

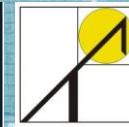
Urban Mining- CSTC

30 April 2019

Une approche Bottom-up du métabolisme bruxellois:
méthodologie via l'analyse de cas d'étude



Dr. Émilie Gobbo



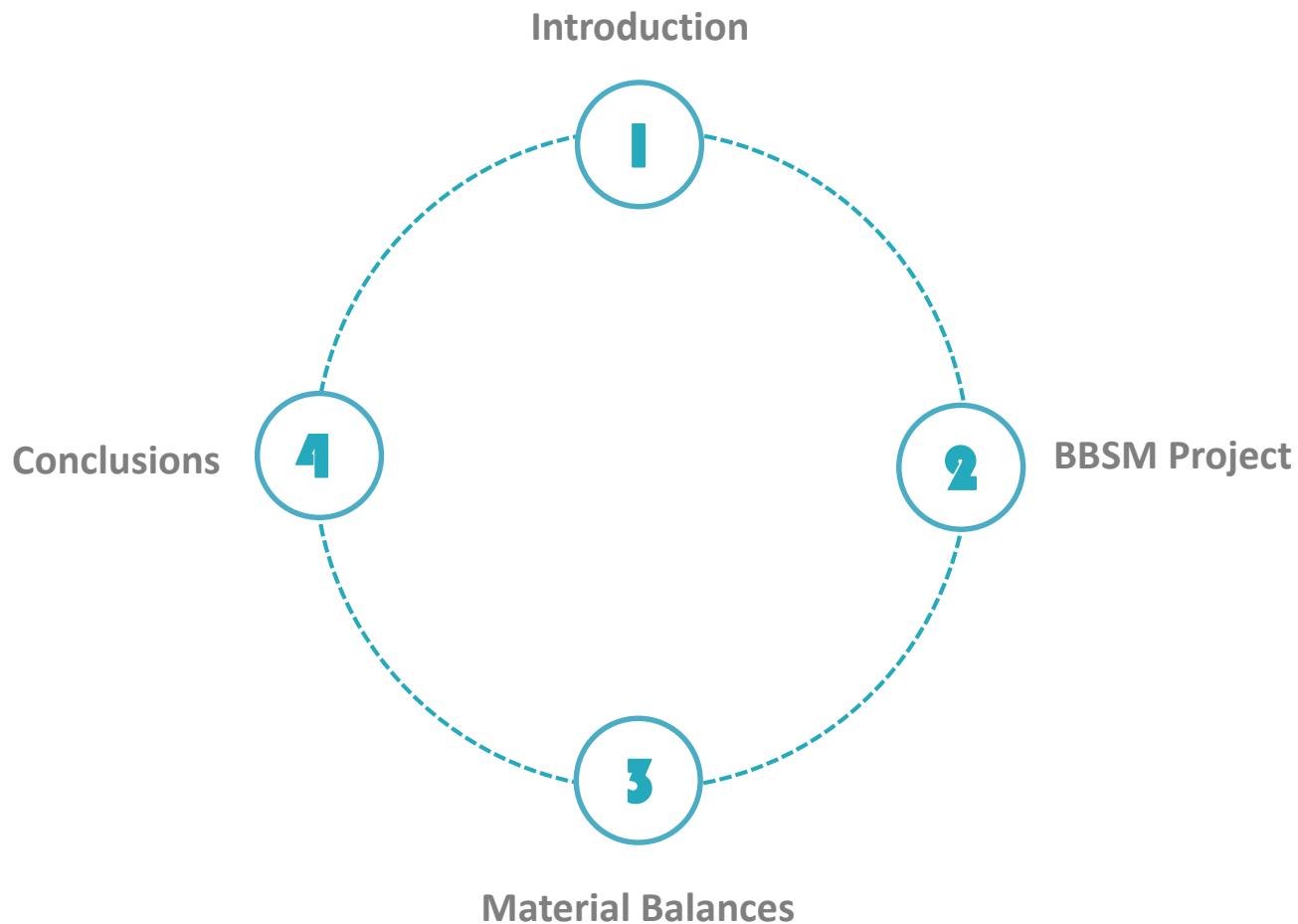
La Région et l'Europe investissent dans votre avenir !
Het Gewest en Europa investeren in uw toekomst!

RÉGION DE BRUXELLES-CAPITALE
BRUSSELS HOOFDSTEDELIJK GEWEST



Union Européenne
Fonds Européen de Développement Régional
Europese Unie
Europese Fonds voor Regionale Ontwikkeling

Summary



La Région et l'Europe investissent dans votre avenir !
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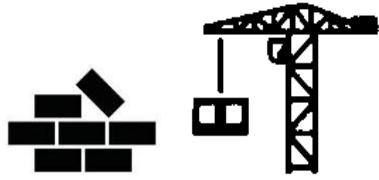
UCLouvain

1

Introduction

Context

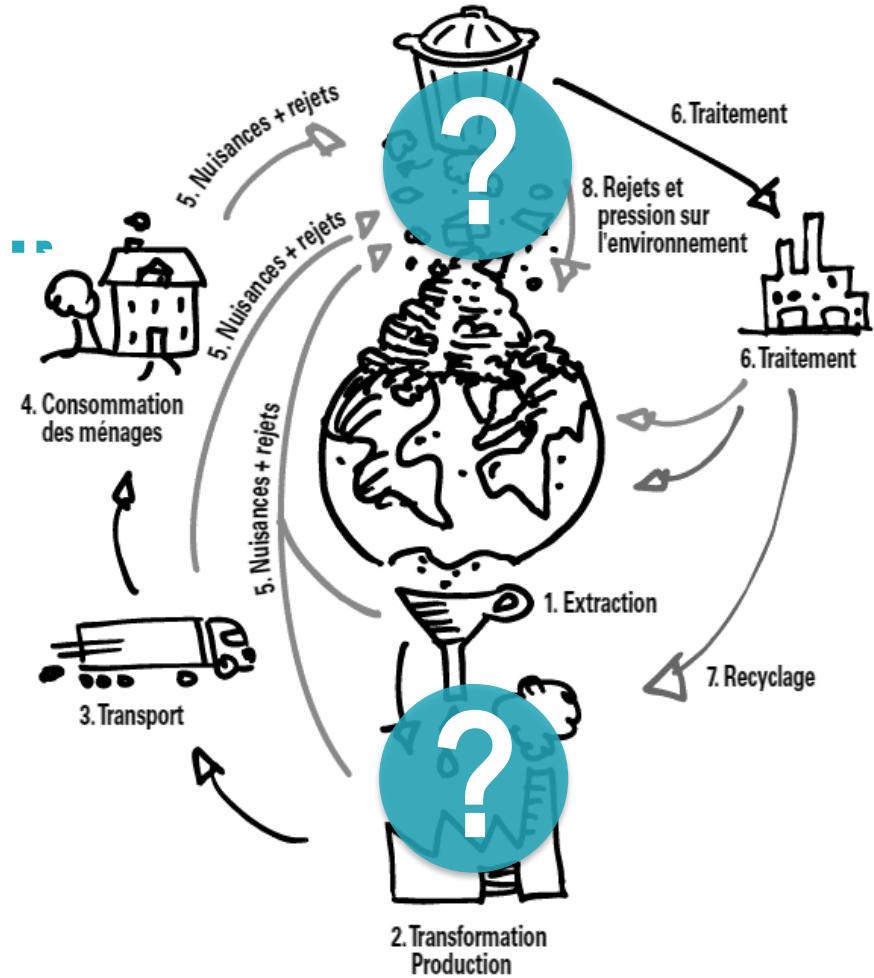
Key Sector



Existing Buildings

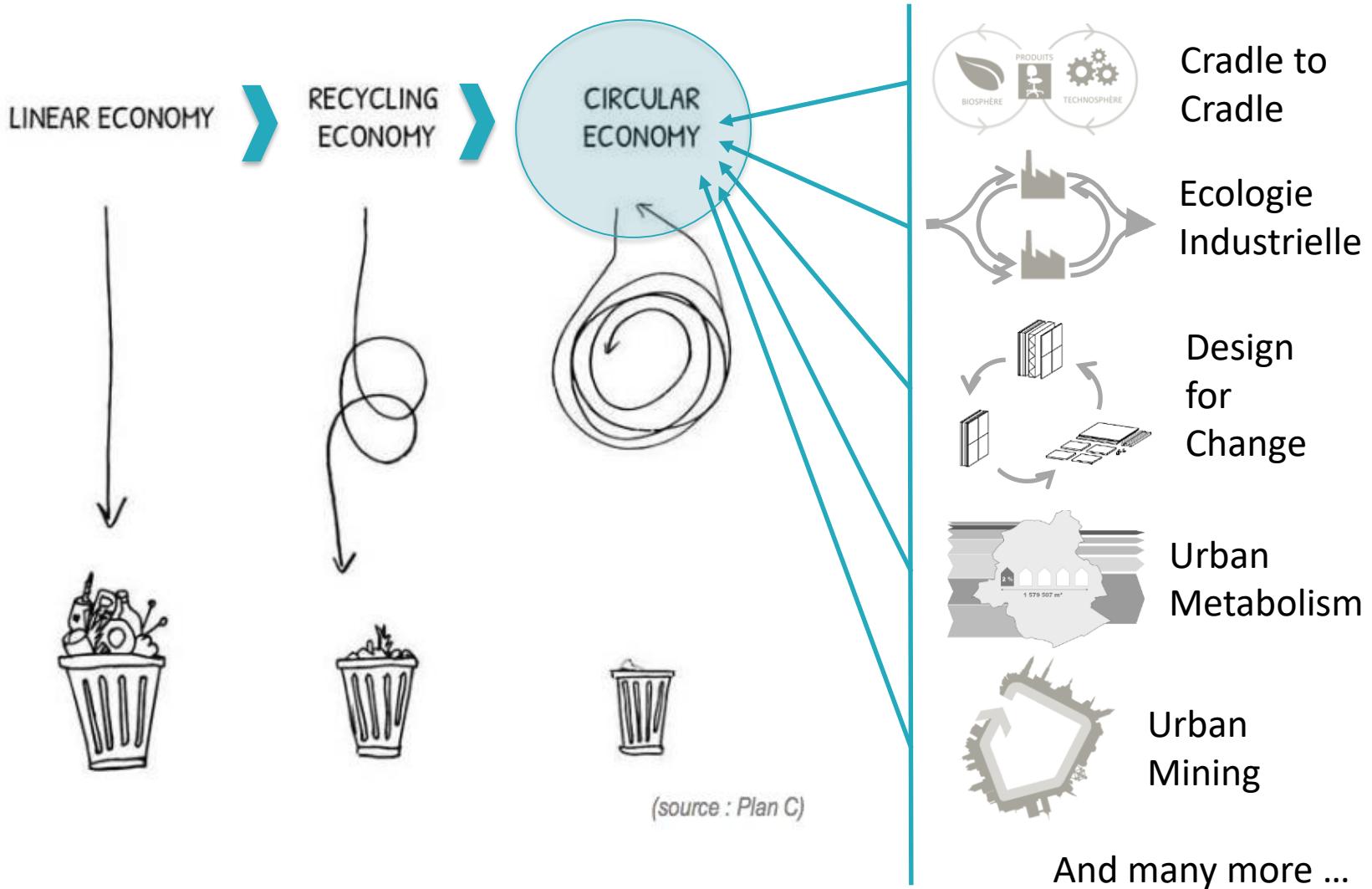


ENERGY RETROFIT
EPB, passive, NZEB ...



