European Geosciences Union – General Assembly
GEOSCIENCE INFORMATION FOR TEACHERS (GIFT) WORKSHOP
Austria Center Vienna, 12-15 April 2015

CITIES: TOMORROW'S MATERIAL RESERVOIRS

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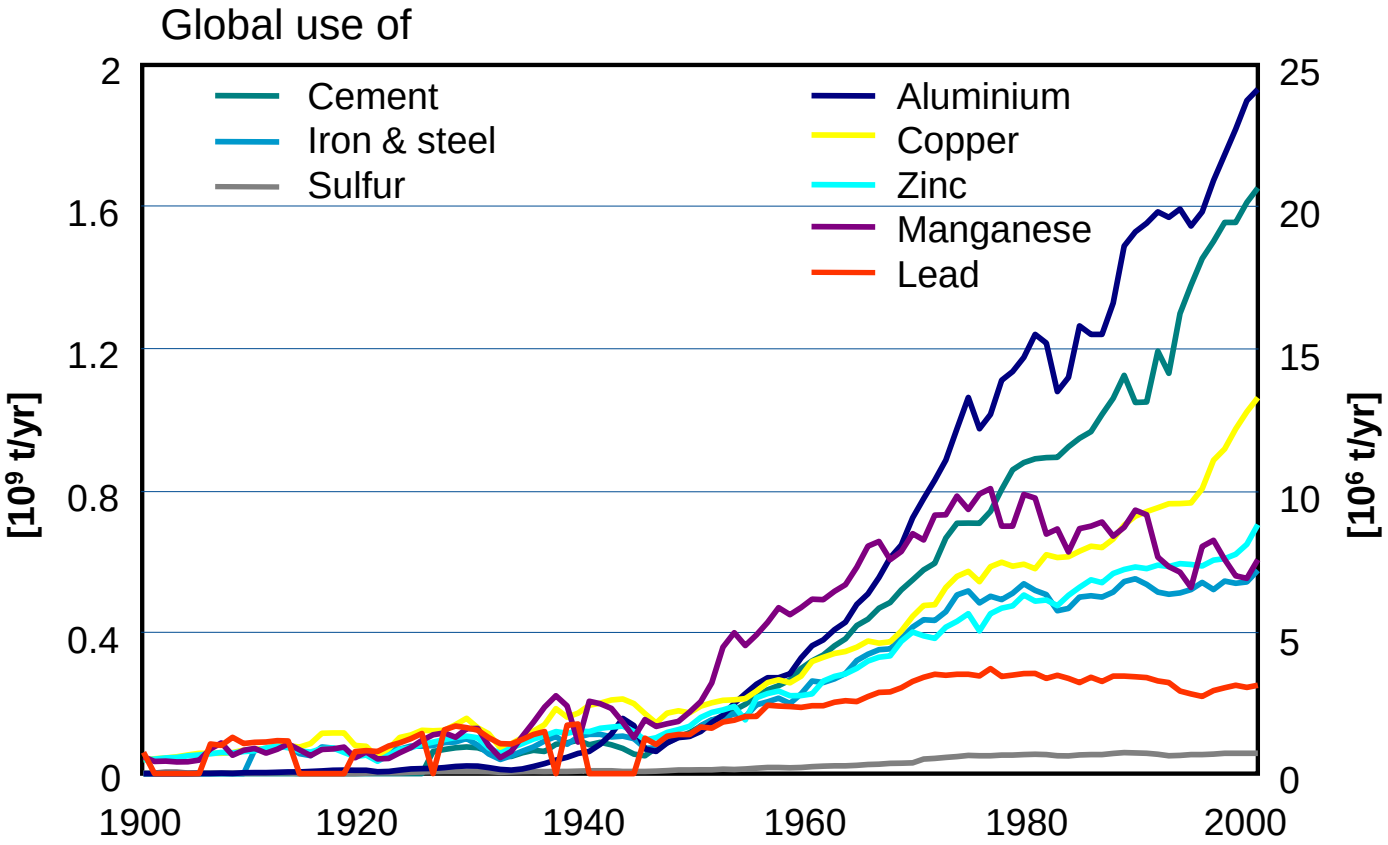
Growing consumption of resources



Source: Brunner & Rechberger 2004

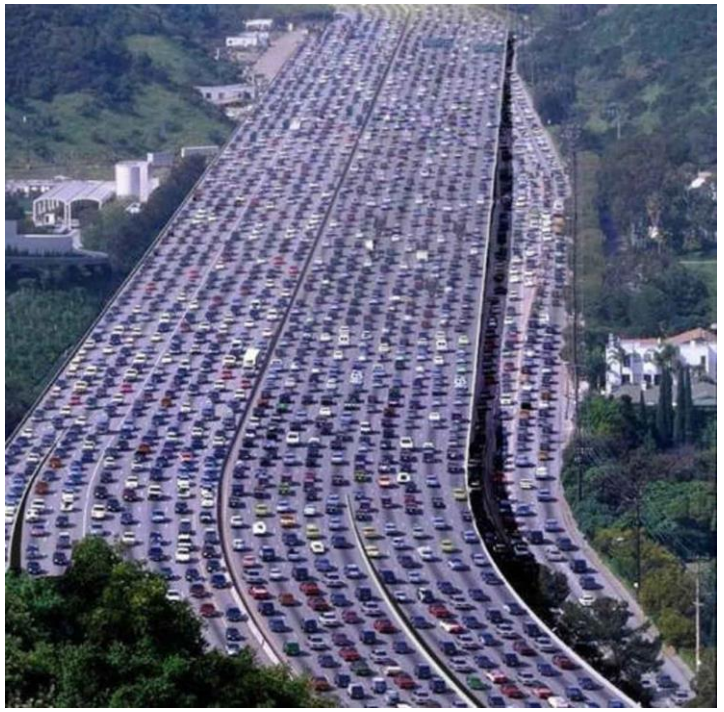
The resource consumption over a person's life

