Objectives and Knowledge Base for Waste Management in Transformation

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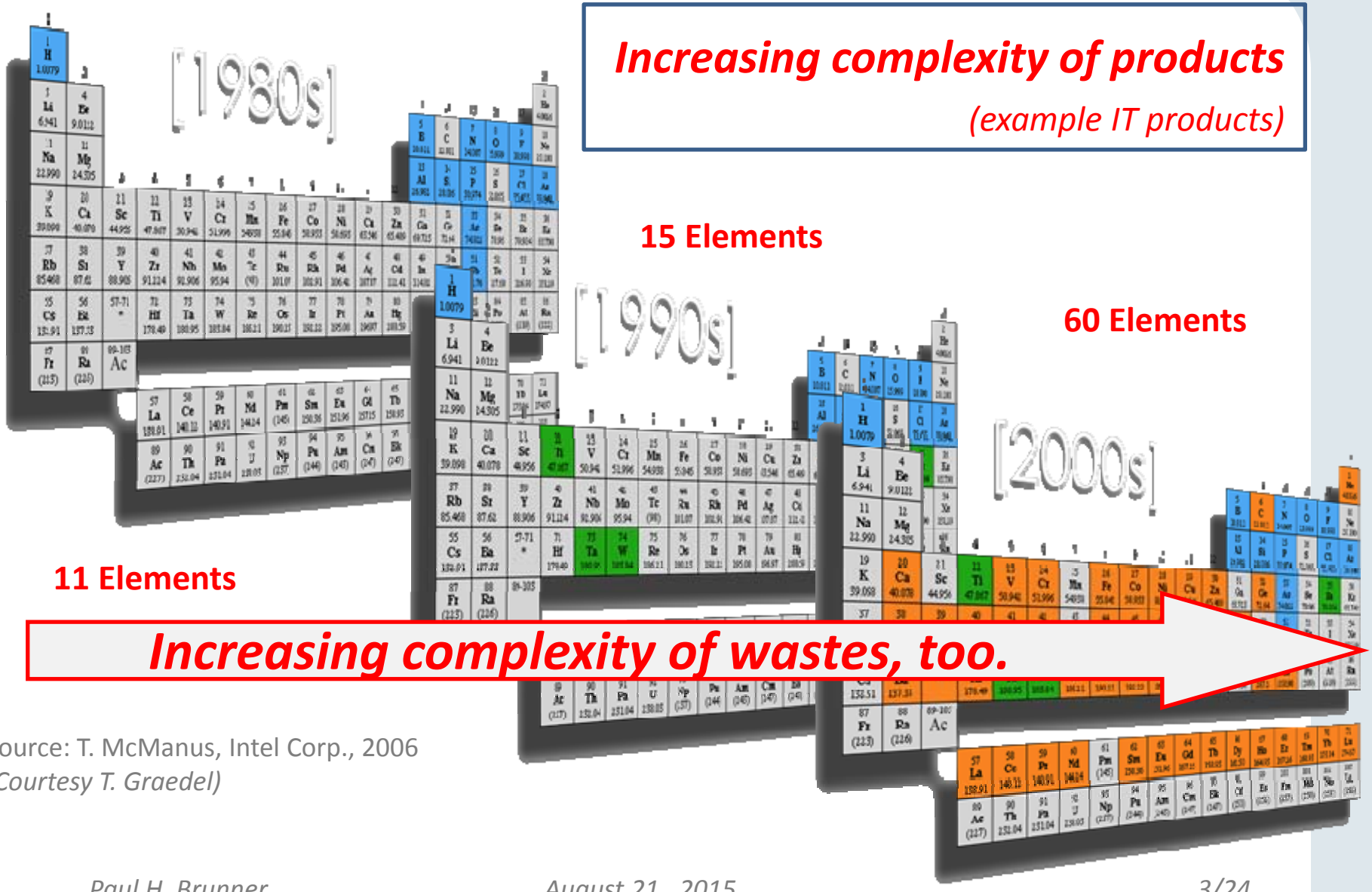
What is a “knowledge base” for waste management?

” information necessary to design a waste management system”

1. Goals of waste management
2. Economic Potential (GDP)
3. Waste characteristics
4. Treatment process characteristics
5. Regional properties
6. Waste management costs (collection, treatment, revenues)
7. Stakeholder issues

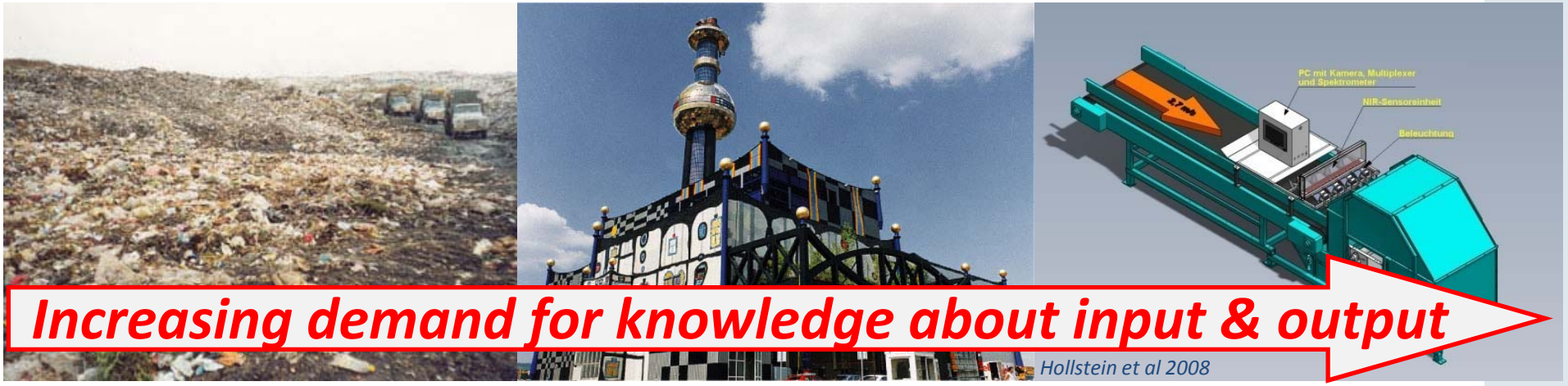
Why do we need a new knowledge base (I)?



Source: T. McManus, Intel Corp., 2006
(*Courtesy T. Graedel)*

Why do we need a new knowledge base II?

Increasing high-tech waste treatment and processing



Increasing demand for knowledge about input & output

Hollstein et al 2008

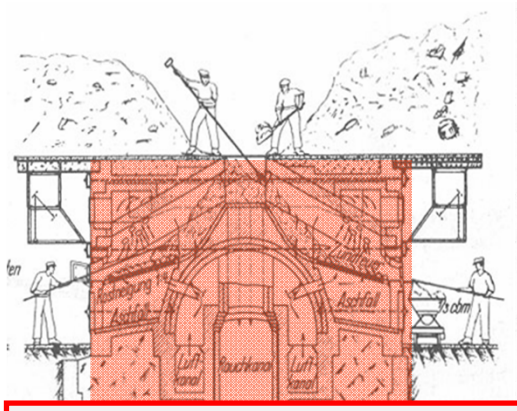
- volume
- mass
- water content
- hazards

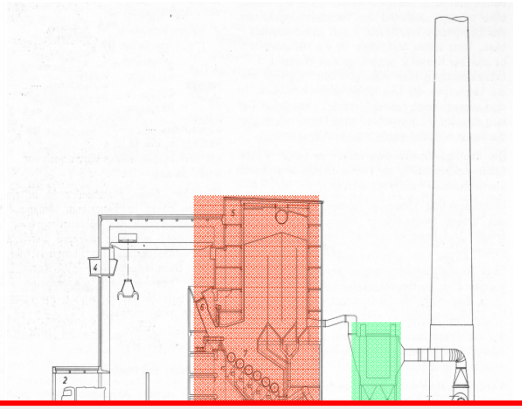
- mass
- energy content
- C, H, N,
- Hg, Cd, Cl, PCBs,
- $C_{biogenic}$,
- etc.

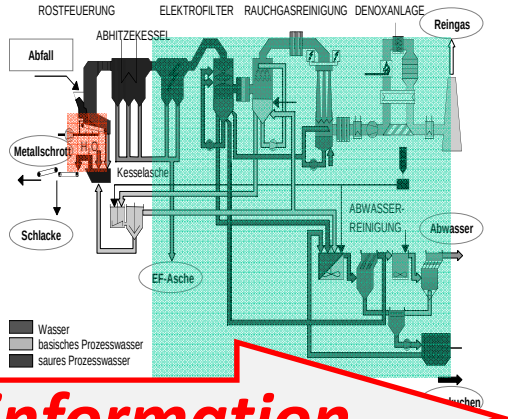
- mass, density, volume
- C, Cl,
- polyethylene, PVC
- Fe, Cu, Sb, Cd, Pb,
- PBDEs
- etc.

Why do we need a new knowledge base III?