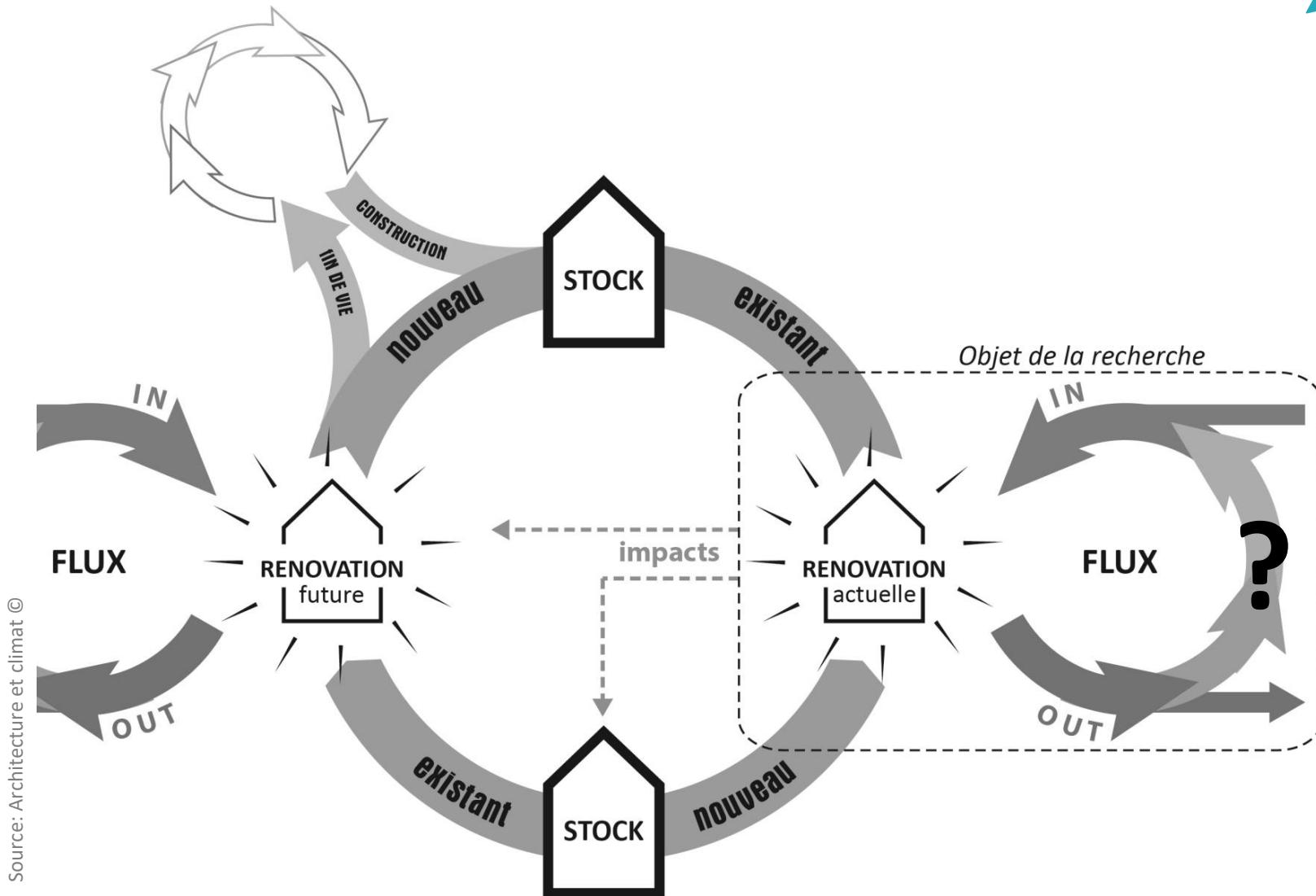
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Context



La Région et l'Europe investissent dans votre avenir !
Het Gewest en Europa investeren in uw toekomst!

Circularity in Energy Retrofit processes?



Source: Architecture et climat ©



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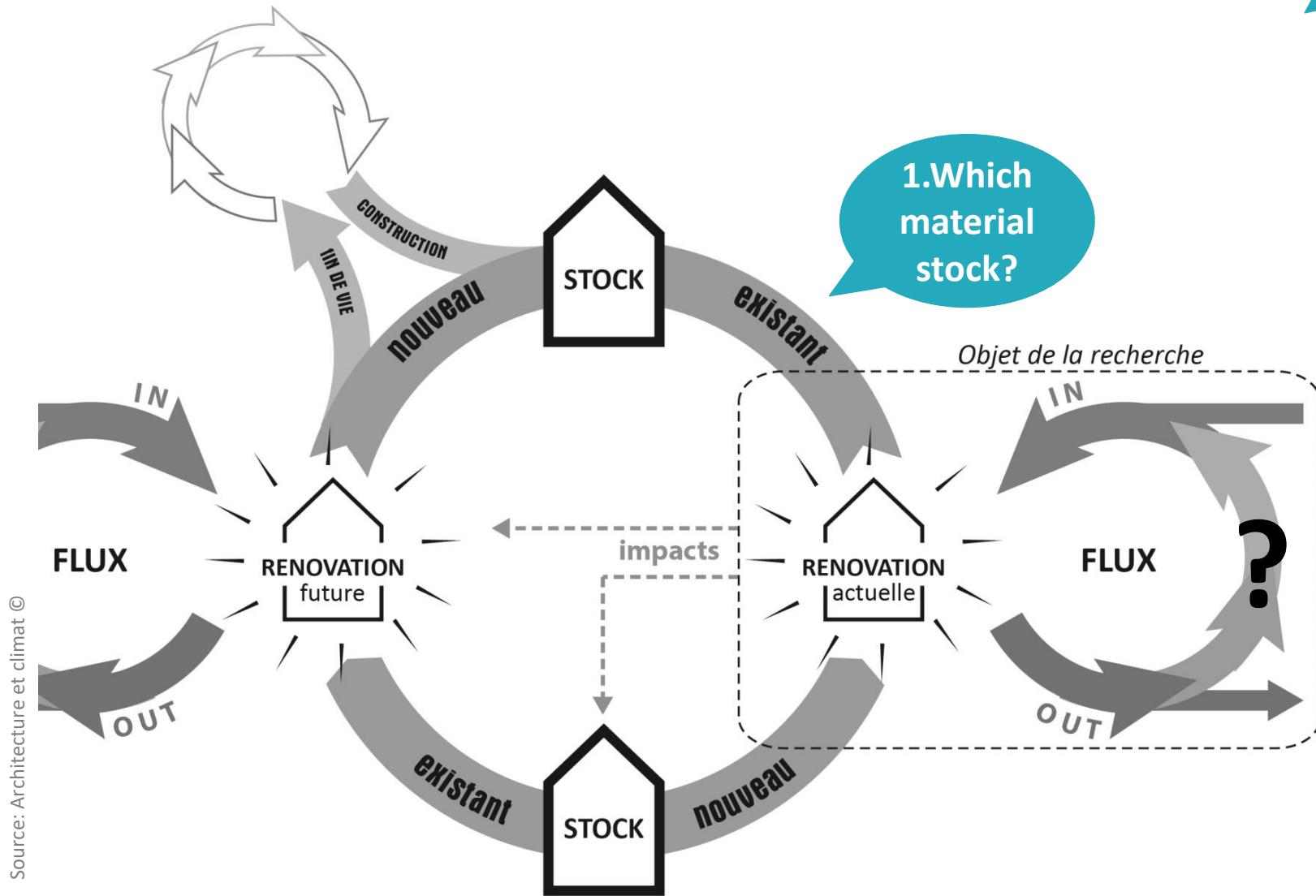
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2

The BBSM Project



Circularity in Energy Retrofit processes?