Sand and gravel	307 t
Lignite	158 t
Hard rock	130 t
Mineral oil	116 t
Natural gas (1000 m^3)	90
Limestone, dolomite	72 t
Hard coal	67 t
Steel	40 t
Cement	29 t
Rock salt	12 t
Gypsum	8,5 t
Industrial sand	4,7 t
Kaolin	4,0 t
Potash (K_2O)	3,4 t
Aluminium	1,7 t
Copper	1,1 t
Steel refiners	0,9 t
Sulphur	0,2 t
Asbestos	0,16 t
Phosphate	0,15 t
Electricity (MWh)	290

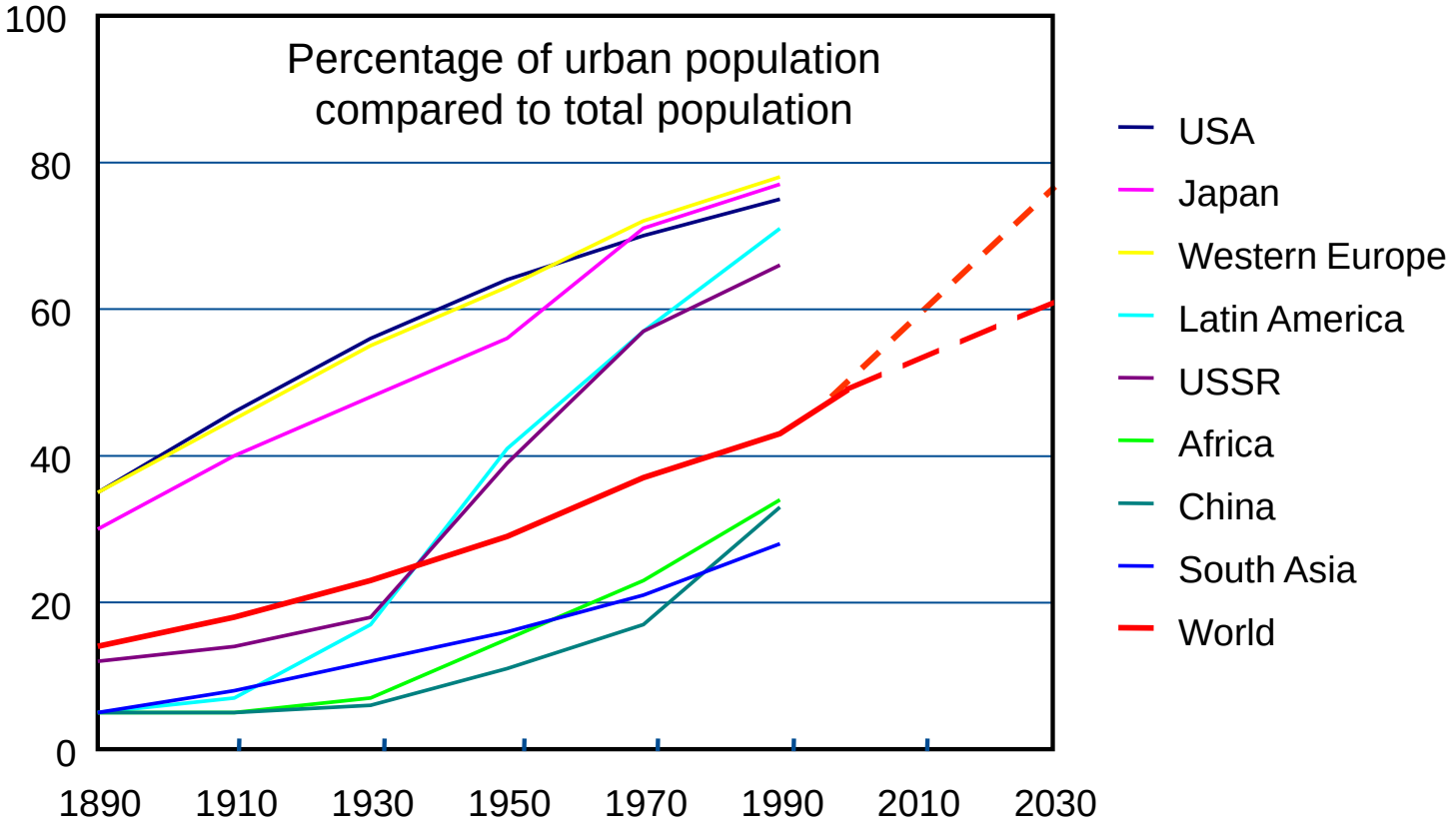
Source: BGR, Germany

1000 tons

or ca. 670 cars

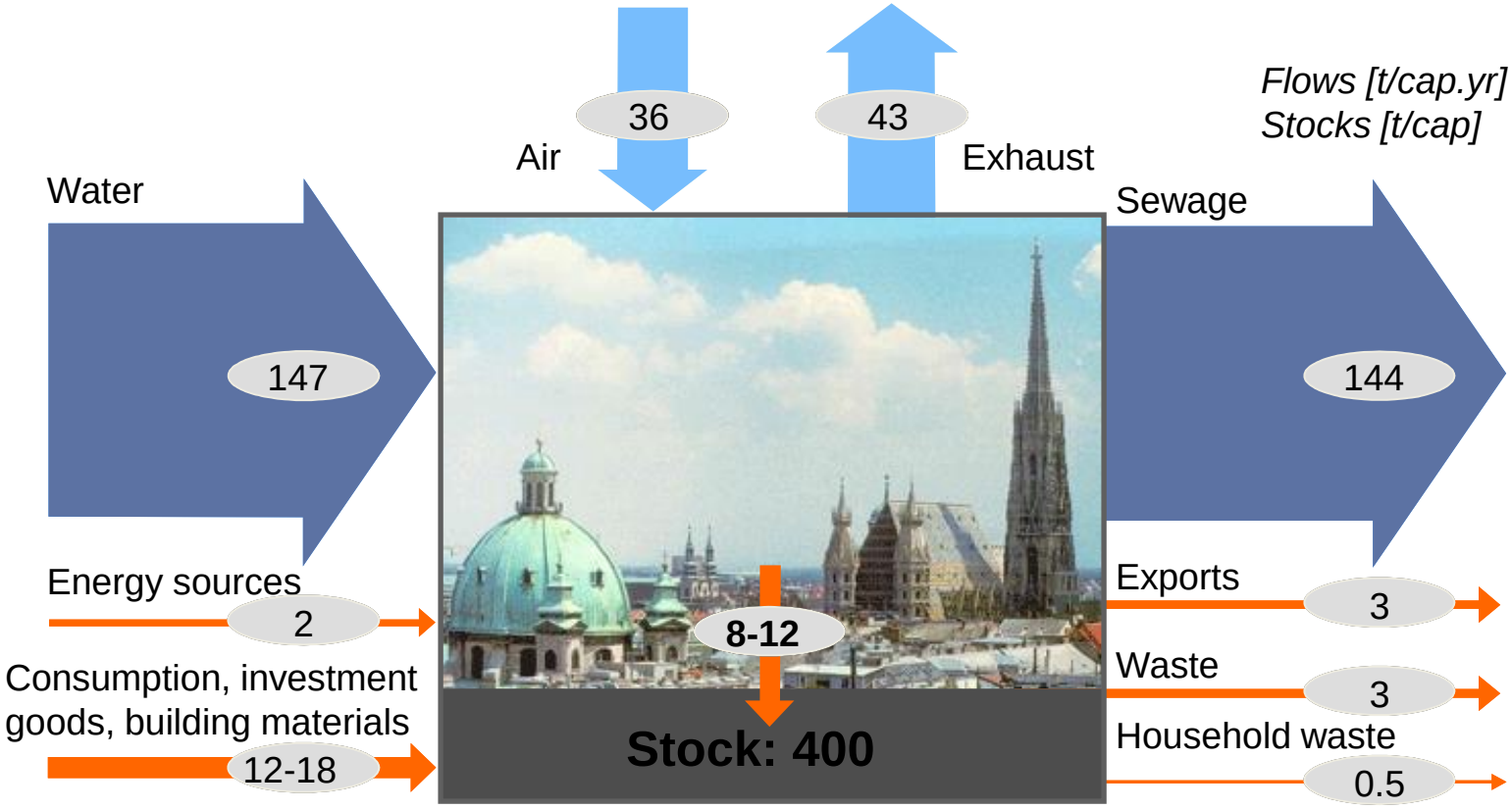


Urban way of life is getting dominant



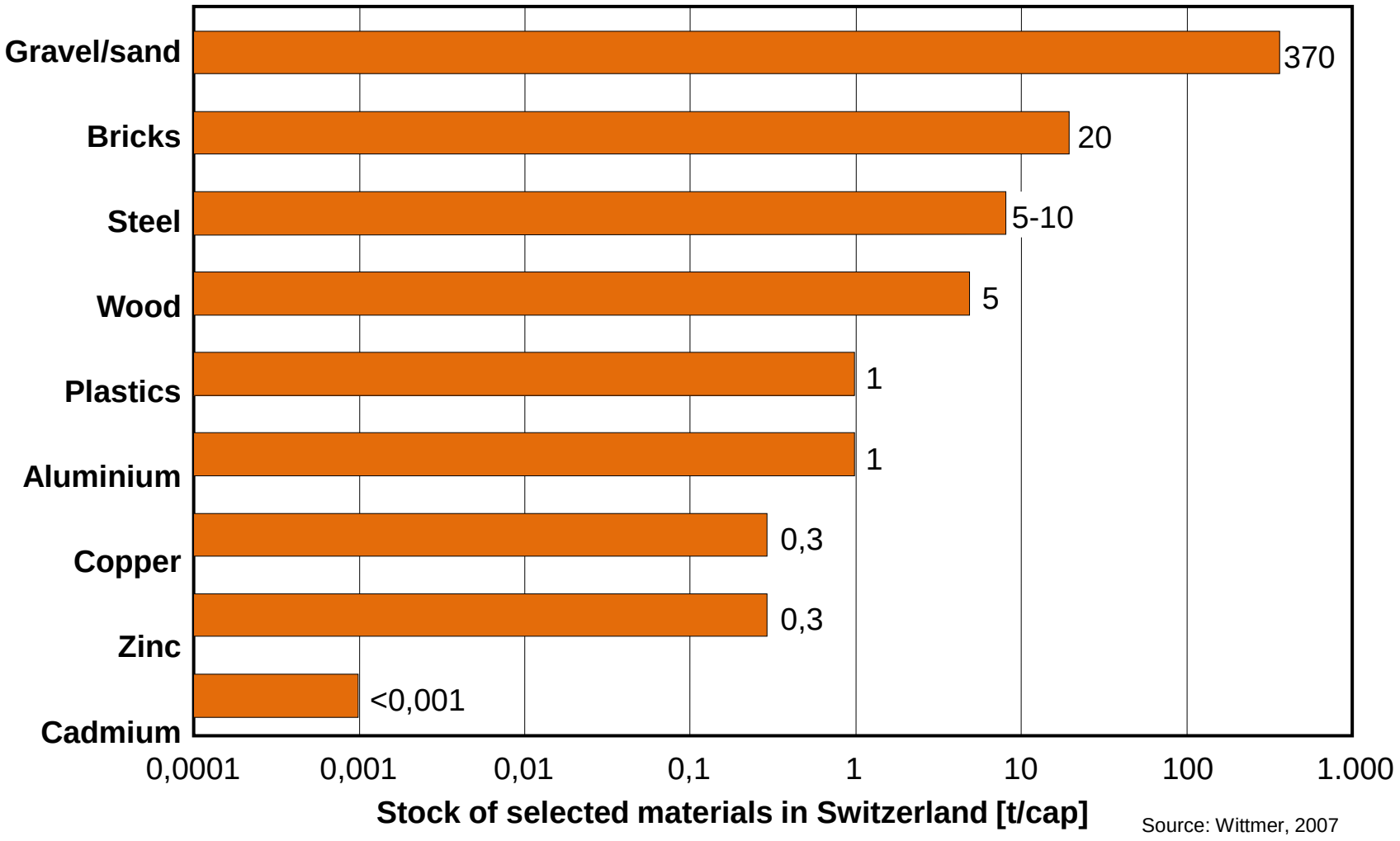
Sources: McNeill 2003; UN Population Division 2002

