VILLES ET ECONOMIE CIRCULAIRE
Changement à la marge ou de système ?

Aristide Athanassiadis – 1er Juin 2023

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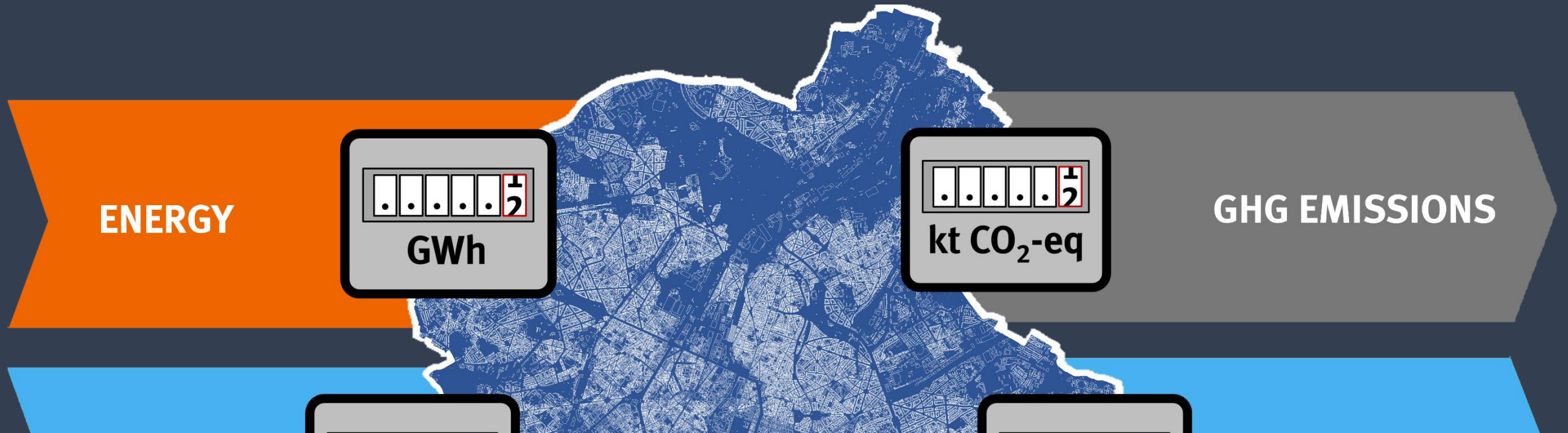
EPFL

www.epfl.ch/labs/herus
www.metabolismofcities.org



Petite intro

Chercheur,
Administrateur,
Accompagnateur,

Quelques projets

BATir

EcoRes

INSTITUT DE CONSEIL ET D'ETUDES EN DEVELOPPEMENT DURABLE

Métabolisme de la Région de Bruxelles-Capitale : identification des flux, acteurs et activités économiques sur le territoire et pistes de réflexion pour l'optimisation des ressources

Rapport final juillet 2015

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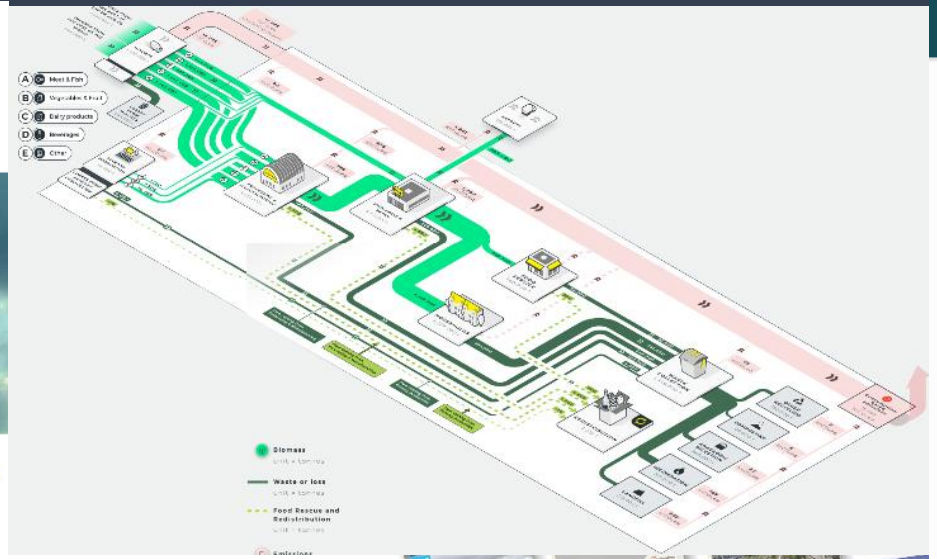
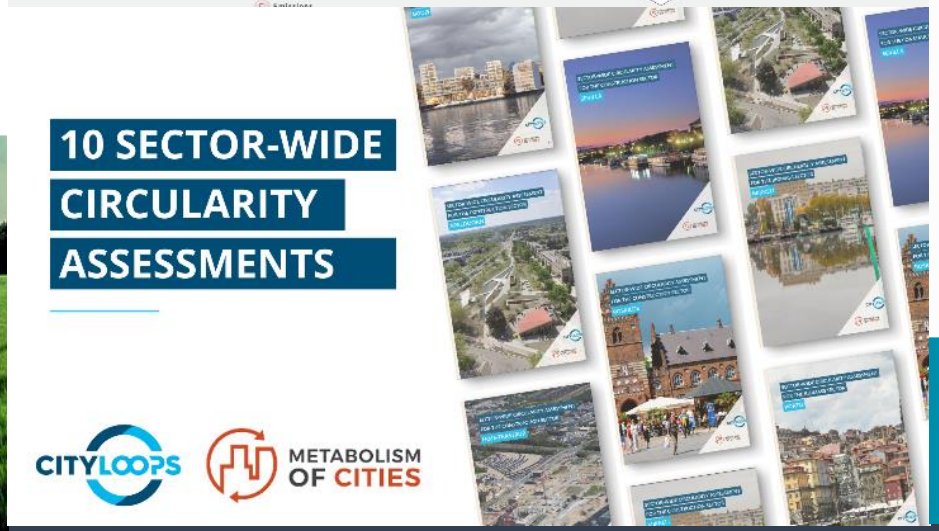
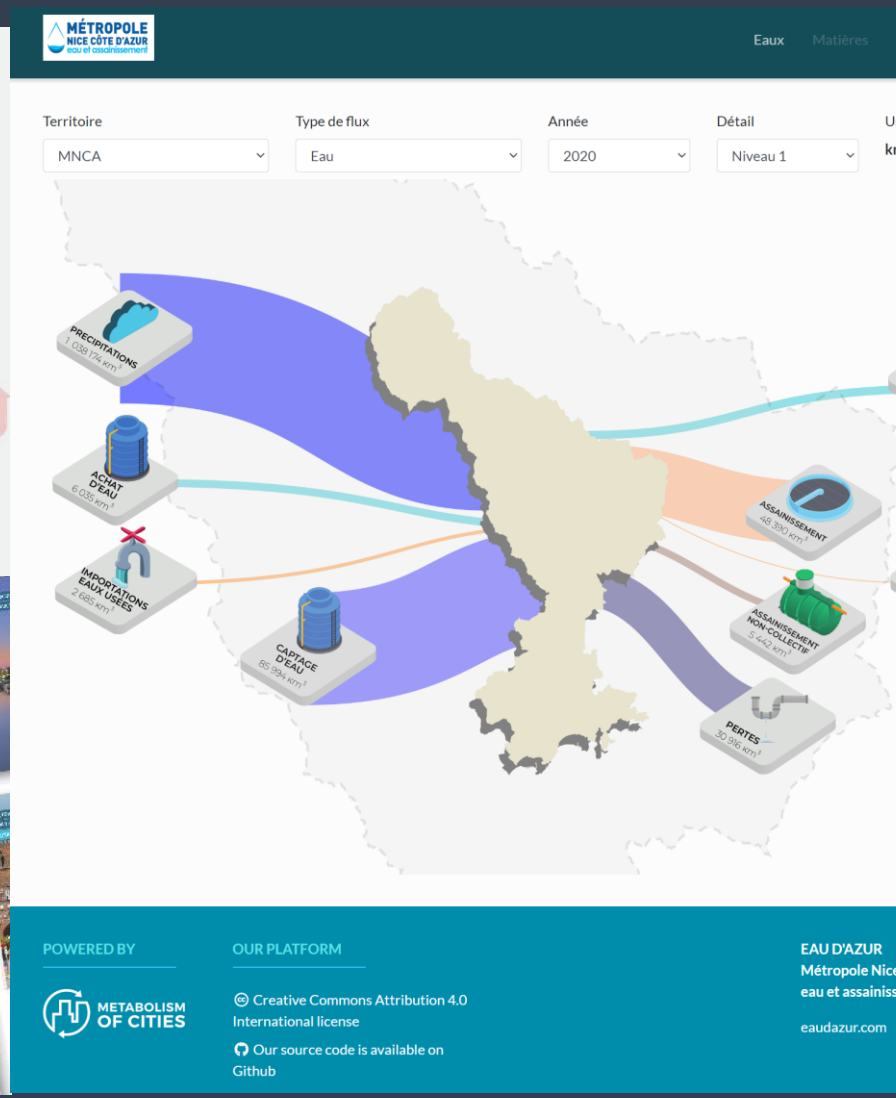
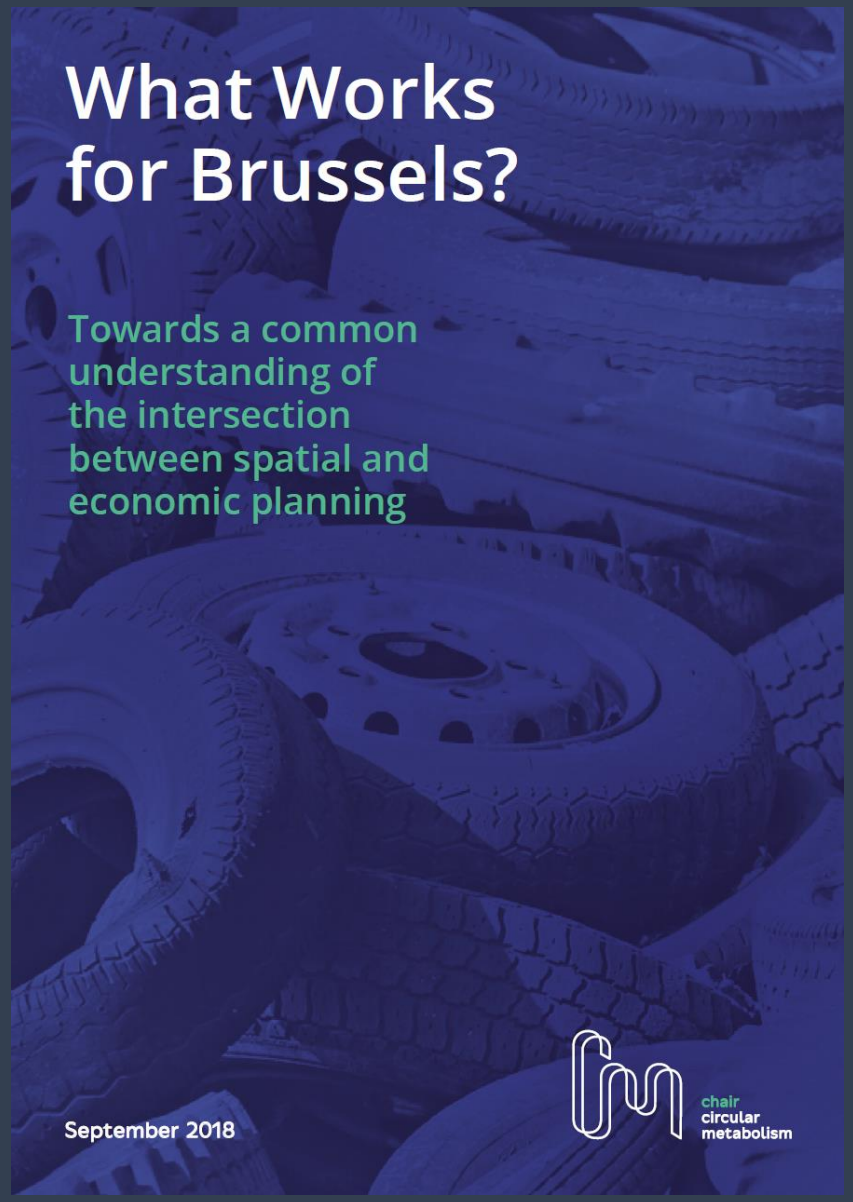
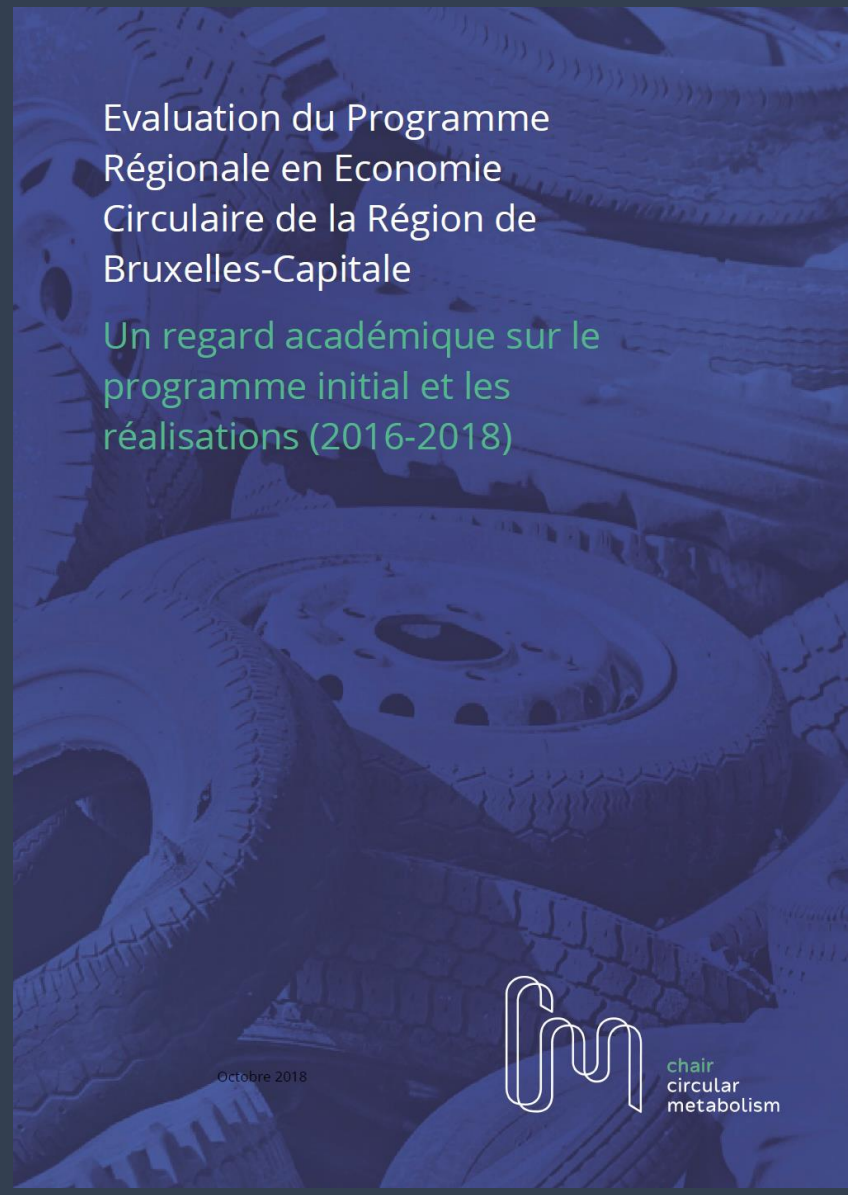




