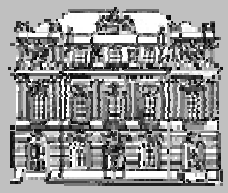

Sludge Disposal
and
Regional Metabolism

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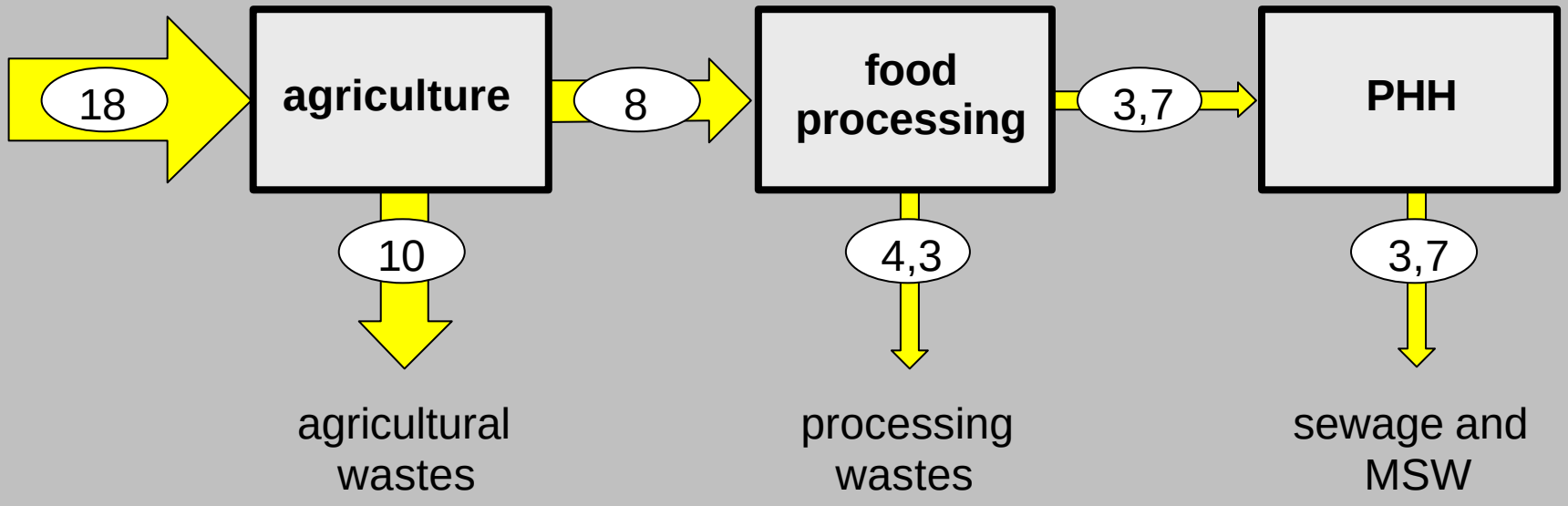
Contribution of sewage sludge to regional material flows

Regional flows	Mass	DM	C	N	P	Cd
		[%]				
Total flow	100	100	100	100	100	100
MSW	0.2	4	2	9	6	20
sludge	*0.3*	*0.3*	*0.2*	*3*	*8*	*1*

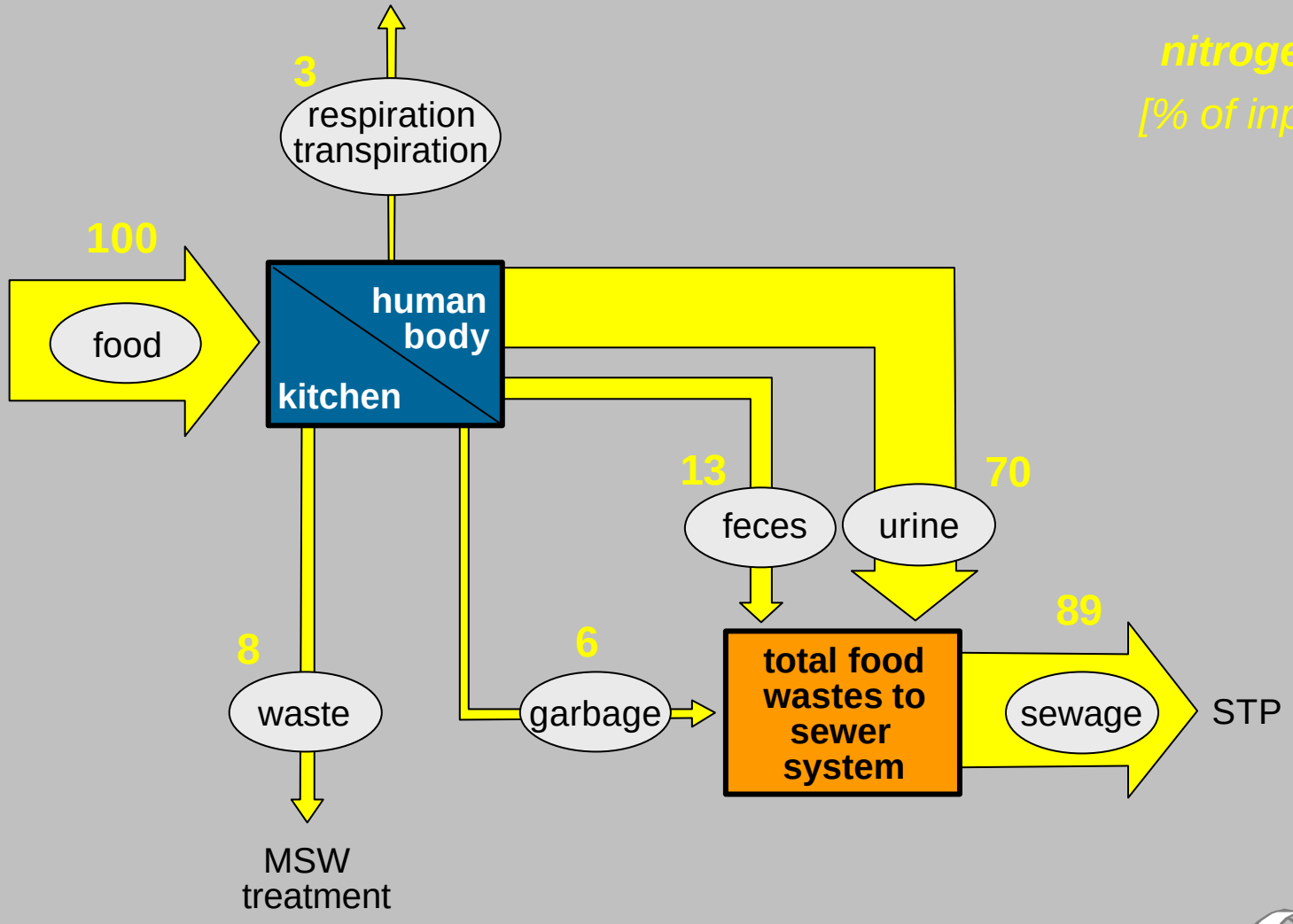
Regional nitrogen flow by food chain

nitrogen

[kg/c.y]



