



HOUSEFUL

**Innovative circular solutions and services
for the housing sector**

BEST PRACTICES BOOK

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Foreword

The building sector has a significant impact on the European economy and the environment. It represents about 9% of the EU's Gross Domestic Product (GDP) and provides 18 million direct jobs¹. Moreover, it creates new jobs, drives economic growth, and provides solutions for social, climate, and energy challenges.

However, at the same time, **this sector is one of the main consumers of resources**: it accounts for about **50% of all extracted materials, while also being responsible for over 35% of the EU's total waste generation**. Greenhouse gas emissions from material extraction, manufacturing of construction products, and the construction and renovation of buildings account for approximately 5-12% of total national GHG emissions².

Moreover, according to GlobalABC, buildings represent 41% of the total final energy use³. **Out of those buildings**, households **account for** about 25% of the total European energy consumption, and a large share of it (79%) is dedicated to heating and hot water.

The data presented clearly shows the need to introduce **circular economic principles**. On these can be built a new strategic vision to drive the construction sector towards the 2030 carbon neutrality goals.

Over the last five years, the Houseful project, through the different areas of expertise of its Consortium partners, has contributed to the application of circular principles in the housing sector by developing 11 circular solutions in the 4 Demonstration Buildings: Saint Quirze and Sabadell (Spain), as well as Cambium and Fehring (Austria).

Drawing on this experience, this handbook offers both best practices for applying circular principles and a set of policy recommendations for local, national, and EU levels.

We hope these best practices will inspire you to adopt some of the solutions developed in Houseful.

1 https://single-market-economy.ec.europa.eu/sectors/construction_en

2 https://single-market-economy.ec.europa.eu/industry/sustainability/buildings-and-construction_en

3 <https://www.weforum.org/agenda/2021/02/why-the-buildings-of-the-future-are-key-to-an-efficient-energy-ecosystem/>

HOUSEFUL at glance



HOUSEFUL proposes a paradigm shift towards a circular economy for the housing sector. The main goal is the development and demonstration of an integrated systemic service composed of 11 circular solutions co-created by stakeholders in the current housing value chain. The HOUSEFUL Service will aim at the circular management and efficient use of water, waste, energy, and material resources across the whole lifecycle of buildings in Europe. The approach has been demonstrated on a large scale at 4 sites in Austria and Spain, adapting the concept to different scenarios, including social housing buildings.

The main goals of the project are:

- **Develop a methodology to quantify the degree of circularity of buildings at different stages along their whole life cycle.**
- **Demonstrate and validate the methodology.**
- **Assess the potential environmental and socioeconomic impacts.**
- **Ensure the marketability of the solutions.**

6 CLEAN WATER
AND SANITATION



7 AFFORDABLE AND
CLEAN ENERGY



9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE



11 SUSTAINABLE CITIES
AND COMMUNITIES



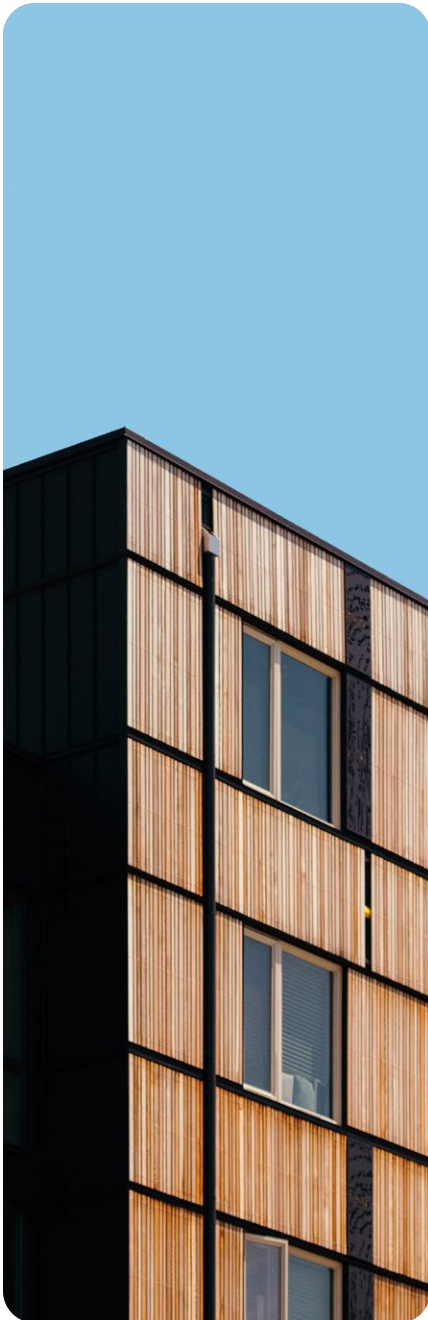
12 RESPONSIBLE
CONSUMPTION
AND PRODUCTION





SECTION 1

WHAT WE LEARNED



Introduction

In this section, the reader will discover what are the main lessons learned by Houseful's partners in developing and implementing the solutions in the 4 demo buildings.

