BUILDING A CIRCULAR IRELAND

A Roadmap for a Resource Efficient Circular Built Environment

IGBC
IRISH GREEN BUILDING COUNCIL

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This project is funded under the EPA Research Programme 2021-2030. The EPA Research Programme is a Government of Ireland initiative funded by the Department of the Environment, Climate and Communications. This project received co-funding from the Department of Agriculture, Food and the Marine.
Grant Agreement Reference: 2022-GCE-1158

epaResearch

ACKNOWLEDGEMENT

We would like to thank the all the participants who presented, attended and contributed to our workshops, focus group session and public consultation process. In particular, we would like to extend appreciation to the project Steering Committee Chair and members in addition to the international advisory board members, plus valuable input from all project partners.

Suggested citation:

IGBC (2025), Building a Circular Ireland - A Roadmap for a Resource Efficient Circular Built Environment, 15th of May 2025

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ATU	Atlantic Technological University
BIM	Building Information Modelling
BoQ	Bill of Quantities
CE	Circular Economy
CIOB	Chartered Institute of Building
CGT	Capital Gains Tax
CLT	Community Land Trusts
CMEX	Construction Materials Exchange
CMUR	Circular Material Use Rate
CoE	Centres of Excellence
CO_2e	Carbon Dioxide equivalent
CPQ	Configure, Price, and Quote
CPD	Continuing Professional Development
CPR	Construction Product Regulation
CRMA	Critical Raw Materials Act
CRMs	Critical Raw Material
CSO	Central Statistics Office
CSRD	Corporate Sustainability Reporting Directive
CWMF	Capital Works Management Framework
C&D	Construction and Demolition
DASBE	Digital Academy for the Sustainable Built Environment

DfA	Design for Adaptability
DfMA	Design, Manufacture, and Assembly
DfD	Design for Deconstruction
DMC	Domestic Material Consumption
DoP	Declaration of Performance
DoPCs	Declarations of Performance and Conformance
DPP	Digital Product Passports
EC	Embodied Carbon
EIB	European Investment Bank
EPA	Environmental Protection Agency
EPBD	Energy Performance of Buildings Directive
EPD	Environmental Product Declaration
EPR	Extended Producer Responsibility
ESB	Electricity Supply Board
ESG	Environmental, Social, and Governance
ETA	European Technical Assessments
ETB	Education and Training Board
EU	European Union
EU Taxonomy	European Union Taxonomy
GGBS	Ground Granulated Blast-furnace Slag
GHG	Greenhouse Gases

GPP	Green Public Procurement
GWP	Global Warming Potential
HPI	Home Performance Index
IFFPG	Irish Farm Film Producers Group
IGBC	Irish Green Building Council
$kgCO_2e/m^2$	Kilograms of CO_2 per square meter
LAs	Local Authorities
LaaS	Lighting as a Service
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
LCGWP	Life Cycle Global Warming Potential
MMC	Modern Methods of Construction
MTU	Munster Technological University
NSAI	National Standards Authority of Ireland
NZEB	Nearly Zero Energy Buildings
OC	Operational Carbon
OGP	Office of Government Procurement
OP	Operational Carbon
PaaS	Product as a Service
PRO	Producer Responsibility Organisation
RIAI	Royal Institute of Architects of Ireland
RMC	Raw Material Consumption

RWMPs	Resource and Waste Management Plans
R&D	Research and Development
SEAI	Sustainable Energy Authority of Ireland
SFDR	Sustainable Finance Disclosure Regulation
SMEs	Small and Medium Enterprises
SPD	Sustainable Products Directive
SRMs	Secondary Raw Materials
sqm	Square metre
SuDS	Sustainable Urban Drainage Systems
TGDs	Technical Guidance Documents
TiCWG	Timber in Construction Working Group
TII	Transport Infrastructure Ireland
TU Dublin	Technological University Dublin
UA	University of Galway
VAT	Value Added Tax
WEEE	Waste Electrical and Electronic Equipment
ZEB	Zero Emissions Building

1. SUMMARY

The construction industry is essential for the Irish economy to remain competitive and provide affordable housing and infrastructure.

At the same time, we need an urgent transition to a net-zero carbon, resource-efficient and a circular economy. In 2022, the Irish Green Building Council (IGBC) launched the "Building a Zero Carbon Ireland" roadmap, which outlined the necessary steps and actions to decarbonise our built environment. This roadmap highlighted the **importance of the circular economy in reducing the need for demolition and rebuilding, as well as in lowering the carbon intensity of construction**. However, there are further reasons beyond climate challenges, to transition to circularity in construction, namely global resource constraints and the biodiversity crisis.

This "Building a Circular Ireland" roadmap (2025-2040) complements the "Building a Zero Carbon Ireland" roadmap (2022-2050). This roadmap's approach focuses on strategies for prevention and reuse, better design, resource efficiency, and the added value of innovative business models rather than simply downcycling.

This roadmap is organised into six main sections (listed below), each of which outlines the steps needed for circularity in the construction sector in Ireland.

- ***Value*** **our existing building stock**
- ***Plan*** **for resource efficiency**
- ***Design*** **for circularity**
- ***Close*** **the materials loop**
- ***Change*** **the business model**
- ***Enable*** **the circular transition**

Each section provides a range of specific short-term and long-term recommendations aimed at transforming the built environment and supporting Ireland's shift towards a circular economy and decarbonisation. To enhance implementation, these recommendations are categorised by sector.

The "Building a Circular Ireland" roadmap is informed by extensive engagement with the construction and property sector, with over 225 stakeholders consulted through 4 large-scale workshops, 12 focus group meetings, and many individual expert interviews. **This roadmap has been developed as part of a research project funded by the Environmental Protection Agency (EPA), prepared by IGBC in conjunction with the University of Galway (UoG), Technological University Dublin (TU Dublin), and Atlantic Technological University (ATU)**, incorporating the Circular Build project team horizon scan report and the associated feedback on circularity input, from the project multiple working groups.

This roadmap is intended for stakeholders involved in the construction value chain, such as policymakers, manufacturers, the financial sector, property markets, Research and Development (R&D), and the construction industry, including end-of-life and retrofitting operators.

May, 2025

WHAT IS MEANT BY THE CIRCULAR ECONOMY?

The European Parliament's definition (2023) states: *"The Circular Economy (CE) is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended."* (see Figure 1).

Figure 1: Circular Economy illustration (IGBC, 2022)

The concept of the circular economy has been developed in response to the negative impacts of our current linear economy, 'take, make, and waste', illustrated in Figure 2. The circular economy avoids using new materials and encourages a high degree of reuse of products, components, and materials (DGBC, 2021).

Unlike the traditional 'take-make-waste' model, a circular economy enhances system health by progressively decoupling economic activity from the consumption of finite resources (UKGBC, 2019). This involves designing and producing products and assets that support circular economy principles by enhancing resource efficiency, durability, functionality, modularity and upgradability by simplifying disassembly and repair.

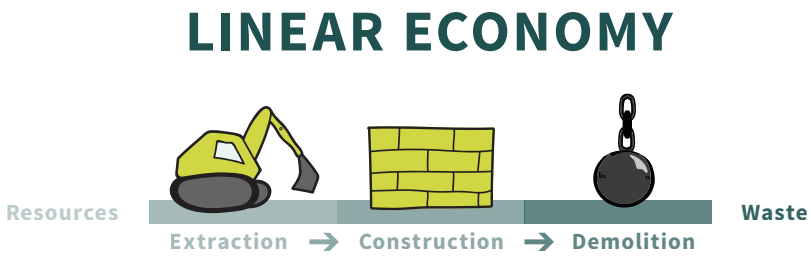

Figure 2: Linear economy illustration (IGBC, 2022)

2. INTRODUCTION

In Ireland, the circular economy is gaining greater visibility in political discussions thanks to initiatives from the European Commission, such as the European Green Deal and the Circular Economy Package (OECD, 2022). While Ireland has made notable progress, the six priority areas— 1. Value our existing building stock, 2. Plan for resource efficiency, 3. Design for circularity, 4. Close the materials loop, 5. Change the business models, and 6. Enable the circular transition —outlined in this roadmap still needs support and improvement to further enhance the country's circular economy in construction and the built environment.

We are experiencing environmental degradation, a climate emergency, significant biodiversity loss, pollution, and excessive consumption of natural resources. These crises underscore the urgency of moving beyond the current linear 'take-make-waste' economic model, which extracts, transforms, and utilises materials, inflicting immeasurable damage on the planet and its inhabitants (WorldGBC, 2023). Globally, more than 29% of biodiversity loss is due to the extraction and processing of natural resources for construction (World Economic Forum, 2020), with a 70% loss in the abundance of animal species since 1970. (WWF, 2024).

Construction and the built environment are responsible for 37% of Ireland's national emissions. This comprises about 23% of Operational Carbon (OP) and 14% of Embodied Carbon (EC) emissions from the production and transport of construction materials, construction processes, maintenance, repair, and disposal of buildings and infrastructure (IGBC, 2022). Ireland needs to embrace a circular economy as a powerful strategy to enhance industry sustainability and improve resilience in our supply chains.

Ireland is at a pivotal moment in a shift to a circular economy, acknowledging its crucial role in sustainability and economic development. Adopting more circular practices in construction offers various advantages for society. It can create economic opportunities by unlocking savings on materials, generating new jobs, particularly in design and reverse logistics, and boosting investment sectors. Furthermore, Irish organisations could enhance their resilience regarding costs and supply security while transitioning to innovative business models that cater to the rising demand from eco-conscious consumers (Impoco, et al., 2021).

We must move beyond the current paradigm of value capture, which usually involves degrading the value of the products and materials recycled, to one where we prevent waste through resource efficiency and the development of circular business models to retain the value of resources at their highest level. Shifting towards a circular economy in construction can help decouple economic growth from increased carbon emissions (WorldGBC, 2023). In line with circular principles, the construction sector has the potential to reduce CO_2e emissions by 84% and material consumption by 25% by 2050 (CSG, 2024).

This Building a Circular Ireland roadmap aims to serve as a turning point for the transition from a linear to a circular economy.

2.1 CIRCULAR VISION FOR IRELAND

Ireland has seen substantial growth in recent years, with the current population reaching 5 million and projections estimating it will rise to 7 million by 2057 (CSO, 2024). This population increase, alongside economic expansion, creates challenges for the country. There is an urgent need to deliver homes, infrastructure, food, services, and manufactured goods. In addition to population and economic growth, greenhouse gas (GHG) emissions are increasing, contributing to biodiversity loss and increased water stress.

Ireland's goal is to create a completely decarbonised built environment that contributes to the restoration of resources and natural systems within a flourishing circular economy. This will be achieved through several strategic frameworks and initiatives aimed at transforming the country's economic model from a linear "take-

make-waste" approach to a more sustainable, circular one, with the following objectives:

- Retain and enhance the (economic, social, and cultural) value of existing buildings and infrastructure, intensifying their use and reducing unnecessary resource use.
- Optimise resources and materials through assessment of need, spatial efficiency, better planning, and building design, as well as material efficiency to ensure that needs can be achieved cost-effectively, using less materials and resources.
- Support the circular flow of materials and resources, minimising the use of primary sources, ensuring materials used are non-toxic, regenerative, or more circular in nature, and identifying and retaining critical raw materials.

Achieving those objectives will require the following actions:

- The government will need to fully support the development of a circular innovation ecosystem through the implementation of integrated policy, fiscal, regulatory, planning, financial and procurement systems, infrastructure (physical and digital), and strategic investment.
- The entire construction value chain, including finance and insurance, will need the awareness, skills, capacity, and tools to understand and deliver the transition.

In conclusion, Ireland's commitment to transitioning to a circular economy is essential to address the challenges posed by population and economic growth, whilst halving greenhouse gas emissions by 2030. By focusing on retaining and enhancing the value of existing infrastructure, optimising material use, and supporting the circular flow of resources, Ireland can create a decarbonised built environment that contributes to ecological restoration. Achieving these objectives will require comprehensive support through integrated policies, investments, and the development of skills and tools across the entire construction value chain. With a coordinated effort from all sectors, Ireland can pave the way toward a sustainable future, fostering economic, environmental, and social resilience.

2.2 THE SCALE OF THE CHALLENGE

14%
Of our national emissions are associated with construction's embodied carbon emissions (O'Hegarty, et al., 2022).

8.3 million tonnes
Quantity of Construction and Demolition (C&D) waste generated annually in Ireland (EPA, 2024).

35%
Share of Ireland's material footprint associated with construction (DETE, 2024).

97%+
of the materials flowing through the Irish economy are from virgin sources (CGR, 2024)

Table 1: Demonstrates with numbers the impact that the construction sector has on the environment.

Table 1 Outlines important statistics regarding the environmental effects of construction in Ireland. Figure 3 illustrates the impact of a 'Business as Usual' scenario on Ireland's carbon emissions by 2030.

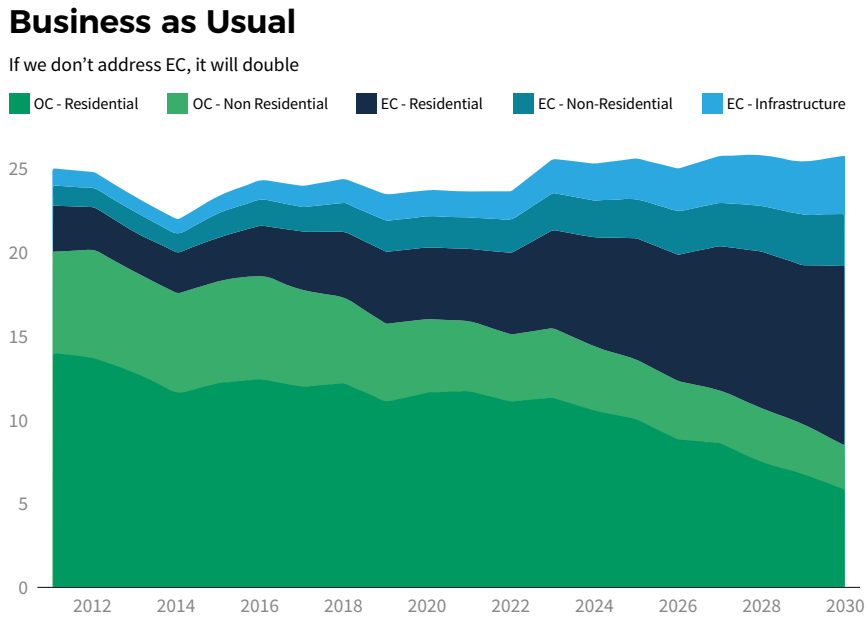

Figure 3: Chart of carbon emissions EC = Embodied Carbon. OC = Operational carbon (IGBC, 2022).

Each year, construction and demolition processes generate 8.3 million tonnes of waste in Ireland, showcasing the extensive amount of materials discarded or demolished, which frequently ends up in landfills or necessitate recycling efforts (EPA, 2024). Furthermore, 35% of Ireland's total material footprint is associated with the construction industry (DETE, 2024). This footprint represents the resources needed to sustain our economy, including minerals, metals and wood. Additionally, 97% of the materials utilised in Ireland are derived from "virgin" sources, for example, newly extracted or produced rather than recycled, contributing to environmental degradation and resource depletion (CGR, 2024).

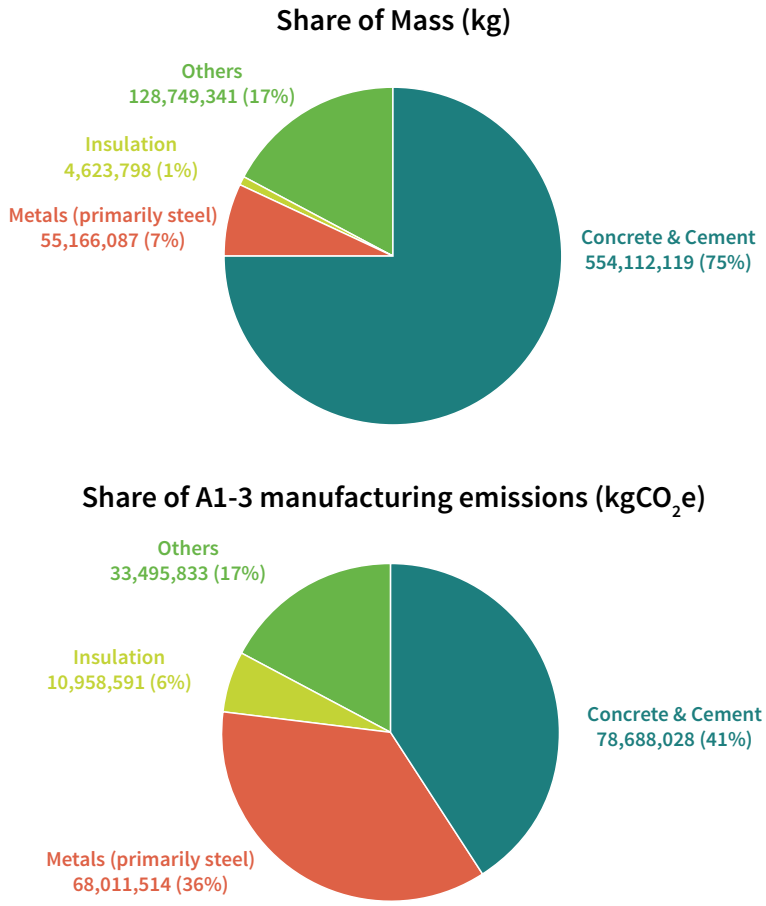

Figure 4: Share of mass and emissions – aggregate all material input across all assessments.

Based on an aggregated study of materials data from 51 recently constructed buildings in Ireland across all typologies, concrete by far made up the greatest mass used at 75% of all materials, representing 41% of CO_2e emissions in new construction (IGBC, 2022). Metals comprised only 7% of mass but 36% of emissions, and insulation, though with an insignificant mass, represented 6% of carbon emissions. The remaining materials comprised 17% of mass and carbon emissions, primarily from glass, brick, tiles, and gypsum[1].

Regenerative materials from the bioeconomy can replace a significant part of high-carbon structural and insulation elements in buildings and offer a way for the agriculture sector to enhance the value of output by making crops and their by-products available for construction materials (Stegmann, et al., 2020). This, in turn, could contribute to reducing GHG emissions from agriculture while providing sustainable jobs across the country.

Transitioning to the circular economy should significantly reduce waste but also contribute to reductions in embodied carbon. Zero-carbon steel is now possible using recycled steel and renewable energy (Halter, et al., 2023). One example is TATA Steel green steelmaking[2]. The clinker content of concrete can be reduced beyond the use of Ground Granulated Blast-furnace Slag (GGBS) by-product, for example, with the addition of recycled glass powder, non-activated cement recovered from recycled concrete using smart crushers (Muhedin & Ibrahim, 2023) and even biochar (Senadheera, et al., 2023), with recycled bauxite residue offering a means to low-carbon concrete polymers.

1. INDICATE carried out Life Cycle Assessments (LCAs) on 52 recently constructed buildings using standardised level(s) aligned national methodology developed through the Sustainable Energy Authority of Ireland (SEAI) funded UpfrontCO2e using standardised background data and assumptions.

2. For more information about TATA green steelmaking, is available on the following link: https://www.tatasteeluk.com/corporate/news/plans-approved-for-electric-arc-furnace

2.3 SUMMARY: ROADMAP KEY OBJECTIVES AND TARGETS

Value our existing building stock

- Prioritise reducing vacancy and dereliction, while increasing the vibrancy of our villages, towns, and cities.
- Retain and enhance the (economic, social and cultural) value of existing buildings and infrastructure.
- Intensify the use of existing homes, buildings and infrastructure.

2030 INTERIM TARGETS:

- Policies are implemented to tackle vacancy resulting in initial reduction of 10% .
- The underuse of buildings identified and strategies put in place to tackle vacancy.

2040 TARGETS:

- 50% - 75% reduction in underuse/ vacancy in the building stock achieved.

Plan for Resource Efficiency

- Strengthen guidance within the planning system to enable resource-efficient and circular built environment neighbourhoods.
- Create a built environment that accommodates evolving needs (e.g. affordable life stage housing) optimising the occupancy of housing.
- Embrace a more efficient approach to design, delivery and operation practices through interconnected strategies, including compact growth, spatial efficiency, sufficiency, and sharing economy.

2030 INTERIM TARGETS:

- Resource efficient planning embedded in policy & development plans.
- Increased availability of affordable, alternative housing/tenure life stage appropriate options.

2040 TARGETS:

- Optimised infrastructure to development ratios achieved through good planning.
- All communities have access to a full range of affordable life stage appropriate housing ensuring better use of the housing stock.

Design for Circularity

- Embed circular design into all stages of building design
- Establish core principles to balance and reconcile trade-offs within project circularity strategies.
- Develop benchmarks and targets to measure and improve lean resource efficiency, waste reduction, and designing for adaptability, disassembly, and deconstruction.

2030 INTERIM TARGETS:

- Resource efficiency baselines established with target of 10-25% reduction below baseline for 2030.
- All larger projects > 5000sqm designed with Design for Adaptability / Deconstruction approaches.

2040 TARGETS:

- 100% buildings adopted Design for Adaptability / Deconstruction approaches.
- Improved resource efficiency by 40-50% over baseline.
- Optimised use of regenerative & biobased materials within viable capacity.

Close the Materials Loop

- Develop a bioeconomy strategy for construction, taking a holistic approach to developing timber and agri-crop supply chains and industries.
- Design, deliver and operate products and buildings adopting 'Waste Hierarchy' principles
- Prioritising Prevention and Preparing for Reuse
- Adopting innovative Recycling and Recovery approaches
- Disposal - only when absolutely necessary
- Support and co-develop both demand and robust supply chains to transition to more efficient use, reuse and repurposing of materials (regenerative/low-carbon).

2030 INTERIM TARGETS:

- Minimum targets in place for bio-based materials.
- Supply chains established for a variety of agri-based materials.
- GPP targets set for 15% recycled material use within buildings.

2040 TARGETS:

- 100% materials from deconstruction reused/recycled.
- 100% of materials from / or can enter non-toxic closed loop supply chains.
- Optimised use of regenerative & biobased materials within viable capacity.

Change the Business Model

- Establish Extended Producer Responsibility (EPR) schemes for construction materials, to reduce levels of construction and demolition waste, and capture materials for reuse.
- Incentivise producers to switch to Product as a Service (PaaS) where appropriate to retain ownership and control of products.
- Sharing measurable indicators, providing a common language between the procurer and supply chain, enabling the setting and achievement of ambitious targets.

