ENERGY RETROFIT SCENARIOS: MATERIAL FLOWS AND CIRCULARITY

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Summary

1. Introduction
2. Methodology
3. Results
4. Conclusions
Introduction: the ERDF-BBSM project

LE BATI BRUXELLOIS SOURCE DE NOUVEAUX MATERIAUX

- “urban metabolism” of the Brussels-Capital Region (RBC) > bottom-up approach
- key sector: the construction industry
  > Identify and encourage the creation of positive-value loops and eliminating the concept of waste
- study representative typologies and extrapolate
- opportunities for creating new channels offered by the sector’s entire value chain
- technical and legal aspects related to recovery (re-use and recycling)
- impact of design on potential current and future use of end-of-life materials as new materials (reversible design and design for change).
  > tool for anticipating, planning, managing and successfully exploiting the local material resources of the building stock and construction industry in the RBC

www.bbsm.brussels
BBSM Project: Partners & Synergies
BBSM Project: Work Packages

WP1 State of the art

WP2 Urban Metabolism
- Bottom-Up
- Building Site

WP3 Existing Value chains

WP4 Opportunities Value Chains

WP5 Circular Design

WP6 Technical Issue

WP7 Reuse & CE marking

WP8 Conclusions

WP9 Proposals / Implications for the BCR

WP10 Material Balance Tool
BBSM Project: Work Packages
2 Zoom ont the WP2: Urban Metabolism

What?

- To achieve a better knowledge of the deposits of material contained in the Brussels’s Building stock
- To evaluate and anticipate the impact of the energy retrofit processes on these deposits and on the IN & OUT flows
- To achieve a better knowledge of the practices of sorting and waste management and the possibilities of valorization

How?

By developing a bottom-up approach

A. UM > development in 3 steps:
   1. typologies > existing deposit
   2. Energy retrofit scenarios (D / R, Reno) > IN / OUT flows & impacts
   3. extrapolation to the region (in WP9-implications)

B. Site monitoring (D / R, C, R):
   1. inventories
   2. waste management on site
   3. valorization opportunities

Why?

To reach a more efficient management of materials consumed (materials) and rejected (waste) by the activity of the Brussels's construction sector in a circular economy approach > Urban Mining

Key Material Flows Anticipation
Methodology

Typological Analysis

Existing Building Stock Analysis

Energy Retrofit Scenarios & Strategies

IN/OUT Flow Analysis

New Building Stock

Scale of Analysis

Historical Evolution, Parameters by type in 3 building types: Maison Bourgeoise, Apartment building, Office Building

~ 70% of the built area

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

Different combinations according to: degrees of demolition <OUT> choice of new materials > IN <

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

Extrapolation

SBE19 Brussels - BAMB-CIRCPATH

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 643284
Energy Retrofit Scenarios: principles

Demolition degrees
Combination of % demolition per layer

Minimum Demolition – D1

Partial Demolition – D2

Maximum Demolition – D3

Wall decomposed into layers

Le

Ls

Li

0%
100%

New materials & Implementation

C1 « Classic »

C2 « Alternative »

C1 « Classic »

C2 « Alternative »

C1 « Classic »

C2 « Alternative »

Influence the OUT-flows

Influence the IN-flows

SBE19 Brussels - BAMM: CIRCPATH

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 642384.
Energy Retrofit Scenarios: degree of demolition

* 10% of demolition for the tiles (replaced by windows) and 100% for the battens and counter battens

Pitched Roof
6 scenarios

Front Façade
4 scenarios

Rear Façade
6 scenarios

Windows
4 scenarios

Flat Roof
4 scenarios

Concrete Floor on cellar
4 scenarios

Wooden Floor on cellar
6 scenarios

Ground Floor Slab
4 scenarios

- 6 scenarios for Gable Walls
- 4 scenarios for Annex Walls
- 2 scenarios for Foundations
Energy Retrofit Scenarios: rear facade

U: 0.24 W/m²K
(same value for each improved wall)

<table>
<thead>
<tr>
<th>Demolitions Rear Facade</th>
<th>Li</th>
<th>Ls</th>
<th>Le</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>D2</td>
<td>20%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>D3</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>
## Energy Retrofit Strategies: building scale

