The role of incineration in circular economy?

- Eastern Serbia example -

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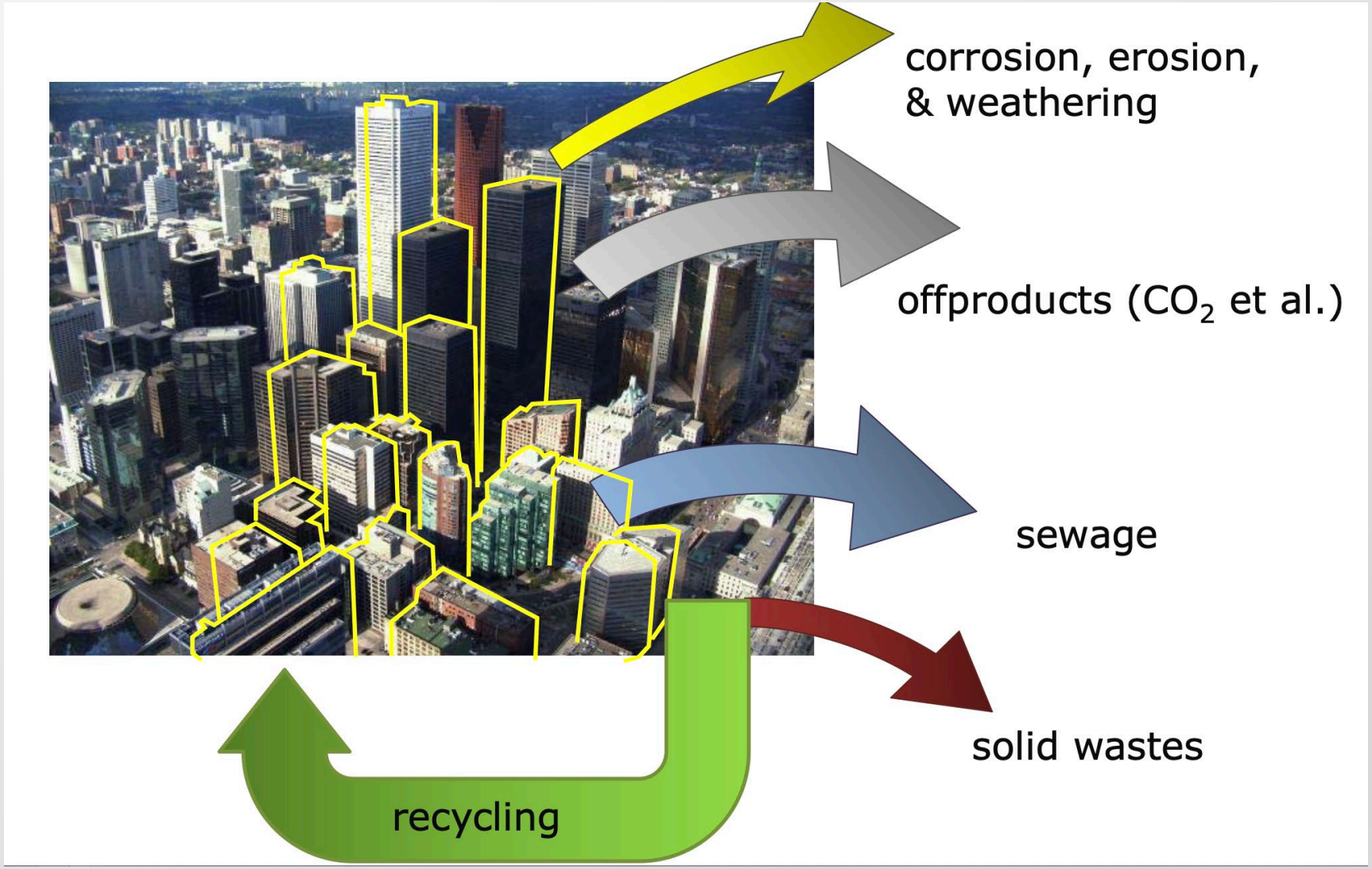
In 1848, August Wilhelm von Hofmann, the first president of the Royal Society of Chemistry and a pioneer in circular economy (CE), stated:

'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!

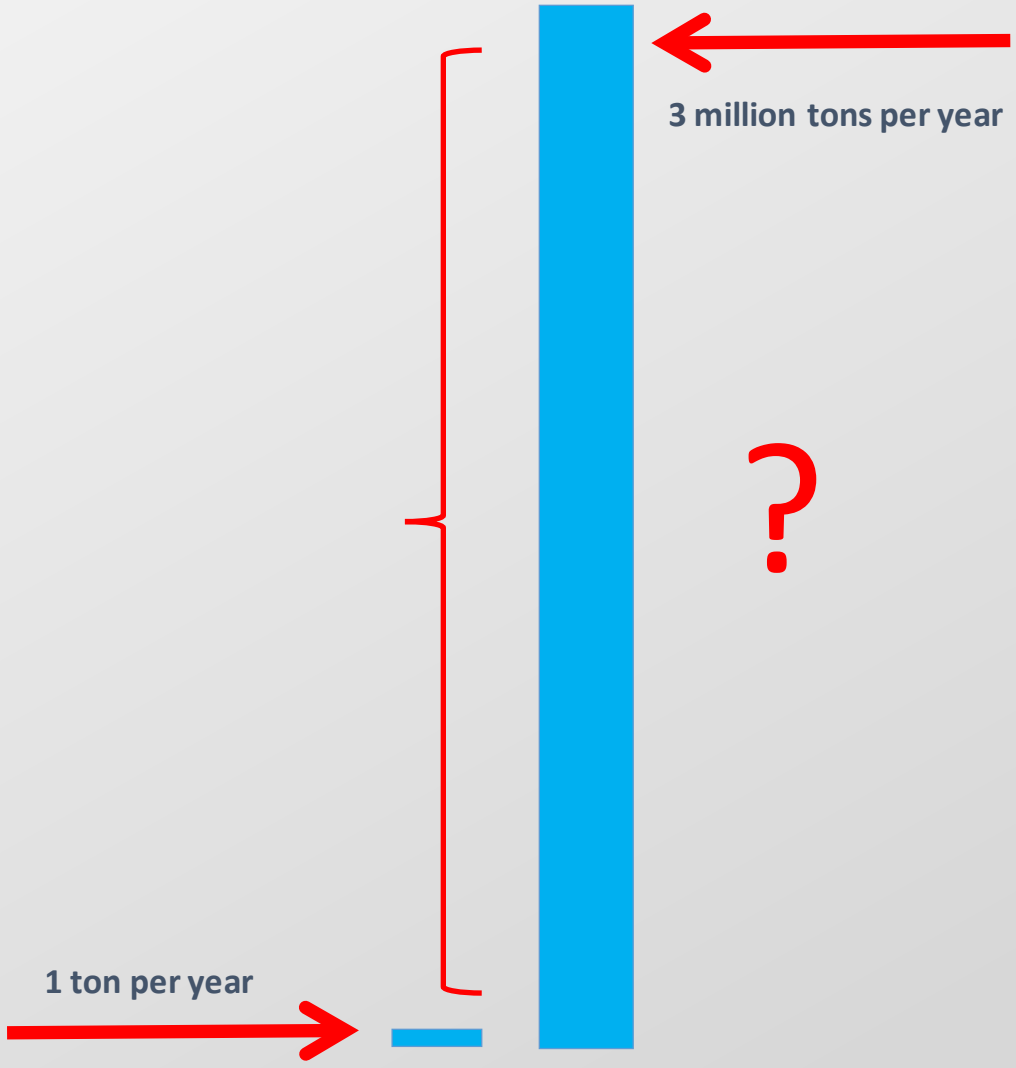
In a circular economy resource use is improved by minimising the extraction of natural resources, maximising waste prevention, and optimising the environmental, social, material and economic values throughout the lifecycles of materials, components and products.