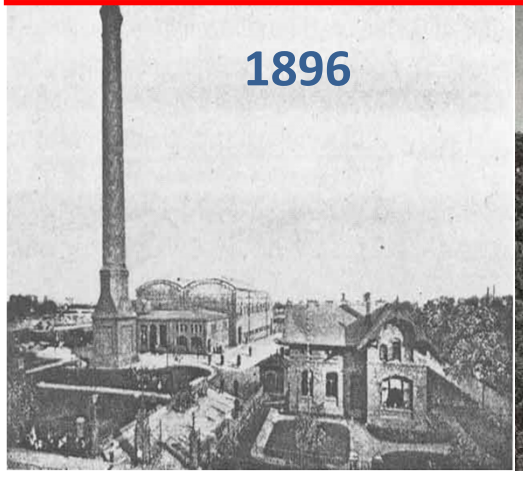
Increasing environmental constraints *(example incineration)*







Increasing demand for process information



1. Goals of waste management

General and global goals :

- Protection of human health and environment
- Resource conservation
- After care free wm (-> sustainability)

regionally appropriate means

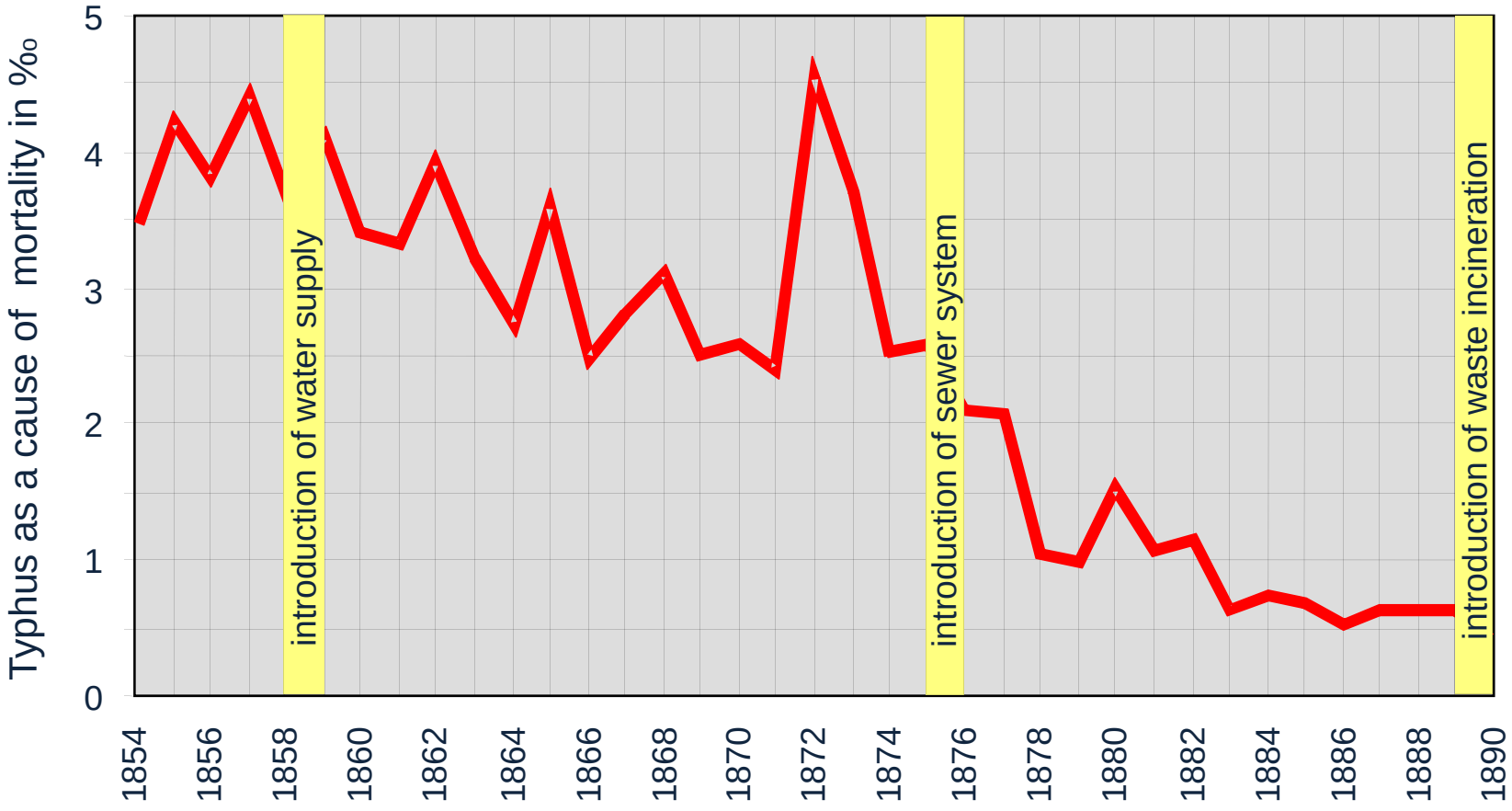
EU: prevention – recycling – disposal

Bangla Desh: disposal – recycling - prevention

-> Copy of EU "waste hierarchy" not appropriate!

To set and reach social goals takes time and efforts!

Decrease of Typhoid fever mortality in Germany from 1854 to 1890



Source: Hösel 1987

To reach goals requires consensus and time

- Consensus finding process among all stakeholders

- Long term issue!

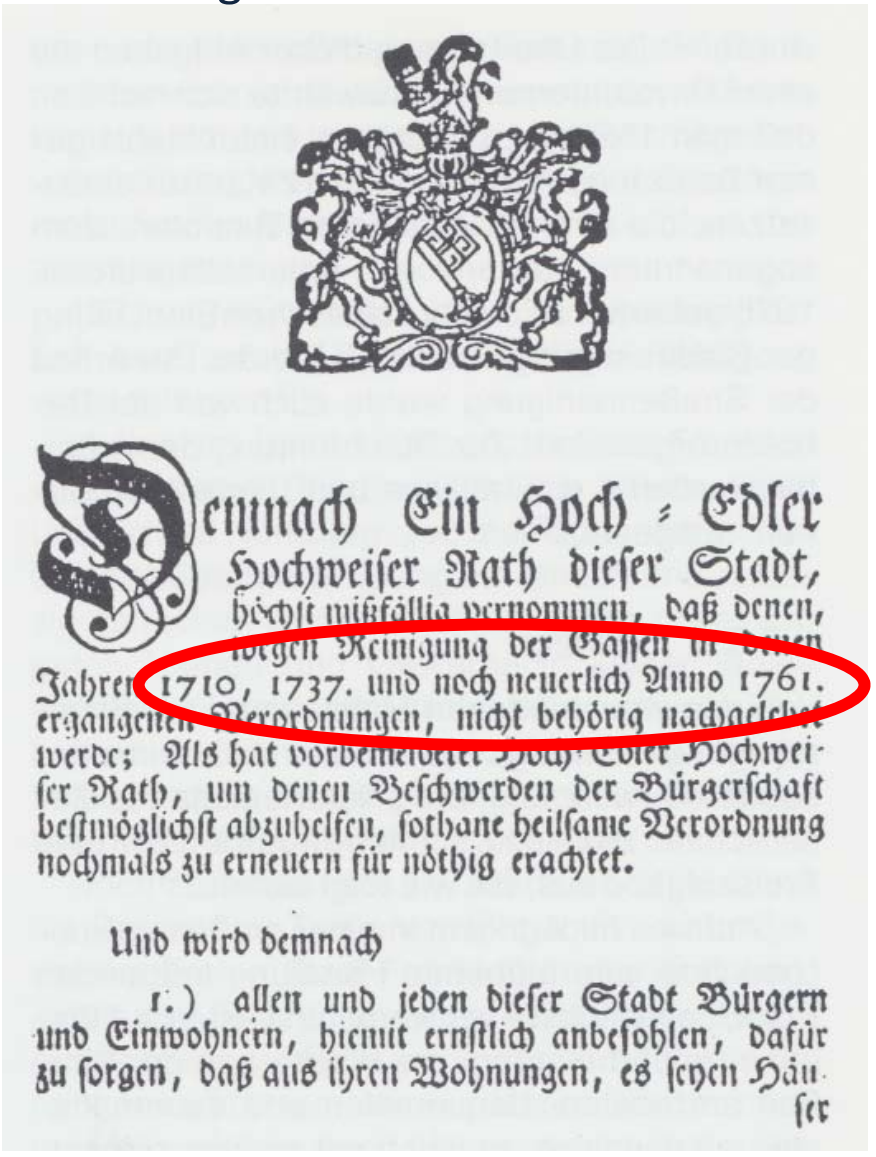
1710

↓

1737

↓

1761



Demnach Ein Hoch-Edler
Hochweiser Rath dieser Stadt,
höchst mißfällig vernommen, daß denen,
wegen Reinigung der Gassen in denen
Jahren 1710, 1737. und noch neuerlich Anno 1761.
ergangenen Verordnungen, nicht behörig nachgelebt
werde; Als hat vorbemeldeter Hoch-Edler Hochweiser Rath, um denen Beschwerden der Bürgerschaft bestmöglichst abzuhelfen, sothane heilsame Verordnung nochmals zu erneuern für nöthig erachtet.