2030 INTERIM TARGETS:

- Extended Producer Responsibility schemes in place for a variety of construction materials.
- PaaS models becoming available and supported by government and industry.

2040 TARGETS:

- All materials within Extended Producer Responsibility (EPR) schemes.
- Product as a Service widely used.

Enable the Circular Transition

- Ensure agile planning, regulatory and certification systems that facilitates innovation whilst ensuring safety and compliance.
- Facilitate procurement practices to act as a driver and enabler of a circular innovation ecosystem supporting contracting authorities, suppliers and contractors.
- Support all in the value chain, including procurers, design professionals, contractors, and building operatives, to upskill and share learnings regarding circularity solutions.
- Invest in activating private sector investment within the circular economy transition for the construction industry.
- Support digital solutions which enable value traceability of components and materials, facilitating adaptation, repair, deconstruction, and reuse.

2030 INTERIM TARGETS:

- Changes in the planning, regulatory and certification system start to facilitate greater integration of circularity.
- Procurement processes starting to be a driver of circular innovation systems.
- All in the construction industry have already started upskilling in circular solutions.
- Government and industry have started to invest in the transition to circularity.
- Digital solutions starting to enable traceability of components and materials, facilitating adaptation, repair, deconstruction and reuse.

2040 TARGETS:

- All above achieved

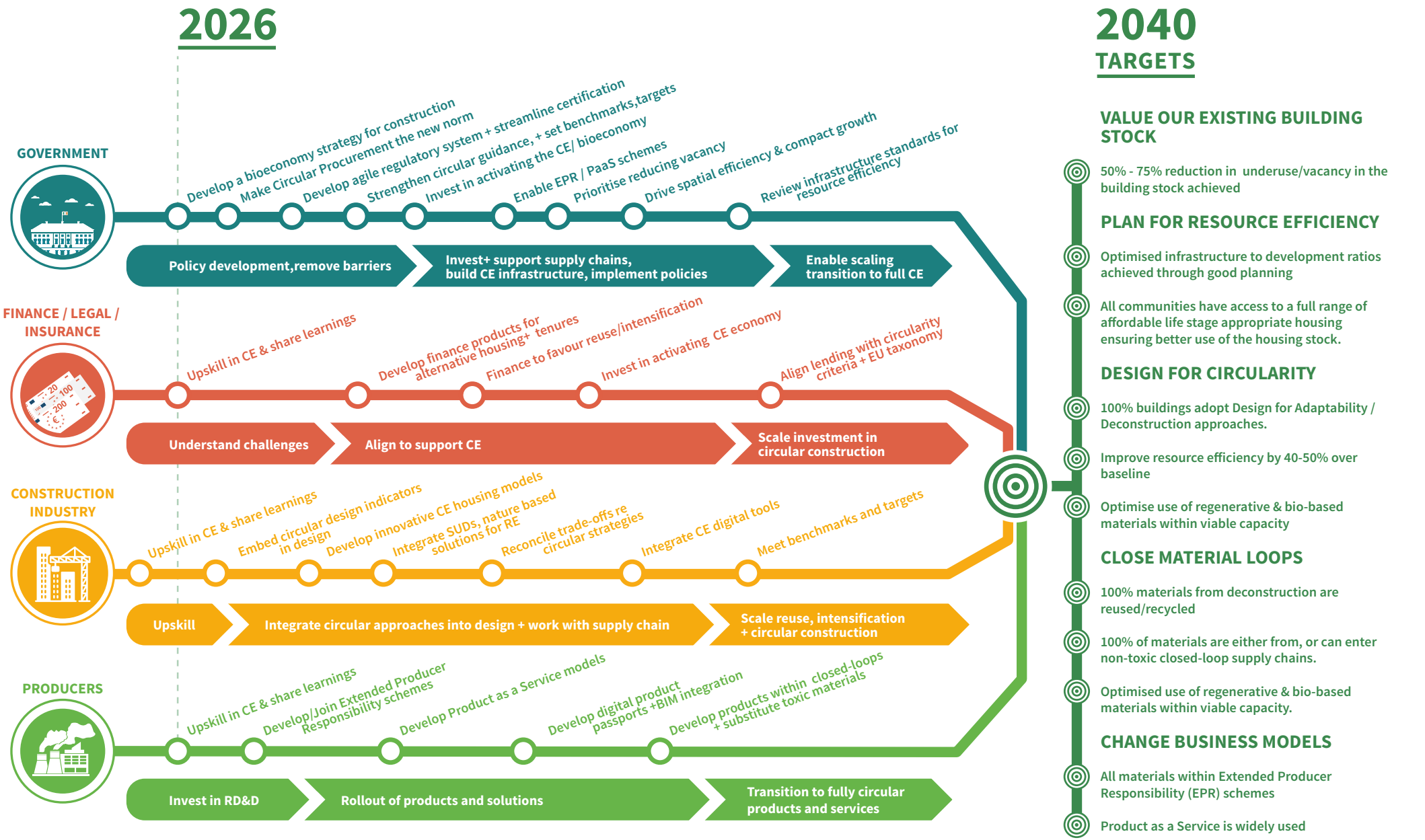

Figure 5: Building a Circular Ireland Roadmap 2040.

3. DEFINITIONS & KEY CONCEPTS

Circular Built Environment

The Circular Economy for construction and the built environment means reusing materials and building parts for as long as possible, using renewable materials and energy, allowing natural systems to regenerate, as well as designing out and minimising waste (Government of Ireland, 2023). Technology, innovation, and new business models can facilitate the circular approach.

The roadmap uses two definitions. One defined by the European Commission (2024b) which prioritises efficient resource use throughout a building's life, aiming for minimal resource depletion and environmental impact: "Circular construction entails the creation, utilisation, and repurposing of buildings, construction elements, products, materials, spaces, and infrastructure, all while minimising the depletion of natural resources, environmental pollution, and negative impacts on ecosystems. Specifically, regarding buildings, a circular structure maximises resource utilisation and minimises waste across its entire lifespan. If a new construction is built, it should be designed for longevity, adaptability, and deconstruction".

The second definition used in the roadmap was developed by the World Green Building Council (WorldGBC) (2023): "A circular building optimises the use of resources whilst minimising waste throughout its whole lifecycle. The building's design, operation and deconstruction maximise value over time, using:

- Durable products and services made of secondary, non-toxic, sustainably sourced, renewable, reusable or recyclable materials.
- Space efficiency over time through shared occupancy, flexibility and adaptability.
- Longevity, resilience, durability, easy maintenance and reparability.
- Disassembly, reuse or recycling of embedded material, components and systems.
- Life Cycle Assessment (LCA), Life Cycle Cost (LCC), and readily available digital information (such as building material passports).

Circular Business Models

Circular business models aim to make companies and their operations more sustainable and resource-efficient by ensuring slow and closed resource flows. Examples of circular business models include PaaS, EPR, and the Sharing Economy. Circular business models belong to the Prevention step of the Waste Hierarchy and need to integrate circular design strategies, governance, and appropriate regulations to work effectively (World Economic Forum, 2022).

Circular Design processes and procurement

Circularity should be integrated into all the stages of construction projects, from the design, planning, and tendering to the construction and maintenance phases (World Economic Forum, 2022).

Circular Indicators

Circularity indicators are metrics used to assess and measure the extent to which a product, company, or economy operates within a circular economy framework. They serve to evaluate how effectively resources are utilised, reused, and recycled, thereby minimising waste and environmental impact (Ellen MacArthur Foundation, 2024).

Circular Products

Circular products are durable products made of secondary, non-toxic, sustainably sourced, renewable, reusable, or recyclable materials.

Construction Products Regulation (CPR)

CPR sets out standardised rules for marketing construction products across the European Union (EU). The most recent regulation, (EU) 2024/3110, was adopted on November 27, 2024, superseding the former regulation (EU) No 305/2011. Its purpose is to establish a unified technical framework for evaluating the performance of construction products, ensuring they uphold essential standards for safety and sustainability (European Union, 2024b).

Circular Renovation & Retrofit

Circular Renovation and Retrofit are based on a few key principles:

- Minimise or prevent additional resource use by designing, using, and renovating buildings so that as little new material as possible is required.
- Utilise what is available, ensuring that buildings, components, products, and materials remain in use for as long as possible in one or more cycles.
- Use reusable building materials, which are recyclable or biodegradable (The Amsterdam Institute).

Demolition

In a circular economy, demolition means taking apart buildings or structures to maximise the recovery, reuse, and recycling of materials instead of merely throwing them away as waste. This method, often called selective demolition or deconstruction, is crucial for minimising environmental effects and conserving resources (Fahy, et al., 2024).

Digital Product Passport (DPP)

The DPP aims to bridge the gap between consumer demands for transparency and the lack of reliable product data. It will include a unique product identifier, compliance documentation, and information on substances of concern (European Union, 2024b). Additionally, it will offer user manuals, safety instructions, and disposal guidance. By providing a digital record of a product's lifecycle, the DPP enhances supply chain management, ensures regulatory compliance, and helps companies address risks related to authenticity and environmental impact. This initiative, part of the Ecodesign for Sustainable Products Regulation[3], seeks to improve transparency across product value chains by delivering comprehensive information on each product's origin, materials, environmental impact, and disposal recommendations (European Union, 2024a).

Design for Adaptability (DfA)

DfA enables buildings and components to extend their lifespan by adapting to changing conditions and occupant needs. DfA allows minimal disruption during modifications, reducing carbon emissions and waste while preserving economic and cultural value (Ottenhaus, et al., 2024).

Design for Deconstruction (DfD)

DfD facilitates the deconstruction and recycling of components for the responsible end-of-life management of construction products. DfD is fundamental to many circularity concepts, including maintenance, repair, adaptation, relocation, reconfiguration, 'building as material banks', and reuse. In buildings, DfD is typically supported by reversible connections (Ottenhaus, et al., 2024).

Design for Manufacture and Assembly (DfMA)

The Royal Institute of Architects of Ireland describe DfMA as " A term originating from the world of manufacturing, where it emphasises two practical design considerations – how a component is manufactured, and how it will be assembled into a product – that together have the potential to improve the efficiency of production" (RIAI, 2022).

Extended Producer Responsibility (EPR)

EPR is an environmental policy approach designed to uphold the "Polluter Pays" principle by incorporating the environmental costs of a product throughout its entire life cycle. This system shifts the burden of waste management from public authorities to the producers themselves (BPIE, 2024).

The core concept is that understanding your ongoing responsibility for market products leads to more thoughtful introductions. This means designing products to be durable, reducing the need for replacement, ensuring they are circular and able to be deconstructed, remoulded, or pulped for reuse as raw materials in future products. In addition to making them safe for retrieval, reuse, while optimising production for greater business opportunities.

Material Passports (MP)

A Material Passport is a digital record that provides information about product materials. It includes various information components, such as life-cycle data and CE-related product specifics (Van Capelleveen, et al., 2023). Typically, Passports consist of detailed data that outlines the unique properties of materials in products, facilitating the identification of recovery, recycling, and reuse values (Van Capelleveen, et al., 2023).

Product as a Service (PaaS)

Paas represents an innovative business model that challenges the traditional approach of one-time sales for physical items. By extending the usage phase of a product, it enhances its utility and value, boosts lifetime revenue, improves resource efficiency, and minimises waste (KPMG, 2024). This model transitions from traditional ownership to a service-focused approach, highlighting access over ownership and assigning responsibility to manufacturers (NikKhah, 2024). PaaS business models emphasise asset utilisation, which measures the efficiency of a product in generating revenue. Increased customer usage leads to higher utilisation and reduced unit costs. By renting, leasing, or granting access to a fixed asset to multiple customers throughout its lifecycle, a PaaS model enhances asset value and use, compared to selling it to a single customer who may not fully utilise it (KPMG, 2024).

Sharing Economy

The sharing economy is known by a number of other terms, such as collaborative consumption or collaborative economy. In the European Commission's communication to the European Parliament (European Commission, 2015), the document refers to business models in which activities are facilitated by collaborative platforms that create an open marketplace for the temporary usage of goods or services, often provided by private individuals.

The sharing economy encompasses diverse organisational models that transform marketplaces and urban landscapes, where goods, services, skills, and spaces are shared or exchanged (Mont, et al., 2020). At the same time, collaborative economy transactions generally do not involve a change of ownership and can be carried out for profit or not for profit.

Waste Hierarchy

The EU Waste Framework Directive (9), established in 1975, presents a hierarchy for waste management options based on their environmental impact. It emphasises the importance of prevention, urging prioritisation of reuse and recycling above recovery and disposal (European Union, 2008) . This hierarchy will be elaborated in Section 7 of this document.

4. VALUE OUR EXISTING BUILDING STOCK

KEY RECOMMENDATIONS

Prioritise reducing vacancy and dereliction, while increasing the vibrancy of our villages, towns, and cities.

Retain and enhance the (economic, social and cultural) value of existing buildings and infrastructure.

Intensify the use of existing buildings and infrastructure.

Achieving carbon neutrality requires both building more efficiently and valuing existing buildings, as significant amounts of resources were needed to build these buildings. Embracing circularity in existing buildings not only enhances their economic value but also contributes significantly to environmental sustainability and social well-being. The greenest building is often the one that already exists.

The concept of circularity in existing buildings focuses on maximising their value through reuse, upgrade, and intensification of use rather than demolishing and building new. These sustainable practices can mitigate resource depletion and environmental pollution while boosting overall asset worth (DGBC, 2021). This approach also presents a valuable opportunity to rejuvenate urban and rural areas and improve living conditions, and can play a crucial role in addressing the housing crisis. In simple terms, investing in adaptive reuse, optimisation, addressing underuse and supporting intensification of use of existing buildings can be the most cost- and carbon-efficient method to deliver the homes and infrastructure we need.

This section outlines various interconnected strategies and actions aimed at enhancing the Value of our Existing Building Stock and it is structured around the following core issues:

- **Reduce Vacancy**
- **Support Adaptive Reuse**
- **Address Underuse and Support Intensification of Use**

4.1 REDUCE VACANCY

Vacancy can lead to the deterioration and neglect of local areas, resulting in social and environmental challenges such as homelessness, neighbourhood decline, and vandalism (Citizens Information, 2023). Nevertheless, preserving and making the best use of the existing building stock can contribute significantly to climate change mitigation and address other environmental challenges, such as resource overconsumption and associated impacts on nature.

The most recent census in Ireland indicated that 7.74% of the housing stock—equivalent to 163,433 residential units—was vacant in 2022. Notably, over 48,000 of these units had been unoccupied for six years or more (CSO, 2024). In addition, according to the Geo-directory, 29,241 commercial units were vacant. Although the data is imperfect, the Collaborative Town Centre Health Check (CTCHC) (2020), highlights that the ground-floor commercial vacancy rate in towns in Ireland is 18 - 31%—the normal target at a European level is 5%. The upper floors in towns are at c. 80% vacancy—both these levels are unheard of in a European context. These statistics highlight significant opportunities within the market for potential tenants and investors. Despite various national and local policies seeking to address vacancy, this issue continues to hinder urban revitalisation efforts.

The circular building concept offers innovative solutions to address vacancy in urban environments by promoting the reuse, refurbishment, and repurposing of existing structures (wbcsd, 2021).

4.2 SUPPORT ADAPTIVE REUSE

Adaptive reuse is the process of repairing and restoring existing spaces for new or continued use (Plevoets & Van Cleempoel, 2019). This practice is similar to concepts such as retrofitting, refurbishing, and renovating, which involve updating a structure to accommodate different functions while considering usability and design solutions (Conejos, et al., 2012).

Using adaptive reuse and retrofitting as strategies to decarbonise the built environment can significantly contribute to the creation of low-carbon villages, towns and cities. These strategies reduce the need for new construction and improve energy efficiency, hence lowering GHG emissions from the built environment (Conejos, et al., 2016). Furthermore, they align with the principles of a circular economy, such as effective material use, minimising construction waste, and conserving resources (Fufa , et al., 2021). The results of the INDICATE project[4] showed that retrofitted buildings have lower global warming potential across their life cycle, even accounting for higher operational carbon versus new build.

The adaptive reuse of vacant buildings plays a crucial role in urban revitalisation efforts. For instance, older commercial buildings which are no longer suitable as office space can be converted into affordable housing units, while abandoned transportation infrastructure, such as old train stations or railway lines, can be transformed into parks, cycle greenways, public markets, or libraries. Adaptive reuse can enhance the vitality of surrounding areas and improve the quality of life in local communities (Vardopoulos, 2022). Additionally, this approach fosters a balanced integration of financial investment, environmental sustainability, cultural heritage preservation, urban regeneration, and social benefits (Vardopoulos, 2022). For example, in Copenhagen, Denmark, the architectural firm COBE has revitalised an industrial area into residential units. (See case study below).

4.3 ADDRESS UNDERUSE AND SUPPORT INTENSIFICATION OF USE

Underuse can be defined as “the condition wherein available resources, properties, or infrastructure are not maximally utilised. This issue can present itself in several forms, such as unoccupied buildings, inadequately utilised commercial areas, and suboptimal land usage”. (European Parliament, 2025). Tackling underuse is crucial for enhancing sustainability and resource efficiency. Rehabilitating underused properties can also stimulate local economies by attracting businesses and residents, thus revitalising communities. This can lead to increased economic activity and job creation (Mcquinn, et al., 2024).

4. More Information about the INDICATE project on the following link: https://www.indicatedata.com/indicate#Results%20and%20findings%20from%20INDICATE

Case Study: The Silo

APARTMENTS REFURBISHMENT PROJECT, COPENHAGEN, DENMARK.

The Silo is an integral part of the transformation taking place in Copenhagen's Nordhavn (North Harbour), a sprawling post-industrial redevelopment that is evolving into a vibrant new city district. Designed by the Danish architecture firm COBE, in collaboration with clients Klaus Kastbjerg and NRE Denmark. The original silo exhibited vast spatial variation due to its multiple functions for storing and managing grain. This 17-storey former grain silo, the largest industrial building in the vicinity, has now been repurposed as "The Silo," which features 39 residential apartments, both single and multi-level, varying in size from 73 m^2 to 305 m^2 and featuring floor heights reaching up to 7 meters. Public access on both the upper and lower levels guarantees a multi-dimensional experience for the building's diverse users.

To modernise The Silo's industrial concrete facade, the exterior has been reclad, while the interior remains largely untouched and raw. The intention was to revitalise the building from the inside out, allowing the new residents and the surrounding urban environment to emphasise the building's identity and historical significance.

The whole case study can be viewed on the following link:

https://www.cobe.dk/projects/the-silo

Figure 6: On the left side is a photograph of the 'pre-renovation' industrial area, and on the right side is a photograph of the current state with the apartments' transformation (Hjortshøj, n.d.).

The intensification of use involves increasing the occupancy or utilisation rates of existing spaces or resources. This can include converting commercial spaces into residential units or repurposing buildings for mixed-use developments. (Mcquinn, et al., 2024). It can involve intensifying the use of our existing building stock by subdividing units as well as extending vertically or laterally on the site to optimise infrastructure.

67% of people in Ireland and 88% of those over 65 live in under-occupied homes, double the European average and the third highest in Europe (Mcquinn, et al., 2024). With the decline in family size, many larger dwellings, particularly those built since 2000, could potentially be subdivided to create thousands of additional residential units. There is also potential to use the existing infrastructure, drainage, sewage treatment, roads, and lighting to build more units within the curtilage of existing homes. Likewise, vertical extensions to existing buildings to add office space and homes could increase the density and vibrancy of our urban settlements.

Schools with short opening hours and long holiday closure periods could facilitate alternative uses at different times[5]. Underutilised office spaces could facilitate the use of meeting rooms, catering, gyms, or other facilities.

5. A good example is the new University of Amsterdam was designed to be used as a cinema theatre in the evenings and weekends, or the City of Paris, which has opened 42 school playgrounds to the public at weekends as a new public amenity.

Case Study: Ava Housing – Intensification of Use

Ava Housing Company Limited by Guarantee ("Ava Housing") is a not-for-profit organisation supports older homeowners living alone in family sized homes to retrofit their houses, creating an independent living unit at garden level and a single occupancy rental unit at 1st floor. It allows older people to share their homes, but retain independence and privacy, with separate living rooms, kitchens and bathrooms on each floor.

It takes a very common and often under occupied typology in Ireland, a 3 bed semi detached homes to create two living units addressing many social objectives. It enables older people to live in their homes and communities and it reduces the need for more costly forms of care, reducing social isolation, and making better use of existing homes.

In December 2018, the retrofit of the first demonstrator house in Clondalkin, South County Dublin was completed.

https://www.avahousing.ie/case-studies/

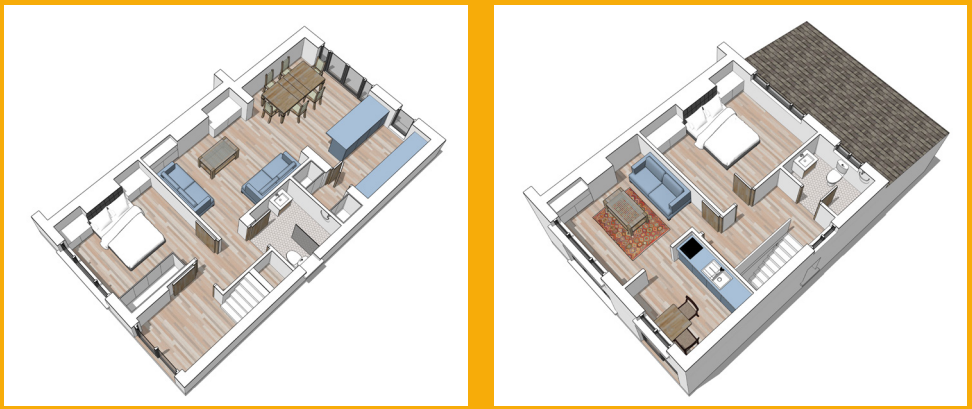

Figure 7: 3D model of the Ava Housing indicative strategy: Modified ground floor and first floor with additions and modifications.

4.4 VALUE OUR EXISTING BUILDING STOCK ACTIONS

4.4.1 2026 - 2030

Government

G1. **Provide sufficient funding to allow for the immediate creation of separate directorates with multi-disciplinary vacant building and adaptative re-use teams across all local authorities**. Empower these directorates with the authority and resources to drive public acquisition and development of vacant and derelict buildings and assist private sector in developing private residences from vacant premises taking a city, town, and village centres first approach.

