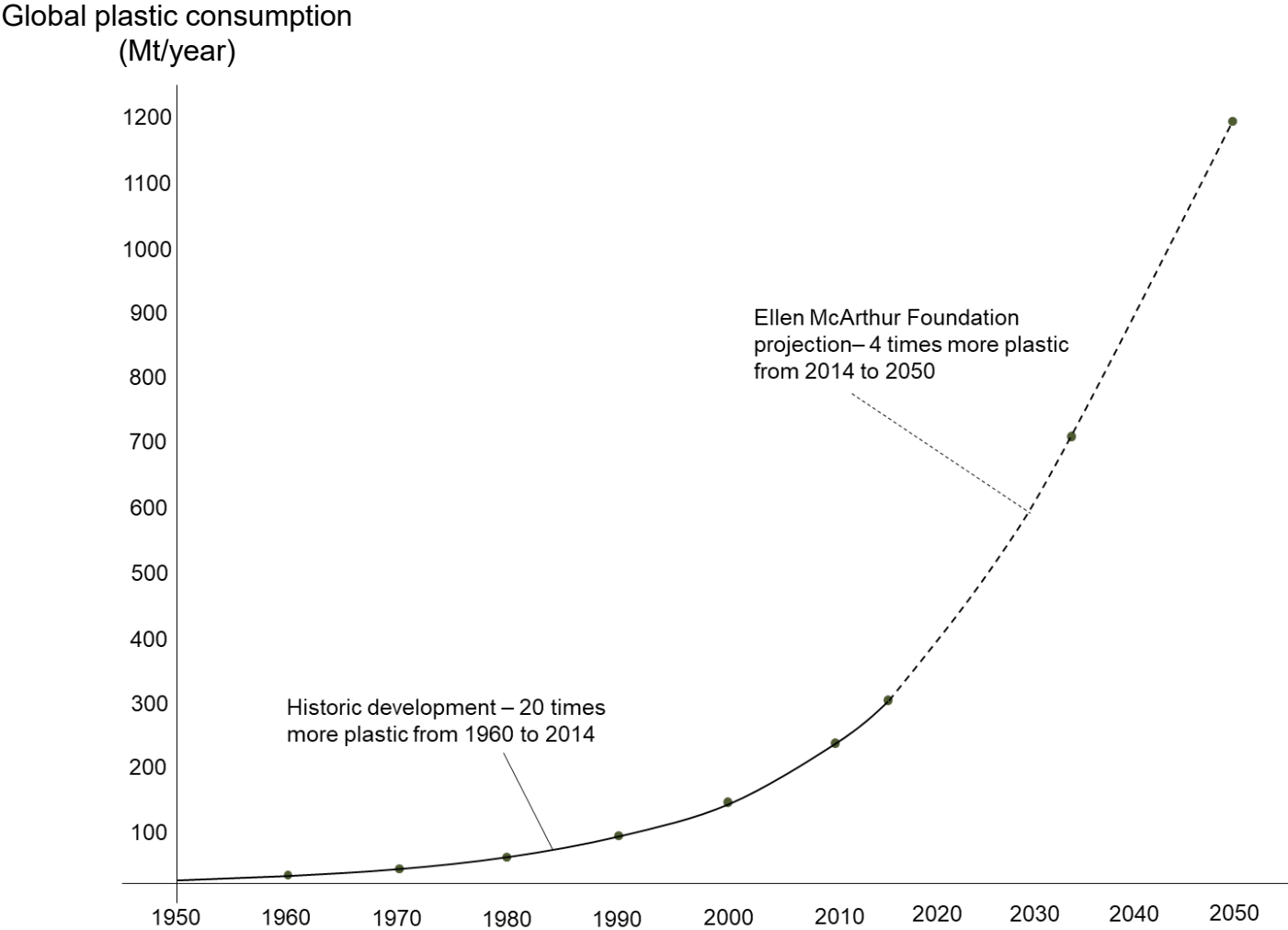
Climate benefits



Rambøll 2022 – comparative LCA

The nature of the plastic system

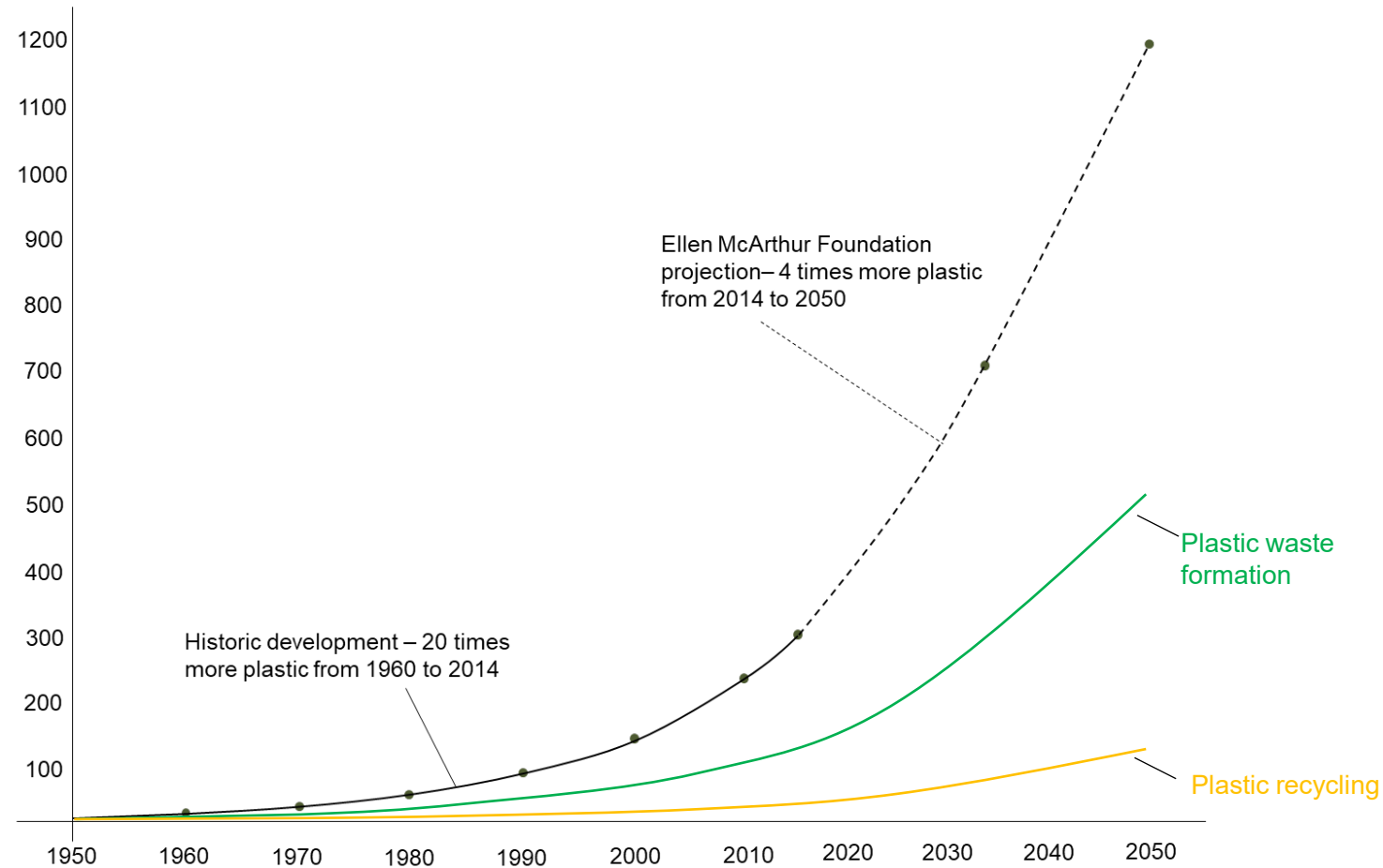
- material flows and plastic waste formation



The nature of the plastic system

- material flows and plastic waste formation

Global plastic consumption
(Mt/year)