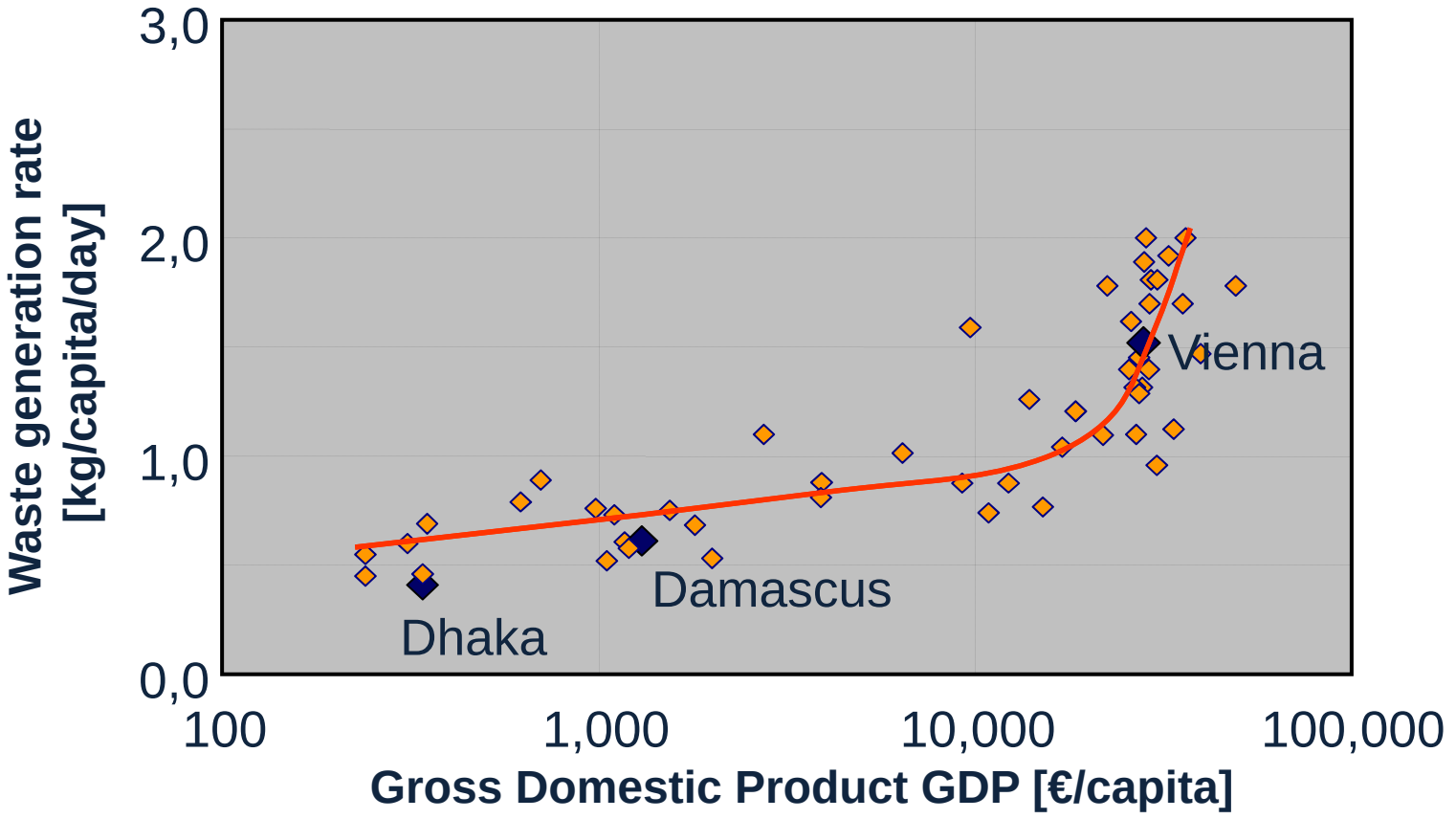
Und wird demnach

1.) allen und jeden dieser Stadt Bürgern und Einwohnern, hiemit ernstlich anbefohlen, dafür zu sorgen, daß aus ihren Wohnungen, es seyen Häu-
ser

2. GDP and Waste Management

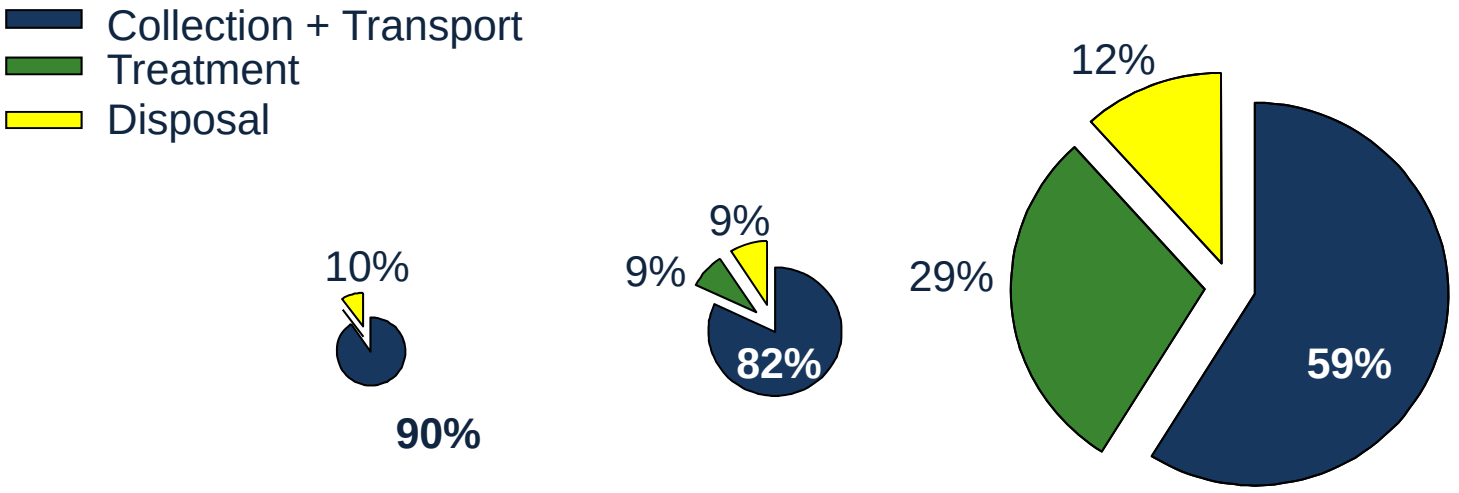
Economic activity	Budget as Fraction of GDP			
	global average [% of GDP]	from [% of GDP]		to [% of GDP]
Health care	7,5	-		-
Education	4	0,6	to	16,8
Water quality management	2,0	-		-
Military	1,7	0	to	11,4
Waste management				

GDP and waste generation



Source: Brunner & Fellner

GDP: How much are you willing to spend for wm?



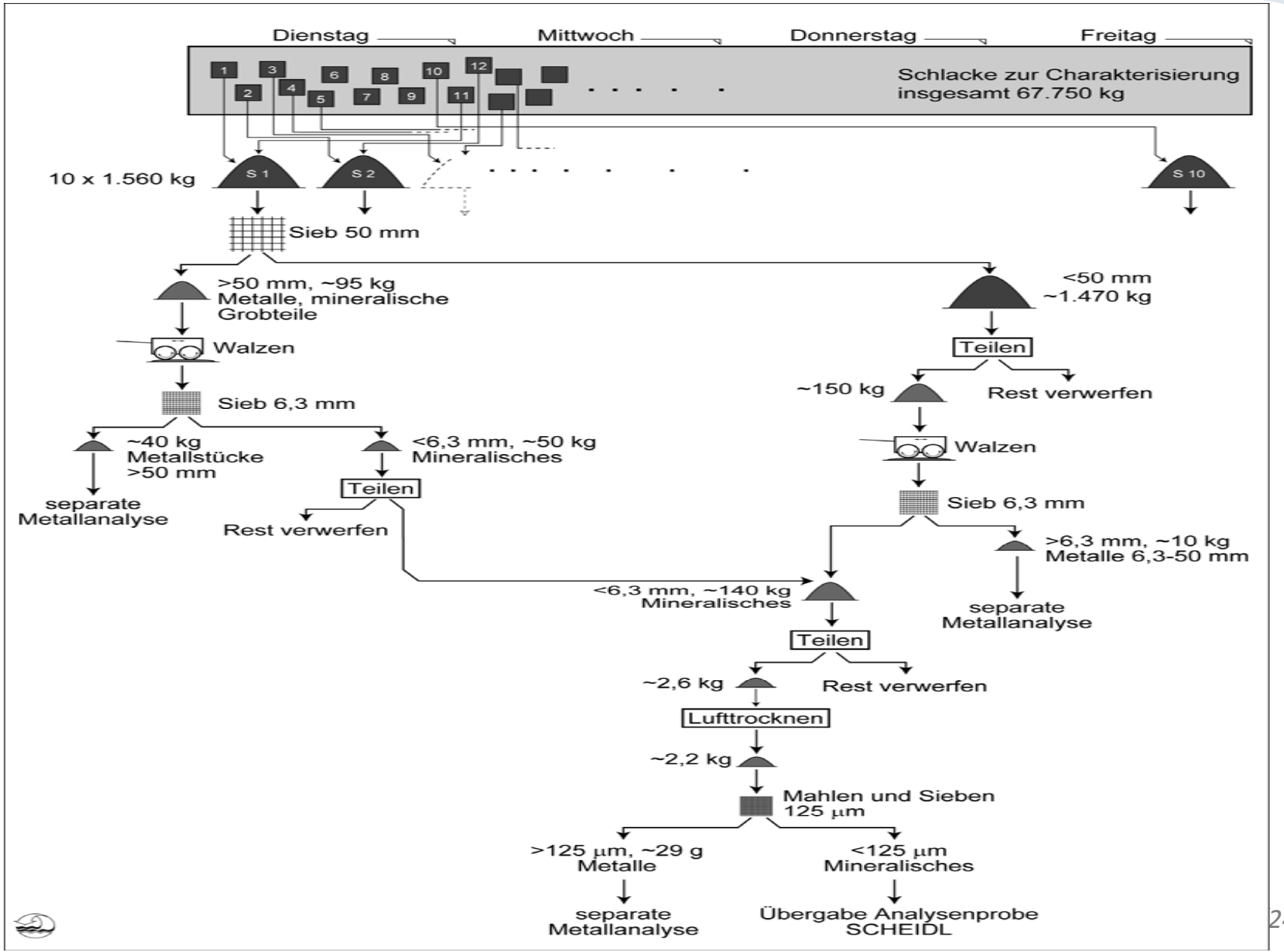
region	Dhaka (Bangladesh)	Damascus (Syria)	Vienna (Austria)
WM costs [€/c.y]	0.7	4	100
% of GDP [%]	0.2	0.3	0.4