G2. **Update the Vacant Property Refurbishment Grant (to fully support the city, town, and village centres' first approach) by:**

- **G2.1.** Basing the total amount of grants provided on the number of residential units brought back into use (as opposed to one grant per building), using MPRN numbers.
- **G2.2.** Ensure the grant is made available for mixed-use properties located in these areas.
- **G2.3.** Extend the eligibility criteria to Small and Medium Enterprises (SMEs) (limited companies) instead of individuals. Many owners of "above the shop" premises have retail businesses on the ground floor that are in the form of limited companies.
- **G2.4.** Expand the "Expertise Grants" (available to advise owners bringing vacant traditional or protected houses back into use) to include a feasibility study for unprotected structure, giving flexibility to vacant building and adaptative re-use local authorities teams (G1) to top-up this grant by up to €2.5k per units based on the complexity of the project/level of dereliction.

G3. Introduce a 5-year exemption for owners from capital gains tax (CGT) on the sale of any vacant premises located in these areas for residential use (based on residential use or planning permission for residential use).

G4. Replace the Vacant Homes Tax with a Vacant Property Tax, gradually increasing it over a 3-year period to support a better use of all vacant premises taking a city, town and village centres first approach.

G5. Establish bold, progressive programmes at scale that align with EU standards to identify and cluster projects at the district level using a village, town and city centres first approach. These should be led by the newly established multidisciplinary vacant building and adaptive reuse teams (G1).

G6. As part of the activities of the new directorate (G1) establish pilot "Information Hub" models to enhance support for property re-use and intensification of use. For example, pilot high-street pop-up shops to promote these actions (as already done in Limerick), or organize community-led information events to engage local stakeholders

G7. Leverage these structures to raise awareness about the importance of better using our existing building stock while sharing best practices, lessons learned and success stories.

G8. Set up a cross-departmental working group to ensure policies, regulations and financial incentives are fully aligned to make adaptation, reuse and intensification of use of existing buildings easier.

G9. **Review planning policies and processes, as well as building regulations and Technical Guidance Documents (TGDs) to better support reuse, adaptive reuse, and intensification of use over demolition and new construction.** Upward extension of low-density housing could, for instance, be supported by removing planning restrictions on subdivision and upwards extension, allowing the doubling of the density of some suburban areas with no increase in infrastructure provision.

G10. **Invest in developing a national, standardised, high-quality, dynamic, open-source database and map of Ireland's existing building stock to get an accurate and up-to-date picture of the number, location, and type of potential homes available, including through intensification of use and adaptive reuse. Repurposing vacant and underused buildings is a low-hanging fruit that begins with identifying available floor area suitable for use.**

G11. Use G9&10 to properly assess what additional space and building types may be needed[6].

G12. Ensure that all policies, programmes and projects introduced are subject to robust pre and post implementation evaluations and that any evaluations are published on a Government Evaluation Portal to ensure transparency and value for money. This would also facilitate access to European funding for regeneration.

G13. Support the development and delivery of industry-wide Continuing Professional Developments (CPDs) to address the perceptions of risk associated with the reuse and intensification of use of many premises located in village, town and city centres. Topics to include conservation, fire safety and disability access.

G14. Develop guidance and standards for the subdivision of larger homes, offering grant support for each unit created for residential use and linking it to existing SEAI schemes for energy renovation[7].

G15. To lead by example in climate action, resource efficiency and optimising building use, develop an office scheduling protocol and portal to optimise public sector office space use, and share key learning with the private sector.

G16. *Introduce annual targets on the number of residential units to be delivered through adaptive reuse and intensification of use to further prioritise a better use of our existing building stock.*

G17. *Review and adjust policies, regulations, and financial incentives to ensure they fully support reuse, adaptive reuse, and intensification of use, taking a village, town and city centres-first approach.*

G18. *Facilitate the European Investment Bank's (EIB) investment in Ireland by ensuring that any new national energy efficiency, housing, or planning plans embrace the key tenets of the European Green Deal and the New European Bauhaus.*

Construction Sector

C1. Orientate the construction sector towards renovation and adaptive reuse solutions, skills and experience.

C2. Upskill in renovation and adaptive reuse across differing building typologies.

C3. Advocate for policies and incentives that support renovation, intensification of use, and adaptive reuse as key strategies to deliver the homes and infrastructure within a short time frame, in a cost and carbon-effective way.

C4. Extend the duration of use of existing buildings through maintenance and renovation.

C5. Support the extension of the service life of buildings, either by facilitating the continuation of their intended use or through changes in use, with a focus on replacement and refurbishment.

C6. *Keep developing business models to reorient the industry towards renovation, adaptive reuse and intensification of use.*

C7. *Designers to integrate reused structures and components as a standard in their design.*

Producers & Solution providers

P1. Invest, research, and develop specific solutions suitable for renovation, adaptive reuse and intensification of use, considering issues such as non-standard dimensions, hygrothermal performance, tolerances, structural loadings, and fire safety.

P2. *Continue to develop specific solutions for renovation, adaptive reuse, and use intensification.*

P3. *Have a strategy in place for the reuse of building components.*

6. The trend of smaller households is likely to continue and get closer to the EU average over the next few years. The fertility rate in Ireland has already dropped from 2.05 in 2010 to 1.6 in 2020. Therefore, the mix of home sizes needs to be re-evaluated with a sufficiency of 3- and 4-bedroom homes likely already within the existing stock.

7. In Baden-Württemberg, the "Turn Old into Two or More" consulting bonus offers property owners guidance on subdividing large single-family homes into multiple units. In the Netherlands, it is estimated that up to 500,000 homes could be created using this approach. More information on the following link: https://www.blgwonen.nl/over-ons/nieuws/woningsplitsing-kan-half-miljoen-extra-woningen-opleveren.html

Finance, Legal, and Insurance

F1. Educate staff on sustainable buildings, encompassing carbon literacy and resource efficiency, to ensure the significance of optimally utilising the existing stock is fully comprehended.

F2. Ensure that lending mechanisms fully support reuse, adaptive reuse and intensification of use of existing buildings.

F3. Financial institutions act on the changes to the Sustainable Finance Disclosure Regulation (SFDR) regarding the new category of 'transition investments' to enable 'brown to green' investments to address the previous issue in Art. 8 and 9 of disincentivising financing improvements in existing property assets[8].

F4. Insurers review their policies to better support the intensification of use. For example, to make office spaces or schools available to community groups outside opening hours, as done in Paris[9].

F5. *Deliver innovative finance mechanisms to ensure more vacant mixed-use buildings can be brought into use.*

F6. *Keep reviewing lending policies to ensure they primarily support reuse, adaptive reuse, and intensification of use.*

Educators & Awareness Raisers

E&A1. Construction bodies: Support the development and delivery of industry-wide CPDs highlighting solutions to and addressing perceptions of risk associated with reuse, adaptive reuse, and intensification of use of buildings. Topics to be covered include conservation, fire safety, and accessibility.

E&A2. Construction bodies: Engage with third-level institutions to ensure that the curriculum for their future members aligns with these objectives.

E&A3. Media/Influencers: Run large-scale awareness-raising campaigns to ensure all citizens understand the benefits and importance of using our existing stock better.

E&A4. Update the local authority and public sector's climate training programme (making it available to councillors) to cover the importance of better using the existing building stock to address carbon emissions and deliver the homes and infrastructure we need.

E&A5. Universities and training institutions to develop courses on adaptive reuse, renovation, and intensification of use.

E&A6. *Researchers and Global Warming Potential (GWP) Life Cycle Assessment (LCA) experts to investigate and develop a guidance document with the most suitable materials and steps for renovation.*

E&A7. *Construction and built environment degrees, CPDs, and apprenticeships are reviewed regularly to ensure curricula and modes of delivery keep pace with technology development, market and societal needs.*

4.5 VALUE OUR EXISTING BUILDING STOCK 2030 INTERIM TARGETS

- Policies are implemented to tackle vacancy, resulting in an initial reduction of 10%.
- Underuse of buildings identified and strategies put in place to tackle vacancy.

4.6 VALUE OUR EXISTING BUILDING STOCK 2040 TARGETS

- 50%-75 % reduction in underuse/vacancy in the building stock achieved.

8. More information about Articles 8 and 9 on the following link: https://www.irishfunds.ie/policy-regulation/eu-regulation/sustainable-finance-regulation/

9. More information about the intensification of use in Paris on the following link: https://www.paris.fr/pages/creches-cours-d-ecoles-et-de-colleges-ouvrent-aux-familles-le-samedi-17940

5. PLAN FOR RESOURCE EFFICIENCY

KEY RECOMMENDATIONS

Strengthen guidance within the planning system to enable resource-efficient and circular built environment neighbourhoods.

Create a built environment that accommodates evolving needs (e.g. affordable life stage housing) optimising the occupancy of housing.

Embrace a more efficient approach to design, delivery and operation practices through interconnected strategies, including compact growth, spatial efficiency, sufficiency, and sharing economy.

This Plan for Resource Efficiency section examines key strategies to enhance urban sustainability and housing efficiency in Ireland, focusing on compact growth, spatial sufficiency, and the evolving sharing economy. It draws upon recent research and policy developments to highlight the environmental, social, and economic advantages of higher-density development, optimised housing stock use, and innovative tenure models. By evaluating carbon impacts, resource use, and emerging collaborative housing solutions, the roadmap outlines a comprehensive approach to addressing Ireland's housing and climate challenges within planetary boundaries.

The aim of this section is to create a built environment that can easily accommodate evolving needs and contribute to reducing overall waste generation by keeping materials and components in the market longer. This section outlines various interconnected strategies and actions to Plan for Resource Efficiency, and it is structured around the following:

- **Address Compact Urban Growth** ensures **efficiency of infrastructure** required to serve buildings and homes, such as the length of road per building, length of piping, external lighting and manholes. This can be further supported by **shared mobility** (e.g. public transport and car sharing), which reduces the resources needed to provide parking, paving, associated flood attenuation, and road infrastructure associated with individual mobility.
- **Promote Spatial Efficiency and Sufficiency** reduces suboptimal use of space and material by ensuring efficient building design, right-sizing of homes, leaner design, and integrating a better mix of buildings and homes in every community, as well as tenure models that facilitate transition at different life stages.
- **Support Sharing Economy** is a socio-economic model where individuals engage in creating, distributing, and consuming goods and services via digital platforms.

5.1 ADDRESS COMPACT URBAN GROWTH

Compact growth is key to increasing resource efficiency (OECD, 2022). In Ireland, the Viable Homes[10] project, which calculated the different carbon impacts on infrastructure per various housing typologies, showed that greenfield sites required 32% more embodied carbon than brownfield sites due to the additional infrastructure of roads, car parking, landscaping, water infrastructure, lighting, and attenuation tanks (Brady, et al., 2024). This was less for denser typologies such as duplexes and apartments. Figure 8 illustrates the percentage of additional embodied carbon due to landscaping and infrastructure per typology, which presents a big difference between semi-detached houses and apartment buildings.

The research found that details of standard road design and water infrastructure contribute significantly to embodied carbon and resource use. For instance, separate manholes for each dwelling, excessive car parking requirements, and over-engineered roads increase material use.

Simple changes to typologies, such as eliminating detached and semi-detached houses in schemes in favour of denser terraces and duplexes and reducing the number of en-suites, could result in less cost and resources used. Through structured interviews with housing developers, it was confirmed that it was more profitable to build less dense homes, as they commanded higher prices that outweighed the additional cost in materials and land (Brady, et al., 2024).

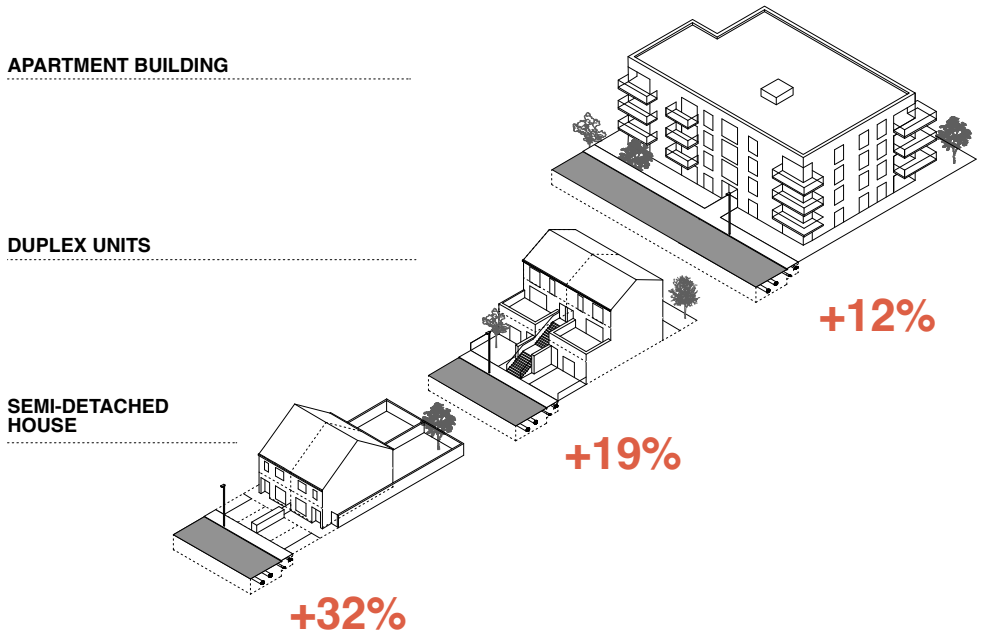

Figure 8: Additional embodied carbon due to landscaping and infrastructure per typology (Brady, et al., 2024).

5.2 PROMOTE SPATIAL EFFICIENCY AND SUFFICIENCY

Spatial efficiency is critical to staying within the planetary ecological boundaries with a growing population. It is the most cost-effective way to address building and transport emissions and the resource and biodiversity crises.

At the national level, it requires a full review of the existing stock to evaluate what is available for use and where, and to assess what additional space and building types may be needed. In Ireland, the trend of smaller households in is likely to converge towards the EU average over the next few years. The mix of home sizes needs to be re-evaluated, with a sufficiency of 3- and 4-bedroom homes likely already within the existing stock (Mcquinn, et al., 2024). Integration of 1- and 2-bedroom homes into neighbourhoods could enable downsizing, freeing up family homes for those who need them. The transition to more compact forms of development, such as apartments and terraced homes, would allow more homes to be built for less cost in manpower, materials, operational energy, and carbon emissions.

Sufficiency can tackle the demand for energy and resources by avoiding the need for materials and goods. Cabeza et al., (2022), define sufficiency policies as: "*a set of measures and daily practices that avoid the demand for energy, materials, land,*

10. More information about the Viable Homes project on the following link: https://www.igbc.ie/resources/viable-homes-v1

Case Study 1: Faelleby urban village, Copenhagen

MINIMISING HARD SURFACES (HENNING LARSEN, 2018)

Faelledby will provide a new residential all-timber quarter for 7,000 occupants when complete, with a density of approximately 140 units per hectare. What is unique about the urban design is the minimisation of hard surfaces - bringing nature to within 2 minutes of every home, minimising vehicular roads and road widths, and providing no dedicated car parking spaces for dwellings. Biodiversity corridors are also maximised through the scheme.

Figure 9: Henning Larson (2018)

and water while delivering human well-being for all within planetary boundaries". According to the Prioritising Existing Buildings for People and Climate report (BPIE, 2024), applying sufficiency measures to the European building stock would result not only in a significant 16% reduction of GHG emissions compared to past EU trends but also a significant 61% decline in demand for renewable resources and a 9% decrease in demand for non-renewable resources.

Sufficiency policies can take various forms, from better using our existing stock (e.g. by tackling vacancy and dereliction) to intensifying use (e.g. using schools at weekends and during school holidays)[11] and right-sizing homes by offering a greater variety of housing options. Based on an analysis of Central Statistics Office (CSO) data in 2023, the average size of homes completed in Ireland was 118 sqm, despite an average household size of only 2.7 persons. The data regarding household size is possibly inflated by the challenges to new household formation due to limited availability of housing (CSO, 2023). The new home size had declined due to the increase in apartment construction from 2011, when single detached homes formed the majority of completions. Table 2 shows the average size of new homes vs average household size in Ireland. Compared against CSO data, the average home is 25% greater than the average requirement (CSO, 2023). This is despite the fact that 67% of existing homes are underoccupied (Mcquinn, et al., 2024). Nevertheless, new housing completions remain unaligned with the mix of household types, tending to cater more for the family formation stage, offering a limited choice in tenure, type, size and affordability for other life stages.

The Housing for All report commits under Housing Policy Objective 20, making more efficient use of the housing stock, proposes to: Develop a national policy on rightsizing and explore options to support and incentivise rightsizing on a voluntary basis (Government of Ireland, 2021).

Average size new home completed 2023	Average household size in Ireland
118m²	2.7
Average scheme home 117m²	

Underoccupancy of existing housing stock

67%

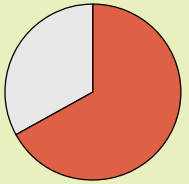

Table 2: Average size of new homes built in 2023 vs Average household size (Ireland) (CSO, 2023).

11. See the Value our existing building stock for further information on this topic.

5.3 SUPPORT SHARING ECONOMY

The terms Sharing Economy and Collaborative Economy are often used interchangeably, but they have subtle distinctions. The Sharing Economy is a socio-economic model where individuals engage in creating, distributing, and consuming goods and services via digital platforms (Minami, et al., 2021). This promotes smaller homes with shared amenities and reduces personal vehicle reliance through initiatives like car-sharing. In contrast, the Collaborative Economy is a broader marketplace where consumers rely on each other rather than corporations, usually via a digital intermediary (Minami, et al., 2021). Examples include co-working spaces, co-housing, Airbnb, car-sharing, and peer-to-peer financing for construction projects such as Property Bridges[12]. Both models are transforming traditional markets by emphasising access, flexibility, and resource efficiency.

However, the growth in the sharing economy means platforms such as Airbnb and Uber can compete directly with existing services, leading to negative side effects on housing and employee protection, so this needs to be considered carefully in the development of new sharing models. Co-living was effectively banned in Ireland in 2020 because profitability was seen as driving up the cost of sites and, hence, having a negative impact on the affordability of other housing types. The development of Government guidance could enable it as a quality affordable housing option rather than a vehicle for profit maximisation, particularly if built by Local Authorities and approved housing bodies on a cost-rental basis, within high quality design guidelines.

There are a number of alternative models to the current limited Irish models of housing tenure, which sit within the area of the sharing/collaborative economy. The Affordable Housing Act (2021) allows for local authorities to enter into alternative models of tenure, such as community-led housing, housing co-operatives and community land trusts beyond models currently being implemented, such as cost rental.

Co-operative housing balances security of tenure, equity and affordability to provide tenants from all income levels and life stages access to housing (Government of Ireland, 2021). These are common across Nordic countries, with 1.6 million people in Sweden alone living in housing cooperatives (Andersen, et al., 2014). These often include collectively managed shared spaces that foster a sense of community. The workshops to develop this roadmap highlighted cultural challenges to the model in Ireland and the fact that financial institutions offer only higher-cost commercial loans for this model (Government of Ireland, 2021).

Community Land Trusts (CLT), where land, often granted by local authorities, is held in trust by the community in perpetuity, can help to ensure long-term land and housing affordability. A pilot CLT was launched in January 2025 in Cork as part of a pilot project, including 5 European cities, and aims to bring vacant and derelict properties back into use (CCL, 2025). The Bristol Community Land Trust, Fishponds is an example of a CLT; a complete case study is below.

Case Study 2: Bristol Community Land Trust

FISHPONDS PROJECT

The Bristol Community Land Trust was initiated with the support of the local council and is structured as a Community Benefit Society, which local people can join for £1. It has a number of projects underway, including one completed at Fishponds for 12 homes.

The council provided the site at Fishponds for £1. It was developed as a partnership with the CLT, which enabled partial funding. The remainder of the funding was through a commercial loan supplemented by self-build contributions from the residents themselves.

Affordability at Fishponds Road is achieved through a partial equity/rental model. Residents purchase between 25% and 75% of the equity in their homes as a 99-year lease and pay rent on the unowned portion. Residents may incrementally purchase the remainder of the equity in their homes or sell the portion of equity they already own at a price controlled to reflect the relative affordability of their original purchase. The minimum period before a resident can sell on is five years to ensure residents have a genuine connection with the community. BCLT retains the site's freehold ownership.

The whole case study can be viewed on the following link: https://soa.ie/bristol-clt/

12. More information about the Property Bridges on the following link: https://www.propertybridges.com/

5.4 PLAN FOR RESOURCE EFFICIENCY ACTIONS

5.4.1 2026 - 2030

Government

G1. Government, as part of the review of the National Development Plan, to identify how resource efficiency should be integrated into the planning of national infrastructure and to provide detailed guidance for development plans by completing:

- **G1.1.** Detailed studies of resource use and carbon emissions associated with infrastructure for different development typologies, from dispersed to compact growth, identifying optimal strategies based on the work of the SEAI funded project, RE-CUGI[13] and the Construct Innovate funded project, Viable Homes[14].
- **G1.2.** Detailed quantitative study on the potential impact of water efficiency regulations or water pricing on current water infrastructure capacity, and for planning future water infrastructure.
- **G1.3.** Detailed quantitative study on the carbon and resource optimisation of road and car parking provision and layouts, and the impact of changes in policies in planning guidance.

G2. Review policy, spatial standards and planning guidance to Local Authorities (LAs) to ensure they plan for availability and optimum mix of housing typologies for every life stage, including co-living and household types in every community.

G3. Transport Infrastructure Ireland (TII), Uisce Eireann, Electricity Supply Board (ESG), LAs, and other infrastructure bodies immediately and jointly undertake a review of their standards, guidelines and specifications in line with a reduction in resource use and ensure resource efficiency in the coordination of activities in housing and other developments.

G4. Work with local authorities and financial Institutions in accordance with the Housing Act 2021 to launch pilot programs to test and demonstrate the viability of alternative community-led housing, CLTs, and Co-Op housing models in Ireland.

G5. Review spatial standards and consider how co-living could be reintroduced by providing guidance on quality, affordable shared amenities or enabling Approved Housing Bodies (AHBs) to maximise affordability.

G6. Deliver Housing Policy Objective 20: Make more efficient use of the existing housing stock, number 20.5: Develop a national policy on rightsizing and explore options to support and incentivise rightsizing on a voluntary basis, as outlined in the Housing for All report (2021). Review Limerick County's housing initiatives, particularly the rightsizing scheme, to understand the challenges faced in engaging with communities and share best practices across local authorities and community engagement agencies.

