Understanding Urban Stocks as Potential Resources A prospective Approach

CityLoops
Expert Workshop

7th December 2021

Dr. Émilie Gobbo

The FCRBE Project

2018 - 2021
2022 - 2023

Interreg
EUROPEAN UNION
North-West Europe
FCRBE
European Regional Development Fund

https://www.nweurope.eu/projects/project-search/fcrbe-facilitating-the-circulation-of-reclaimed-building-elements-in-northwestern-europe/#tab-1

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Booklets

October 27, 2021 11:29 AM

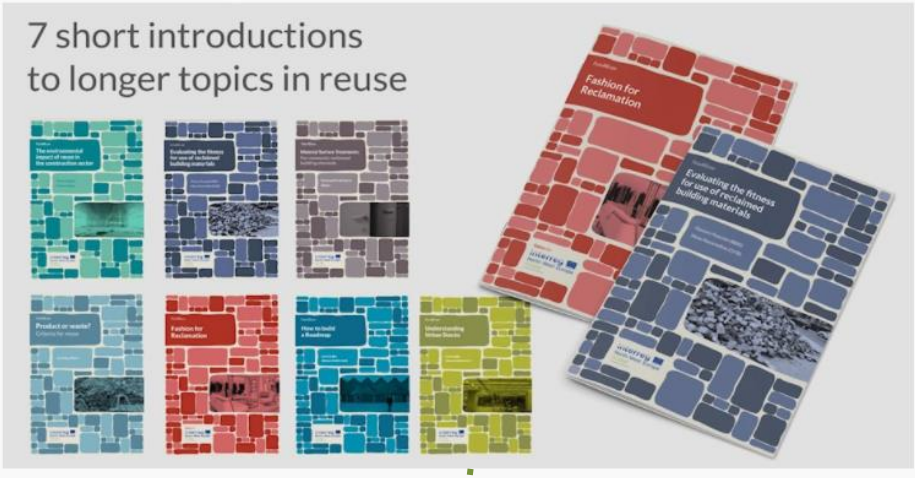
FutuREuse: 7 SHORT INTRODUCTIONS TO THE WORLD OF REUSE

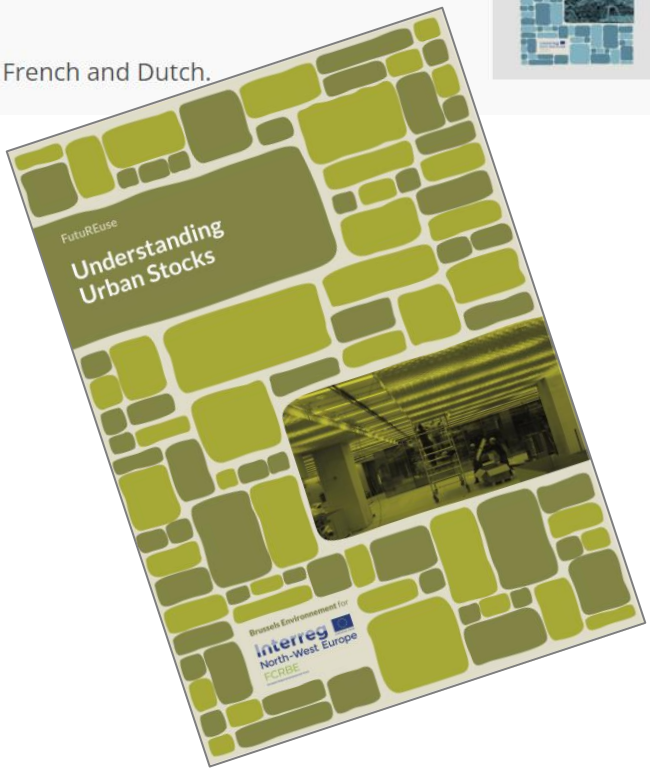
This is a series of seven booklets that have been produced to serve as a taste of what the FCRBE project aims to achieve.

The subjects span the broad spectrum of reuse, covering considerations before, during and after with useful information to guide and inspire working with reclaimed materials.

The booklets also highlight environmental benefits, clarify grey areas and frequently asked questions regarding best practices, whilst sparking curiosity for a future where use is reuse.

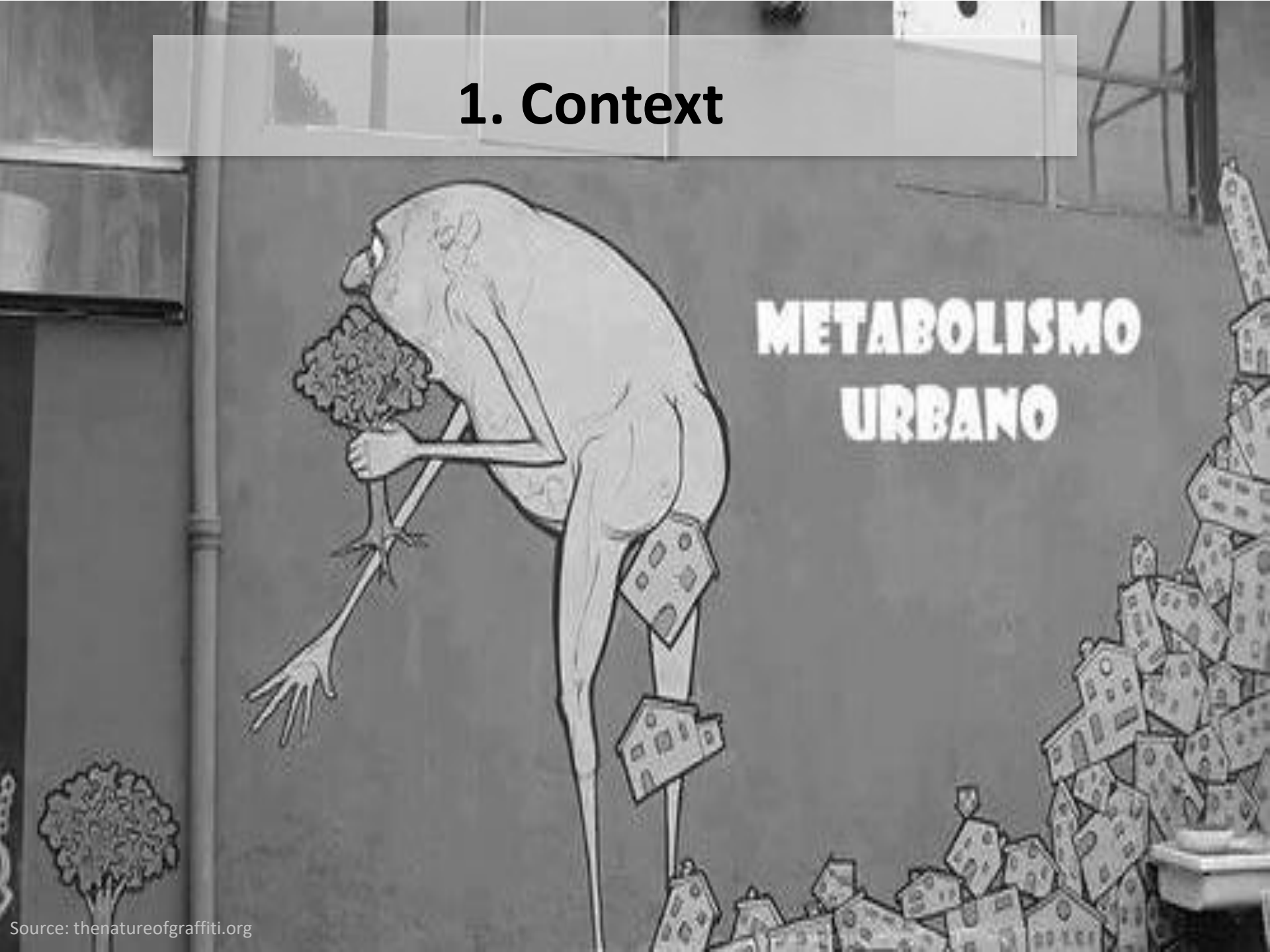
The seven booklets are available in English, French and Dutch.





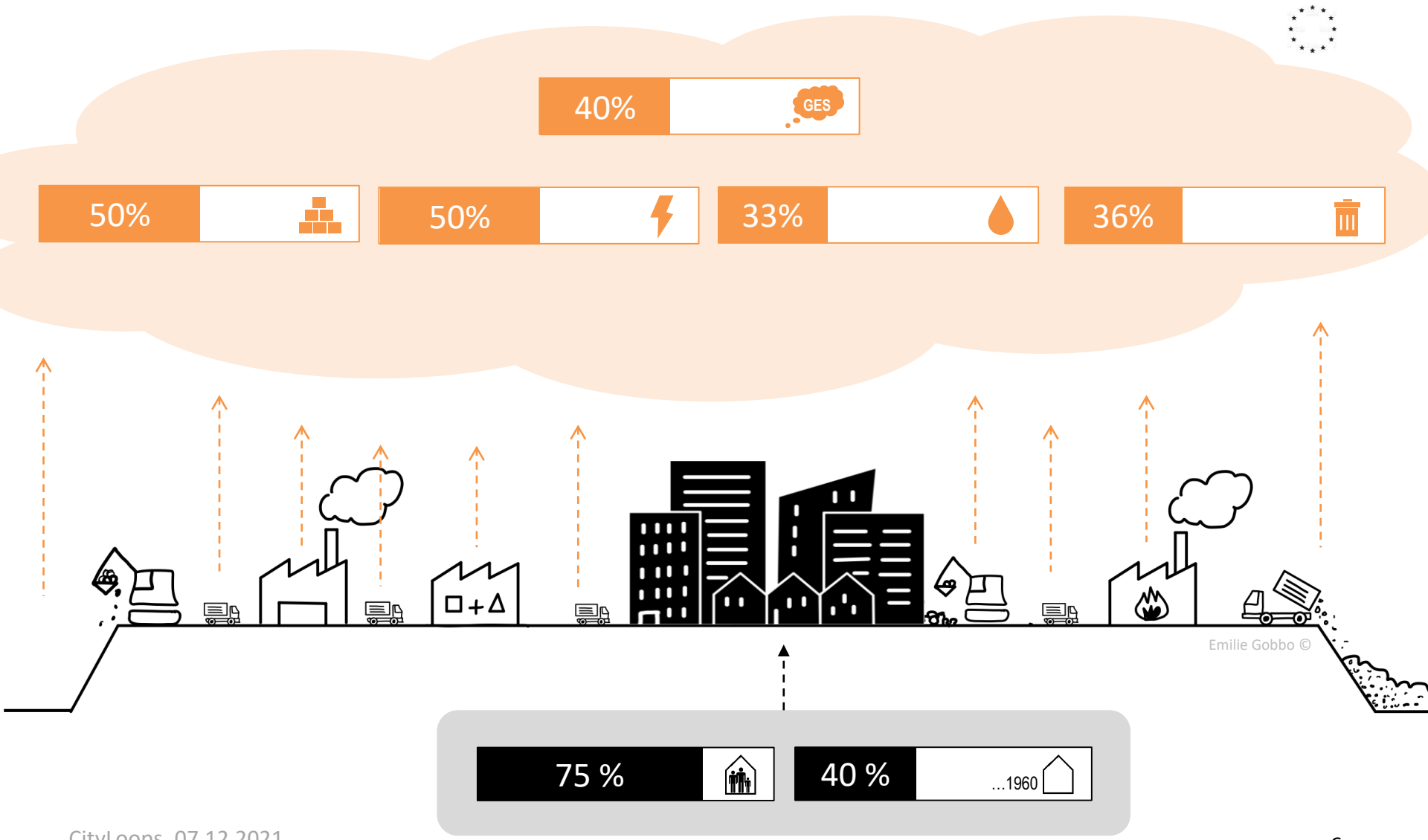
1. Context
2. Characteristics
3. Approaches and Methodology
4. Existing Studies
5. Perspectives
6. Q&A