Cities are becoming „heavier“



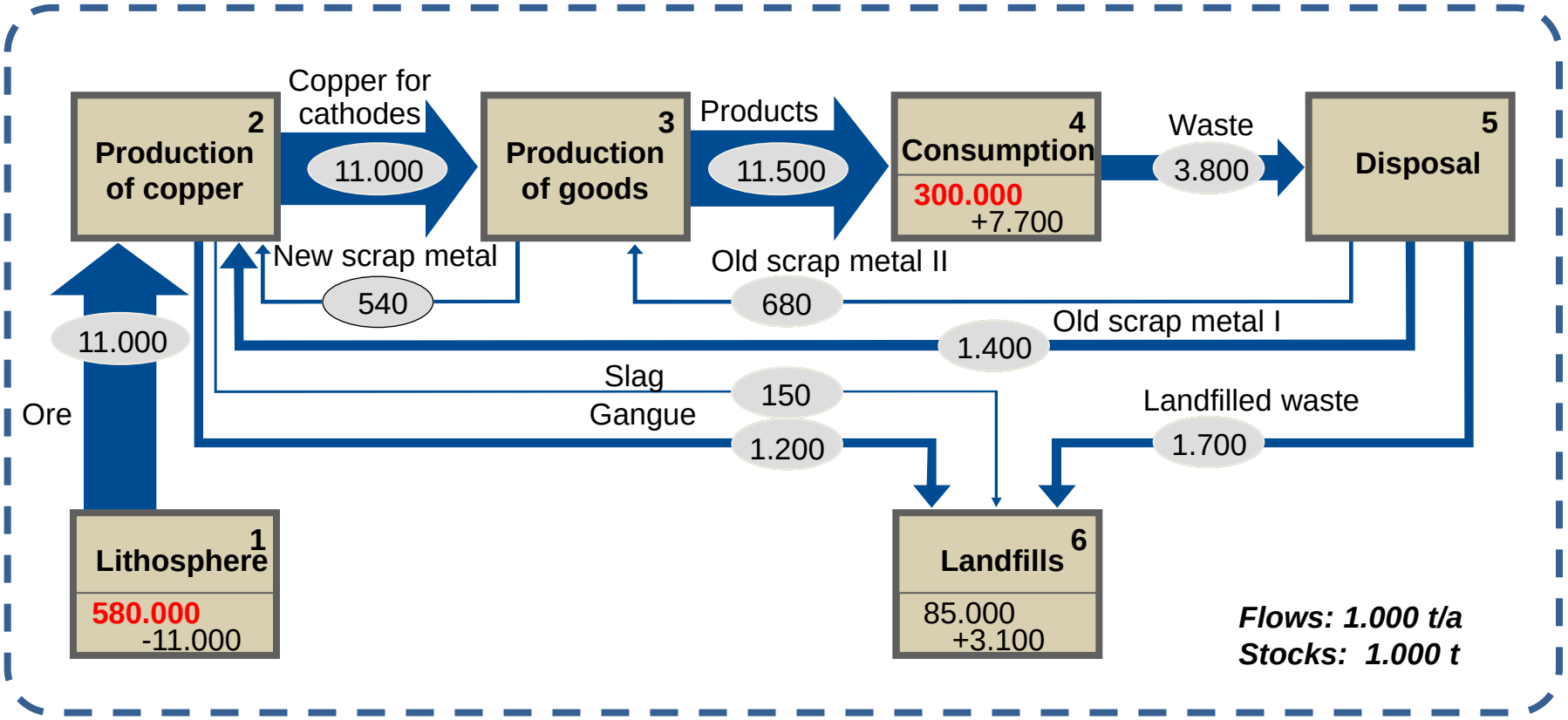
Source: Daxbeck et al. 1996 (updated)