Antropogenic metaboslim



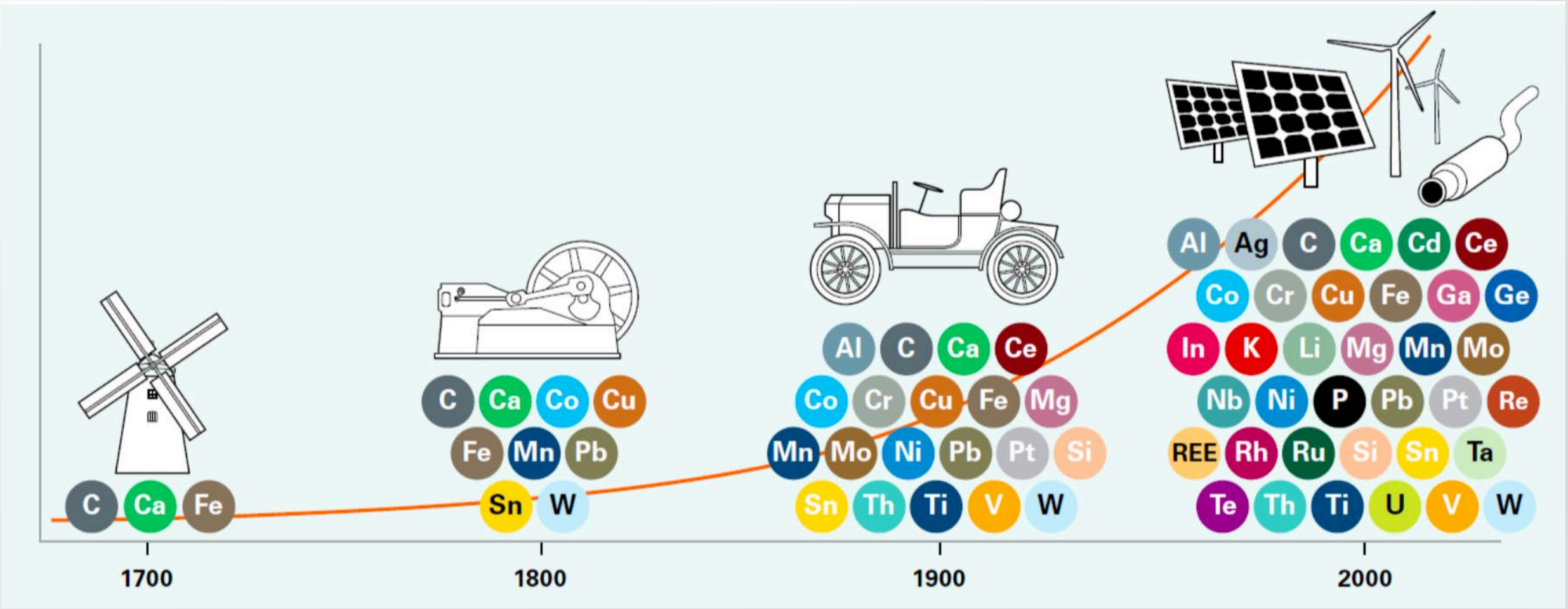
Velentuf and Purnel 2021

Lead?

