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AGRIMA

Circular economy - goal or tool for waste management?

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Agri-food Waste Management for Sustainable bio-economy through Higher Education curricula and upskilling

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Goals

AGRIMA aims to foster universities' **capacity building** for the **green transition** through **innovative practices and higher education curricula updating in agri-food waste management** for the **circular bioeconomy**.

AGRIMA addresses:

1. **Advancing pedagogical methods** for industrial agri-food waste valorisation **based on business-academia synergies**.
2. **Integrating citizen science** in bio-economy-enhanced waste valorisation as a means of **civic engagement and environmental advocacy**.

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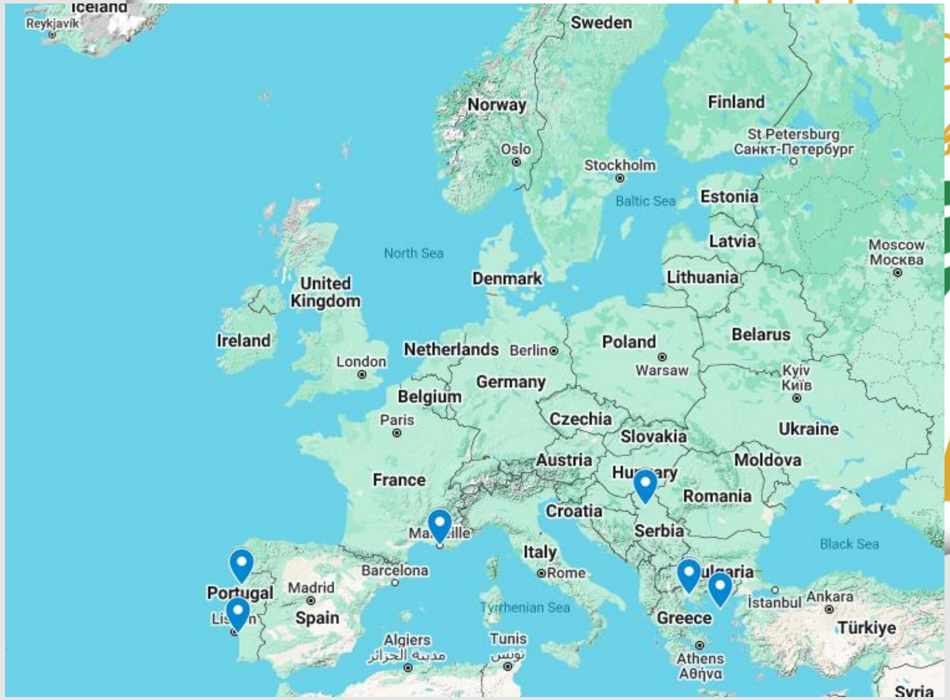
Partners



Aix*Marseille université
Socialement engagée

AVIPE
Associação de Viticultores do Concelho de Palmela

P.PORTO

UNIVERSITY OF THE AEGEAN

UNIVERSITY OF NOVI SAD

Web2Learn
Open, social learning

Circular economy – goal or tool for waste management?

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Department of Environmental Engineering

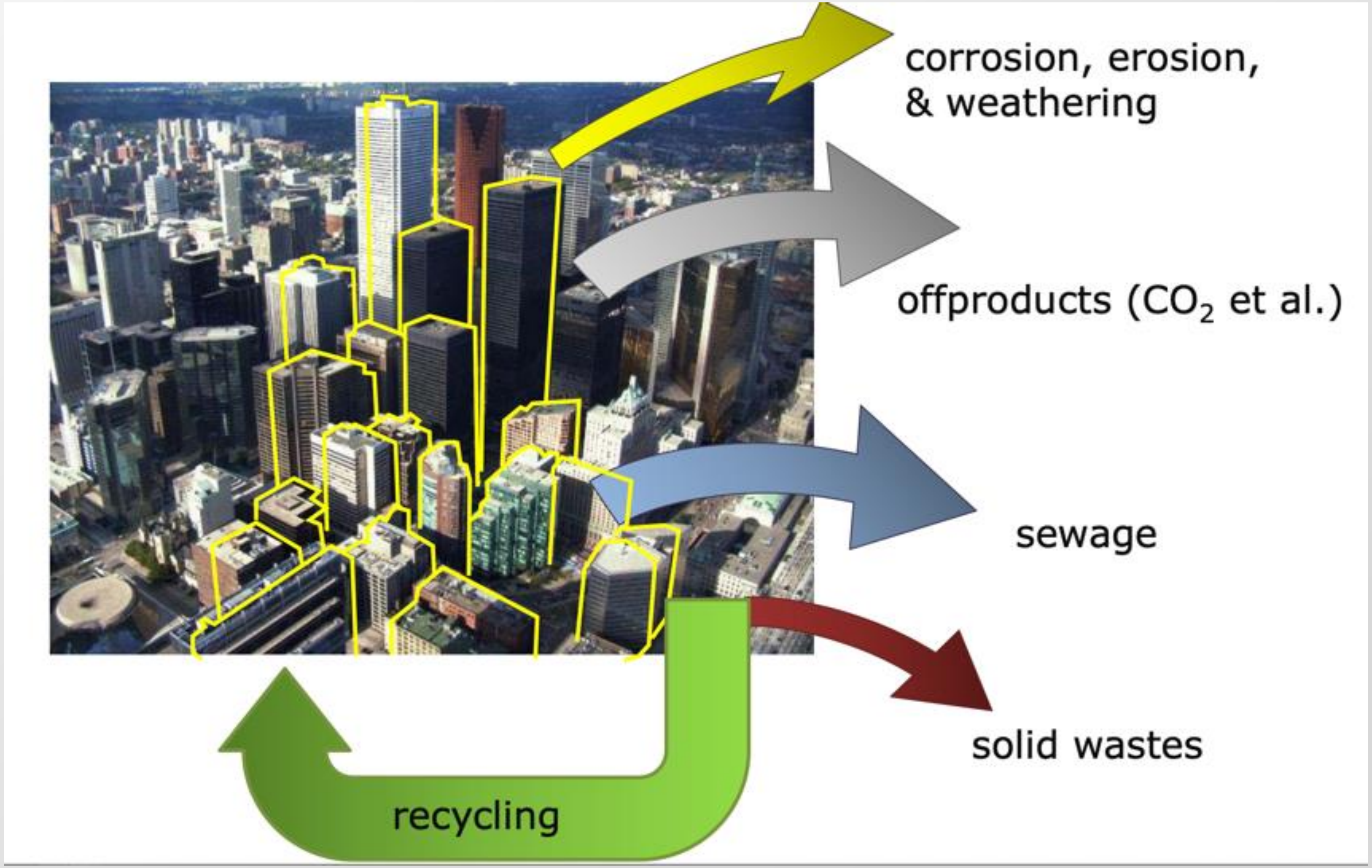
In 1848, August Wilhelm von Hofmann, the first president of the Royal Society of Chemistry and a pioneer in circular economy (CE), stated:

‘In an ideal chemical factory there is, strictly speaking, no waste but only products. The better a real factory makes use of its waste, the closer it gets to its ideal, the bigger is the profit’.