Specifically, this chapter of the best practices book identifies the **11 best practices** that span 4 of the 5 vectors identifying the project: **Holistic, Materials, Water, and Waste.**

They have been learned, and refined, through fieldwork over the past two years. We hope they can be, on the one hand, a guide for future projects that will replicate the circular solutions developed by Houseful, and on the other hand, a study and analysis tool for policymakers who, at the community and national levels, work daily to build a solid working framework that can facilitate the transition to a circular building model.



HOLISTIC



MATERIALS



WATER



WASTE



ENERGY



Engage digitally with Stakeholders from Building sector

SUMMARY

Nowadays a lot of digital platforms and digital tools are accessible through the net online. Sometimes it is difficult to find the appropriate network or content that each individual needs and it is not easy to create a critical mass linked to your region and your expertise, that you will frequently check, contribute and interact. Our best practice is to generate valuable adhoc functionalities to your target user, as example the Circularity Tool is a **perfect match for construction companies.**

REAL CASE

Stakeholders Platforms like Houseful SaaS exist locally, regionally and internationally. Each of them are mixed together with hundreds of Mobile Apps and multiple hubs of information on-line. Digital tools like HOUSEFUL SaaS are detailed easy to find in order to fulfill that demand.

<https://houseful.iris-eng.com>



Our Advice

- Makes simple registration process.
- Work with digital marketing.
- Develop powerful dedicated functionalities easy to use.



Circularity Evaluation Tool for residential buildings

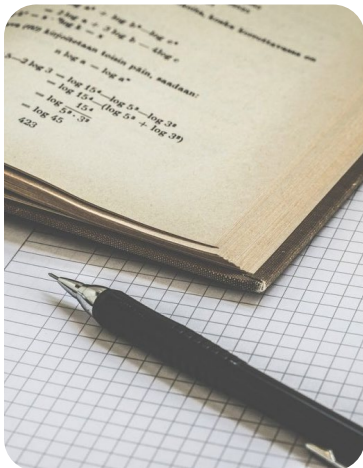
SUMMARY

The Circularity Tool (CT) is web-based tool tailored for building designers and / or policy-makers. Given a certain project, the CT evaluates the degree of Circularity of the design according to a number of vectors: Energy, Water and Material flows and Social, Environmental and Economic impacts.

The Circularity Tool is aligned with the **Level(s) framework** and the set of transversal standards on the Sustainability of Building Construction works (EN 15978 and sister standards).

REAL CASE

The Circularity Tool (CT) has been tested in real scenarios within HOUSEFUL project. Namely, it has been tested, validated and used to evaluate the degree of circularity of the HOUSEFUL solutions implemented in Demo buildings in Spain and Austria.



Our Advice

- Use the CT at early project design stages to evaluate the circularity and implement changes to improve the design (building designers).
- Use the CT to evaluate the impact on building circularity and sustainability of certain policies (Policymakers).
- Investigate whether new financing mechanisms enabled by EU-Taxonomy might be available thanks to CE certification (real estate, consultants).



Social conditions to stimulate co-creation for circular housing

SUMMARY

Co-creation in the Houseful project focused on the implementation of a strategy where key stakeholders and tenants in each demo site building provided ideas to safeguard their needs based on the circular solutions provided by the project. The co-creation process (Service 2 of Houseful) echoes the EC approach to open innovation, using the “backasting” process. It relies on a collaborative development of innovative circular interventions to address socio-economic and business challenges.

REAL CASE

The demonstration sites represented diverse social contexts including vulnerable communities that are not used to dealing with sustainability issues at home, and even less accustomed to co-creation processes. This process has allowed us to reach out to a wider community to gain a better understanding of how affordability and sustainability can go hand in hand.



Our Advice

- Allocate sufficient resources to the process: time and personal resources. Build in flexibility to the project to adapt to a multitude of setbacks, the practice of engagement involves a high degree of complexity, requiring continuous adaptation.
- Ensure that co-creation remains cross-cutting to ensure that hybrid knowledge is not lost (ensure to focus on social and economic innovations as well as technological).