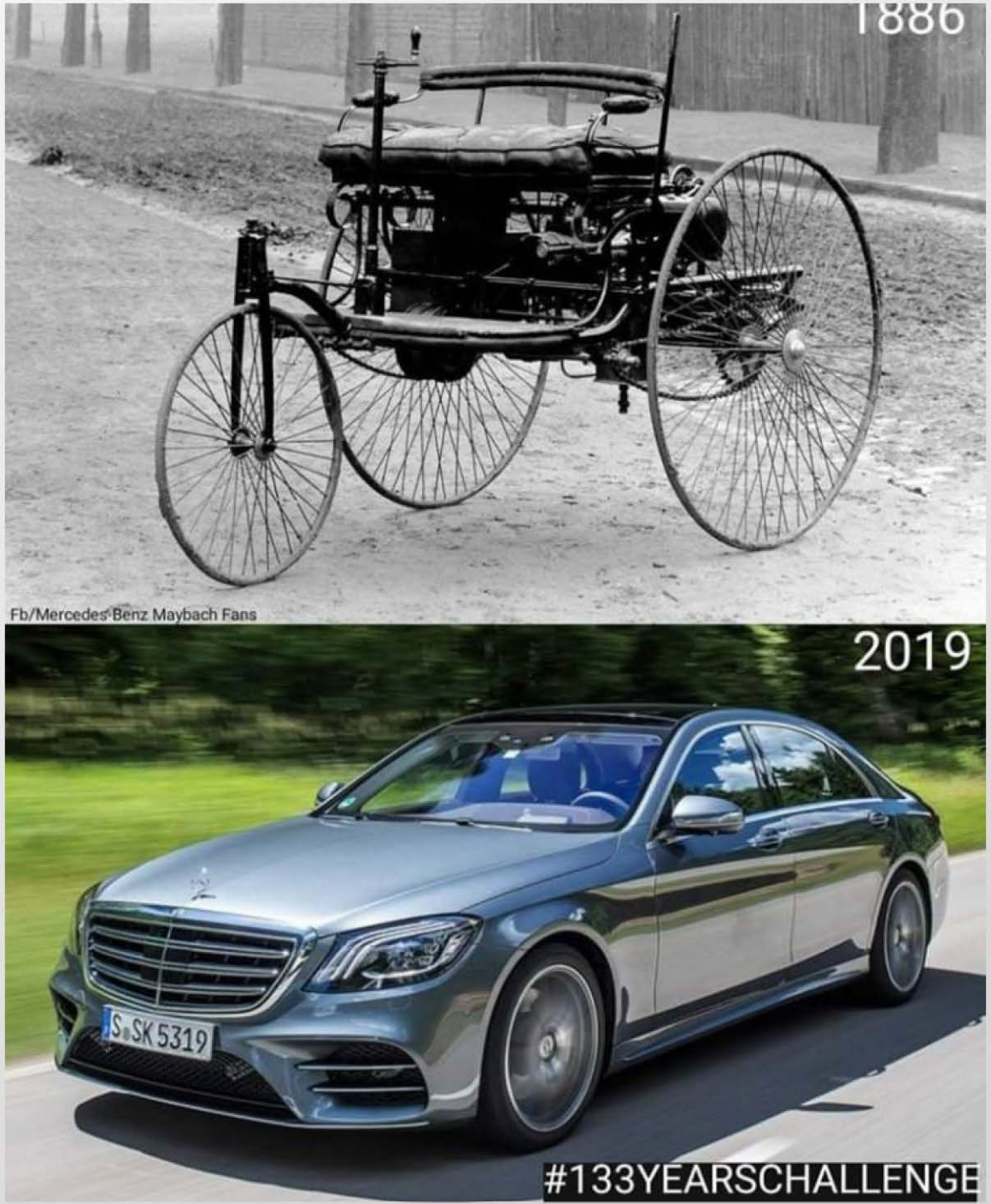


Settle and Patterson 1980

..more and more complex products



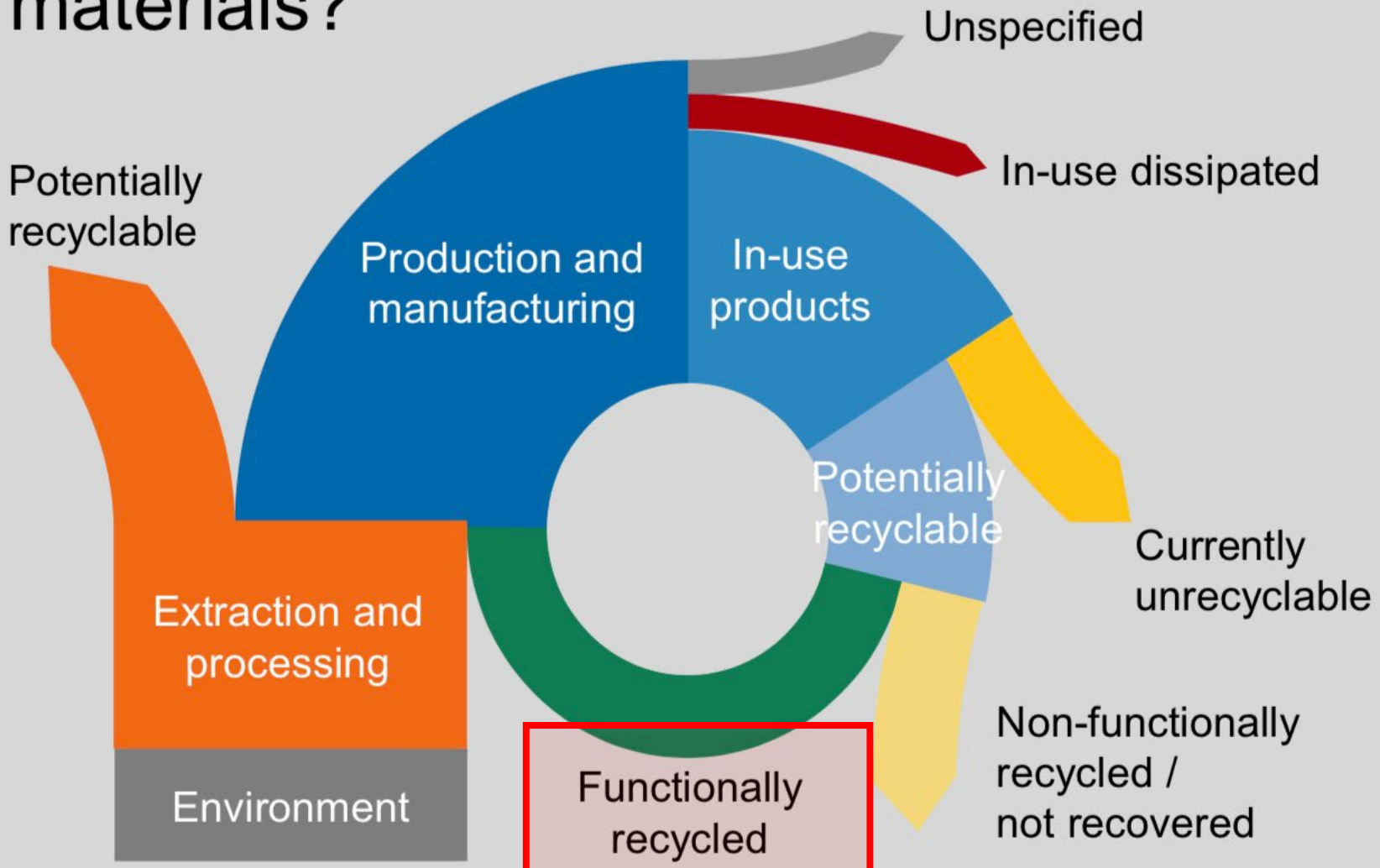
Source: Achzet et al (2009)


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

From a linear economy …

… to a circular economy

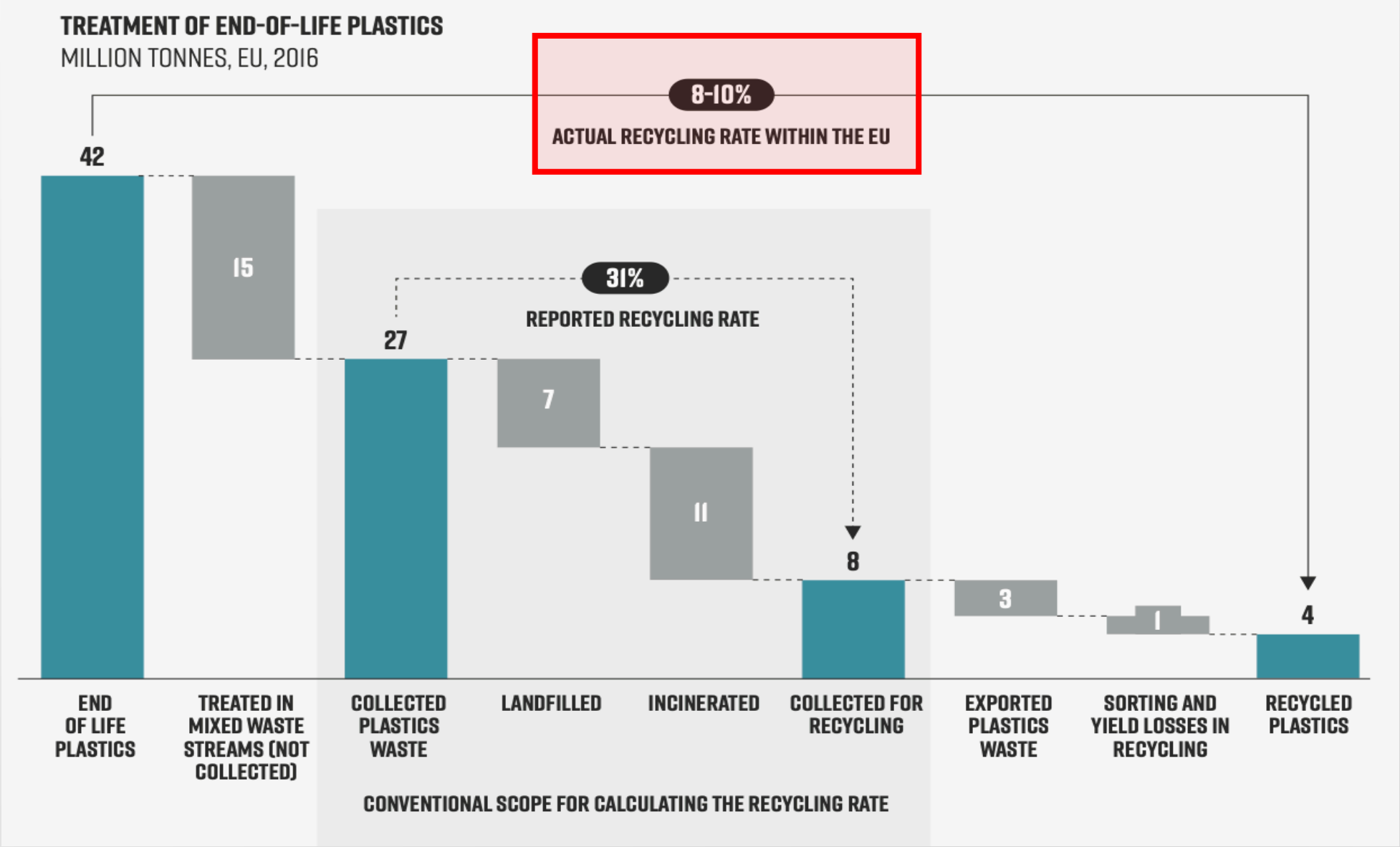
Where are recovery potentials for materials?