### SCENARIO X (m³)

<table>
<thead>
<tr>
<th>Component</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front Facade</td>
<td>D1C1</td>
</tr>
<tr>
<td>Rear Facade</td>
<td>D1C1</td>
</tr>
<tr>
<td>Shared Wall (left gable)</td>
<td>D1C1</td>
</tr>
<tr>
<td>Shared Wall (right gable)</td>
<td>D1C1</td>
</tr>
<tr>
<td>Annex Walls</td>
<td>D1C1</td>
</tr>
<tr>
<td>Windows</td>
<td>D1C1</td>
</tr>
<tr>
<td>Pitched Roof</td>
<td>D1C1</td>
</tr>
<tr>
<td>Flat Roof (Annex)</td>
<td>D1C1</td>
</tr>
<tr>
<td>Slab-on-grade</td>
<td>D1C1</td>
</tr>
<tr>
<td>Foundation</td>
<td>D1C1</td>
</tr>
</tbody>
</table>

### SCENARIO Z (m³)

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<td>D3C1</td>
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<tr>
<td>Ground Floor Slab</td>
<td>D3C1</td>
</tr>
<tr>
<td>Foundation</td>
<td>D3C1</td>
</tr>
</tbody>
</table>

*Note: The choice to operate by wall type between the six possible scenarios.*
Results

Minimum demolition (D1) \(\geq\) Maximum Demolition (D3)
Both « classical » choices (C1)
(new materials and implementation)

SCENARIO X (m³)

<table>
<thead>
<tr>
<th>Stock Type</th>
<th>Initial Stock</th>
<th>Outflows</th>
<th>Inflows</th>
<th>« New » Stock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>10.18</td>
<td>-0.23</td>
<td>0.01</td>
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<tr>
<td>Lime</td>
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<tr>
<td>Cement fiber</td>
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<td>0</td>
<td>0</td>
<td>0.00</td>
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<tr>
<td>Composite</td>
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<td>0</td>
<td>0</td>
<td>0.00</td>
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<tr>
<td>Insulation</td>
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<tr>
<td>Metal</td>
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<tr>
<td>Wood</td>
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<td>Inert</td>
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<td>8.86</td>
<td>124.86</td>
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SCENARIO Z (m³)

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<tr>
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<tr>
<td>Cement fiber</td>
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<td>0.00</td>
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<tr>
<td>Composite</td>
<td>0</td>
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<td>0.00</td>
</tr>
<tr>
<td>Insulation</td>
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<td>39.84</td>
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<tr>
<td>Plastic</td>
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<tr>
<td>Metal</td>
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<tr>
<td>Wood</td>
<td>6.6</td>
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<tr>
<td>Gypsum</td>
<td>0.0</td>
<td>-0.24</td>
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<td>7.12</td>
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<tr>
<td>Inert</td>
<td>118.4</td>
<td>-118.80</td>
<td>117.53</td>
<td>117.53</td>
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</tbody>
</table>
### Results

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Volume [m$^3$]</th>
<th>Weight [t]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Sigma$ Outflows</td>
<td>9</td>
<td>143</td>
</tr>
<tr>
<td>$\Sigma$ Inflows</td>
<td>50</td>
<td>196</td>
</tr>
<tr>
<td>$\Sigma$ Total Flows</td>
<td>59</td>
<td>339</td>
</tr>
<tr>
<td>Difference $\Delta$</td>
<td>280</td>
<td>431,153</td>
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<tr>
<td>Multiplicative factor</td>
<td>6</td>
<td>15</td>
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</tbody>
</table>

$\Sigma$ Total Flows (in/out)

$\Sigma$ Outflows $>$ Impact

- 30km
- 50km

- 40 t

- 2945 kgCO$_2$ eq
Conclusions

The research project proposes:

• To compare, anticipate, measure the impact of energy retrofit solutions on material stocks and flows

• A replicable methodology at different scales: to other cities/regions but also to other building types and walls

• A potential for a better material stocks and flows management: to reach a circular economy in the construction sector

But...

• Not exhaustive in terms of intervention scenarios and building types: the proposed model is voluntary simplified

• It’s the beginning of a real application of Urban Mining but it will take some time to be implemented
Conclusions: future work

The research will continue in the future to deepen the knowledge of the material deposit contained in buildings and energy retrofit impacts on material flows through:

- Extension of the analysis methodology to other case studies including other Brussel’s building types (offices and apartment buildings built after 1945): development of specific intervention scenarios, analysis of the material balance and impacts of the interventions on material stocks and flows.

- Extension in the developed tool to include environmental aspects and recovery potential assessment (through reuse and recycling)

- Extrapolation of results at the regional level (in an urban mining perspective) based on the cadastral matrix.

> This can move us forward to a more circular economy as advocated by the Brussels-Capital Region and correlates with the principles of urban mining.
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