1. Context



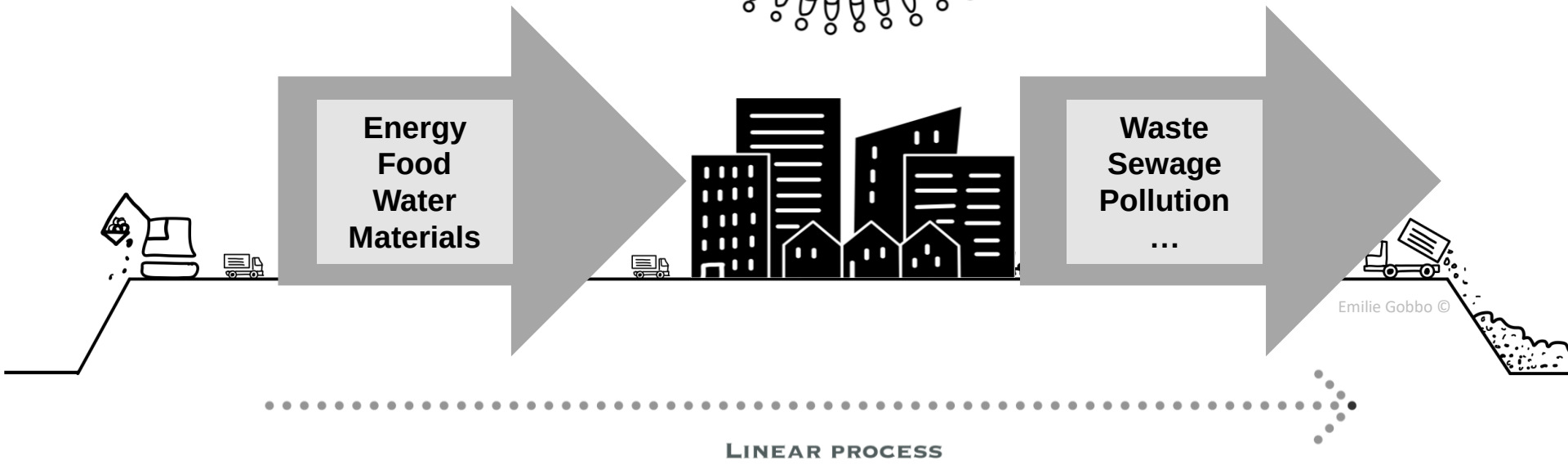
Source: thenatureofgraffiti.org

1. Context



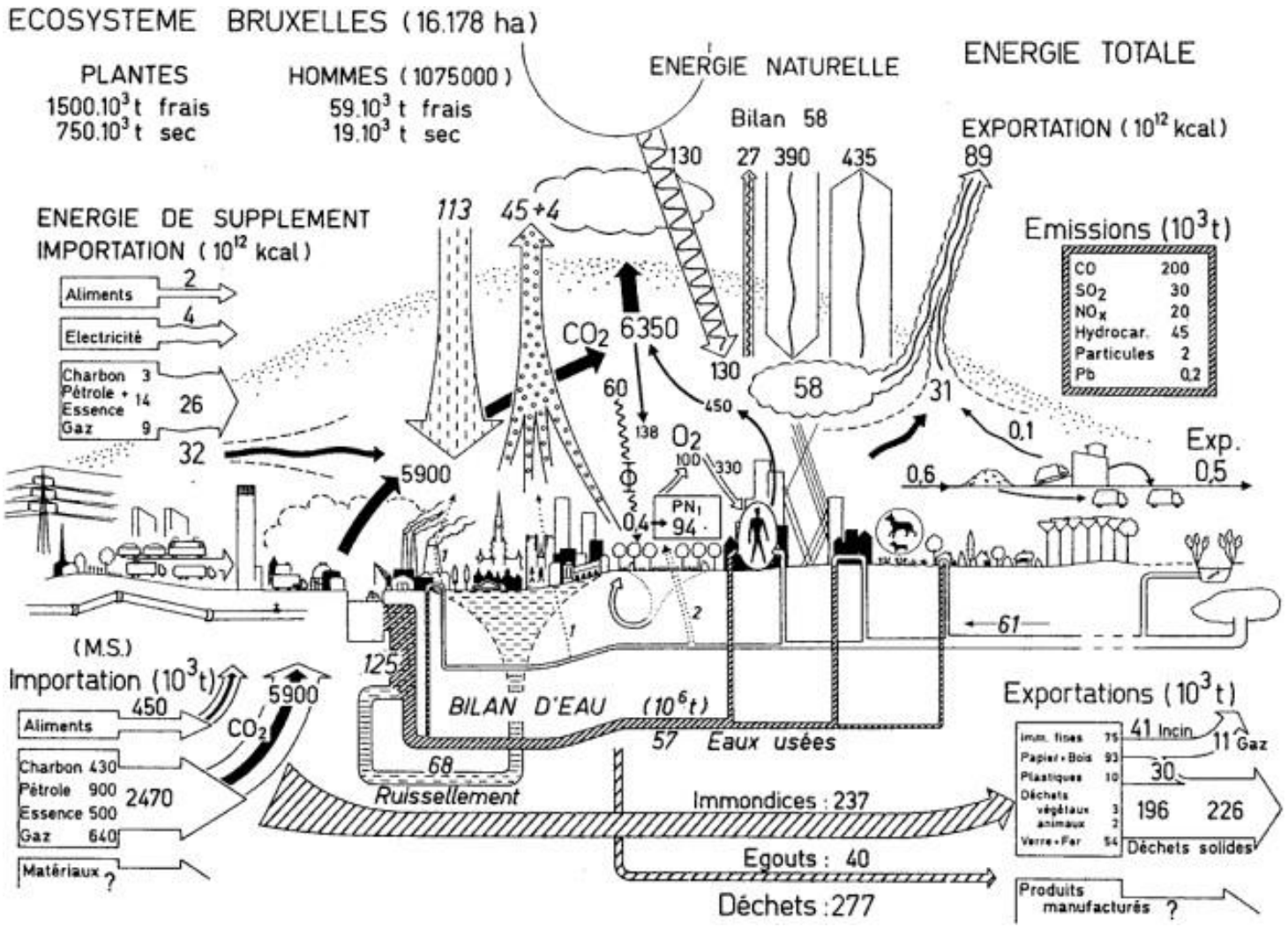
1. Context


60%
expected by 2030


Energy
Food
Water
Materials
Waste
Sewage
Pollution
…
Emilie Gobbo ©
LINEAR PROCESS

1. Context

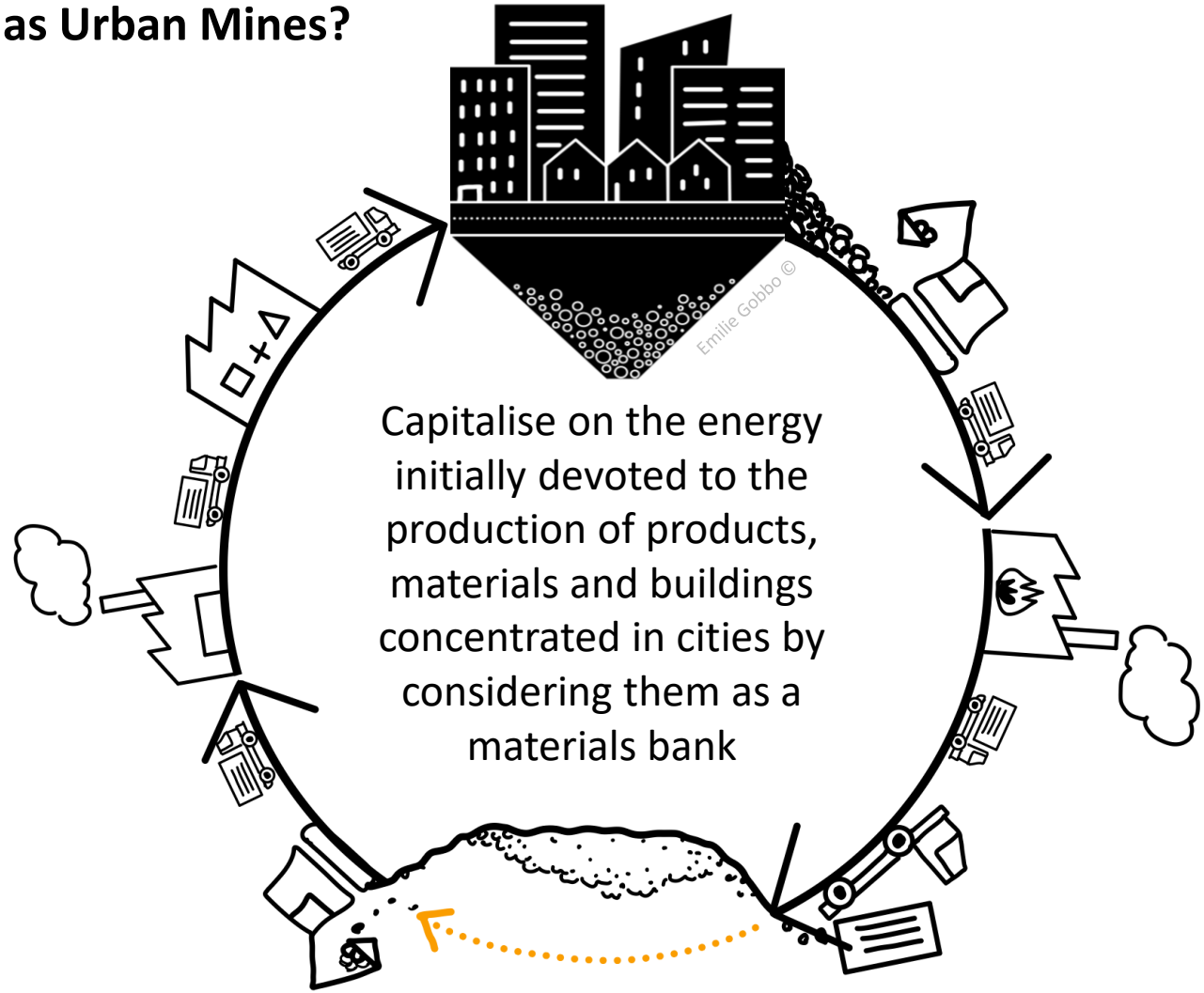
Cities as Living Organisms?



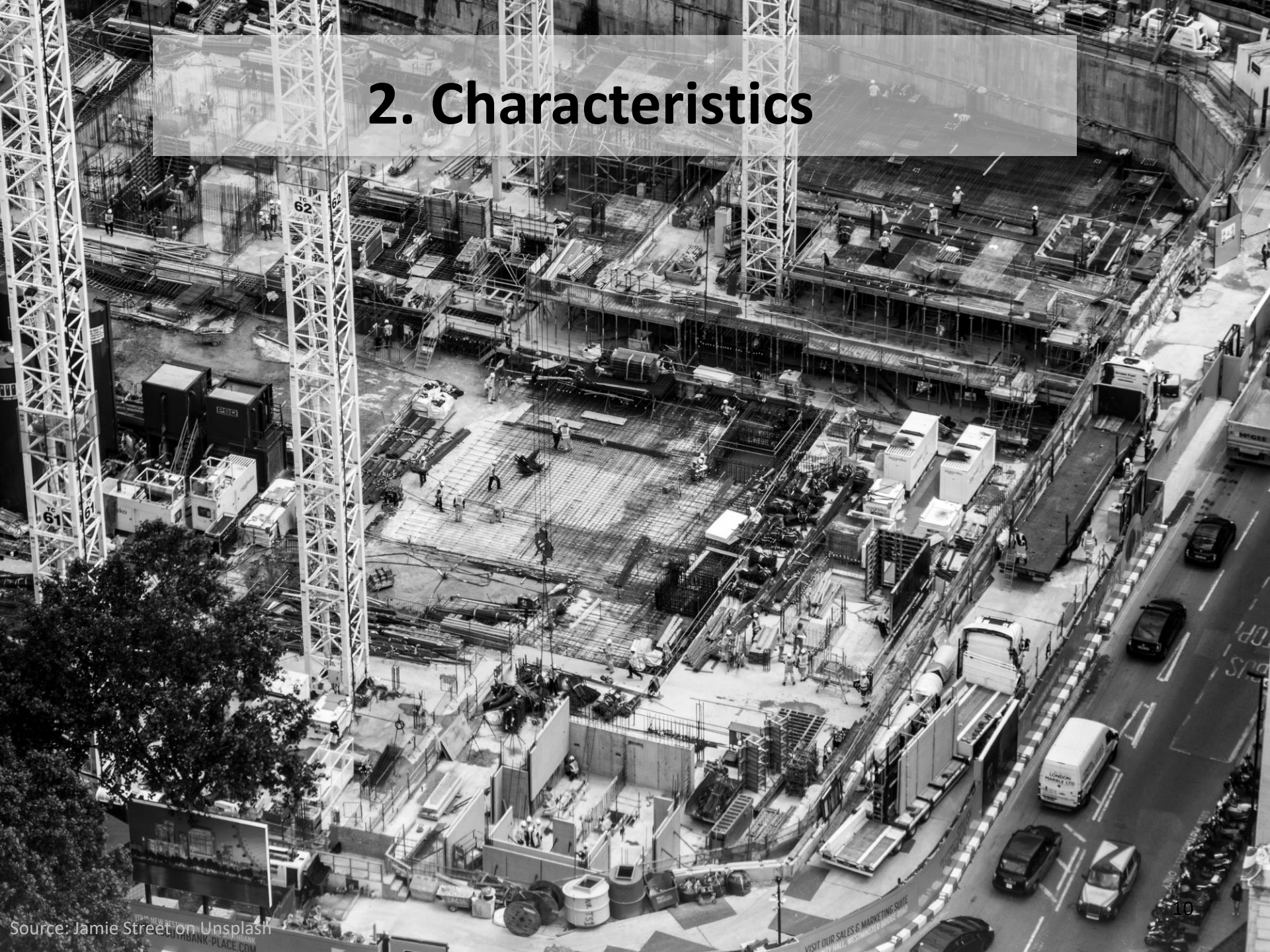
Source: Paul Duvigneaud, 1980

1. Context

Cities as Urban Mines?