Material passports based on advanced 3D modelling

SUMMARY

A material passport is a digital dataset for a specific building. It provides an inventory of all the materials, components, and products used in a building, as well as detailed information on typology, dimensions, and locations of each element. Assessing the end of life of a material at the design stage is at the heart of the circular economy philosophy, as it increases the possibility of keeping building materials in the economy.

REAL CASE

Material passports have improved the identification and traceability of every material used in the construction and renovation of the Houseful project. They give insights into both new and existing buildings, not only environmental but also about financial, regulations, health and safety. They give insights about new and existing buildings in terms of the environment but also financial and regulatory information and in terms of health and safety.



Our Advice

- Get in touch with professionals who can help you from the early stages of the project, to make information gathering easier.
- Estimate the reduction in maintenance costs, raw material costs and profit from selling second-hand materials at the end of their life cycle.: Using a proper digital model info enrichment process will make it easier to create the material passport.



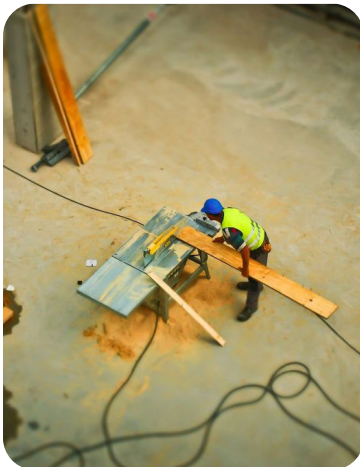
Database of local circular building material

SUMMARY

A list of 50 types of building materials from secondary material platforms, databases and/or local producers. The goal is to facilitate the use of local circular materials in construction by simplifying their accessibility and the comparison of their characteristics. In particular, this solution aims to provide valuable information to help the decision-making process, while amplifying the debate about quality, origin, and material reuse at local scale.

REAL CASE

The database contains information not only on the physical properties of the materials, but also on their cost and delivery conditions. The location of the supplier or manufacturing plant will help in the selection of local materials. The information in the database will facilitate the analysis of the impact of the building's circularity.



Our Advice

- Choose your materials by finding out about embodied energy and CO² and other recycling-reuse values. Changing the design method to include circular materials and processes will make end-of-life material reuse more effective.
- Search databases that allow the comparison of material circularity data from objective and certified sources





Green walls for water purification and on-site reuse

SUMMARY

Green walls or constructed wetlands for wastewater treatment represent nature-based solutions (NBS) which allow for on-site purification of household wastewater or greywater (excluding toilet flush water), respectively. The NBS use microbial processes in the pore spaces of the filter media, together with plant synergies and a variety of other physical and biogeochemical processes to purify the water for irrigation, toilet flushing, street cleaning and more.

REAL CASE

Systems like alchemia-nova's vertECO® vertically aligned green wall constructed wetland at an eco-community in Austria and the GRETA™ green wall in a social housing in Spain, are successfully treating domestic wastewater and greywater, respectively. The purified water can be safely reused on site for garden irrigation and toilet flushing.



Our Advice

- There is no one-size fits all NBS, so involve stakeholders early on in the planning process in order to provide the best tailor-made solution for the local context;
- Scale is important, as fixed costs – for example for regular water quality testing – are better shared among a bigger community;
- Avoid separating the greywater piping after a building has been already constructed or renovated.



Upcycle food waste on-site and create renewable energy

SUMMARY

The residents of the project have agreed to feed the HomeBiogas system with a daily food waste input of 4 liters. The HomeBiogas system has no balance, meaning it will not be possible to measure the amount of food waste fed in per day. It was expected that the residents would weigh the food waste before feeding it into the system and report this data. Unfortunately, they did not do this. The HomeBiogas system operates in a very low-pressure range, between 1 to 13 millibars. While there are advanced tools available for measuring such low gas pressure, it was out of budget, and we decided to have a manual monitoring gas pressure system.

REAL CASE

In an eco-community located in southeastern Austria, a biogas system is being utilized to treat up to 6 liters of food waste per day. The system generates biogas daily, which is used for cooking, and biofertilizer, used to promote the growth of crops locally produced in the community.



Our Advice

- Assess the quantity of food waste requiring treatment;
- Assess the stove's location and determine the optimal piping placement;
- Optimal biogas system integration is achieved when considered during the design phase of the building rather than added post-construction. E.g.: planning the gas piping and the use for the bio-fertilizer.