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.

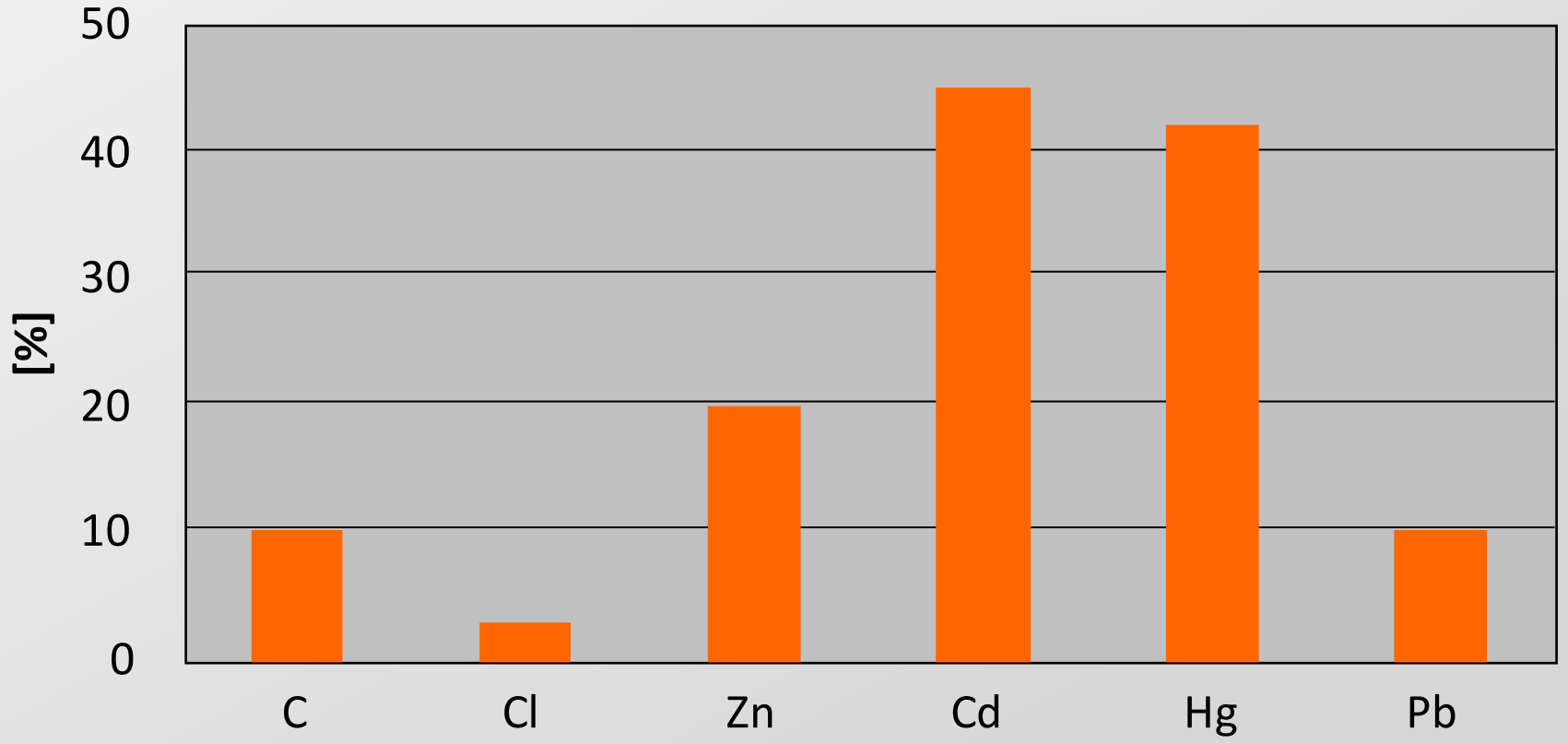
?

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)

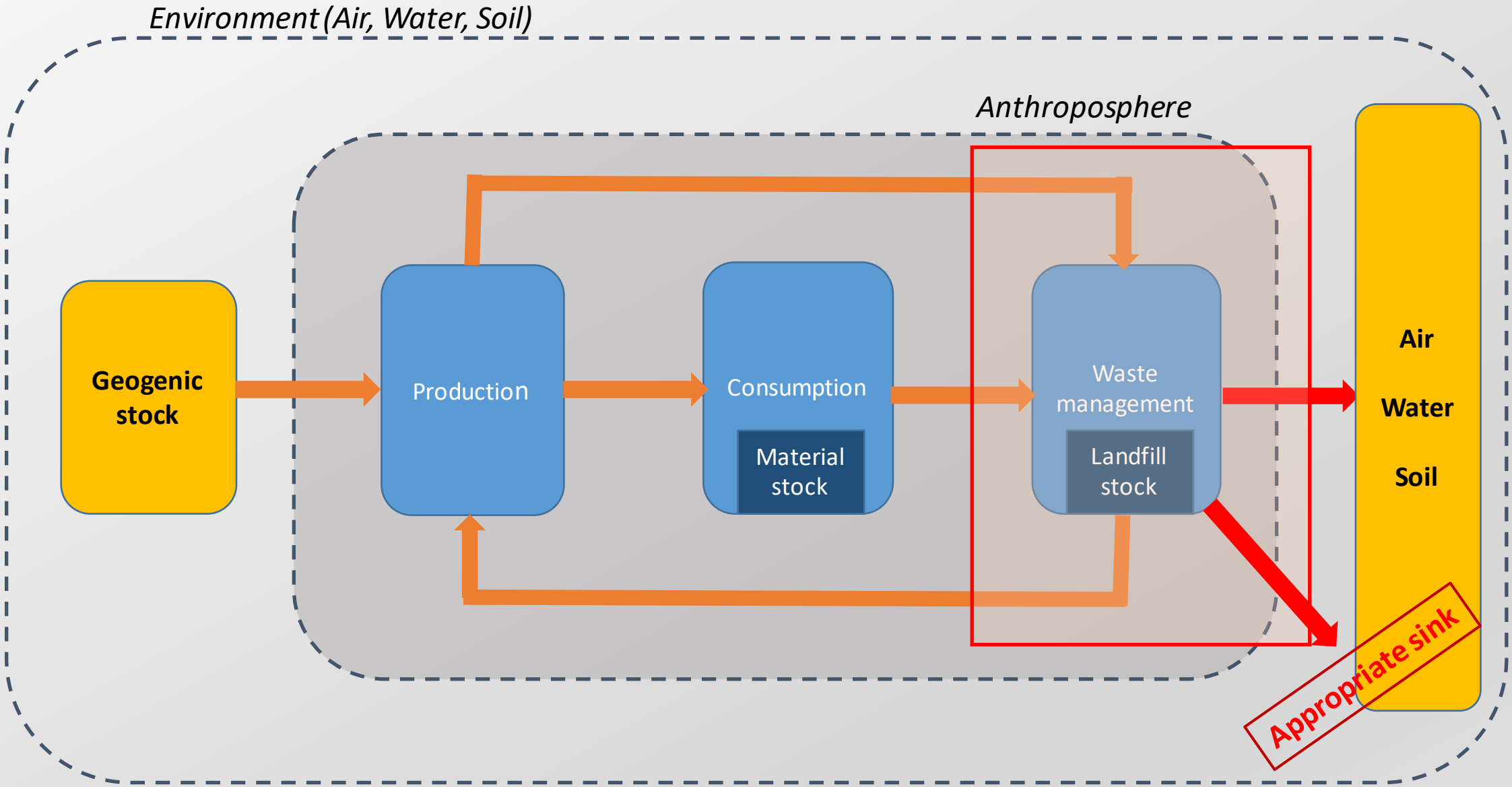
„Economic boundaries = Affordability of waste management“