G7. *Implement policy and regulatory changes on sustainable mobility, planning and building regulations to take a more holistic approach and better support resource efficiency in the built environment.*

G8. *Continue to support behavioural change at the community level to drive the transition to the sharing economy.*

G9. *Start implementing the transition towards integrated digital 3-dimensional design-led planning based on an evidence-based detailed assessment of the local housing and service needs, and optimising infrastructure and resource efficiency.*

Construction Sector

C1. Explore resource-efficient development types through involvement with architects, urban planners, and developers, discussing actions to adopt efficient, space-saving design models and alternative living arrangements with shared amenities and services.

C2. Integrate resource efficiency measures in planning new developments, such as nature-based solutions and Sustainable Urban Drainage Systems (SuDS) for flood mitigation, realising co-benefits for biodiversity.

13. More information about the RE-CUGI project on the following link: https://www.igbc.ie/re-cugi

14. More information about the Viable Home project on the following link: https://www.igbc.ie/resources/viable-homes-v1

C3. *Continue to develop and share more innovative forms of development:*

- **C3.1.** *Greater levels of shared space use.*
- **C3.2.** *Greater levels of resource sharing, such as cars, tools, etc.*
- **C3.3.** *Pilot housing and space as a service models.*

Producers & Solution Providers

P1. Develop innovative digital and other solutions that facilitate the sharing economy.

P2. *Explore the potential to offer sharing space service solutions to investors and developers through innovative software, hardware, and modular construction.*

Financial, Legal, and Insurance

F1. Review current offerings to enable alternative forms of housing. For example, to allow cooperative housing to be financed by standard mortgages.

F2. Fully consider the future adaptability and flexibility of asset loans through offering discounted loans on buildings and homes certified under green schemes, taking these aspects into consideration, for example, the Home Performance Index (HPI) for residential developments.

F3. Law firms establish rights of surface or rights of leasehold so that customers do not assume economic ownership of the products and services, and providers can have access/rights for maintenance when needed.

F4. *Enable alternative forms of housing, such as cooperative housing, to be financed by standard mortgages.*

F5. *Provide green development loans/green mortgages aligned with the EU taxonomy's circularity criteria.*

F6. *Offer bridging finance to facilitate the rightsizing for homeowners/buyers.*

Education & Awareness Raisers

E&A1. Emphasise the benefits of compact living in reducing mortgage, utility, and maintenance costs thereby improving wellbeing and comfort.

E&A2. Implement fundamental changes to 3rd level qualifications for planners, similar to the Higher Education Authority 'HCI Building Change' program for architectural education, to orient around design-led 3-dimensional integrated planning for climate and circularity.

5.5 PLAN FOR RESOURCE EFFICIENCY 2030 INTERIM TARGETS

- Resource efficient planning embedded in policy & development plans.
- Increased availability of affordable, alternative housing/tenure life stage appropriate options.

5.6 PLAN FOR RESOURCE EFFICIENCY 2040 TARGETS

- Optimised infrastructure to development ratios achieved through good planning.
- All communities have access to a full range of affordable life stage appropriate housing ensuring better use of the housing stock.

Actions in italics to happen closer to 2030

6. DESIGN FOR CIRCULARITY

KEY RECOMMENDATIONS

Embed circular design into all stages of building design.

Establish core principles to balance and reconcile trade-offs within project circularity strategies.

Develop benchmarks and targets to measure and improve lean resource efficiency, waste reduction, and designing for adaptability and deconstruction.

As the built environment increasingly embraces sustainability, resource efficiency and circularity have become essential pillars of modern design. Emerging approaches such as Lean Design, Design for Adaptability (DfA), and Design for Deconstruction (DfD) play a critical role in minimising waste, optimising material use, and extending the life cycle of buildings. These strategies are driven by technological innovation, regulatory frameworks, and evolving industry standards that promote flexibility, reuse, and long-term environmental performance. By integrating lean principles with digital tools, and designing for future use and disassembly, the construction sector can significantly reduce carbon footprints while enhancing the functionality and resilience of the built environment

This section outlines various interconnected strategies and actions aimed at enhancing Design for Circularity, structured around the following issues:

- **Adopt Lean Design for Resource Efficiency** is key in addressing carbon emissions and waste at the building level. This means using less materials and energy by optimising building form factor, efficient structural design, and material use.
- **Design for Adaptability (DfA)** to extend a building's lifespan by making it possible to adapt the space with minimal disruption. This is key in reducing carbon emissions and waste and contributes to preserving a building's economic and cultural value.
- **Design for Deconstruction (DfD)** to enable easier deconstruction and reuse/recycling of components and materials in the future, hence playing a vital role in the responsible end-of-life management of construction products.

It should, however, be understood that there are trade-offs between the different strategies. Leaner design can conflict with the need for more adaptable spaces, which are sometimes facilitated by longer spans, higher floor-to-ceiling heights, or higher structural loadings, all of which lead to more material use, so it is essential to balance the different approaches.

6.1 ADOPT LEAN DESIGN FOR RESOURCE EFFICIENCY

Lean design emphasises reducing all types of waste, including materials, time, and labour. Within a circular economy, this concept is broadened to minimise waste generation and promote repurposing instead of disposal (Salibi, et al., 2022). Lean methodologies aim to maximise customer value while reducing costs. In a circular context, this means crafting products that address customer needs while enabling reuse, recycling, or remanufacturing after their lifecycle ends. Products are created with a focus on durability and ease of repair, allowing them to be utilised longer and fixed when necessary (Ellen MacArthur Foundation, 2024). This method resonates with circular economy ideals that stress keeping materials in circulation for as long as possible (Ellen MacArthur Foundation, 2024).

Lean design fosters a comprehensive perspective on production systems, taking into account the entire lifecycle of products and their environmental effects. It includes recognising how design choices influence not only the final product but also the supply chain, resource use, and waste management. Blending lean principles with circular economy strategies encourages collaboration among stakeholders to create innovative business models that prioritise sustainability. For instance, some companies may implement PaaS models, leasing products instead of selling them, which motivates manufacturers to design for durability and repairability (CIRCULÉIRE, 2024).

Advanced manufacturing and Modern Methods of Construction (MMC) play a key role in reducing waste and integrating leaner design. The Royal Institute of Architects of Ireland (RIAI) has created a Design for Manufacture and Assembly/DfMA Report (2022) to support designers with the use of MMC from the earliest work stages. This assists in reducing lost opportunities for producers by allowing them to engage with building design from the early stages, and helping them to realise future possibilities for standardising and repeating components, all facilitated by digital tools such as Building Information Modelling (BIM).

The standardised design approaches study by the Department of Housing (2024) also offers an opportunity for producers to standardise housing design, including a kit of parts, to enable greater efficiencies in production through standardising components.

There is considerable potential for optimisation of structures through detailed computational design, resulting in structures that can be 50% or more lighter, demonstrated by the government funded BUILD-OPT project[15]. This partnership of industry, academics, and the Institute of Structural Engineers sought to the develop knowledge of efficient structural layouts within the industry, and their key elements, such as location of columns and the design of trusses and floor plates. The research work of ETH Zurich[16] has explored the potential for digital parametric design and 3D printing to reduce material use in concrete structures by 70% while enhancing their design and aesthetic possibilities.

6.2 DESIGN FOR ADAPTABILITY (DFA)

Buildings must be designed for optimum use by facilitating alternative uses at different times[17] and over their life spans while retaining value. It can be as simple as allowing enough leeway within the building design so that when occupants' needs change, the building can be easily adapted. For example, homes can be designed for life by using a modular approach to transition

15. More information about BUILD-UP project is available on the following link: https://www.build-opt.org/

16. More information about ETH Zurich research is available on the following link: https://dbt.arch.ethz.ch/research-stream/

17. A good example is the new University of Amsterdam which was designed to be used as a cinema theatre in the evenings and weekends, or the City of Paris, which has opened 42 school playgrounds to the public at weekends as a new public amenity.

Case Study: Combining Lean Design with Digital Technology - Smart Slab (Jipa, et al., 2018)

The 78 sqm prestressed concrete Smart Slab is part of a collaborative demonstrator of digital fabrication with eight researchers from ETH Zurich. It demonstrates the cutting-edge possibilities of reducing materials use through advanced parametric structural design in combination with 3D printing of formwork.

The structural design used digitally-designed geometry, starting with a basic structural grid to develop the complex structural shapes. By distributing the material in a hierarchical grid of curved ribs between 30 and 60 cm in depth with extremely thin connecting surfaces, the design is optimised for cantilevers of up to 4.5 meters. The slab weighs only 15 tonnes, almost 70% less than a conventional solid concrete slab.

The complex formwork was created by combining 3D printing and laser cutting, then casting and spraying concrete into the geometrically complex shapes. This overcomes the geometric and economic limitations of traditional formwork fabrication methods. By further replacing the clinker content of the concrete, it is possible to radically reduce the carbon impact of the concrete slab through the combination of structural design and low-carbon materials.

Figure 10: Photograph of the Implementation of the concrete Smart Slabs (Digital Building Technologies, ETH Zürich. Image: Tom Mundy, 2018)

The whole case study can be viewed in the following link: https://dbt.arch.ethz.ch/project/smart-slab/

from a one-bed property to a three-bed home easily and vice versa[18]. It also means considering whether a building can be easily adapted to a new use. For example, can an office building be easily converted into accommodation? Designing homes for adaptability allows a quicker response to demographic changes, such as the trend toward smaller households.

Adaptability can be achieved through three key strategies: *versatility*: which intensifies use by allowing spaces to serve multiple functions with minor system changes; *convertibility*: which enables buildings to accommodate changing user needs through non-structural modifications; and *expandability*: which supports future growth by facilitating the addition of new space, either vertically or horizontally (ISO 20887:2020, 2020). These strategies enhance long-term usability, reduce environmental impact, and promote resource efficiency in the built environment.

The *EU Level(s) indicator 2.3: Design for adaptability and renovation, User manual: Overview, instructions and guidance (Publication version 1.0)* (Dodd, et al., 2020a) scores the adaptability of an asset together with ISO 20887:2020 and provides a structured way of measuring adaptability. The Mayor of London introduced a requirement for larger developments to submit Circular Economy statements[19], with larger developments, but encouraged local boroughs to use them also in smaller developments. Templates were produces to be used in the submission of planning permits, such as one template examining how the design permits future adaptability.

18. More information about the case study on the following link: https://space10.com/projects/urban-village

19. More information about the Circular Economy Statement Guidance on the following link: https://www.london.gov.uk/programmes-strategies/planning/implementing-london-plan/london-plan-guidance/circular-economy-statement-guidance#template-58115-title

6.3 DESIGN FOR DECONSTRUCTION/ DISASSEMBLY (DFD)

DfD, also known as Design for Disassembly, ensures products, services, and entire buildings are designed to be deconstructed and their components used again. Reducing waste and supplying high-value secondary materials suitable for reuse and recycling at a later stage requires designs that support ease of deconstruction and disassembly. Design for deconstruction focuses on ensuring that as many components of a building as possible can be reused when the building or its parts reach the end of their life. This approach can enhance the residual value of the building at the end of its life cycle by taking those parts back and then refurbishing them or utilising them somewhere else.

Digitalisation and material passports can further support the process[20]. These tools provide structures to collect information on a product's safety, environmental impact, and reusability.

Case Study: Superlofts

Superlofts is a modular housing system built around adaptability, with a variety of loft types and flexible layouts that can evolve to meet changing user needs. Homes range from XS (35m^2) for young urban professionals to XL (200m^2) for larger families.

The project uses prefabricated concrete modules and timber structures, reducing material waste, promoting reuse, and enabling long-term flexibility. Modular construction allows individual components to be updated or replaced without demolishing the entire building. The design also supports easy reconfiguration, ensuring the spaces can adapt to evolving needs without structural changes.

The foundation and superstructure are designed to accommodate vertical expansion, allowing additional floors to be added without extra reinforcement. The use of precast concrete modules, untreated surfaces, and minimal finishing promotes material reuse and reduces environmental impact. The system also allows components to be disassembled and repurposed in other projects, reinforcing its commitment to circular economy principles. Superlofts offers a sustainable, adaptable housing solution that can meet the changing needs of its residents over time.

The whole case study can be viewed on the following link: https://superlofts.co/

Shearing Layers

The concept of the shearing layer allows visualisation of the different layers of buildings with different lifespans. This, in turn, allows for a better understanding of how buildings can be designed to strategically target new business models linked to their lifespan and the frequency of change.

The *EU Level(s) indicator 2.4: Design for deconstruction User manual: Introductory briefing, instructions and guidance* (Publication version 1.1) report (2020b), scores the Deconstruction of an asset together with ISO 20887:2020 and provides a structured way of measuring an asset's adaptability.

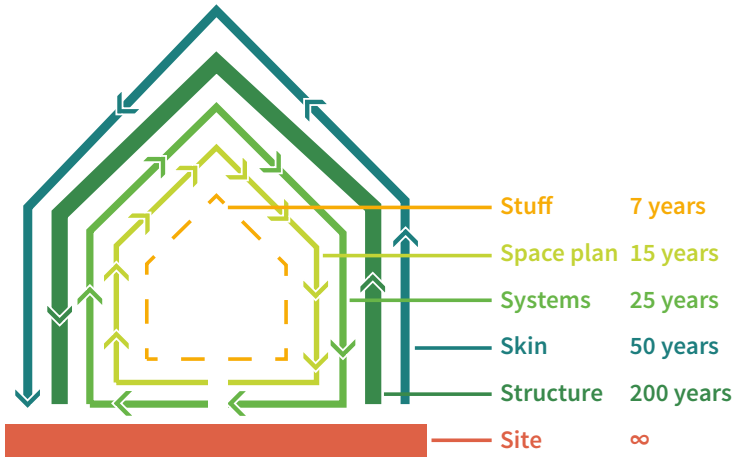

Figure 11: Shearing layers of Change (Brand, 1994).

20. See the Close the Materials Loop for further information on this topic.

6.4 DESIGN FOR CIRCULARITY ACTIONS

6.4.1 2026 - 2030

Government

G1. Integrate EU Level(s) indicators reporting for Resource efficiency + circular material life cycles, 2.1-2.4 Design for Adaptability and Design for Deconstruction indicators into GPP and develop scoring templates, benchmarks and targets for use in the industry.

G2. Ensure that the standardised design approach and studies (eg by DHLGH) optimise the potential to integrate standardisation of parts to minimise waste and resource efficiency.

G3. Collect baseline data for resource efficiency using a BoQ to set benchmarks for resource use per square meter or functional unit, such as occupant, to allow for future benchmarks.

G4. Life Cycle Analysis (LCA)s to be included as a condition of planning permission for all new planning applications for all developments in excess of 1,000 sqm, in line with the Energy Performance of Buildings Directive (EPBD).

G5. Use pre-demolition audits in order to identify materials in proposed demolition projects that can be recycled or downcycled.

G6. Set out a resource efficiency roadmap with targets based on collected data for GPP projects and signal to industry the future tightening of these targets.

Construction Sector

C1. Integrate EU Level(s) indicators reporting for Resource efficiency + circular material life cycles, 2.1-2.4 DfA and DfD indicators into design and construction workflows.

C2. Adopt universal standards for data management to ensure consistency, accuracy and reliable data across the supply chain.

C3. Use standard building components that can be easily replaced or upgraded, avoiding demolitions and waste.

C4. Integrate modular design techniques that allow for components to be easily disassembled and reused

C5. Integrate design for manufacturing and disassembly into workflows from early concept design, involving producers.

C6. Involve the construction contractor earlier in the design process promoting integration and collaboration in the design and build process.

C7. Set targets for and use standard templates to show compliance with the EU taxonomy for all projects that facilitate ease of adaptability and optimise ease of deconstruction and repair

Producers & Solution Providers

P1. Evaluate current product offerings and start the process of developing and bringing to market products that facilitate ease of adaptability and optimise, ease of deconstruction, and repair.

P2. Embed lean and sustainability principles in the initial design and conceptualisation phases, addressing both economic and environmental goals from the outset.

P3. Integrate key aspects such as modularity, component recovery, ease of disassembly, quality standards, and maintenance simplicity as part of product

design and work closely with the Department of Housing, Local Government and Heritage, on Standardised Design kit of parts approaches. By prioritising these factors, products can be designed for longer lifecycles, easier repair, and efficient end-of-life recovery.

P4. Understand the implications of the Construction Products Regulations (CPR) and Eco-design for the Sustainable Products Directive (SPD), including enhanced Declaration of Performance (DoP) with environmental data and Digital Product Passports (DPP), and associated implications for business development.

P5. Support and work alongside designers to ensure Design for Manufacture and Assembly (DfMA) is integrated into their workflows from early concept design, ensuring the development of standardised approaches.

P6. Continue to develop, improve and bring to market products that facilitate ease of adaptability and optimise ease of deconstruction and repair.

P7. Continue to set targets for improving the resource efficiency of the products.

Finance, Legal, and Insurance

F1. Align lending with EU taxonomy criteria, DfA and DfD, to ensure future adaptability and flexibility of the assets they lend on, by offering discounted loans on buildings and homes that are certified under EU Taxonomy-aligned certification, for example, the HPI for residential developments.

F2. Provide green development loans/green mortgages aligned with the EU taxonomy, which includes circularity criteria, DfA and DfD.

Educators & Awareness Raisers

E&A1. Develop training on the use of EU Level(s) indicators reporting for Resource efficiency + circular material life cycles, 2.1-2.4 DfA and DfD indicators.

6.5 DESIGN FOR CIRCULARITY 2030 INTERIM TARGETS

- Resource efficiency baselines established with target of 10-25% reduction below baseline for 2030.
- All larger projects > 5000sqm designed with Design for Adaptability / Deconstruction approaches.

6.6 DESIGN FOR CIRCULARITY 2040 TARGETS

- 100% buildings adopted Design for Adaptability / Deconstruction approaches.
- Improved resource efficiency by 40-50% over baseline.
- Optimised use of regenerative & biobased materials within viable capacity.

7. CLOSE THE MATERIALS LOOP

KEY RECOMMENDATIONS

Develop a bioeconomy strategy for construction, taking a holistic approach to developing timber and agri-crop supply chains and industries

Design, deliver and operate products and buildings adopting 'Waste Hierarchy' principles

1. Prioritising Prevention and Preparing for Reuse
2. Adopting innovative Recycling and Recovery approaches
3. Disposal - only when absolutely necessary

Support and co-develop both demand and robust supply chains to transition to more efficient use, reuse and repurposing of materials (regenerative/low carbon).

Based on an aggregated study of materials data from 51 recently constructed buildings in Ireland across all typologies, concrete made up by far the greatest mass used at 75% of all materials, representing 41% of CO_2e emissions in new construction (IGBC, 2022). Metals comprised only 7% of mass but 36% of emissions, and insulation, though with an insignificant mass, represented 6% of carbon emissions. The remaining materials comprised 17% of mass and carbon emissions, primarily from glass, brick, and gypsum (Barrett, et al., 2024).

Agriculture is a significant industry in Ireland, and supporting diversification within the industry while sustaining rural incomes will be essential for achieving Ireland's climate targets and ensuring a just transition. An opportunity lies in expanding the use of low-carbon, bio-based materials in construction. Fast-growing bio-based materials not only sequester biogenic carbon throughout a building's lifespan but also provide economic benefits by adding value to agricultural crops, creating rural employment, and reducing dependence on imported materials (Pittau, et al., 2018).

This section outlines various interconnected strategies and recommendations to enhance use and value of materials. It addresses:

- **Regenerative and bio-based materials**
- **Ensuring greater reuse and recycling**
- **Waste hierarchy**
- **Primary and secondary raw materials**
- **Critical Raw Materials (CRMs)**

7.1 DEVELOP THE BIOECONOMY FOR CONSTRUCTION

The introduction of GWP limit values for the construction of new buildings through the updated Energy Performance of Buildings Directive (EPBD) (European Commission, 2024b), already implemented in Denmark in 2022, France in 2021, and the Netherlands in 2016, will increase demand for low-carbon materials. The Environmental Product Declaration Programme in 2022 shows that bio-based materials generally have lower embodied carbon to produce (EN15804 for EPD/EN15978 for building modules A1-A3) than concrete, steel, or plastic-based alternatives (EPD Ireland, 2022).

Several European countries are already prioritising bio-based materials. France has mandated that all new public buildings be built from at least 50% timber or other bio-based materials such as wood, hemp or straw (European Commission, 2020). The city of Stuttgart provides additional funding for homes built with certified green products such as "Nature Plus" and "Blauer Engel". The Improving Energy Efficiency in Traditional Buildings Report (Government of Ireland, 2023) also highlights the benefits of bio-based materials for retrofitting existing buildings.

Fast-growing bio-based materials used for building and renovation store biogenic carbon absorbed during plant growth, effectively acting as carbon sinks for the duration of the building's life. However, at the end of the building's life, this carbon can be released depending on how the building is disposed of, either through incineration or in a landfill, emitting gases such as methane that should be reported in Whole Life Carbon Assessments – End-of-life scenario module (EN15978 for buildings module C3) (Government of Ireland, 2023).

A key challenge is that many bio-based construction products contain synthetic adhesives, binders (up to 20% in insulation materials) and other contaminants, preventing them from re-entering the bio-cycle (Government of Ireland, 2023). To address this, alternative bio-based adhesives and binders are entering the market and are being developed and investigated as part of research projects such as NXTGENWOOD[21] with the aim to address end-of-life uses and CRESTIMB[22], which looks at extending the life span of timber buildings.

21. More information about the NXTGENWOOD project is available on the following link: https://biorbic.com/nxtgenwood/

22. More information about CRESTIMB is available on the following link: https://itech.lukasiewicz.gov.pl/en/crestimb-consortium/

The European Council recently greenlighted the EU certification framework for permanent carbon removals, carbon farming and carbon storage in products (European Commission, 2024b). Where buildings are designed with circularity in mind, through adaptability to extend their life, or for disassembly, allowing the product to be easily removed and reused in another building or use, this biogenic carbon can remain fixed for a longer period.

Timber

There is an opportunity to increase the use of timber in Irish construction, which is presently being explored by the Government's Timber in Construction Working Group (TiCWG), and to address current barriers. The working group is expected to bring out recommendations for a national standard for the use of mass timber in the summer of 2025 to address current issues in the TGDs (Government of Ireland, 2024). When properly designed and constructed to international fire safety standards, timber buildings can be as safe, predictable, and fire-resistant as those made from other materials. Ensuring that regulations align with these advancements will support the wider adoption of timber in construction (Government of Ireland, 2024).