Sludge treatment wetland for compost production

SUMMARY

A sludge treatment wetland (STW) is a nature-based solution (NBS) for the valorisation of sewage or settling sludge from wastewater treatment plants or water works. The sludge is applied on the whole planted surface, dewatered by drainage through the filter media and the leftover solids on the surface mineralise. Over time valuable compost is thus produced from the nutrients contained in wastewater.

REAL CASE

At an eco-community in south-eastern Austria all household wastewater is pre-treated in a 4-chamber septic tank system in order to separate as much as possible the liquid and the solid fraction of this originally unsegregated wastewater. The solid fraction can be applied to an STW and produces compost for community gardening



Our Advice

- Check your local regulations for the use of STWs (also called sludge treatment reed bed systems);
- Consider the economy of scale to share fixed costs such as sludge quality testing;
- The systems are better suited for (semi-)rural or green areas than densely populated urban areas.



Valorise kitchen waste as compost

SUMMARY

More than 30% of total solid waste in households comes from the kitchen. Kitchen waste is composed mainly of organic matter that can be valorized as organic fertilizer (compost in this case) after hygienisation through composting. To ensure the final product quality as well as minimize the appearance of flies and other insects, it is important to separate improvers such as egg shells or fish bones and to control product humidity carefully.

REAL CASE

In HOUSEFUL, vermicomposting bins were provided to several volunteers who carried out composting at home for 4 months. After this period, users highlighted that the activity raised waste management awareness, became a good family experience and that compost production allowed both self-use and sharing with friends and neighbors.



Our Advice

- Purge frequently the leaching compartment and recover liquid fertiliser for assuring proper moisture of compost and prevent flies and other insects from appearing.
- Separate hard parts (fruit stones, bones...) and citric products (pineapple, tomato...) for enhancing composting efficiency.
- Be aware that composting is not a substitute for an organic waste bin. Not all organic waste can be added.



Water and energy recovery from blackwater

SUMMARY

Blackwater contains not only organic matter but also pathogens from human faeces. However, it can be used as secondary raw material for energy recovery (as biogas) through anaerobic digestion. To enhance biogas production, temperature or harsh chemical conditions can be used and reclaimed water quality can be increased by using membrane technologies and/or disinfection. Biogas production can be enhanced by adding co-substrates containing high organic content.

REAL CASE

In the HOUSEFUL project, blackwater and ground kitchen waste from a family of 4 people (120 L of blackwater and 3 kg of kitchen waste per day) were valorised to produce 60 - 80 L/d of biogas and 80 L/d of reclaimed water using two-stage anaerobic digestion coupled with ultrafiltration membranes.



Our Advice

- Be patient while starting up the anaerobic digestion system as microorganisms should acclimate first;
- If kitchen waste is added for enhancing biogas production, avoid adding meat and fish waste.



Bio-methane: Biogas upgrading

SUMMARY

Biogas production is currently growing in EU, driven by a favourable environmental legislation. This has led to increased deployment of anaerobic reactors for organic waste treatment. However, to produce biomethane, the biogas must be cleaned to separate the trace components, refined to remove CO₂ and adapt the calorific value to the required uses. Thus, biogas upgrading is a key issue today in improving biomethane to create an interesting substitute for natural gas.