2. Characteristics



Source: Jamie Street on Unsplash

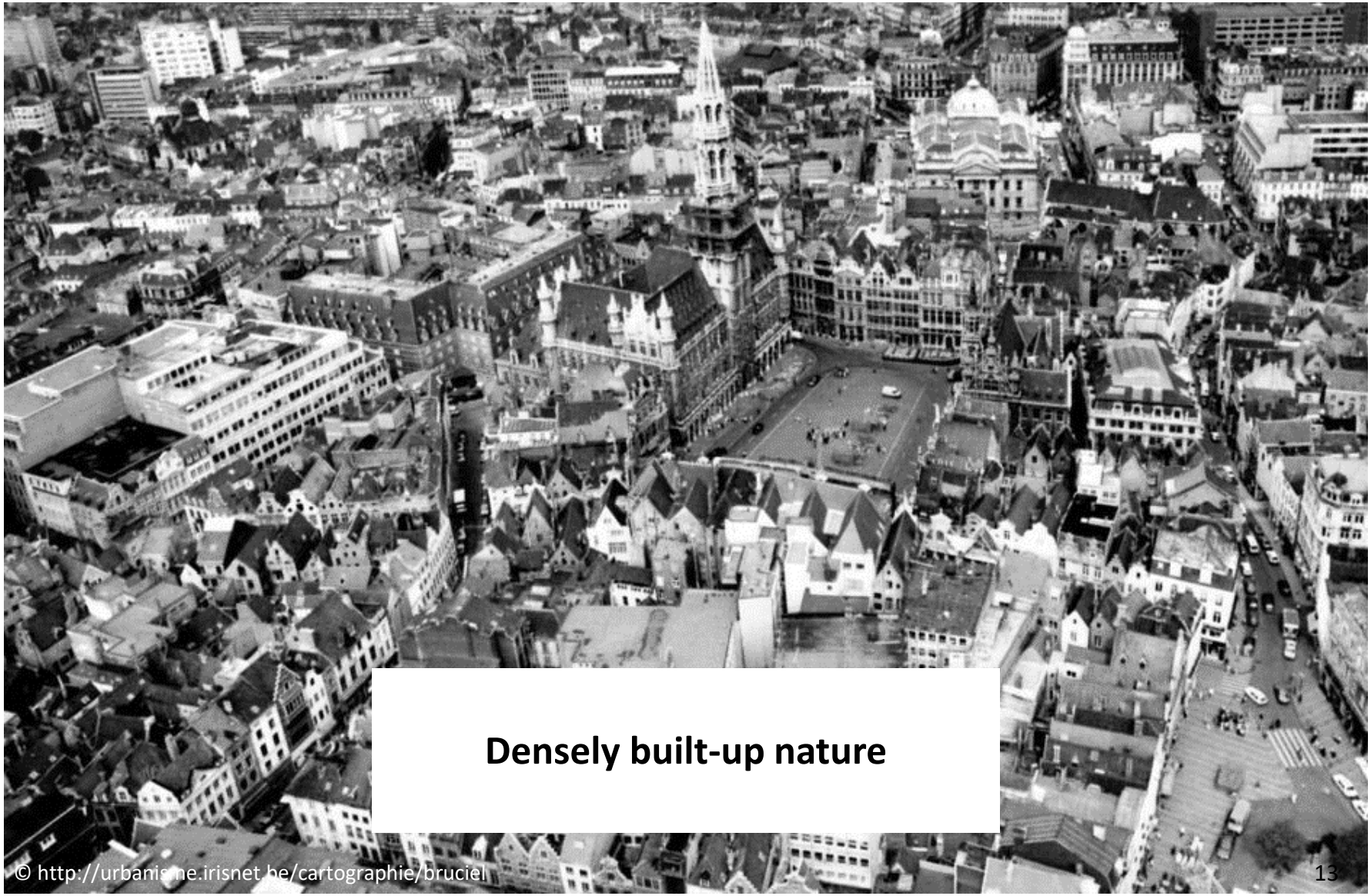
2. Characteristics

2. Characteristics

Heterogeneous nature

Source: Opalis

2. Characteristics



Densely built-up nature

2. Characteristics

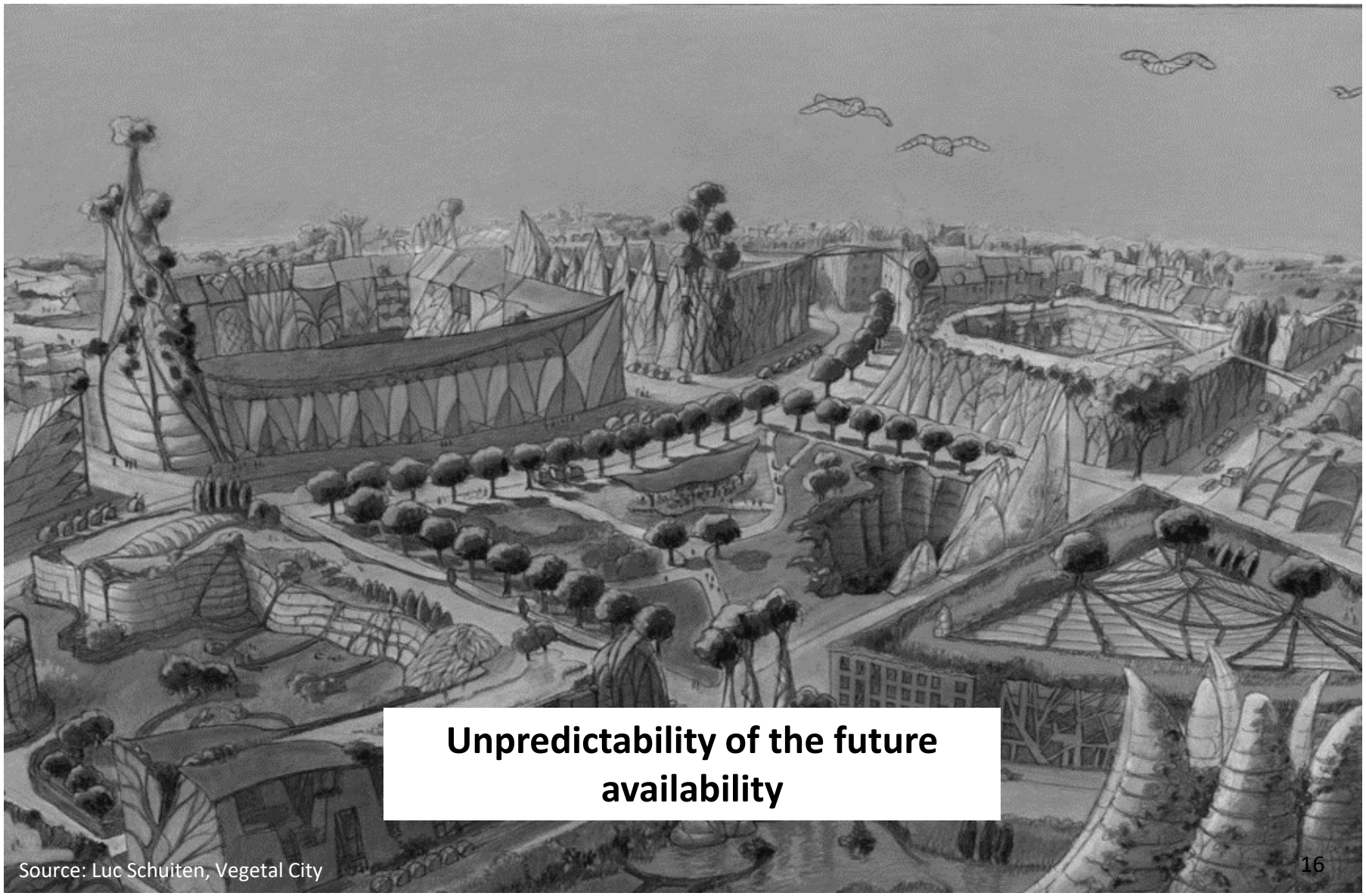
Lack of accessibility

Source: Weiesley Tingey on Unsplash

2. Characteristics

Dynamic nature

2. Characteristics



Source: Luc Schuiten, Vegetal City

2. Characteristics

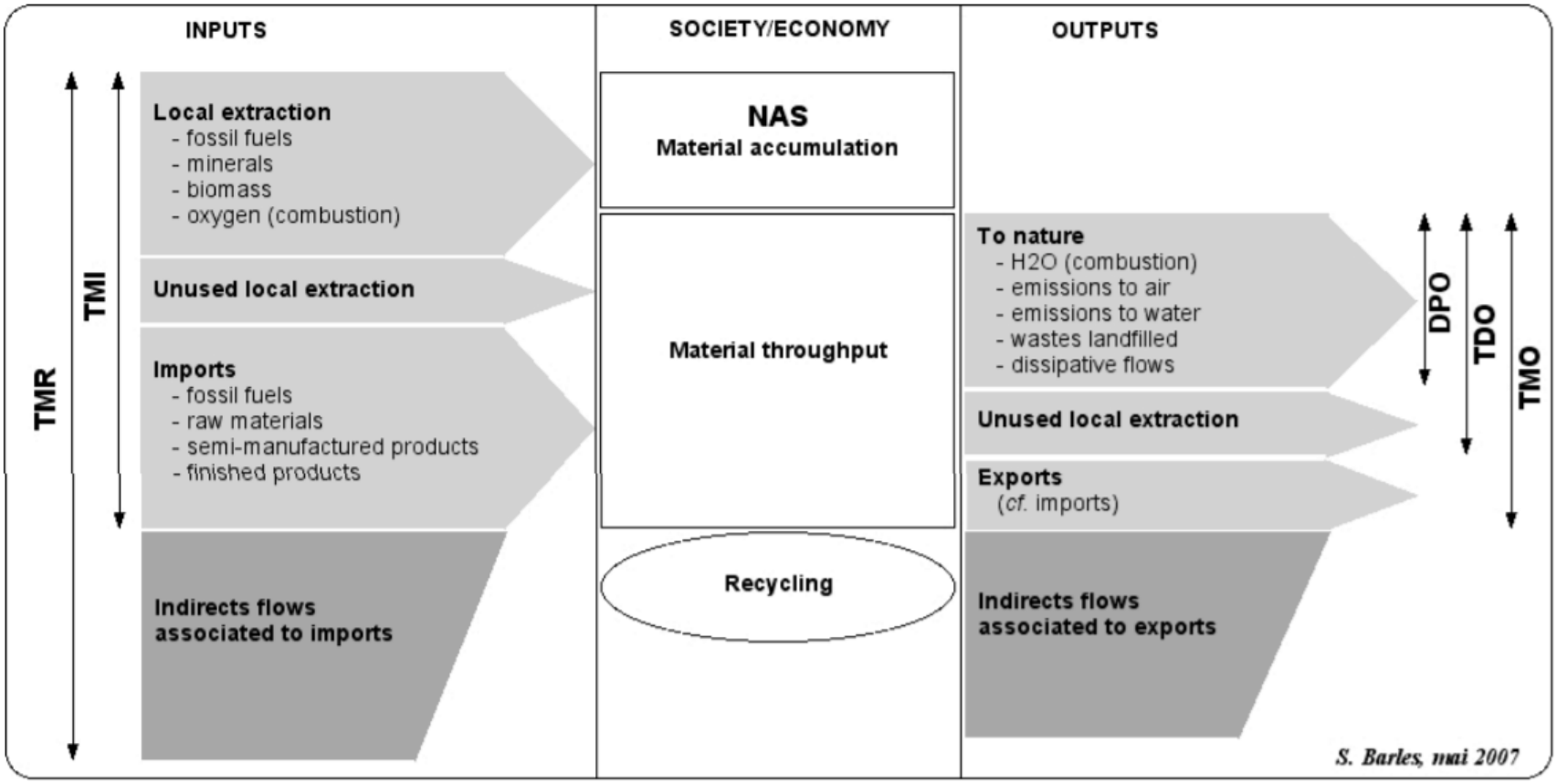
Different status (employed, expended, hibernating, obsolete)

Source: Emilie Gobbo, Sewer Museum Brussel

3. Approaches and Methodology

3. Approaches and Methodology

Main flows in material balance according to the Eurostat method



TMI: Total Material Input — TMR: Total Material Requirement — TMO: Total Material Output

TDO: Total Domestic Output — DPO: Direct Processed Output — NAS: Net Addition to Stock

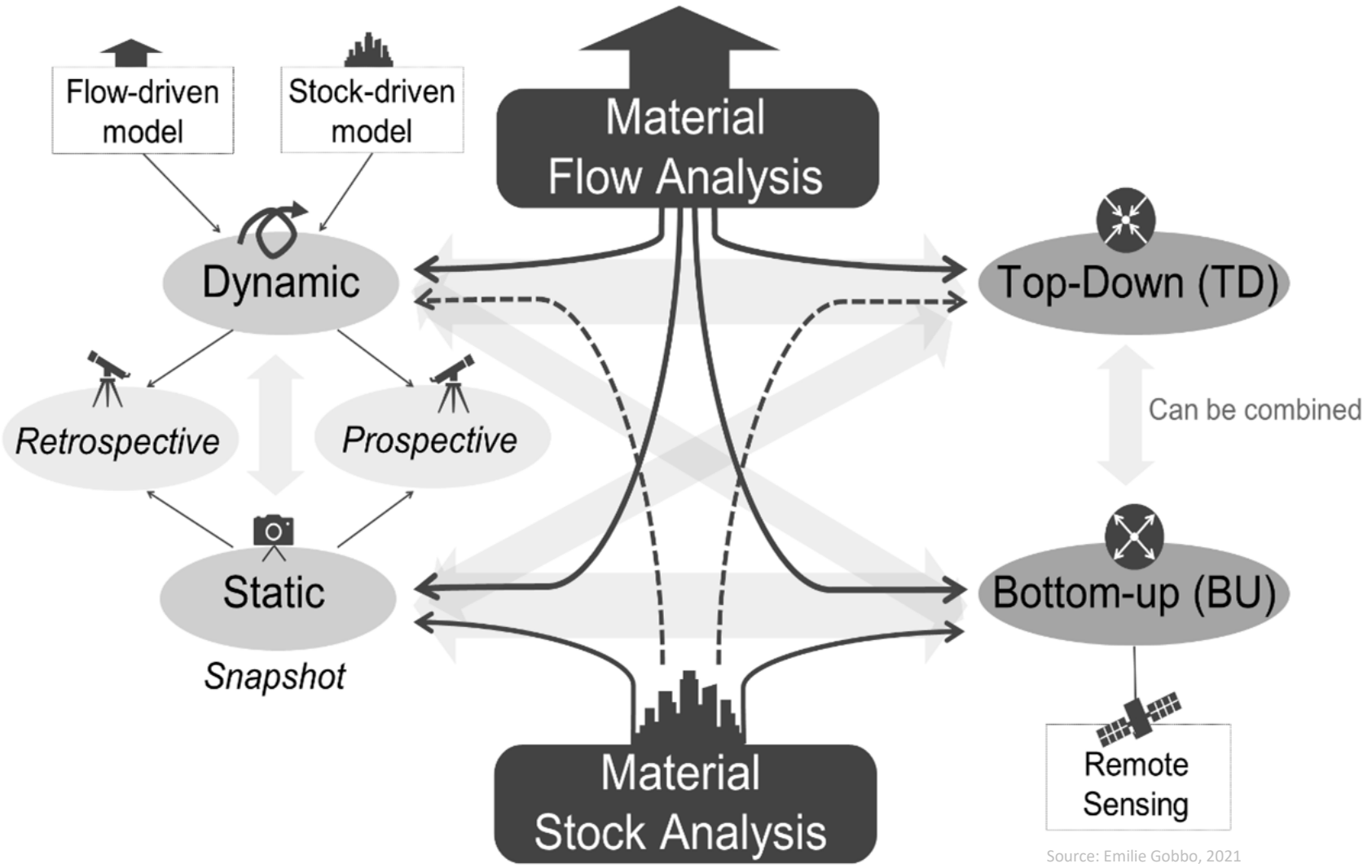
Other indicators: DMI: Direct Material Input (local extraction (used)+imports)

DMO: Direct Material Output (DPO + exports) — DMC: Direct Material Consumption (DMI – exports)

TMI = NAS + TMO — **DMI = NAS + DMO**

Source: Sabine Barles, 2007

3. Approaches and Methodology



Source: Emilie Gobbo, 2021

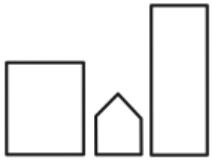
3. Approaches and Methodology

Top-Down (TD)

Aggregated data

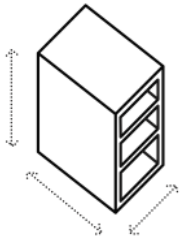
Macroeconomic data

Bottom-up (BU)