3. Waste characterization: generation and composition

Sample #	Start Weight		Date	Recorded by	
CATEGORY	**Gross Weight**	**Container Type/Tare**	**CATEGORY**	**Gross Weight**	**Container Type/Tare**
Paper			**Other Organic**		
(a) Corrugated/Paper Bags			(a) Food		
(1) Uncoated Corrugated			(b) Yard/Landscape		
(2) Coated Corrugated			(1) Leaves/Grass		
(3) Brown Paper Bags			(2) Prunings/Trimmings		
(b) Newspaper			(3) Branches/Stumps		
(c) Office Paper			(c) Ag. Crop Residues		
(1) White Ledger			(d) Manures		
(2) Coloured Ledger			(e) Wood		
(3) Computer Paper			(f) Textiles		
(4) Other Office Paper			(g) Tires		
(d) Mixed Paper			(h) Remainder/Composite		
(1) Magazines/Catalogues			**Other Inorganic**		
(2) Phone Books/Directories			(a) Inerts		
(3) Other Mixed Paper			(1) Rock		
(e) Remainder/Composite			(2) Concrete		
Glass			(3) Brick		
(a) Clear Bottles/Containers			(4) Soil & Fines		
(b) Coloured Bottles/Containers			(5) Asphalt		
(1) Green Bottles/Containers			(6) Gypsum Board		
(2) Brown Bottles/Containers			(b) Remainder/Composite		
(c) Flat Glass			**HHW & Special Waste**		
(d) Remainder/Composite			(a) Household Hazardous		
Metal			(1) Paint		
(a) Ferrous Metals			(2) Automotive Fluids		
(1) Tin/Steel Cans			(3) Batteries		
(2) Other Ferrous			(4) Remainder/Composite		
(b) Non-Ferrous Metals			(b) Special Waste		
(1) Aluminium Cans			(1) Ash		
(2) Other Non-Ferrous			(2) Biosolids		
(c) White Goods			(3) Industrial Sludge		
(d) Remainder/Composite			(4) Treated Medical Waste		
Plastic			(5) Bulky Items		
(a) HDPE			(6) Remainder/Composite		
(1) Natural HDPE			**Mixed Residue**		
(2) Coloured HDPE			**Comments:**		
(b) PET					
(c) Film Plastic					
(d) Other Plastic					
(1) PVC					
(2) PP					
(3) PS					
(e) Remainder/Composite			(continue on reverse side if needed)		

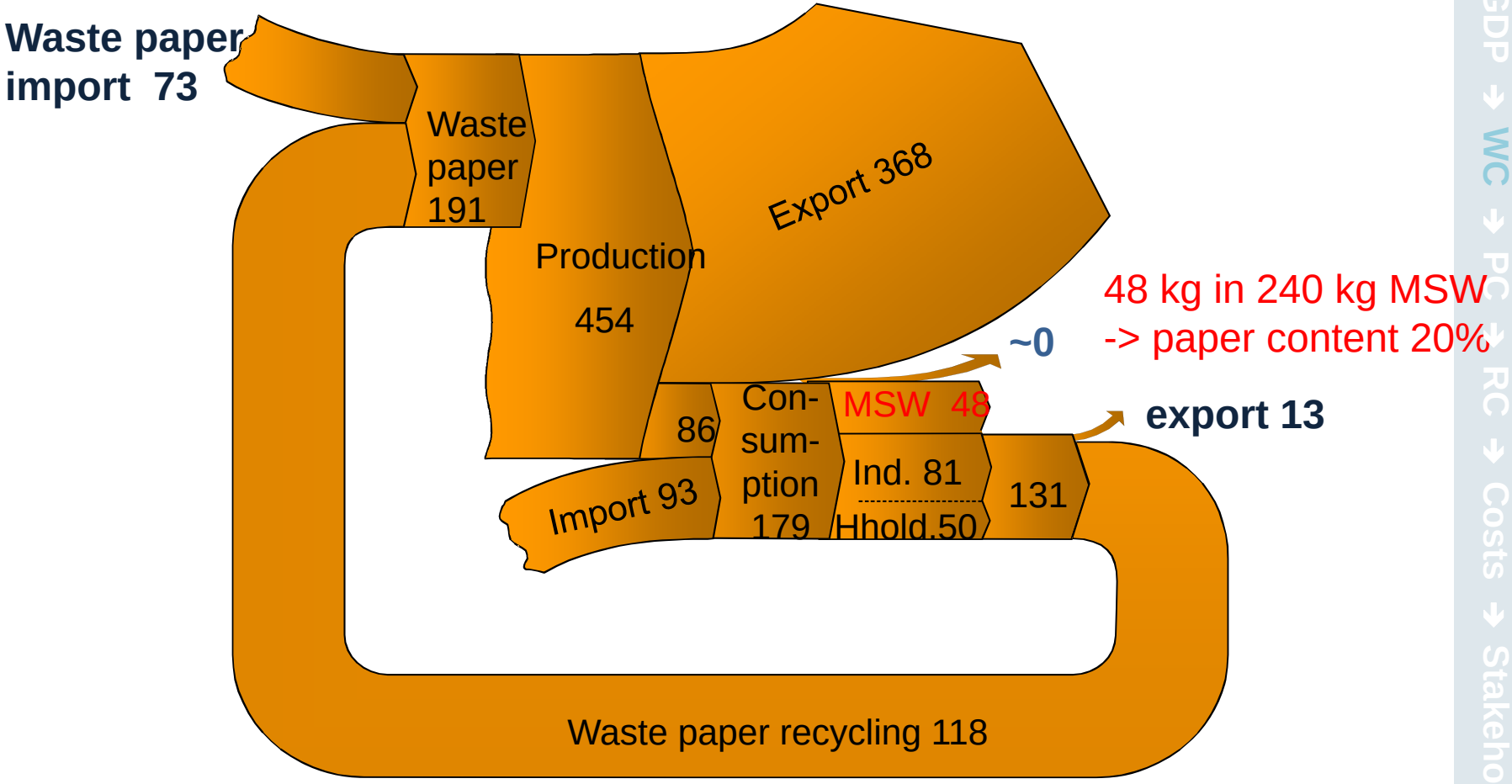
Actual practice of waste analysis

How much are you willing to pay for analysis: 1%,10%...?



Indirect methods of waste characterization

Example waste paper in MSW [kg/c.year]