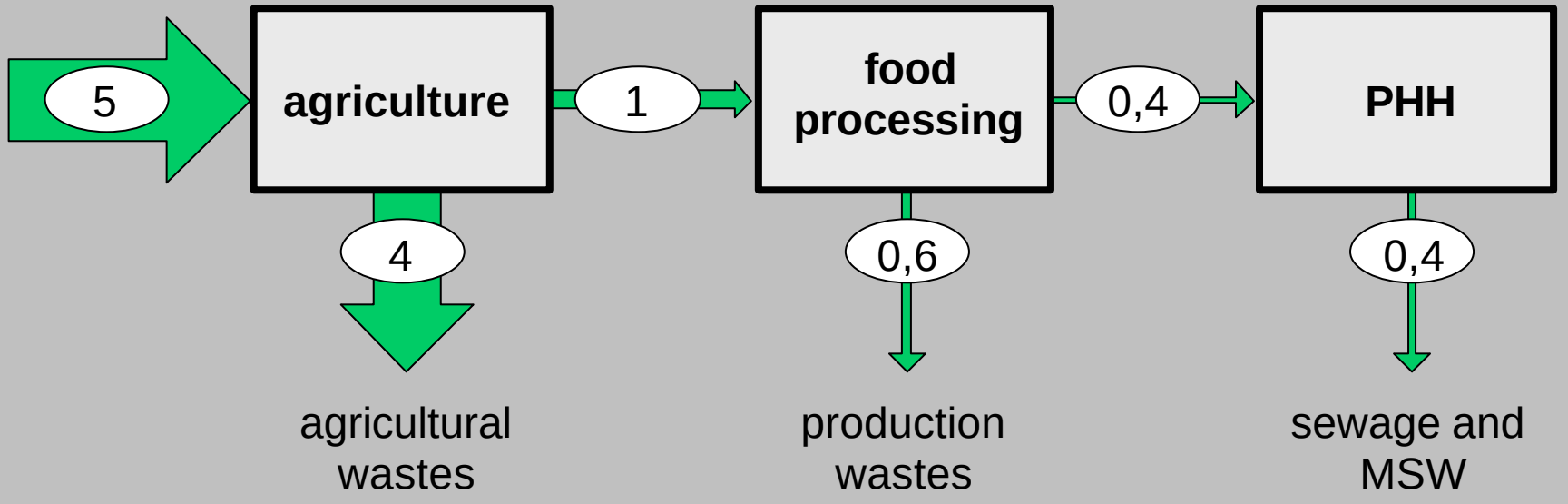
Partitioning of food-derived N in households



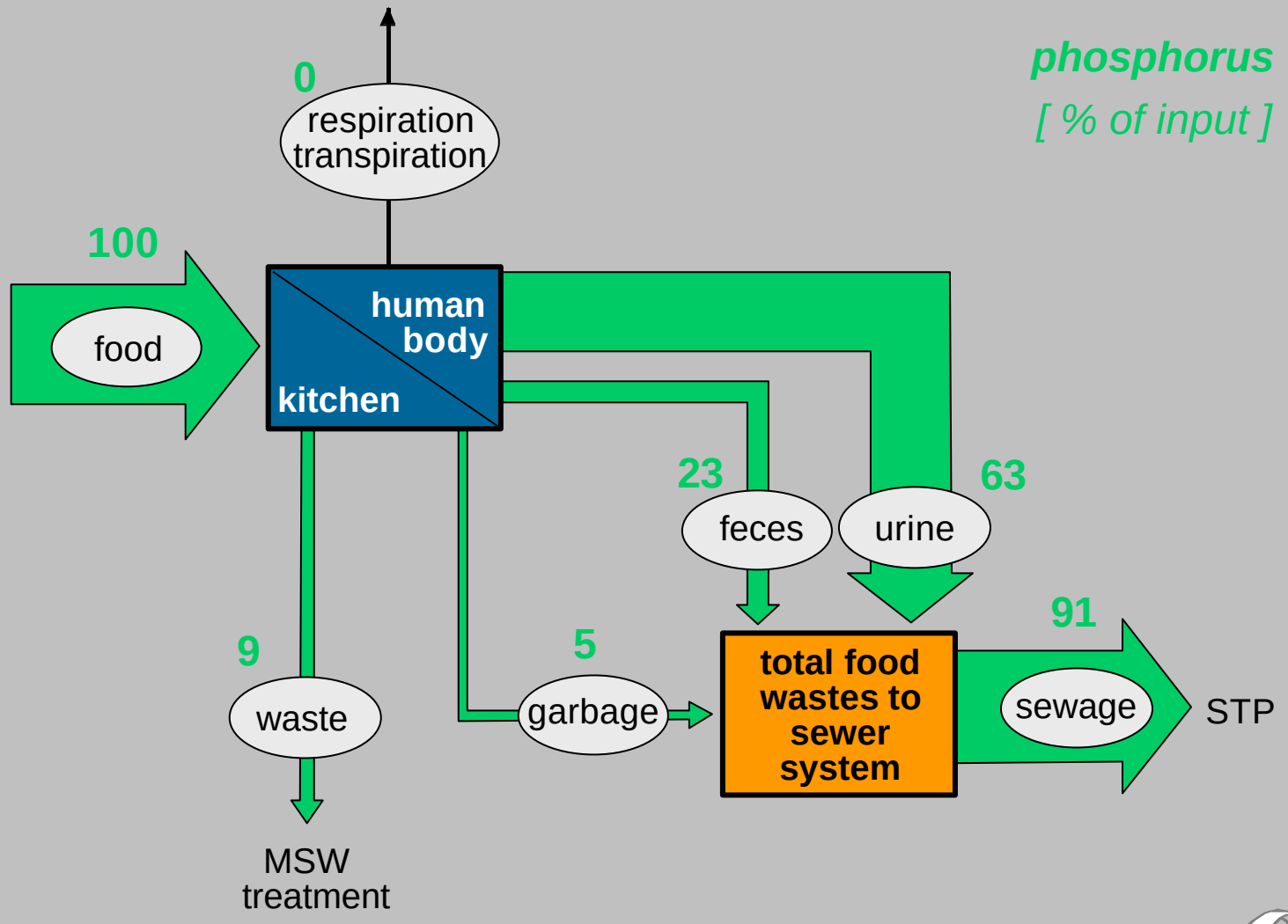
Regional phosphorous flow by food chain

phosphorus

[kg/c.y]