REAL CASE

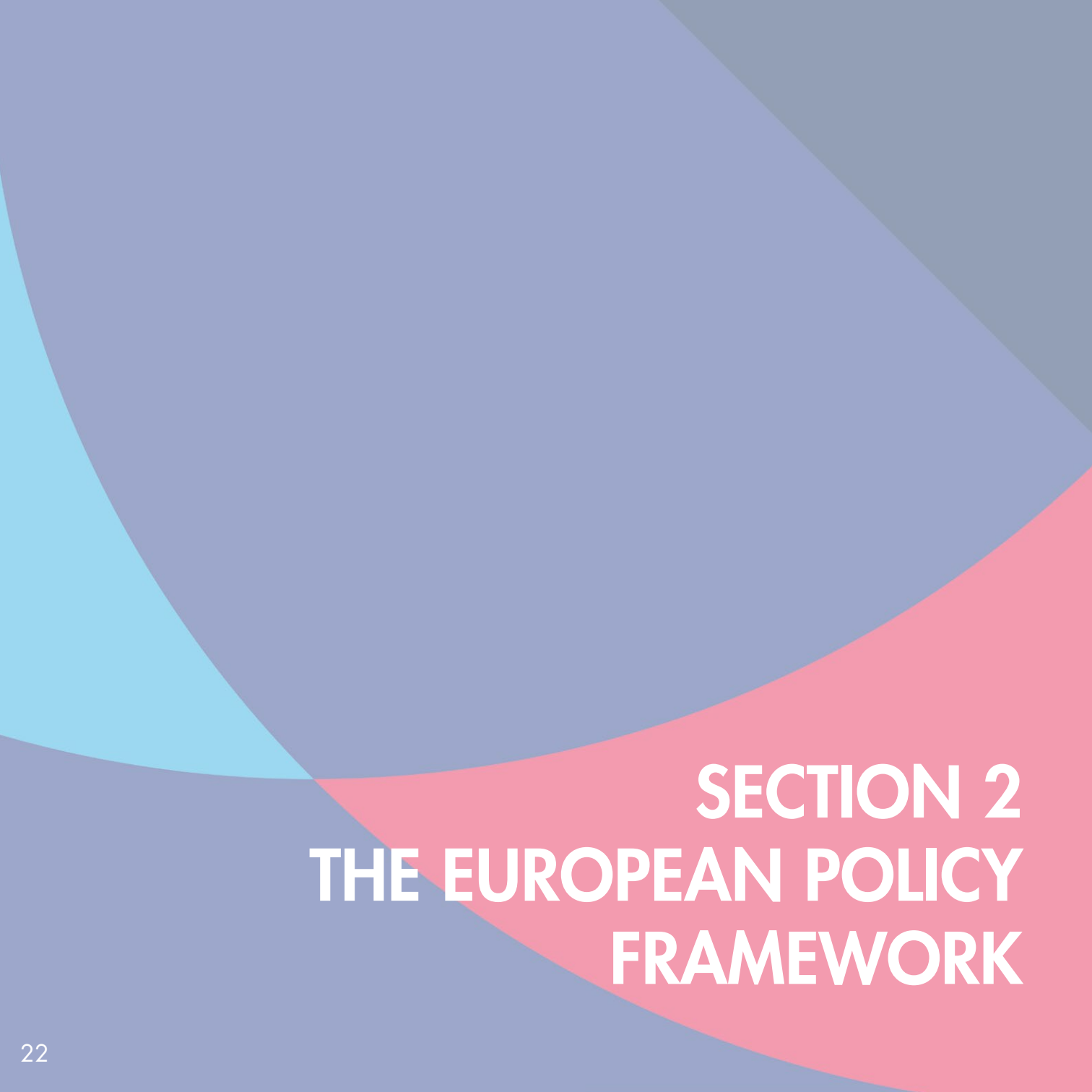
In the HOUSEFUL project, an absorption system based on gas-liquid membrane separation was developed to treat 1 L/min biogas at laboratory scale – enough for a biogas building production under anaerobic digestion. However, an analysis of environmental and security conditions is needed.



Our Advice

- Biogas could be treated in a few minutes but must be stored;
- Biomethane is strongly recommended for grid injection or CHP valorization. However, burning for boiling decreases the upgrading feasibility;
- An ATEX Zone is highly recommended for its implementation.





SECTION 2

THE EUROPEAN POLICY FRAMEWORK



Green New Deal, Next Generation EU and Fit for55

One of the key objectives of the HOUSEFUL project was to better understand the existing 'climate' in the EU regarding the circular economy in the built environment. This included a review of existing regulatory and legislative frameworks, financing opportunities, and the development of necessary skills and knowledge, to name but a few.

The review found that in most cases frontrunner circular projects were fighting an uphill battle against systems that were often ill-equipped to facilitate ambitious circular residential renovations. However, the review also concluded that such obstacles were largely reflective of systems that were designed at a different time when available construction products and other technologies were not the same. Thus, work is needed to modernize and adapt existing systems.

Twenty of the policy recommendations developed by HOUSEFUL are briefly outlined. If they were taken on board by policymakers, they would stand to significantly improve the overall climate in which building owners operate. At the same time, new obligations, standards, and objectives would also be required.

One of the ways that this can already be facilitated is through access to funding. In cases where the availability of funding, or the conditions under which it is provided, can be the decisive factor in determining the scale of circular ambition, such schemes can be vital. This section includes a brief overview of just some of the funding opportunities which exist. Of course, this list is far from exhaustive.