Building Archetypes
> composition

Geographic Information System (GIS)
> Location / intensity

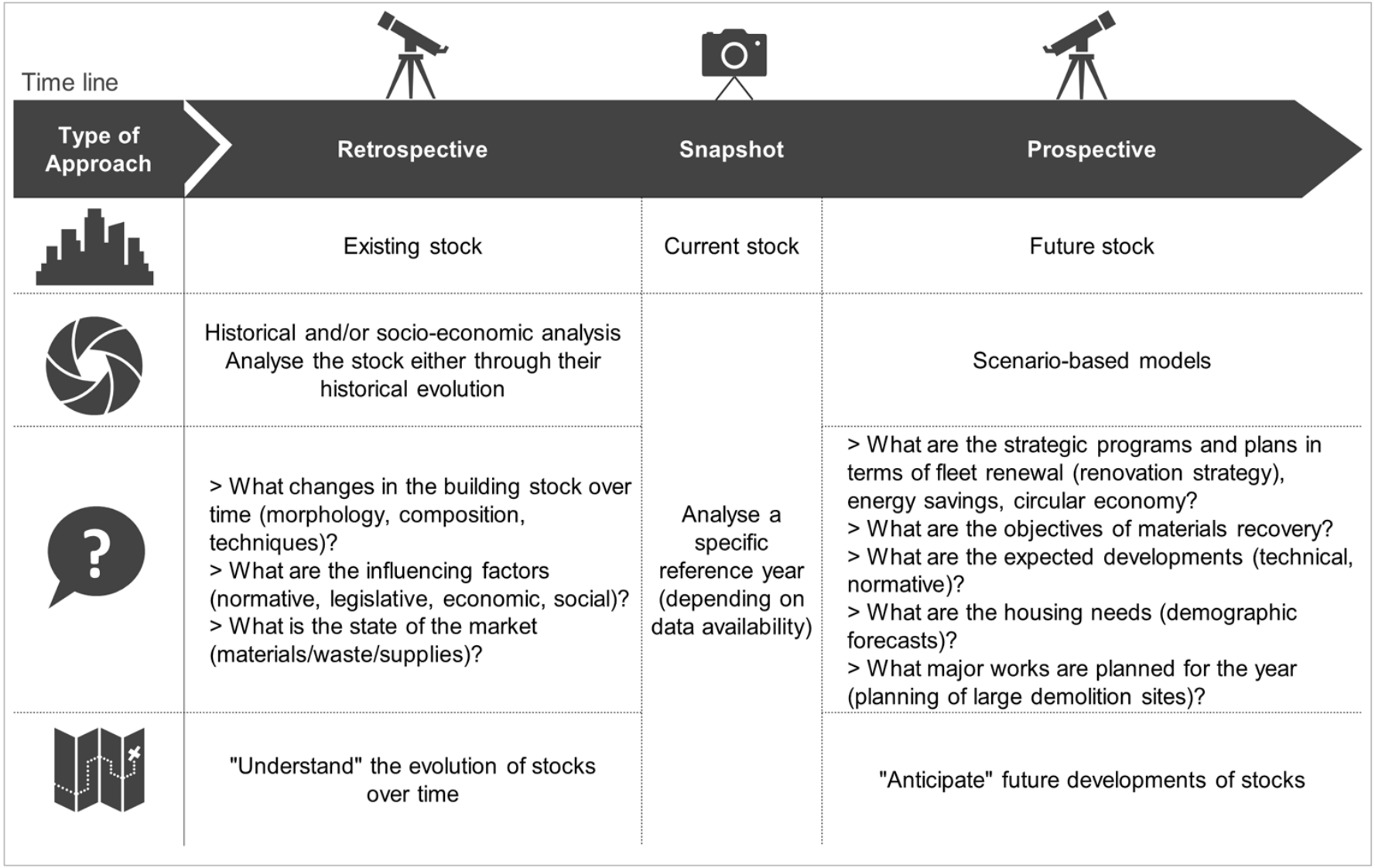


Geometric specifications
> morphology

Source: Emilie Gobbo, 2021

Data collection

3. Approaches and Methodology



Source: Emilie Gobbo, 2021

3. Approaches and Methodology

Scale and Units

socio-economic value?

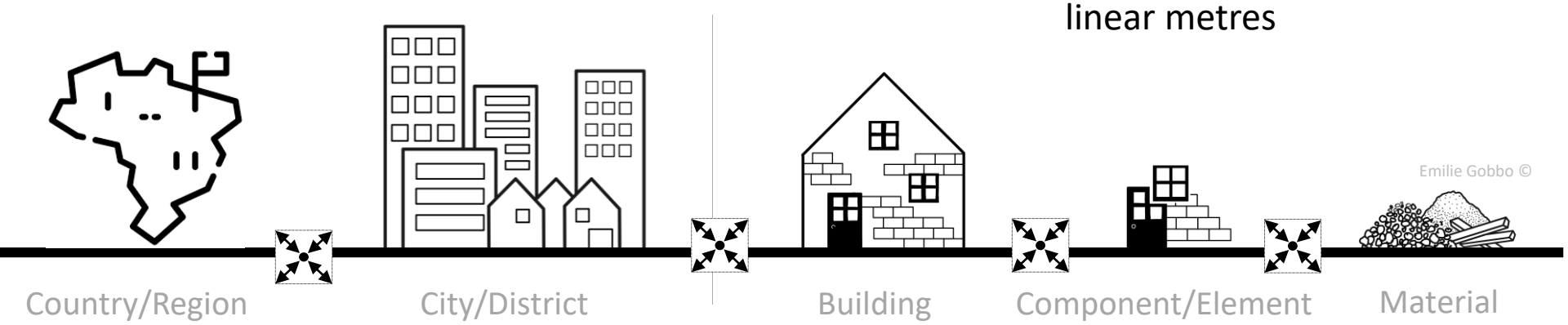
mass/capita — mass/m² — **mass**

m³/capita — m³/m² — volume

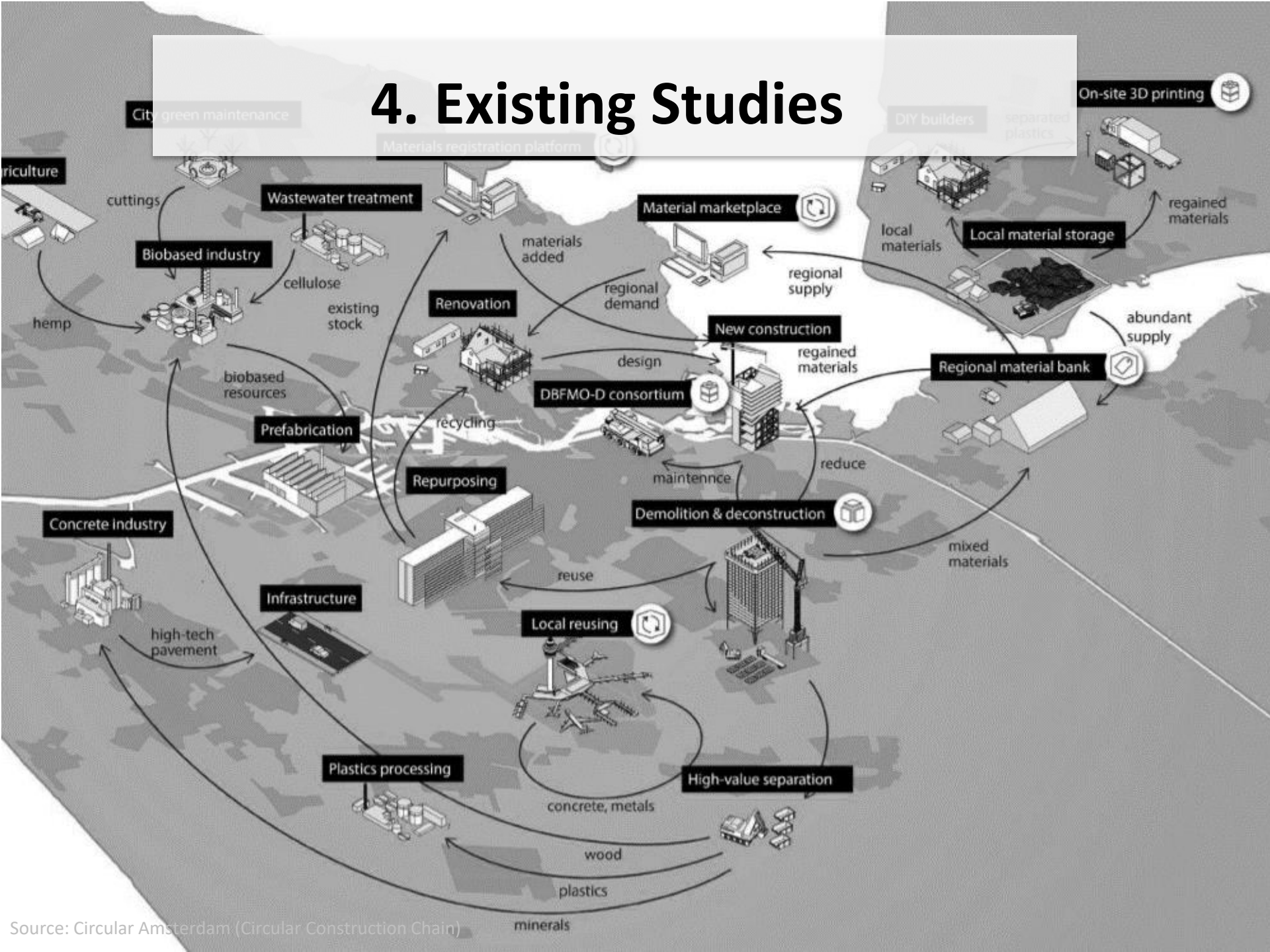
m²/capita — surface area

number

linear metres

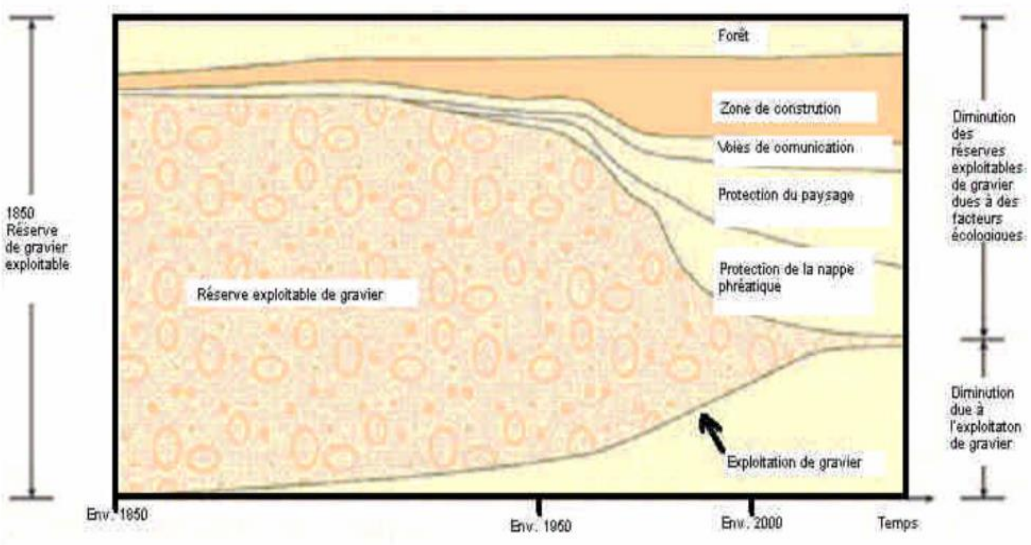


4. Existing Studies



Source: Circular Amsterdam (Circular Construction Chain)

4. Existing Studies



Industrial Ecology in Geneva (2002-2010)

Challenges:

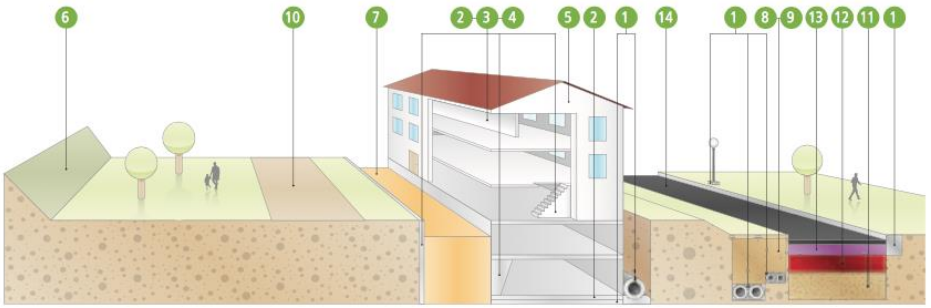
- Scarcity of local gravel resources (reserves exhausted in 30 years)
- Huge amount of construction and demolition waste (mainly inert)
- Congestion of landfills sites

- ➢ Test on recycled materials
- ➢ Guide recommended applications
- ➢ Directive for the choice of construction materials: priority for recycled materials

N° Fiches	Dénomination	Applications
1	Béton maigre CP 100-250	Béton de remplissage, béton de propreté, béton d'enrobage, conduite SIG, socles et fondations divers.
2	RC Euro-Béton CP 20/25, XC1, XC2 (grue)	Radier, fondation, élément structurel à faibles contraintes.
3	RC-B ou RC-M, C25/30, XC1, XC2 (grue, Dmax 32mm)	Construction armée, paroi berlinoise, paroi moulée, mur intérieur, paroi, escalier, dalle de petite portée.
4	RC-B ou RC-M, C25/30, XC1, XC2 (pompé, Dmax 32mm)	Construction armée, paroi berlinoise, paroi moulée, mur intérieur, paroi, escalier, dalle de petite portée.
5	RC-B, C30/37, XC3 (pompé, Dmax 32mm)	Construction armée, dalle, mur porteur intérieur, mur extérieur avec protection.
6	Remblais	Butte antibruit, aménagement extérieur, parcs et jardins.
7	Parafouilles	Comblement de fouilles après terrassement.
8	Canalisations : eau potable, gaz, électricité	Remblais de fouilles SIG, travaux en marge du génie civil.
9	Canalisations : eaux usées EU et eaux claires EC	Remblais de fouilles, travaux en marge du génie civil.
10	Chemin forestier, communal, piste de chantier	Accès chantier, accès provisoire, chemin.
11	Renforcement des sols	Infrastructure zone hors gel.
12	Couche de fondation	Route, chemin, piste de chantier.
13	Couche de base et de liaison	Superstructure avant la pose de la couche de roulement.
14	Couche de roulement	Route, piste cyclable, trottoir.