Experience from abroad

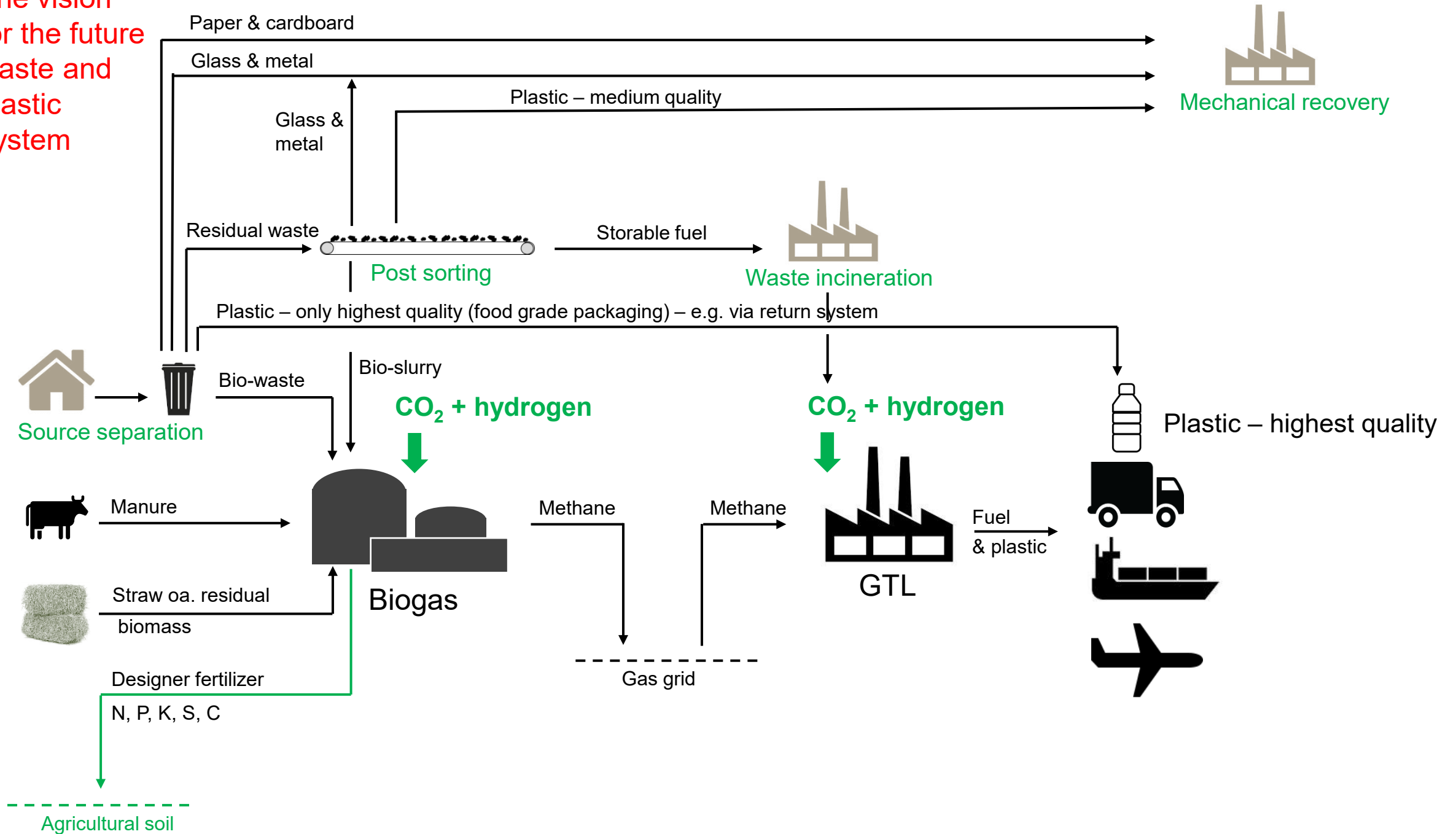
- post sorting replaces source separation in Norway and The Netherlands

From January 2019 to January 2021, 17 Dutch municipalities have left source separation of plastic and cartons after having established post sorting.

Municipality	Left source separation since	No. of Citizens
Leiden	Januar 2019	124.320
Cappele aan den Ijssel	Januar 2019	66.864
Rotterdam	November 2019	638.751
Leiderdorp	Januar 2020	27.214
Oegsgeest	Januar 2020	23.889
Ridderkerk	Januar 2020	45.797
Barendrecht	Januar 2020	48.485
Albrandswaard	Januar 2020	25.226
Noord-Beveland	Januar 2020	7.313
Borsele	Januar 2020	22.721
Reimerswaal	Januar 2020	22.565
Terneuzen	Januar 2020	54.440
Amsterdam	Januar 2021	855.896
Utrecht	Januar 2021	347.526
Westerwolde	Januar 2021	24.684
Nieuwegein	Januar 2021	62.448
Bunschoten	Januar 2021	21.265

Later, Den Haag and other municipalities have followed

The vision for the future waste and plastic system





Q&A