Even if CE is recognised today as a necessary cornerstone of sustainable development, we are still far from von Hofmann’s ideal!

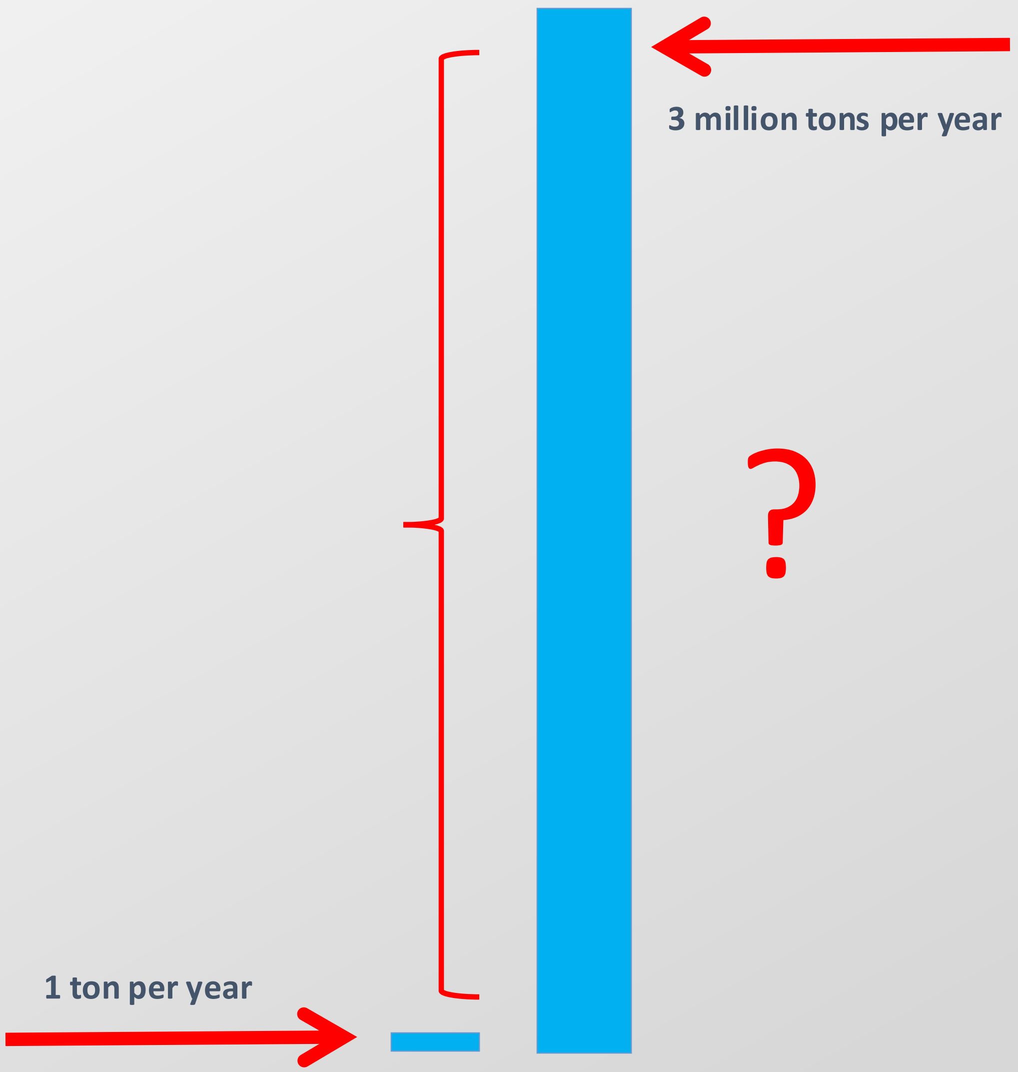
In a circular economy resource use is improved by minimising the extraction of natural resources, maximising waste prevention, and optimising the environmental, social, material and economic values throughout the lifecycles of materials, components and products.