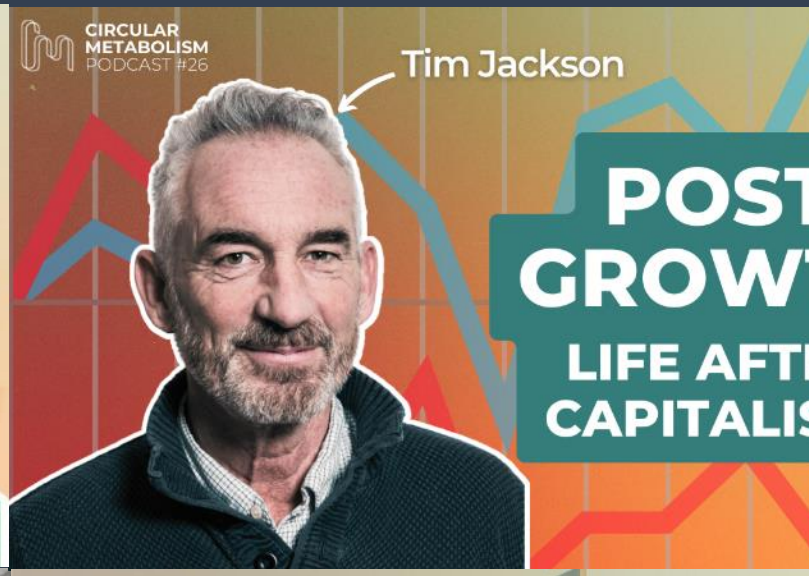


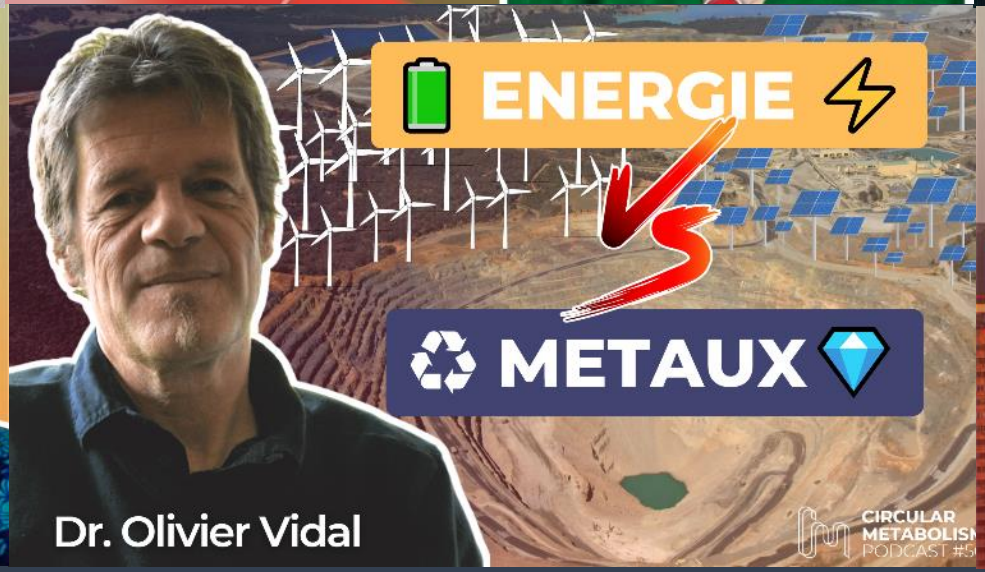
Circular Metabolism Chair



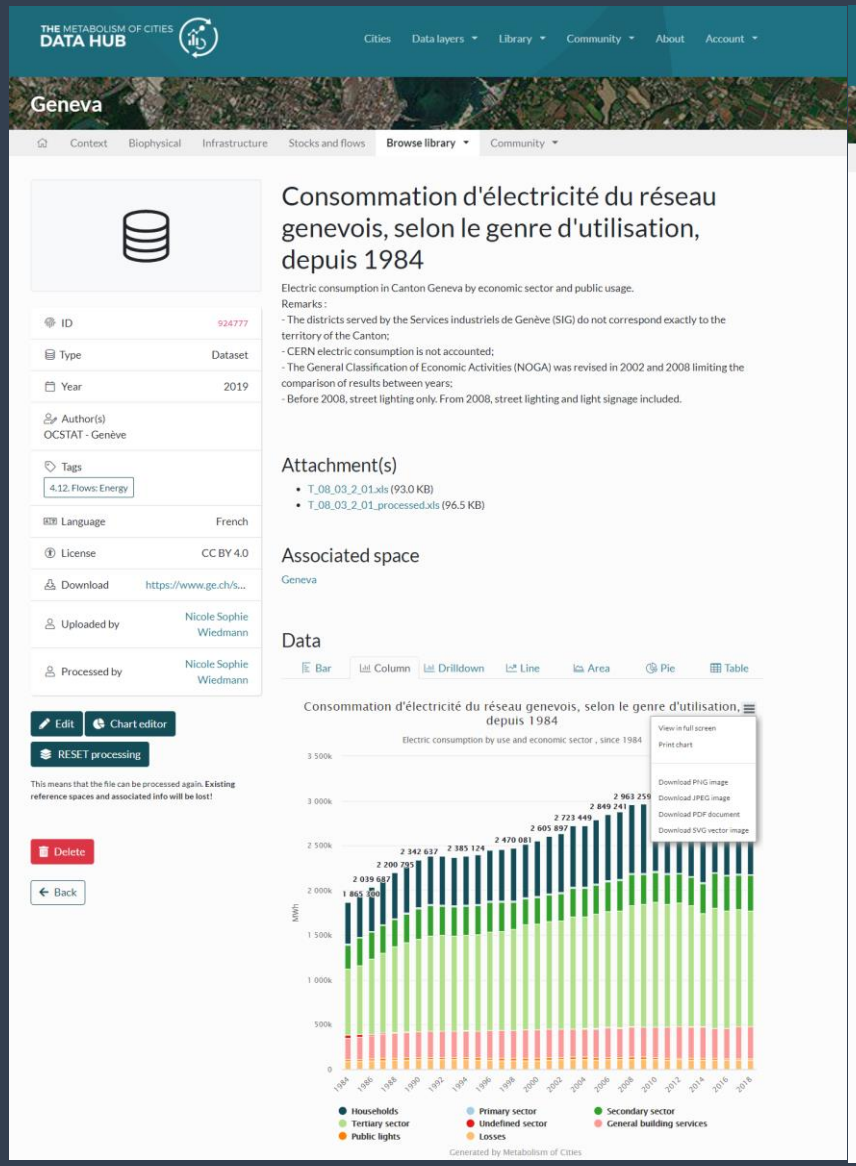


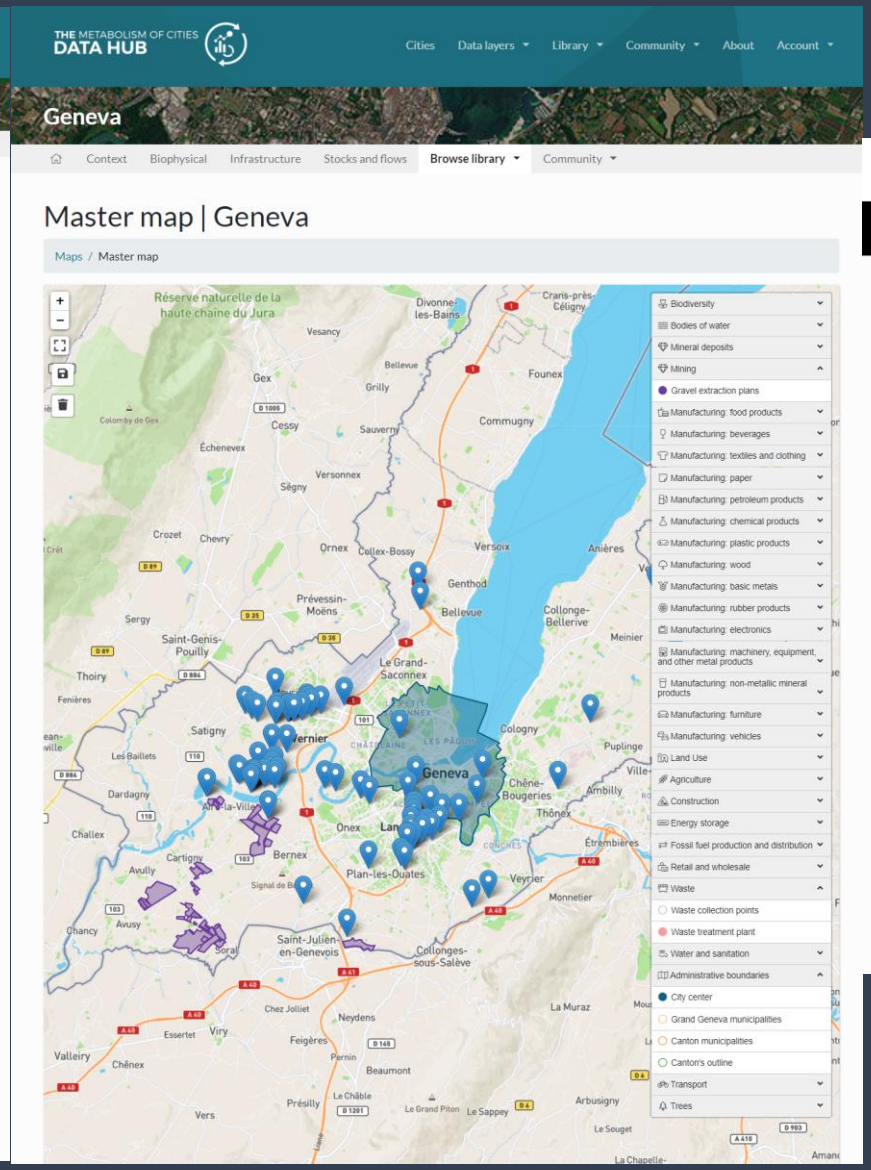
Circular Metabolism Podcast

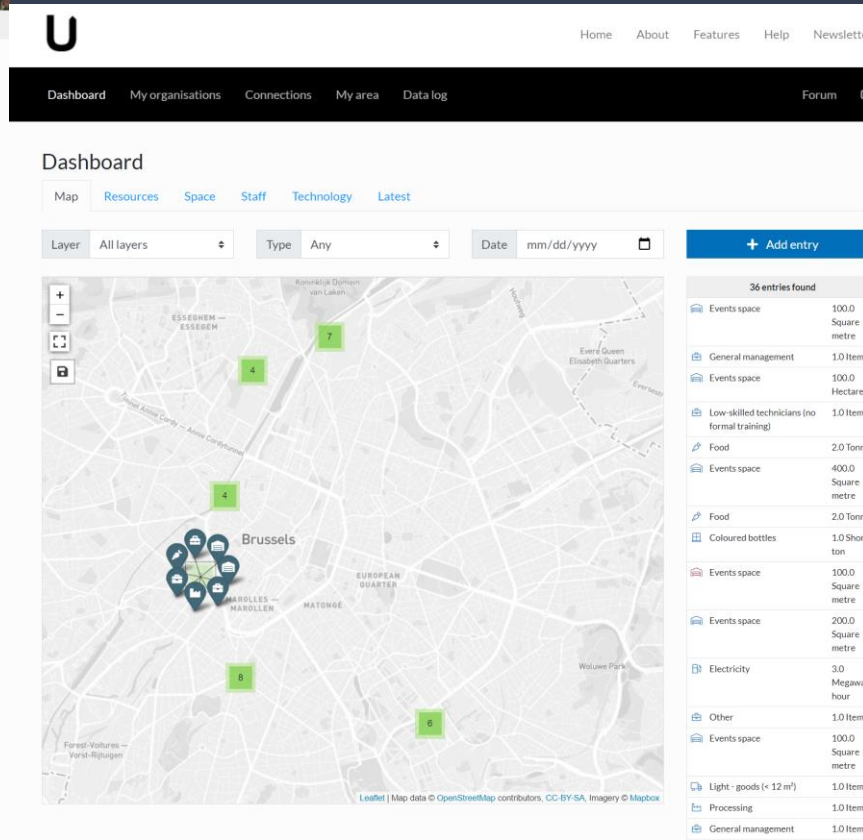




Metabolism of Cities

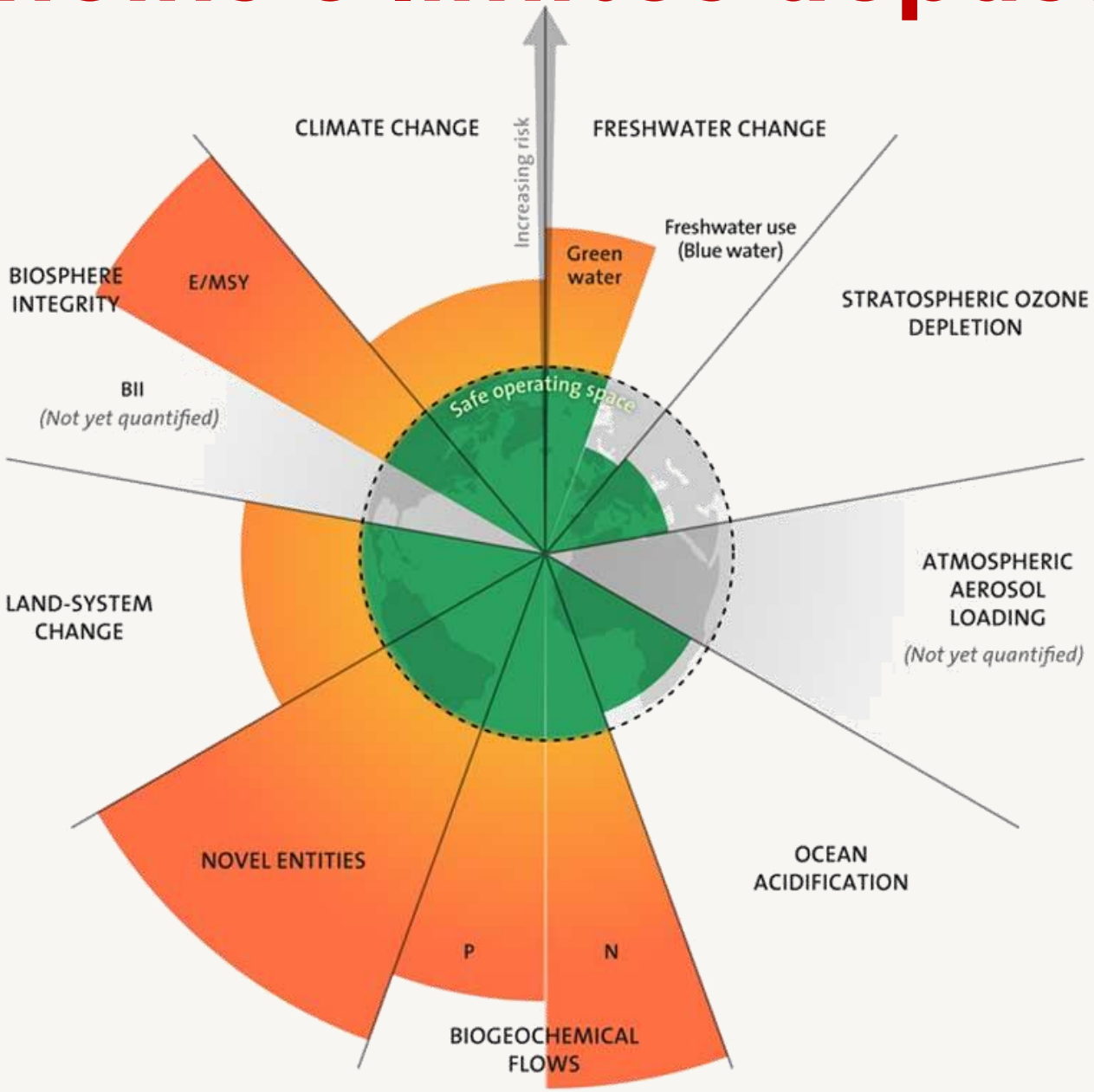




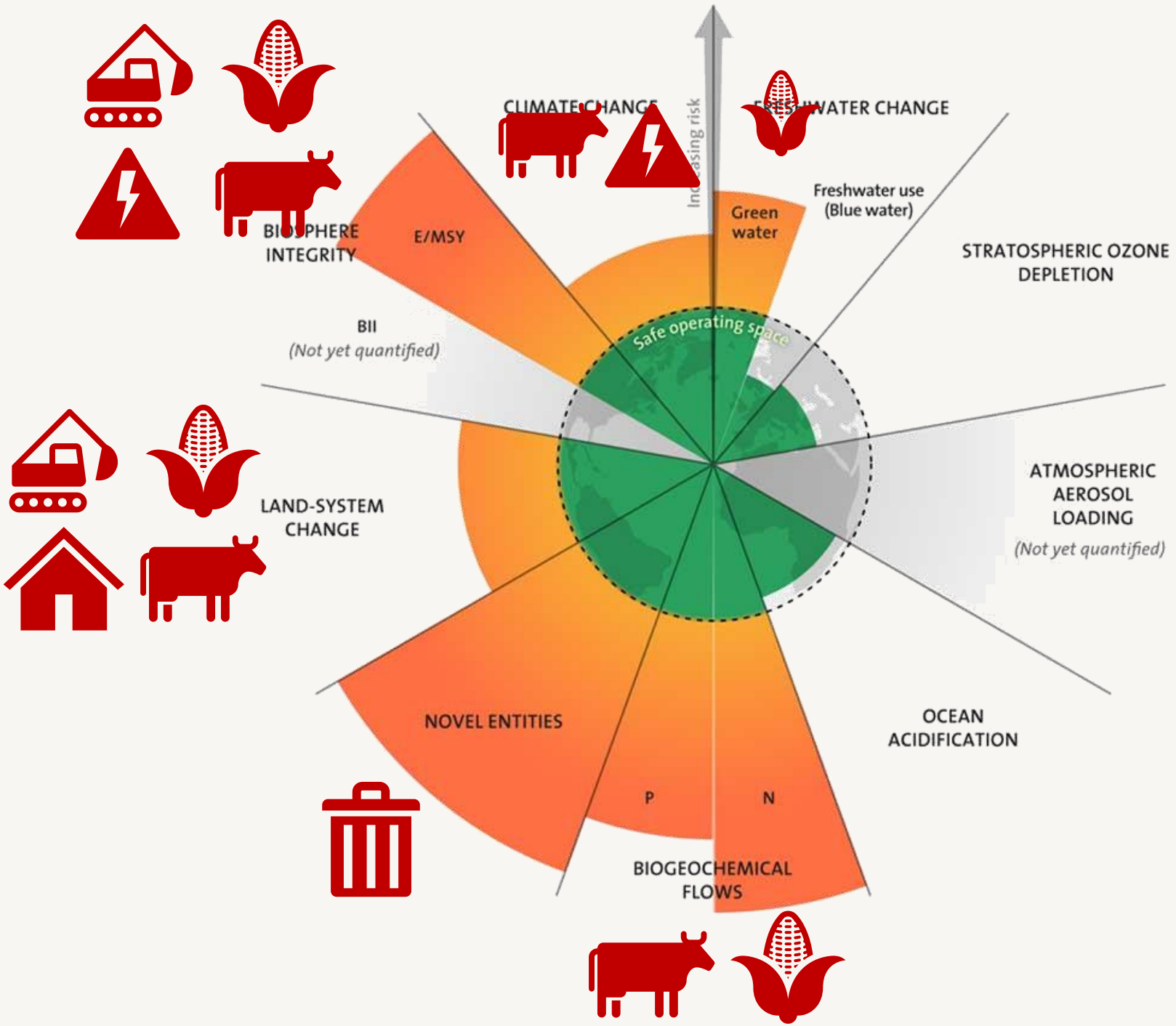