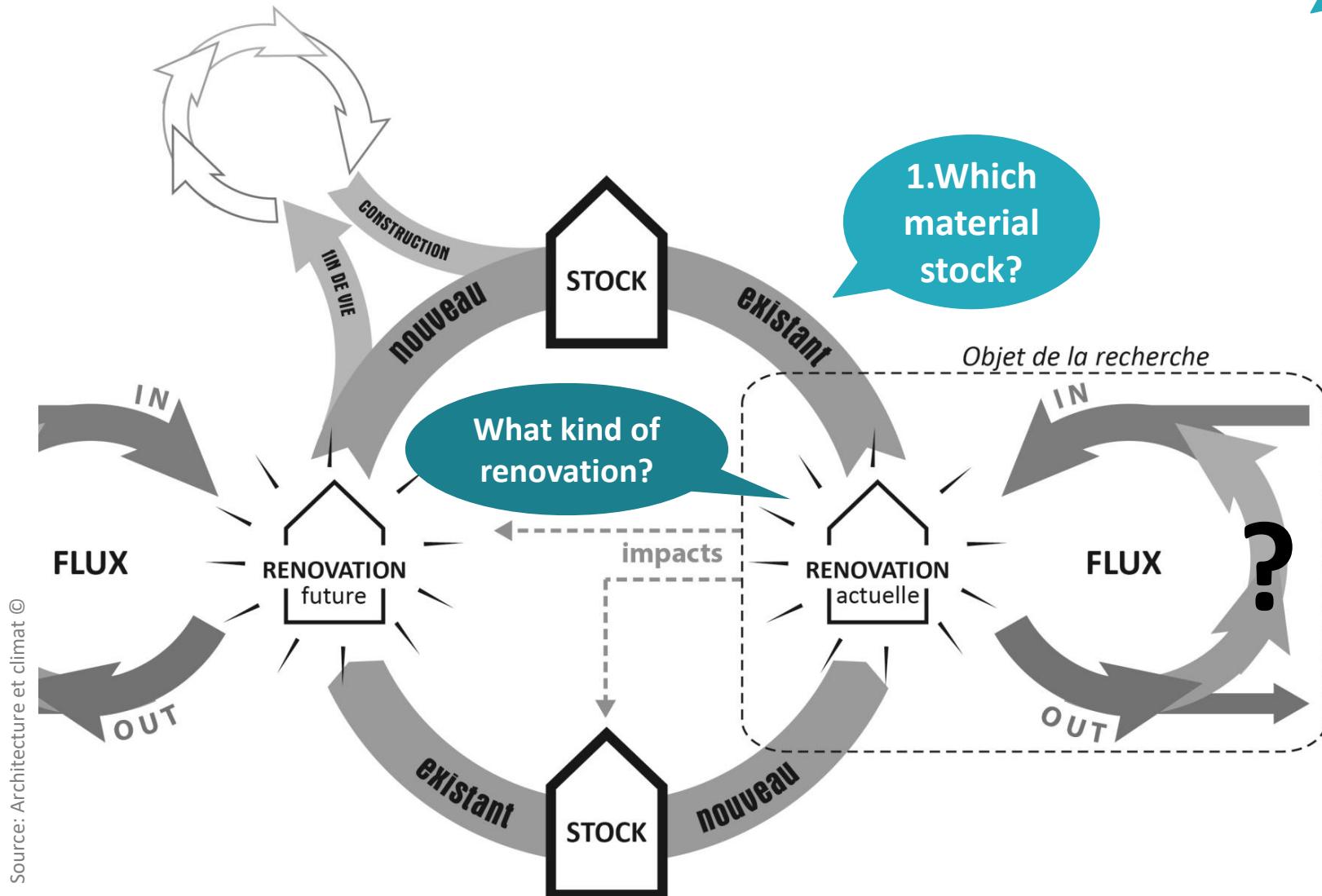


Source: Architecture et climat ©



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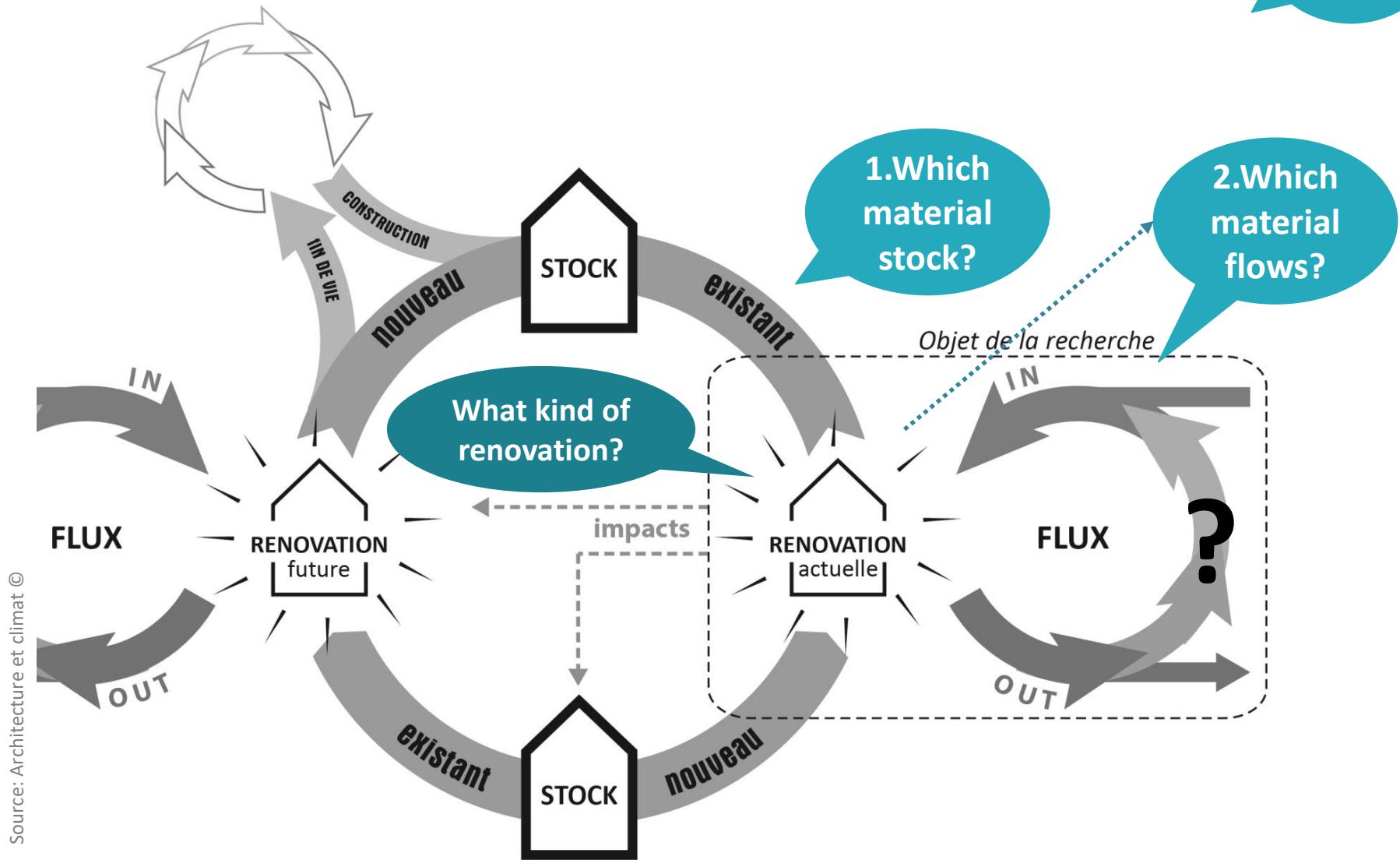


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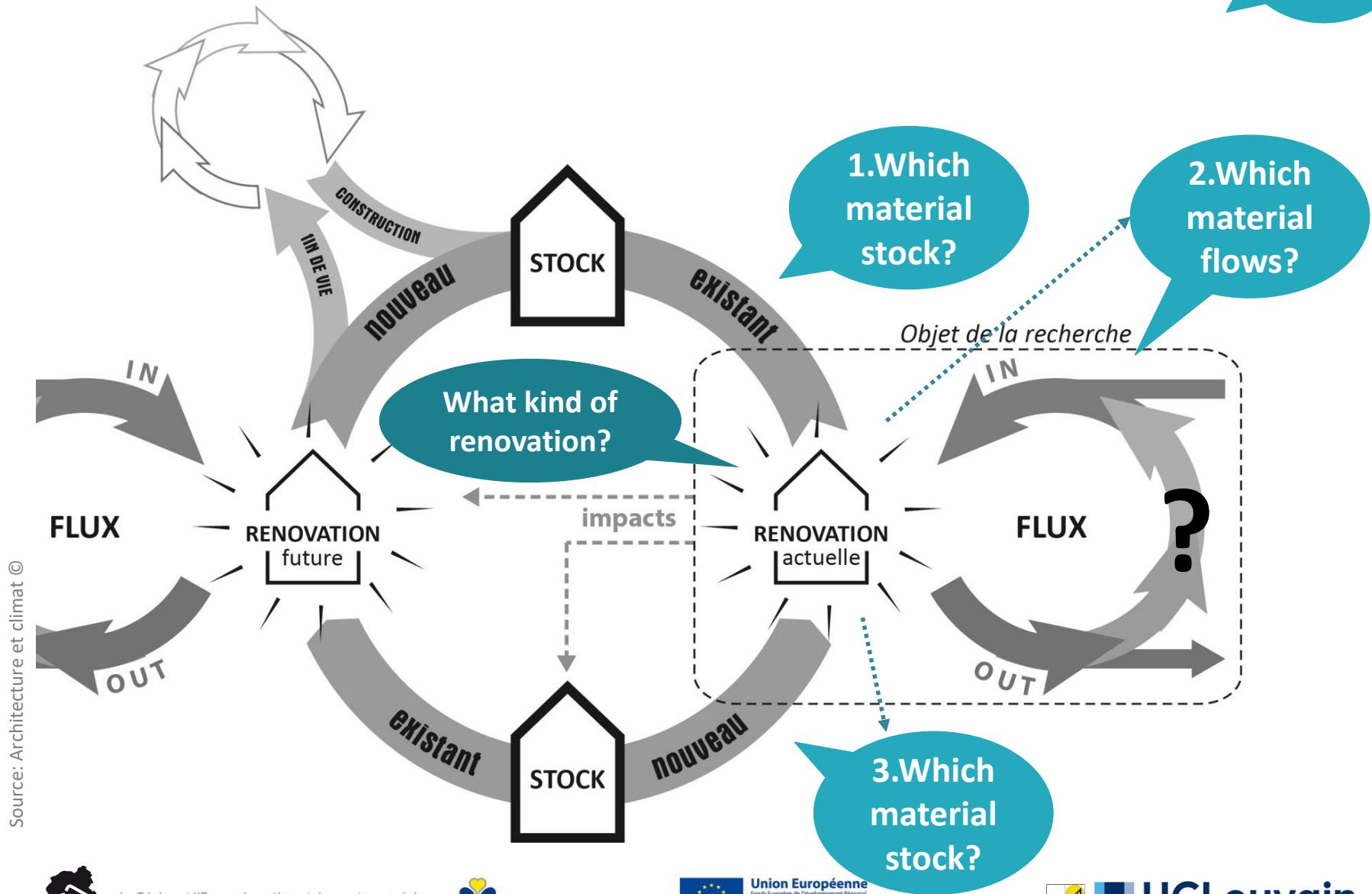
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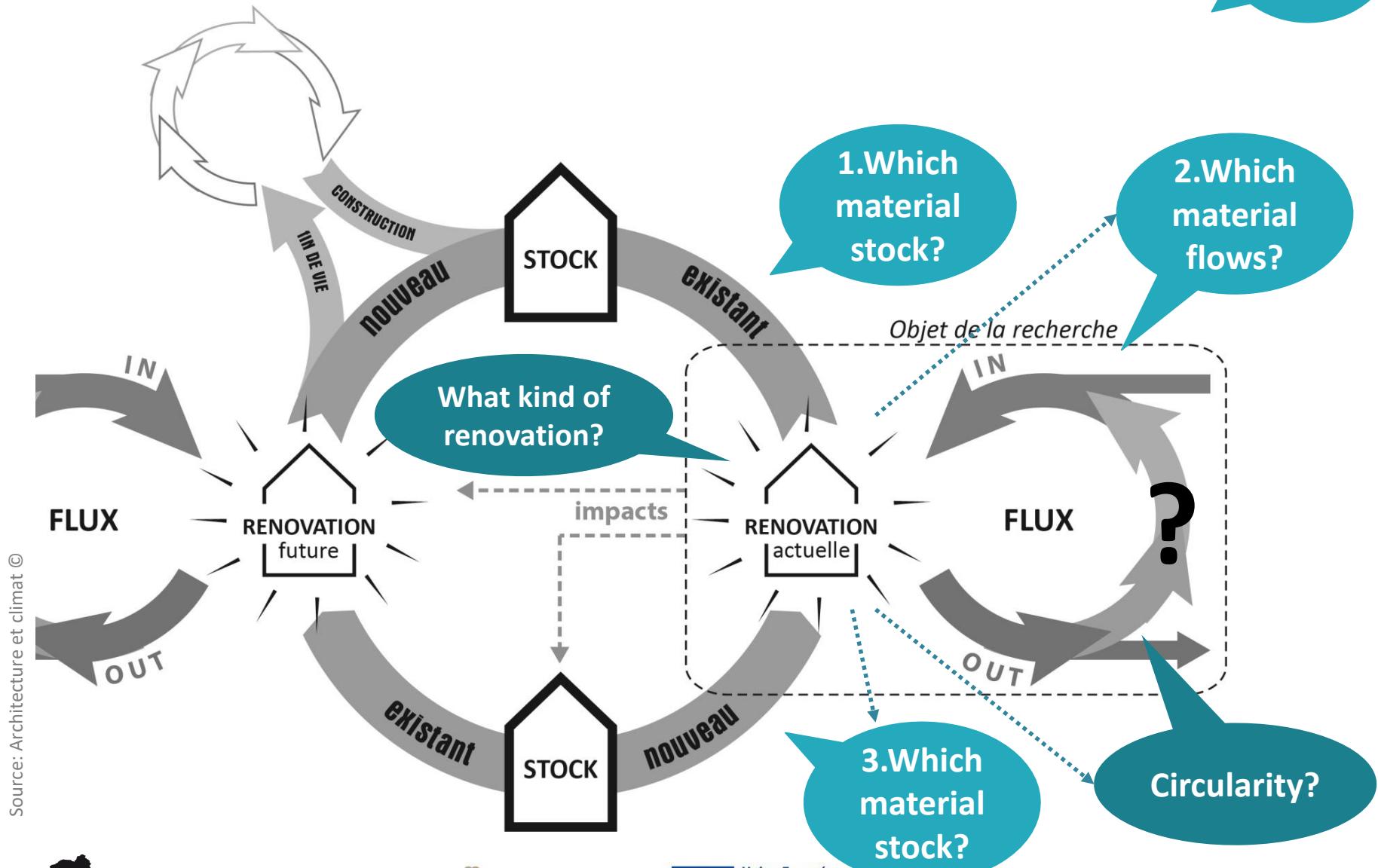
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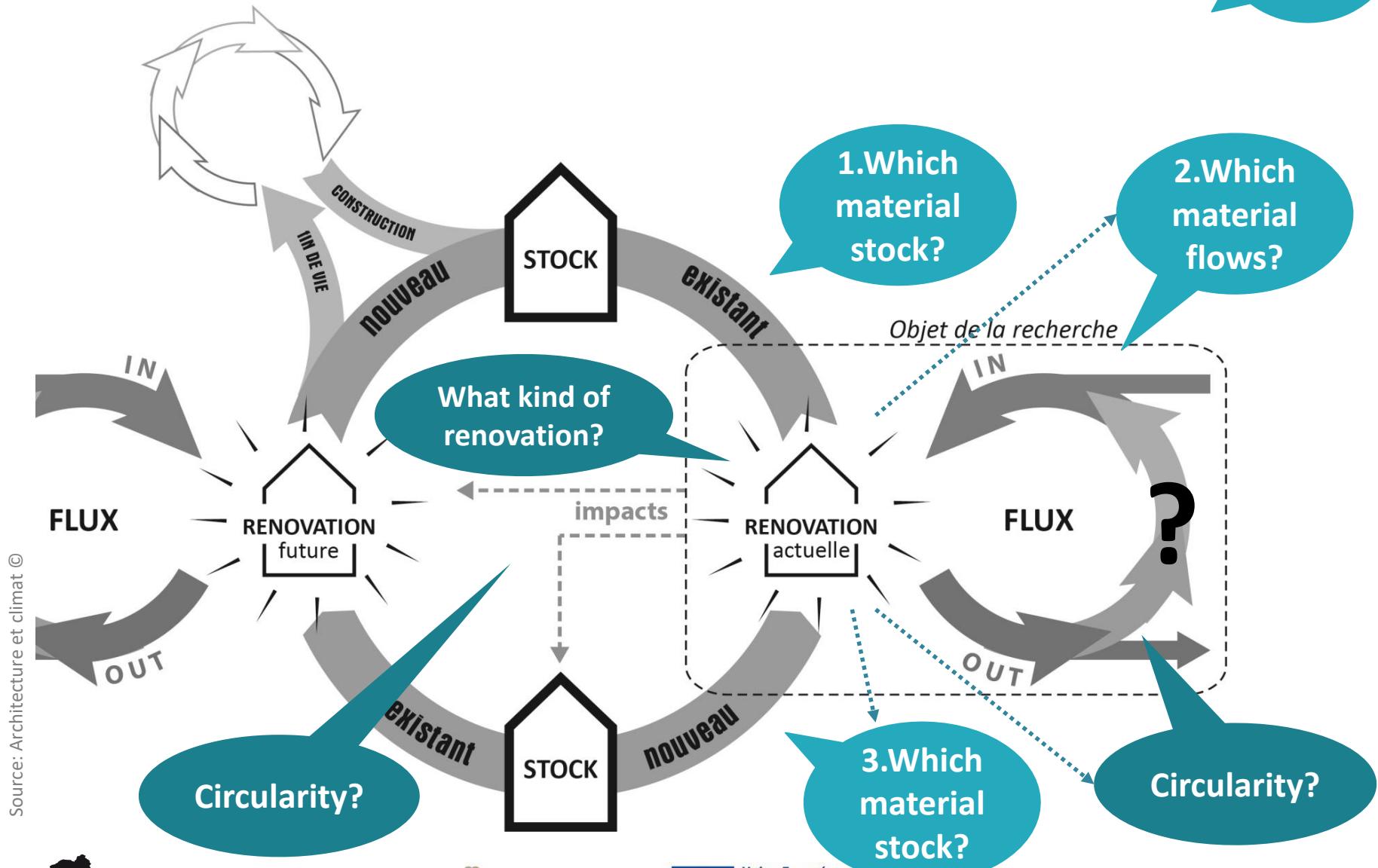