Composition of the urban stock



Source: Wittmer, 2007

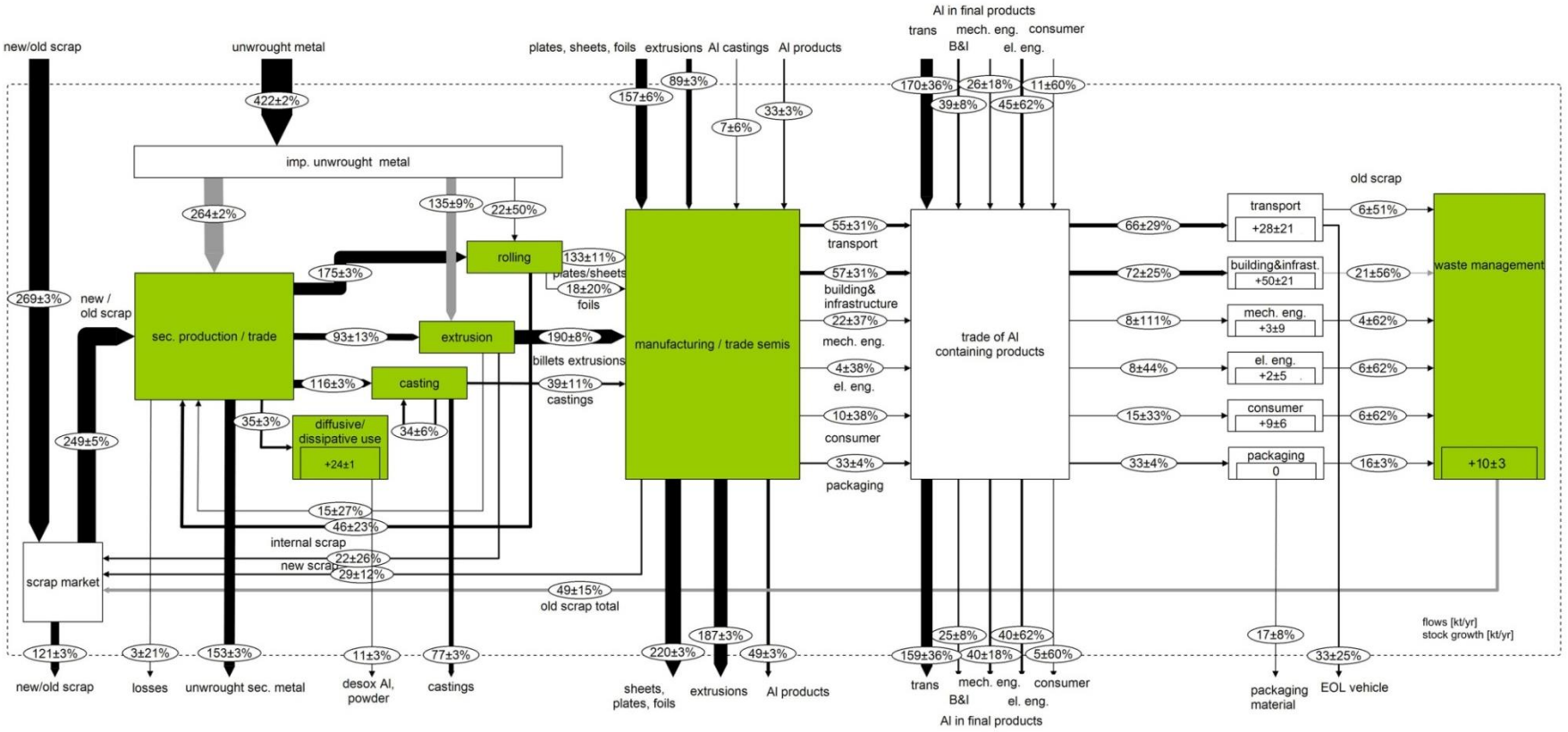
Primary and secondary stocks same order of magnitude (example copper)



System boundary "World 1994"

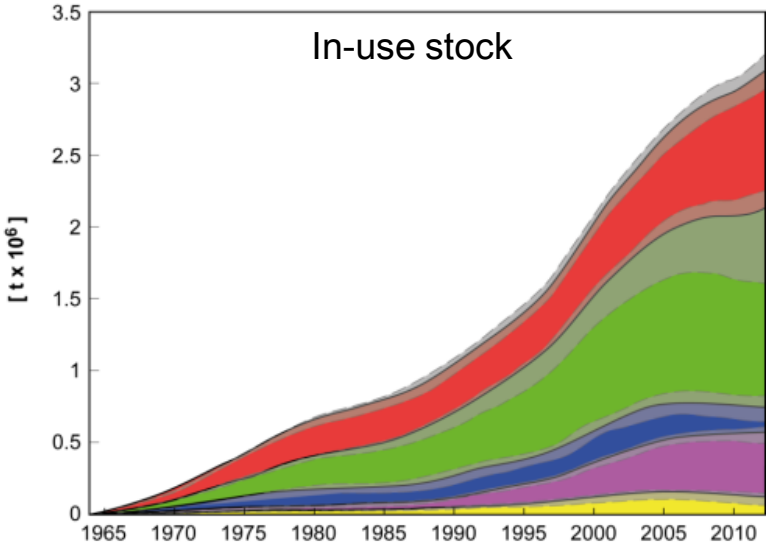
Source: Graedel et al. 2002 (completed)