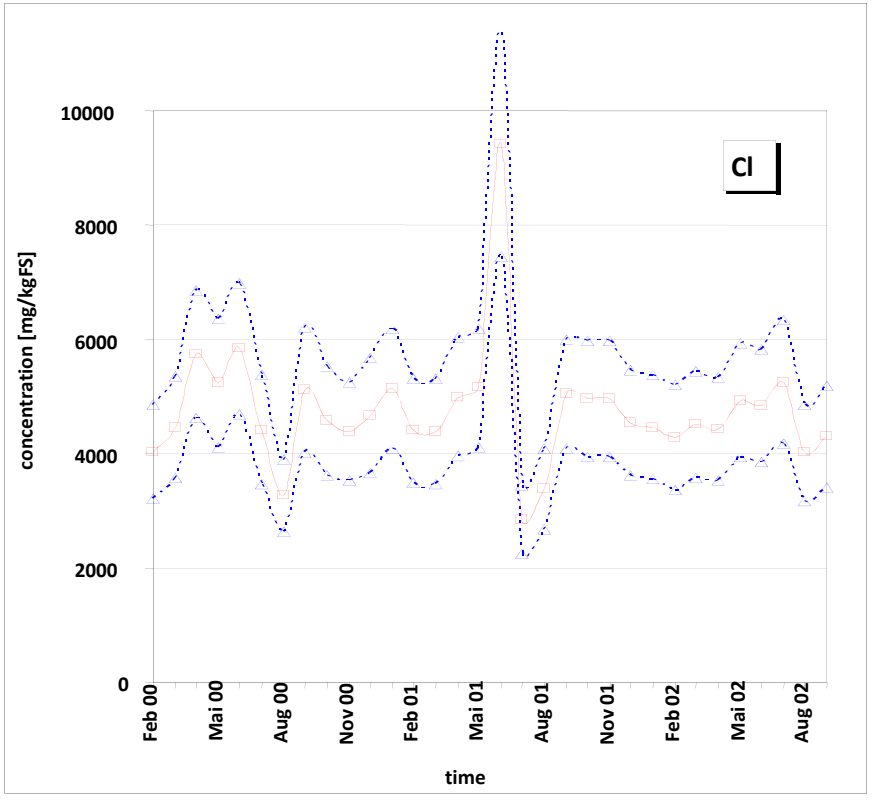


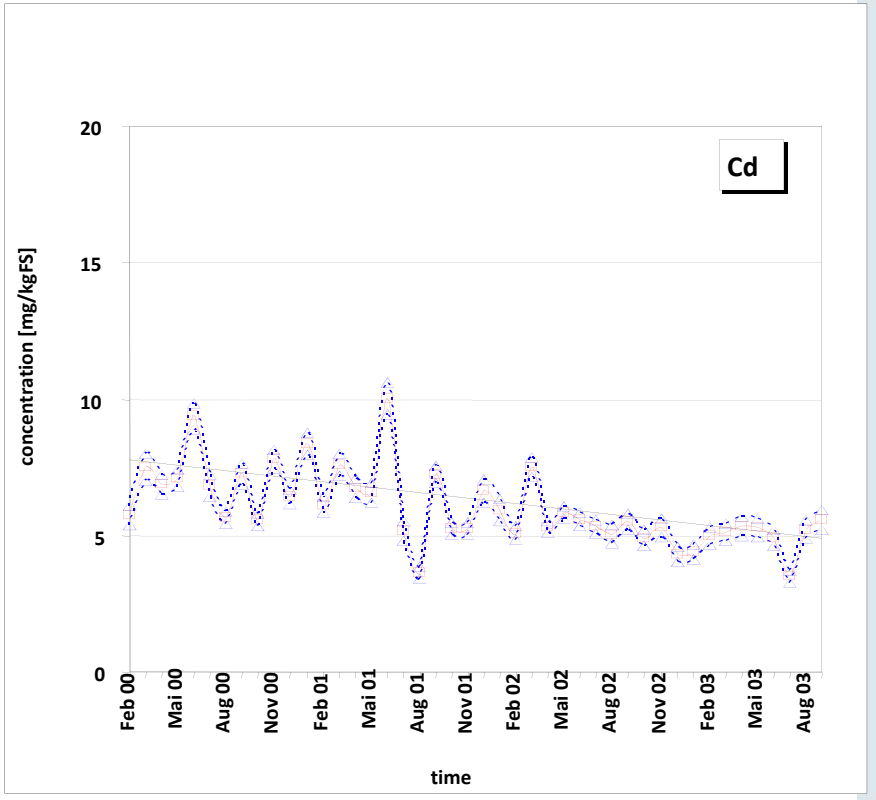
Data: Austrian Paper Industry, 1996

Goals → GDP → WC → PC → RC → Costs → Stakeholder

Indirect determination of MSW composition by WTE

Monthly mean values of Cl and Cd in MSW determined in WTE products





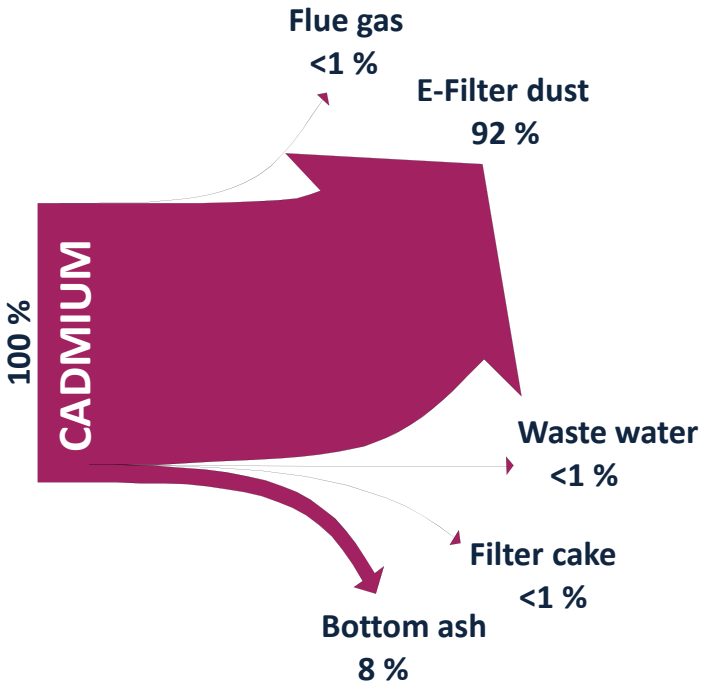
Source: Morf et al. 2003; Morf et al. 2004

4. Treatment process characterization

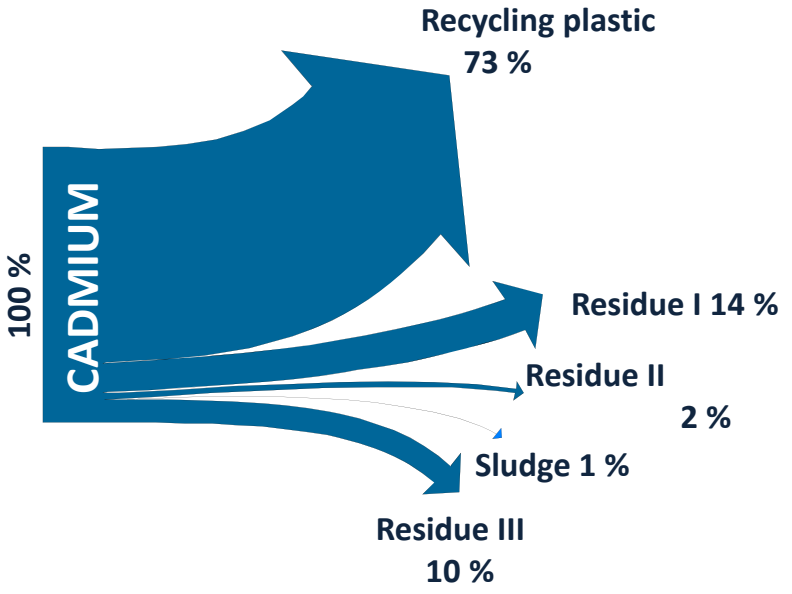
Minimum information requirement: Transfer coefficients k_i

"What goes in must come out" -> no hiding of hazardous materials

MSW incineration



Plastic recycling



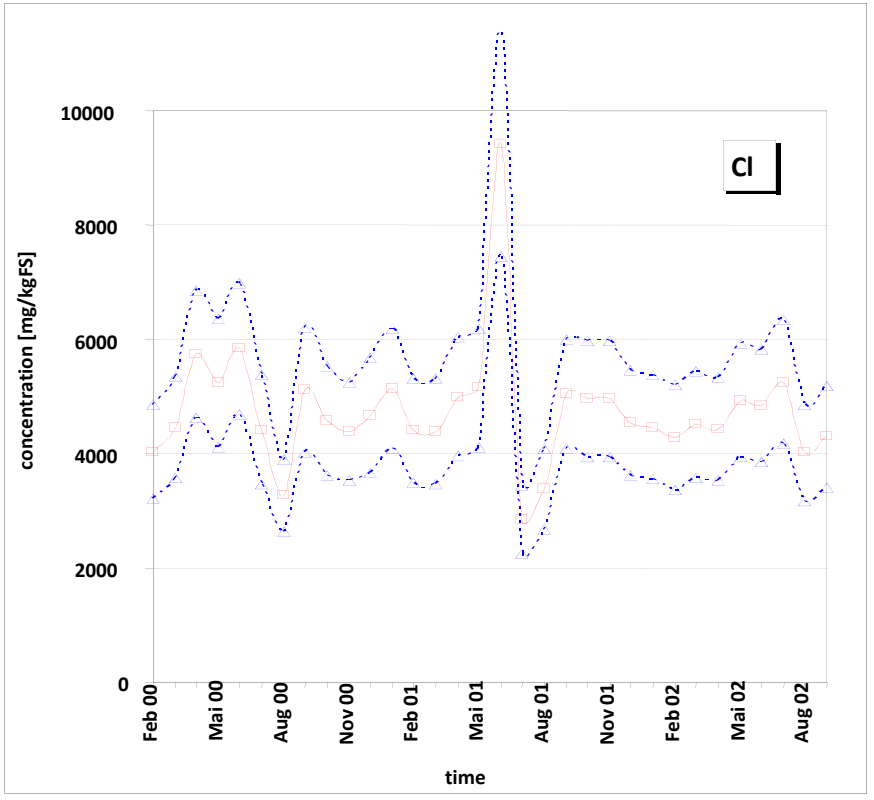
High quality recycling requires process information

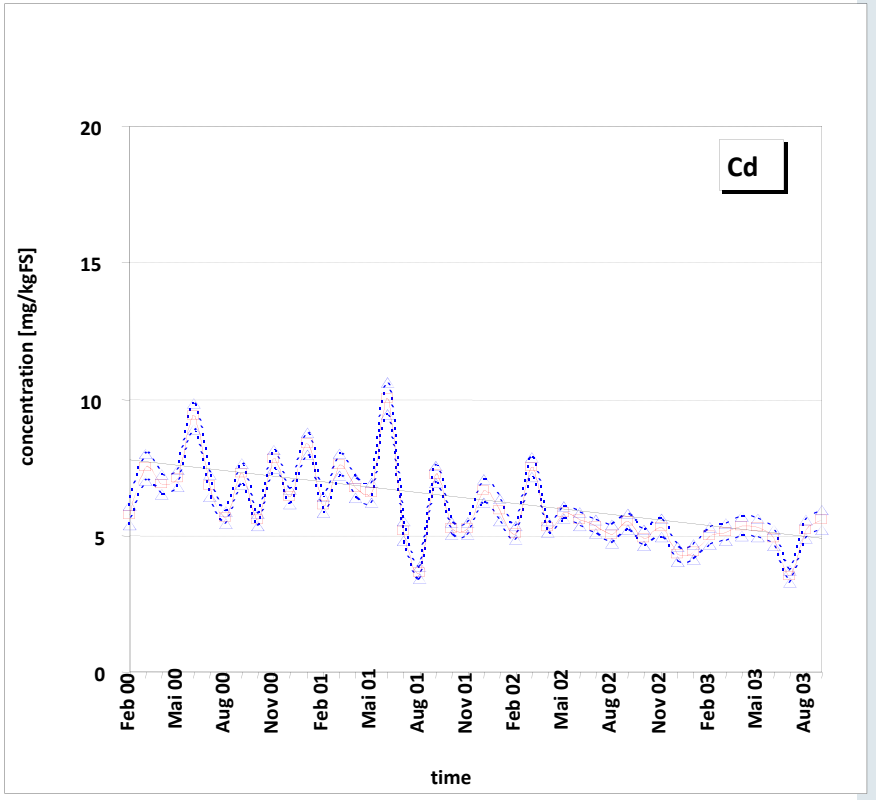
PBDE/BFRs in Videotapes et al, BFR 2007)

in coffee cups (J. Samsonek ype, FAC, 2013)

