Understanding Urban Stocks
as Potential Resources
A prospective Approach

CityLoops
Expert Workshop

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European Regional Development Fund


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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
1. Context

- 50% (building)
- 50% (lightning)
- 33% (water)
- 36% (trash)

- 75% (people)
- 40% (...1960)

Emilie Gobbo ©
1. Context

Energy
Food
Water
Materials

Waste
Sewage
Pollution
...

60%
expected by 2030
1. Context

Cities as Living Organisms?

Source: Paul Duvigneaud, 1980
1. Context

Cities as Urban Mines?

Capitalise on the energy initially devoted to the production of products, materials and buildings concentrated in cities by considering them as a materials bank.
2. Characteristics
2. Characteristics
2. Characteristics

Heterogeneous nature

Source: Opallis
2. Characteristics

Densely built-up nature
2. Characteristics

Lack of accessibility

Source: Weiesley Tingey on Unsplash
2. Characteristics

Dynamic nature
2. Characteristics

Unpredictability of the future availability

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

Source: Sabine Barles, 2007
3. Approaches and Methodology

Flow-driven model

Stock-driven model

Dynamic

Material Flow Analysis

Retrospective

Prospective

Static

Snapshot

Top-Down (TD)

Can be combined

Bottom-up (BU)

Remote Sensing

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

Data collection

Source: Emilie Gobbo, 2021
3. Approaches and Methodology

**Time line**

<table>
<thead>
<tr>
<th>Type of Approach</th>
<th>Retrospective</th>
<th>Snapshot</th>
<th>Prospective</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing stock</td>
<td>Current stock</td>
<td>Future stock</td>
</tr>
<tr>
<td>Historical and/or socio-economic analysis</td>
<td>Analyse the stock either through their historical evolution</td>
<td></td>
<td>Scenario-based models</td>
</tr>
<tr>
<td>&gt; What changes in the building stock over time (morphology, composition, techniques)?</td>
<td></td>
<td>&gt; What are the strategic programs and plans in terms of fleet renewal (renovation strategy), energy savings, circular economy?</td>
<td></td>
</tr>
<tr>
<td>&gt; What are the influencing factors (normative, legislative, economic, social)?</td>
<td>&gt; What are the objectives of materials recovery?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; What is the state of the market (materials/waste/supplies)?</td>
<td>&gt; What are the expected developments (technical, normative)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Understand&quot; the evolution of stocks over time</td>
<td>&gt; What are the housing needs (demographic forecasts)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; What major works are planned for the year (planning of large demolition sites)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;Anticipate&quot; future developments of stocks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Emilie Gobbo, 2021
3. Approaches and Methodology

Scale and Units

- mass/capita
- mass/m²
- m³/capita
- m³/m²
- m²/capita
- m²/m²

**mass**

**volume**

**socio-economic value?**

**surface area**

**number**

**linear metres**

Country/Region  City/District  Building  Component/Element  Material
4. Existing Studies

Source: Circular Amsterdam (Circular Construction Chain)
4. Existing Studies

**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

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**Industrial Ecology in Geneva (2002-2010)**

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**Top-down, Flows, Snapshot (and prospective)**

Reuse is not directly addressed, it is more about recycling process.

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Source: ECOMATGE
4. Existing Studies

The Urban Metabolism Study of the Brussels Capital Region (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

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.
  - $6187$ m$^3$ 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.

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

Source: Gorgolewski and Ergun, 2015

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**Table 1**

<table>
<thead>
<tr>
<th>Archetype</th>
<th>Construction time period</th>
<th>Usable floor area (m$^2$)</th>
<th>Key features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Century</td>
<td>Pre-1930</td>
<td>116</td>
<td>Double and triple width brick SDH, over 100 years old.</td>
</tr>
<tr>
<td>Wartime</td>
<td>1931–1960</td>
<td>102</td>
<td>Small one and half story double wide brick SDH built en-mass after the Second World War.</td>
</tr>
<tr>
<td>Baby Boomer</td>
<td>1961–1975</td>
<td>128</td>
<td>Larger SDH built for baby boomers entering the market, wanting more space to raise families.</td>
</tr>
<tr>
<td>Modern</td>
<td>Post-2001</td>
<td>262</td>
<td>Larger SDH built to current OBC standards.</td>
</tr>
</tbody>
</table>
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
- **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

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

Source: BELLASTOCK, 2021
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 come 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

Brussels Building Stock as new Material resources (BBSM)

www.bbsm.brussels

MATERIAL BALANCE
EBS - Flows OUT + Flows IN = NBS

Source: Emilie Gobbo ©

Articles

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 [HUHKA, 2019]

Huuhka S., Vestergaard I., Building conservation and the circular economy: a theoretical consideration, Emerald Insight, November 2019
1. Context

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

**Energy performance**
> European Directive 2010/31/EU

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**Circular Economy**
Circular Economy Action Plan (2020)
Closing the loop: EU action plan for the Circular Economy (2015)

**For resources**
Roadmap to a Resource Efficient Europe (2011)

**For waste**

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Waste becoming resources?
Questions ?