Source: Architecture et climat ©

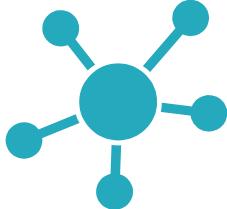


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Circularity in Energy Retrofit processes?



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The BBSM Project: what / who?

Your region and Europe invest in your future!

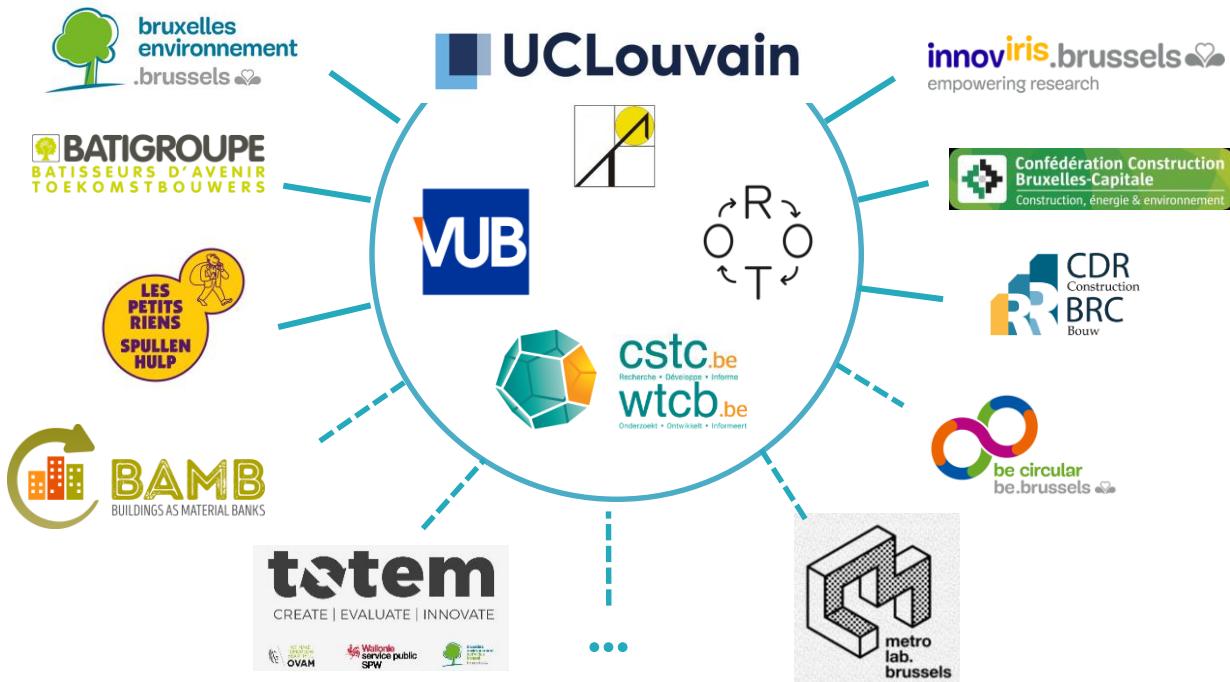


EUROPEAN UNION
European Regional Development Fund



LE BATI
BRUXELLOIS
SOURCE DE
NOUVEAUX
MATERIAUX

www.bbsm.brussels



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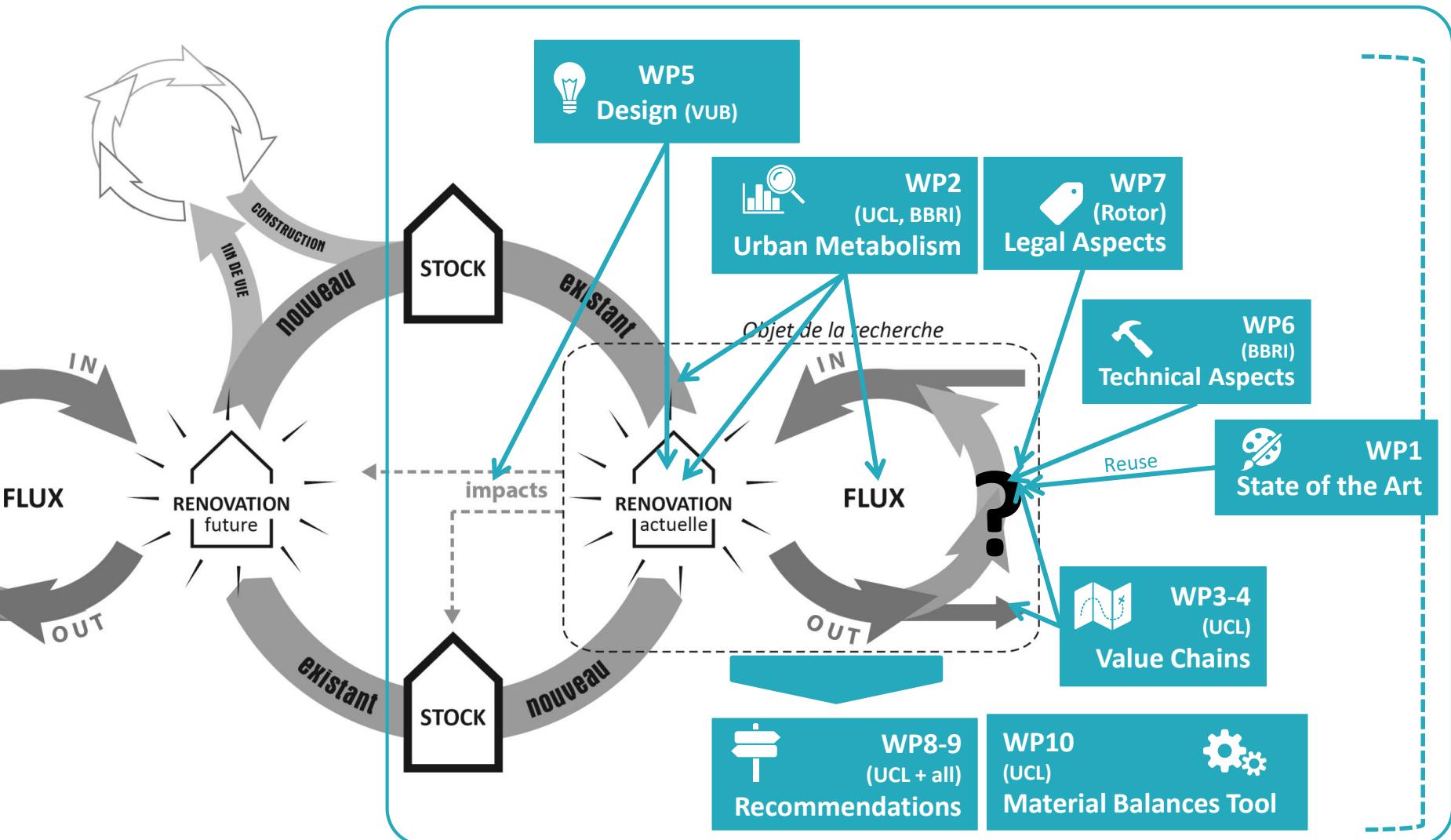
REGION DE BRUXELLES-CAPITALE
BRUSSELS HOOFDSTEDELIJK GEWEST