Villes et Limites Planétaires

Au moins 6 limites dépassées



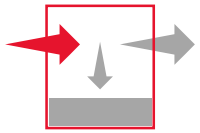
Steffen et al. (2015). Planetary boundaries: Guiding human development on a changing planet

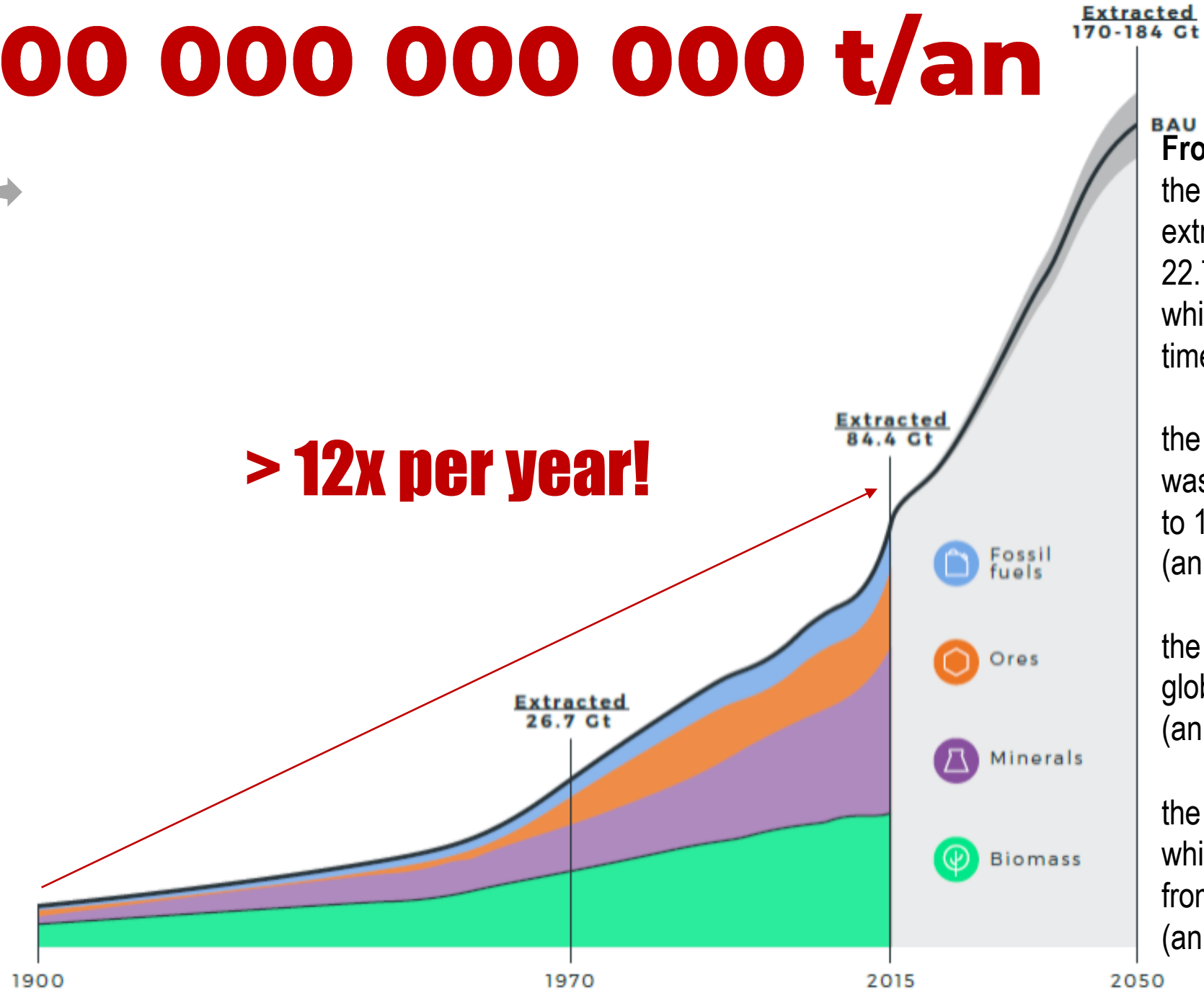


Steffen et al. (2015). Planetary boundaries: Guiding human development on a changing planet

Comment on est arriver à cette impasse ?