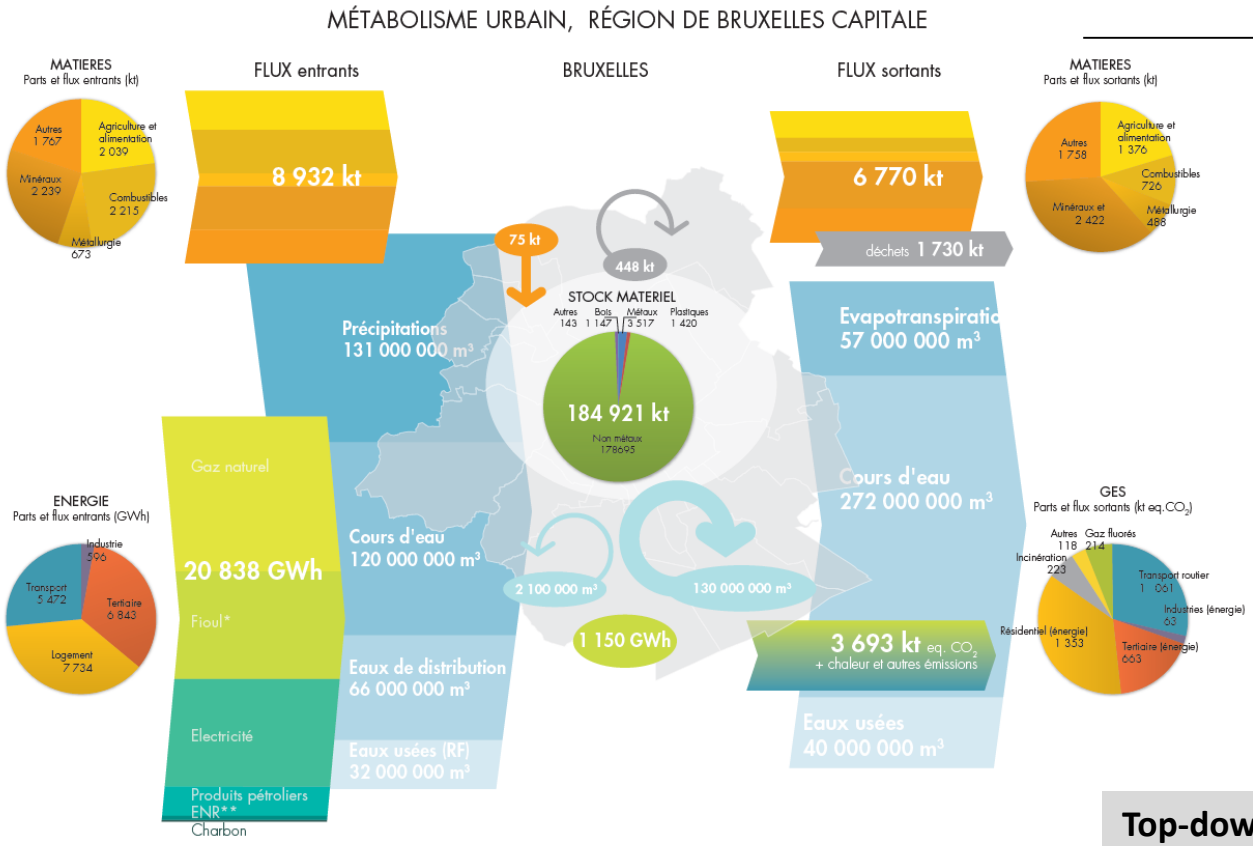
Source: ECOMATGE

Top-down, Flows, Snapshot (and prospective)
Reuse is not directly addressed, it is more about recycling proccess.



4. Existing Studies

The Urban Metabolism Study of the Brussels Capital Region (2015)



Source: ECORES, BATIR, 2015

The urban stock around 185 billion t:

- 84% contained in buildings
- 15% in infrastructure
- 1% others (vehicles)

Additional study considering the construction sector

➢ Some key flows identified (potential circular savings): modular partitions, carpet tiles, technical floor tiles and false ceilings.

Top-down, Flows (and stocks to a lesser extent), Snapshot

Reuse is not directly addressed, but some key flows are cited in the additional study as potential circular savings.

4. Existing Studies

Table 1
Five SDH archetypes and their key features.

Archetype	Construction time period	Usable floor area	Key features
Century	Pre-1930	116 m^2	Double and triple width brick SDH, over 100 years old.
Wartime	1931–1960	102 m^2	Small one and half story double width brick SDH built en-mass after the Second World War.
Baby Boomer	1961–1975	128 m^2	Larger SDH built for baby boomers entering the market, wanting more space to raise families.
Ontario Building Code (OBC)	1976–2000	173 m^2	SDH built with the first provincial building code, enacted in 1975.
Modern	Post-2001	262 m^2	Larger SDH built to current OBC standards.

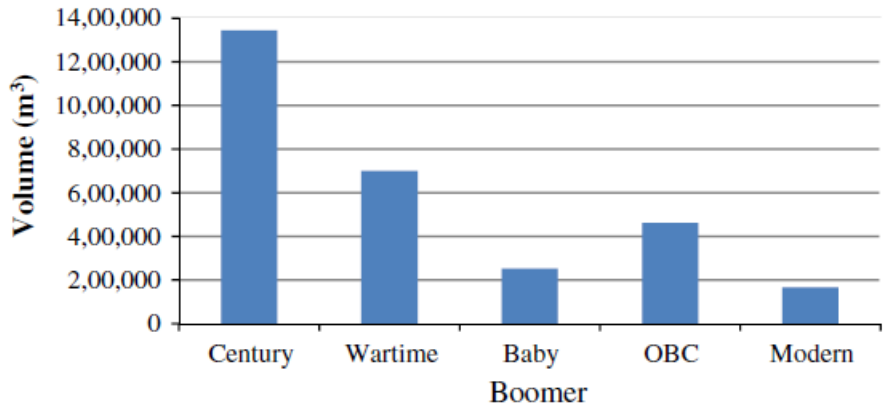


Fig. 4. Volume of brick (m^3) in Toronto's in-use SDH stock in 2012, by archetype.

Inventorying Toronto's single detached housing stocks to examine the availability of clay brick for urban mining (2015)

- Focus on clay brick
- Archetype: Toronto's single detached housing
- Estimation of reusable and recyclable stocks at the city scale
- Understanding of what volume could be saved from landfill and reintroduced into the urban fabric.

➢ 2523–4542 m^3 of brick available annually for reuse = 20–36% of the volume of virgin brick consumed in new house construction in 2012.

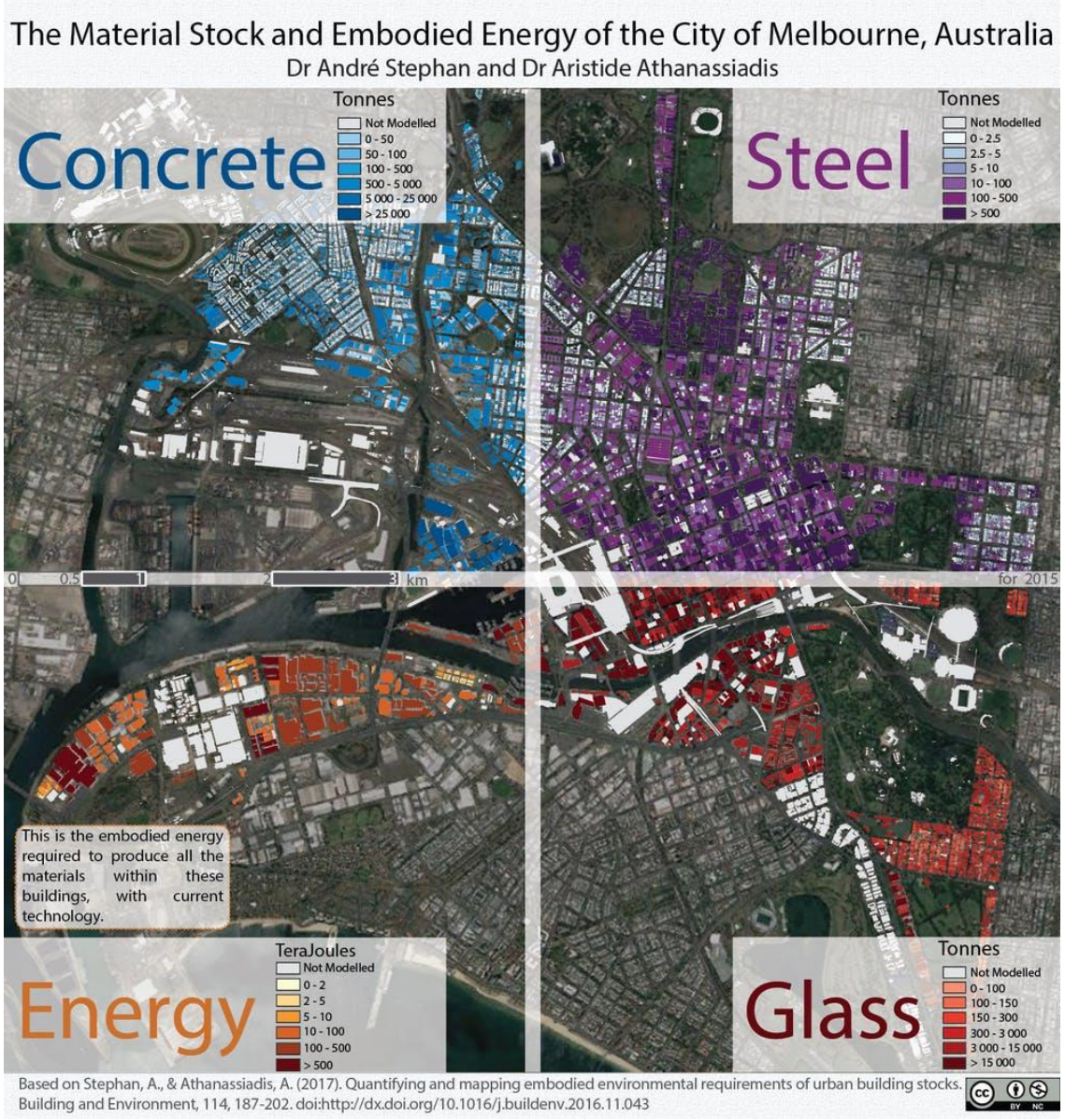
➢ 6187 m3 of brick available annually for recycling due to cement-based mortar

Older housing containing reusable brick are mostly landfilled and replaced with housing that contained only recyclable brick.

Bottom-up, Stock & Flows – focus on Clay-Bricks, Retrospective + snapshot
> Reuse and recycling potential.

Source: Gorgolewski and Ergun, 2015

4. Existing Studies



Prospective study of material stocks in Melbourne (2017)

- FLOWS:

Estimation of material flows caused by replacement of non-structural materials at end of life

- Environmental impact assessment
- STOCKS:

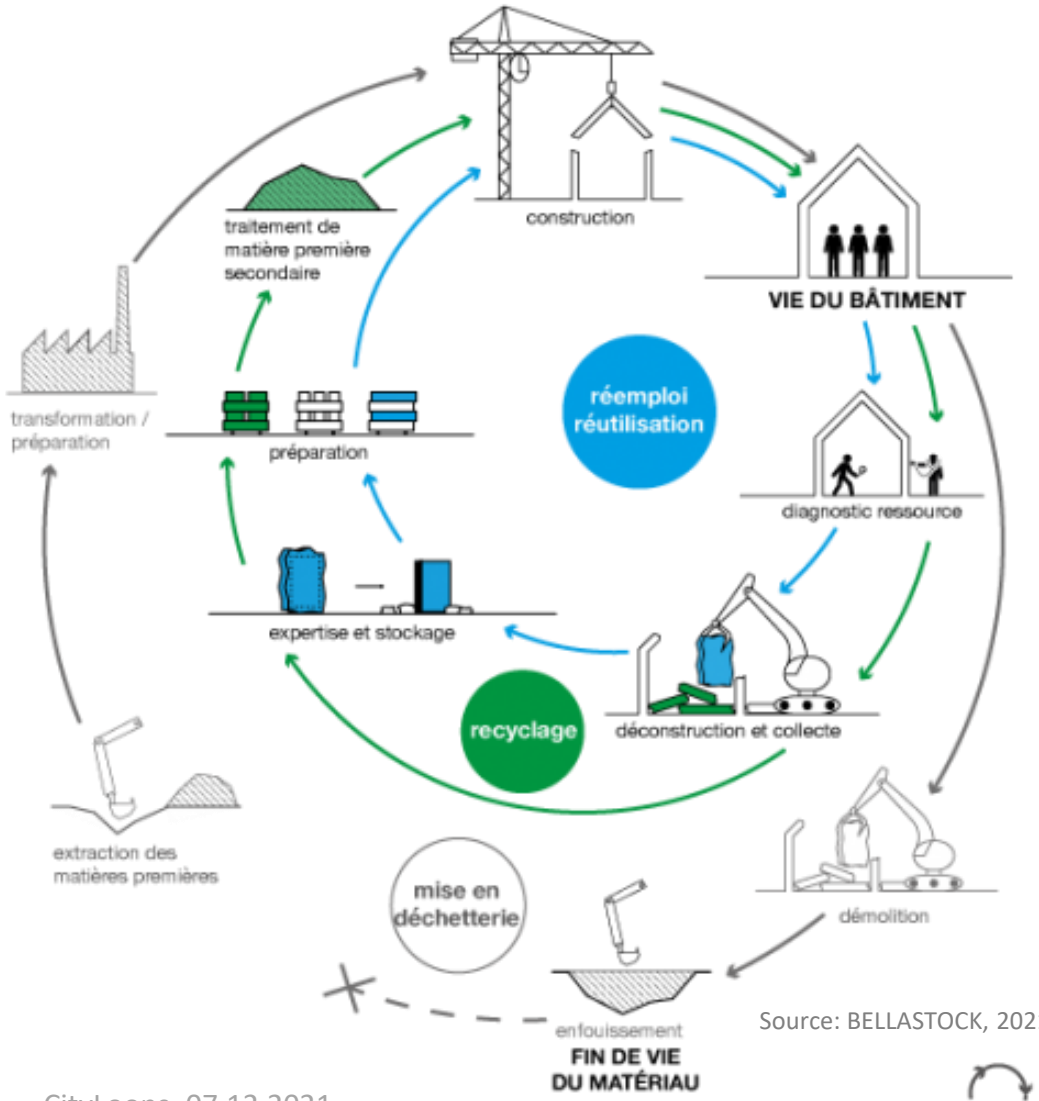
Spatial modelling of material intensity

- 48 building archetypes modelled
- Material type approach

Bottom-up-Archetypes, Stock & Flows, Retrospective and Prospective
> Reuse is not directly pointed in this study.