Partitioning of food derived-P in households



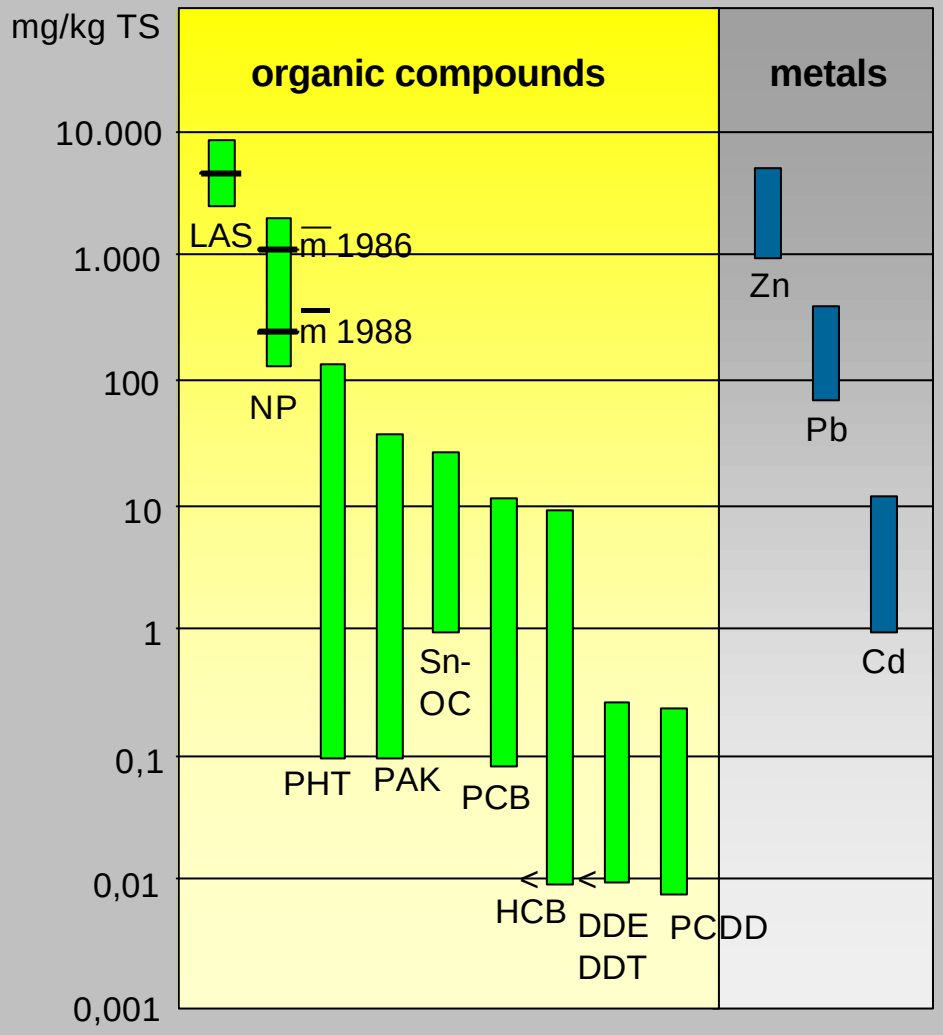
Main elements in sewage sludge

element	typical content	
	[mol/kg DM]	[g/kg DM]
hydrogen	34	34
carbon	18	220
oxygen	11	170
silica	2.3	65
calcium	1.9	73
nitrogen	1.9	27
phosphorus	1.1	34
aluminum	0.9	25
magnesia	0.4	9
iron	0.3	20
sulfur	0.2	8
titanium	0.1	5

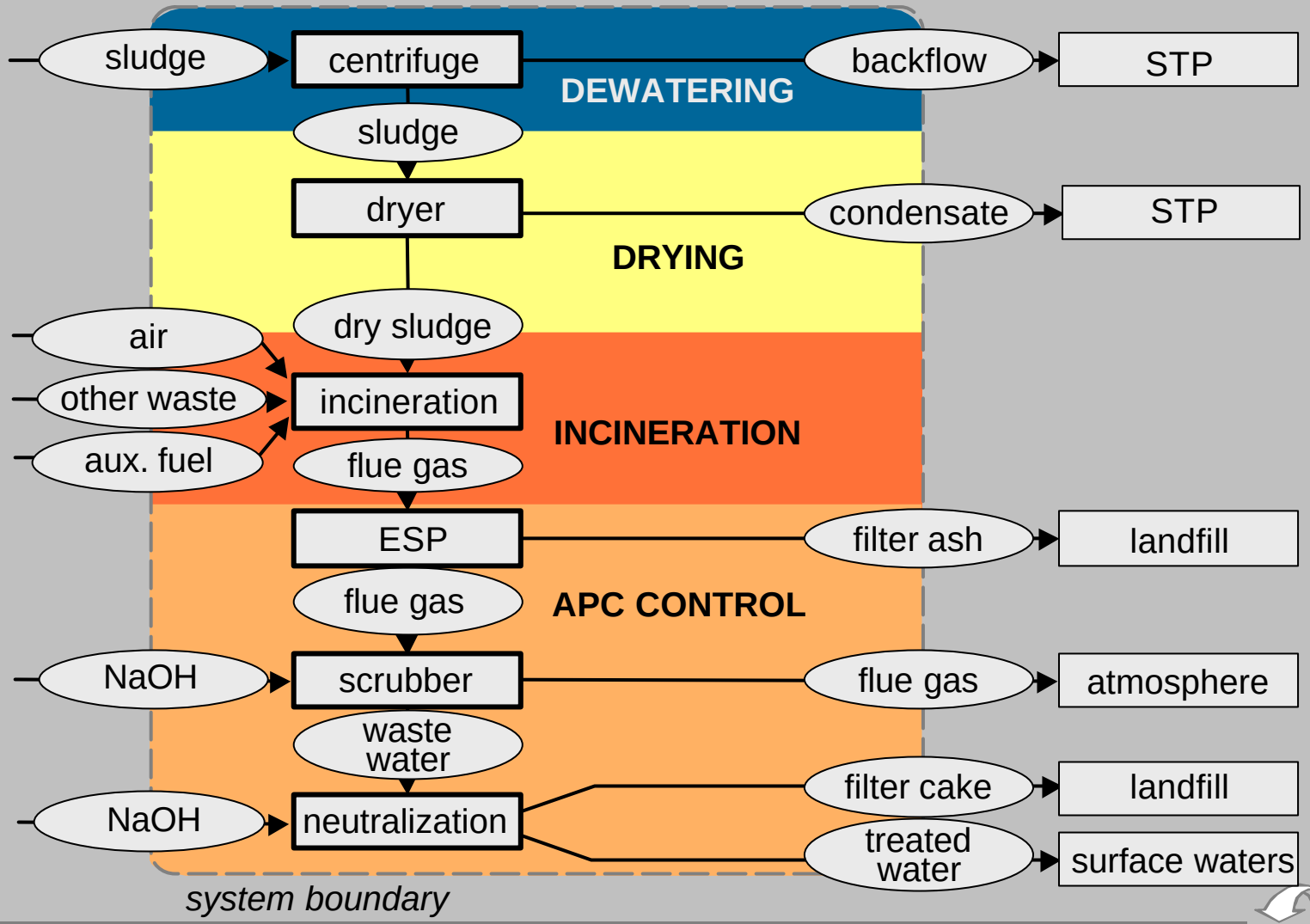
Inorganic trace elements

element	typical content [mg/kg DM]
zinc	1 000
copper	800
lead	400
silver	10
arsenic	7
cadmium	5
mercury	6
antimony	2
selenium	2
gold	1