100 000 000 000 t/an





> 12x per year!

From 1900 to 2015,
the amount of biomass which was extracted globally went from 5.5 Gt/yr to 22.7 Gt/yr (**an increase of 4.3 times**) while global population increased by 4.5 times.

the amount of fossil energy carriers which was extracted globally went from 1 Gt/yr to 14.5 Gt/yr
(an increase of **14.5 times**)

the amount of ores which was extracted globally went from 0.2 Gt/yr to 6.5 Gt/yr
(an increase of **33 times**)

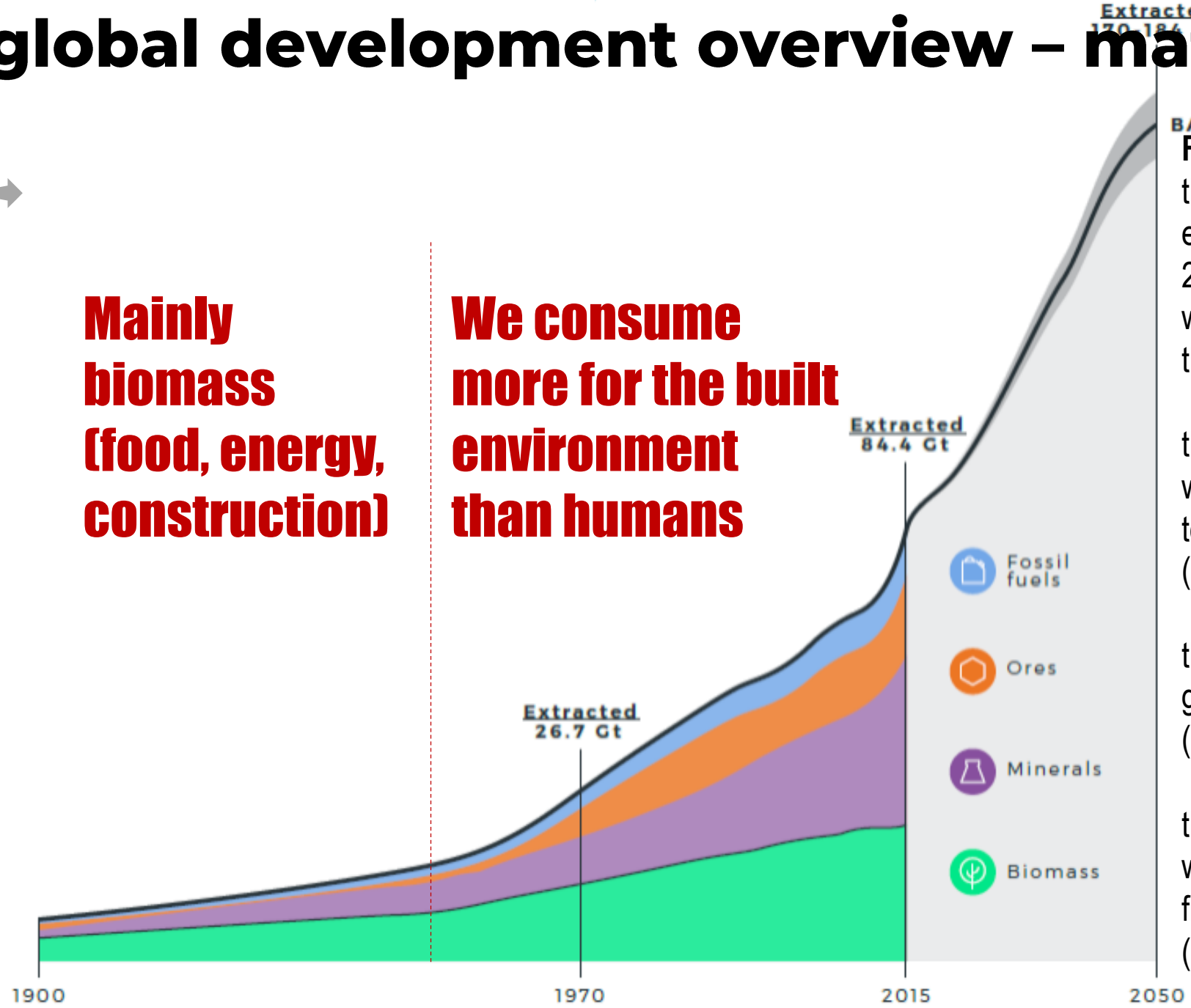
the amount of non-metallic minerals which was extracted globally went from 0.9 Gt/yr to 45.3 Gt/yr
(an increase of **50 times**).

Krausmann, F., Lauk, C., Haas, W., & Wiedenhofer, D. (2018). From resource extraction to outflows of wastes and emissions: The socioeconomic metabolism of the global economy, 1900–2015. *Global Environmental Change*, *52*, 131-140.

A global development overview – material extraction

Mainly biomass (food, energy, construction)

We consume more for the built environment than humans



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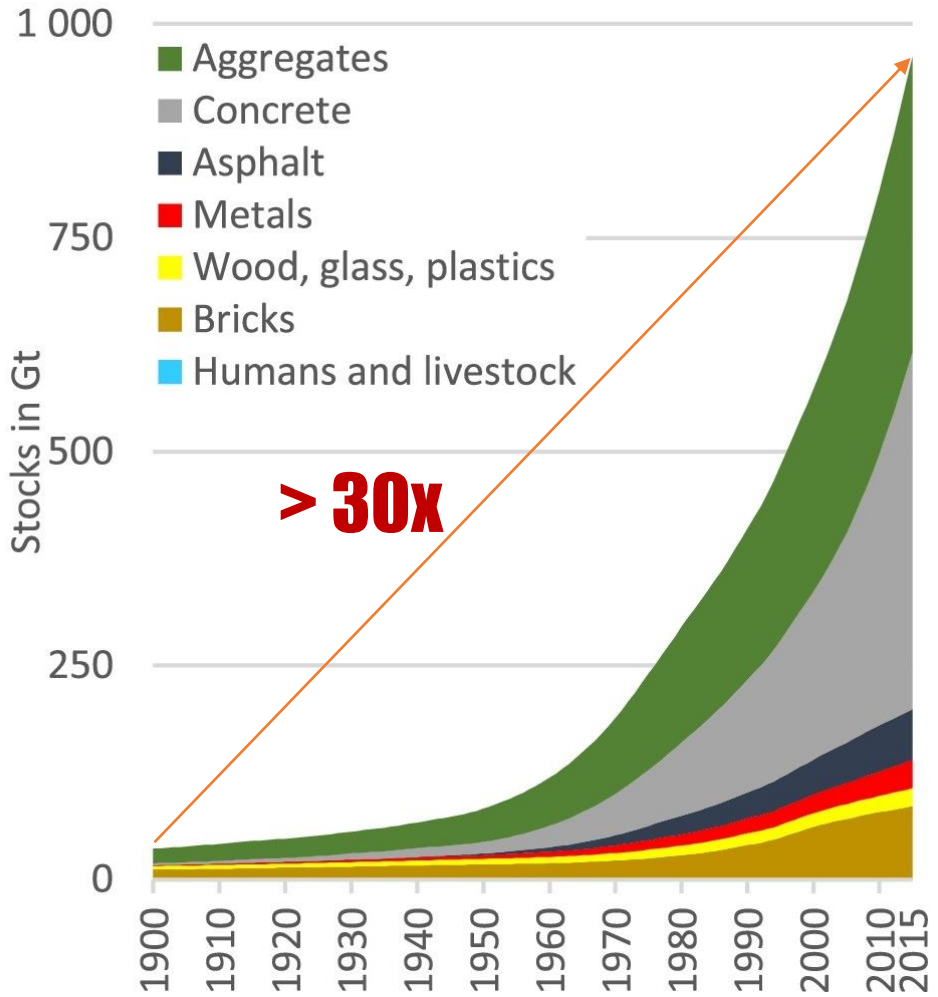
1 000 000 000 000 t (150/cap)

A global development overview – material stock



Krausmann, F., Lauk, C., Haas, W., & Wiedenhofer, D. (2018). From resource extraction to outflows of wastes and emissions: The socioeconomic metabolism of the global economy, 1900–2015. *Global Environmental Change*, *52*, 131-140.

A global development overview – material stock

Elhacham, E., Ben-Uri, L., Grozovski, J., Bar-On, Y. M., & Milo, R. (2020). Global human-made mass exceeds all living biomass. *Nature*, *588*(7838), 442-444.
Krausmann, F., Lauk, C., Haas, W., & Wiedenhofer, D. (2018). From resource extraction to outflows of wastes and emissions: The socioeconomic metabolism of the global economy, 1900–2015. *Global Environmental Change*, *52*, 131-140.

Circularité

Entrants

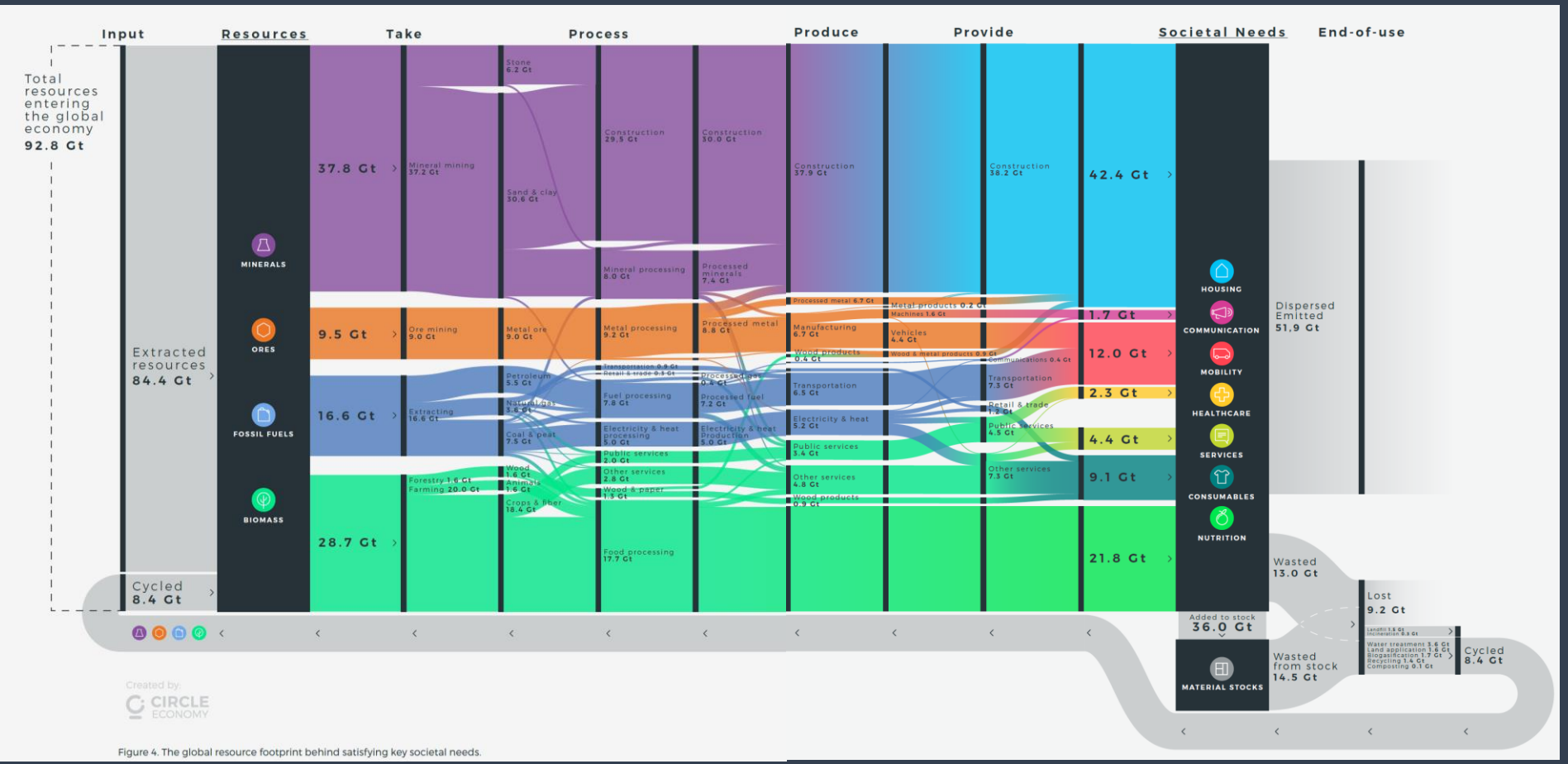


Figure 4. The global resource footprint behind satisfying key societal needs.

