BAMB
BUILDINGS AS MATERIAL BANKS

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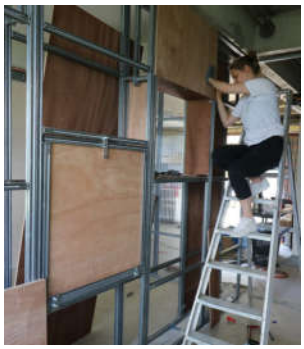
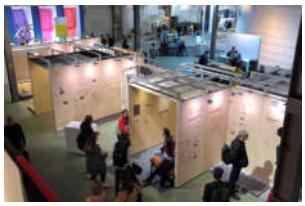
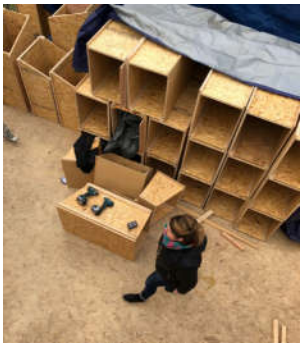
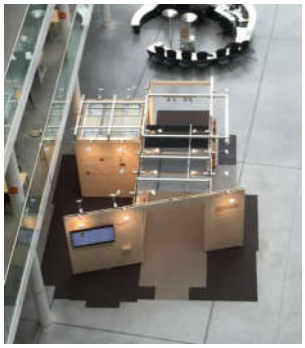
TESTING BAMB RESULTS THROUGH PROTOTYPING AND PILOT PROJECTS

D14 – 4 pilots built + Feedback report 28.02.2019





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ACRONYMS AND ABBREVIATIONS USED

Pilot Projects

List of project beneficiaries
(complete and shortened names)

BE	Brussels Environment
BRE	Building Research Establishment
EPEA	EPEA Nederland B.V.
VITO	Vlaamse Instelling Voor Technologisch Onderzoek N.V.
VUB	Vrije Universiteit Brussel
TUM	Technische Universität München
UTwente	Universiteit Twente
SGDF	Sarajevo Green Design Foundation

Pilot Projects

GTB Lab	Green Transformable Building Lab
REM	Reversible Experience Modules
CRL	Circular Retrofit Lab
BRIC	Build Reversible in Conception

Acronyms

BAMB	Buildings As Material Banks
BIM	Building Information Modelling
D	Deliverable
LCA	Life Cycle Assessment
LCCA	Life Cycle Costing Analysis
MP	Material Passport
MPP	Materials Passports Platform
PCT	Project Coordination Team
SN	Stakeholder Network
WP	Work Package
WP1	Developing a blueprint for dynamic and circular buildings and materials upcycling
WP2	Developing Materials Passports and corresponding database & platform
WP3	Developing Reversible Building Design tools for dynamic and circular buildings
WP4	Testing BAMB results through prototyping and pilot projects
WP5	Facilitating future applications and exploitation of BAMB results

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BUILDINGS AS MATERIAL BANKS

Within the BAMB Project – **Buildings as Material Banks** – 15 partners from 7 European countries have worked together with one mission: enabling **a systemic shift in the building sector** by creating circular solutions.

Today, building materials end up as waste when no longer needed, with effects like destroying eco-systems, increasing environmental costs, and creating risks of resource scarcity. To create a sustainable future, the building sector needs to move **towards a circular economy.**

Whether an industry goes circular or not depends on the value of the materials used – worthless materials are waste, while valuable materials are recycled. Increased value equals less waste, and that is what **BAMB is creating – ways to use and maintain the value of building materials and construction systems over time.**

BAMB contributes to a systemic shift where dynamically and flexibly designed buildings can be incorporated into a circular economy. **Through circular design and value chains, materials in buildings sustain their value**. Instead of being to-be waste, buildings will function as banks of valuable materials – slowing down the usage of resources to a rate that meets the capacity of the planet and producing less waste.

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1. BUILDINGS AS MATERIAL BANKS

1.1. A SYSTEMIC APPROACH

Designing buildings as repositories of valuable materials is a concrete contribution towards the development of a circular construction industry. The *"Buildings as Material Banks"* H2020 innovation project has provided **practical** answers for **the preservation of raw materials and the implementation of waste reduction strategies and solutions.** The project has identified actions along the construction industry activities[1] and given in-depth insights into the necessary **changes within the value chains** to support the **circular economy transition**.