Antropogenic metaboslim



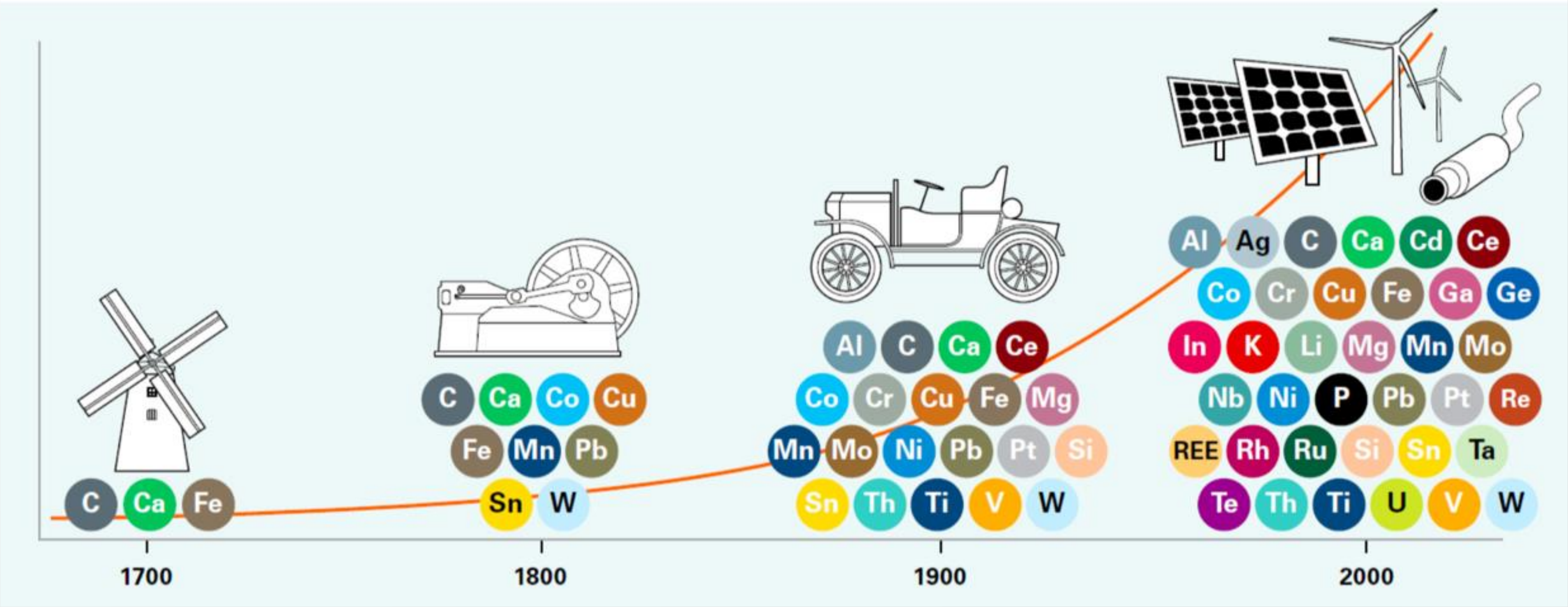
Velentuf and Purnel 2021

Lead?