Source: André Stephan, Aristide Athanassiadis, 2017

4. Existing Studies



Source: BELLASTOCK, 2021

Experimental project of Plaine Commune (2021)

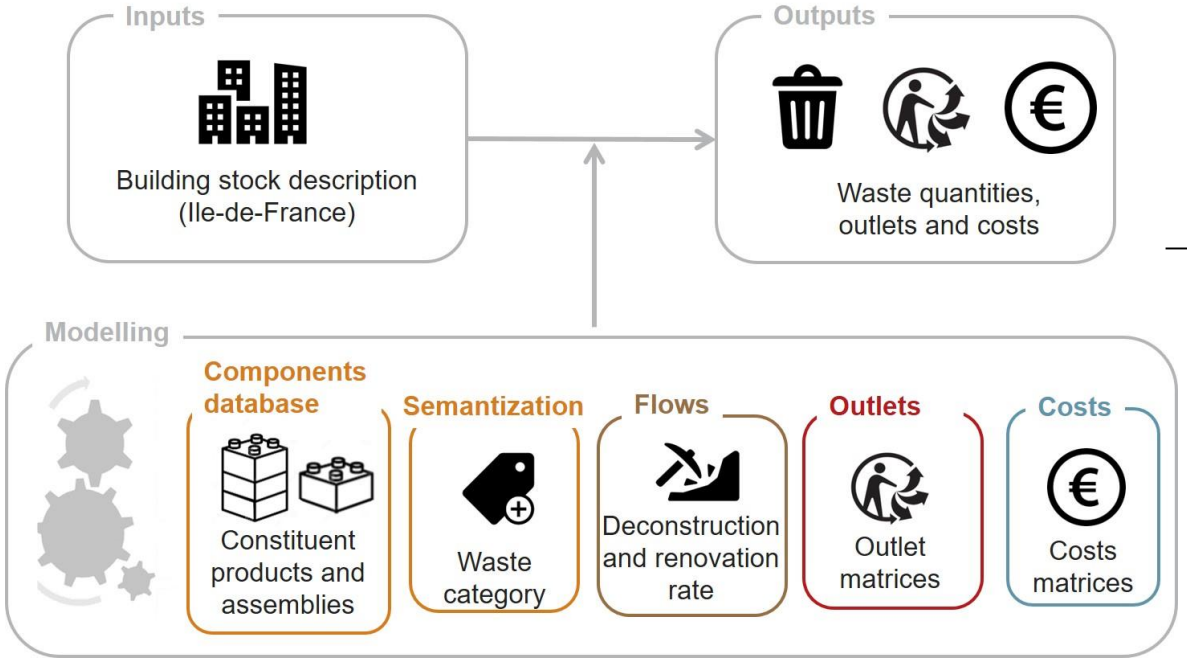
- Characterising the 'urban mine':
- Developing a digital tool making the deposits visible
- Conducting resource diagnosis on 30 pilot projects
- Integrating Urban metabolism clauses into documents
- Developing a sorting, storage and recycling platform
- Supporting local skills (training)
- Developing of local channels (reuse)

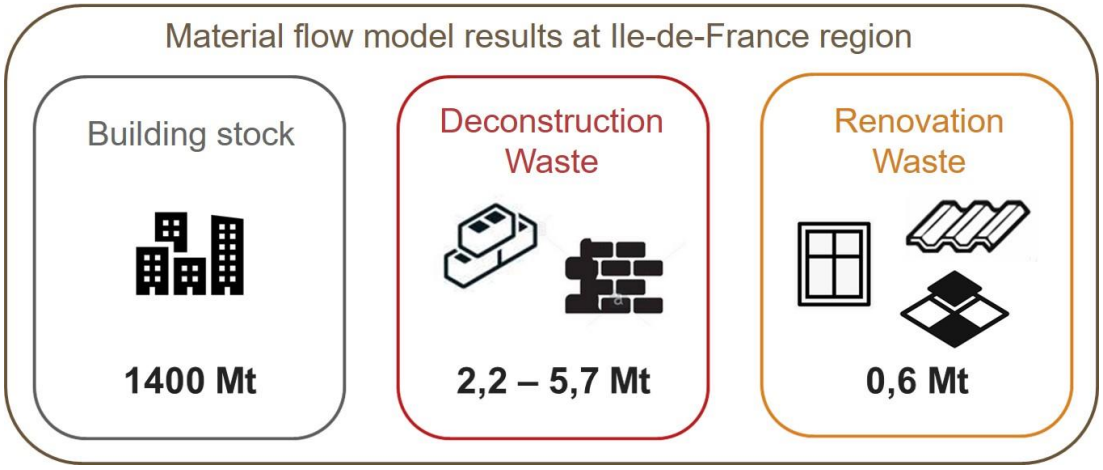
Bottom-up, Flows (and stocks to a lesser extent), Snapshot
> Reuse is directly addressed by the study and implemented concretely in projects including the various actors

économie linéaire avec rupture de filières et mise en décharge des ressources

procédés d'économie circulaire en filières courtes et locales

4. Existing Studies





Prospective study of material stocks and flows in Ile de France (2021)

- Five uses modeled > 101 352 buildings
- Buildings geometry comes from geographical information
- Material buildings characteristics comes from a macro-component and assemblies database
- Environmental impacts and treatment costs generated by waste
- Renovation and demolition scenarios

Bottom-up, Macro-component description, Stock & Flows, Prospective
> Reuse scenarios are included in this study.

Source: CSTB, 2021

4. Existing Studies

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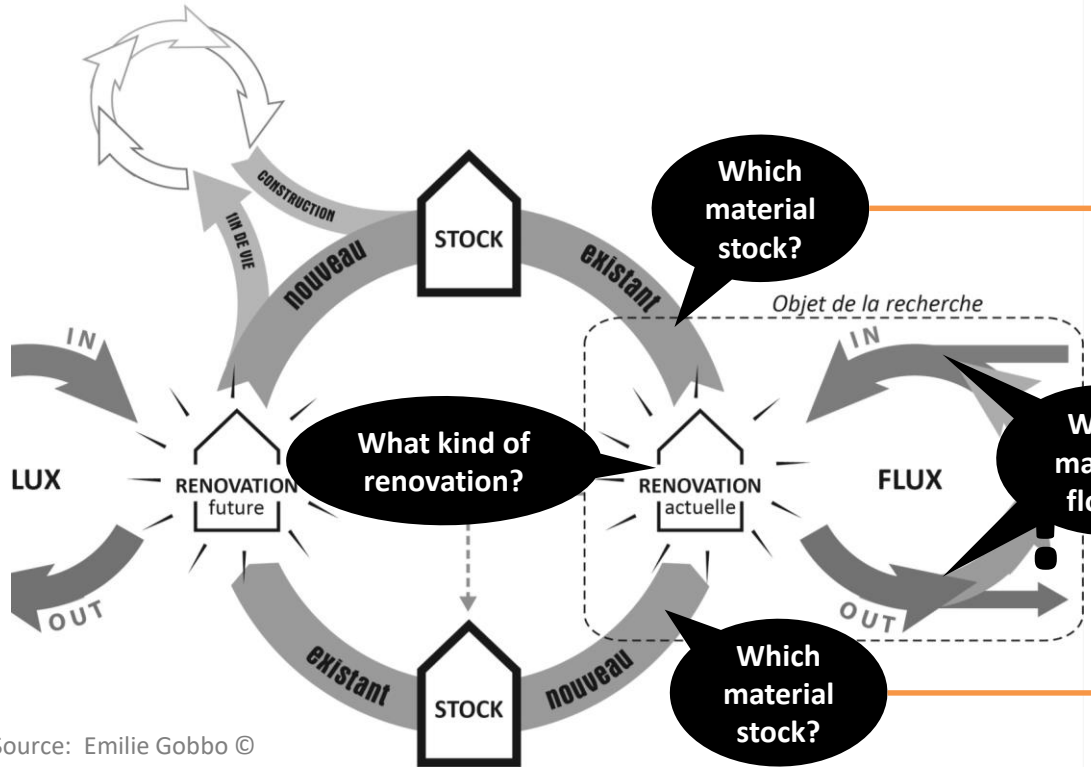
Articles