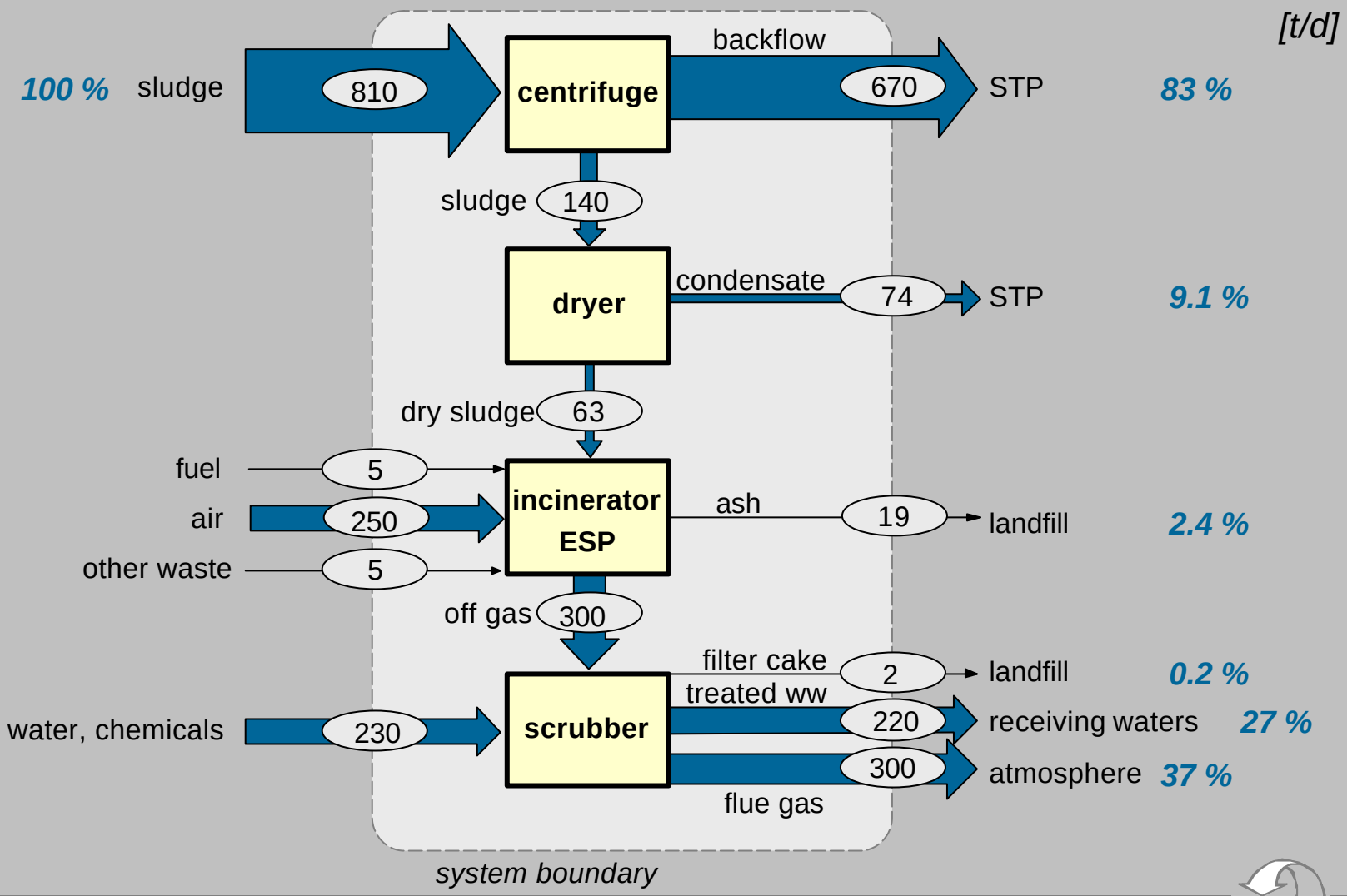
Organic trace compounds



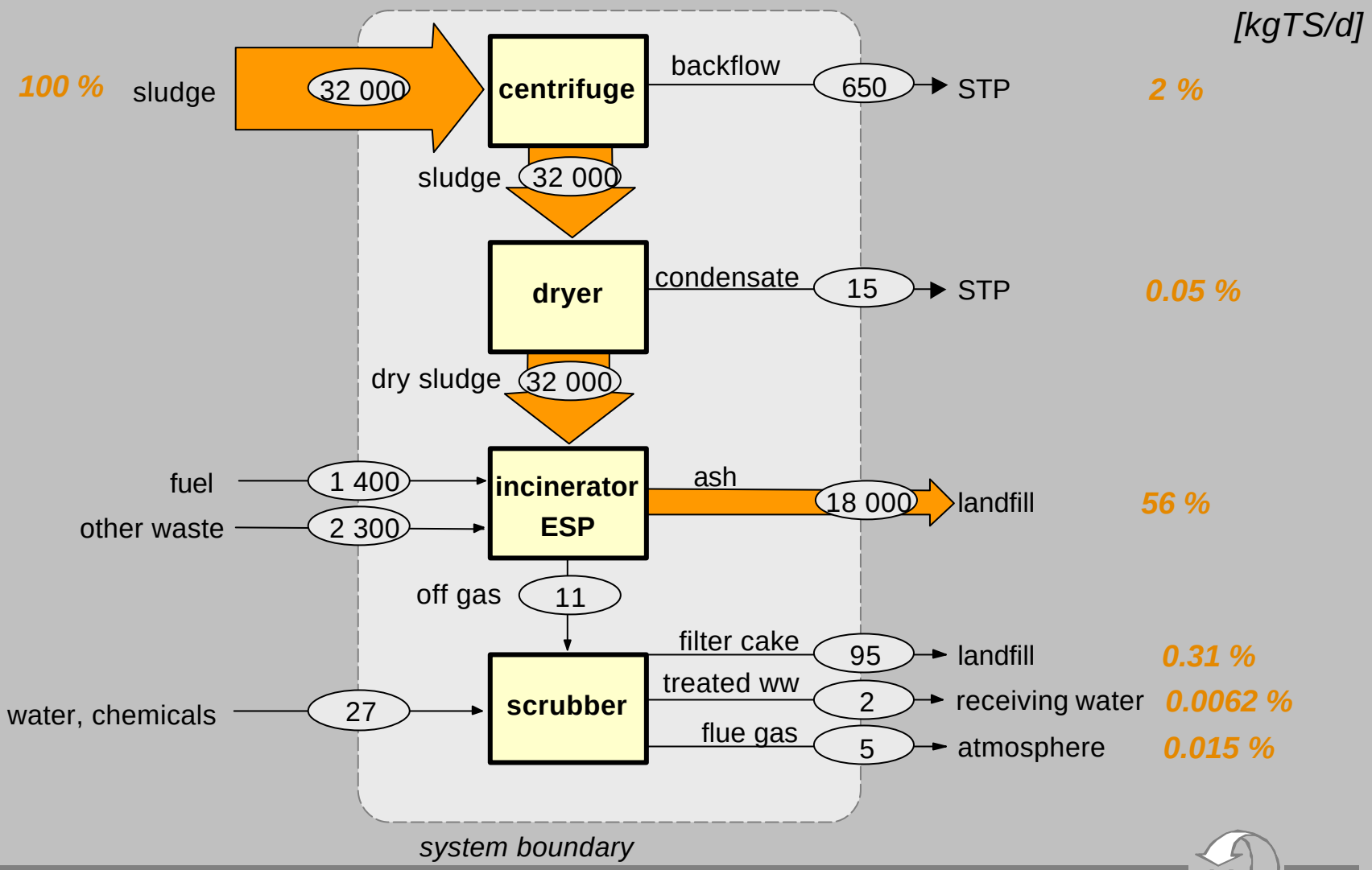
Material flow through sludge incineration