Evaluation of treatment processes requires time series

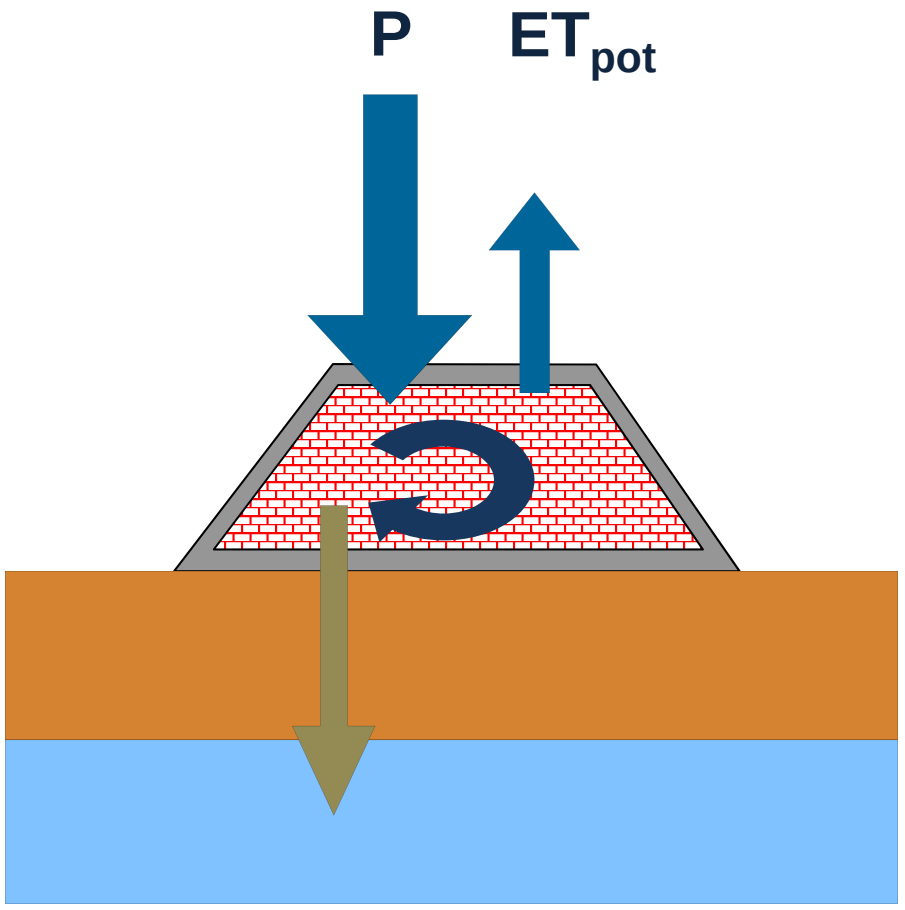
Monthly mean values of Cl and Cd in MSW determined from products of incineration