4. Existing Studies

Brussels Building Stock as new Material resources (BBSM)

www.bbsm.brussels

MATERIAL BALANCE
EBS - Flows OUT + Flows IN = NBS

Source: Emilie Gobbo ©

4. Existing Studies

Historical Evolution
3 building types: Maison Bourgeoise, Apartment building, Office Building

Data collection (plans, measurements, photos, CDC...)
Identification

Quantification
Existing building type

Energy Retrofit scenarios/strategies

Material Balance Assessment: Scenarios and strategies’ impacts on stocks and In&Out Flows, Data gathering

~ 70% of the built area

Extrapolation

Source: Emilie Gobbo
4. Existing Studies

Maison Bourgeoise Type

<table>
<thead>
<tr>
<th>SCENARIOS</th>
<th>Maison Bourgeoise Type</th>
<th>Strategy X: Commonly implemented</th>
<th>Strategy Y: reduced degree of demolition</th>
<th>Strategy Z: increased degree of demolition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front Facade</td>
<td>D2C1</td>
<td>Front Facade</td>
<td>D1C1</td>
<td>Front Facade</td>
</tr>
<tr>
<td>Rear Facade</td>
<td>D2C1</td>
<td>Rear Facade</td>
<td>D1C1</td>
<td>Rear Facade</td>
</tr>
<tr>
<td>Common Walls</td>
<td>D2C1</td>
<td>Common Walls</td>
<td>D1C1</td>
<td>Common Walls</td>
</tr>
<tr>
<td>Rear Facade (Extension)</td>
<td>D3C1</td>
<td>Rear Facade (Extension)</td>
<td>D1C1</td>
<td>Rear Facade (Extension)</td>
</tr>
<tr>
<td>Outside Windows</td>
<td>D3C1</td>
<td>Outside Windows</td>
<td>D2C1</td>
<td>Outside Windows</td>
</tr>
<tr>
<td>Pitched Roof</td>
<td>D2C1</td>
<td>Pitched Roof</td>
<td>D1C1</td>
<td>Pitched Roof</td>
</tr>
<tr>
<td>Flat Roof</td>
<td>D2C1</td>
<td>Flat Roof</td>
<td>D2C1</td>
<td>Flat Roof</td>
</tr>
<tr>
<td>Slab-on-Grade + foundations</td>
<td>D2C1</td>
<td>Slab-on-Grade + foundations</td>
<td>D1C1</td>
<td>Slab-on-Grade + foundations</td>
</tr>
<tr>
<td>Interior Floors</td>
<td>D2C1</td>
<td>Interior Floors</td>
<td>D1C1</td>
<td>Interior Floors</td>
</tr>
<tr>
<td>Interior Walls</td>
<td>D2C1</td>
<td>Interior Walls</td>
<td>D1C1</td>
<td>Interior Walls</td>
</tr>
</tbody>
</table>

Source: Emilie Gobbo

Energy retrofit scenarios: building
4. Existing Studies

**Maison Bourgeoise Type**

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Volume [m³]</th>
<th>Weight [t]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>Existing Stock</td>
<td>176,1</td>
<td></td>
</tr>
<tr>
<td>∑Outflows</td>
<td>-49,7</td>
<td>-9,8</td>
</tr>
<tr>
<td>∑Inflows</td>
<td>126,4</td>
<td>61,4</td>
</tr>
<tr>
<td>New Stock</td>
<td>253,9</td>
<td>229,1</td>
</tr>
<tr>
<td>∑Total Flows</td>
<td>176,1</td>
<td>71,2</td>
</tr>
<tr>
<td>Difference Δ</td>
<td>-104,9</td>
<td>+235,2</td>
</tr>
<tr>
<td>Multiplicative factor</td>
<td>0,404</td>
<td>2,34</td>
</tr>
</tbody>
</table>

Source: Emilie Gobbo

### SCENARIO X
- Commonly implemented

### SCENARIO Y
- Reduced degree of demolition

### SCENARIO Z
- Increased degree of demolition

**Material Balance: building**
Thank you