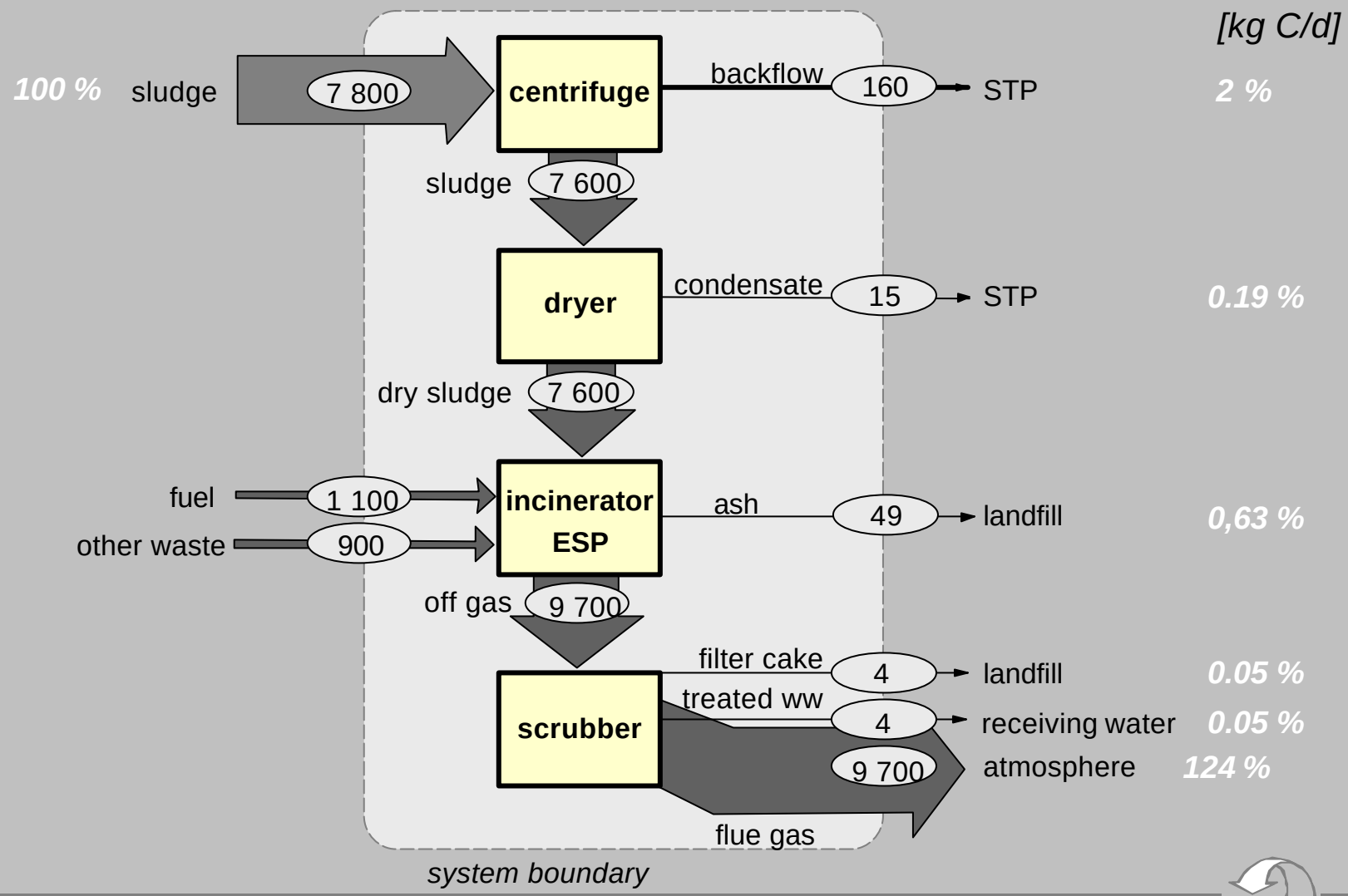
Sludge total mass flow through incineration



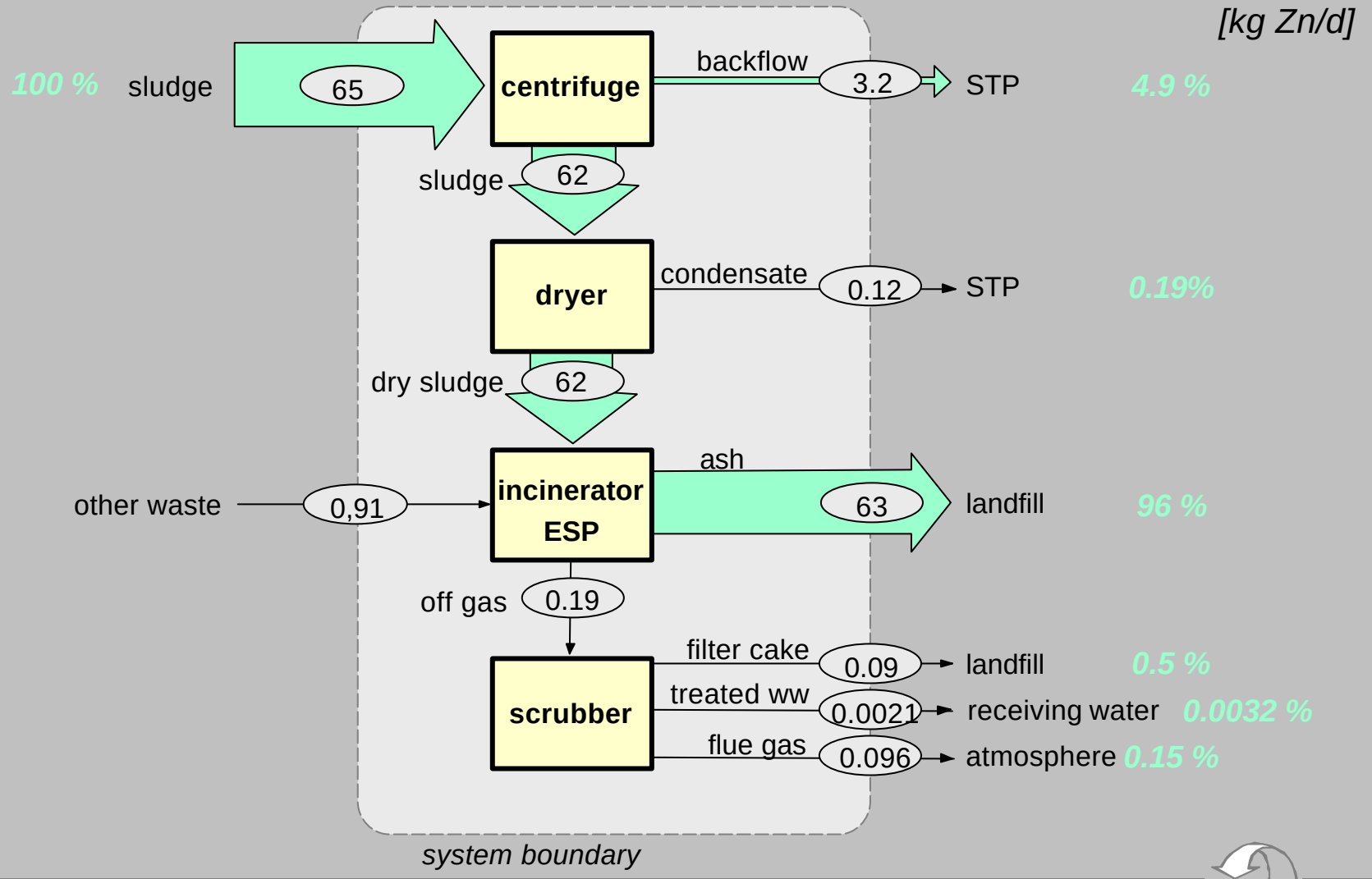
Sludge dry matter flow through incineration