Ireland's timber harvest is set to double by 2035, providing a strong foundation for expanding the domestic timber supply chain. However, afforestation levels must increase to meet future demand (Government of Ireland, 2024).

Agri-crops and by-products

There is significant potential to extract greater value from agricultural by-products generated from existing crops. Materials such as straw from tillage farming and wool from sheep farming can be used to develop products for the construction industry. For example, natural insulations can be produced from hemp, wool, straw, reeds, verge grass, elephant grass, seagrass, flax, and mycelium.

These materials also serve as complementary components in timber construction systems, including timber frames and modern methods of construction (MMC). Additionally, straw and miscanthus can be processed into panel board products, offering eco-friendly alternatives to traditional plywood.

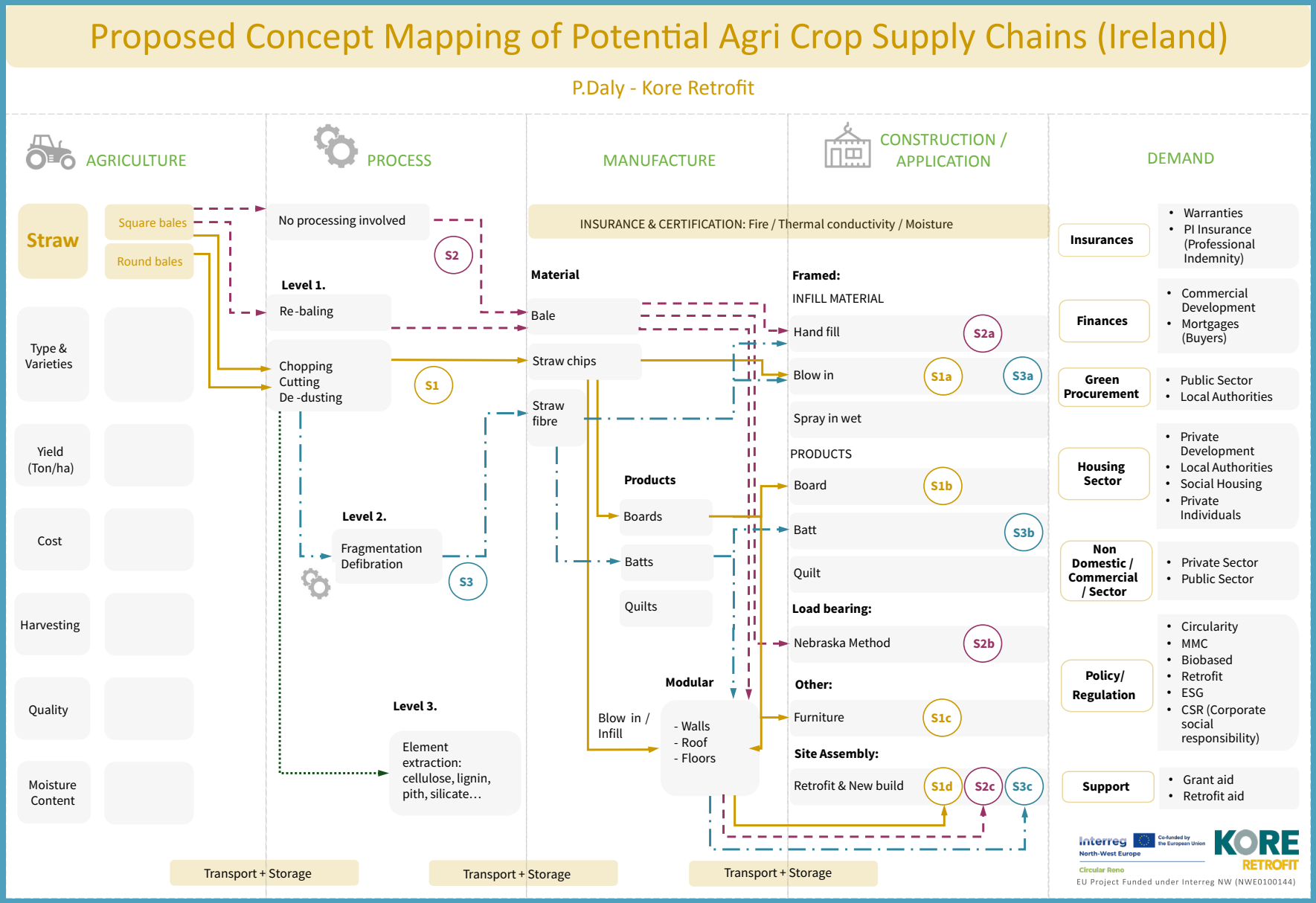

Figure 12: Proposed Concept Mapping of Potential Agri Crop Supply Chains (Ireland) (Daly & Barril, 2024).

The ideal strategy is maximum value extraction rather than single purpose crops. For example, hemp production ideally would extract all the value from the plant, including for food, medicine, chemicals and finally construction products such as fibre insulation and hurd. This approach is exemplified by a pilot Biorefinery Glas project[23]. The project, funded by the Department of Agriculture, Food and the Marine and led by Munster Technological University (MTU), seeks to maximise the value extracted from grass by converting freshly harvested grass into a range of products, including animal feeds, proteins, and grass whey. There is also potential to create insulation from the press cake after extracting the juice.

The Circular Reno Interreg project's State of Play research into agri-crop bio-based construction in Europe identified over 57 companies engaged in the manufacture and application of straw, miscanthus, and hemp as construction materials, products, and modular systems across a variety of supply chains. Figure 12 illustrates the proposed concept mapping of potential agri supply chains in Ireland for the project.

Expanding the use of bio-based materials offers multiple benefits, including social sustainability within communities and reduced reliance on imported materials. Certain crops can even be used as break crops, helping improve soil structure (Teagasc, 2017).

The Irish state has had a long tradition of establishing new rural industries to achieve social and economic co-benefits of employment and supply chain resilience, including Irish Sugar, Bord na Mona[24], and Medite Smartply[25]. Given the need to decarbonise construction and the implementation of the EPBD this offers an opportunity for Irish farmers regarding diversification (The Housing Commission, 2024).

23. More information about the Biorefinery Glas project is available on the following link: https://biorefineryglas.eu/

24. More information about Bord na Mona is available on the following link: https://www.bnm.ie/

25. More information about Medite Smartply is available on the following link: https://mdfosb.com/en

Case Study: Straw-Based Modular Wall System

This case details an innovative modular system manufacturer based in Lithuania and Slovakia, which utilises automotive production and aims to establish additional factories across Europe. The modular system features compressed straw as insulating infill, sourced from readily available straw resources across the continent. The manufacturer acts as the main processor, handling large quantities of rye straw (5,000 – 6,000 round bales) harvested in winter for long-term storage and drying over one to two years. Their process involves cleaning, chopping, dusting, and compressing straw into modular wall panels designed with twin studs and small panels. These panels are 'open'—meaning they are partially finished—to enable stackable storage, transport, and easier handling. The modular units can be sent directly for on-site assembly or further assembled in local temporary factories before installation. The panels form a wall system that is typically load-bearing up to six stories but can also be integrated into post-and-beam structures. While the main focus is on new build applications, there is also interest in creating modular retrofit systems. The company supplies products throughout Europe and strives to set up additional plants strategically near urban centres, transport hubs, and ports to optimise shipping logistics rather than proximity to raw materials. They have national testing for their products and are working toward obtaining European Technical Assessment (ETA) certifications for their straw system. Additionally, they face challenges with local, regional, and national regulatory standards and variations in testing requirements, especially regarding fire safety. This case underscores several key aspects: compact module design for enhanced handling and transport, strategic location selection for shipping efficiency, use of patented manufacturing technology, development of retrofit panels, secondary assembly factories, plans for multiple regional manufacturing sites, and further automation integration. Figure 13 presents a high-level mapping of this hemp product supply chain.

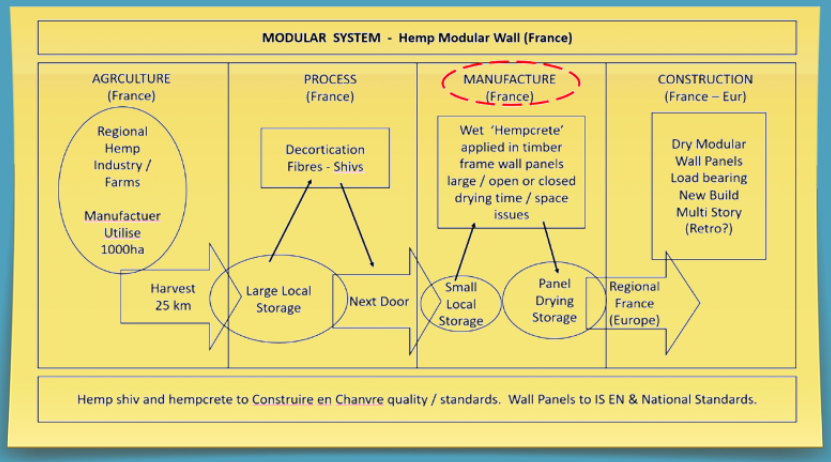

Figure 13: Presents a high-level supply chain mapping of this wet process hempcrete-based modular wall panel manufacturer, which is located adjacent to the processor and seeking to develop several regional factories (Daly & Barril, 2024).

Case Study: Hemp-Based Construction Material and Products (Italy)

This case study examines a manufacturer of hempcrete and hempcrete blocks, a subsidiary of a cement construction company in northern Italy. Hemp shiv is transported from France, adhering to the quality standards of the French hemp construction association. It is stored in bulk and can be sourced locally if it meets these standards. The hemp shiv is supplied in bags for a proprietary lime/probiotic binder and water, creating a hempcrete mixture for infill in timber-framed structures and for producing hemp blocks via a modified processing line. The company also offers training, installation, and consultancy services. The hempcrete serves as insulating infill, while the blocks are typically non-loadbearing. Operating mainly in Italy and central Europe, the company exports internationally and has obtained thermal and fire certifications as well as an Environmental Product Declaration (EPD). This case highlights effective supply chains away from resource locations, adaptability in creating biobased products, and the importance of training for integrating these solutions in commercial projects. Figure 14 presents a high-level mapping of this hemp product supply chain.

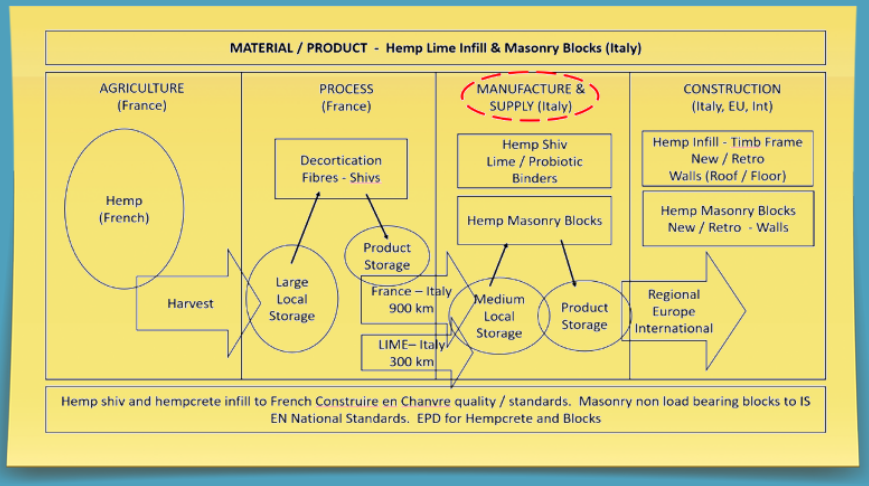

Figure 14: shows a high-level supply chain mapping of this hemp lime supplier/ manufacturer based on French hemp resource (Daly & Barril, 2024).

Case Study: Hemp-Based Modular Wall System

This case study examines a modular wall system manufacturer in northern France that specialises in hemp-based products and is part of the Construire en Chanvre association, which establishes quality standards for hempcrete. Supported by a strong industrial hemp sector, around 100 local farmers grow hemp within a 25 km radius, supplying about 1000 hectares of processed hemp shiv to the manufacturer.

A nearby processor provides storage and decontamination services, allowing the manufacturer to minimise transportation needs and long-term storage. Supplies are delivered as needed and mixed with lime and water to create hempcrete. The factory produces approximately 30 panels per week, using a timber stud frame filled with hempcrete. The panels undergo an initial setting phase before being finished and are suitable for both load-bearing and non-load-bearing applications in various building types.

The manufacturer aims to expand regionally and internationally while adhering to certification standards set by Construire en Chanvre and conducting its own performance testing. This case highlights the benefits of a mature hemp industry and resource proximity, as well as drying challenges, and plans for growth. Figure 15 presents a high-level mapping of this hemp product supply chain.

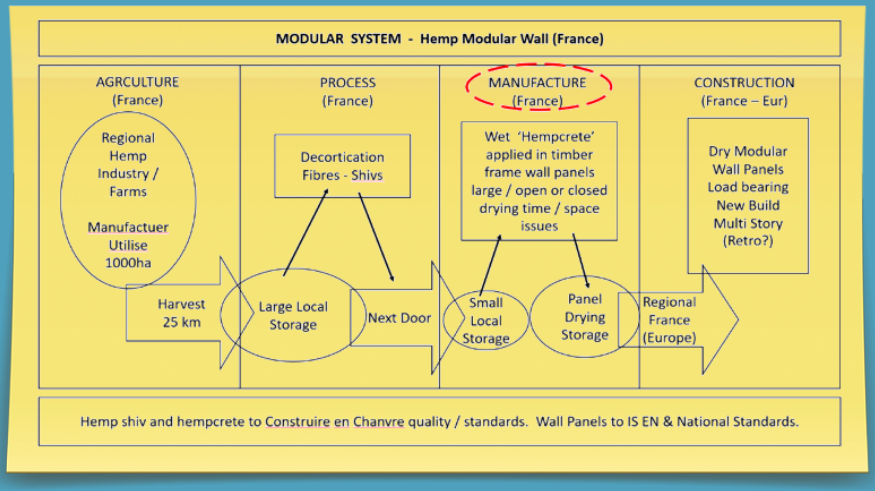

Figure 15: Presents a high-level supply chain mapping of this wet process hempcrete-based modular wall panel manufacturer, which is located adjacent to the processor and seeking to develop several regional factories (Daly & Barril, 2024).

Case Study: Specialist Miscanthus Processor (Germany)

This case involves a specialised miscanthus processor in Germany that serves various sectors across Europe, including construction. The processor manages around 170 hectares of miscanthus, including its own 20-hectare trial farm for specialised varieties. It employs specific processing techniques to produce key outputs such as cellulose, fiber, silicone, pith, and shiv chips. In the construction sector, it supplies insulation materials, thatch for roofing, 'miscrete' blocks, mycelium acoustic boards, and various panels. The case emphasises expertise in miscanthus agronomy and tailored processing for diverse client needs. Figure 16 for high level supply chain mapping.

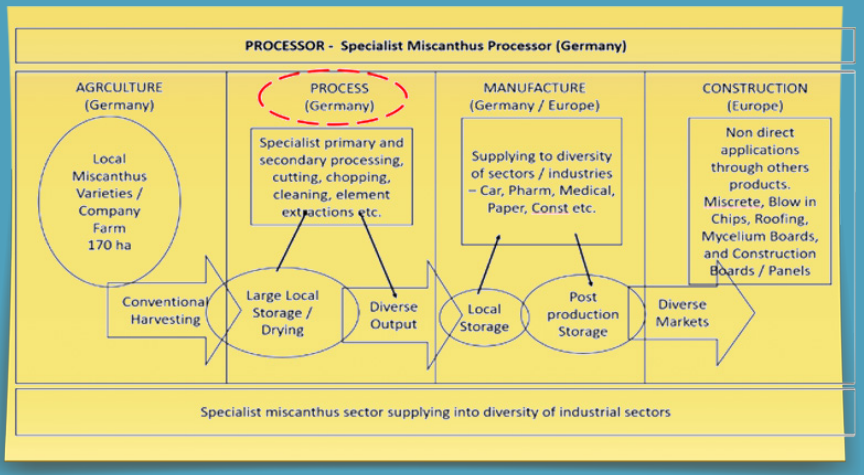

Figure 16: Presents a high-level supply chain mapping of a specialist miscanthus processor tailoring its processing to supply a range of sectors/industries with raw materials for third-party manufacture, including the construction sector (Daly & Barril, 2024).

Case Study: Straw Processor/Construction Material (Austria)

This case involves a straw processing and supply company in Austria that offers construction straw bales and blown-in straw chips. The company has transitioned from processing agricultural straw for animal bedding to utilizing approximately 1,000 hectares of straw (round bales) sourced from a few large regional growers. Initially focused on producing straw bales for construction, the company later expanded its offerings to include chopped straw for insulation. The company provides two main products:

1. Straw Bales: Sourced directly from farms or processed in-house to meet certified standards.
2. Straw Chips: Produced for blown-in insulation, involving cutting, dedusting, and bagging.

Additionally, the company offers straw construction consultancy and certification testing for its products. The straw bales are primarily used in new timber frame housing, and blown-in insulation is applied in walls and roofs of new builds, with some retrofitting potential. The company operates regionally across Central Europe and holds ETA and CE certifications for both product lines. See Figure 17 for high level supply chain mapping.

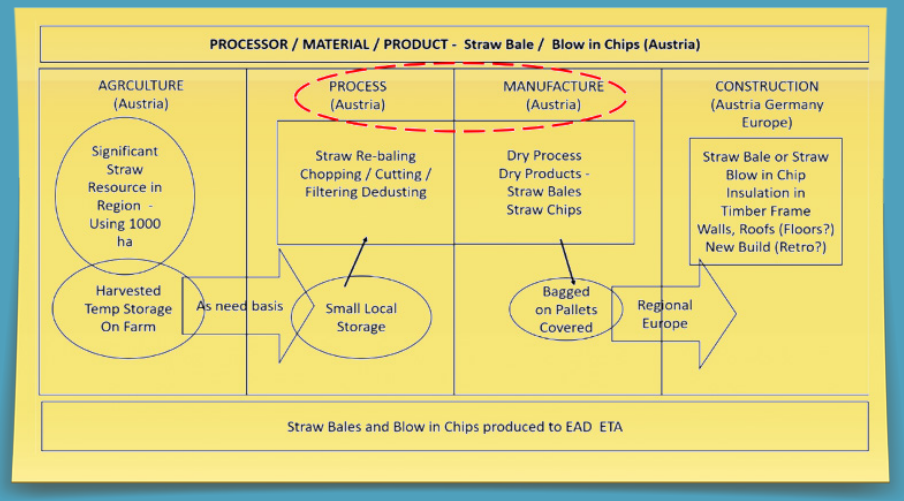

Figure 17: Presents a high-level supply chain mapping of a straw bale/chip processor supplier for timber frame construction with either straw bales or a blow in straw chip insulation infill (Daly & Barril, 2024).

Case Study: Straw Based Construction Products (Poland)

This innovative Polish company has developed patented technology for straw fibre extraction to produce a range of straw-based boards, batts, and loose-fill insulation. They source approximately 1,000 tonnes of straw annually from local cereal farmers within a 30-50 km radius, using covered storage and on-demand delivery to minimise large-scale storage needs. The production involves a patented wet process for fibre extraction and combines the fibres with polymers and recycled materials. Their products, including low-density blow-in insulation (45-75 kg/m^3), are primarily used in timber frame construction for walls and roofs, as well as in historic building conservation projects requiring breathable construction. They supply mainly across continental Europe, facing some limitations due to transport costs and certification barriers, despite having CE marking based on harmonised standards. See Figure 18 for high-level supply chain mapping.

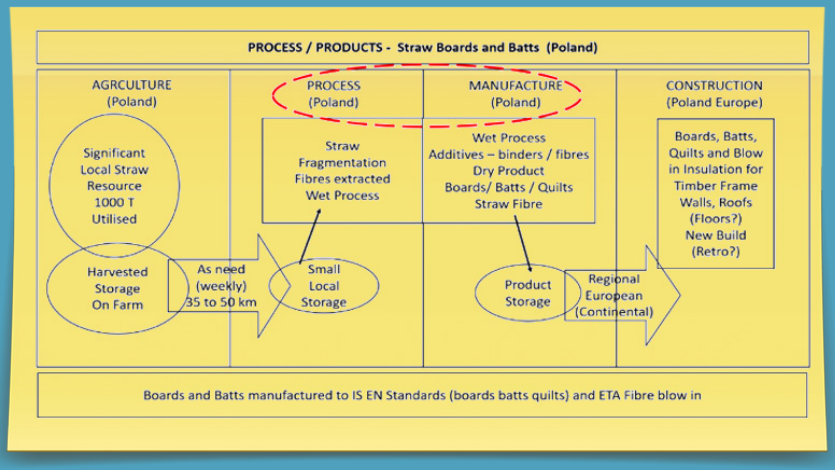

Figure 18: Present high-level mapping of straw-based processor/product manufacturer with patented technology for fibre extraction of straw, manufacturing and supplying a range of boards and batts for timber frame construction and fibre blow-in insulating infill (Daly P and Barril PG, 2024).

Case Study: Stabilising supply and demand – Bio-based materials – Netherlands

The Netherlands Government set out to solve the supply and demand issue through its National Approach to Bio-Based construction strategy. In 2023, it announced that it was investing €200 million in the development of biobased building materials to build supply chains. It established a Building Balance program comprising multiple government agencies to implement the strategy. Currently, demand outstrips local supply in Holland for locally produced bio-based materials. The programme aims at motivating farmers to grow the raw materials for bio-based building materials, building the production lines and ensuring public procurement is driving demand by setting requirements for the use of biobased materials in public contracts. This ensures that all parts of the supply chain exist simultaneously: farmers to supply, producers to manufacture, and the construction industry to buy.

This also creates a stable market, ensuring price certainty for farmers. Importantly, it also addresses the issue of certification through the creation of generic open-source data, enabling smaller producers to certify their products for use in construction. https://frameweb.com/article/what-can-a-eur200-million-investment-in-biomaterials-get-you

7.2 ENSURE GREATER REUSE AND RECYCLING

7.2.1 The current baseline

Ireland's material consumption has steadily increased, conflicting with our circular economy and climate goals. The country's Technical Cycling rate is only 2.7%, far below the global average of 7.2% (Circle Economy, 2024), with over 97% of materials sourced from virgin resources. Ireland's annual material footprint is 111 million tonnes, or 22 tonnes per capita, substantially above the EU average of 17 tonnes (Circle Economy, 2024). Figure 19 shows some figures comparing Irish data with European and global data, and Figure 20 presents figures related to the construction and built environment.