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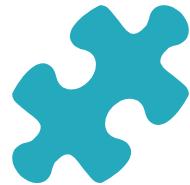


UCLouvain

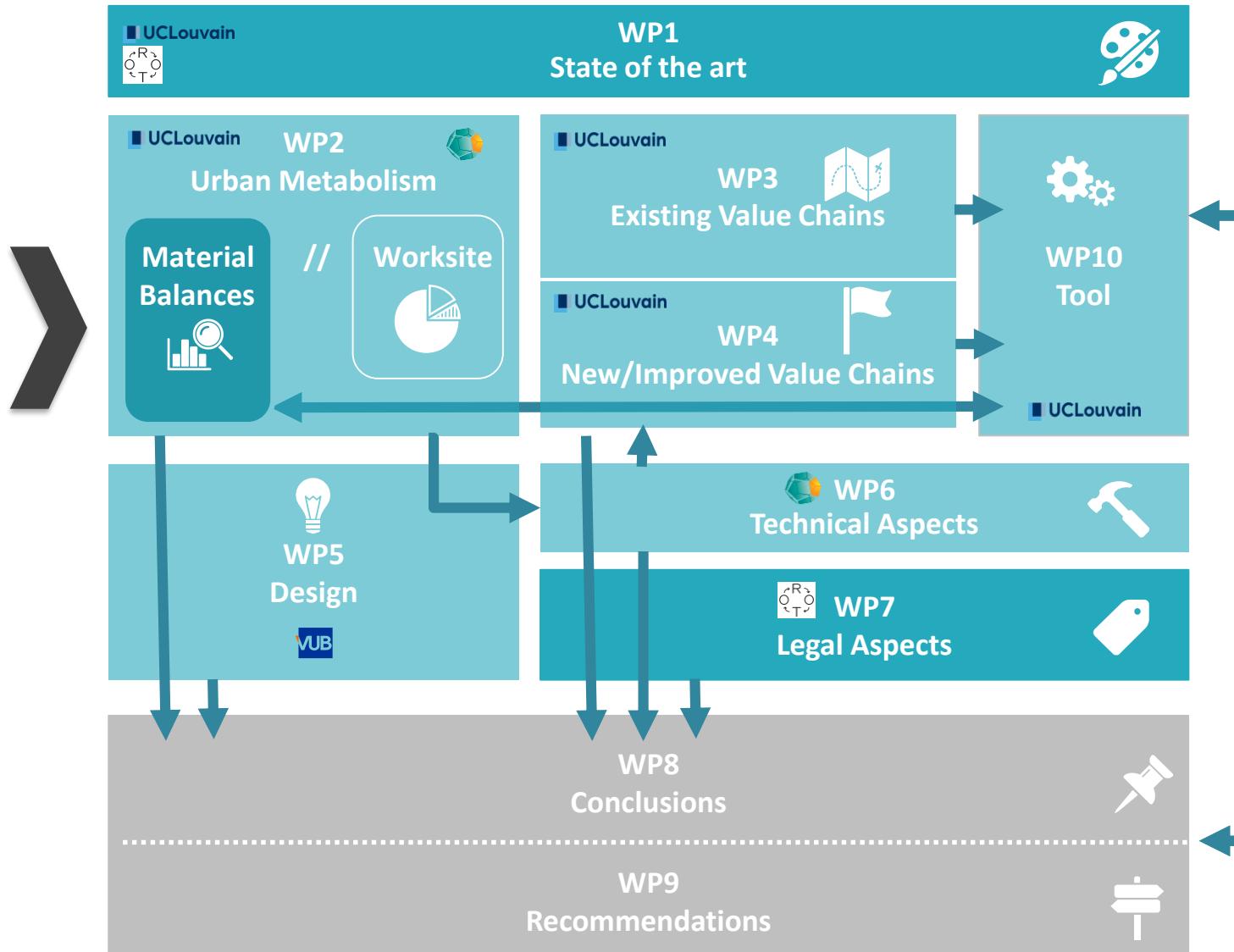
WorkPackages



La Région et l'Europe investissent dans votre avenir !
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WorkPackages



La Région et l'Europe investissent dans votre avenir !
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3

WP2: Urban M² (metabolism/mining) Material Balances



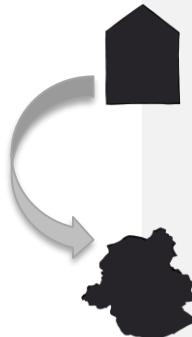


What? How? Why?

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 developping 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?



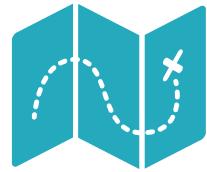
To reach a more efficient management of materials consumed (materials) and rejected (waste) by the activity of the Brussels's construction sector in a circular economy approach > **Urban Mining**

Key Material Flows
Anticipation



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Methodology



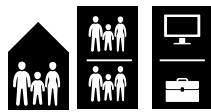
Material Balances

+ Environmental Impacts

+ Material Recoverability



Scale of Analysis



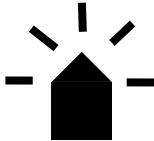
Historical Evolution,
Parameters by type in
3 building types:
Maison Bourgeoise
Apartment building
Office Building

~ 70%
of the built area

$$\sum m^2$$



(t-1)
Data collection
(plans, measurements,
photos, CDC ...)
Identification /
Quantification



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



(t) (t+1)

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

$$\text{Ratio}/m^2$$

$$\text{Ratio}/m^2$$



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Methodology: state of progress



Scale of Analysis

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



Type
MB

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



Quantification
Analyse
Existing building type



Energy Retrofit
scenarios/strategies



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



Type IA



Type B



Extrapolation

Σm^2

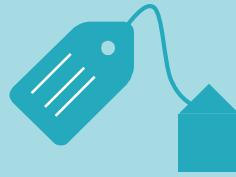
Ratio/ m^2

Ratio/ m^2



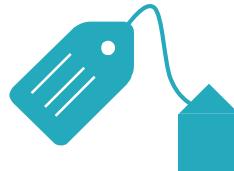
$\sim 70\%$
of the built area





Typological Analysis

I Typological Analysis



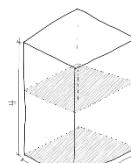
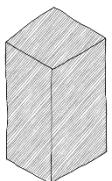
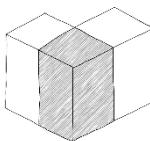
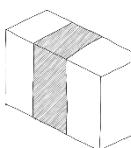
Historical evolution
Classification parameters by type
Representativeness



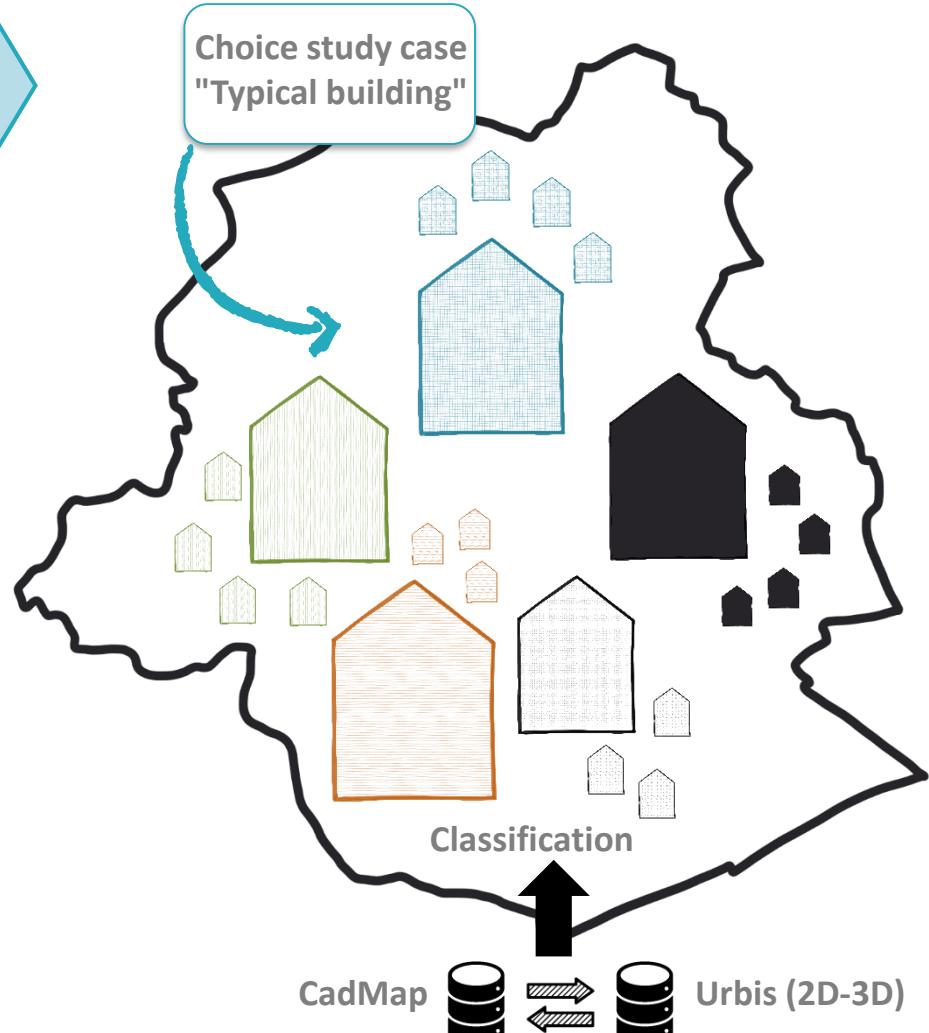
- 1914 1918 - 1940 1945 - 1959 1960 - 1969 1970 - 1979



~ 75 % du parc bâti



// More detailed analysis by case study and no classification parameters



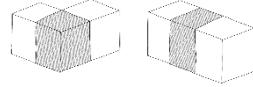
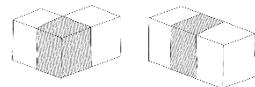
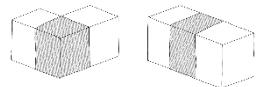
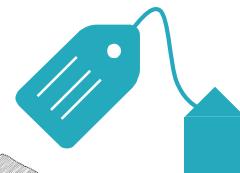
Source: Architecture et climat ©



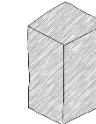
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I

Typological Analysis



et



Offices



5%

 $\Sigma 13.000.000 \text{ m}^2$ (2015)

6%

16%

19%

Housing



Development of collective housing

39%
15%

27%
26%

Mainly collective housing

> 27%
48%

$\Sigma 194.269$ buildings
 $\Sigma 473.216$ dwellings
(2008)



Mainly individual housing

Individual housing



- 1914

1918 - 1940

1945 - 1959

1960 - 1969

1970 - 1979

Source: [CERA, 2008; SPF Economie, 2015; STAT, 2015; OdB, 2015; B3Retrotool, 2015]



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Existing Building Stock Analysis