Top 20 Policy Recommendations

#1 Project funding databases & agencies

Each member state should, working to a common structure, establish a centralized interactive online funding database, and a national funding agency. Currently, information on funding can be dispersed or difficult to identify. Consequently, many eligible circular projects may encounter a funding shortage or miss out on valuable assistance.

#2 Online project modeling tools

Policymakers should work to create online tools that will make available information (cost of linear approach versus the cost of innovative/circular approach, expected climate impacts; available funds; beneficiaries) and use it to generate standardised and acceptable counter-factual investment analysis. This would help building owners to make more informed decisions on the adoption of circular solutions.

#3 Pre-financing of projects

Where public financial supports for circular projects are available, Governments should consider offering pre-financing. This reflects that these solutions may be more costly to implement and there may, therefore, be a “funding gap” that needs to be bridged.

#4 Supporting maintenance costs

Public funding should be made available to help meet the life-cycle maintenance costs related to innovative circular systems, in addition to also supporting their initial purchase and installation. Many circular solutions are more complex and require monitoring, such as greywater treatment, that in turn implies additional costs over the medium-to-long term.

#5 Develop circular loan products

Circularity needs special considerations on the part of financing institutions, since it is not only about environmental sustainability but also reducing costs over the lifetime of a building. For example, loans from public or ethical banks could be structured to be repaid in line with cost savings generated from using circular solutions (e.g., lower water bills).

#6 EU Recovered Materials Agency

The European Union should look to establish a new public agency in order to better understand the reusability of certain construction materials and to help establish a healthy secondary market for materials. The European Union should also work with building owners to test and support the reuse of different common materials and components.

#7 Regulatory sandboxes to develop circular water systems

Regulatory sandboxes should be used in order to test and further develop low-cost, low-effort water treatment systems that still ensure the maintenance of high standards of on-site water treatment and reuse. This could include digital tools for off-site monitoring by independent experts.

#8 Reduce taxes and levies

Policymakers should reduce or wave altogether charges, taxes, and levies related to the development of construction and renovation projects that meet defined environmental and resource efficiency criteria. Nowadays, in many EU regions, local building taxes and levies to be paid do not consider the circularity or overall sustainability of the building.

#9 Circularity criteria in public procurement

Actors subject to public procurement rules (“contracted authorities”) should insert circularity requirements into public tenders, in order to drive economies of scale and overall capacity to apply circular solutions. To further facilitate this, national agencies charged with developing clear and up-to-date green procurement guidelines and digital procurement tools would also need to be established.

#10 Mandate building material passports

Policymakers should consider requiring material passports for all new buildings over a certain size. A well-regulated and transparent material passport system can increase the traceability of materials and help to improve confidence in their reuse.

#11 Circular one-stop-shops

Regional advice and circularity innovation hubs, based on the one-stop-shop model, should be established in order to assist local stakeholders (e.g., engineers, architects, building owners) in developing more sustainable, circular projects.

#12 Lighthouse circular buildings

In the short-to-medium term, the EU should have at least one circular lighthouse building in each of the 242 regions at NUTS 2 and one lighthouse in each of the 1,166 regions at NUTS 3 in the medium-to-long-term. These buildings will serve to set better standards and inspire the construction of additional buildings following the same model.

#13 A review of the public sector

Each member state should conduct a holistic review of its processes in public administration vis-à-vis meeting its objectives as part of the EU Renovation Wave. The goal should be to walk through the process of applying for the necessary permits and licenses in order to see where there is room for improvements in efficiency.

#14 Co-creation templates

National environmental agencies, such as those in the Eionet network, should work on developing appropriate co-creation models at the local level that can be used by project leaders. This would help to save on the time, effort and expense required to develop a new co-creation framework for each circular project.

#15 CE Markings

It is necessary to adapt CE markings for construction products in order to more clearly highlight the benefits of certain products over others, in terms of life-cycle costs, reparability, replaceability, and recyclability. This will help project managers to more easily explain the benefits of circular approaches to end-users and policymakers.

#16 Apprenticeships and reskilling

Each Member State should be obliged to develop a clear national strategy to ensure that key workers in the construction and renovation sectors receive adequate training to support the transition to a circular economy. This should include both the training of new workers, through education and apprenticeship programmes, as well as the retraining of existing workers.

#17 Circular training modules

Member states should work with national representative bodies to co-design training modules and tools for key workers in the upscaling of the circular economy in the built environment, e.g., architects, engineers, construction workers.