While the quantity of Construction and Demolition (C&D) waste generated in Ireland decreased from 9 million tonnes in 2021 to 8.3 million tonnes in 2022, the overall composition of C&D waste changed little between 2020 and 2021 (EPA, 2024). At 82%, soil and stone waste remained dominant, followed by waste concrete, brick, tile and gypsum (7%) and mixed C&D waste (4%). The proportion of segregated (wood, paper, glass, plastic and metal) C&D waste collected remained small at just under 4%, increasing from 3.1% in 2020 (EPA, 2024).

Of the treated C&D waste, 81% was backfilled, mainly consisting of soil and stone; however, this percentage may decrease, as it is no longer required to make a by-product notification to the EPA for determination where it complies with national criteria for end-of-waste for soil and stone. This should result in greater

	IRELAND TOTAL*	IRELAND PER CAPITA*	EU AVERAGE PER CAPITA**	GLOBAL AVERAGE PER CAPITA***
Domestic extraction	80 million tonnes	16 tonnes	12 tonnes	12 tonnes
Material footprint	111 million tonnes	22 tonnes	17 tonnes	12 tonnes
Carbon footprint	61 million tonnes of CO_2e	12 tonnes of CO_2e	14 tonnes of CO_2e	7 tonnes of CO_2e

Figure 19: Comparing Irish footprint (Circle Economy, 2024).

SECTOR	INDUSTRY	MATERIAL FOOTPRINT		CARBON FOOTPRINT		CIRCULAR JOBS	
		Total mass (million tonnes)	Share of material footprint (% of total)	Total GHG emissions (million tonnes CO_2e)	Share of carbon footprint (% of total)	Circular jobs (% of total)	Circular jobs split by direct/indirect
Built environment	Construction materials	0.4	0.4%	0.1	0.2%	10.7%	8.2% / 2.6%
	Construction	37.7	34%	6.3	10.4%		
	Real estate	1	0.9%	0.5	0.9%	4.7%	1.7% / 3%

Figure 20: Industries contributing to Ireland's (Circle Economy, 2024).

soil and stone diverting from the backfill. Implementing more efficient spatial planning and promoting higher-density developments could be effective strategies to limit soil and stone waste generation. By reducing the dependence on greenfield sites for construction, these approaches can help preserve our most carbon-rich, fertile soil that might otherwise be lost to backfilling (EPA, 2024).

Moreover, Ireland's material footprint and carbon footprint are above the European average. Between 2010 and 2020, Ireland's recycling volumes remained stagnant at 1.29 million tonnes annually despite total waste treatment increasing by about one-third (McCarthy, et al., 2022). The rise in waste treatment was primarily due to backfilling, which grew from 2 million tonnes in 2010 to 7.5 million tonnes in 2020, with construction and demolition activities driving most of this growth (McCarthy, et al., 2022). Figure 22 shows the different waste treatments over the decade (2010-2020).

Backfilling, however, does not count toward the Circular Material Use Rate (CMUR) target, which is a key indicator under the EU Circular Economy Action Plan, which aims to measure the circularity of materials in the economy (European Commission, 2015). Figure 23 shows a comparison between Ireland and a few EU member states in terms of waste treatment and recycling.

Ireland's circularity rate remains critically low at just 1.8%, significantly below the EU average of 12.8%. Methodological factors — including the reliance on Domestic Material Consumption (DMC) rather than Raw Material Consumption (RMC) data, and the classification of imported brewers' spent grains as waste — have further reduced Ireland's reported CMUR by an estimated 2.4% (EPA, 2024). Targeted interventions in sectors such as construction, demolition, and biomethane could increase Ireland's CMUR by up to 3.15%. However, achieving meaningful progress will require improvements to primary data quality, harmonising waste definitions, and greater expansion of reuse and recycling practices across key sectors.

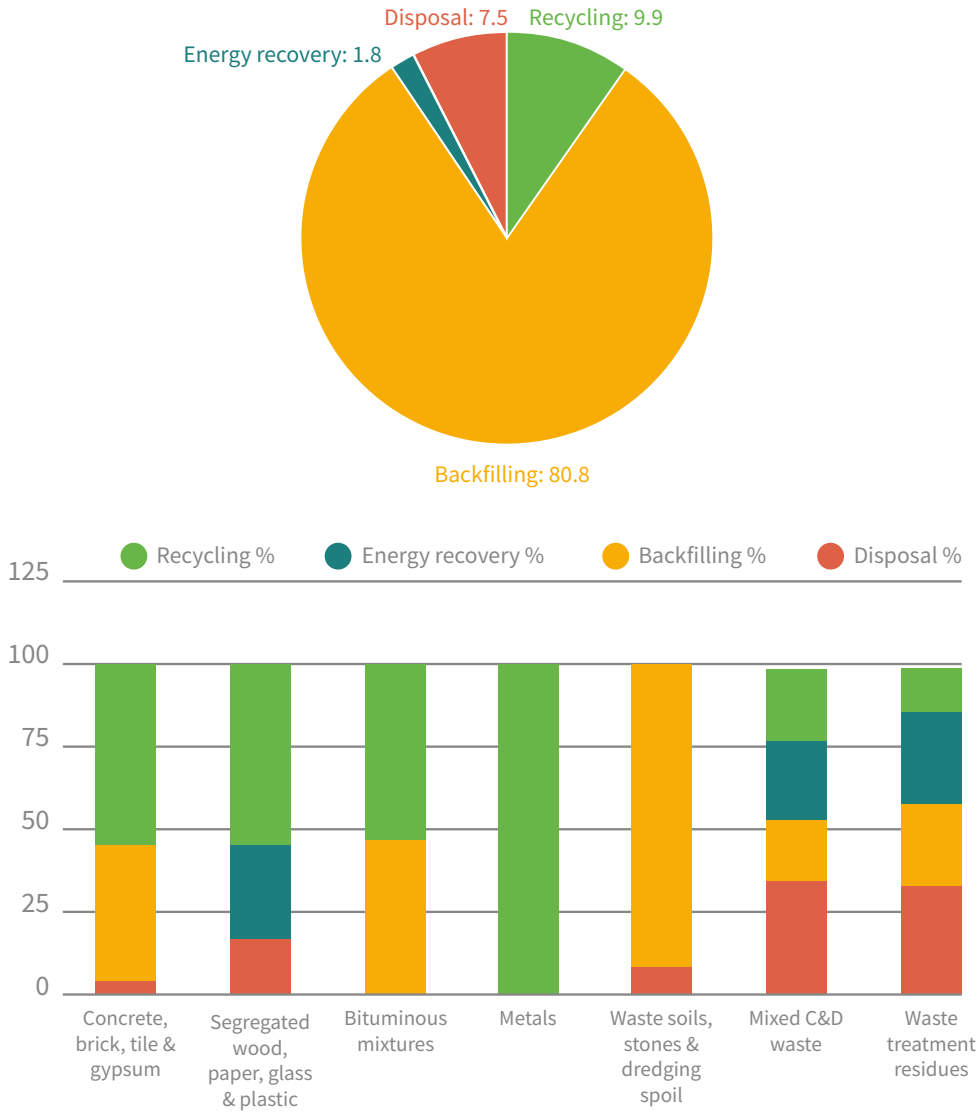

Figure 21: Treatment of C&D Waste in Ireland 2022 (IGBC, 2024).

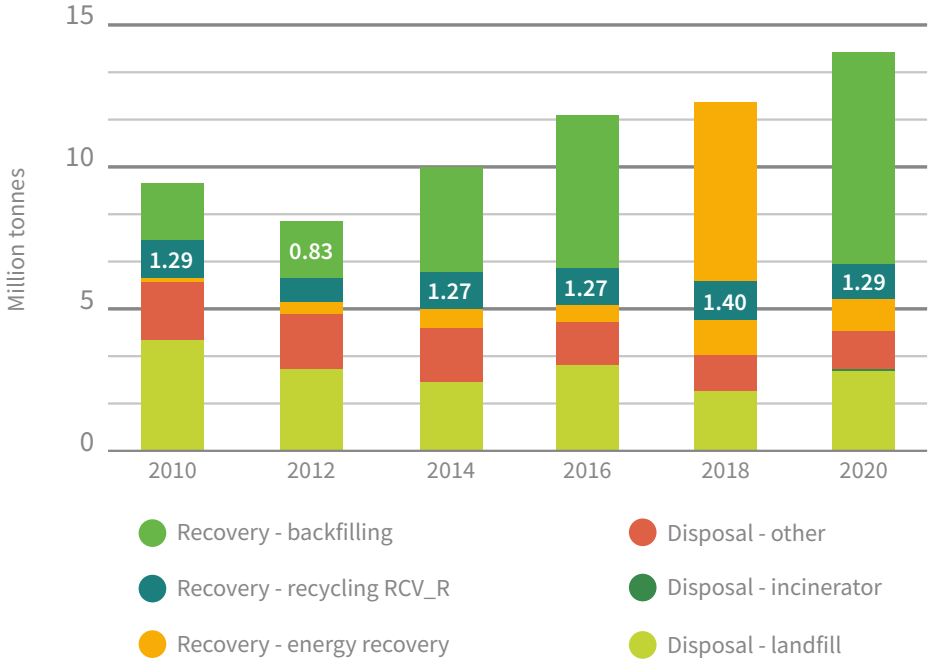

Figure 22: Waste Treatments in Ireland (McCarthy, et al., 2022).

CDW CATEGORY	IRELAND	AUSTRIA	NETHERLANDS	CROATIA
Waste soils				
Treated (Mt)	7.3	40.95	7.98	0.49
Recycled (%)	1	9	99	29
Mineral waste from construction and demolition				
Treated (Mt)	0.55	10.7	20.26	0.42
Recycled (%)	39	86	99	76

Figure 23: Treatment and recycling of CDW in four EU countries (McCarthy, et al., 2022).

7.2.2 The waste hierarchy

One of the ways to achieve a Circular Economy is to follow the waste hierarchy strategy. This visualises how products and assets can be thought about and designed to reduce overall waste. The approach prepares for a product's end-of-life so that materials can re-enter the cycle through reuse, recycling, and recovery. Figure 24 illustrates the Waste Hierarchy principles.

Figure 24: Waste Hierarchy Pyramid Principles (European Commission, 2023).

Regardless of the project, waste will inevitably arise from construction and demolition activities. For these materials, it is essential to consider the best possible routes for their management, following the principles of the Waste Hierarchy. The aim should be to keep materials as high up the hierarchy as possible, prioritising prevention, reuse, and recycling. Downcycling and disposal to a landfill should always be the last resort.

Prevention

Actions in the preceding sections are examples of prevention and preparation for reuse, from retaining existing structures to resource efficiency to avoid creating waste in the first place.

Preparing for reuse

The chapter on 'Design for Circularity' explored how we should design to enable the reuse of products through 'Design for Deconstruction' to more easily recover components and materials. Materials should be recovered from demolition at their highest value. The direct use of materials and products with minimal loss of value and only minor interventions involves checking, cleaning, repairing, and refurbishing whole items or components. Reuse options explored for re-integrating materials into a new project, can be through resale, donation, or off-site reuse (European Commission, 2023).

Recycle

When reuse is not possible or practical, recycling offers a way to recover value from materials. There are various methods to handle materials, each with different levels of value recovery:

- **Upcycling** involves transforming waste products and materials into higher-quality and/or more valuable products and materials, reducing the need for raw material extraction.
- **Recycling** is the process of converting materials into something of equal or similar value, allowing them to be reused within the same supply chain. For example, building glass can be recycled into new glass, extending its life cycle.
- **Downcycling**, in contrast, turns materials into products of lower quality or value. While it is the least preferred option in the waste hierarchy, it is still more sustainable than disposal, particularly for certain materials.

Recovery

Recovery focuses on finding alternative uses for waste, such as generating energy or replacing other materials. This helps to maximise resource efficiency and reduce environmental impact.

The "Recovery and Recycling model" offers a way to rethink production and consumption by repurposing waste into reusable materials. Breaking down products into their components reduces landfill use. However, recycling alone does not prevent waste generation or preserve product value (Lacy, et al., 2020). To be effective, recycling must be integrated with sustainable/circular procurement and design practices to address waste at source and maximise resource efficiency: maintenance and reuse make much more economic sense than recycling and are more effective in terms of material and carbon footprint.

Disposal

In a truly circular economy, disposal is to be avoided, but it is not possible to eliminate it entirely. Even the most advanced systems generate residual materials that cannot be reused, repaired, recycled, or recovered. These include contaminated, degraded, or hazardous substances for which no safe or economically viable treatment exists. In such cases, disposal becomes the least harmful solution.

7.2.3 Moving up the waste hierarchy

Improve Demolition and renovation practices

The Value our Existing Building Stock section, explored how we can reduce the demolition of existing buildings and extract more value through supporting the intensification of use. Demolition significantly contributes to embodied carbon emissions due to material extraction, transport, and processing. In response, the Chartered Institute of Building (CIOB) has advocated for tax reforms that encourage refurbishment instead of demolition, aiming to lessen environmental impacts.

Initiatives such as Demolition Take Down[26] highlight the necessity for cultural changes towards adaptive reuse rather than demolition, pushing for sustainable practices in the industry.

Where demolition is unavoidable or where extensive renovation is required, the EU Construction & Demolition Waste Management Protocol (2016), including guidelines for pre-demolition and pre-renovation audits of construction works, should be followed. This outlines key processes such as identifying hazardous materials and assessing reuse potential through pre-demolition audits and employing selective demolition to segregate waste safely. The document also emphasises transparent waste logistics, enabling the tracking of materials throughout their life cycle. This was developed to improve confidence in C&D waste management processes and increase trust in reused products and recycled materials, avoiding contamination of materials through quality assurance schemes (European Commission, 2016).

Pre-demolition and pre-renovation audits involve a detailed building assessment before any work begins, identifying hazardous substances, mapping out materials that can be safely removed, and evaluating their potential for reuse or recycling. These audits enable more selective demolition, allowing valuable components like steel, timber, bricks, and fixtures to be recovered in good condition rather than being sent to landfill or downcycled. By providing clear information about the types, quantities, and locations of materials, audits facilitate better planning for reuse, improve material recovery rates, and support a more circular approach within the construction sector.

Additionally, the Environmental Protection Agency (2024) has introduced guidelines that encourage resource efficiency in demolition efforts. These guidelines include the development of Resource and Waste Management Plans (RWMPs), which emphasise reuse and recycling during the deconstruction process.

Overcoming barriers to reuse and recycling

A key issue is the regulatory status of reused materials. Under Ireland's implementation of the EU Waste Framework Directive, any material that has reached end-of-life is generally classified as waste when removed from the site, even if it still has reuse potential (European Commission, 2023). To change this classification, companies must go through a lengthy and expensive end-of-waste or By-Product application process with the EPA. This process has been simplified for some materials with the development of national end-of-waste criteria for soil and stone, and recycled aggregates, though in the case of aggregates, the use is considerably restricted (EPA, 2024).

Additionally, Ireland lacks the infrastructure, storage areas, and collection points needed to support reuse and recycling. Few take-back schemes exist where companies collect used products or leftover materials to reuse them, and we set out in the 'Change the Business model' section how EPR schemes could help here (CSG, 2024).

The industry is also uncertain about the status of reused or secondary materials under Building Regulations (TGD Part D: Materials and Workmanship). In workshops for preparing this roadmap, it was felt that section 1.1 Fitness of Materials paragraph (c) Performance in use, enabled reuse, but there was a recognised need to derisk this through recertification schemes.

Several EU member states have already launched pilot schemes to develop standards for recycled materials in construction, and Ireland can leverage these experiences to align with broader EU goals.

Create a secondary raw materials market

Secondary Raw Materials (SRMs) are derived from waste. Even though materials generated through construction and demolition, like concrete, metals, and wood, can be considered waste, they are underutilised resources that hold significant potential to be recovered and reused. Once these materials undergo appropriate recovery processes, they can perform the same function as primary raw materials (SPI, 2021). They reduce the need for primary raw materials, conserve natural resources, and typically result in lower carbon emissions and energy usage compared to virgin materials. SRMs also enhance material supply security due to their local sourcing and can decrease production costs while increasing profit margins as consumers prefer sustainable options.

26. More information about the Demolition Take Down project is available on the following link: https://www.demolitiontakedown.ie/

Moreover, there is a perception in the sector that reclaimed materials are inferior to virgin materials. This perception, coupled with limited knowledge and advocacy efforts around high-quality reclaimed products, results in the persistent preference for newly manufactured materials (ReBuilt, 2024).

Bauxite residue (or red mud) at the processing facility in Aughinish, Limerick, also offers the potential to recover valuable rare earth minerals with advanced circular processing and to create low-carbon geopolymer concretes. There is currently no end-of-waste criteria for the residue restricting exploitation of this resource.

Recycled concrete offers another opportunity to move up the waste hierarchy. Better quality recovery using smart crushers could enable non-activated cement to be recovered. This can be up to 50% of the cement in recyled concrete (Muhedin & Ibrahim, 2023). Additionally, employing robotics or interactive design along with analytical processes could facilitate the direct reuse of floor space slabs. This was successfully demonstrated in Switzerland, where reinforced concrete slabs from a 1980s residential building in Geneva were reclaimed (Küpfer, et al., 2024). The 15-cm-thick cast-in-place slabs, spanning 3.10 meters, were reused directly, achieving up to an 88% reduction in GWP compared to new construction, highlighting the environmental benefits of material reuse.

To fully capitalise on the potential of SRMs in Ireland, investment in various recovery, reuse, and recycling initiatives is essential. Both public and private sectors must collaborate to improve infrastructure, technology, and regulatory frameworks. Exploring innovative recycling methods to improve the recovery rates of construction material is crucial in encouraging an emerging SRM market.

Case Study: Treasury Building, Dublin – Reusing Materials

Originally built in 1946 as Boland's Bakery, this four-story, steel-framed, brick-clad building underwent renovations in 1986, which added a fifth floor and an entrance atrium. In 2022, planning permission was approved for a further vertical extension of two stories and a horizontal expansion of the atrium.

The proposed works required strengthening and modifying the existing steel structure. Additional steel was introduced, while redundant steel components were carefully removed, sent to a steel fabricator for alterations, and re-certified as CE-marked materials following procedures outlined in SCI Publication P427. This allowed the steel to be reused in the building as if it were new, significantly reducing embodied carbon. Reclaimed steel embodied just 50kgCO_2e/m^2 compared to 2,450kgCO_2e/m^2 for new blast furnace steel.

Sustainability efforts extended to the building's raised access floor tiles, which were lifted, sorted, cleaned, and reused on new pedestals. Only about 5% of damaged or cut tiles were discarded. Additionally, reinforced concrete removed during modifications was crushed, screened, and graded for reuse as recycled aggregates in unbound applications (Government of Ireland, 2021).

Reduce dependency on Critical raw materials

Critical raw materials such as cobalt, lithium, and silicon are essential for Europe's green and digital transitions, enabling technologies like electric vehicles, renewable energy, and advanced electronics. Classified as "critical" due to their economic importance and high supply risk, CRMs are central to Europe's sustainability goals.

The EU's Critical Raw Materials Act (CRMA), effective in Ireland since May 23, 2024, sets binding targets to reduce Europe's dependency on third-country suppliers of critical raw materials. By 2030, member states must ensure that at least 10% of annual CRM consumption is sourced from EU extraction, 40% from EU processing, and 25% from recycling. The Act also limits reliance on a single non-EU country to no more than 65% for any strategic material. To meet these targets, Ireland must establish a National Exploration Programme, streamline permitting, and invest in domestic CRM supply chains and recycling infrastructure (European Commission, 2024a).

However, due to their high supply risk, recycling alone is insufficient to significantly reduce the need to extract critical raw materials. A comprehensive Circular Economy approach—integrating design, reuse, repair, remanufacturing, and consumption reduction—is vital to addressing supply challenges and environmental impacts (Suarez, 2024).

Case Study: Circular Pavilion Amsterdam

The project integrates principles of circular design to minimise waste and maximise flexibility. The building avoids unnecessary components: pipes and cable ducts are left exposed, and no fitted ceilings were installed. Material efficiency was prioritized by slightly oversizing beams, making them easier to reuse, and by sourcing leftover wood from suppliers for the restaurant and other interior spaces.

To reduce the use of virgin and non-renewable materials, Circl incorporated reclaimed elements such as hardwood floors from a former monastery and a bar from a Dutch football club. Walls in the basement conference rooms were sourced from an old Philips building. In an effort to lower the use of carbon-intensive materials, the original concrete-heavy design was revised; instead, large larch wood beams were used and screwed together to enable easier disassembly. Denim jeans were repurposed as insulation material, further reducing the project's environmental footprint.

Versatility and convertibility were embedded in the structure. Open-plan layouts allow spaces to easily accommodate changing needs. The basement serves as a conference room during the day and an event space during evenings and weekends. Office infills can be adapted over time, and the building skin can be detached from the superstructure to enable future horizontal expansion.

Ease of access to services was prioritised by using visible screw, bolt, and clamp connections, facilitating maintenance and upgrades. Independence between the skin and superstructure was maintained, allowing components to be replaced or adapted separately.

Unnecessary finishes were deliberately avoided: beams were left unpainted to preserve their reusability. Components were designed to be simply sawn off at connection points, making them immediately suitable for reuse in new projects. In addition, Circl implemented a "lift-as-a-service" model, leasing elevators rather than purchasing them, thereby encouraging service-based circular business practices.