Practical implications of circular economy goals?

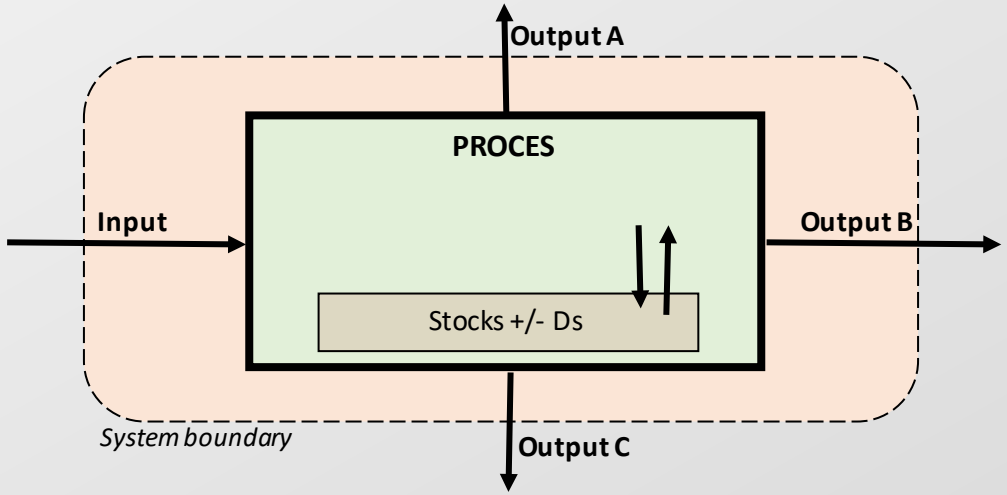
- Clean materials suitable for recycling and recovery
- Stable materials for landfilling without long term negative environmental implications
- Emissions in compliance with environmental standards with not impact on the natural balance (geogenic concentrations and loads)

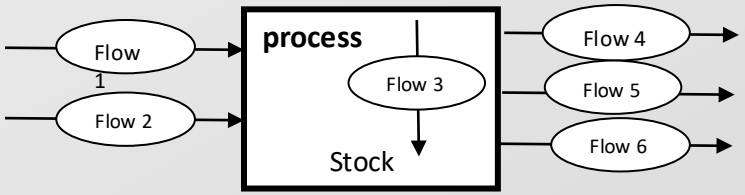
Stanisavljevic & Brunner (2021)

Why is waste management important



MFA – Basic principles





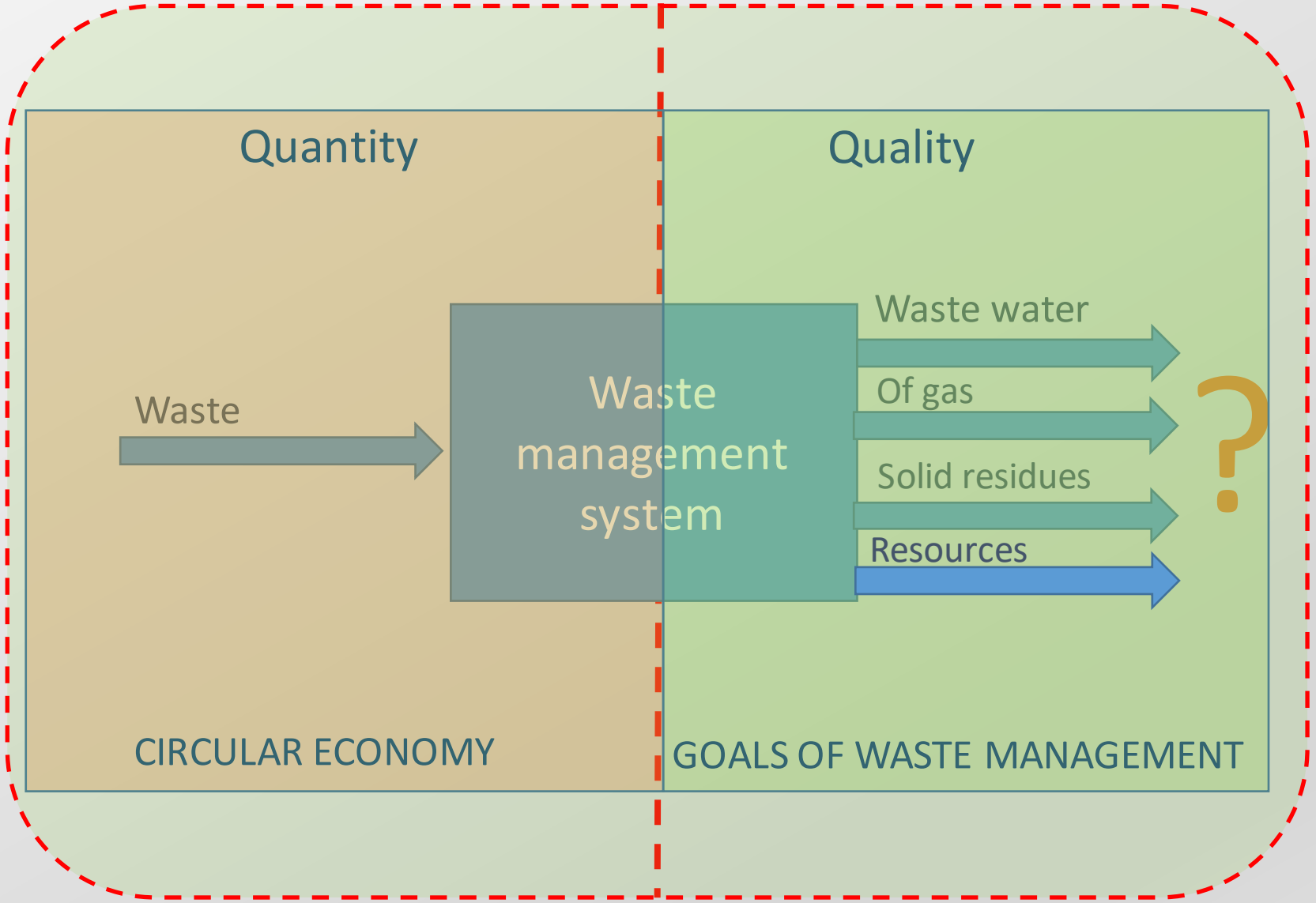
$F1 + F2^{?} = F3 + F4 + F5 + F6$
Control mehanism