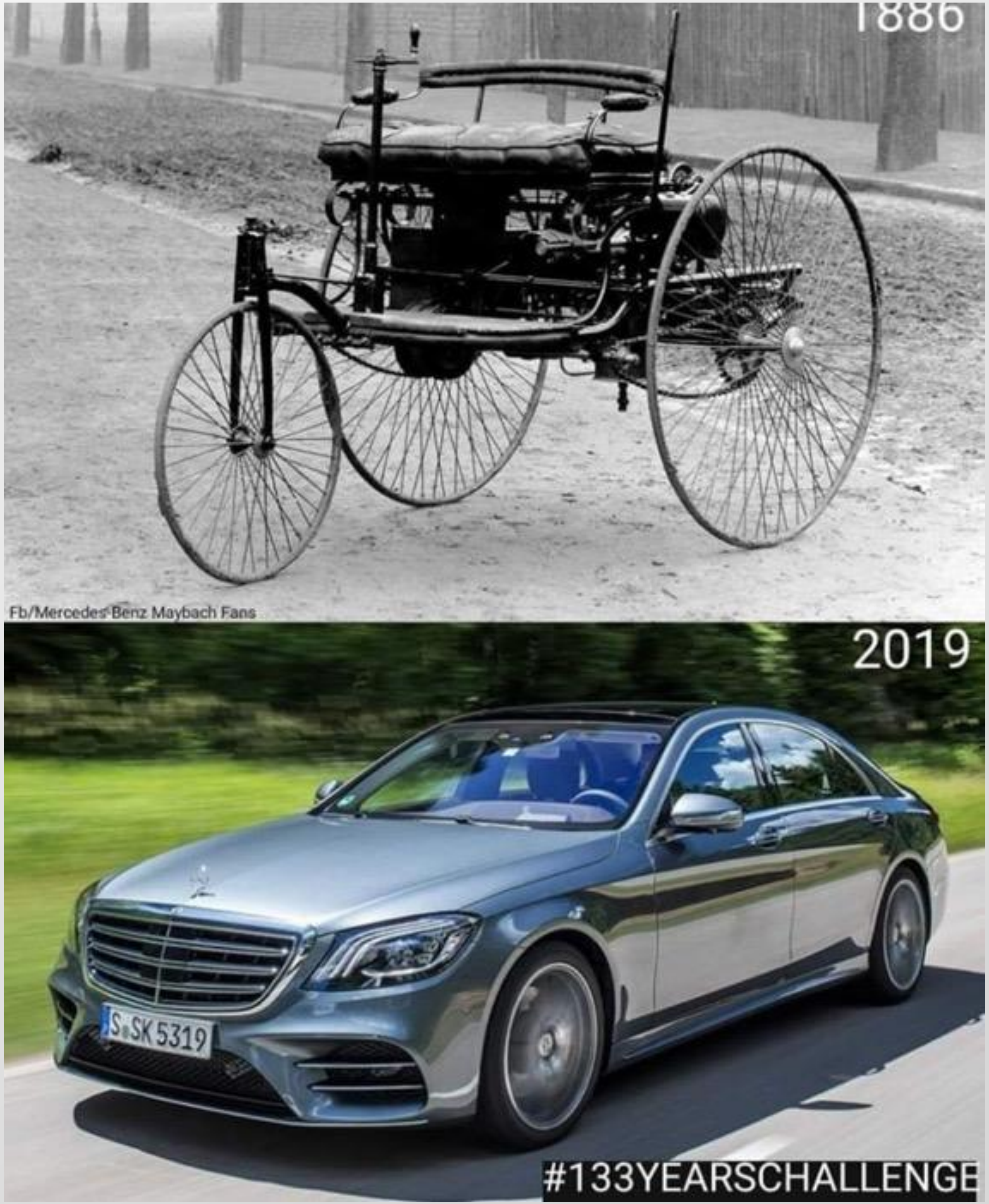


Settle and Patterson 1980

..more and more complex products

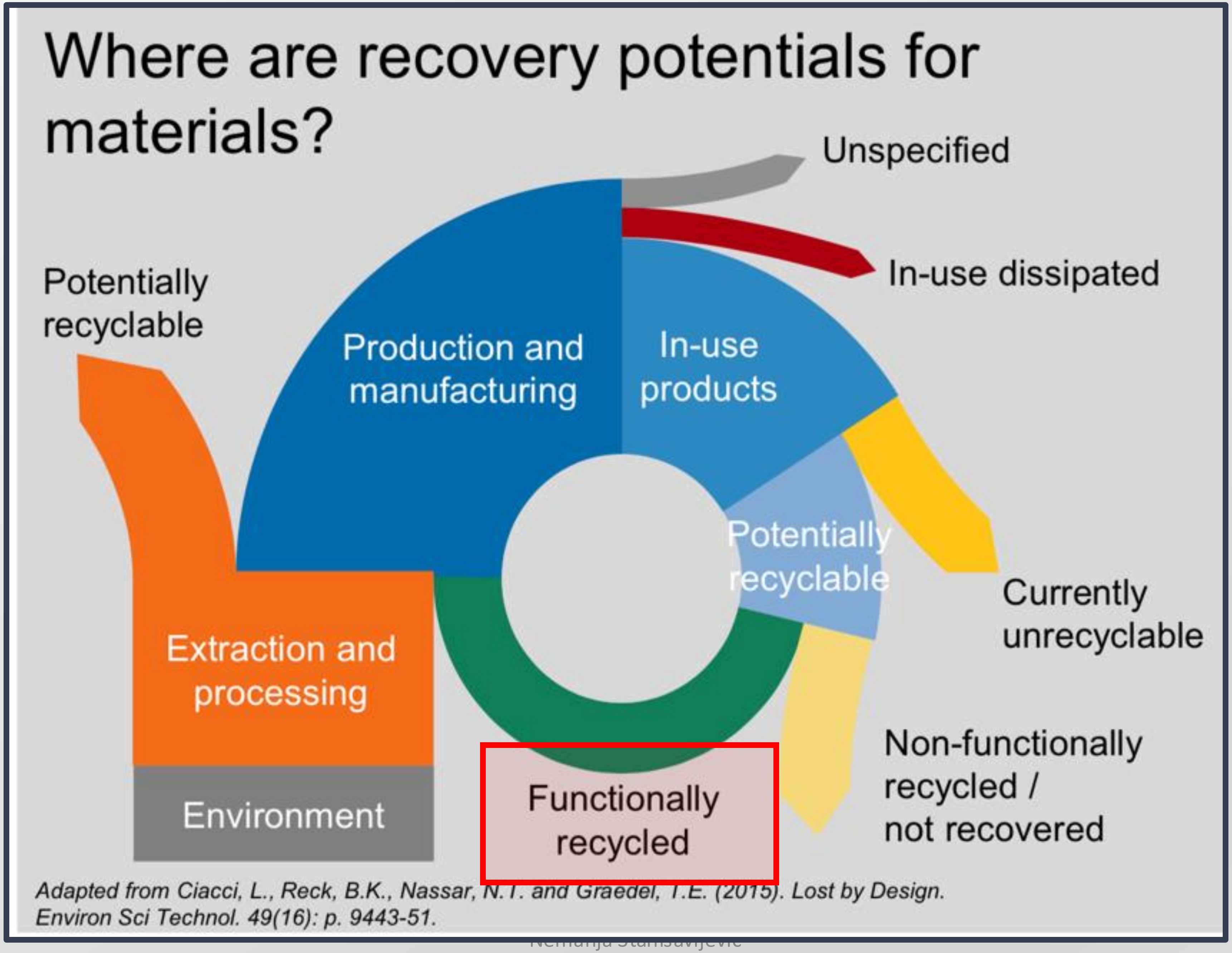


Source: Achzet et al (200


1886
Fb/Mercedes-Benz Maybach Fans
2019
S SK 5319
#133YEARSCHALLENGE

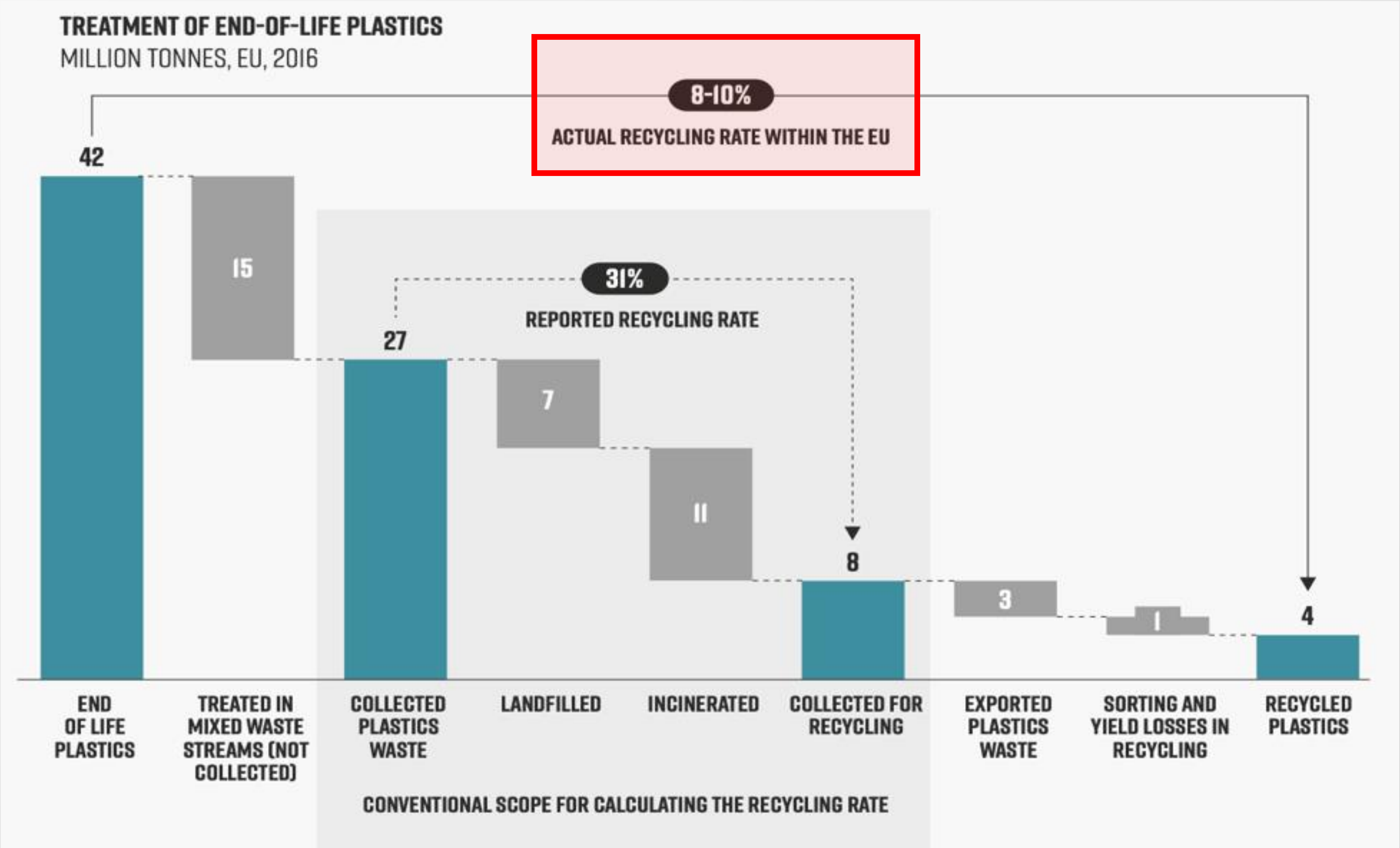
From a linear economy …

… to a circular economy


Where are recovery potentials for materials?
Unspecified
In-use dissipated
Potentially recyclable
Production and manufacturing
In-use products
Potentially recyclable
Currently unrecyclable
Extraction and processing
Environment
Functionally recycled
Non-functionally recycled / not recovered
Adapted from Ciacci, L., Reck, B.K., Nassar, N.T. and Graedel, T.E. (2015). Lost by Design. Environ Sci Technol. 49(16): p. 9443-51.