2018: 9,1%

2020: 8,6%

2023: 7,2%

Les villes au ❤️ des enjeux

Des villes linéaires et ouvertes

Desolidarisation / Linéarisation

Source: Barles, S. (2005). L'invention des déchets urbains: France, 1790-1970. Editions Champ Vallon.

Nouvelles infrastructures

Spécialisation d'Emplois

Spécialisation Spatiale

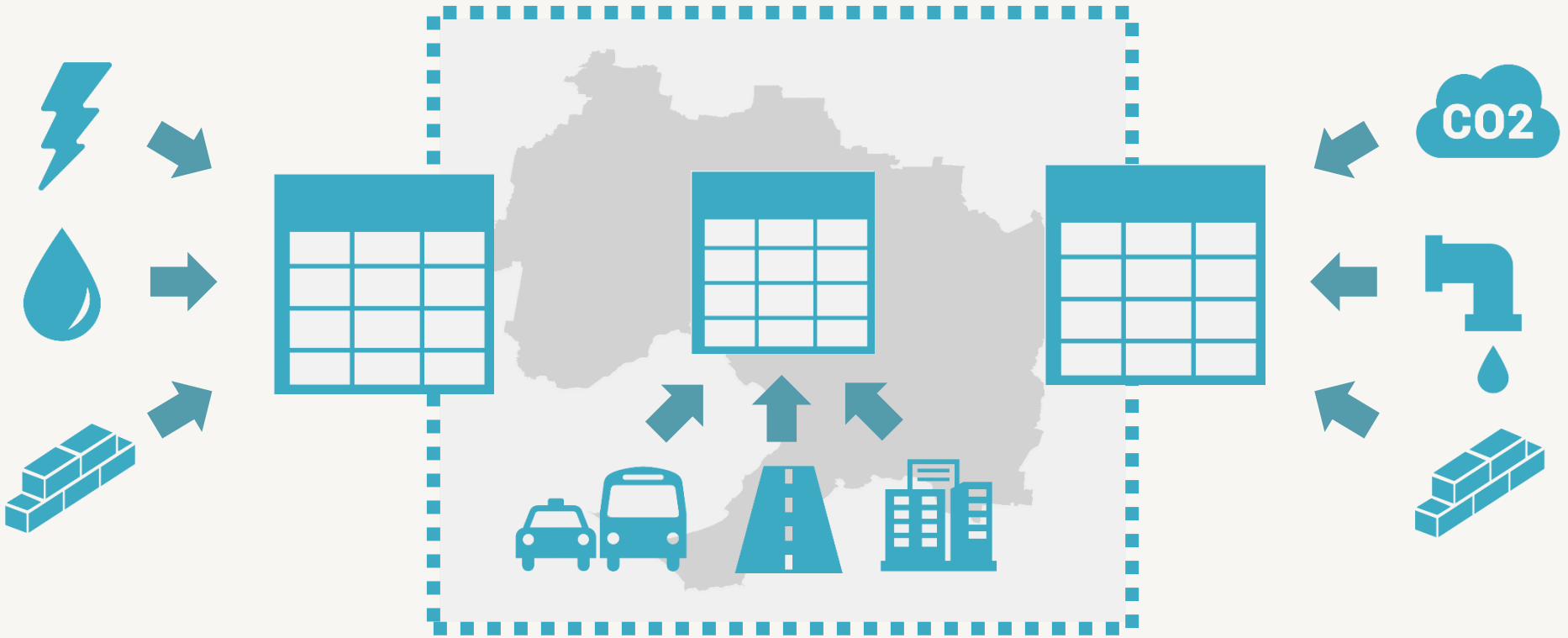
Nouvelles technologies

City without resources ?

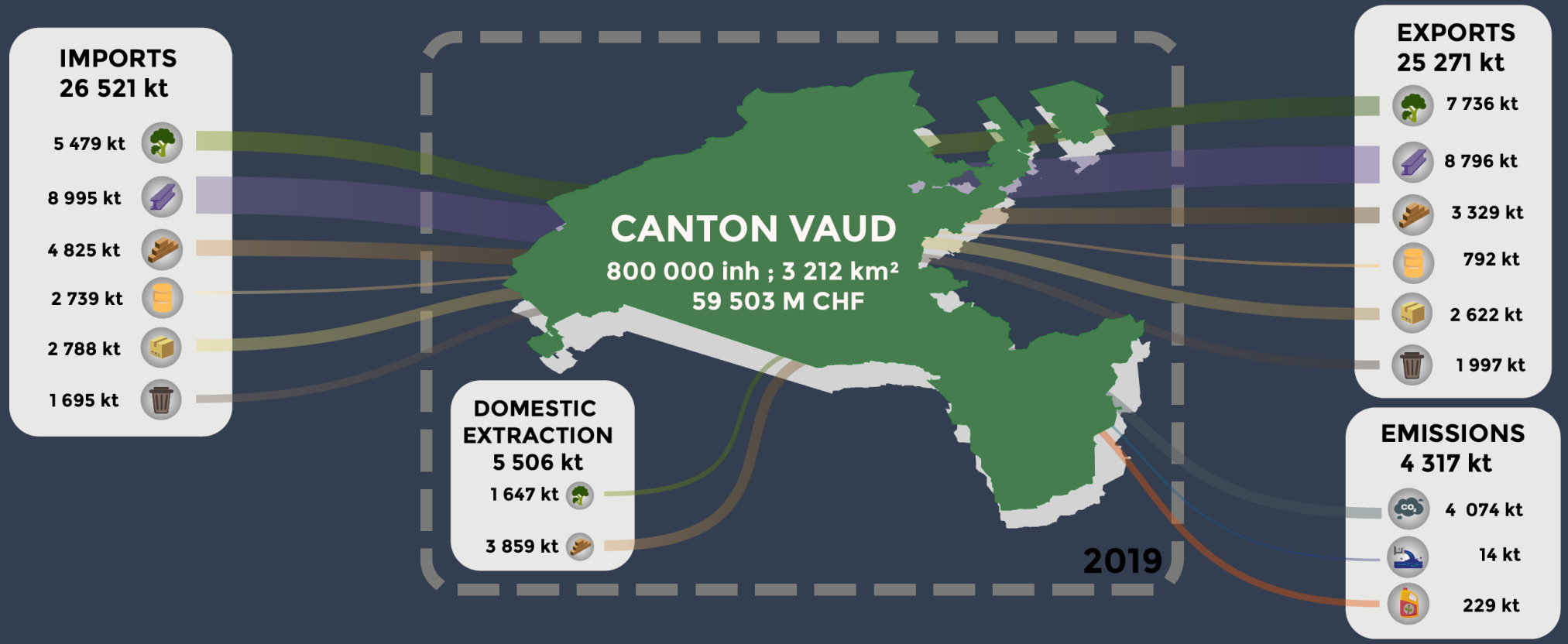
Et maintenant ?

=

Urban Metabolism

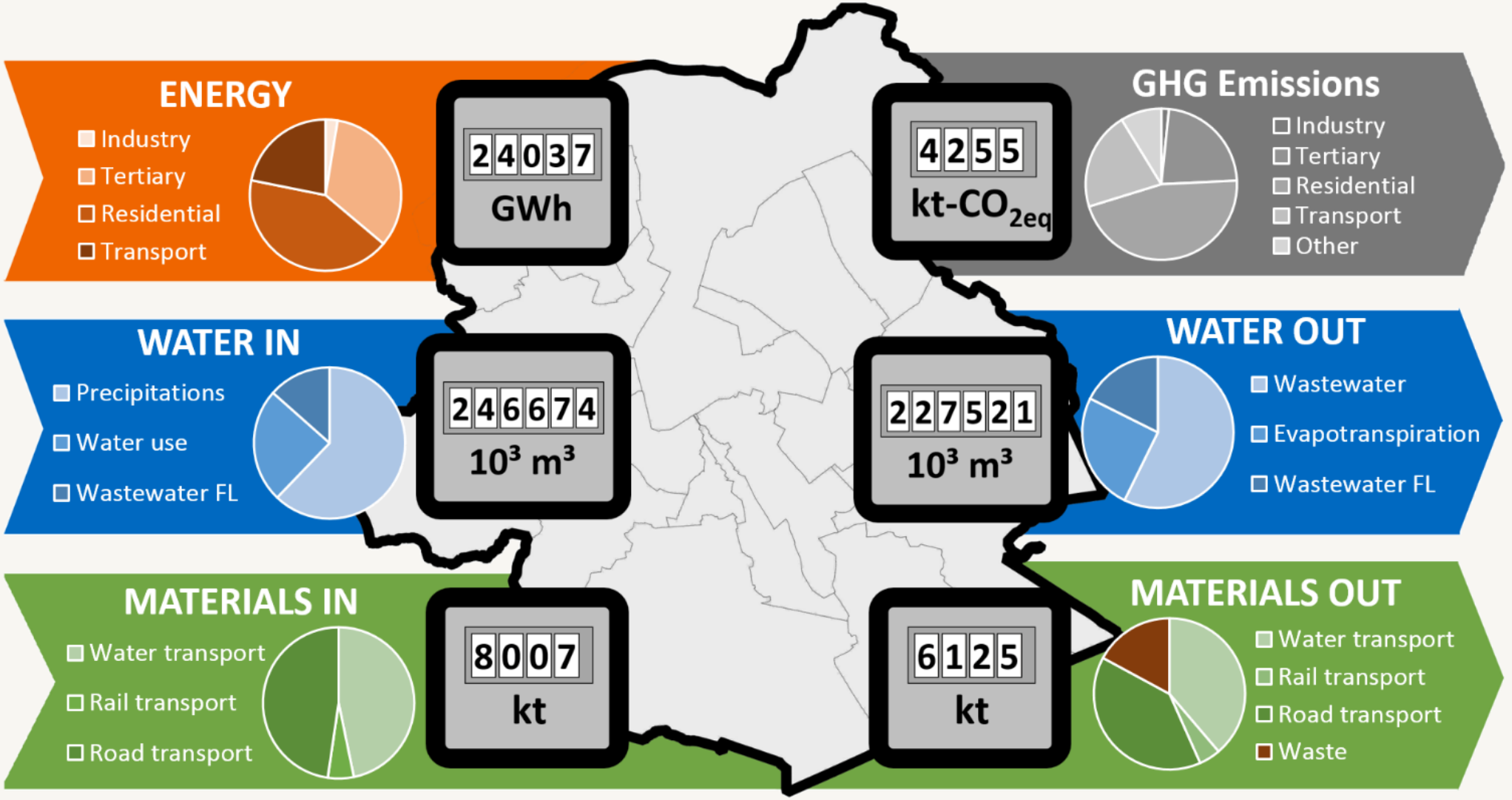


An unconsolidated field studying stocks, flows, infrastructures, actors and their agency from a systemic point of view