https://iopscience.iop.org/article/10.1088/1755-1315/225/1/012029/pdf

https://iopscience.iop.org/article/10.1088/1742-6596/1343/1/012175/pdf



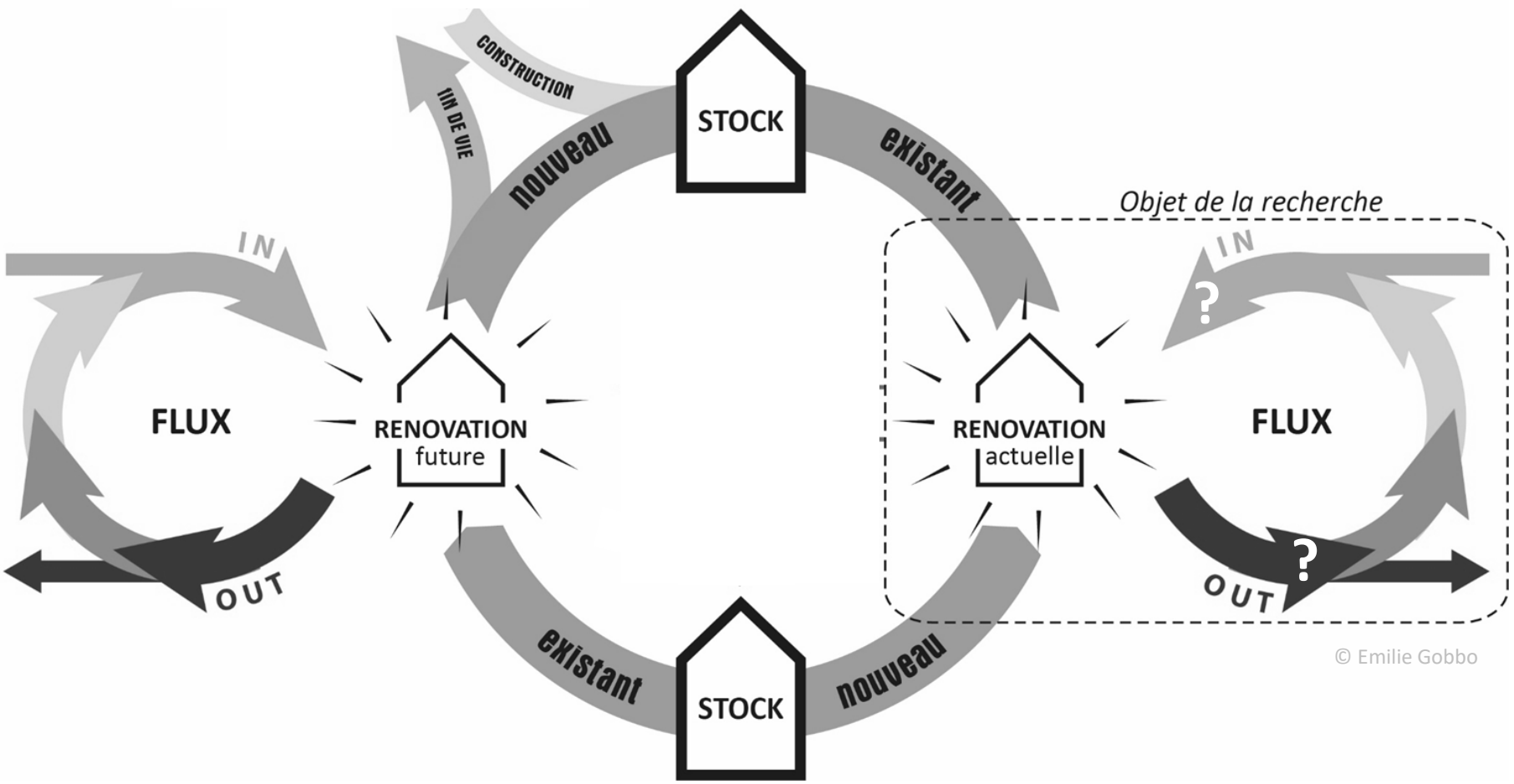
Source: Emilie Gobbo ©

MATERIAL BALANCE

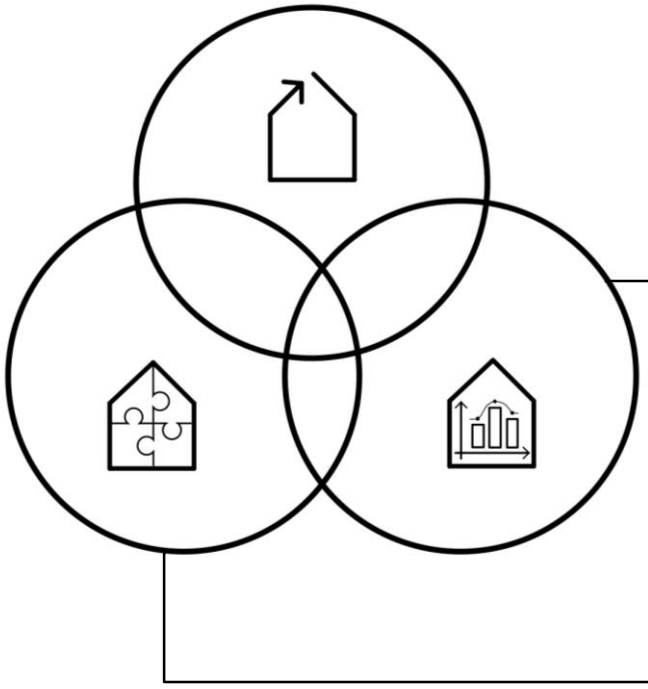
EBS - Flows OUT + Flows IN = NBS

5. Perspectives

5. Perspectives



5. Perspectives



An emerging research field

A data intensive research field

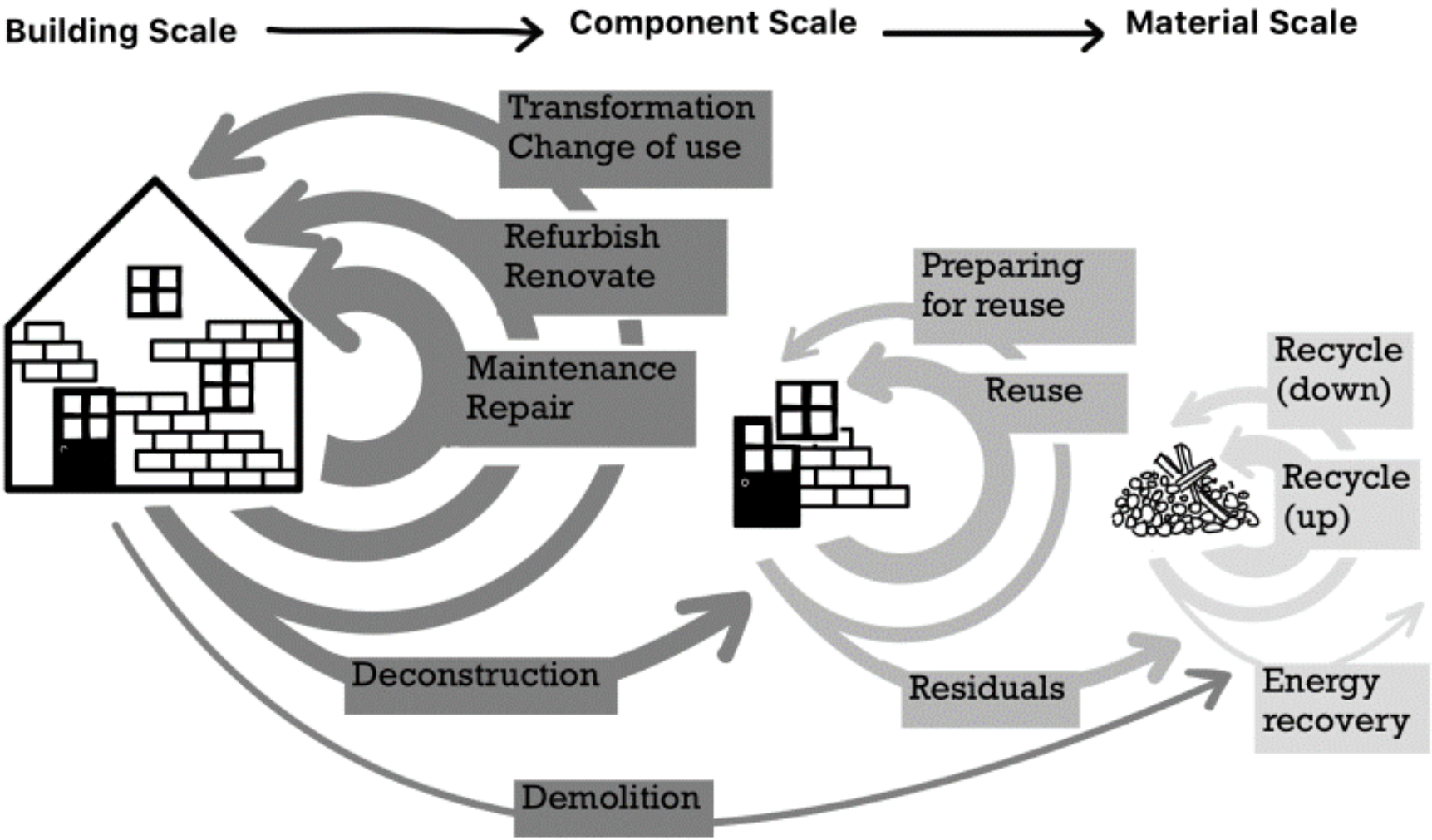
Necessary but not sufficient on their own:

> A need to integrate actors

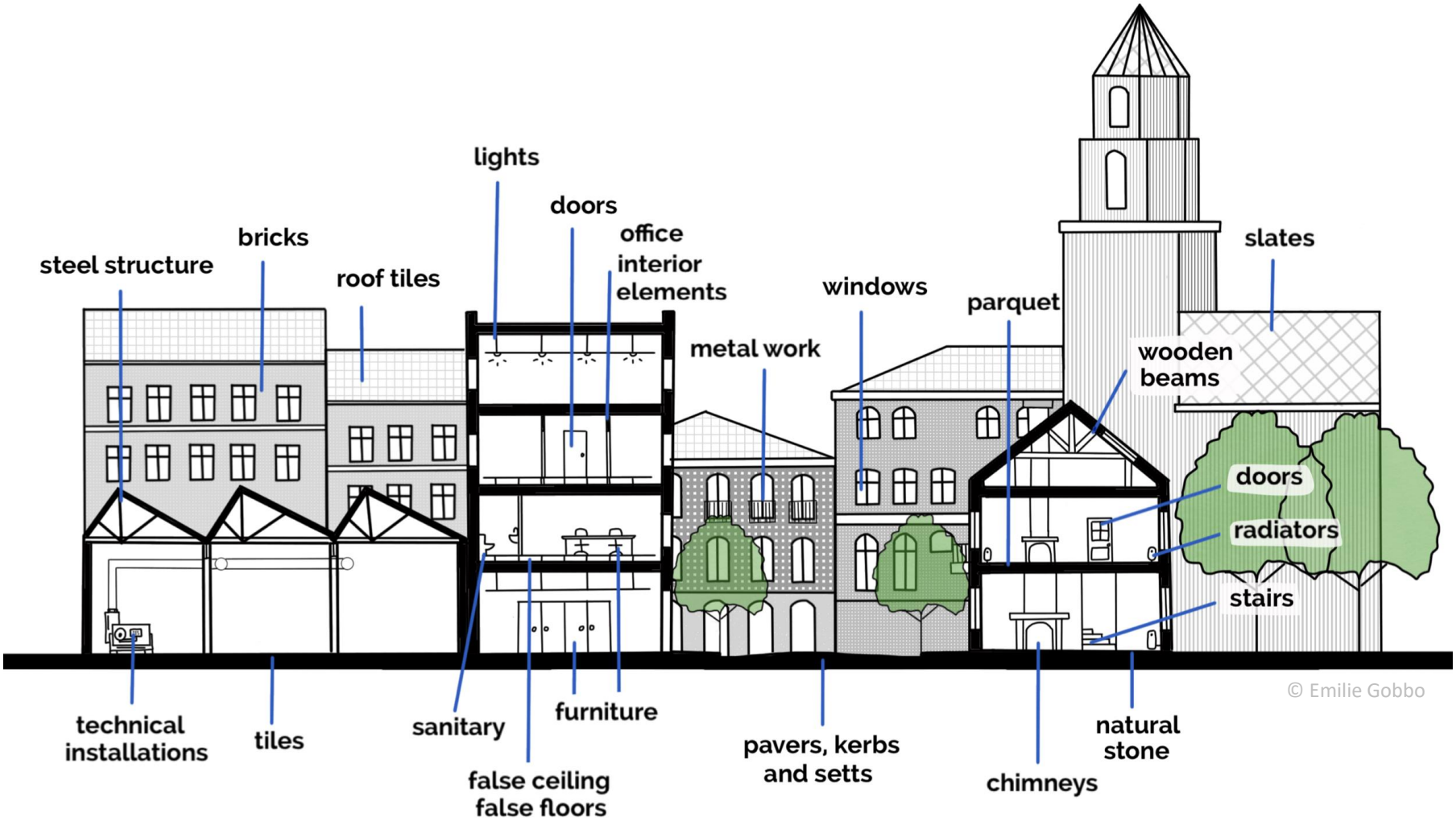
> Requires a multi-disciplinary approach

5. Perspectives

Hierarchy of loops of the circular economy applied to the building industry
Source: Emilie Gobbo based on [HUUHKA, 2019]



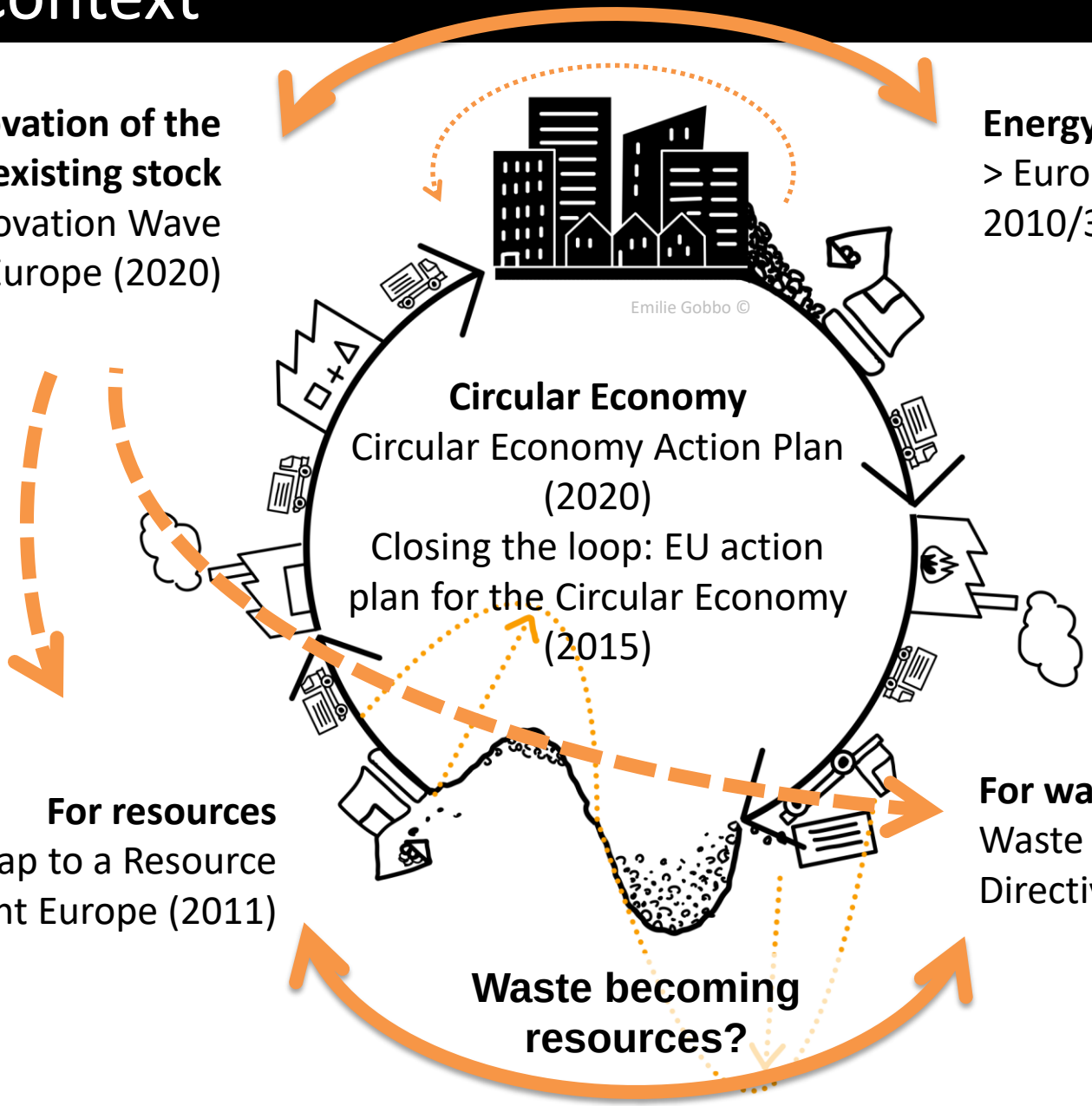
5. Perspectives



1. Context

Renovation of the existing stock
> Renovation Wave Europe (2020)

Energy performance
> European Directive 2010/31/EU

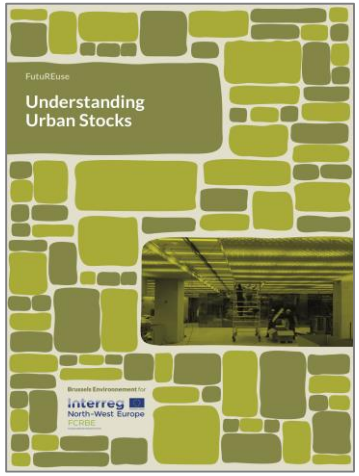


For resources
Roadmap to a Resource Efficient Europe (2011)

For waste
Waste Framework Directive 2008/98/EC

Questions ?

References



https://vlaanderen-circulair.be/en/circular-cities/circular-metabolism

Articles

Augiseau, Vincent & Barles, Sabine. (2016). Studying construction materials flows and stock: A review. Resources, Conservation and Recycling. 123. 10.1016/j.resconrec.2016.09.002.

Gobbo, Emilie & Trachte, Sophie & Massart, Catherine.(2019a). Energy retrofit scenarios: material flows and circularity. IOP Conf. Series: Earth and Environmental Science 225 (2019) 012029 IOP Publishing doi:10.1088/1755-1315/225/1/012029

https://iopscience.iop.org/article/10.1088/1755-1315/225/1/012029/pdf

Gobbo, Emilie & Trachte, Sophie & Massart, Catherine.(2019b). Influence of energy retrofit on material flows: comparison between various strategies. In: Journal of Physics: Conference Series (Print), Vol. 1343, no.012175, p. 6 (20 9). 10.1088/1742-6596/1343/1/012175

https://iopscience.iop.org/article/10.1088/1742-6596/1343/1/012175/pdf

Lanau, Maud & Liu, Gang & Kral, Ulrich & Wiedenhofer, Dominik & Keijzer, Elisabeth & Yu, Chang & Ehlert, Christina. (2019). Taking Stock of Built Environment Stock Studies: Progress and Prospects. Environmental Science & Technology. 53. 10.1021/acs.est.8b06652.