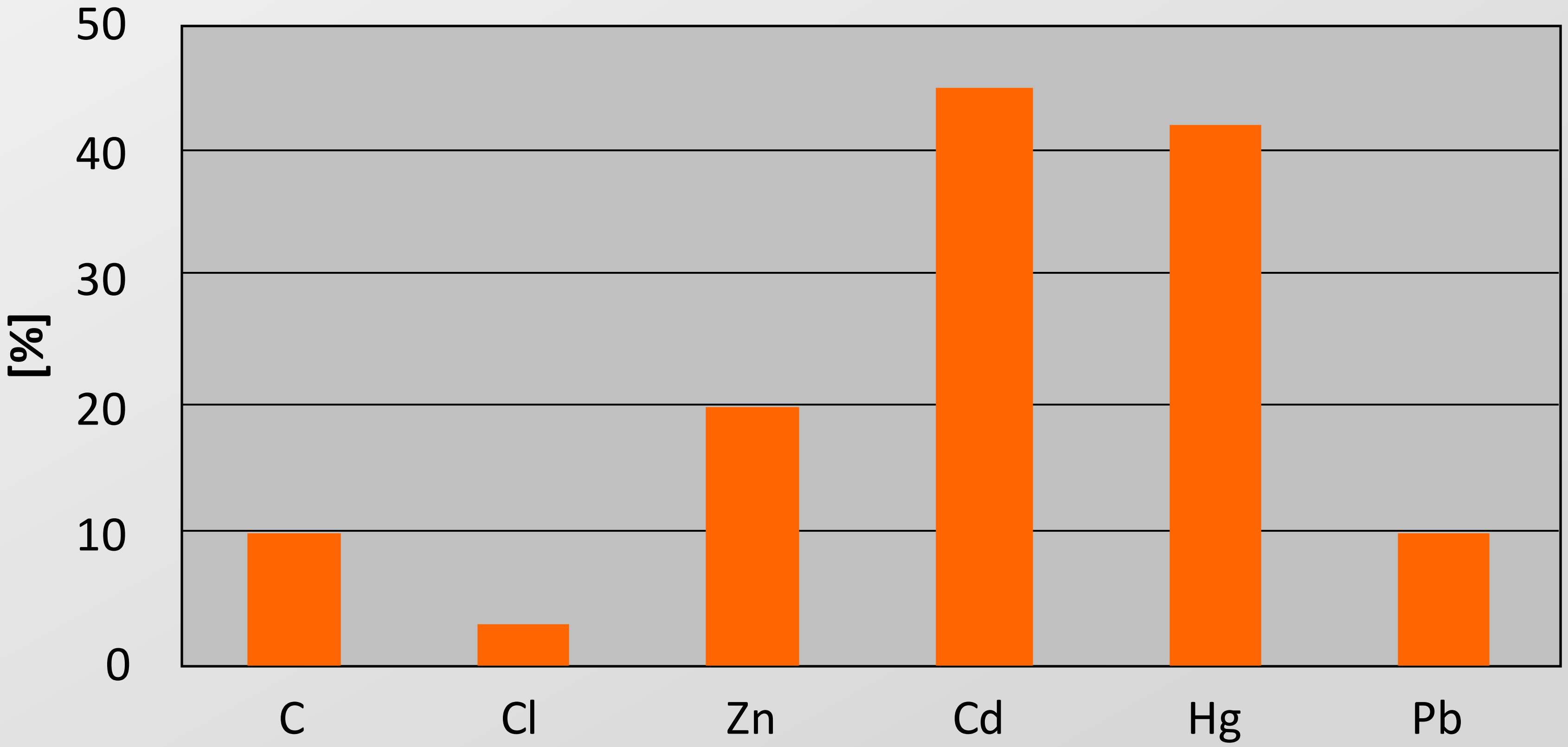
?

The actual plastic recycling rate in the EU…



Material Economics (2020). Preserving value in EU industrial materials - A value perspective on the use of steel, plastics and aluminium

Waste management as substance destinations in circular economy



Morf (1998)

Regulatory conditions for using waste as a construction aggregate and as a fertilizer in Sweden, Denmark, and Germany

	Bottom ash			Sewage sludge		
	Sweden	Denmark	Germany	Sweden	Denmark	Germany
Allowed use	As an aggregate according to two defined applications: free use and landfill cover	As an aggregate according to three categories; (1) partly free use (2), covered application, (3) capped application	As an aggregate according to three categories; (Z0) free use, (Z1) partly exposed application, (Z2) capped application	For fertilizer purposes in farmland	For fertilizer purposes in farmland	For fertilizer purposes in farmland
Restrictions	Stated case by case	Height, drainage and density.	Maturation for at least 3 months	Restrictions on pasture and arable land	Restrictions on the first year and water protection areas.	Restrictions on pasture land, arable land and water protection areas
Number of substances to be tested for leaching concentrations in the waste	13	14	12	–	–	–
For total concentrations in the waste	13	9 (category 1), 0 (2, 3)	12 (Z0), 12 (Z1, Z2)	7[a]	13	11
For total concentrations in the targeted soil	–	–	–	7	7	11
Legal force	Guiding	Binding	Guiding	Binding	Binding	Binding

[a]A certificate requires that 60 substances are tested in the waste.
"–," non-applicable.

Johanson & Krook 2021

Demistification of „modern“ circular economy goals?

Circular economy goals = waste management goals?