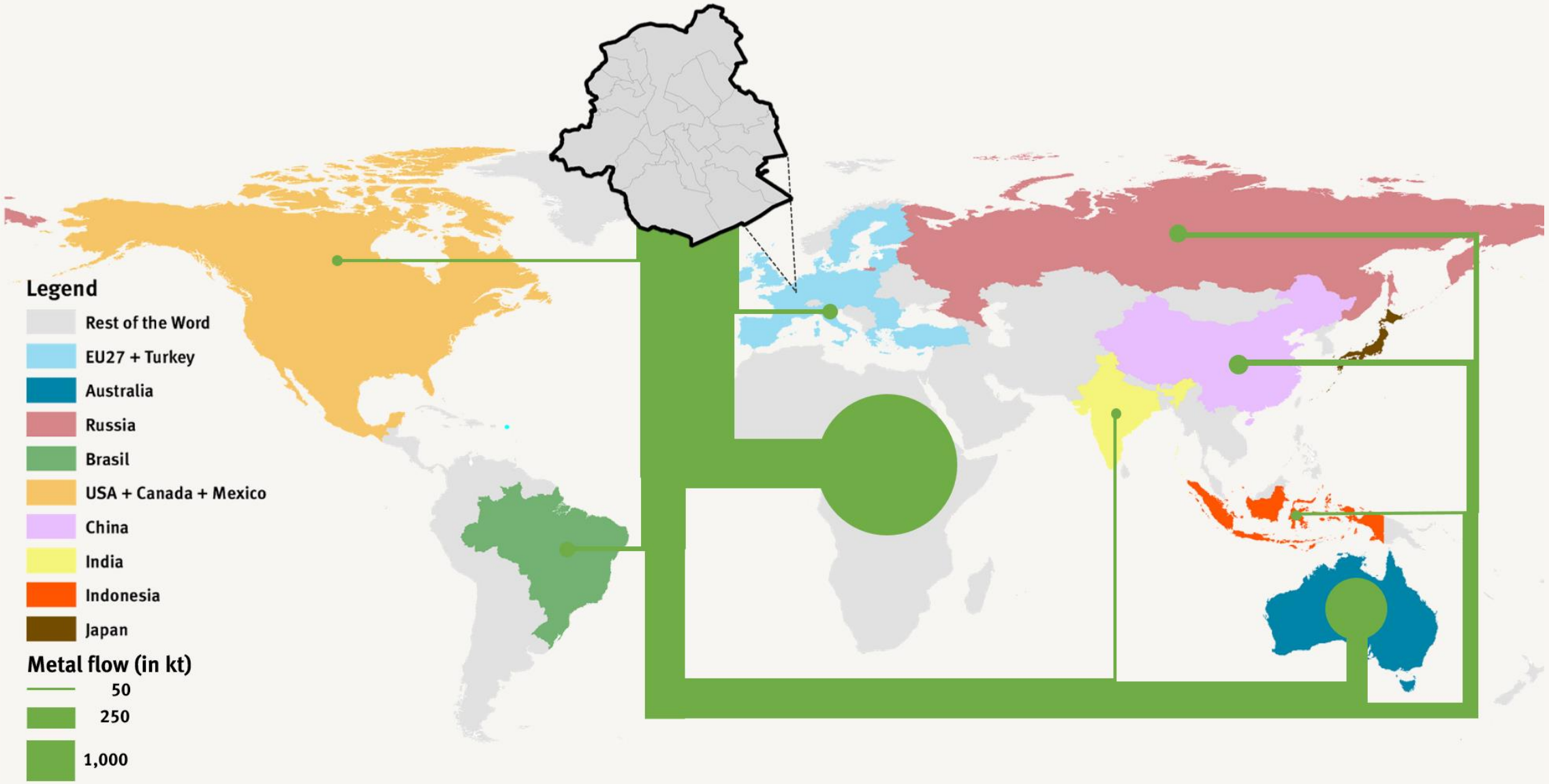


Legend

- Biomass
- Metal ores
- Non-metallic minerals
- Fossil energy carriers
- Other products
- Waste for final treatment
- Emissions to air
- Emissions to water
- Dissipative use of products

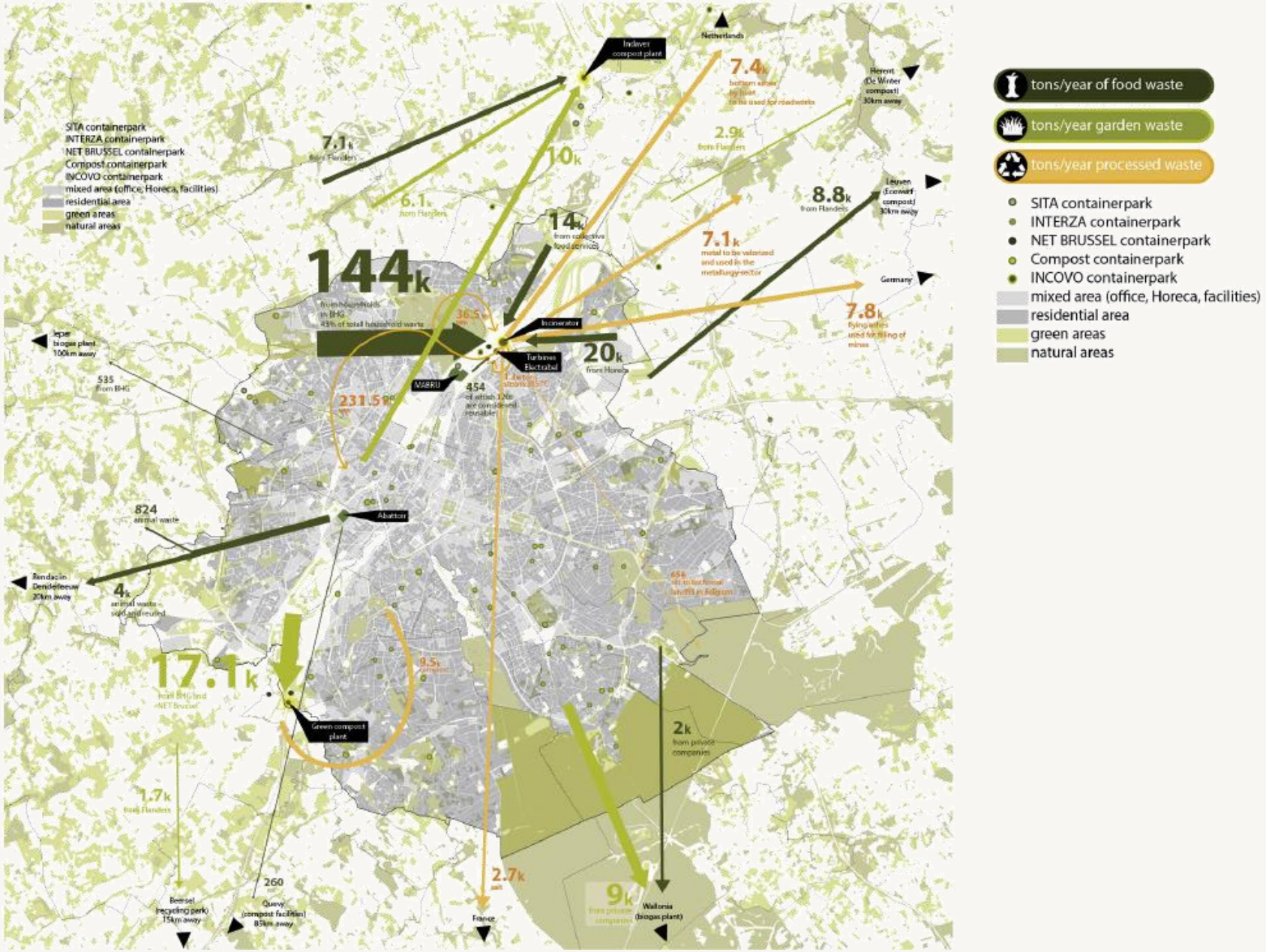


Brussels' urban metabolism – linear & open (3%)



Indirect flows

Athanassiadis, A., M. Christis, P. Bouillard, A. Vercalsteren, R. H. Crawford, and A. Z. Khan. 2018. Comparing a territorial-based and a consumption-based approach to assess the local and global environmental performance of cities. *Journal of Cleaner Production* 173: 112-123.



Mapping flows, actors, infrastructure, agency

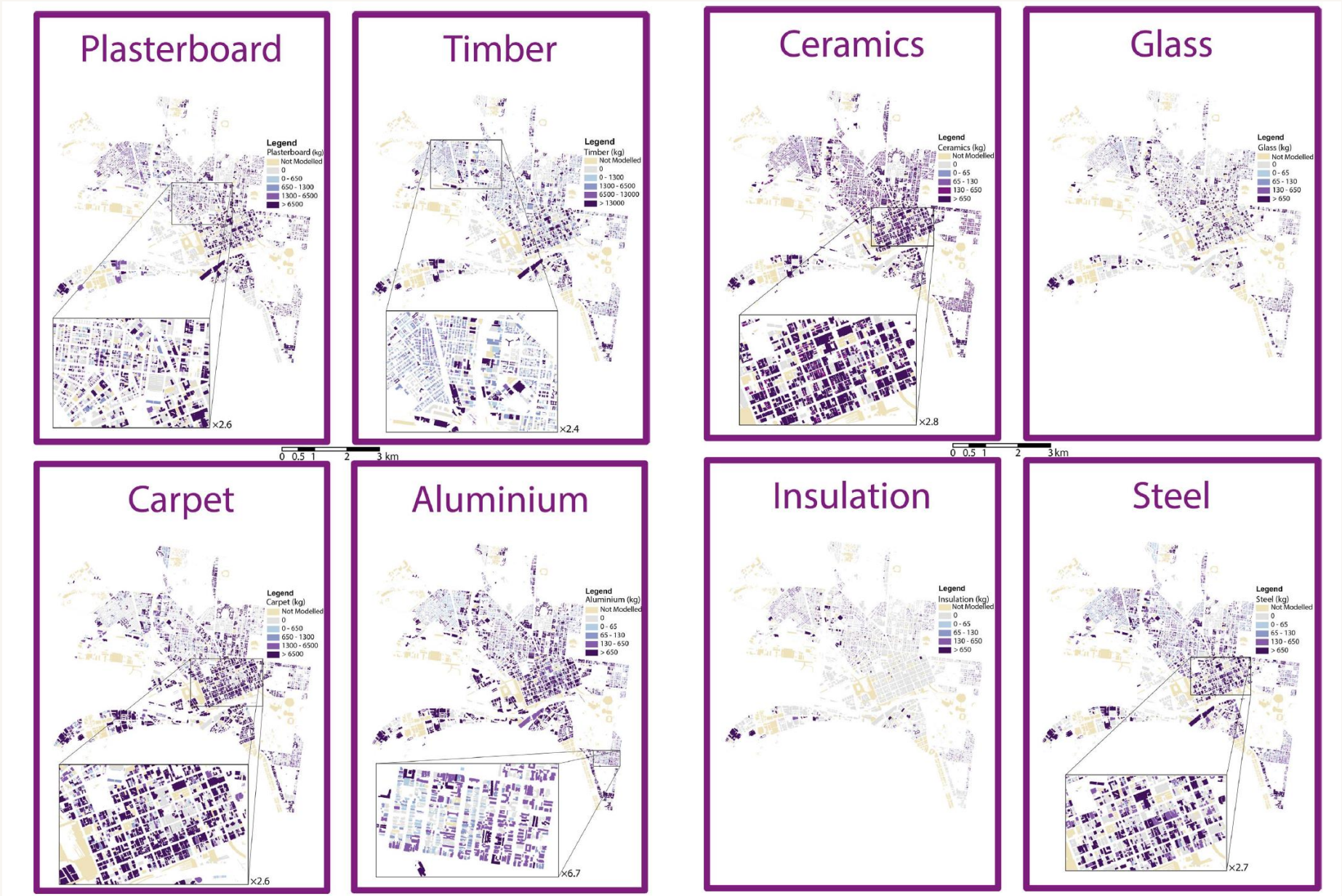


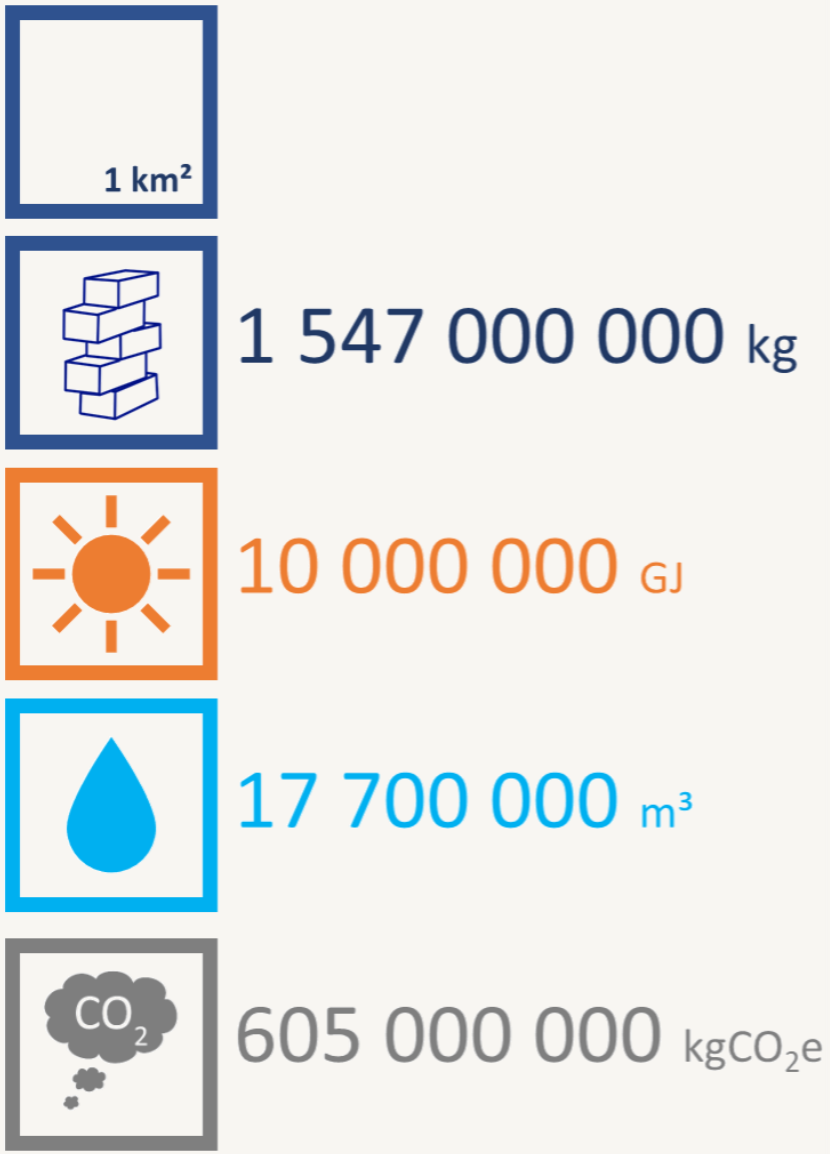
Fig. 4a. Eastimated accumulated building material replacement flows in the City of Melbourne, for plasterboard, timber, carpet and aluminium, from 2018 to 2030.