Aluminium balance, Austria 2010

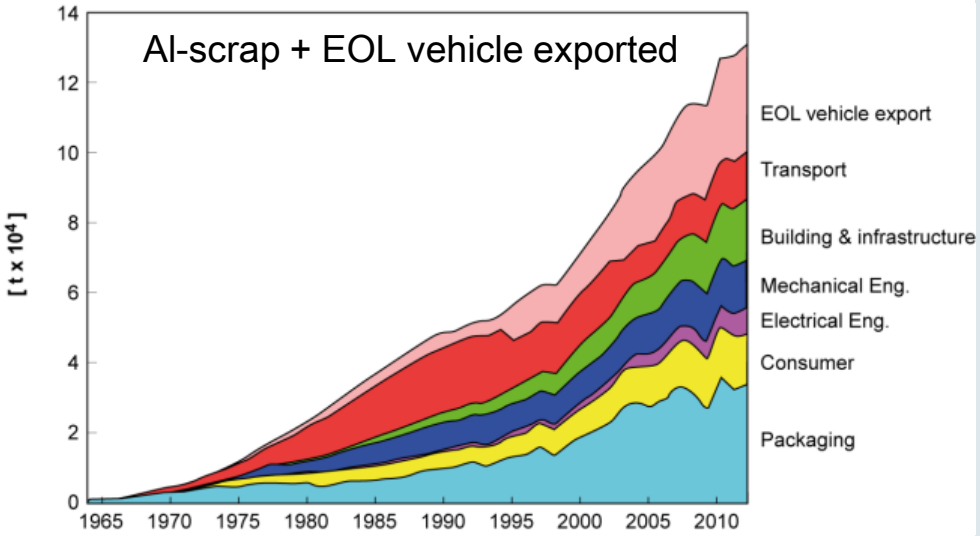


Buchner et al., 2014, In-depth analysis of aluminum flows in Austria as a basis to increase resource efficiency

Selected results from the dynamic model



360 kg/cap



12 kg/cap.yr

Buchner et al., 2015: Dynamic material flow modelling: An effort to calibrate and validate aluminium stocks and flows in Austria (submitted)

Resource potential of built infrastructure

Material composition of different building types in Vienna

- Case studies (investigation of buildings before demolition based on available documents, inspection, and selective sampling)
- Construction files of demolished buildings
- Tender documents, final bills, LCA-Data of new buildings
- Literature

Analysis of the building structure to estimate the overall material stock of buildings in Vienna

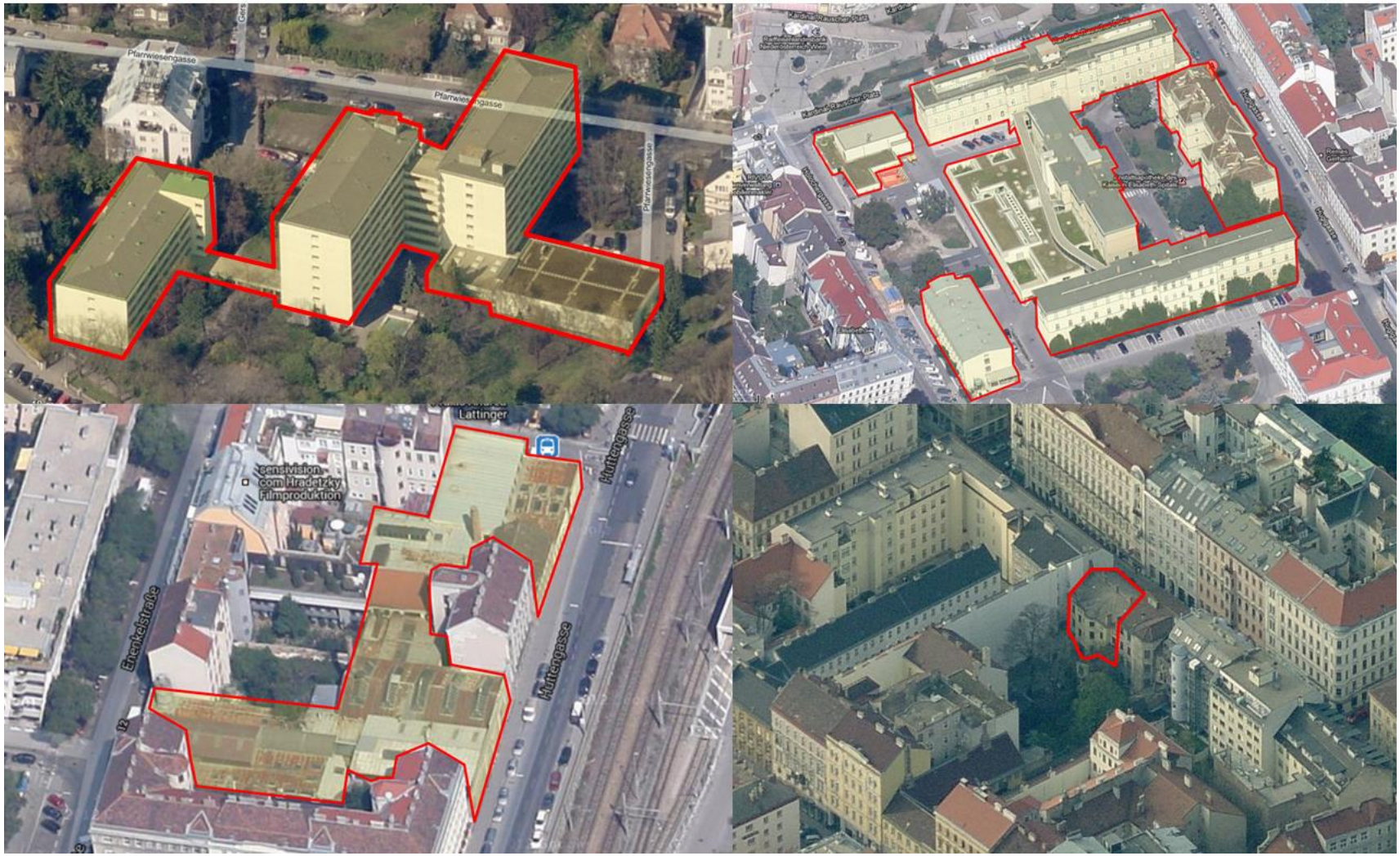
- Based on: GIS-data (size, period of construction, utilization), and
- the material composition of different building types