Available technology treatments

EU Hierarchy

Circular economy goals

- Protection of mankind and the environment
- Conservation of recourses
- After care free (landfills without after care, and clean cycles of recycled materials)

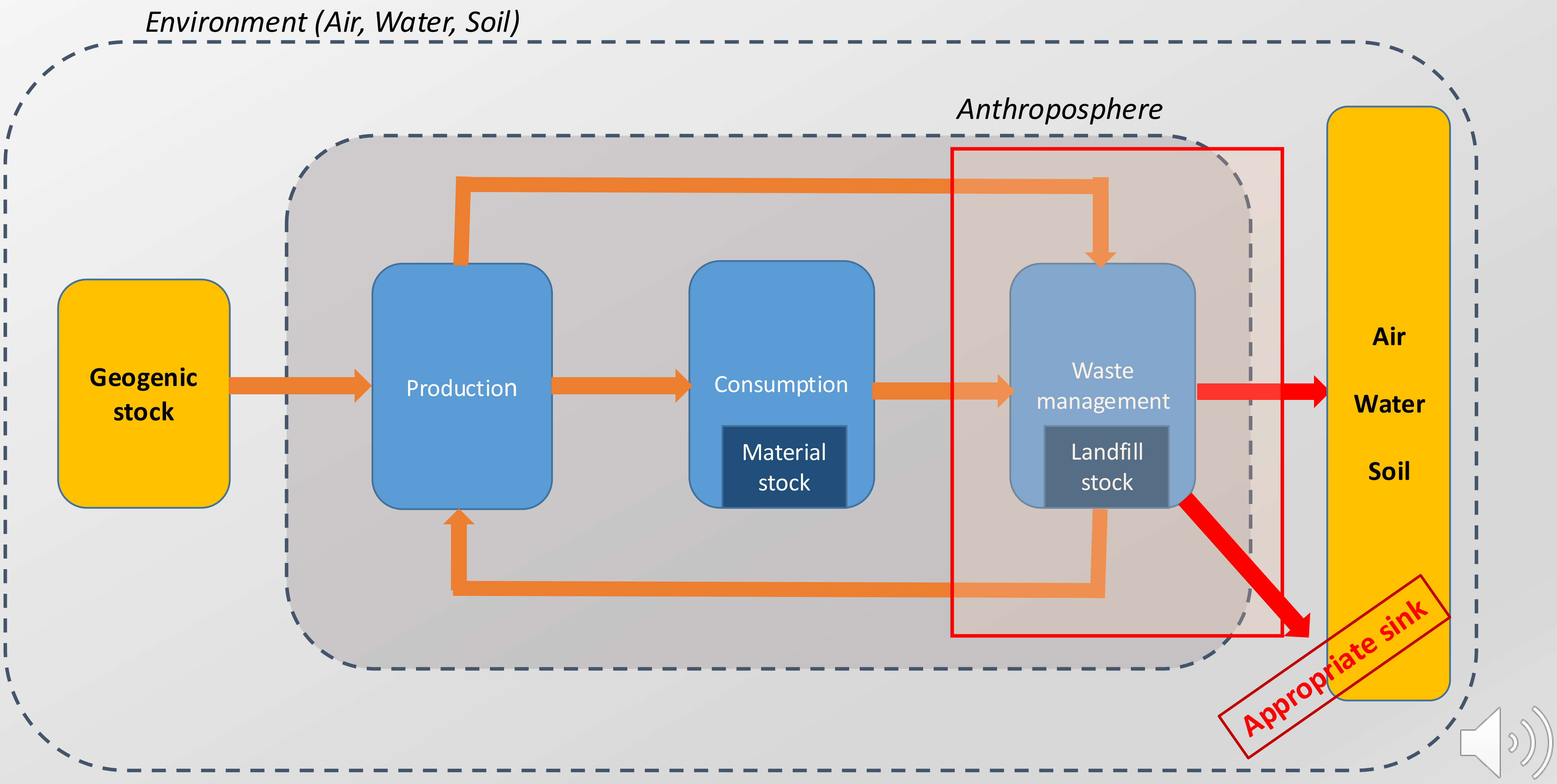
„Economic boundaries = Affordability of waste management“

Practical implications of circular economy goals?

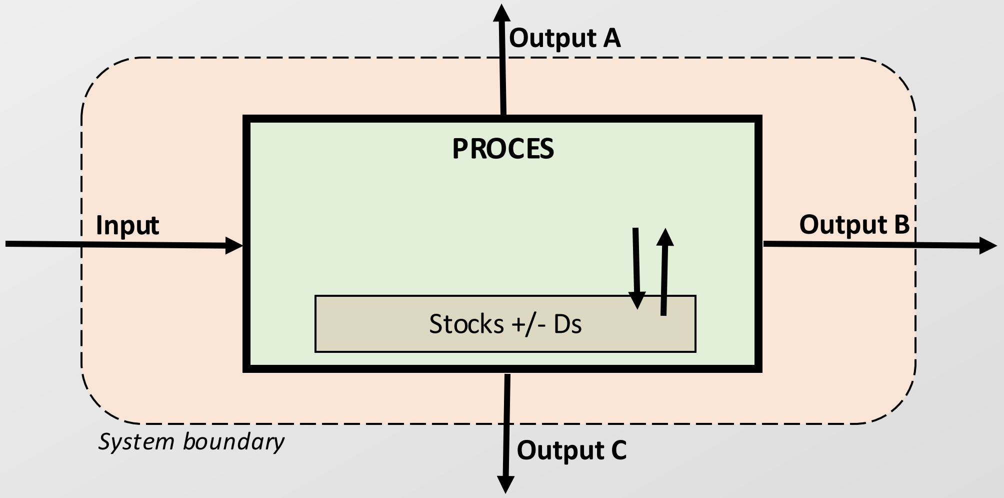
- Clean materials suitable for recycling and recovery
- Stable materials for landfilling without long term negative environmental implications
- Emissions in compliance with environmental standards with not impact on the natural balance (geogenic concentrations and loads)

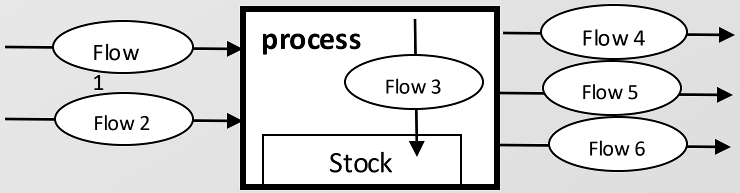
Stanisavljevic & Brunner (2021)