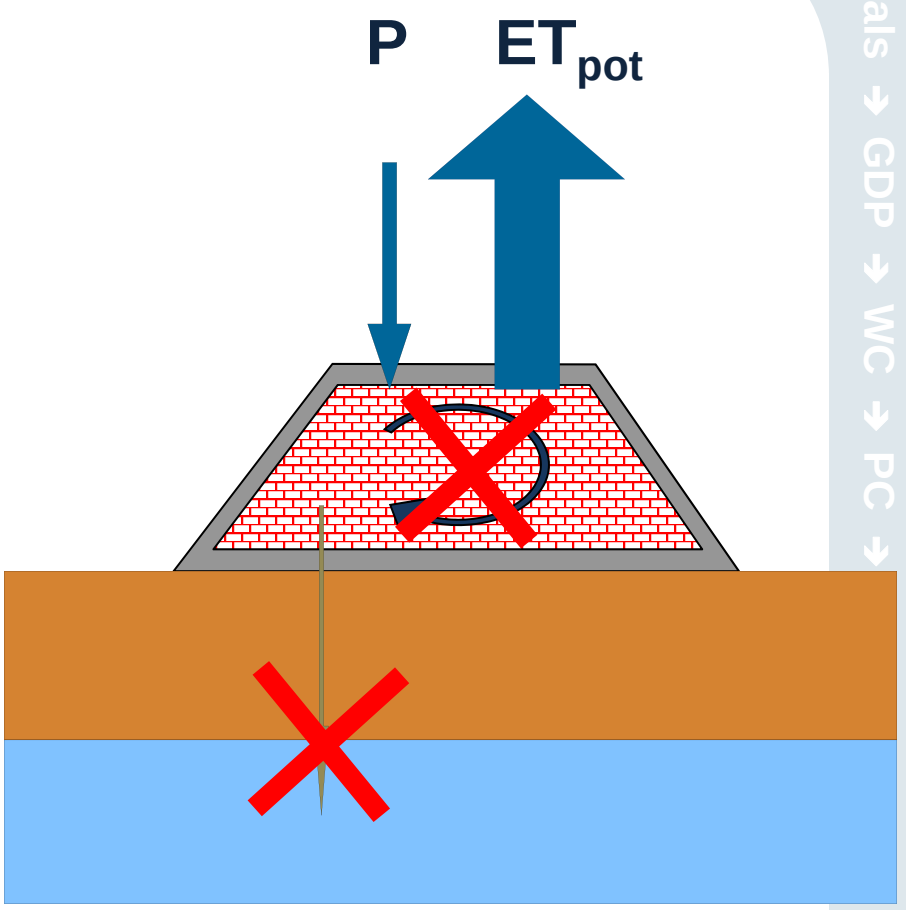


Source: Morf et al. 2003; Morf et al. 2004

5. Regional characteristics: climate and site properties

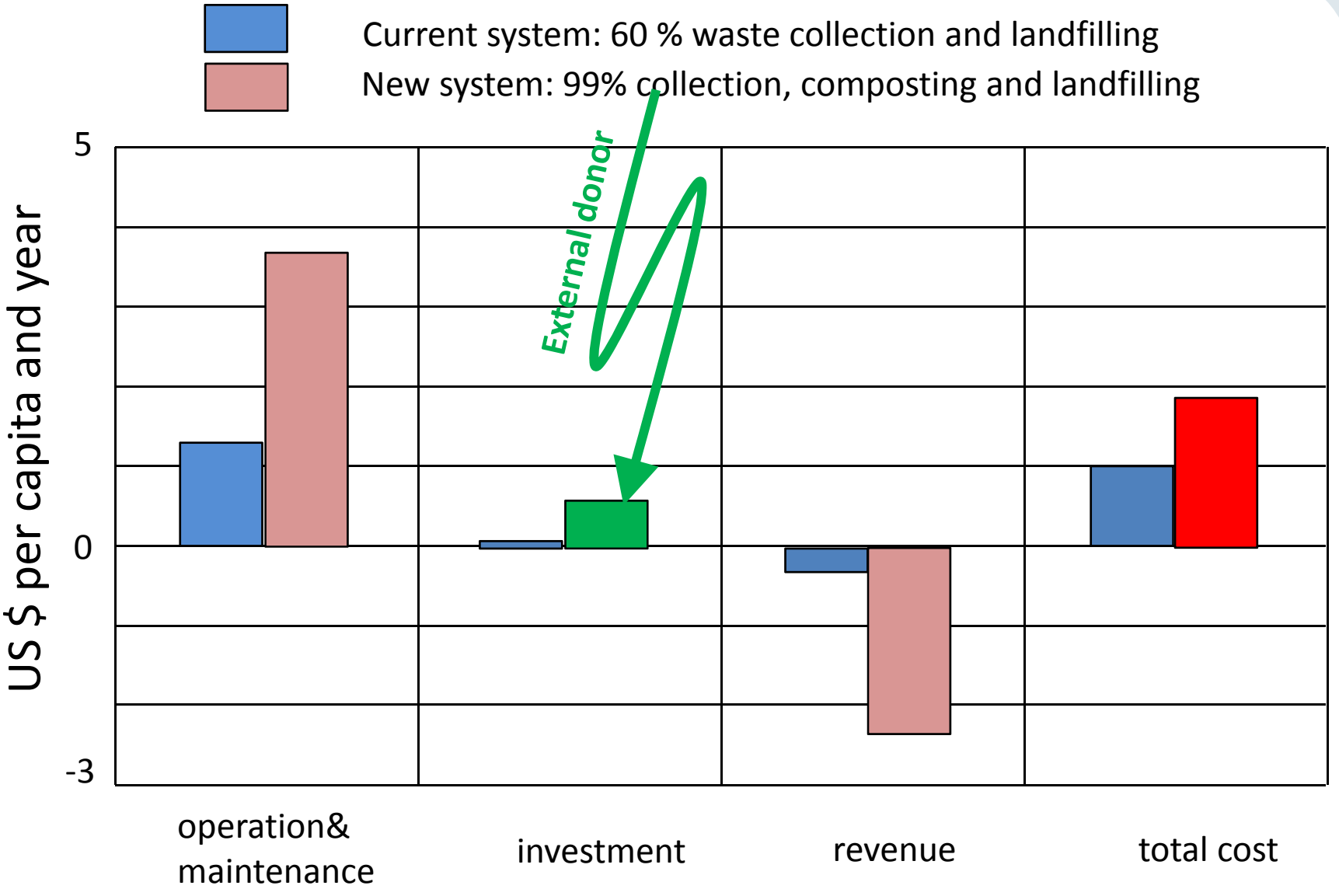


tropical climate:
large amount of leachates



arid climate:
zero amount of leachates

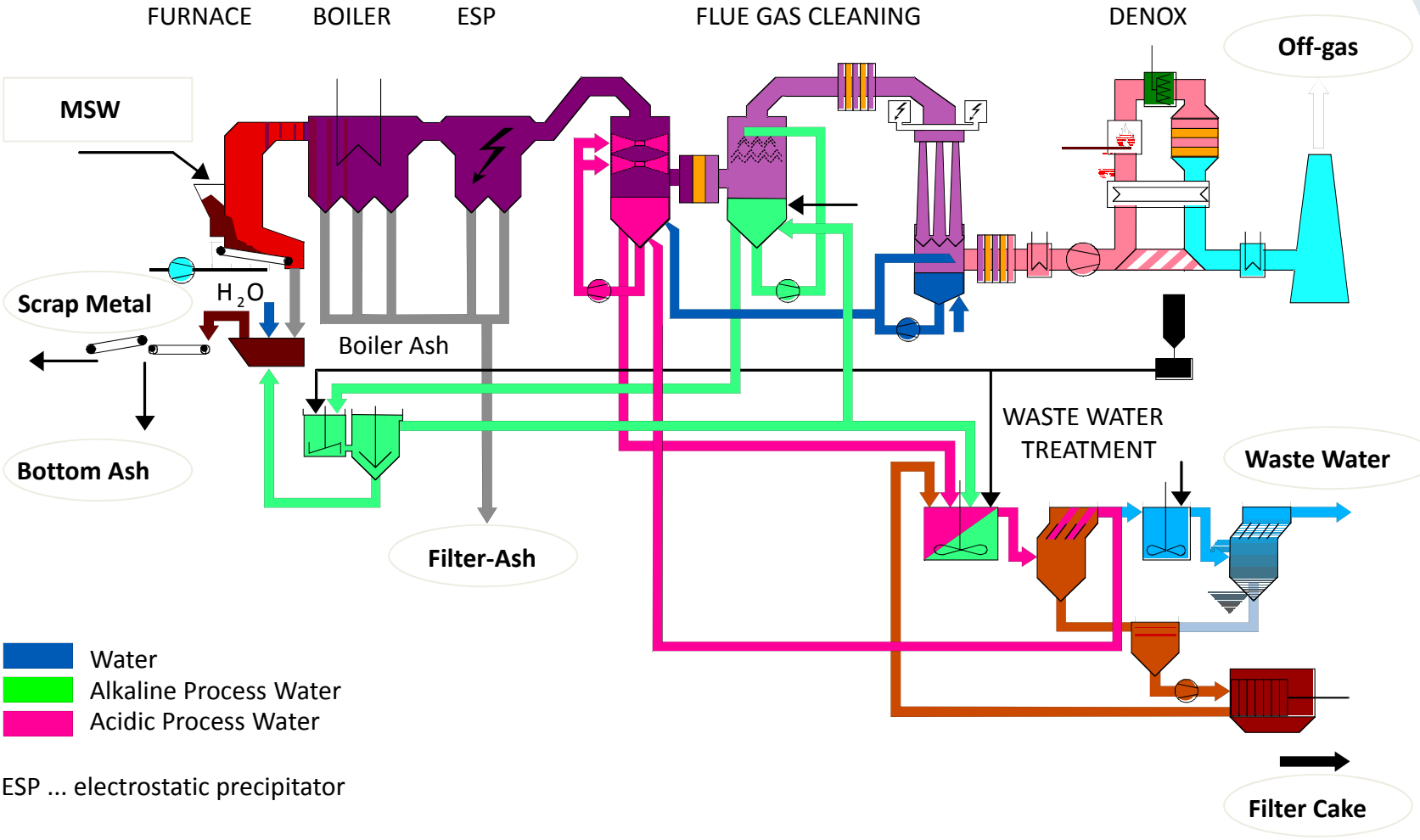
6. Life cycle costs of investment and operation



7. Stakeholder values, interests and concerns

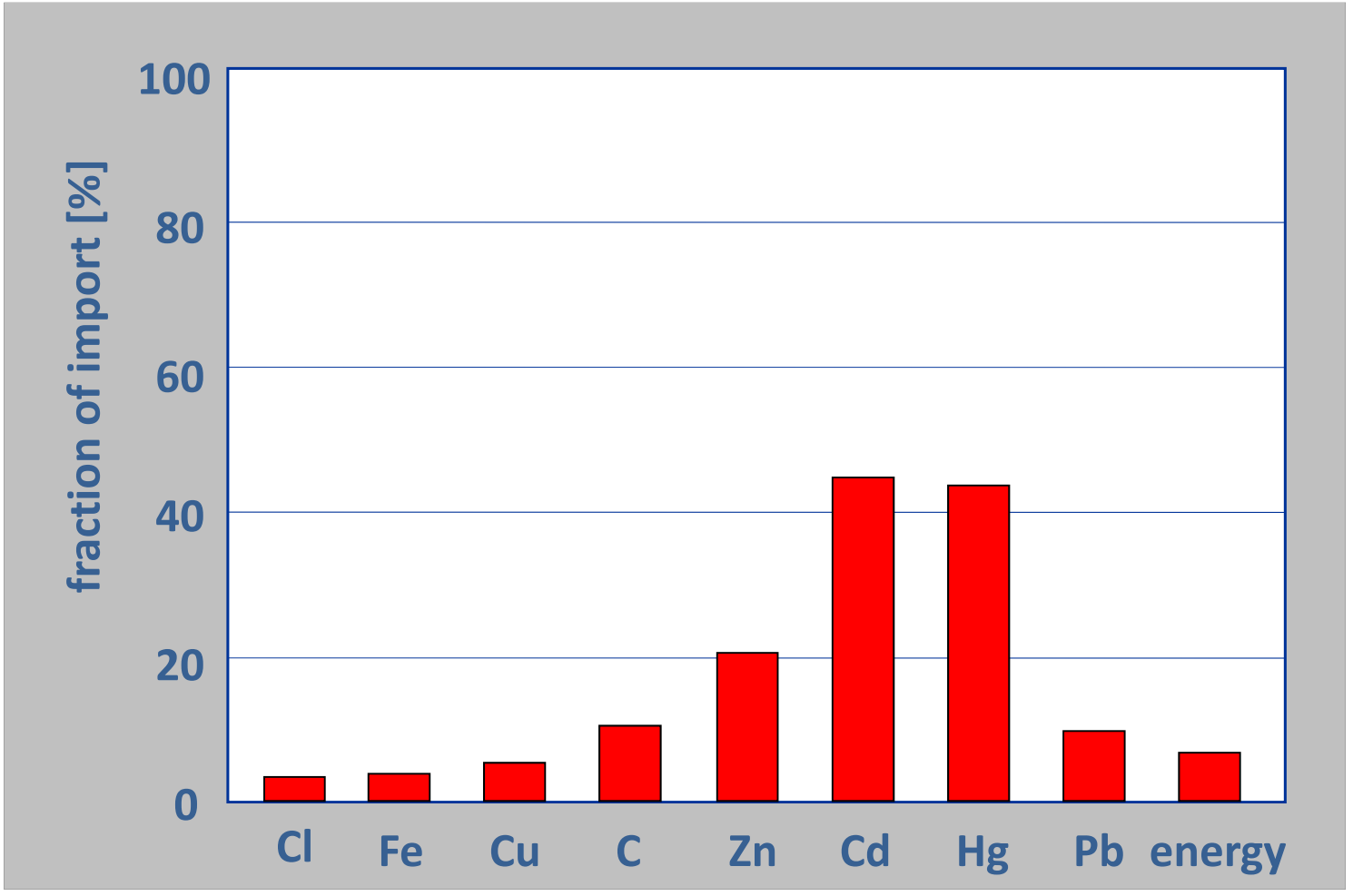
Thank you

Incineration costs are determined by air pollution control



Source: SGP-VA

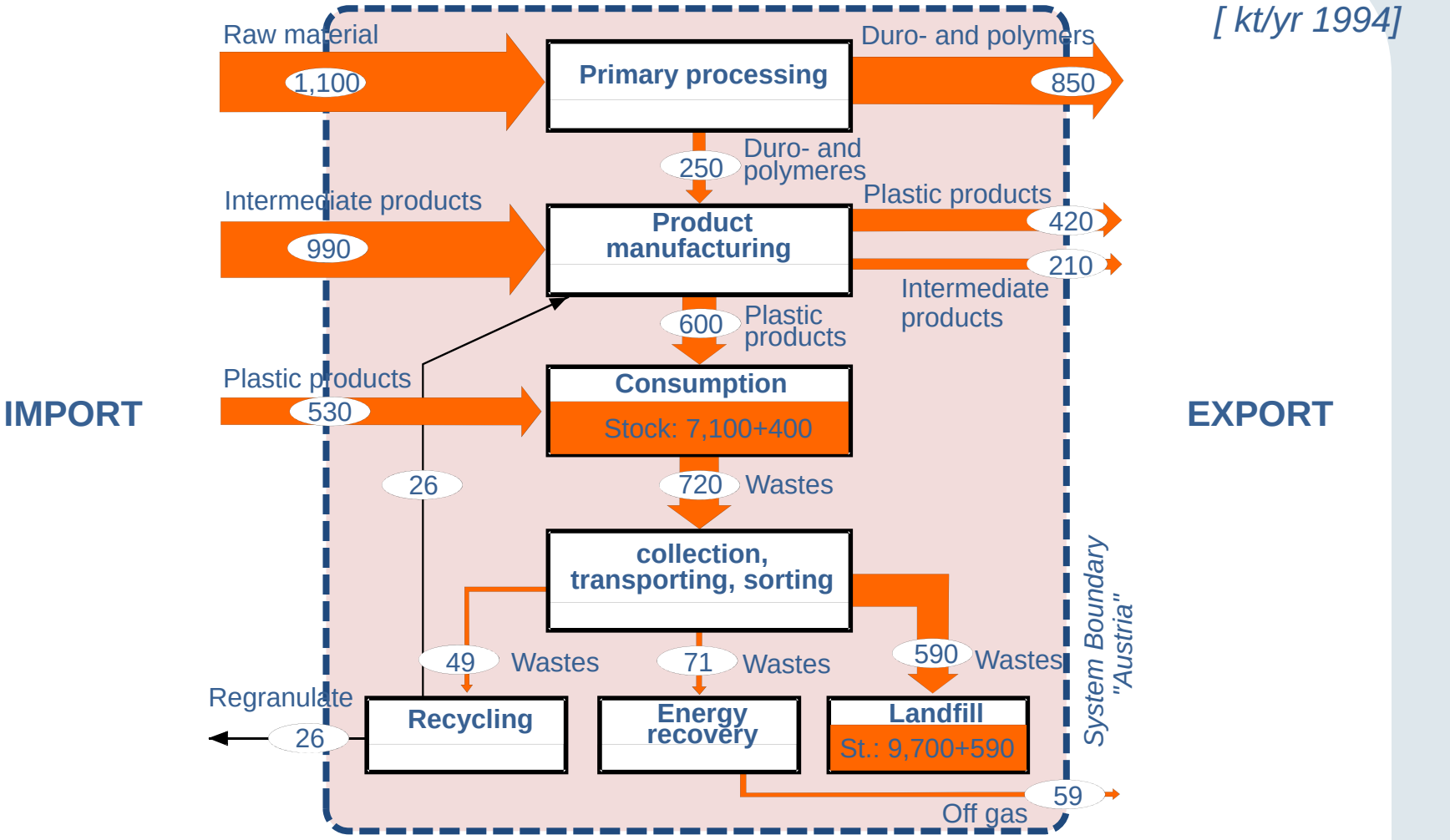
Selecting parameters for waste characterisation, (expl. MSW incineration)