Estimation the material output from demolition activities in Vienna

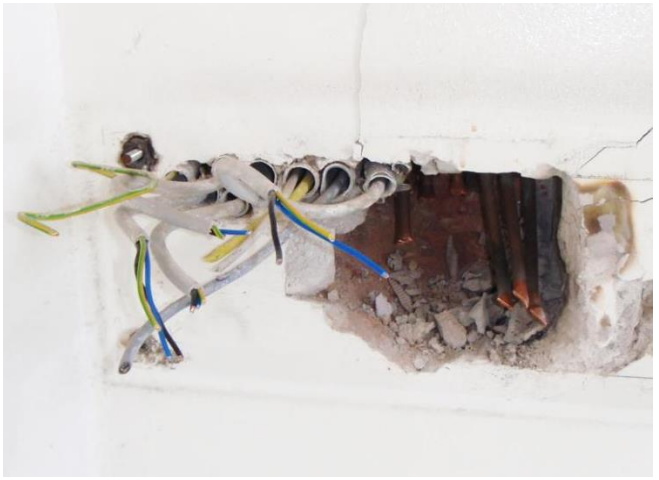
- Based on: information about demolition activities in Vienna (construction files of demolished buildings, data from remote sensing), and
- the material composition of different building types

Kleemann, F.; Lederer, J.; Aschenbrenner, P.; Rechberger, H.; Fellner, J. A method for determining buildings' material composition prior to demolition, *Building Research & Information*, 43, 0, 1-12, 2015.