The whole case study can be viewed in the following link:
https://www.cie.nl/Circl?lang=en

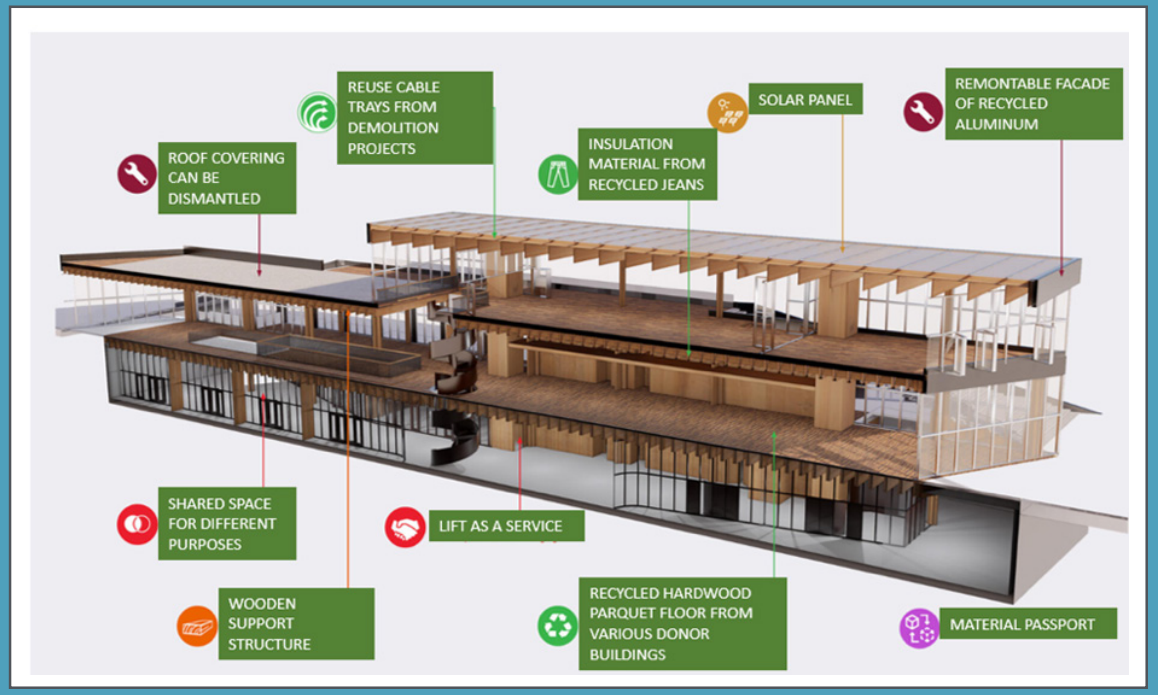

Figure 25: Examples of circularity within Circl (Hammink, 2017).

7.3 CLOSE THE MATERIALS LOOP ACTIONS

7.3.1 2026 - 2030

Develop the bioeconomy for construction

Government

G1. Enable greater use of Irish timber in construction through prompt completion of the work of the Timber in the construction working group, removing regulatory barriers, including fire performance, where safe practices and scientific evidence support use of timber.

G2. Support the development of a broader range of bio-based materials for use in construction, as necessary, through a similar approach to timber as noted in G1, focusing on Agri-crop by-products, seeking to extract maximum value from existing crops such as cereals (straw), grass, such as press cake, sheep production (wool), and industrial hemp.

G3. **Mandate pre-development audits to justify demolition and pre-demolition audits at the planning stage, where demolition is permitted.**

G4. Introduce a multi-annual fund (€30 million per annum) open to all three parts of supply/production/demand stakeholders to kickstart support for farmers, the development of production facilities, and the development of pilot projects to build capacity in the industry.

G5. Develop an infrastructure of 'eco-park' business clusters and collection hubs that combine bioeconomy processing and cluster companies to maximise value extraction from agricultural products for food, chemicals, and construction materials.

G6. Support construction projects with new capital funding using innovative low-carbon products to cover additional design team costs in piloting innovative products and enabling the sharing of outcomes and learning.

G7. Develop a public procurement strategy for bio-based materials to support demand (e.g. Minimum % requirements for biomaterials).

G8. Introduce Life Cycle Global Warming Potential (LCGWP) limit values ahead of the EPBD deadlines to drive demand for bio-based materials.

G9. Review the existing licensing process for industrial hemp production.

G10. Advocate for the development of specific European Standards for bio-based products. For example, bio-based insulation has different characteristics from fossil or mineral-based insulations.

G11. Implement the findings of the Wool feasibility report and support the development of facilities for the production of insulations and other materials available from wool (DAFM, 2022).

G12. *Increase funding to support the development of bio-based materials in Ireland, including export potential.*

G13. *Develop national standards or a range of standards to promote and develop bio-based materials and processes.*

G14. *Invest in the development of the bioeconomy for construction materials, with the government driving simultaneously supply through support for growers, investment in production, and demand through procurement.*

Construction Sector

C1. Engage in exemplary demonstration projects to build experience in the use/specification of these materials.

C2. Integrate bio-based material options at the early design stage within the project specification.

C3. **Capture critical raw materials from the construction sector for secondary markets as required by the European Union CRMA[27].**

Actions in italics to happen closer to 2030

27. More information about Critical Raw Materials Act (CRMA) is available on the following link: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan/european-critical-raw-materials-act_en

C4. Manufacturers and verifiers to work with EPD Ireland to offer information on end-of-life options and circularity for designers and contractors.

C5. Upskill in technical knowledge and the application and use of bio-based materials.

C6. *Increase targets for using a significant percentage of locally produced bio-based materials.*

Producers & Solution Providers

P1. Carry out R&D assessing at the potential for bio-based materials for use in products and MMC.

P2. Engage with material suppliers to pilot 'take back schemes' from site waste products to recycle, for example, plasterboard, insulation, timber, wiring etc.

P3. Make greater use of renewable bio based materials in lieu of petrochemical based ingredients.

P4. *Invest in R&D, including ensuring carbon storage benefits are not lost at the end of life.*

P5. *Support the development of processing and production facilities for various types of bio-based construction materials.*

Finance, Legal, and Insurance

F1. Engage in the development of an 'Insurance Playbook' for the use of Mass Timber Insurance in Ireland.

F2. Consider developing similar playbooks for other novel bio-based building systems, similar to The Mass Timber Insurance Playbook: A Guide to Insuring Mass Timber Buildings (ASBP, 2023).

F3. Invest in producers providing low-carbon solutions to the market.

F4. Consider financial support through grants/reduction in Value Added Tax (VAT) for innovative low-carbon materials, including bio-based materials.

F5. *Invest in low-carbon biobased solutions, ensuring additional benefits such as carbon storage and end-of-life benefits are optimised.*

F6. *Fully align capital flows with the EU taxonomy and CSRD, supporting farmers and producers to drive forward regenerative materials for the construction/bio-materials supply chain.*

Educators & Awareness Raisers

E&A1. Integrate the structural design of timber, as well as the best practice design for durability and fire performance of timber and bio-based materials, into all undergraduate construction courses.

Ensure greater reuse and recycling

Government

G1. Streamline re-certification systems to enhance the credibility and adoption of pre-used products and materials.

G2. Carry out a full review of the implementation of Art. 27 & 28 of the Waste Framework Directive in Ireland to better support reuse, ensuring the EPA have sufficient resources to process art. 27 & 28 applications quickly and smoothly, and the fee for doing so is not prohibitive.

Actions in italics to happen closer to 2030

G3. Develop the market for secondary materials through collaboration between the Government and industry to streamline the implementation of Articles 27 (By products) and 28 (End of waste) of ECOS Environmental Consultants and recertification, and develop physical and digital marketplaces, as well as targets for reused materials in procurement.

G4. Support the development of secondary raw materials depots and marketplaces to facilitate reuse (publicly operated and/or facilitated), potentially collocating in Eco-business parks with bioprocessing and EPR collection points to enable company clustering.

G5. Provide further certainty to industry on TGD Part D (section 1.1 Fitness of materials) and how the reuse of material can be supported particularly for major building elements such as precast flooring, facades with regard to the revised CPR.

G6. Develop a legal framework for a Digital Building Logbook to capture and centralise data, hence facilitating reuse, with the potential for cross-referencing to other legislative requirements, such as the EPBD and the CPR.

G7. Leverage financial incentives for pre-demolition audits, pre-renovation audits and local recycling.

G8. Pilot the concept of Regulatory Sandboxes for circular construction.

G9. Broaden BIM mandate to address circularity metrics and minimum requirements.

G10. Develop a national construction & demolition use hierarchy as an output to set out preferred options for the management of C&D waste resources.

G11. Undertake ongoing review of policies, standards and guidelines as feasible, to increase circular design principles in concrete, steel and other material value chains in Ireland. This includes TII, National Standards Authority of Ireland (NSAI) and Department of Housing, Local Government and Heritage publications. It also includes European Standards adopted as Irish Standards.

G12. Creation of Material Passports and building logbooks to include all the materials that are included in a product or construction during its life cycle to facilitate circularity decisions in supply chain management, and promotion of the use of digital material passports for tagging and tracking along the full lifecycle of a product, material or system. Use of BIM for material passports, component and assembly labelling and identification.

G13. Creation of quality criteria for secondary raw materials and their provisioning processes, as well as clear requirements (e.g. obligatory recycled quantities in the products) and regulations on their use.

G14. Establishment of goal agreements for the amount of renewable or secondary raw materials in new products within the framework of industry agreements.

G15. Fund research and pilot projects focused on reducing Critical Raw Materials (CRM) dependency through material substitution, product redesign, and greater efficiency in CRM use.

G16. Revise the Circular Economy Strategy to include specific objectives and actions related to the sustainable management of CRMs, aligning with the EU's Critical Raw Materials Act.

G17. Development of National Standards for Non-Portland Cements for use in concrete.

Construction Sector

C1. Work in close collaboration with the Government to develop re-certification standards to support reuse, for example, on raised access flooring.

C2. Support the reuse of materials through existing mechanisms, for example, TGD Part D (Section 1.1 Fitness of Materials), and share best practices and application findings.

C3. Invest in technology to increase the value of recovered materials from demolition, e.g., smart crushers to recover cement from concrete, and robotics to recover building elements.

C4. Set out targets for reused/secondary materials in construction, and require Life Cycle Assessments (LCAs) with all planning application submissions, with additional requirements for buildings of 1,000 sqm and over in line with the current EPBD.

C5. Coding or use of materials passports of construction materials, components, and assemblies to facilitate deconstruction and reuse.

C6. Contractors to sign up to Materials Exchange Platforms such as (CMEX) and integrate it with procurement, estimating and contract management functions.

Producers & Solution providers

P1. Adopt material exchange platforms, as already existing in other EU countries.

P2. Establish a technical framework for certification and standardisation for the reuse of construction products.

Finance, legal and insurance

F7. Support compliance with EU Taxonomy, Corporate Sustainability Reporting Directive (CSRD) and other relevant legislation.

Educators & Awareness Raisers

E&A1. Increase the use of technology and invest in R&D to enable recycled materials to move up the value chain, for example, via innovative crushers for cement and building element recovery via smart demolition.

7.4 CLOSE THE MATERIALS LOOP 2030 INTERIM TARGETS

- Minimum targets in place for bio-based materials.
- Supply chains established for a variety of agri-based materials.
- GPP targets set for 15% recycled material use within buildings.

7.5 CLOSE THE MATERIALS LOOP 2040 TARGETS

- 100% materials from deconstruction reused/recycled.
- 100% of materials from / or can enter non-toxic closed loop supply chains.
- Optimised use of regenerative & biobased materials within viable capacity.

8. CHANGE THE BUSINESS MODEL

KEY RECOMMENDATIONS

Establish Extended Producer Responsibility (EPR) schemes for construction materials, to reduce levels of construction and demolition waste, and capture materials for reuse.

Incentivise producers to switch to Product as a Service (PaaS) where appropriate to retain ownership and control of products.

Sharing measurable indicators, providing a common language between the procurer and supply chain, enabling the setting and achievement of ambitious targets.

This section introduces the importance of innovative business models and highlights key recommendations for stakeholders to enhance the circular economy in the Irish construction and built environment. These concept models are defined as follows.

- **Extended Producer Responsibility (EPR)**
- **Product as a Service (PaaS)**

8.1 IMPLEMENT EXTENDED PRODUCER RESPONSIBILITY (EPR)

Originally, EPR was developed as a strategy for managing products at their end-of-life, primarily to fund the proper disposal and treatment of waste across different streams. However, it also has significant potential to foster a secondary market for materials and encourage business models that advance circular economy principles. In addition, EPR can drive manufacturers to make more sustainable design choices, as the environmental impact is factored into the shared costs between consumers and producers (BPIE, 2024). Figure 26 illustrates that waste management fees and responsibility are moved from the local authority to the producer itself.

In construction, there are collective EPR schemes in Europe. For instance, the Netherlands has an EPR scheme focused only on flat insulation glass, and France on two categories of Construction and Demolition waste, inert waste and other materials, products such as rockwool, glass wool, plastics, metal and wood.

There are also examples of Individual EPR systems in Ireland and Europe, including take-back schemes, such as:

- Gypsum plasterboard Ireland[28]
- Stonewool Insulation UK[29]
- timber construction products[30]
- bricks[31]
- bitumen roofing[32], or
- interior fittings, such as floor panels, wooden doors, or partition walls[33].

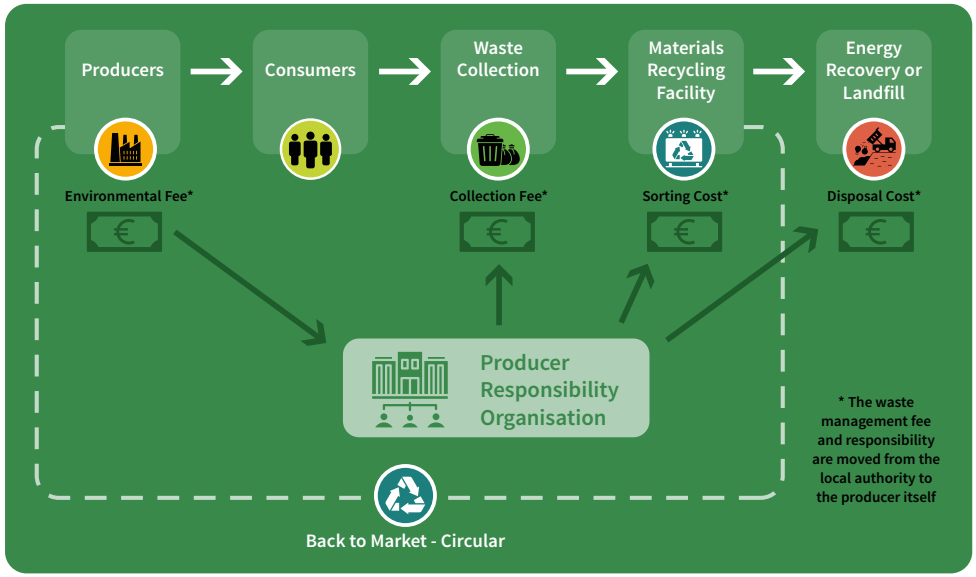

Figure 26: Fees and Responsibilities - Adapted from Ramasubramanian (2023).

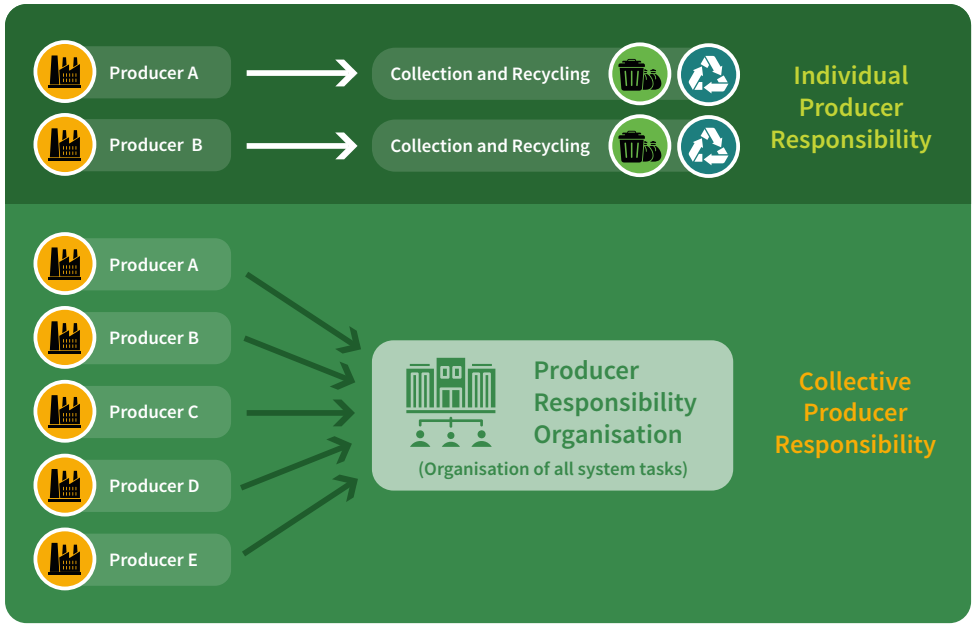

Figure 27: Individual and collective Producer Responsibility schemes (BPIE, 2024).

28. Plasterboard manufacturers, see Gyproc Saint-Gobain website.
29. The Recovery, Recycling Technology Worldwide magazine focuses on recycling strategies worldwide; see the recovery website.
30. DERIX is a group of companies specialising in timber engineering. See Derix website.
31. Wieneberger is an Austrian brick maker, leading manufacturer of roof tiles, see Wieneberger's website.
32. Derbigum is a roofing company which offers waterproofing solutions, see Derbigum website.
33. The Linder group is an Austrian agricultural machinery manufacturer, see Linder website.

EPR and compliance schemes currently available in Ireland are listed in Table 3. All business-led compliance schemes were licensed by the Irish government under the following legislation framework and existing conditions: Relevant EU Directives (e.g., Packaging, Batteries, and Waste Electrical and Electronic Equipment (WEEE)) and texts transposing them into Irish law.

EPR/COMPLIANCE SCHEMES	DESCRIPTION
Packaging, end-of-life vehicles, and farm plastics	Due to the extensive self-compliance requirements, most major packaging producers in Ireland have joined the country's sole compliance scheme for packaging waste, which is managed by Repak Limited. A similar program exists for end-of-life vehicles (Elves), and there is also an equivalent scheme for farm plastics, which is operated by the Irish Farm Film Producers Group (IFFPG) and overseen by Repak Limited.
Waste Electrical and Electronic Equipment (WEEE) and batteries	Two compliance schemes in Ireland to collect WEEE and old batteries: WEEE Ireland and EPR Ireland.
Waste tyres	Two compliance schemes: Tyre Recovery Activity Compliance Scheme and Tyre Waste Management Limited. Both schemers are regulated by local authorities.

Table 3: Extended Producer Responsibility Organisations (PRO) operating in Ireland (Impoco, et al., 2021).

Case Study: France: EPR for Construction and Demolition (C&D) Waste.

In 2023, France became the first country to implement EPR for C&D waste. It differs from the Netherlands scheme for flat glass, which was introduced only after market actors agreed to it. The broader scope of the French EPR initiative was, in part, a response to the significant reduction in landfill capacity, to address illegal dumping of construction waste, and to promote recycling and the reuse of materials. The regulation mandates that all producers—including manufacturers, importers, and distributors—of specific products and materials are responsible for managing the end-of-life phase of their goods. They are required to pay an “eco-contribution” per unit of product placed on the market to a non-profit Producer Responsibility Organisation (PRO), referred to as an eco-organisation.

Currently, there are four PROs, which are tasked with overseeing waste management activities such as collection, recycling, and treatment (Jacques, 2021). The scope of materials covered includes inert waste and a variety of other products, such as metals, wood, chemicals, joinery, plaster, plastics, bituminous membranes, glass wool, rock wool, and bio-based plastics.

The eco-contribution fees are calculated based on the type and weight of the products (e.g., per unit, linear meter, or weight), and these fees will be increased annually until 2027 to align with the evolving costs of waste management. In business-to-business transactions, invoices must break down the fee amounts. Each PRO is required to publish a price list that specifies the fees producers must pay (Jacques, 2021). A key part of the implementation is ensuring that there is a dense collection infrastructure with one PRO trying to ensure collection points not greater than 10 Kilometres in urban areas and 20 Km in rural areas.

The full case study can be viewed at the following link: https://www.bpie.eu/wp-content/uploads/2024/06/Extended-Producer-Responsibility-in-Construction-June-2024.pdf

8.2 IMPLEMENT PRODUCT AS A SERVICE (PAAS)

PaaS model shifts away from traditional ownership towards a service-oriented approach, emphasising access over ownership and placing responsibility in the hands of manufacturers (NikKhah, 2024).

The PaaS business model can take various forms:

- **Pay for Use:** Customers pay for the output they receive rather than owning a product, with fees based on usage metrics such as hours of operation or data transferred.
- **Leasing:** Customers acquire the right to use a product for a longer-term, usually with exclusive and individual access rights.
- **Rental:** Customers rent a product for a short-term period, typically less than 30 days. Rental agreements are generally more flexible than leases, with no guarantee of unlimited access.
- **Performance Agreement:** Customers purchase a service with a guaranteed level of performance, where companies commit to achieving specific outcomes.

Furthermore, the PaaS model can drive performance improvements by ensuring suppliers guarantee uptime, maintenance, functionality, and availability. This is particularly valuable when users lack the capacity to manage these aspects themselves.

The model reduces risk by alleviating customers of the financial burden associated with product ownership, maintenance, and disposal once products have reached the end of their useful life. Leading manufacturers of industrial equipment, construction machinery, and heavy machinery have already developed mature PaaS offerings.

PaaS has particular potential where there is a requirement for regular maintenance or rapid turnover, such as fit-outs. Examples that already exist include lifts as a service, lighting as a service and carpet as a service. Irish company Arcology proposes an interior construction fit-out system that combines DfA and DfD and can be leased. The Circular Buildings Coalition has published a number of white papers, including product as a service for building services and façade as a service, exploring how contractual and legal issues could be dealt with (Circular Buildings Coalition, 2025).

Digital technologies such as BIM, Digital Product Passports (DPPs), and traceability tools facilitate real-time data exchanges between users, machines, and management systems within the PaaS framework.