Carbon flow through incineration



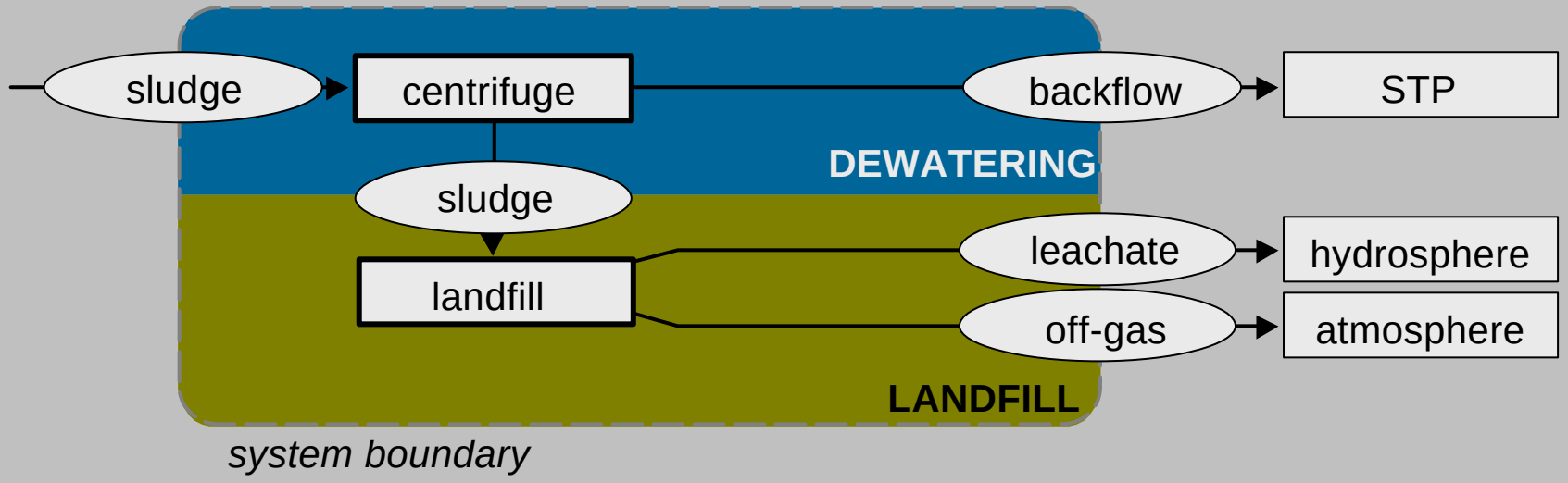
Zinc flow through incineration



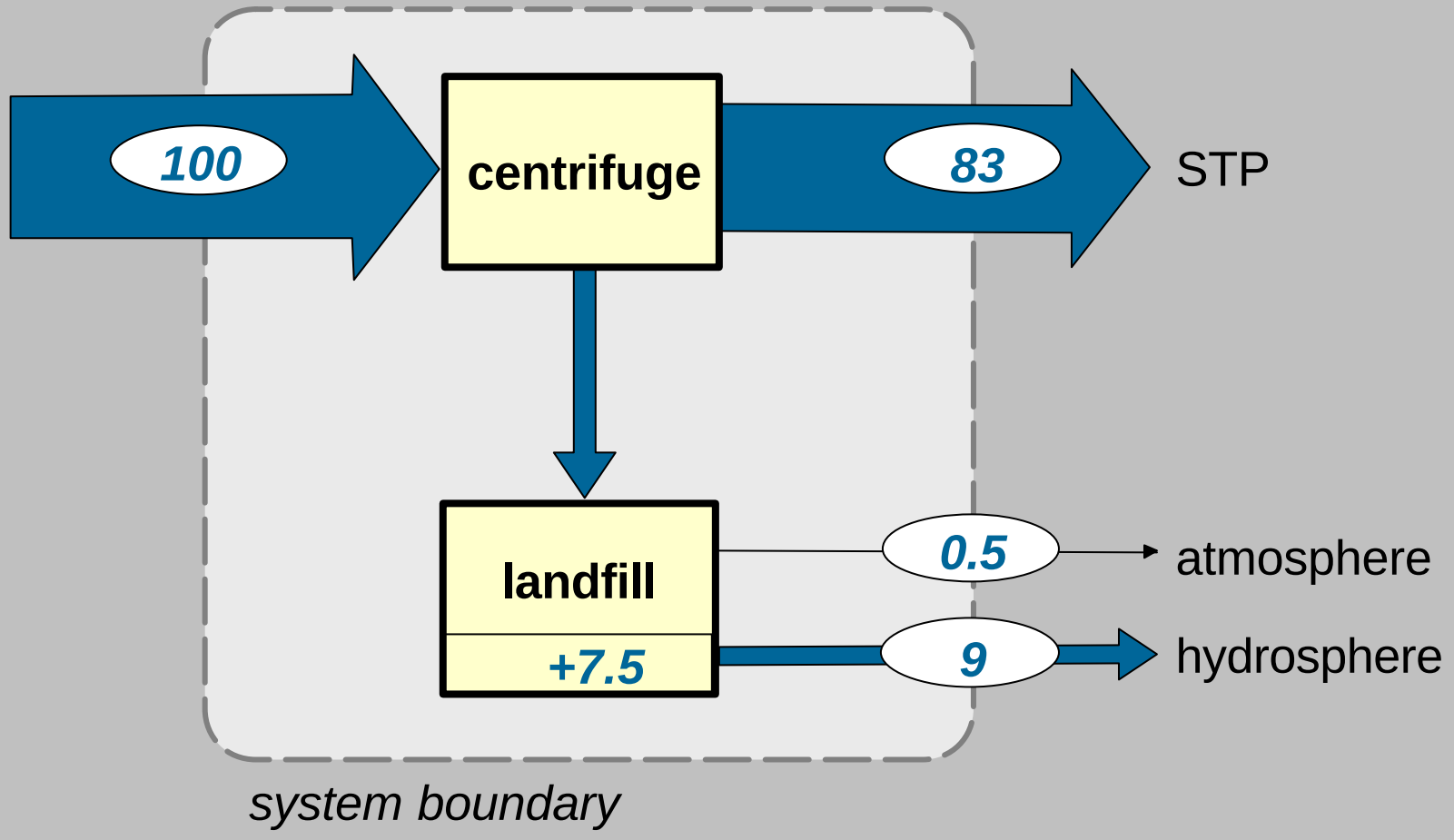
Sinks for material flows from sludge incineration

constituent	atmosphere	water	landfill
		[%]	
carbon	124	2	0.7
nitrogen	63	3	0.7
dry matter	49	2	57
mass	37	120	2.6
mercury	14	12	72
sulfur	3.8	34	65
zinc	0.15	5	96
cadmium	0.15	5	95