Why is waste management important



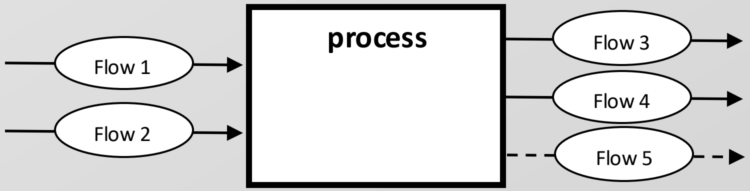
MFA – Basic principles





$F1 + F2 \stackrel{?}{=} F3 + F4 + F5 + F6$

Control mehanism

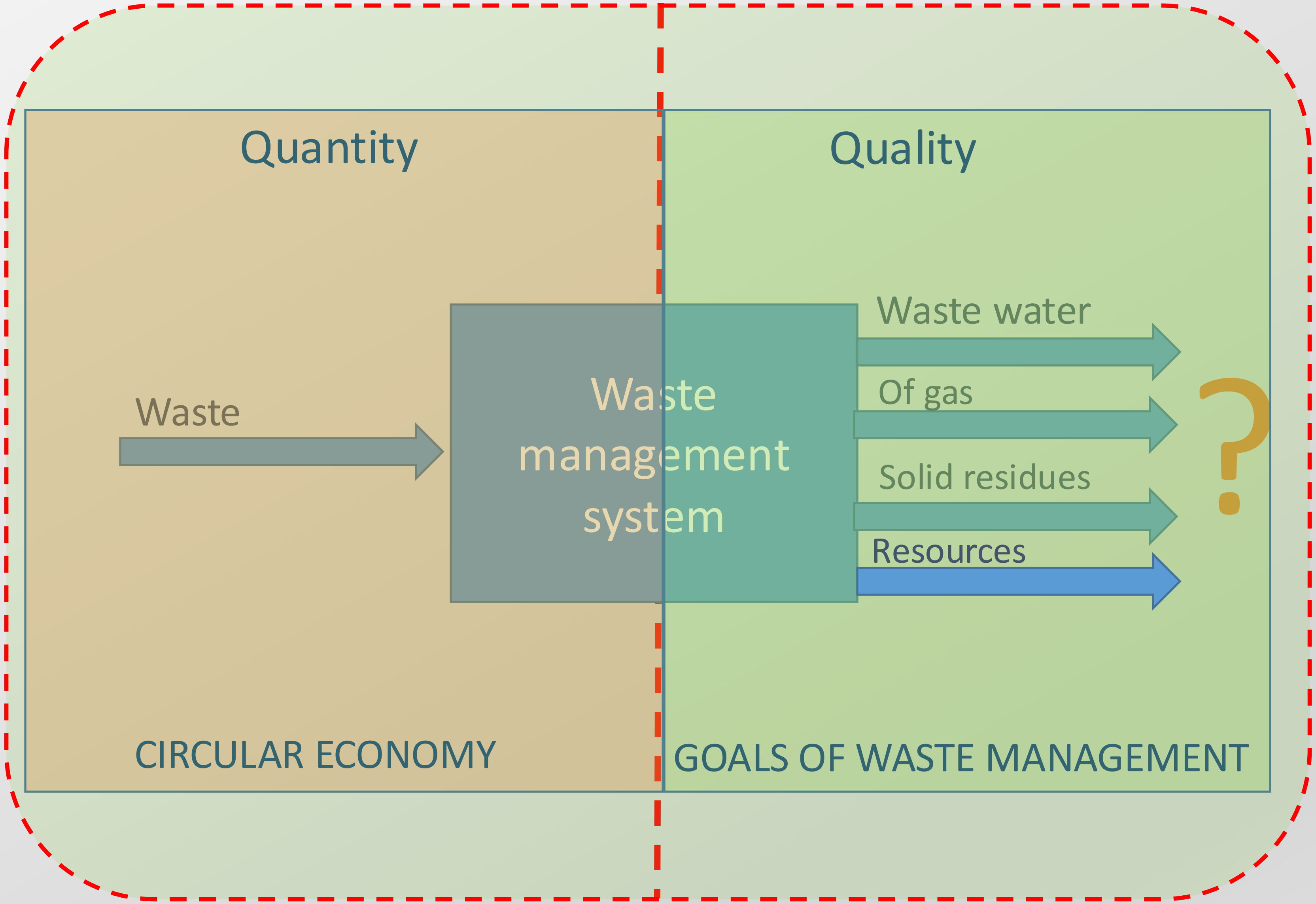


$F5 = F1 + F2 - F3 - F4$

Determination of unknown flows

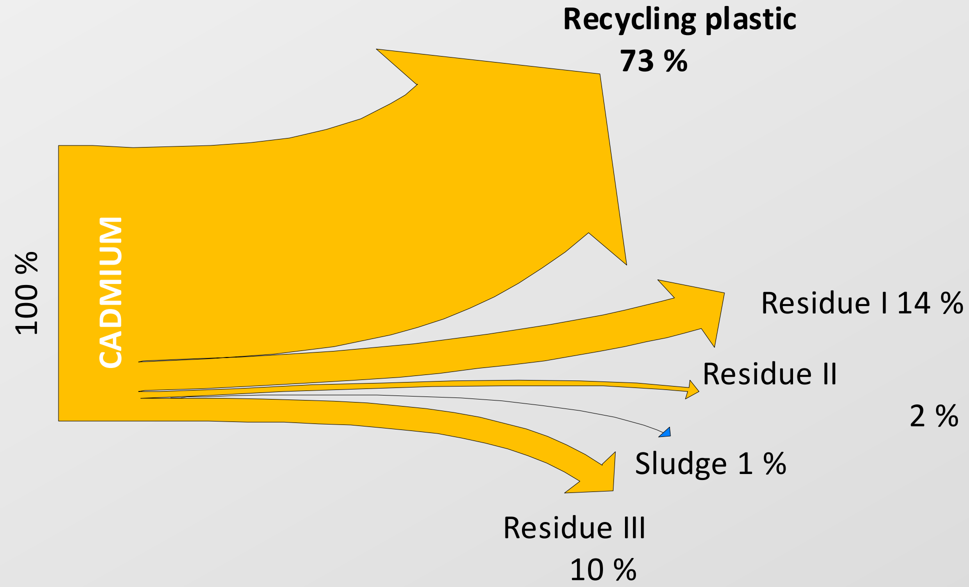
Known flows   Unknown flows

Waste management in material based societies

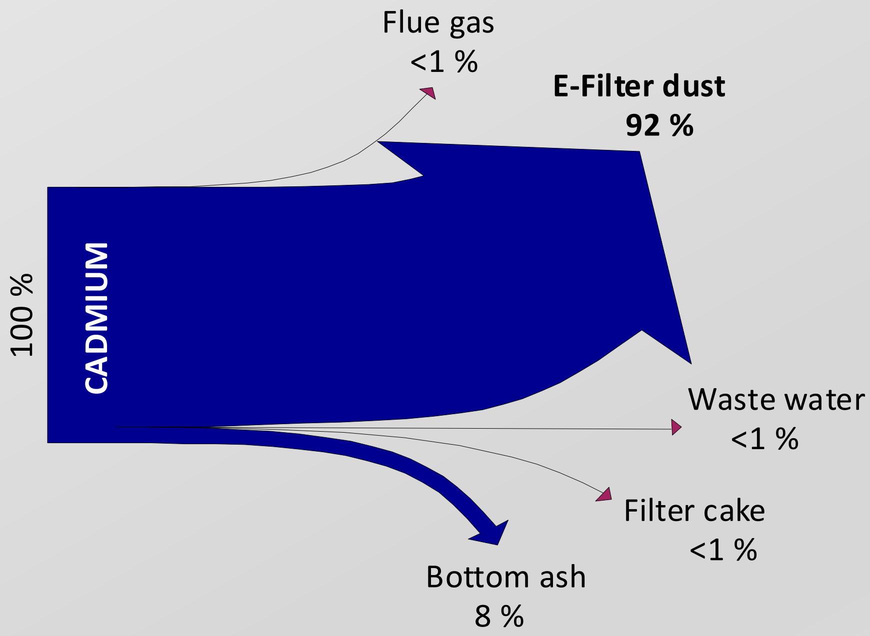


Recycling VS incineration

Plastic recycling



MSW incineration



Brunner 2011

Thermal treatment - integral part of CE

- Modern thermal treatment facilities with *effective air pollution control systems* are appropriate sinks for many *organic and inorganic substances*. They fulfil the goals of waste management and provide excellent *destination for non recyclables in CE*.

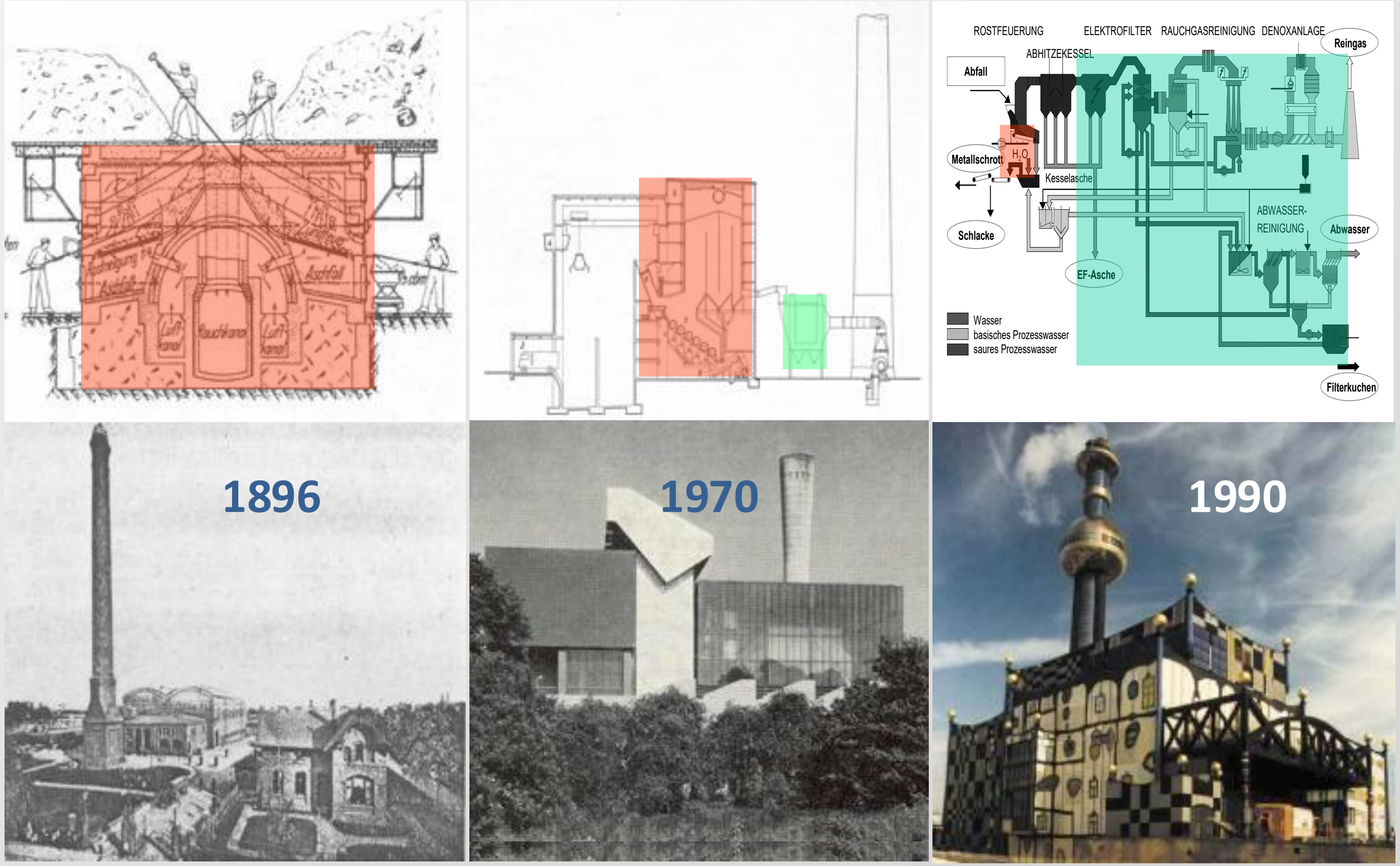
PBDE/BFRs in Videotapes (Hirai et al, BFR 2007)

PBDE in children toys (Chen et al, ES&T, 2009)

PBDEs in coffee cups (J. Samsonek & F. Puype, FAC, 2013)

Brunner 2011

Advanced incineration



Brunner 2016

The advantages of integrating WtE in CE strategies are:

- **Final destination for hazardous substances**: State-of-the-art incinerators are excellent sinks for most hazardous organic sub- stances. Organic pollutants are mineralised and converted to non-hazardous substances such as CO_2 and H_2O. Inorganic residues from WtE are much more suitable for a following immobilisation step than the original waste. For CO2 from WtE, carbon capturing is being investigated at present and might become feasible and economic soon.
- **Contribution to clean cycles:** WtE is the only means of waste management capable of extracting and concentrating highly diluted hazardous substances in a comparatively small amount of residues.
- **Advanced recycling**: Bottom ash and air pollution control (APC) residues have become new sources of secondary metals. Several valuable materials such as iron, aluminium, copper and even gold are concentrated in bottom ash and can be extracted. In addition, heavy metals such as zinc can be recovered from APC residues. Such advanced processes are already established and in use in a few pioneering countries such as Japan and Switzerland.

Stanisavljevic and Brrunner 2021

Clean circular economy!

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