Existing Building Stock Analysis



Building Type



Office Building



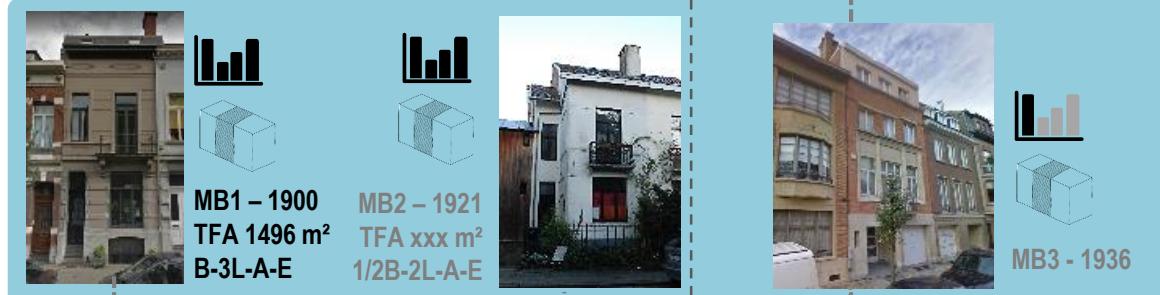
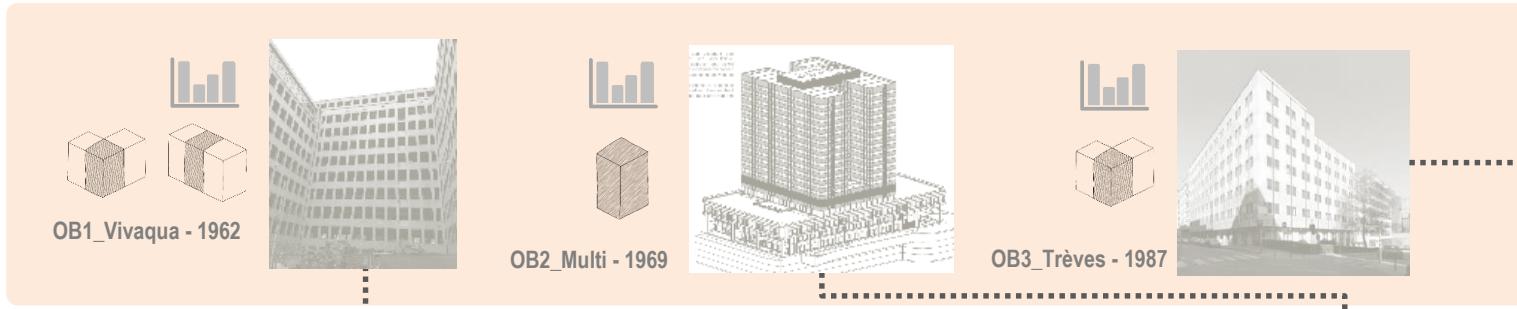
Appartement Building



Houses



Date of construction



- 1914

1918 - 1940

1945 - 1959

1960 - 1969

1970 - 1979

TFA – Total Floor Area; B – Basement; L – Levels; A – Attic ; E - Extension

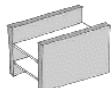


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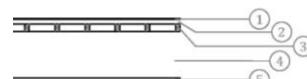
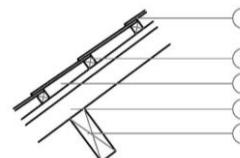
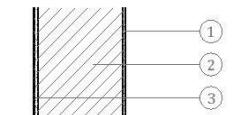
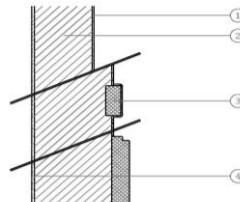
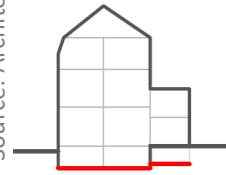
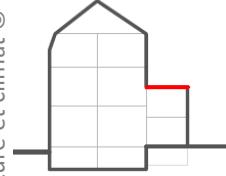
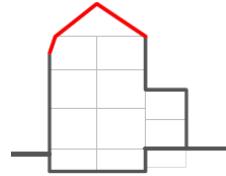
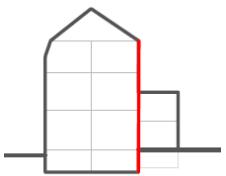
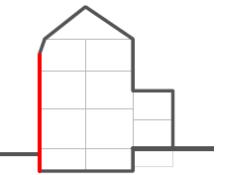
Existing Building Stock Analysis: case study



1900



Source: Architecture et climat ©



1. Cimentage (1cm)
2. Briques en terre cuite – 90% + mortier de chaux -10% (32,5cm ou 42.5cm)
3. Ornancement en pierre
4. Enduit de chaux (1.5cm)

1. Cimentage (1cm)
2. Briques en terre cuite – 90% + mortier de chaux -10% (32.5cm)
3. Enduit de chaux (1.5cm)

1. Tuiles en terre cuite (2cm)
2. Contrelatéte (16x30mm) -16%
3. Lattage en bois résineux européen (18x38mm) – 16%
4. Chevron en bois massif résineux européen (63x86mm) – 18%
5. Pannes en bois massif résineux européen (73x225mm) – 8%

1. Etanchéité bitumée élastomère (4mm)
2. Panneau de fibre de bois (2cm)
3. Voligeage en bois, résineux européen (19x32) – 15%
4. Poutre bois massif, résineux européen (70x200) – 15%
5. Plaque de carton plâtre (1.2cm)

1. Granito (4.5cm)
2. Dalle de béton (20cm)
3. Sable (10cm)

Échelle
Analyse

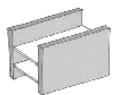


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Existing Building Stock Analysis: case study



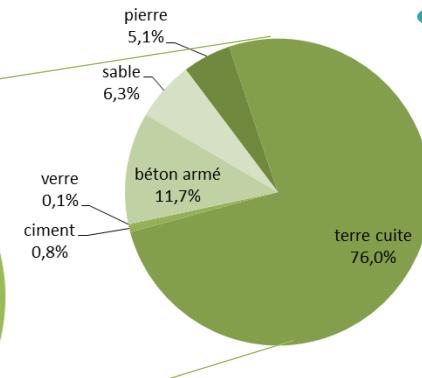
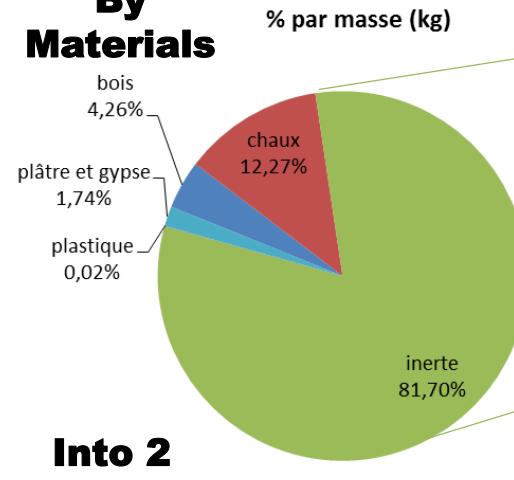
1900



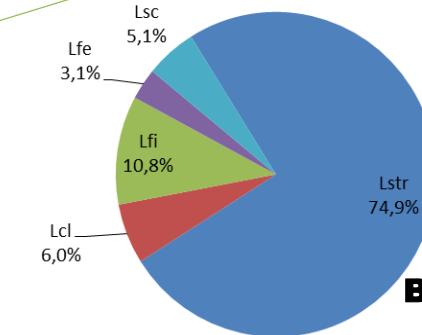
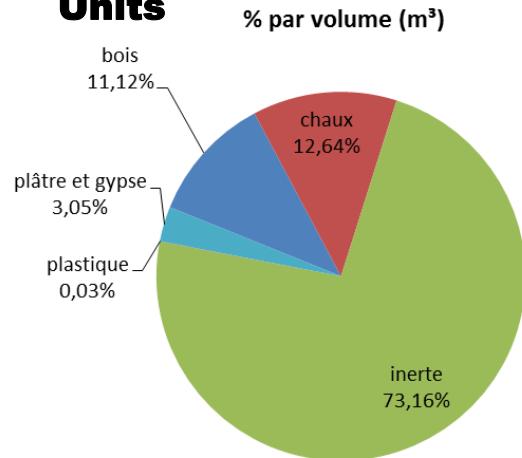
Échelle
Analyse



By Materials



Into 2 Units



Within a specific fraction

- pierre
- terre cuite
- ciment
- verre
- béton armé
- sable

By Layers

- bois
- chaux
- inerte
- plastique
- plâtre et gypse

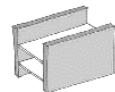
Existing Building Stock Analysis: case study



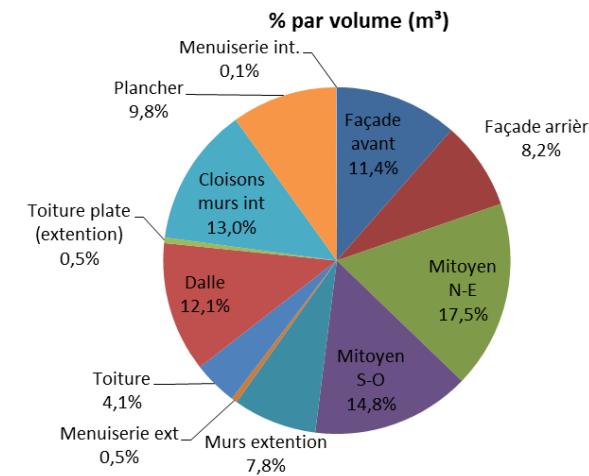
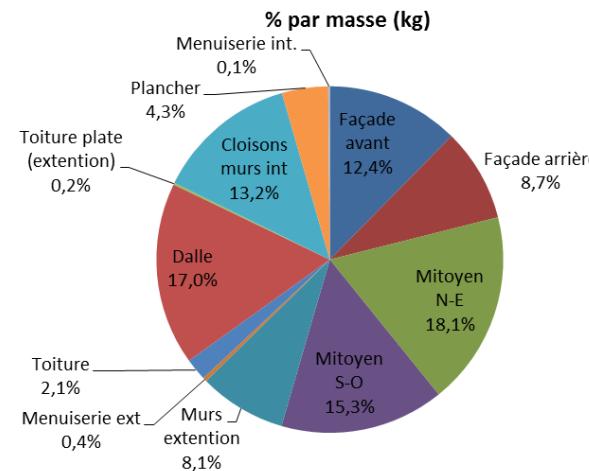
By Part of the building



1900



Into 2 Units



- Façade avant
- Façade arrière
- Mitoyen N-E
- Mitoyen S-O
- Murs extention
- Menuiserie ext.
- Toiture

Échelle
Analyse

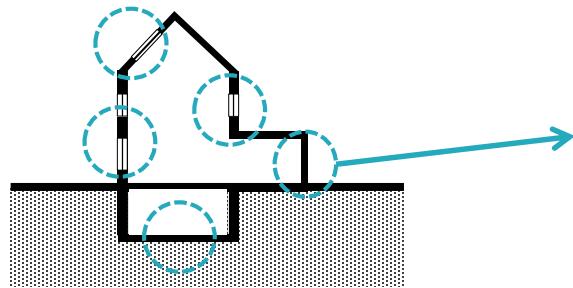


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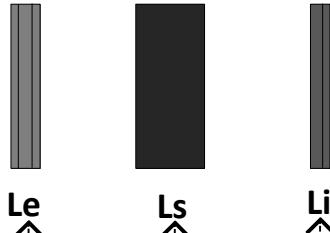