The Buildings as Material Banks project has contributed to the creation of a new culture of "**recovery, re-use, and upcycling**". The team developed protocols and tools for **reversible building design**[2], addressing different layers ranging from materials through components to buildings.

The project seizes the opportunities offered by digitalisation through the development of more than **400 Material Passports** and by creating a **Circular Building Assessment** tool.

> *Materials Passports are electronic and inter-operable data sets that collect characteristics of materials and assemblies. They enable building stakeholders to better capture the value of products they use by extending their life span.*

> *The Circular Building Assessment tool*[4] *assesses the transformation capacity, and reuse potential of buildings. It allows efficient data management at project level to generate optimal decision-making models for the stakeholders.*

The research process developed during the project has provided insights into **how policies and standards** can shape the systemic shift. It helped identify new **needs and opportunities for emerging businesses** in the industry.

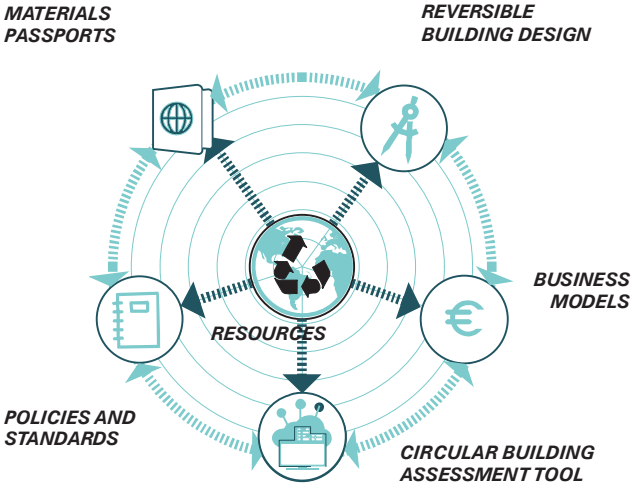

Figure 1: Towards a circular construction ecosystem Buildings as Material Banks Horizon2020 Innovation project

1.2. PILOT PROJECTS

In order to maximise BAMB´s innovation potential, dissemination impact and stakeholder involvement, six pilot projects tested and demonstrated the project outputs in various settings.

The pilot projects investigate and demonstrate new design approaches to making buildings more flexible throughout their life. From the start, they focus on reversible conception, manufacturing to increase the quality of materials and products, on construction and maintenance, integrating the re-design phase of the building within the process (Figure 3).

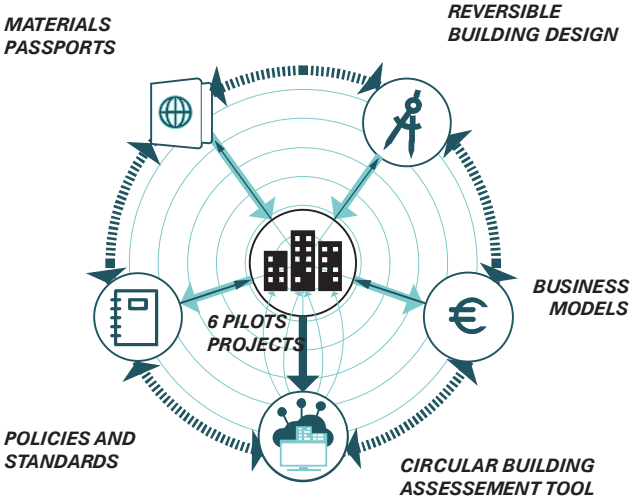

Figure 2: Articulation of the pilots projects around the Buildings as Material Banks Horizon2020 Innovation project's major topics