#18 Using the Level(s) framework

The EU's Level(s) framework could help improve knowledge and the transfer of best practices in terms of circularity and sustainability of buildings by providing a common language and evaluation method for building sustainably.

#19 Support SMEs

Financing schemes (loans, grants, tax breaks, etc.) need to be accessible for SMEs in particular, to ensure that they can play their part in improving the circularity of the built environment. Indeed, not all sector participants may be able to invest in new processes, training programmes, and other capital needed to adopt a more circular approach.

#20 Social housing renovation funds

Social housing providers should consider setting up renovation funds to spread renovation costs over an extended period. This avoids the need for sudden increases in rents related to renovations, leaving room for more ambitious, innovative, and circular renovation projects. This is the model already being used in Austria.

Financial schemes for HOUSEFUL replication

#1 European Territorial Cooperation (Interreg)-grants

Interreg is one of the key instruments of the European Union supporting cooperation across borders through project funding. Interreg projects must align with the five pillars of the Structural Funds. One of the specific aims of Interreg Europe under the current EU budget is the promotion of circular economy; specifically, the re-use of materials. Thus, potential follower buildings would be encouraged to follow the project funding announcements of their local Interreg bureau.

#2 European Urban Initiative (EUI)-grants

The European Urban Initiative is a tool with the aim of strengthening integrated and participatory approaches to sustainable urban development by facilitating and supporting innovative actions, capacity and knowledge building, policy development, and communication on sustainable urban development. In terms of eligibility, building owners (e.g., social housing providers) are not directly eligible, but they can work with cities as partners. As for the budget, 20% will be allocated for capacity-building, 60% to innovative actions, and another 20% shall be allocated for knowledge-related activities.

#3 Horizon Europe-grants

Horizon Europe is the successor to the Horizon 2020 programme, which funded projects like HOUSEFUL. Currently, it is the EU's main funding programme for research and innovation, with a budget from the MFF of €95.5 billion. We have already seen several calls under Horizon Europe for projects related to circularity in the built environment. With the EU's push toward lower emissions and greater resource efficiency, many more calls between now and the end of 2027 are expected.

#4 LIFE Programme-grants

LIFE is the funding instrument for the transition to a climate-neutral and resilient society, by supporting the implementation of the EU's climate policy. This includes the specific funding programme **"Circular economy and quality of life"**, which aims to facilitate the transition toward a sustainable, circular, toxic-free, energy-efficient, and climate-resilient economy, as well as to protect, restore, and improve the quality of the environment. It also includes the sub-programme **"Climate change mitigation and adaptation"**, which supports EU strategic objectives, such as "the transition to a circular economy".

#5 Innovation Fund (IF)-grants

The Innovation Fund is one of the world's largest funding programmes for the demonstration of innovative low-carbon technologies. The IF focuses on highly innovative technologies and big flagship projects with European value added that can bring significant emission reductions. Projects will be selected based on the effectiveness of greenhouse gas emissions avoidance, degree of innovation, project maturity, scalability, and cost efficiency.

#6 Affordable Housing Initiative (AHI)-grants

The AHI is part of the European Commission's Renovation Wave strategy; the aim of which is to at least double renovation rates, by breaking down long-standing barriers, as well as improving reuse and recycling. The AHI will guarantee access to necessary technical and innovation capacity and project support for local social housing projects by providing funding for district renovation 'demonstrators'. These projects are encouraged to promote "efficient access and use of innovative processes such as circular and modular building as well as social innovation and engagement models to empower residents in the renovation process".

Financial schemes for up-scaling:

#7 EU Structural Funds (ESIF)-grants and Financial Instruments (FI)

The **ESIFs** are financial tools that aim to invest in job creation and a sustainable and healthy European economy and environment. A total of €378bn will be provided in the 2021-2027 period. A "greener, low carbon transitioning towards a net zero carbon economy" is one of the financing pillars of the ESF. This includes promoting "the transition to a circular economy". Any EU region can apply for Structural Funds. However, the allocation conditions vary between regions based on their level of economic prosperity. The most 'developed' regions can avail themselves of co-financing rates of 40% to 50%, while 'less developed' regions can avail themselves of rates as high as 85%.

#8 European Investment Bank (EIB)-FI

The European Investment Bank is the biggest multilateral financial institution in the world and one of the largest providers of climate finance. The EIB contributes to the provision of social and affordable housing, inclusive growth, and social and economic cohesion. EIB support is eligible for a wide range of operations, including energy efficiency or circularity. The EIB is seeking to position itself as the 'Green Bank' in the EU, in order to back the European Commission's commitment to the EU Green Deal. As part of this, it is aiming for at least 50% of its investments to be 'Green' by 2025.