Material flow by sludge land filling

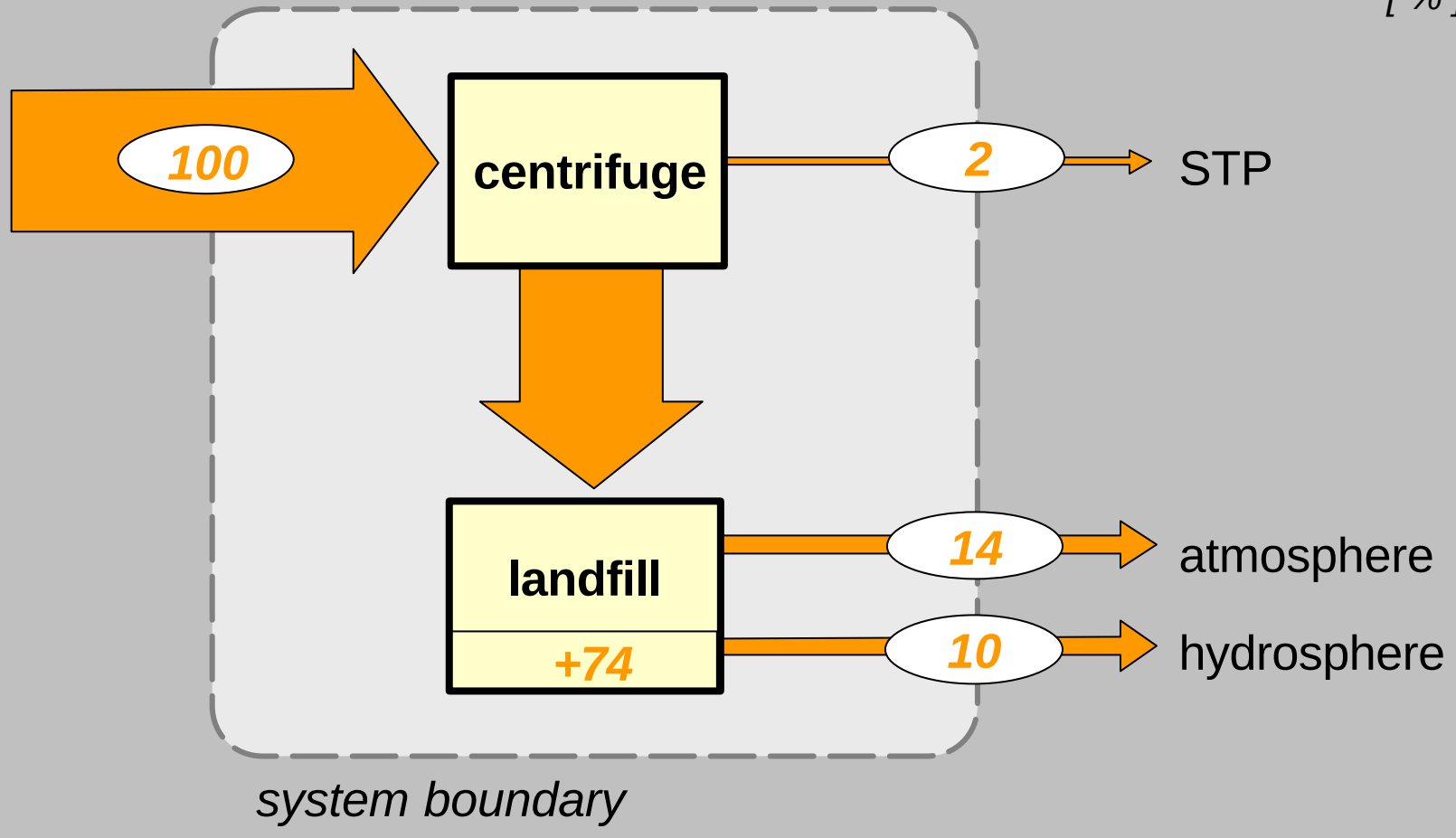


Mass flow by sludge land filling

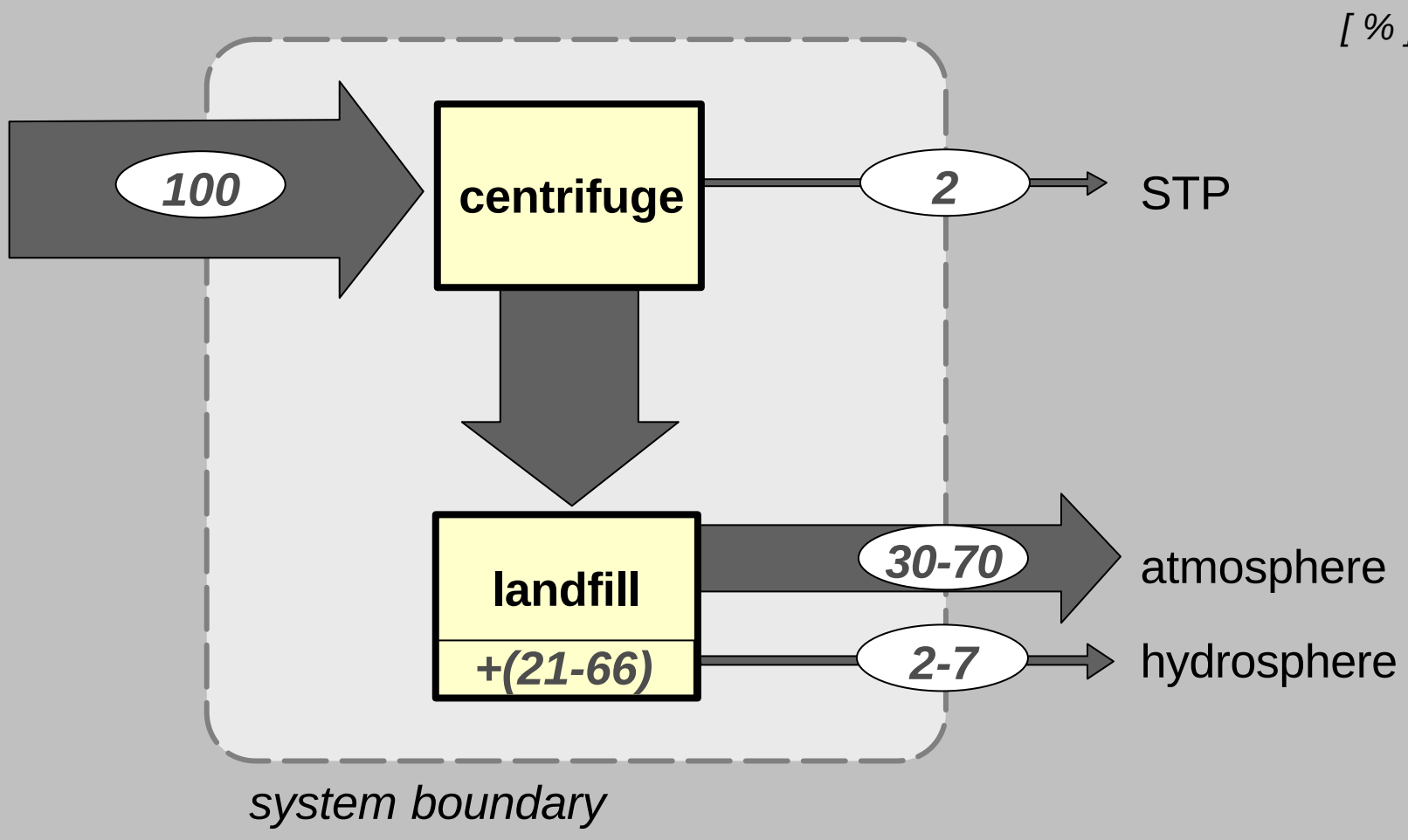


Dry matter flow by sludge land filling

[%]