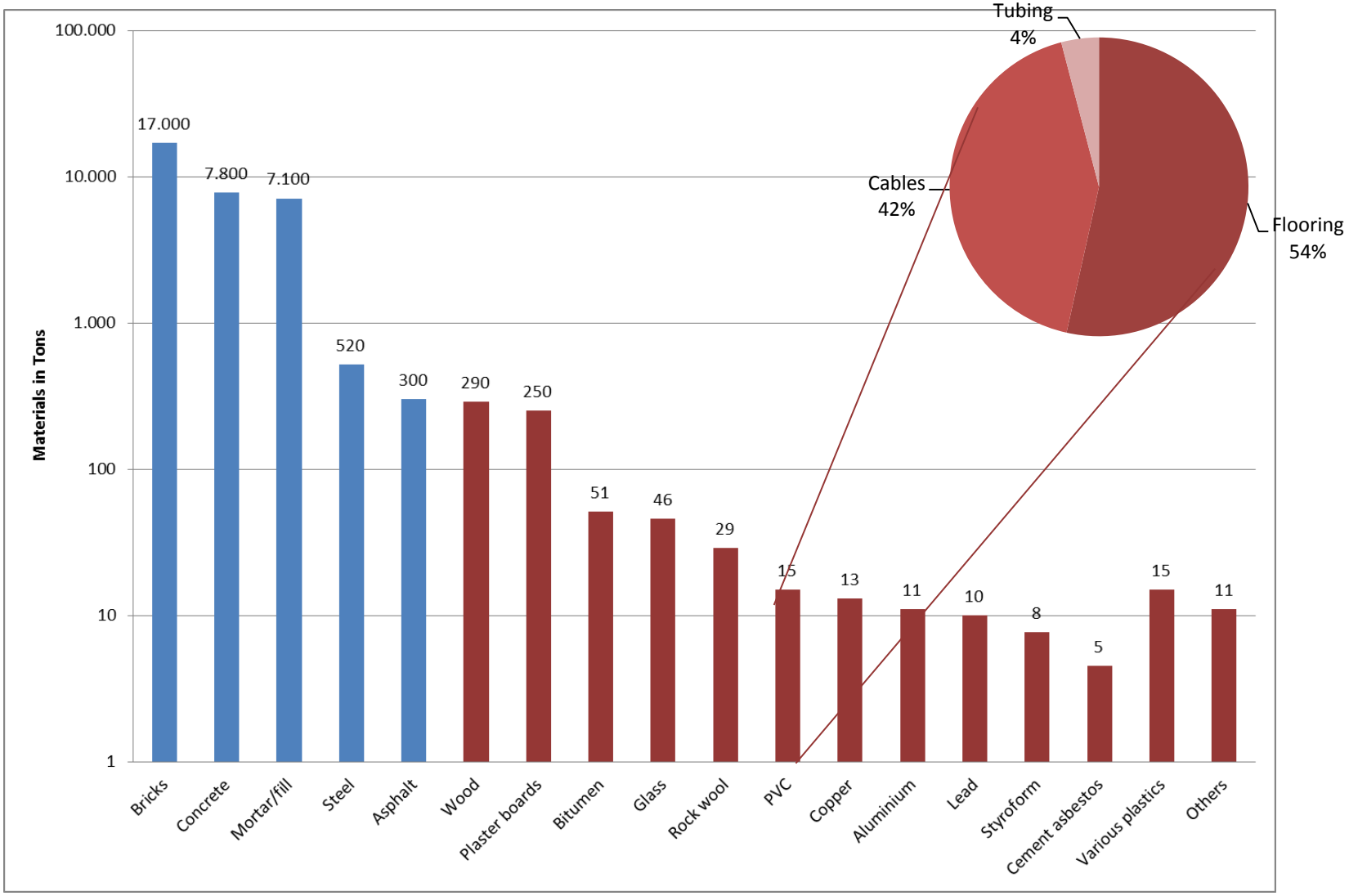
Selected investigated buildings



On-site investigation



Result for single building



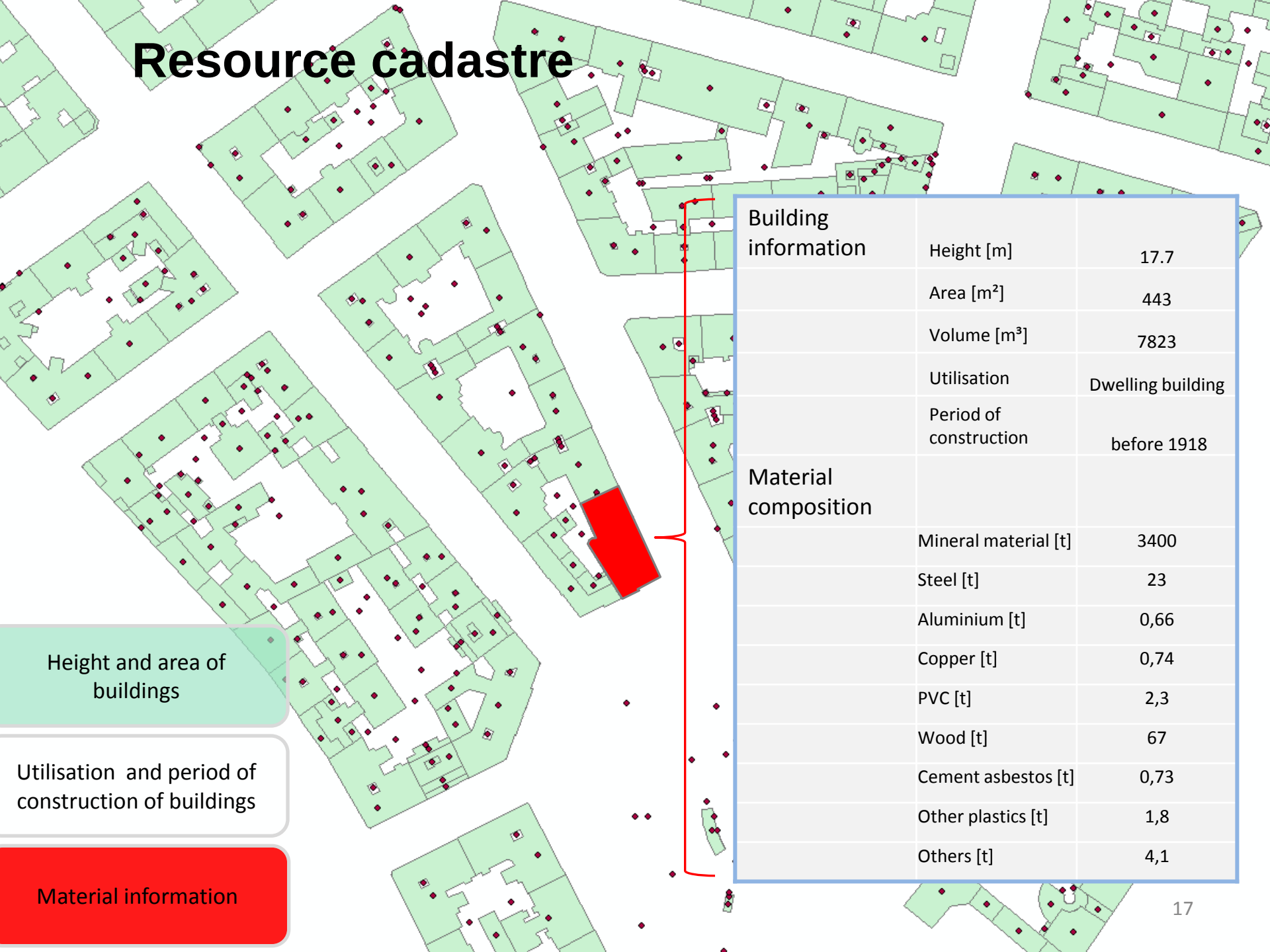
Material composition [kg/m³ gross volume]

Material	CS1 1970	CS2.1 1870	CS2.2 1960	CS2.3 2003	CS3 1930	CS4 1890
Minerals	430	420	410	320	260	450
Steel	7.6	5.1	4.6	8.6	5.8	0.97
Aluminium	0.22	0.049	0.057	0.55	0.03	0.16
Copper	0.11	0.15	0.16	0.24	0.0019	0.062
PVC	0.52	0.19	0.21	0.18	0.0093	0.2
Wood	2.3	4.3	2.2	0.62	3.6	20
Asbestos	1.5	0.04	-	-	0.14	-
Other plastics	1.3	0.16	0.35	4.9	0.14	0.46
Others	1.1	0.54	1.2	0.69	0.43	0.13
Total	**440**	**430**	**420**	**340**	**270**	**470**


Height and area of buildings


Height and area of buildings
Utilisation and period of construction of buildings

Resource cadastre



Building information	Height [m]	17.7
	Area [m²]	443
	Volume [m³]	7823
	Utilisation	Dwelling building
	Period of construction	before 1918
Material composition		
	Mineral material [t]	3400
	Steel [t]	23
	Aluminium [t]	0,66
	Copper [t]	0,74
	PVC [t]	2,3
	Wood [t]	67
	Cement asbestos [t]	0,73
	Other plastics [t]	1,8
	Others [t]	4,1

Height and area of buildings

Utilisation and period of construction of buildings

Material information

How far have we come….and what is ahead?

✓ We have methods and knowledge to determine the anthropogenic stock
→ We need to classify into reserves and resources
→ We need to provide sound prediction about waste generation

This is the vision