Fig. 4b. Ebstimated accumulated building material replacement flows in the City of Melbourne, for ceramics, glass, insulation and steel, from 2018 to 2030.

4D flow assessment

Stephan, A. and A. Athanassiadis. 2017. Quantifying and mapping embodied environmental requirements of urban building stocks. *Building and Environment* 114: 187-202.

Stephan, A. and A. Athanassiadis. 2018. Towards a more circular construction sector: Estimating and spatialising current and future non-structural material replacement flows to maintain urban building stocks. *Resources, Conservation and Recycling* 129: 248-262.



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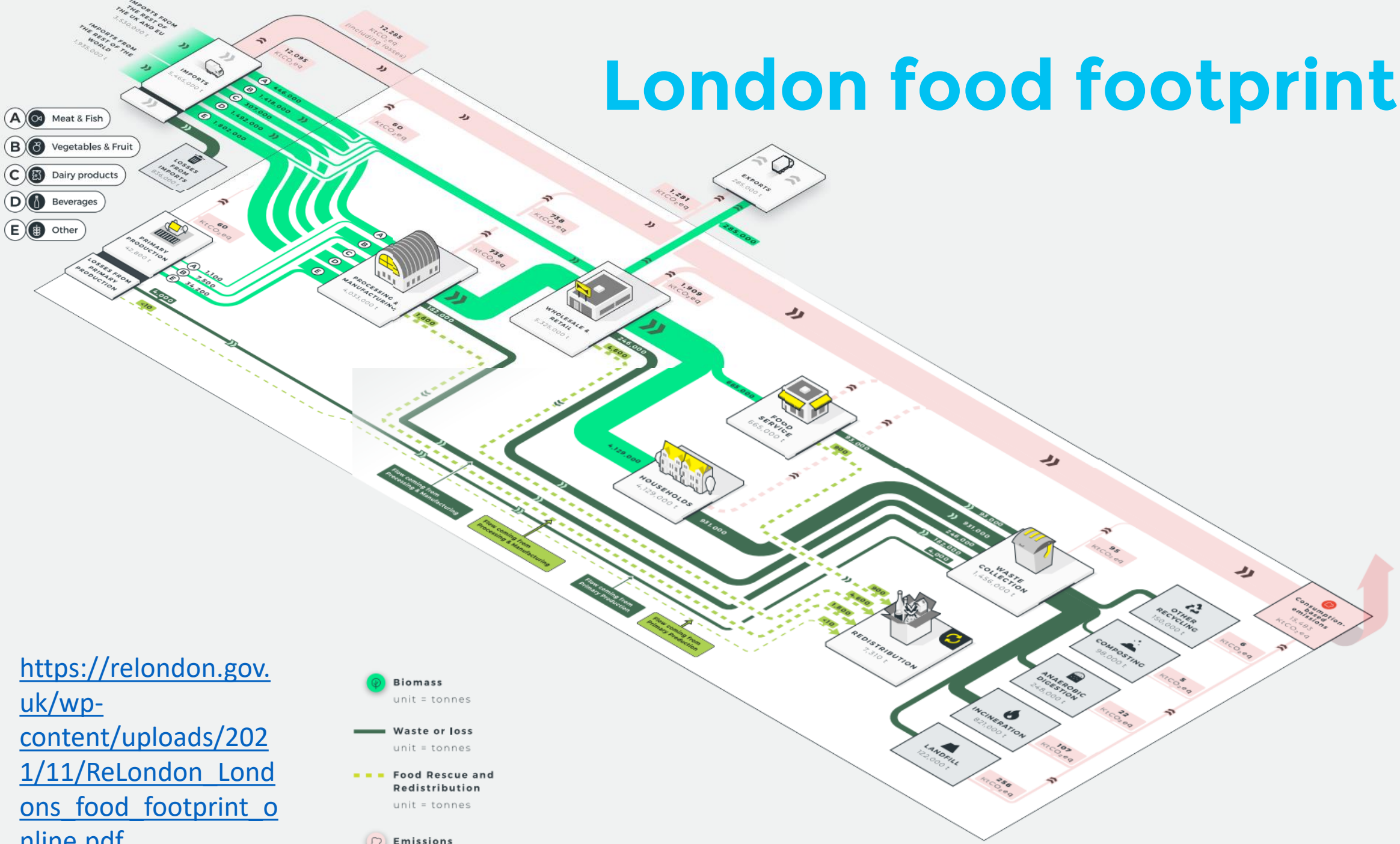
Stephan, A. and A. Athanassiadis. 2018. Towards a more circular construction sector: Estimating and spatialising current and future non-structural material replacement flows to maintain urban building stocks. *Resources, Conservation and Recycling* 129: 248-262.

Explorer la mine urbaine – et ses impacts

London food footprint

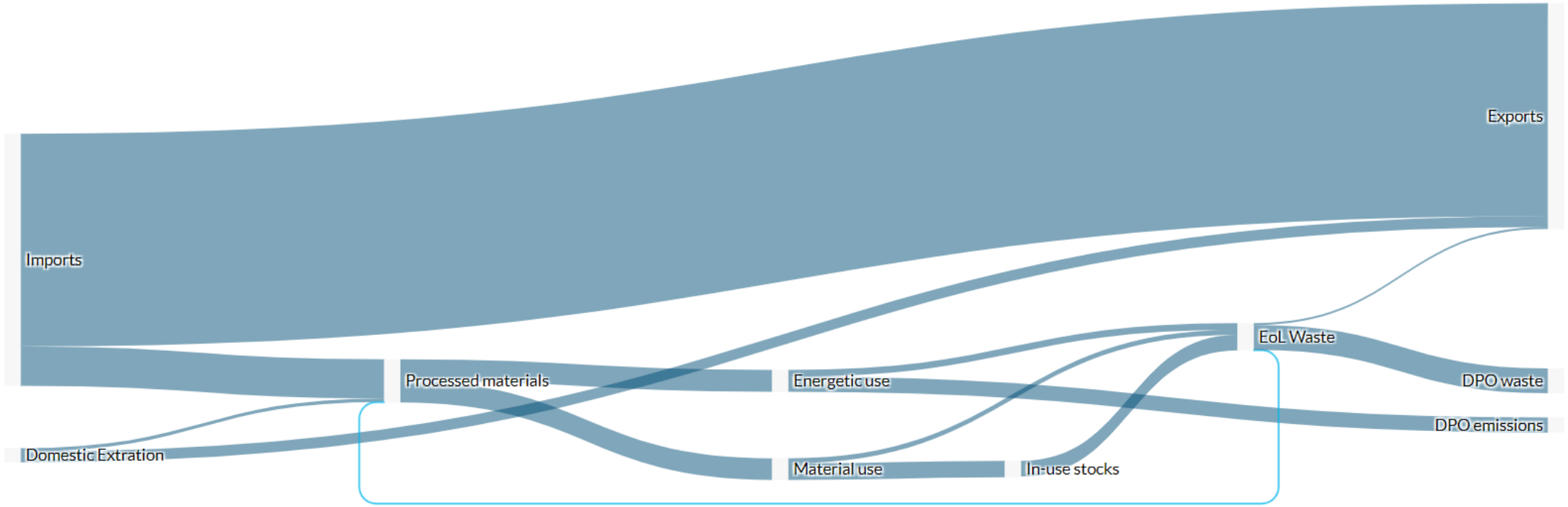


https://relondon.gov.uk/wp-content/uploads/2021/11/ReLondon_Londons_food_footprint_online.pdf

Circularity Apeldoorn

Material Flows in Apeldoorn

Measuring material flows and circularity is a data heavy exercise. Numerous datasets were collected and visualised throughout the Urban Circularity Assessment process. To synthesise these findings, a Sankey diagram illustrates how material flows of the local economy of Apeldoorn are circulating from one lifecycle stage to another. The height of each line is proportional to the weight of the flow. This diagram therefore helps to quickly have an overview of all the materials flows that compose the economy and their respective shares. The flows that are coloured in light blue in the Sankey diagram, are return flows. This means that they flow in the opposite direction of the lifecycle stages and are subjected to reuse, redistribution, or remanufacturing. Their size relative to the others is a good indication for a materials' circularity.



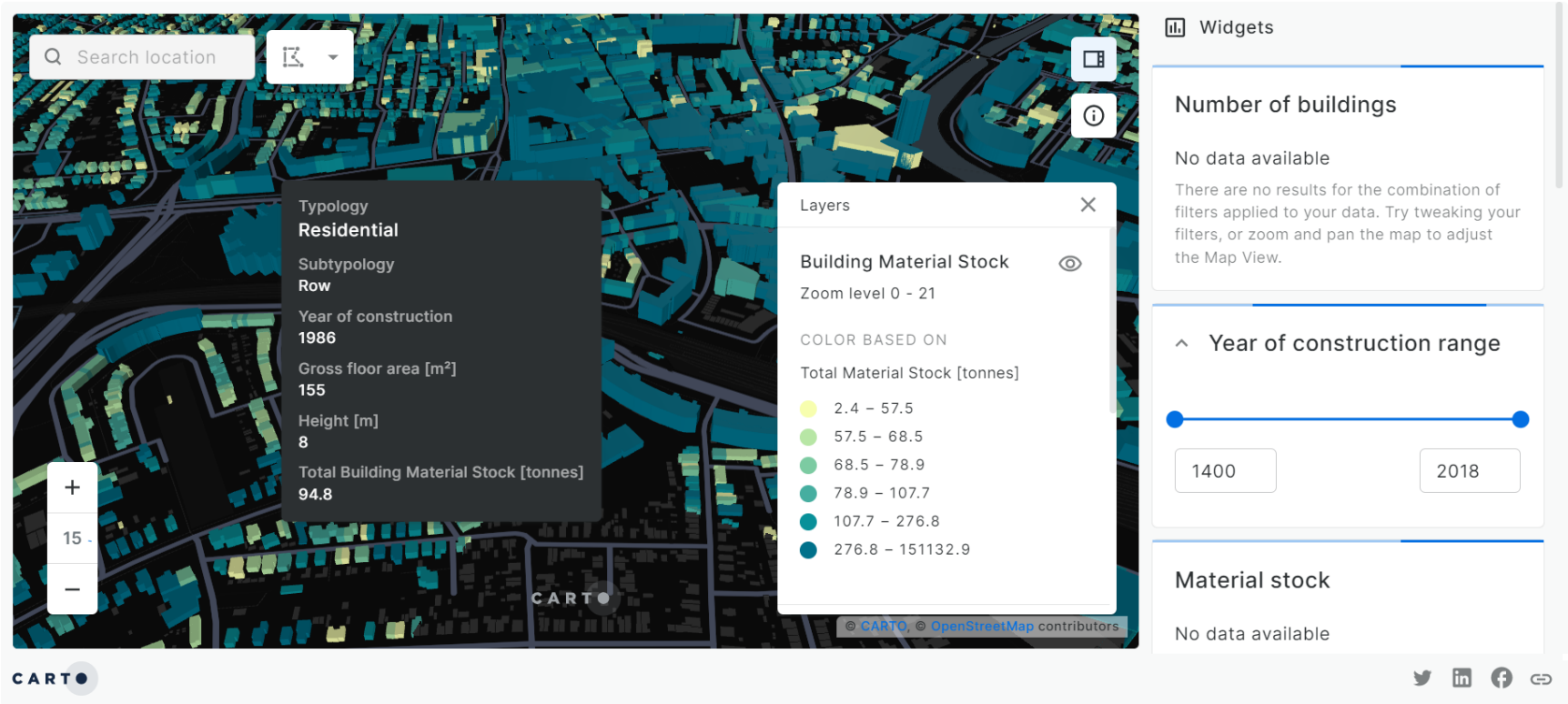
https://cityloops.metabolismofcities.org/city/apeldoorn/uca-report/

Material Stock Apeldoorn

Material stock in Apeldoorn

Determining and analysing the material stock of a city can, similarly to the material flow accounting, also be a data intensive endeavour. The intensity depends on the scope and the data availability. For the Urban Circularity Assessment, the scope includes all residential and non-residential buildings in the municipality. Unlike for the material flow quantification, the analysis is not done for one or several specific reference years, but considers all buildings that have been constructed and still exist, up until and including 2022 (year of study). The aim is to quantify the materials that every single building contains and represent them spatially on a map. Depending on the data availability around building typologies, age cohorts, building height and material intensities, different, specific quantifications and investigations can be made.