substance flows in MSW as a fraction of total import

Better decisions by expanding knowledge base (ex. plastic wastes)

[kt/yr 1994]



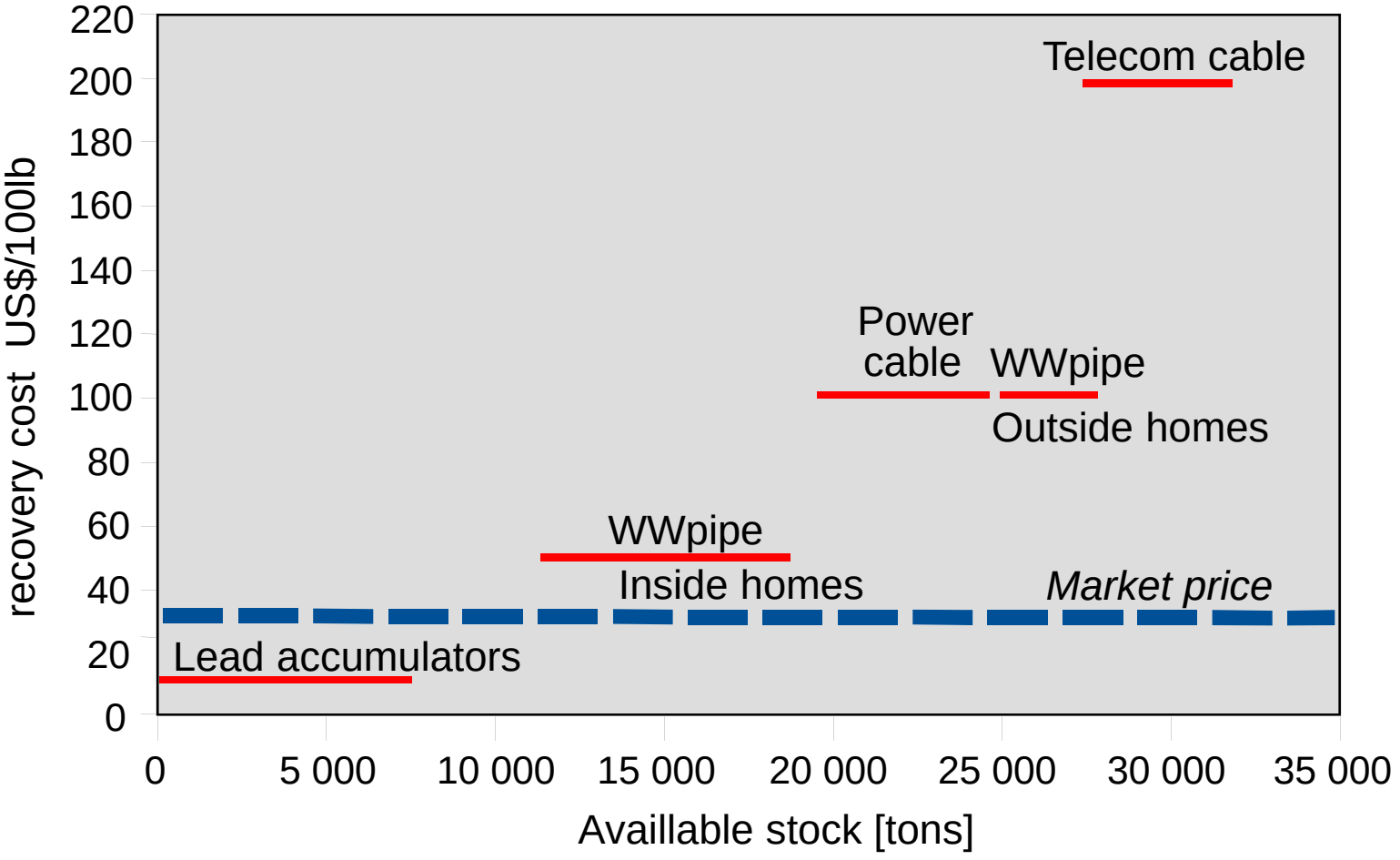
Source: R. Fehringer, 1998

Better decisions by expanding information base (ex. plastic additives)

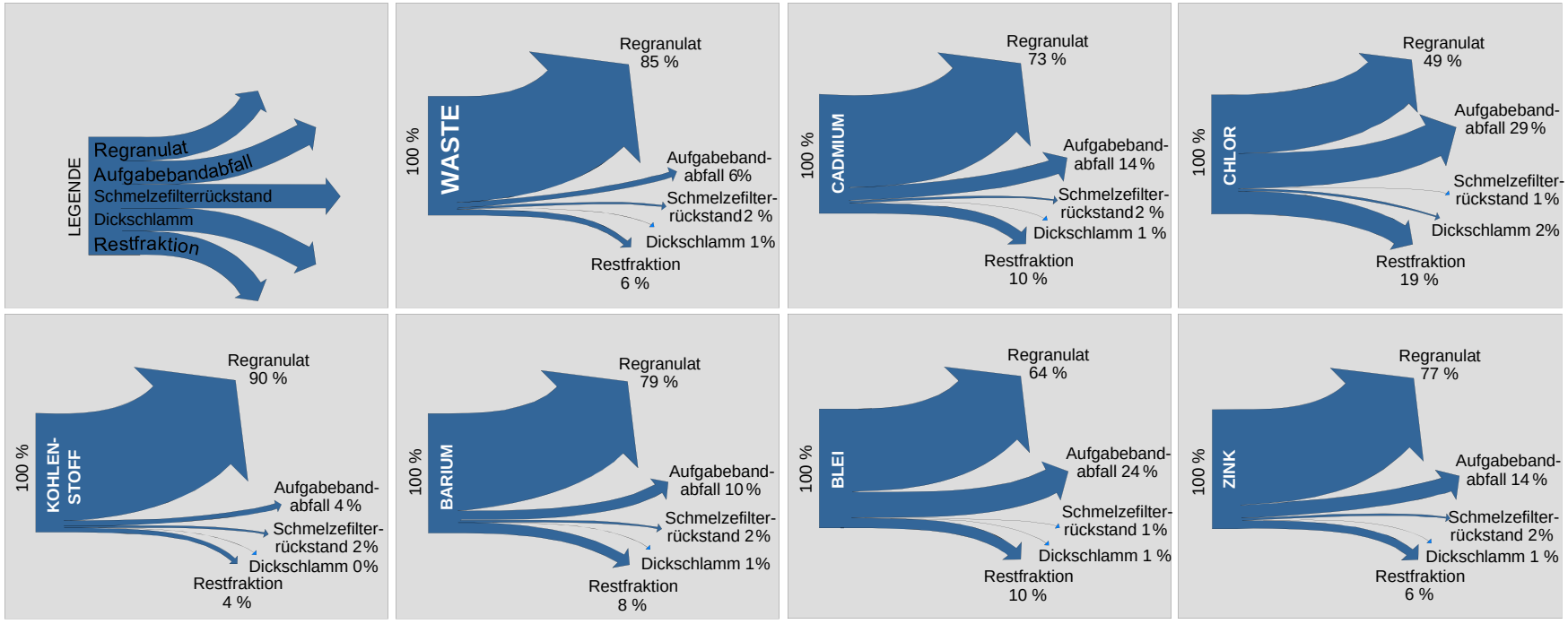
Additives in plastics	Total consumption	Total stock	Packaging material	
	in kt/yr	in kt	in kt/yr	in %*
Plastics	1,100	7,100	200	**18**
Softeners	14	140	0.2	**2**
Ba/Cd- stabilizers	0.27	2.6	0.0002	**<1**
Pb-stabilizers	1.8	18	0.002	**<1**
Fire retardants	2.3	22	0	**~0**

* *% of total consumption*

Economic data necessary for wm knowledge base (expl. lead)



Source: Lohm et al., 1998

Knowledge base must include process information

Example plastic recycling