4. Existing Studies

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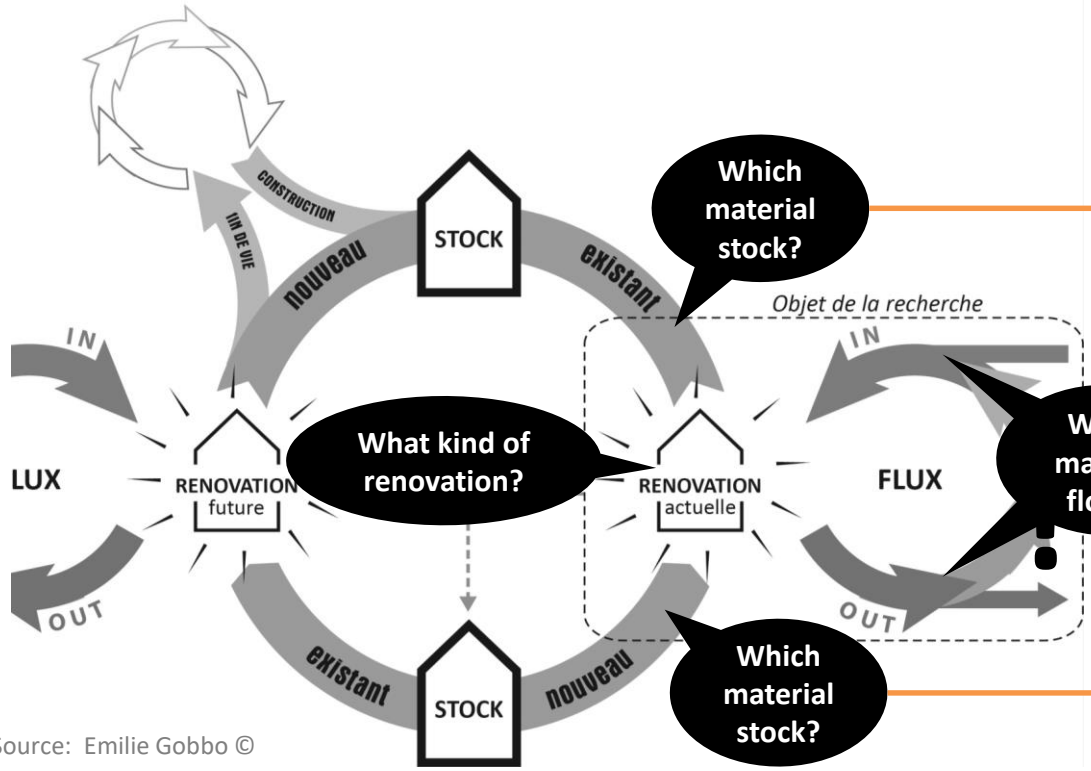
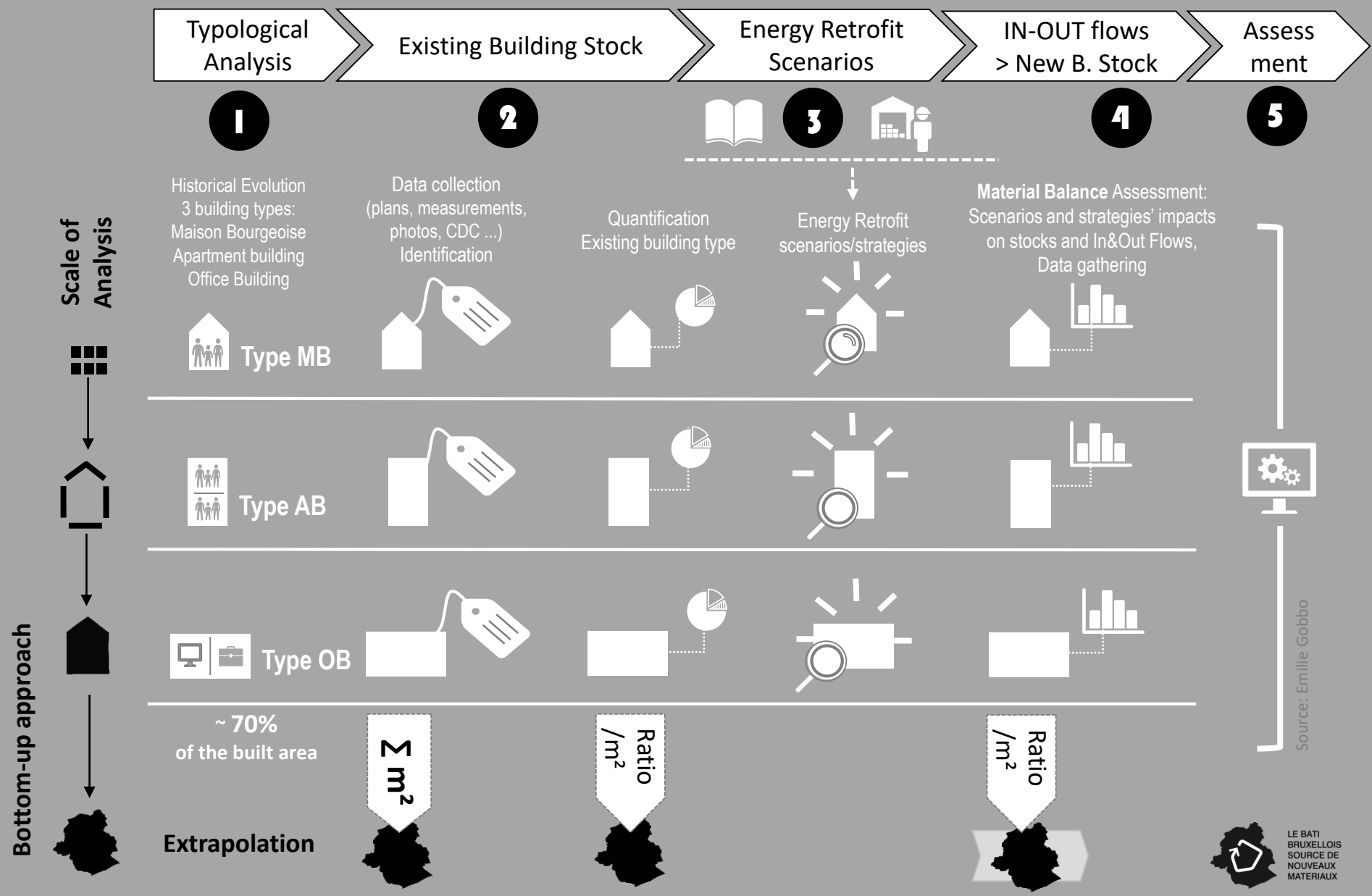


Source: Emilie Gobbo ©

MATERIAL BALANCE

EBS - Flows OUT + Flows IN = NBS

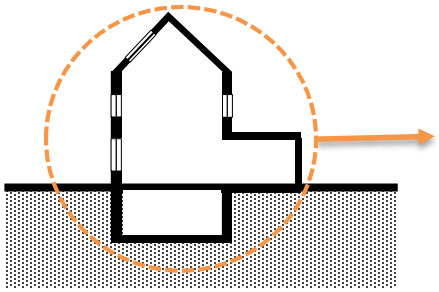
4. Existing Studies



4. Existing Studies

Energy retrofit scenarios: building

Maison Bourgeoise Type



SCENARIOS

Pour les 3 scénarios global (X, Y et Z), faites un choix de rénovation pour chaque paroi (D1C1, D1C2,...) Les sc

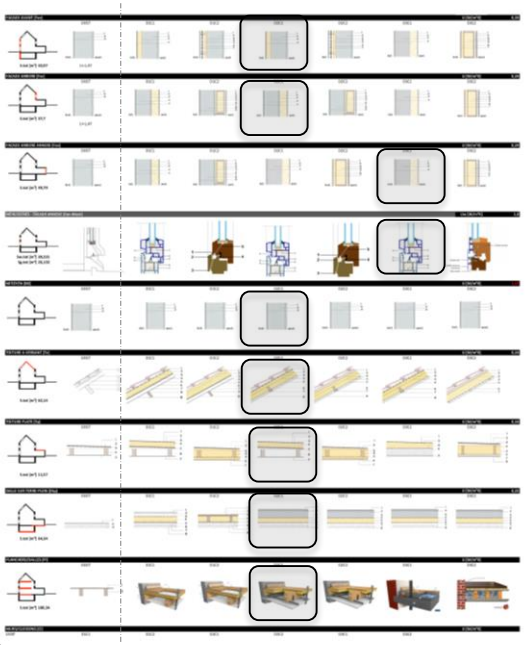
scénario X	
Front Facade	D2C1
Rear Facade	D2C1
Common Walls	D2C1
Rear Facade (Extension)	D3C1
Outside Windows	D3C1
Pitched Roof	D2C1
Flat Roof	D2C1
Slab-on-Grade + foundations	D2C1
Interior Floors	D2C1
Interior Walls	D2C1

scénario Y	
Front Facade	D1C1
Rear Facade	D1C1
Common Walls	D1C1
Rear Facade (Extension)	D1C1
Outside Windows	D2C1
Pitched Roof	D1C1
Flat Roof	D2C1
Slab-on-Grade + foundations	D1C1
Interior Floors	D1C1
Interior Walls	D1C1

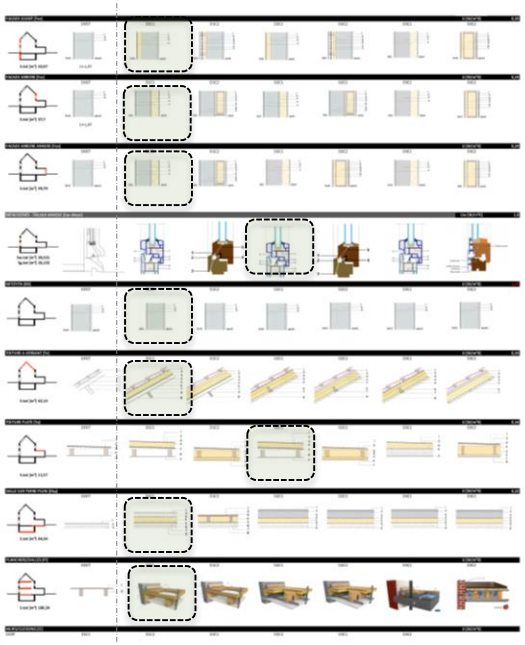
scénario Z	
Front Facade	D3C1
Rear Facade	
Common Walls	
Rear Facade (Extension	
Outside Windows	
Pitched Roof	D3C1
Flat Roof	D3C1
Slab-on-Grade + foundations	D3C1
Interior Floors	D3C1
Interior Walls	D3C1

D1C1
D1C2
D2C1
D2C2
D3C1
D3C2

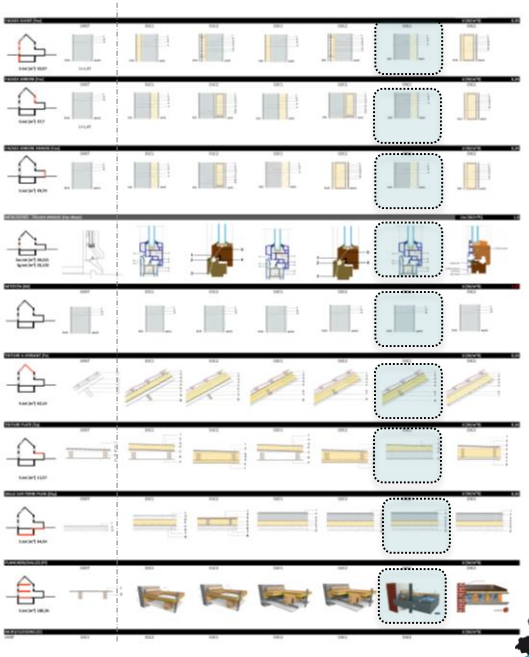
Strategy X: Commonly implemented



Strategy Y: reduced degree of demolition



Strategy Z: increased degree of demolition

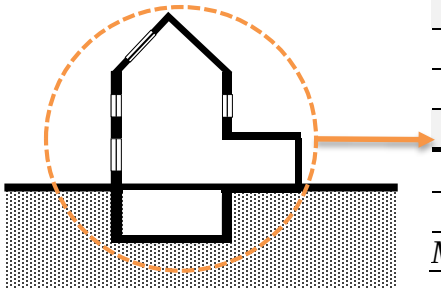


Source: Emilie Gobbo

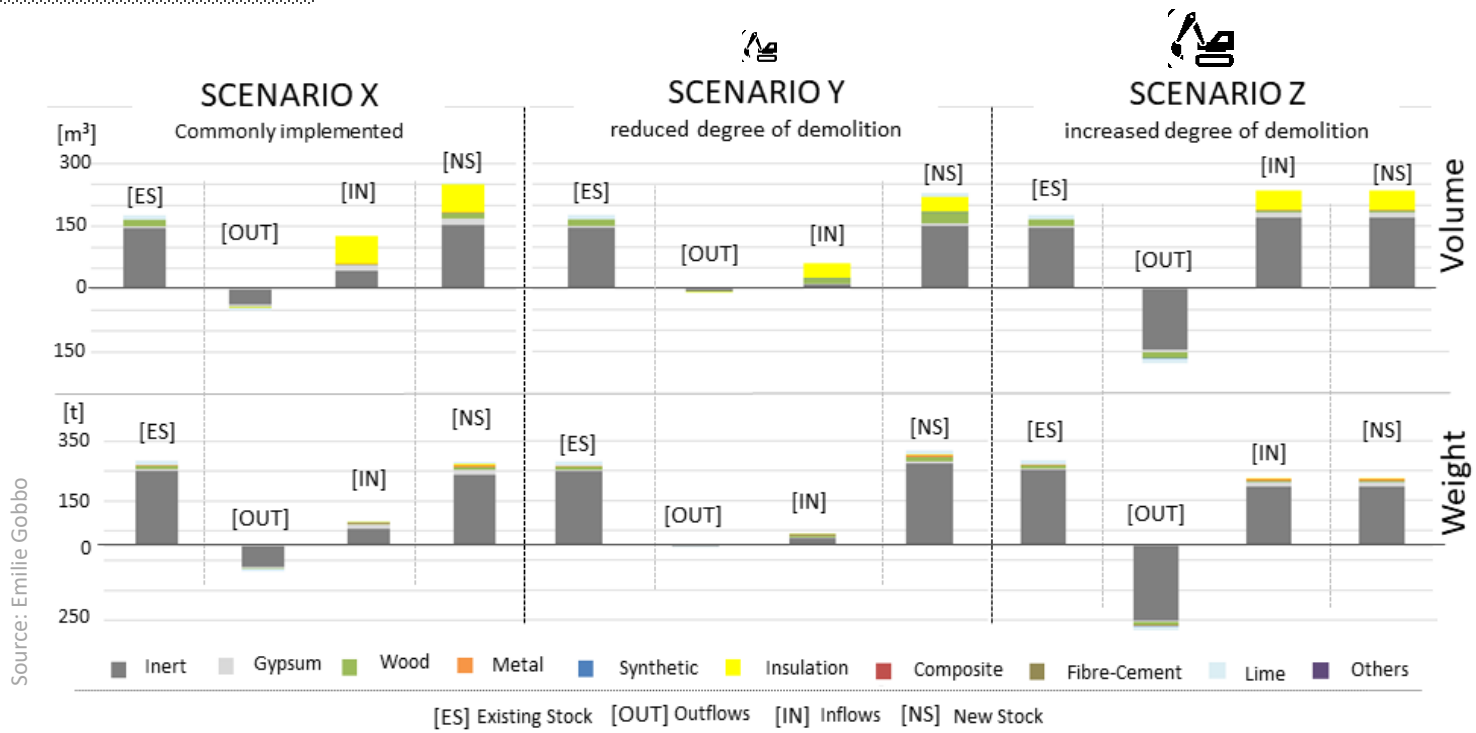
4. Existing Studies

Material Balance: building

Maison Bourgeoise Type



Scenarios	Volume [m³] X	Volume [m³] Y	Volume [m³] Z	Weight [t] X	Weight [t] Y	Weight [t] Z
Existing Stock		176,1			284,18	
∑Outflows	-49,7	-9,8	-177,1	-85,81	-4,84	-285,31
∑Inflows	126,4	61,4	234,2	80,89	37,71	224,06
New Stock	253,9	229,1	234,2	280,3	318,37	224,06
∑Total Flows	176,1	71,2	411,3	166,7	42,55	509,37
Difference Δ		-104,9	+235,2		-124,15	+342,67
Multiplicative factor		*0,404*	*2,34*		*0,255*	*3,06*



LE BATI BRUXELLOIS SOURCE DE NOUVEAUX MATERIAUX


Thank you
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