$F5 = F1 + F2 - F3 - F4$
Determination of unknown flows

Known flows

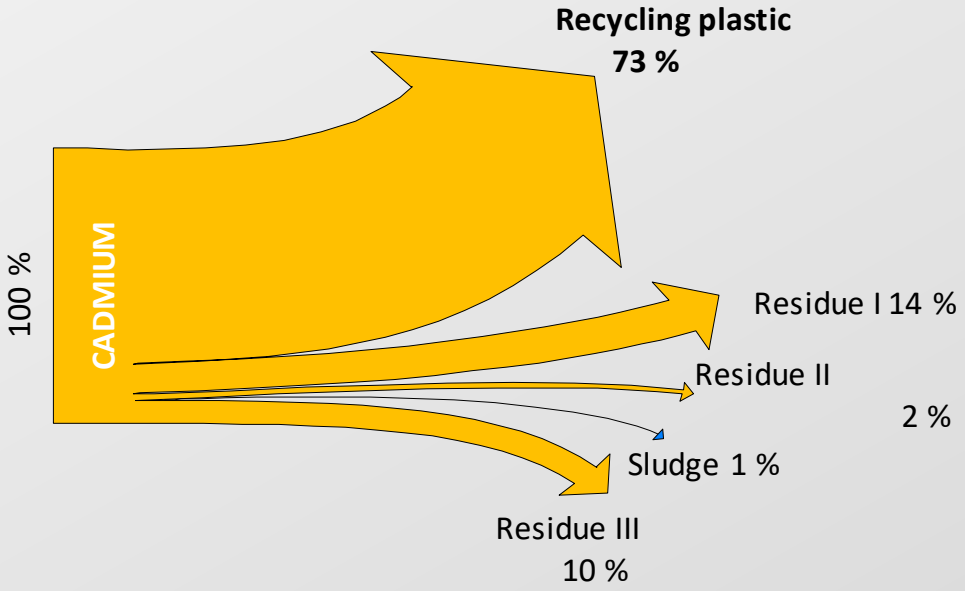
Unknown flows

Waste management in material based societies

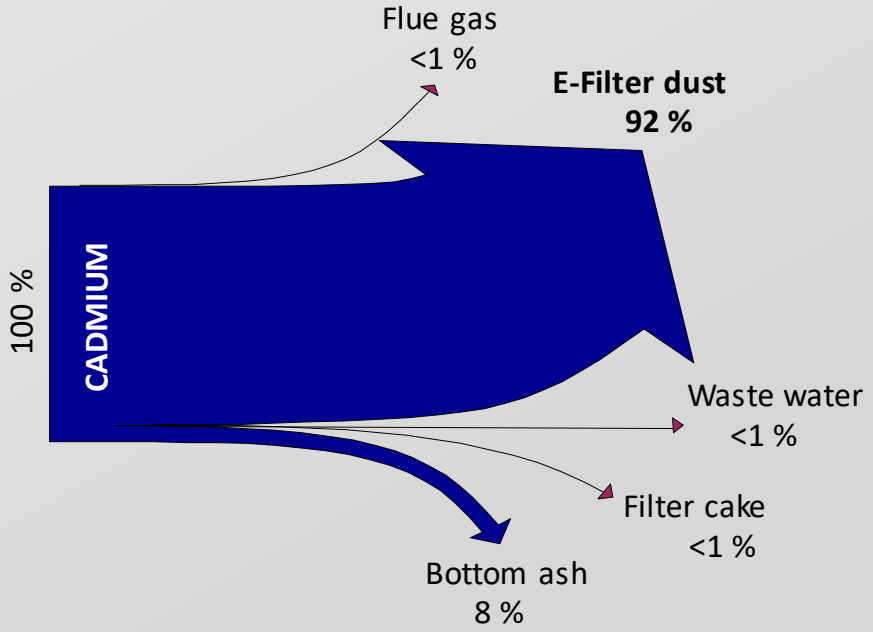


Recycling VS incineration

Plastic recycling



MSW incineration



Brunner 2011

Incineration - integral part of CE

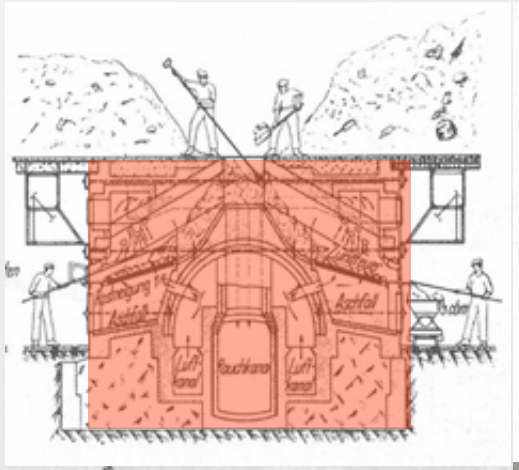
- Modern incinerators with *effective air pollution* control systems are appropriate sinks for many *organic and inorganic substances*. They fulfil the goals of waste management and provide excellent *destination for non recyclables in CE*.

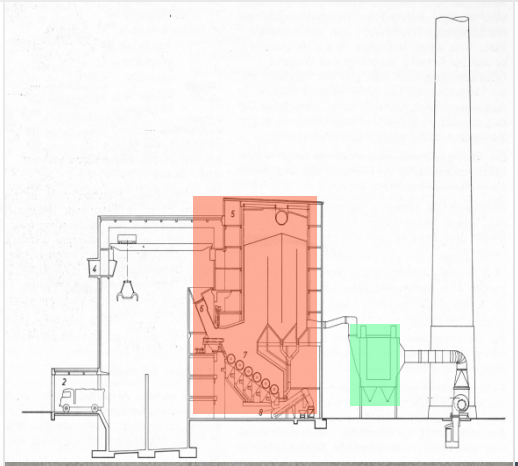
PBDE/BFRs in Videotapes (Hirai et al, BFR 2007)

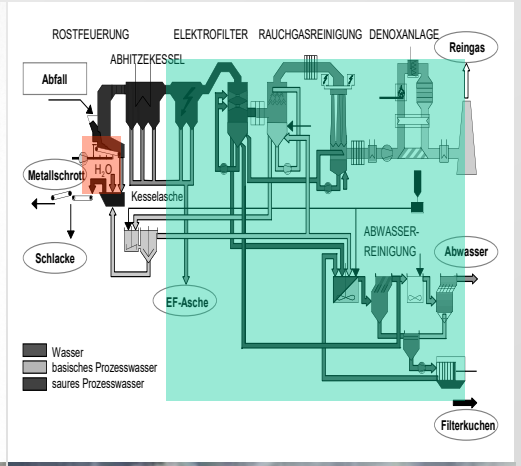
PBDE in children toys (Chen et al, ES&T, 2009)