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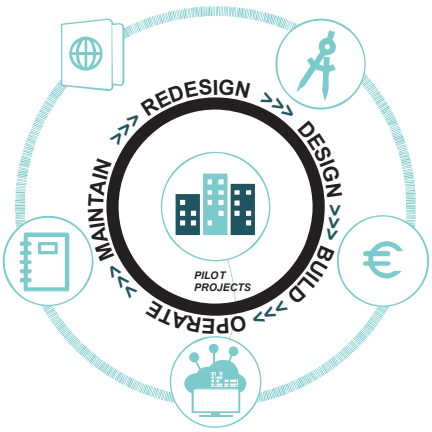

Figure 3: A new life-cycle approach in the construction industry, enabled by BAMB tools

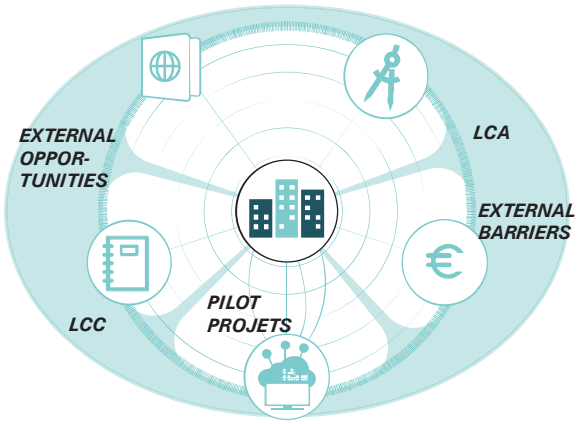

Figure 5: Integration of the broader societal challenges and of environmental cost and impact into the circular reflection

The whole pilot development process highlights concrete opportunities to capture more value from resources while offering a better, more liveable built environment to users.

The real scale projects are providing information about different stages of the buildings' life cycle. They include design phases, prototyping phases, actual constructions or renovations, dis-assemblies, and ultimately the transformation of the buildings while limiting waste generation. They have provided valuable insights about the role of each stage in achieving circularity.

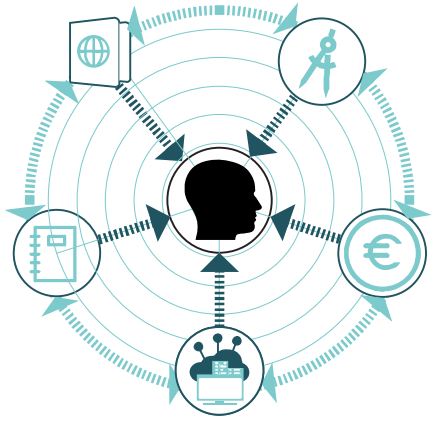

Figure 4: In a circular economy, the user's needs and consciousness about environmental challenges are key for a successful transition

Yet, achieving circularity requires important change in the way people think about their built environment. Aware of these major societal challenge, the BAMB team worked on development scenarios and strategies to overcome barriers and to ease the path towards circular human settlements (Figure 5).

1.3. LABORATORY OF CIRCULAR KNOWLEDGE

The pilot projects are real laboratories for circularity that:

- ***integrate reversible design concepts (transformation capacity and re-use potential) at different levels, providing flexible buildings, creating independent systems (envelopes, interior walls, roofs...)***
- ***highlight the "re-use" potential of materials, by proving that their economic value can be preserved throughout several transformations***
- ***identify necessary changes in project governance. In order to achieve circularity, the project's stakeholders need to be involved upstream, in a collaborative design process***
- ***prove the importance of linking physical buildings and digital systems to maximise (re)use opportunities***
- ***provide feedback on supporting activities in the value network (e.g. procurement, etc.).***

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2. REPORT SUMMARY

1.1. TESTING BAMB RESULTS THROUGH PROTOTYPING AND PILOTS

The reversible building design approach, the Materials Passports, the Circular Building Assessment Tool and new business models for a circular material value network developed in BAMB have been tested in pilot cases within the project's work package 4 (WP4).

This was done in three steps, each leading to a separate report on its findings:

- The *pilot projects' feasibility study (D12)* published in August 2017,
- The *prototyping report (D13)* describing the manufacture of prototypes and providing feedback published in April 2018,
- The present report on the built pilots (D14) published in February 2019 contains the results of the construction of four pilots.