The embedded map allows to explore the building stock of Apeldoorn and interact with the different scales and buildings by zooming in and out, and clicking on the buildings to discover more about typologies and quantity of building materials. The widgets on the right can be used to account for certain information, e.g. the number of buildings in an area, or to filter for specific construction years, which in combination with the average useful life of buildings can be used to calculate the potential urban mine. Furthermore, an analysis can also be performed by using the lasso tool and drawing an area (a block, a neighbourhood or an urban area) to be analysed.



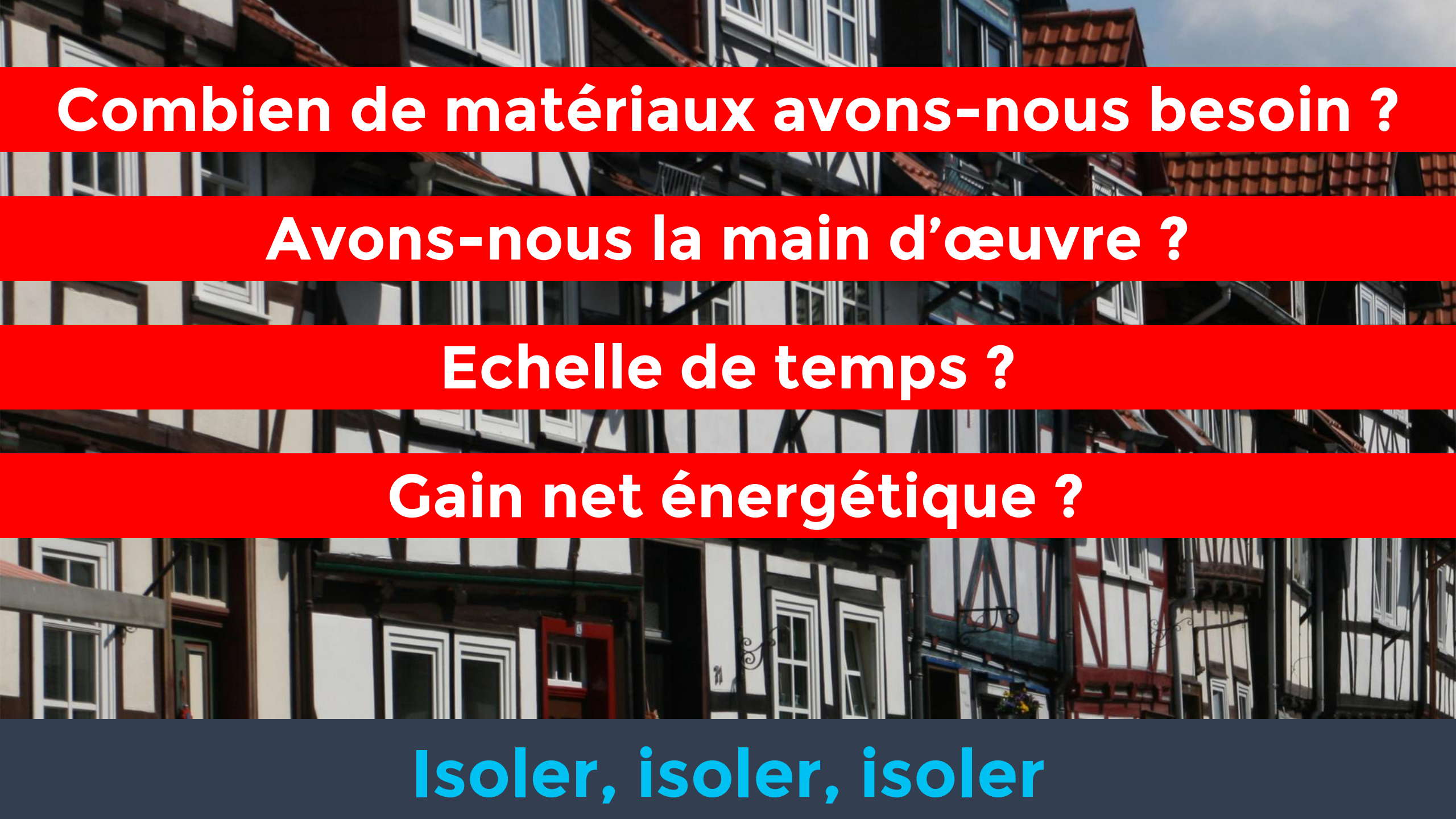
https://cityloops.metabolismofcities.org/city/apeldoorn/uca-report/

Beaucoup d’études mais quelles conclusions ?

Trop petit,
trop peu,
trop lent

Quelles sont les nouvelles pistes ?

Réduire les entrants,
Faire de la place
Questionner les besoins



Isoler, isoler, isoler

Combien de matériaux avons-nous ?

Avons-nous la main d'œuvre ?

Avons-nous la place ?

Source: http://www.circulareconomy.brussels/bc-materials-bc-materials-de-la-terre-dexcavation-au-materiau-de-construction/#images-2

Des matériaux locaux bio/géo-sourcés

Combien de matériaux avons-nous ?

Avons-nous la main d'œuvre ?

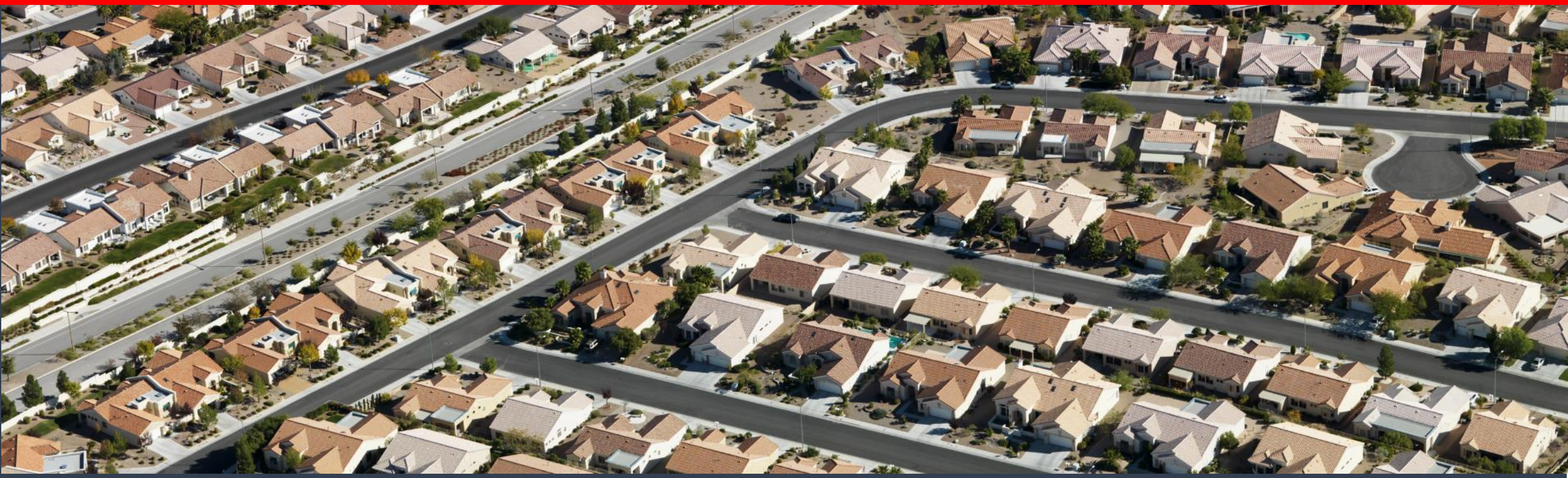
Avons-nous la place ?

Source: http://www.circulareconomy.bru
de-reemploi-en-flux-tendu/#images-3
Source: https://chroniques-architecture.c
materiaux-doccasion-@-Rotor-750x500.jp

Réutiliser la mine urbaine

Comment protéger du foncier ?

Comment réduire les m² par pers ?



En finir avec l'étalement urbain

Chaque nouveau m² construit =

+ Flux pour opérer, maintenir, rénover

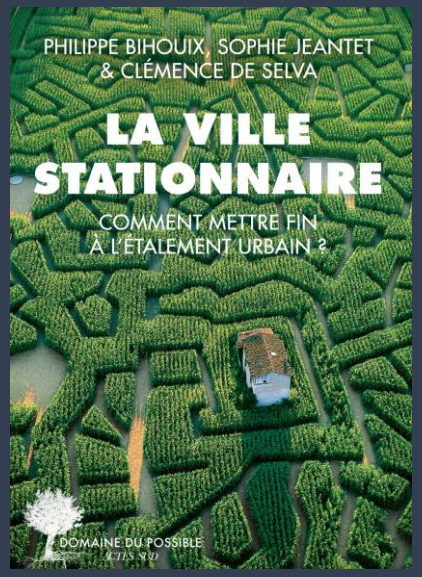
- De foncier pour besoins essentiels

Préserver du foncier (productif, naturel, ..)

En conclusion

Réduire / Sacrifier

Ralentir



Reboucler

Laissez de la place

Main d'œuvre

Relocaliser

Quelques piliers pour rester dans les limites planétaires

Table 2

. Inventory of the prerequisites for *Decent Living Standards* (DLS) (Rao and Min, 2018a) alongside activity levels and direct and indirect energy intensities of products, supply chains and infrastructure. Numbers are rounded and presented as ranges where there are variations between countries or sub-activities (e.g. different transport modes). *Approximate* percentage increases for *Higher Demand* (HD) and *Less Advanced Technology* (LAT) scenarios are included where possible, but these cannot always be summarised in this high-level format. Full details can be found in the Supplementary materials.

DLS dimensions & services	Activity levels		Energy Intensities		
	Default levels	HD	Default (direct)	Default (indirect)	LAT
Nutrition					
Food	2000–2150 kcal/cap/day	15%	–	3 KJ/kilocalorie	30%
Cooking appliances	1 cooker/household	–	0.8 KJ/kilocalorie	1 GJ/app[+]	50%
Cold Storage	1 fridge-freezer/household	–	0.44 GJ/app[+]/yr	4 GJ/app[+]	–
Shelter & living conditions					
Household size	4 persons/household	−25%	–	–	–
Sufficient space	15 meters^2 floor-space/cap[*]	80%	–	2–4 GJ/m^2	100%
Thermal comfort	15 meters^2 floor-space/cap[*]	80%	20–60 MJ/m^2/yr	–	300%
Illumination	2500 lm/house; 6 hrs/day	100%	150 lm/W	14 MJ/house/yr	–
Hygiene					
Water supply	50 Litres/cap/day	100%	–	5–17 KJ/L	–
Water heating	20 Litres/cap/day	100%	96–220 KJ/L	–	50%
Waste management	*Provided to all households*[**]	–	–	180 MJ/cap/yr	200%
Clothing					
Clothes	4 kg of new clothing/year	33%	–	100 MJ/kg	–
W ashing facilities	80 kg of washing/year	33%	2.4 MJ/kg	2 GJ/app[+]	–
Healthcare Hospitals	200 meters^2 floor-space/bed	50%	410–560 MJ/m^2/yr	14–23 GJ/m^2	130%
Education Schools	10 meters^2 floor-space/pupil	50%	100–130 MJ/m^2/yr	4.5–7.5 GJ/m^2	150%
Communication & information					
Phones	1 phone/person over 10yrs old	–	28 MJ/phone/yr	110 MJ/phone	30%
Computers	1 laptop/household	–	220 MJ/laptop/yr	3 GJ/laptop	30%
Networks & data	*High*[**]	100%	–	~0.4 GJ/cap/yr	–
Mobility					
Vehicle production	*Consistent with pkm travelled*[**]	–	–	0.1–0.3 MJ/pkm	50%
Vehicle propulsion	5000–15,000 pkm/cap/year	3–10%	0.2–1.9 MJ/pkm[++]	–	100%
Infrastructure	*Consistent with pkm travelled*[**]	–	–	0.1–0.3 MJ/pkm	–

Millward-Hopkins, J., Steinberger, J. K., Rao, N. D., & Oswald, Y. (2020). Providing decent living with minimum energy: A global scenario. *Global Environmental Change*, *65*, 102168.

Quelques besoins sont nécessaires et compatibles aux limites planétaires ?

ARISTIDE ATHANASSIADIS

CIRCULAR METABOLISM PODCAST

METABOLISM OF CITIES

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