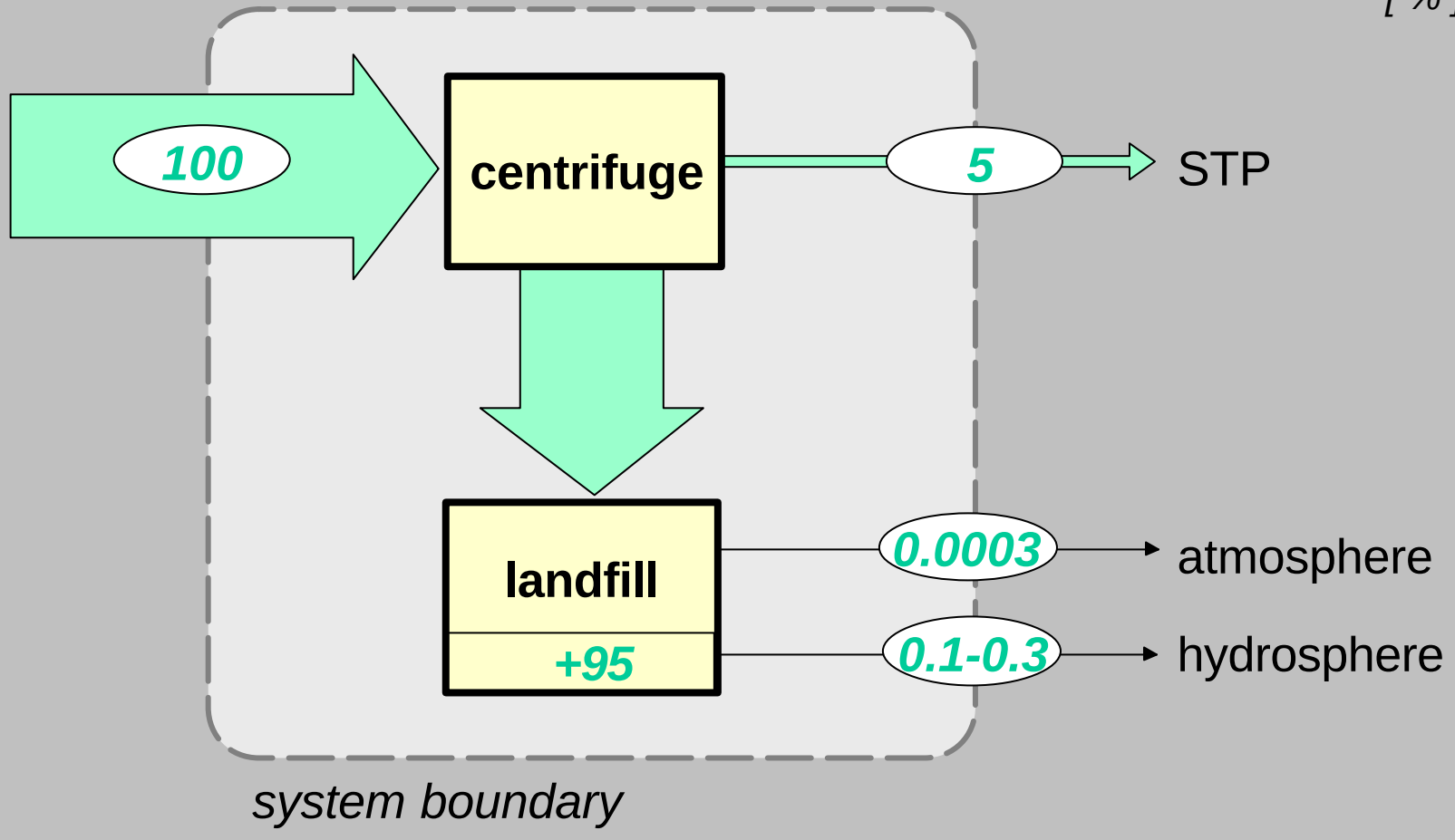


Carbon flow by sludge land filling

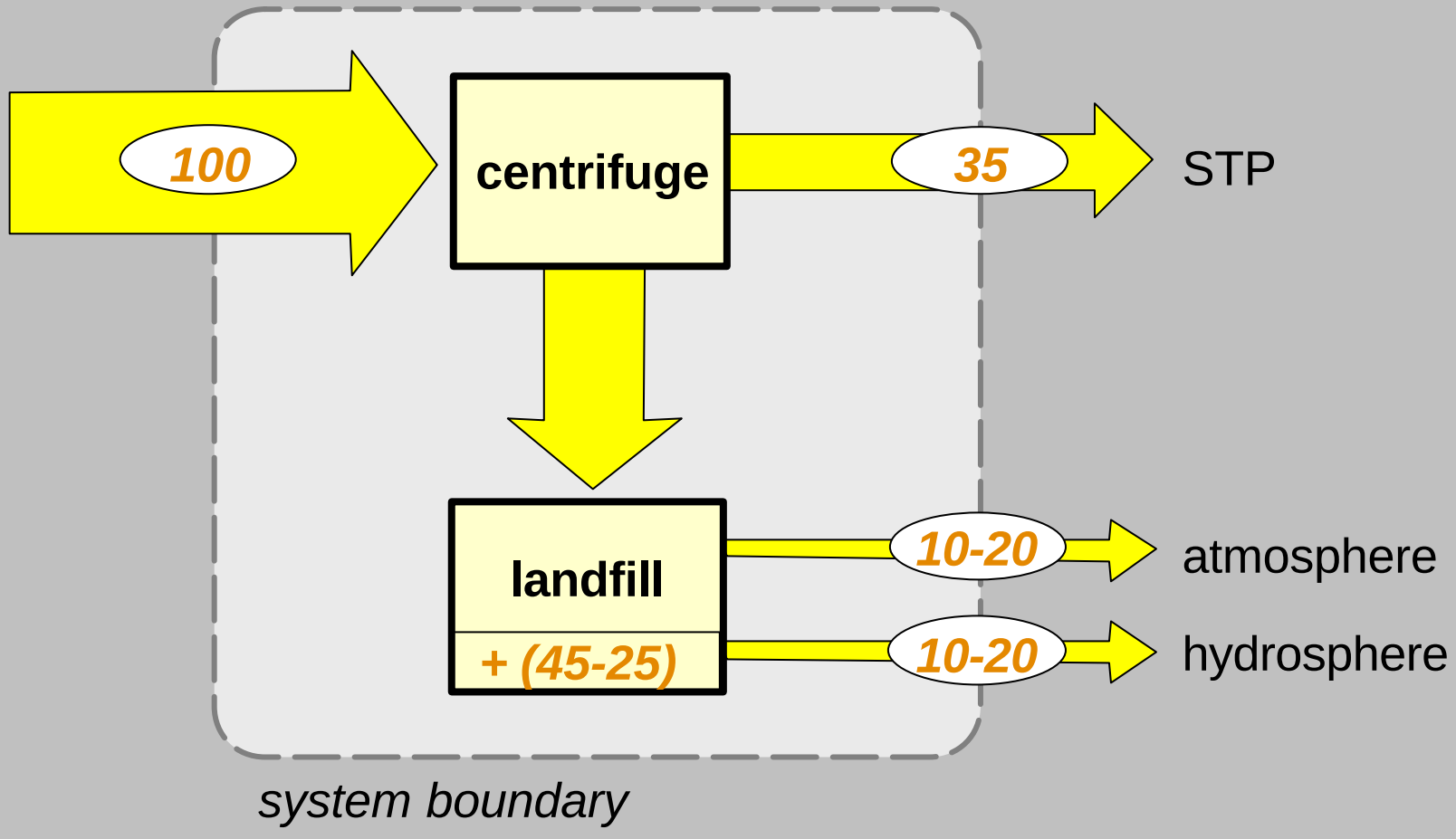


Zinc flow by sludge land filling

[%]



Nitrogen flow by sludge land filling



Sinks for material flows from sludge land filling

constituent	atmosphere	STP [%]	hydrosphere	land fill
mass	0.5	83	9	7.5
dry matter	14	2	10	74
carbon	30-70	2	2-7	66-21
nitrogen	10-20	35	10-20	45-25
sulfur	~1	1	~0.3	98-97
zinc	0.0003	5	~0.2	95
cadmium	0.002	5	~0.1	95
mercury	~0.03	3	~0.1	97

Conclusions

- Sewage sludges have comparatively:
  - low resource potential
  - low pollutant potential

- Incineration
  - mineralizes organic compounds
  - reduces landfill volume by ~98 % (~65%*)
  - concentrates metals in ash landfill

- Land filling
  - concentrates metals in organic landfills
  - poses a long term risk due to C and N stock