Following the feasibility study, prototyping key elements of the pilot projects was an essential first step to materialise, test and improve building elements and systems in order to maximise the building's circularity. The process assessed how certain building products and systems (existing or newly designed) could be transformed and disassembled during the building phase with minimum waste generation and limited use of natural resources through improved reuse, refurbishment, and recycling.

Taking into account the results and feedback from the feasibility report and the prototyping, **the construction process** provided rich information on how a successful circular project should be shaped from the very start.

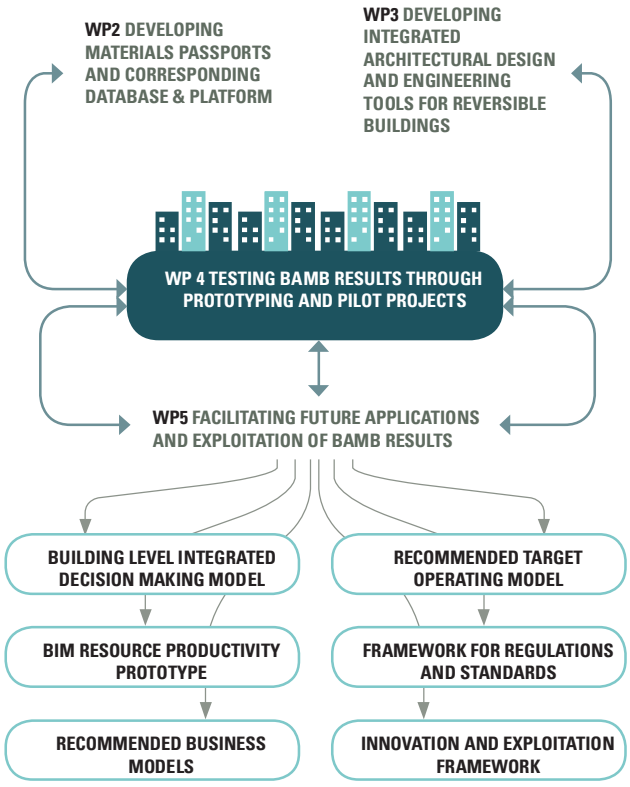

Figure 7: Testing BAMB Results Through Pilot Projects

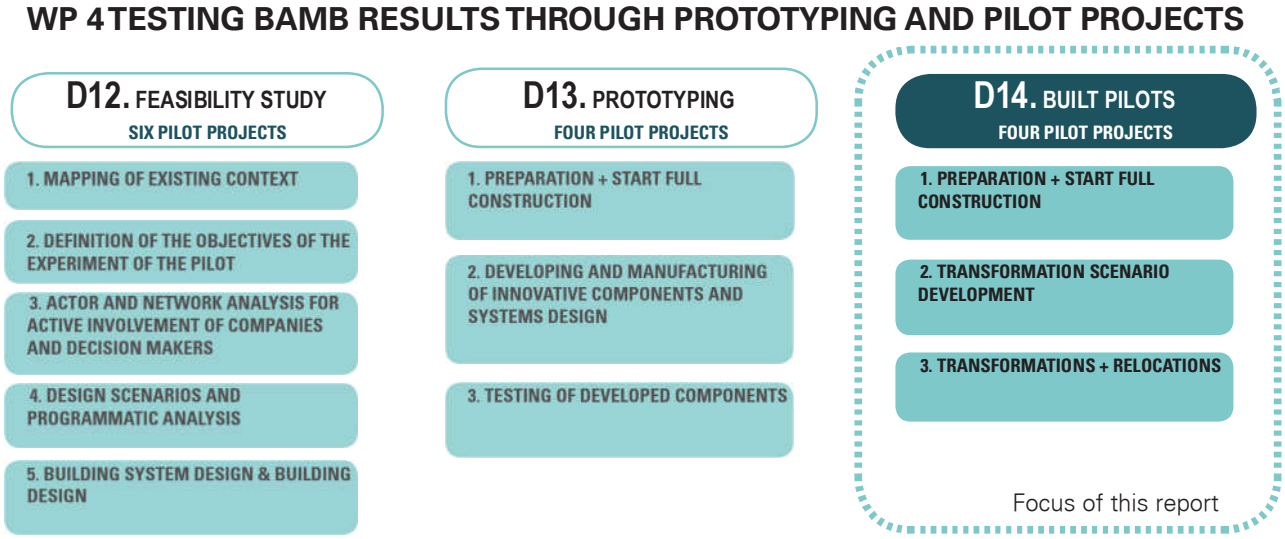

Figure 6: Overview of the pilot projects and BAMB work package 4 (WP4) actions

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2.1. PILOTS BUILT AND FEEDBACK REPORT