Energy Retrofit Scenarios

Energy retrofit scenarios: principles



Wall decomposed into layers

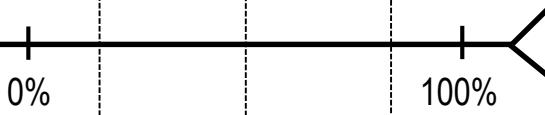


Demolition degrees

Combination of % demolition per layer

Minimum Demolition -

D1



Partial Demolition -

D2



Maximum Demolition -

D3



New materials & Implementation



C1 « Classic »



C2 « Alternative »



C1 « Classic »



C2 « Alternative »



C1 « Classic »



C2 « Alternative »

Influence
OUT-flows

Influence
IN-flows

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

Source: Architecture et climat ©



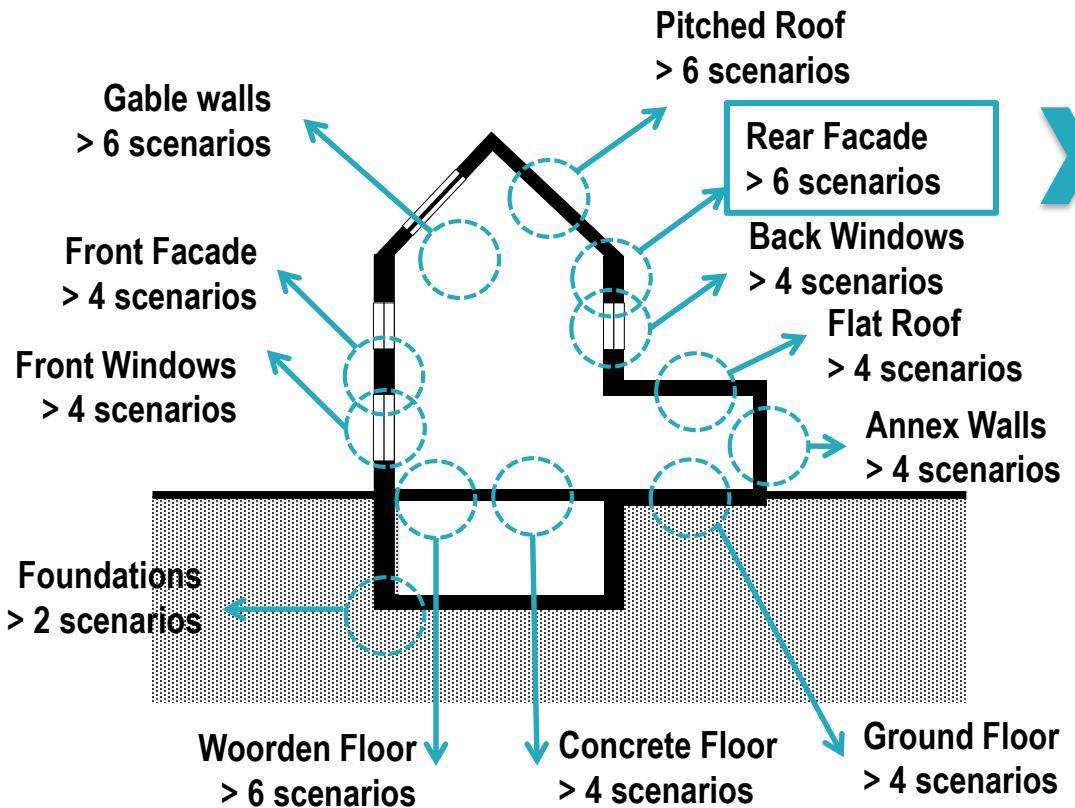
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3

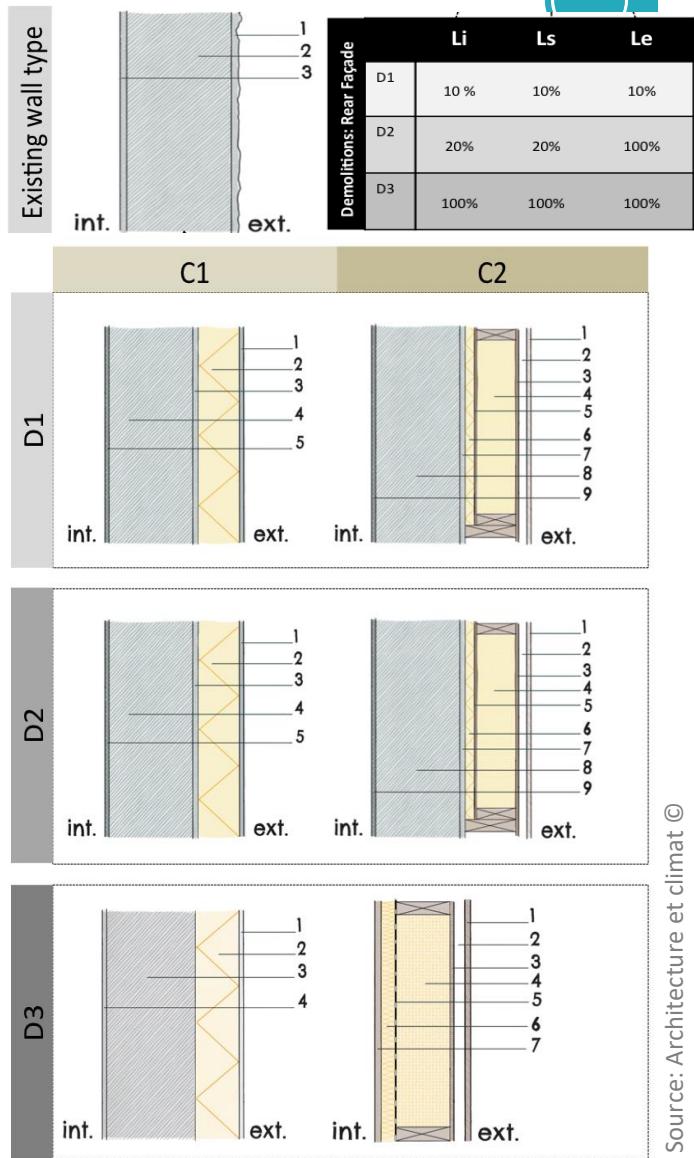
Energy retrofit scenarios: wall scale



Maison Bourgeoise Type



Resulting on ~ 54 energy retrofit scenarios
(at the wall scale)



Source: Architecture et climat ©



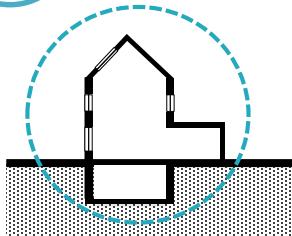
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Impacts on IN/OUT flows: Material Balance analysis

4

Material Balance > building scale

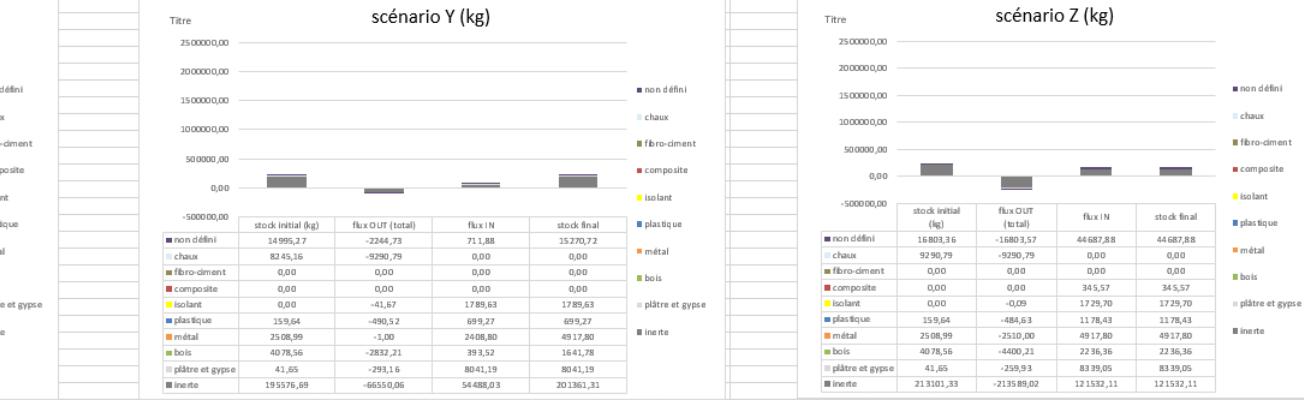
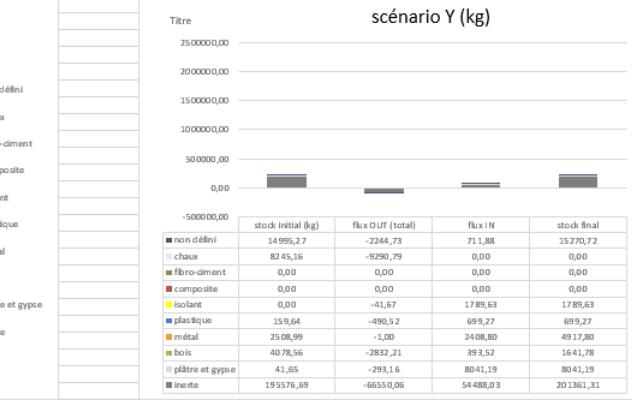
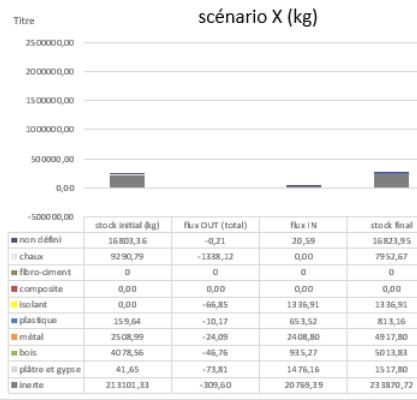
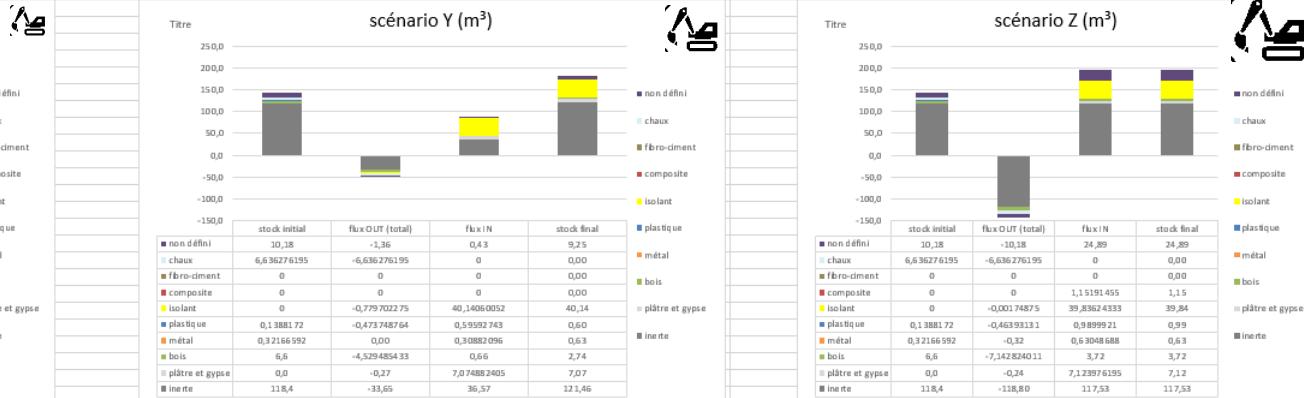
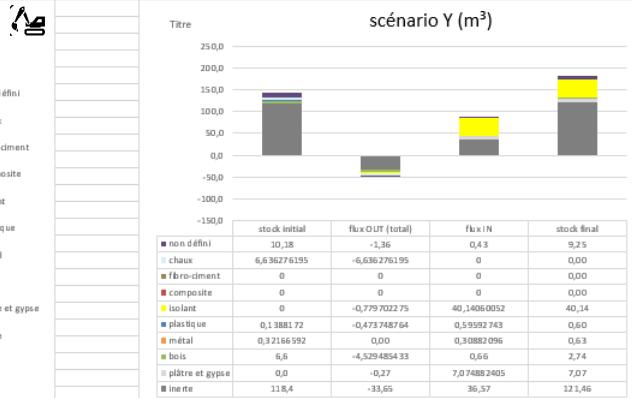
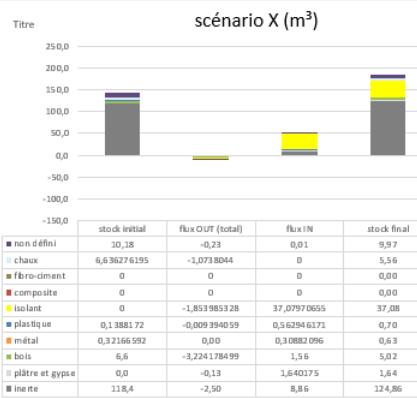