#9 European Local ENergy Assistance (ELENA)-90% grant

ELENA is a joint initiative between the European Commission and the European Investment Bank. It provides grant support for the preparation (but not implementation) of investment programs and is focused on energy efficiency measures (e.g., renovation/renewables/district heating and PV). ELENA supports programs above €30 million, and can cover up to 90% of technical assistance/project development costs. Smaller projects can be supported when they are integrated into larger investment programs. In terms of payment, 40% pre-financing is possible.

#10 The Circular City Centre scheme (C3)-FI

The C3 is a competence and resource center within the European Investment Bank, established with the support of the European Commission through the European Investment Advisory Hub. The C3 aims to support EU cities in their circular economy transition, facilitating access to advisory and financing for circular projects. These consults to cities are offered pro bono.





Conclusions

After 5 years of the HOUSEFUL project, our demo buildings have been able to implement circular solutions with the support of partners with multidisciplinary profiles.

Working in a coordinated way, the final objective was to improve environmental, economic, technical and social aspects, creating the necessary evidence for replication in other buildings.

However, the road travelled has not been linear, it was not a “bed of roses”, and during this time, success stories have been achieved and many lessons learned have been collected on the circular economy applied to the building sector.

The solutions deployed in the demo buildings have generated impacts that have been measured and evaluated, demonstrating their effectiveness in addressing the challenges related to the carbon neutrality of the European building sector.

Finally, at the end of this long journey, it is important to thank those who have accompanied the consortium of partners up to here, those who have followed us through our logbooks which told what happened in the demo buildings. Without the trust of others, and without strong teamwork, nothing would have been possible.

Annex 1: Repository of scientific publications

During the project, HOUSEFUL partners have capitalized on the project results to develop several scientific publications that have been published in international peer-reviewed journals. Papers produced cover several topics that are fundamental to foster circular economy applied to the building sector. Those topics and the related publications are listed below.

SCIENTIFIC PAPER	PARTNERS	DATE	LINK
Assessment of two-stage anaerobic digestion of blackwater and kitchen waste for reducing environmental impact of residential buildings	LEITAT	April 2023	https://doi.org/10.1016/j.scp.2023.101090
Factors influencing the social perceptions and choices towards circular renovation in the housing sectors	WE&B; Agència de l'Habitatge de Catalunya; alchemia-nova	November 2022	https://library.oapen.org/handle/20.500.12657/59714
Nature-based units as building blocks for resource recovery systems in the city	alchemia-nova	July 2022	https://doi.org/10.3390/w13223153
Validating circular performance indicators: the interface between circular economy and stakeholders	alchemia-nova	August 2021	https://doi.org/10.3390/w13162198
Potential nutrient conversion using nature-based solutions in cities and utilization concepts to create circular urban food systems	alchemia-nova	July 2021	https://doi.org/10.1007/s43615-021-00081-6

Annex 2: Repository of webinars

During the project, HOUSEFUL partners have hosted several webinars focused on the 4 vectors: Materials, Water; Waste; Energy and dedicated to the main technical stakeholders. The topics and the related recordings are listed below.

WEBINAR	PARTNERS INVOLVED	DATE	LINK
Material solutions for a circular economy	ITeC; Turntoo	September 2022	https://urly.it/3v_s9
Circularity within construction: diving into sustainable solutions and business models	AIGUASOL	March 2022	https://urly.it/3v_sb
From water polluters to water providers. Green buildings and social impact challenges	alchemia-nova; LEITAT	March 2023	https://urly.it/3v_sc
From waste to resources: renewables, better soil health, and circular solutions to cut GHGs	Homebiogas	April 2023	https://urly.it/3v_sd



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LEITAT
managing technologies

ITeC

CARTIF

**alchemy
nova**

**Agència de l'Habitatge
de Catalunya**

IRIS

AIGUASOL

LGI
sustainable innovation

ARCHITEKTURBÜRO REINBERG
ZT GMBH

**turn
too**

**NEUES
LEBEN**
gemeinnützige Real Estate und Consulting
gesellschaft mbH, Real Estate und Consulting
gesellschaft mbH, Real Estate und Consulting
gesellschaft mbH

**HOUSING
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Beratung

ICONS

HOME BIOGAS
Cooking on food-waste.



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