The objective of the present report is to provide an overview of the essential insights and outcomes of the construction of four circular pilot projects out of the six BAMB pilot projects :

- Green Transformable Building Lab (GTB Lab)
- Reversible Experience Modules (REMs)
- Circular Retrofit Lab (CRL)
- Build Reversible in Conception (BRIC).

This information has been gathered from the four pilot studies provided by pilot project leaders. Designed as a synthesis, the D14 report focuses on BAMB's innovation goals, the identification of lessons learned and recommendations that emerged from the process.

The responsible partner and coordinating author of the present report is Brussels Environment. Partners in charge of specific pilot projects have contributed with individual reports and analyses. Action 1, GTB Lab was managed by Green Design Center. Action 2, REMs was led by EPEA, Netherlands. Vrije Universiteit Brussel was in charge of the CRL, Action 4. Brussels Environment together with efp Training Center managed Action 5, the BRIC project. Building Research Establishment (BRE) the developer of the Circular Building Assessment tool realised the LCA analyses.

The report is structured around the following chapters:

1. Description of the Pilots
This chapter provides a short overview of the pilots. Each project and its reversible concept are briefly introduced. The chapter describes the overall objectives, highlights the innovative solutions and the achievements. It showcases the ambition and motivation of the project developers as a key driver for developing sustainable and circular solutions.

2. Reversible Building Design (RBD)
Making use of the pilot projects, the BAMB team has tested the reversible design protocols used in work package three (WP3). The development of the design protocols and catalogue has a strong theoretical background, but pilot projects focus on the most practical aspects, such as expected lifetime, how materials and components can be demounted, reused or recycled, what is the performance over time, the health aspects and sustainability of the materials, and their market value over time.

3. Materials Passports (MP)
Once data is collected on the Materials Passports platform, more effective reversible design building solutions can be drawn. Owners, designers, and users can anticipate future functional needs by both designing flexible buildings and utilizing re-used products and materials. Demountable, adaptable and reusable, no-waste solutions can increase reversibility. The chapter explores how the pilot teams used the work developed in work package two or how they developed their own system adapted to the intrinsic logic of the project.

4. Environmental Assessment
Quantitative environmental criteria allow for the continuous evaluation of the achievements related to the initial objectives (e.g. reduction of waste, CO_2 emissions...). Two value proposals for the project BRIC are assessed through a circular Life Cycle Assessment

5. Business Models Circular Opportunities
The chapter highlights important aspects, such as ownership transfer, leasing versus purchasing, and changes in the value network. It takes into consideration financial aspects and how opportunities and long term profitability can be improved during the extended lifespan of a circular building. The innovative strategies developed by each team and their capacity to propose new value proposals for the existing and new markets are evaluated.

6. A new business ecosystem. This chapter presents an overview of the stakeholders and their contributions to each project. A circular economy involves a process-based approach. The interaction with stakeholders during the conception, prototyping and building phases, the co-creative aspects and the upfront intervention of players traditionally positioned at the back end of the value chain are highlighted in this chapter.
However, the key to achieving a strong value network of stakeholders resides in operational effectiveness. Insights of the projects are highlighting the need for lean operational approaches.

7. Policies and Standards
The pilot projects, realised under realistic market conditions and constraints identify both current barriers to develop circularity and opportunities to foster collaboration amongst a value network of stakeholders. Needed changes to achieve circularity include improved partnership between public and private organisations, and enhanced coherent industry support. Companies managing the projects, and public bodies alike would benefit from internal transformations and more fluidity in decision making in order to support the successful circular transition. The pilot projects highlight the barriers encountered during various project development stages. Based on the findings developed in work package five, policy priorities related to the case studies are highlighted.

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