SCENARIOS

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

scénario X		scénario Y		scénario Z	
Facade avant	D1C1	Facade avant	D2C1	Facade avant	D3C1
Facade arrière	D1C1	Facade arrière	D2C1	Facade arrière	D3C1
Mitoyens / façade latérale	D1C1	Mitoyens / façade latérale	D2C1	Mitoyens / façade latérale	D3C1
Façade annexe	D1C1	Façade annexe	D2C1	Façade annexe	D3C1
Menuiseries extérieures	D1C1	Menuiseries extérieures	D2C1	Menuiseries extérieures	D3C1
Toiture en pente	D1C1	Toiture en pente	D2C1	Toiture en pente	D3C1
Toiture plate	D1C1	Toiture plate	D2C1	Toiture plate	D3C1
Dalle de sol + fondations	D1C1	Dalle de sol + fondations	D2C1	Dalle de sol + fondations	D3C1
Planchers intérieurs	D1C1	Planchers intérieurs	D2C1	Planchers intérieurs	D3C1
Murs/Cloisons intérieurs	D1C1	Murs/Cloisons intérieurs	D2C1	Murs/Cloisons intérieurs	D3C1

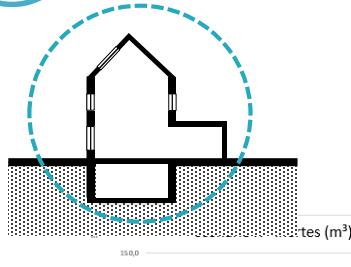
RESULTATS



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4

Material Balance > building scale

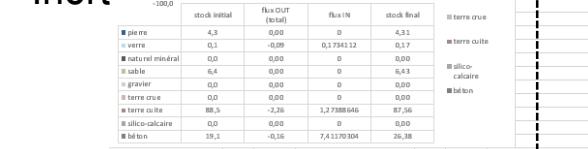


SCENARIOS

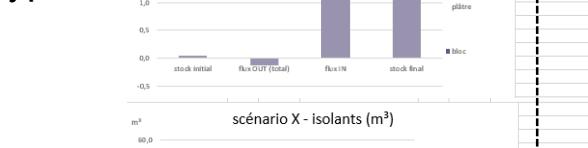
	scénario X	scénario Y	scénario Z
Facade avant	D1C1	D2C1	D3C1
Facade arrière	D1C1	D2C1	D3C1
Mitoyens / façade latérale	D1C1	Mitoyens / façade latérale 1	D3C1
Façade annexe	D1C1	D2C1	D3C1
Menuiseries extérieures	D1C1	D2C1	D3C1
Toiture en pente	D1C1	D2C1	D3C1
Toiture plate	D1C1	D2C1	D3C1
Dalle de sol + fondations	D1C1	D2C1	D3C1
Planchers intérieurs	D1C1	D2C1	D3C1
Murs/Cloisons intérieurs	D1C1	D2C1	Murs/Cloisons intérieurs

Zoom on Material flows

Inert



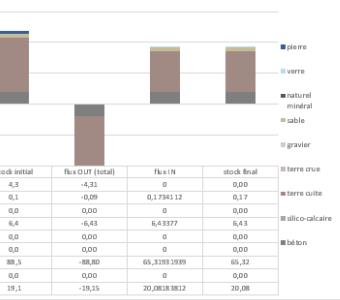
Gypsum



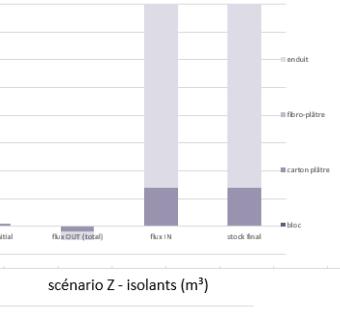
Insulation



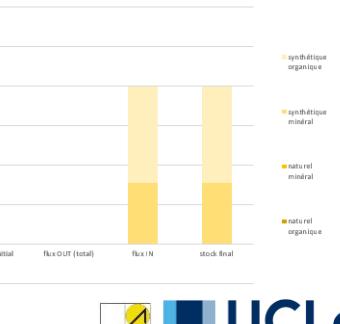
scénario Z - inertes (m³)



scénario Z - plâtres et gypse (m³)



scénario Z - isolants (m³)



Source: Architecture et climat ©

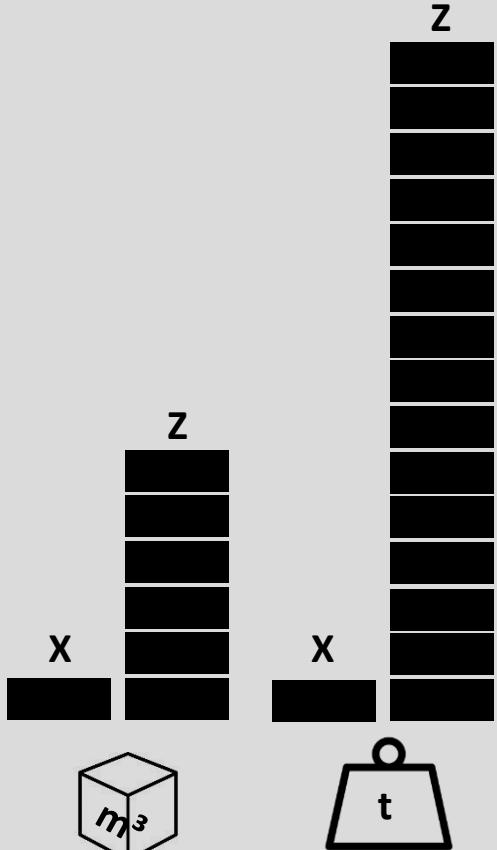


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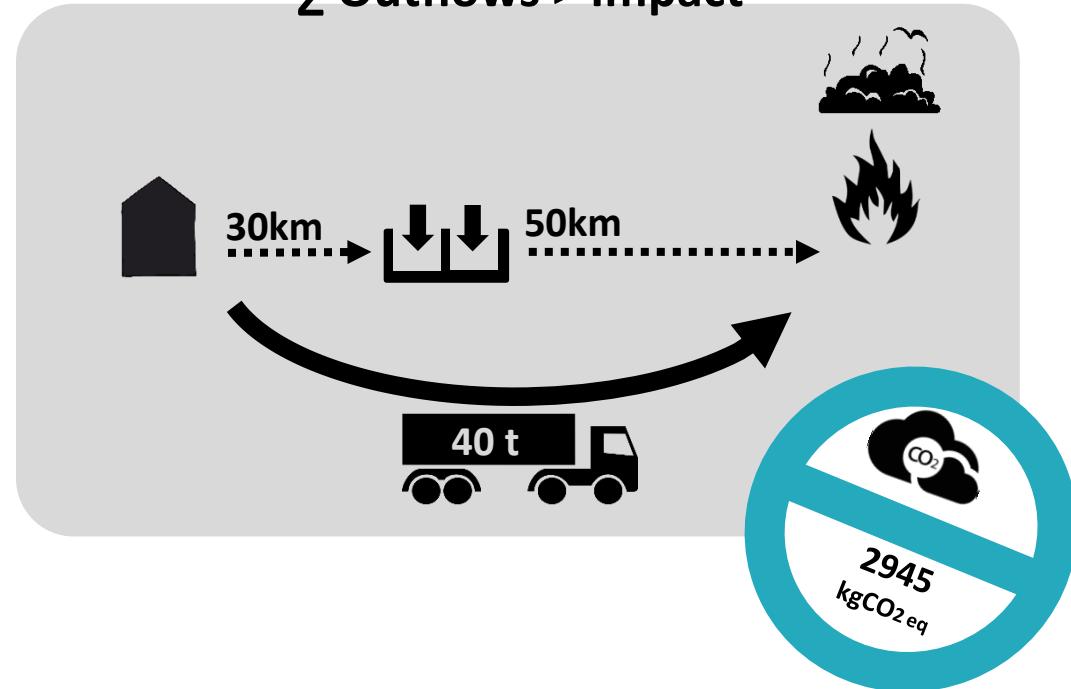
Material Balance > impacts



Σ Total Flows (in/out)



Σ Outflows > Impact



	Volume [m^3]		Weight [t]	
Scenarios	X	Z	X	Z
Σ Outflows	9	143	1,880	247,338
Σ Inflows	50	196	26,272	184,967
Σ Total Flows	59	339	28,152	459,305
Difference Δ	280		431,153	
Multiplicative factor	6		15	

Source: Architecture et climat ©



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4

Conclusions



Conclusions

- Lack of quantitative and qualitative data > ongoing research
- Existing / new: specificities
- Change of practices
 - > Deconstruction
 - > Sorting at the source
 - > Design
- Awareness-raising and training of actors in the sector (all of them)
- Change of labor costs / materials
- Adaptation of legislation
- Market maturity
- New professions? (valuers, site guard, design offices ...)
- Pilot projects ...

The research project proposes:

- To anticipate, measure and compare the impact of energy retrofit solutions on material flows, and the opportunities in terms of circularity
- A replicable methodology

But...

- Not exhaustive and to be continued...
- It's the beginning of a real application of Urban Mining but it will take some time (urban scale)



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



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Conclusions

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



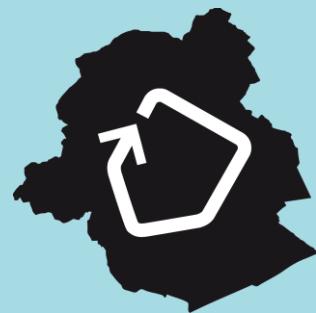
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Any questions?

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