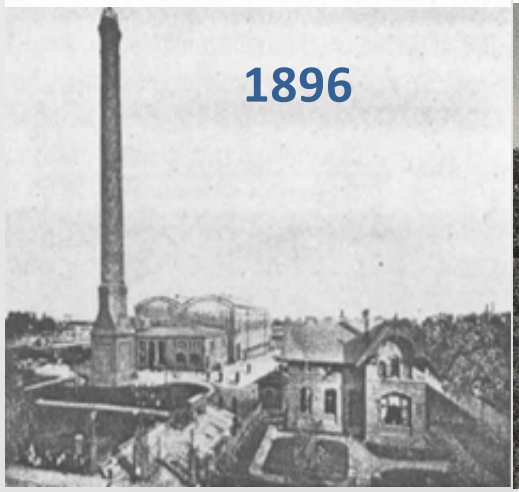
PBDEs in coffee cups (J. Samsonek & F. Puype, FAC, 2013)

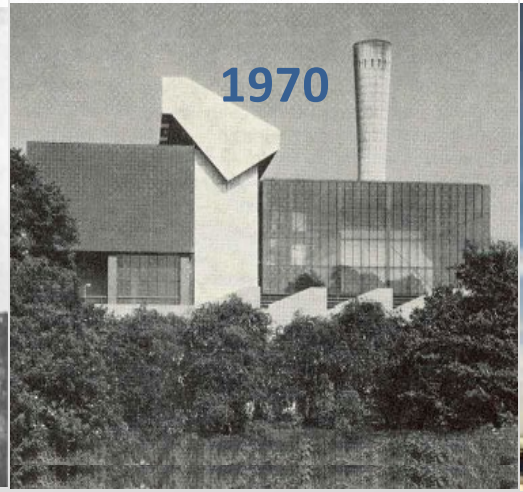
Advanced incineration











Brunner 2016

The advantages of integrating WtE in CE strategies are:

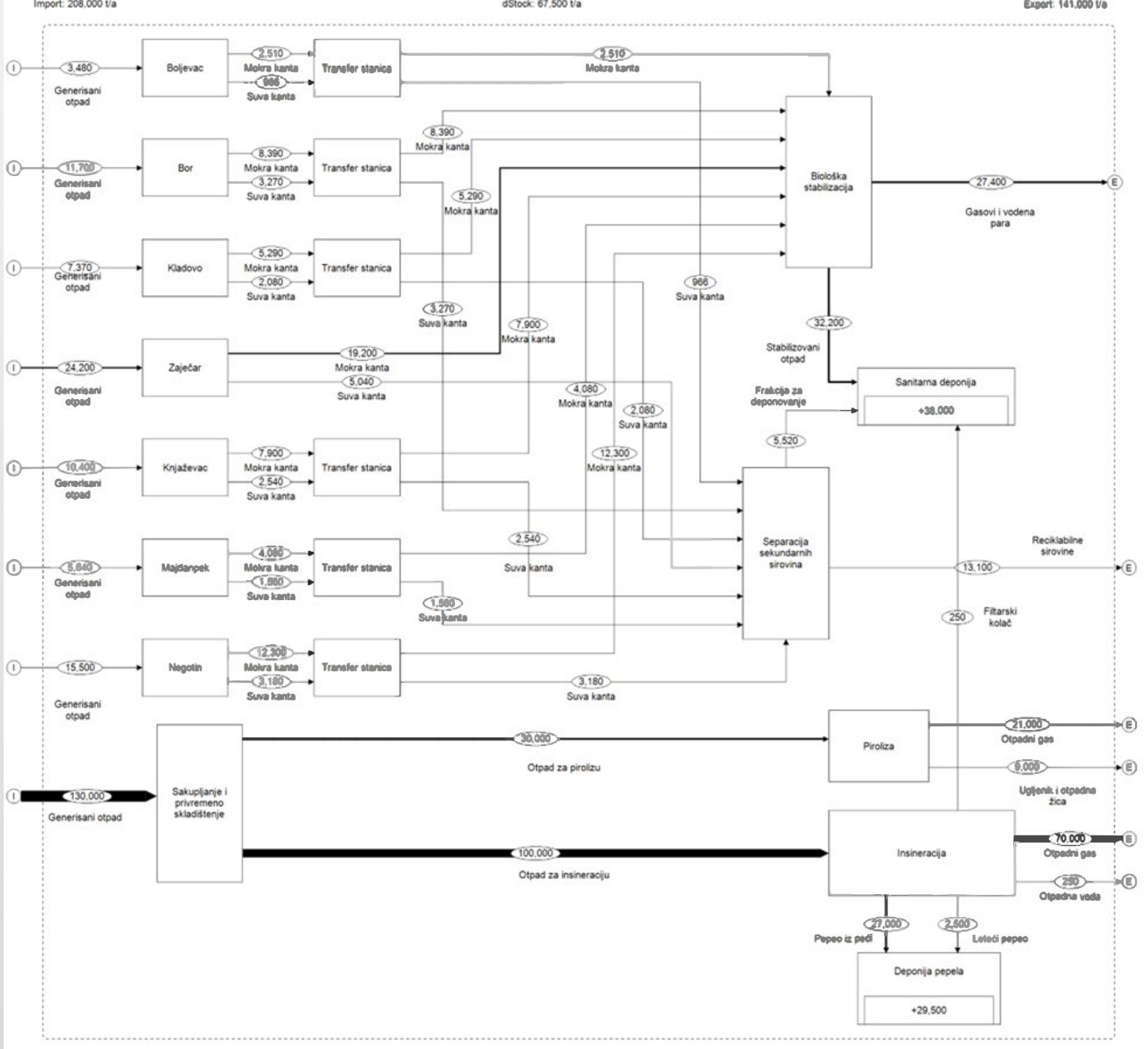
- **Final destination for hazardous substances**: State-of-the-art incinerators are excellent sinks for most hazardous organic sub- stances. Organic pollutants are mineralised and converted to non-hazardous substances such as CO_2 and H_2O. Inorganic residues from WtE are much more suitable for a following 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.


SAKUPLJANJE
OTPADA
REGIONALNI CENTAR
ZA TERMIČKI
TRETMAN NEOPASNOG
I OPASNOG
OTPADA I OTPADNE
GUME

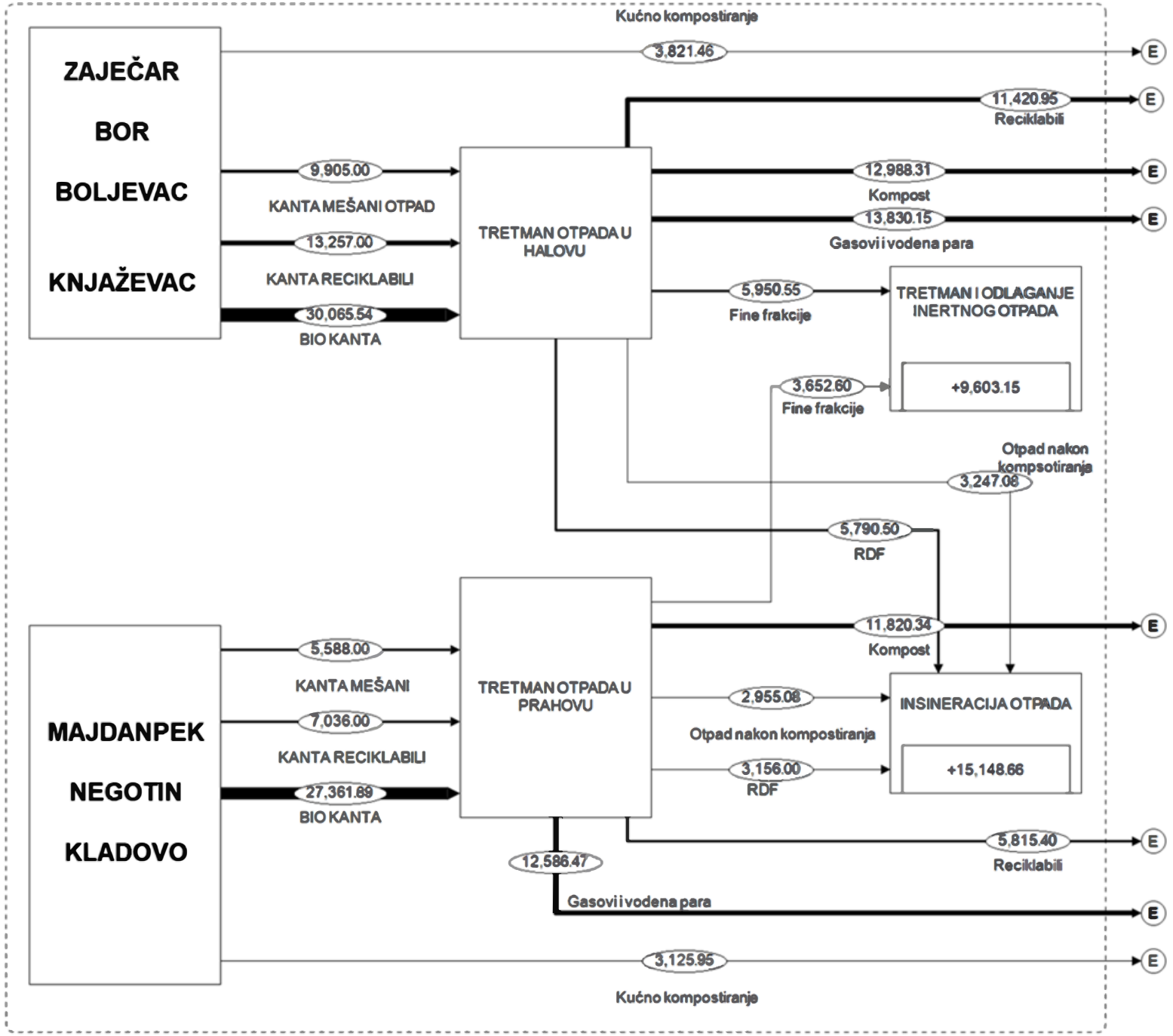
Udaljenosti (km) opština od Halova i Prahova

Grad/Opština	Regionalni centar za upravljanje komunalnim otpadom „Halovo“	„Elixir“ Prahovo
Zaječar	16	65
Boljevac	53	100
Bor	41	82
Kladovo	103	58
Majdanpek	94	83
Negotin	52	10
Knjaževac	54	103

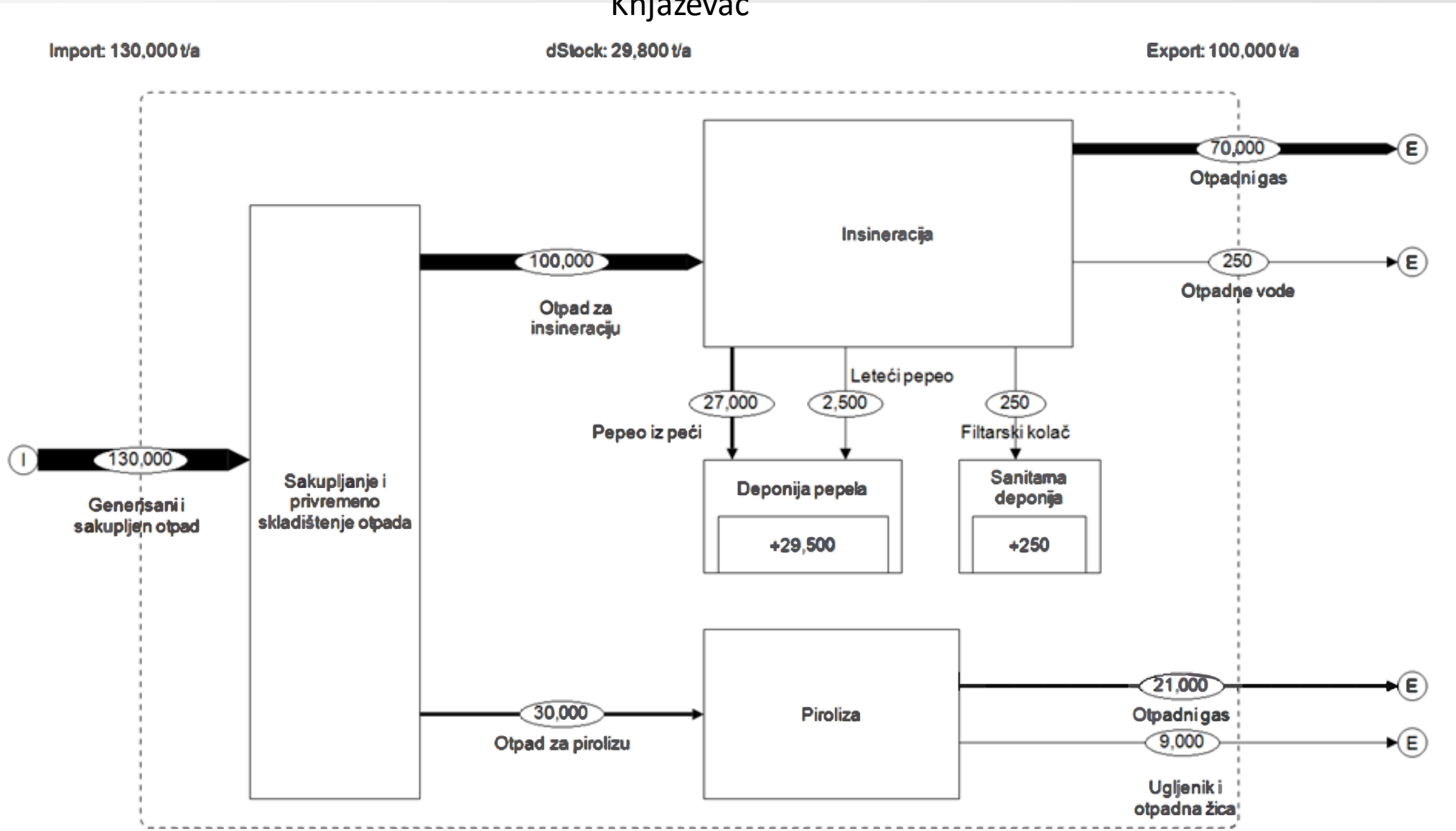
Analiza tokova materijala Opcija sa kompostiranjem i izgradnjom postrojenja za termički tretman otpada i pirolizu guma, svaka opština ima svoju transfer stanicu, t/god



Model sakupljanja u tri kante uz povećan obuhvat sakupljanja otpada na 100% uz projekcije količina otpada do 2030. godine i implementiran tretman otada u Halovu i Prahovu, t/god



Analiza tokova materijala za termički tretman otpada za grad Zaječar i opštine Boljevac, Bor, Kladovo, Majdanpek, Negotin i Knjaževac



Clean circular economy!

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