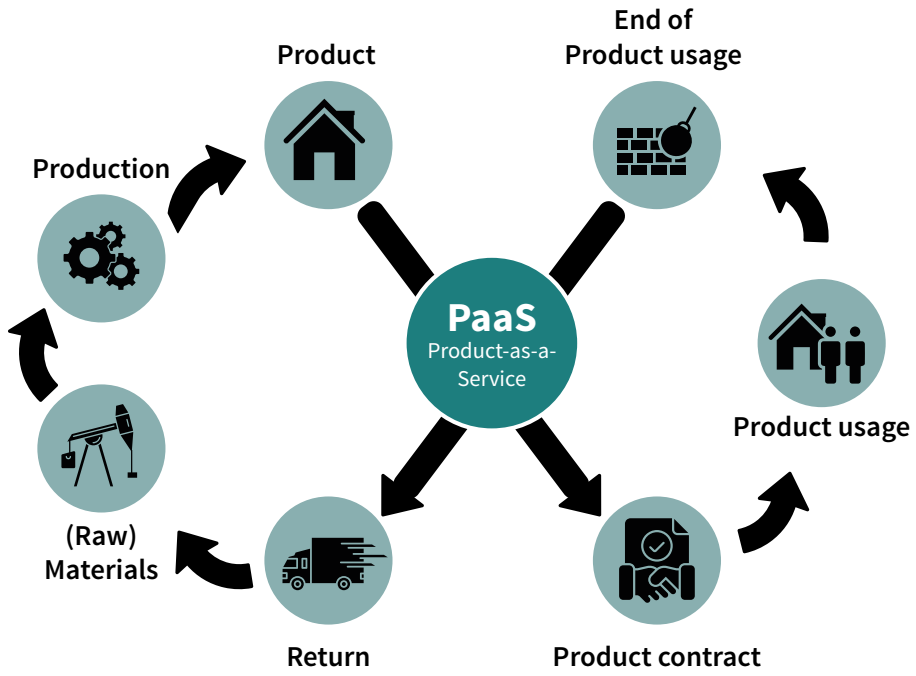

Figure 28: Product as a Service stage -Adapted from Olsen (2024)

Case Study: The Netherlands - Lighting as a Service (LaaS)

Philips, in collaboration with architect Thomas Rau, developed a "Pay per Lux" service at Amsterdam's Schiphol Airport. In this model, the airport pays based on the amount of light consumed, rather than owning the lighting system itself. Philips acts as the primary contractor, meaning that the company is responsible for both the installation and the energy costs associated with the lighting while retaining ownership of the equipment. At the end of the contract, Philips takes back the lighting products, reintegrates them into the production process and reuses the raw materials. This minimises waste production and maximises recycling (One Planet Network, 2022)

The customised service allowed the airport to reduce initial installation costs for energy-efficient lighting while benefiting from regular upgrades and ongoing maintenance. This model ensures that ownership of the fittings and controls remains with the vendor throughout the entire lifecycle, including recycling. Instead of purchasing lighting outright, users now rent it, turning what would be a capital expenditure into an operating cost (One Planet Network, 2022).

Key Stages for Delivering PaaS to Customers

1

DEVELOPMENT OF OFFERING AND CONTRACT

- Establish a Clear Financing Structure: Define a sustainable and scalable financial model.
- Assess Customer Readiness: Evaluate customer preparedness in terms of operational, technical, and financial capacity.
- Ensure Provider Readiness: Verify that the provider's resources, processes, and infrastructure align with the proposed PaaS model.
- Prepare Network Readiness: Organise delivery partners and sub-suppliers, such as installers, to ensure seamless deployment.
- Ensure Partnership Readiness: Strengthen collaborations with key stakeholders and partners to support delivery.

2

CONTRACTING STAGE (BETWEEN PAAS PROVIDER AND CUSTOMER)

- Identify and Screen Opportunities: Prioritise and select potential projects based on feasibility and alignment with strategic goals.
- Develop Detailed Proposals: Create comprehensive proposals tailored to customer needs and objectives.
- Negotiate Contract Terms: Finalise mutually beneficial terms that reflect both parties' expectations and obligations.
- Handover to Delivery Team: Transition from negotiation to execution, ensuring alignment and readiness across teams.

3

EXECUTION AND DELIVERY OF CONTRACTS

- Implement and manage the PaaS offering efficiently, focusing on meeting contract specifications and customer expectations.

4

LONG-TERM MANAGEMENT

- Continuously monitor and optimise the contract lifecycle, emphasising service quality, customer satisfaction, and performance enhancements.

5

KEY CLAUSES FOR PAAS CONTRACTS:

To ensure alignment and accountability, the PaaS contract should include:

- **Energy Efficiency Targets:** Define measurable goals for reducing energy consumption.
- **Performance Metrics:** Specify system reliability benchmarks, including limits on downtime and performance issues.
- **Optimised Maintenance Schedules:** Outline proactive maintenance plans to sustain system performance and longevity.

8.3 CHANGE THE BUSINESS MODEL ACTIONS

8.3.1 2026 - 2030

Government

G1. Start a dialogue with producers and industry and define the approach for construction Extended Producer Responsibility (EPR) schemes in Ireland:

- **G1.1.** Define the approach for EPR, mandatory or voluntary.
- **G1.2.** Map who is legally the "producer" and clearly define the role and responsibilities of the procurer/developer and the contractor.
- **G1.3.** Set clear responsibilities and obligations for companies and manufacturers who bring construction products to market with regard to end-of-life.
- **G1.4.** Facilitate the establishment of EPR for construction materials through a licensed, approved body (SI 149, 2014, Part 4, pages 45 to 47) organisation.
- **G1.5.** Define whether infrastructure, for example, collection processing, is fully funded from Eco modulation fees initially or subsidised as per French EPR and the potential for location within 'eco-park' business clusters and collection hubs to maximise cross-sector value optimisation.

G2. Develop policy and flexibility within public contracts to incentivise sustainable innovation and promote advanced models like PaaS.

G3. Set conditions, such as tax depreciation and free take-back, to allow second-life products/remanufactured/refurbished to have a final cost equal to or lower than new equipment.

Construction Sector

C1. Asset managers (including public sector) are to update tenancy agreements to include provisions for the take-back of end-of-life products and fit-outs made from responsible materials. Additionally, incorporate clauses that promote modular and adaptable fit-outs to enhance flexibility.

C2. Use the recognised Configure, Price and Quote (CPQ) system to evaluate service performance, carbon, and circular materials metric. This will allow contractors to benchmark the best economic value and improve the suppliers' selection process.

C3. Establish a connection between product design choices and their end-of-life status, focusing on disassembly efficiency and circularity to enhance decision-making and long-term product sustainability.

C4. Develop strategies to address challenges around data availability and complexity in disassembly analysis. For example, streamline data collection processes and enhance systems for handling and processing disassembly-related data.

C5. Adopt early circular procurement and research of construction material options to secure supply and explore alternative material options available.

C6. Increase collaboration between the Government and the industry to develop EPR schemes for a range of construction materials.

Producers & Solution providers

P1. Prioritise collaboration with legal experts and industry practitioners to ensure that the developed guidelines for PaaS are practical, legally robust, and tailored to specific contexts.

P2. Combine the existing lifecycle management tools and the DfD methodology to streamline data collection and improve design and disassembly processes.

P3. Liaise with the government to create a consortium of companies to promote the creation of an approved body (SI 149, 2014, Part 4, pages 45 to 47) that can apply to create EPR schemes under Irish legislation for specific types of construction products.

P4. Drive the greater use of PaaS where appropriate, particularly for mechanical and electrical equipment.

P5. Consider an EPR scheme for insulating materials, as there are many difficulties dealing with these materials in the demolition phase. Retrofit & Renovation methods and materials should also align with circularity principles. High embodied carbon insulation, which is difficult to reuse or recycle (such as polyurethane), should be phased out.

P6. Include warranty period or recertification with extended coverage to end-of-life conditions for reuse.

Finance, Legal, and Insurance

F1. Establish separate service contracts to govern the ongoing services provided by Service Companies to building owners or Property Owners Associations.

F2. Implement a dual-contract approach, looking at operational efficiency and flexibility to enable the seamless integration of circular PaaS models in the built environment. This will safeguard tenancy rights and ensure continuity of service over the contract term.

Educators & Awareness Raisers

E&A1. Business schools to modify curricula to encompass new & innovative business models.

E&A2. Complete research into implications in relation to liability, indemnity, and insurance as it relates to the mechanisms of the implementation of circular economy principles in the construction sector.

8.4 CHANGE THE BUSINESS MODEL 2030 INTERIM TARGETS

- Extended Producer Responsibility schemes in place for a variety of construction materials.
- PaaS models becoming available and supported by government and industry.

8.5 CHANGE THE BUSINESS MODEL 2040 TARGETS

- All materials within Extended Producer Responsibility (EPR) schemes.
- Product as a Service widely used.

9. ENABLE THE CIRCULAR TRANSITION

KEY RECOMMENDATIONS

Ensure agile planning, regulatory and certification systems that facilitates innovation whilst ensuring safety and compliance.

Facilitate procurement practices to act as a driver and enabler of a circular innovation ecosystem supporting contracting authorities, suppliers and contractors.

Support all in the value chain, including procurers, design professionals, contractors, and building operatives, to upskill and share learnings regarding circularity solutions.

Invest in activating private sector investment within circular economy transition for the construction industry.

Support digital solutions which enable value traceability of components and materials, facilitating adaptation, repair, deconstruction, and reuse.

This section explores key areas in which Ireland can enhance the circular economy transition, focusing on regulatory systems, procurement strategies and developing skills and awareness. The regulatory framework plays a significant role in facilitating or hindering circular practices, and understanding how to tackle potential barriers is crucial for progress. Public procurement is a strategic lever for creating demand for circular products and services while fostering collaboration across the supply chain. Furthermore, a shift in skills and awareness is essential to support this transition, addressing gaps at various levels within the construction industry, policy-making, and business sectors. The concepts are defined as follows:

- **Strengthen Regulatory and Certification Systems.**
- **Mandate through Procurement**
- **Increase Awareness and Facilitate Upskilling**
- **Investment – Government and Private**
- **Digital Enablers**

9.1 STRENGTHEN REGULATORY AND CERTIFICATION SYSTEMS

The planning and regulatory system can create real or perceived barriers to the faster uptake of circularity. Examples have been highlighted in the preceding sections, such as the application of articles 27 and 28 of the Waste Framework Directive, planning requirements setting infrastructure requirements, and TGD Part D of the building regulations. As the circular economy develops, there will likely be additional issues that have not yet been identified. Hence, it is important that the regulatory system can deal with and anticipate issues that could act as barriers or slow down the adoption of innovation. There are several ways to do this. For instance, under the Dutch Green Deal (van Langen & Passaro, 2021) the government undertook to engage with an industry review of perceived barriers in the regulations. Regulatory sandboxes are another example that offers a general framework that innovators can apply to test their innovative products, services, and methodologies for a certain period (European Commission, 2023). The system of certification for new products and recertification of secondary materials and reused products or components will need to be fully streamlined to stop this from becoming a barrier. This can be facilitated by the requirement in the CPR for notified bodies to share documentation with other notified bodies.

9.2 MANDATE THROUGH PROCUREMENT

Public procurement is a strategic instrument for the Government to influence the market, and given that the Irish government's annual budget is approximately €100 billion, it can be leveraged to create demand for circular goods and services. This, in turn, can support circular business models and supply chains, including take-back schemes and 'servitisation' business models (Circle Economy, 2024). Public procurement can provide the industry with real incentives for investing and upskilling in circularity and provide other stakeholders with the confidence they need to support the transition. Additionally, **circular procurement helps to link supply and demand by encouraging the market to invest in innovative and circular solutions** (CityLoops, 2023), fostering collaboration across the value chain.

While circular procurement is often associated with the public sector, private investment can leverage procurement to integrate producers and contractors at the earliest stage of a project. Yet, procurement is currently not widely used this way in Ireland.

Focus on Circularity Benchmarks

The inclusion of circularity targets, based on the indicators included in the European framework for sustainable buildings, EU Level(s), as part of the brief and requirements for reporting at each design stage, enables the design team to follow a structured process for the integration of circularity solutions (European Commission, 2020). This should reward integrated design team working, allowing for early engagement with potential contractors, suppliers and service providers and enabling the identification of multiple opportunities for innovation. This approach requires an understanding of how innovation can be integrated into the process, particularly where there is only one or even no supplier.

In this sense, the procurement process's initial phase is crucial, as it defines needs and initiates market dialogue. During this phase, procurement strategies and opportunities need to be explored, including all the strategies identified in this roadmap. Three key elements could be prioritised:

1. Focus on services instead of products.
2. Consider the product's design, use phase, and end-of-life.
3. Emphasise market dialogue to encourage collaboration and innovation (SPP Regions, 2017).

Case Study: Circular Procurement - Mechelen, Belgium

The Impact Factory is a circular building project in Mechelen, Belgium. The renovation work done on the Impact Factory, including the Potterij building, was funded by a €1.4 million subsidy from the European Regional Development Fund and scheduled for completion in mid-2024. The building was renovated following the pillars of circular construction: dismantled building, replicable design, design for adaptability with movable walls, material passport, and digital twin.

The following circular procurement process was put in place: the first step was to inform through masterclasses, and well-known speakers were invited to speak about circular procurement. Masterclasses also gave the opportunity to attract interest and to highlight the aim and plans. They also acted as a kind of natural filter: interested parties started to team up and cooperate. Seven consortia ended up expressing interest. A jury with an independent chair narrowed the choice down to three. Then, dialogue sessions were held with each of them to talk in detail about the procurement documents and improve them where necessary based on feedback from all parties. Cooperation was a key driver as it dissolved the fragmentation that exists in the industry, but also internally in organisations when it comes to setting up a circular project (van 't Hoff, 2022).

9.3 INCREASE AWARENESS AND FACILITATE UPSKILLING

To date, awareness of circularity at a policy level in Ireland is generally focused on the lower levels of the waste hierarchy. Engagement by IGBC with design teams around piloting circularity plans in 2022, through the piloting of the CMEX material exchange platform in 2023, showed a lack of awareness amongst construction professionals. Interviews conducted with architects in 2024 confirmed a lack of priority given to circularity on projects.

General upskilling recommendations for the construction sector were made in the National Upskilling Roadmap 2030 (BUSI2030, 2024). These included the need to **connect the silos** through stronger governance and collaboration to develop a more effective and efficient construction skills eco-system. The need for the Government to mandate **ZEB Fundamentals Training** across the sector, with a focus on life cycle analysis and circular economy principles was also stressed. Finally, the need to support an innovative public awareness campaign to **maximise awareness of circularity** principles and solutions was highlighted.

In terms of educational provisions for students and those working in the construction industry, innovative and tailored content must be added to existing (short—and long-term) courses to reflect emerging technologies and methods addressing multiple key issues. These include circular economy processes, digitisation, life cycle assessment, life cycle costing, indoor air quality, water usage, and biodiversity.

Awareness raising and upskilling are needed in the following areas to enable Ireland to move up the waste hierarchy:

- Planning and systems level—Policymakers, Planners, Regulators, and Infrastructure Providers: System-levels awareness of the impact on resource use and circularity of the national spatial strategy, national infrastructure, housing policy, spatial standards, and local development plans is needed. As further research and guidance emerge, more specific training on how to optimise resource use at a strategic planning policy-making level will be required.
- Business development - Producers, Entrepreneurs, Developers: The implications and solutions for innovative business model development, including PaaS and new tenure models and typologies, will need to be understood and adopted.
- Procurement - Procurers (Public and Private): Procurement practices that enable the transition, including knowledge of shared indicators, also discussed in section 8.1., and new innovative ways of collaborating with the supply chain outside of traditional contracting practice.
- Digital skills—Producers, Designers, Property Owners: Use digital tools such as material passports, digital product passports and BIM to share data on products and materials used within buildings to facilitate reuse.
- Design - Designers: Application of circularity to design, including the use of indicators for design and construction, for adaptability, disassembly, leaner and resource-efficient design, and the use of innovative bio-based materials.

- Auditing – Consultants, Developers, Planners: Skills for those submitting and evaluating pre-development audits, including credible comparative analysis for carbon and resource use, as well as options for retention of structures and reuse.
- Deconstruction - Contractors, Designers: Auditing skills for recovery of materials, including carrying out pre-renovation and pre-demolition audits (European Union, 2024b). The piloting of the CMEX platform showed a lack of awareness of the importance of providing quality information on products offered for reuse. On-site skills for deconstruction and segregation to avoid contamination. This should include emerging technologies, including robotics and technology for the recovery of higher-value materials.
- Construction - Contractors: Skills in construction designed for deconstruction

9.4 INVESTMENT – GOVERNMENT AND PRIVATE

In the initial period up to 2030, the Government needs to play a role in activating private sector investment by providing certainty to the industry on the commitment to the circular economy. The private sector cannot activate the supply chain on its own. For example, targets, however low for circularity in green public procurement, can only be met if there is a supply chain to meet them. Private sector investment is dependent on there being confidence that there will be demand for their goods and services to develop these supply chains. The private sector also needs to show proof of concept and demonstrate their innovation, get support in getting to market, and demonstrate these innovations on real development/construction projects.

Construction is capital-intensive, and trying new construction methods and materials can demand additional design team time and added risk. Stakeholders, including developers and producers, have stated repeatedly during the consultation on this roadmap that it is necessary to de-risk innovation, and they would be more willing to try new approaches if some of the additional costs could be covered.

Government investment in the transition to circularity should go beyond funding desktop research to direct intervention to help create the supply chains. This will require the Government to invest directly in the supply of new models of circularity, increasing certification/recertification, funding production and storage infrastructure, and finally build capacity by offering capital funding for built demonstrator projects.

For example, the Netherlands, the leading circular economy in Europe, supports its bio-based construction strategy with a €200 million activation fund to help simultaneously tackle supply, production and demand.

On the private sector side, companies will need investment, and financial institutions need to understand the value of investing in the circular economy. Research from the Bocconi University, Ellen MacArthur Foundation, Intesa Sanpaolo (2021) showed the opportunities for financial institutions investing in companies, including those producing construction materials with a high circularity score.

After 2030, as the supply chain develops and new circular business models appear, it should be possible to transition from direct Government support to using fiscal and procurement incentives to accelerate the transition. Once there is a clear long-term strategy and targets in place, this will give the confidence to the private sector to continue to invest.

9.5 DIGITAL ENABLERS

The use of digital traceability tools integrated into BIM will play a key role in enabling the disassembly and reuse of materials at their highest level. Digital Tools such as Madaster[34] can enable the retention of all materials data, the calculation of the residual value of the materials in the building, and the potential for disassembly.

The Eco Design for Sustainable Products Regulation and the Construction Products Regulation will facilitate information tracking. They now mandate Digital Product Passports (DPPs) for most products in Europe starting in 2025. The DPP system will be implemented in principle in 2027 but will take several years to roll out for all products, starting with cement, rebar, windows, and insulation.

The European Commission (2019) on its Construction Products Regulations sets out the purpose: ‘In view of enhancing the circularity of construction products, in line with the goals of the Circular Economy Action Plan and the waste hierarchy,

34. More information about Madaster is available on the following link: https://madaster.com/

product requirements should also be able to improve resource efficiency, prevent waste generation, prioritise repair, reuse and remanufacturing, favour the use of secondary materials and address the recyclability of the product and the production of by-products'. Preparing for reuse, remanufacturing, and recycling requires certain design, namely by facilitating the separation of products, components and materials at deinstallation, deconstruction and demolition and the later stage of recycling, and, when possible, avoiding mixed, blended or intricate materials and substances of concern (European Commission, 2019).

The digital passports will include an enhanced DOP, which will contain lifecycle environmental data developed in compliance with EN15804 (International Standards, ISO 20887:2020, 2020).

It will be essential for the construction sector to work together with producers to embrace digitalisation to ensure seamless integration of data from DPPs into BIM and into the design and construction workflow, retaining quality data on new and refurbished buildings for the future, realising the ambition of 'buildings as material banks'.

9.6 ENABLE THE CIRCULAR TRANSITION ACTIONS

9.6.1 2026 - 2030

Government

REGULATORY

G1. Government to promote a supportive regulatory system that supports circular innovation, for example, through the use of regulatory sandboxes[35].

G2. Accelerate the restructuring and resourcing of NSAI to enable streamlined certification of products and systems as per the 2025 programme for government ·

G3. Establish a technical framework in terms of certification and standardisation for the reuse of construction products.

G4. Establish policy, regulations, standards, and incentives, as well as infrastructure, to support DfD, DfA, and flexible building use.

G5. Develop new standards, certification schemes, and regulations leading to the sustainable management of recycled materials in the framework of a circular economy (increase confidence in recycled materials).

G6. Review planning legislation and best practices in the context of circular economy and design principles, and provide clear guidance for integration into development plans of the impact of density, infrastructure ratios, building typologies, development mix, car parking provision, nature-based solutions and demolition on resource consumption.

G7. Support fast-tracking certification processes to encourage innovation.

PROCUREMENT

G8. Office of Government Procurement (OGP) to fully integrate measurable circularity indicators based on EU Level(s) into the Capital Works Management Framework (CWMF). For example, EU Level(s) indicators 1.1-1 1.2 and 2-2.1-2.4. and ISO standard 20887:2020

G9. Strengthen GPP mandate and implementation, such as:

- **G9.1.** Mandate circularity benchmarks with year-on-year improvements for projects over 5,000 sqm.
- **G9.2.** Establish minimum criteria for secondary, bio-based, reused materials and products.
- **G9.3.** Switch focus to the total cost of ownership using LCC indicators over the upfront cost.
- **G9.4.** Encourage the use of GPP tools, for example, the CO2 Performance Ladder, within the public sector[36].

G10. DPENDR/OGP to develop a strategy for collaboration models with the industry around circular procurement, such as the Dutch Green Deal approach.

G11. Require all tiers of mandatory training for procurers to be expanded to senior managers and consultant design teams. These should cover the integration of circularity at all stages of the procurement process, as well as innovation clauses[37].

G12. Develop standardised clauses, indicators, award criteria, and reporting templates to facilitate the integration of circularity at all stages of the procurement process in all public bodies, including smaller local authorities.

G13. Strengthen the technical staff support within the OGP construction procurement unit to proactively support Local authorities and public procurers to integrate and implement GPP and circularity.

35. Regulatory sandboxes provide a framework for testing products and services in a controlled, regulated setting. They aim to promote innovation while ensuring consumer protection and safeguarding the overall market. More information available at: https://www.wallstreetmojo.com/regulatory-sandbox/

36. The CO2 Performance Ladder is a GPP tool that helps public bodies buy green by incentivising engaged green suppliers to reduce emissions and encouraging others to start for a financial advantage in winning public contracts and tenders. Reduce CO2 emissions with the CO2 Performance Ladder - Irish Green Building Council

37. Structured interviews by IGBC with nearly 26 Irish architectural firms in 2024 revealed a limited understanding of what circularity in construction means, and this is likely replicated across procurement in Ireland, despite clear reportable indicators being in place since 2021 through the Level(s) framework.

G14. *Establish a Circularity/Innovation Procurement Centre of Excellence backed by an expanded circular innovation capital fund to assist in the development of a circularity innovation ecosystem.*

G15. *Develop open-source digitised tools to focus on the total cost of ownership and use to favour circularity models, (OGP).*

G16. *Support the uptake of low-carbon innovative technologies and processes through GPP and grants to improve resource efficiency, contribute to building capacity in the industry, and stimulate demand and support within circular processes, regenerative materials, and biomaterials. For example, require Environmental Product Declarations (EPDs) and Declarations of Performance and Conformance (DoPCs) for all materials.*

G17. *Expedite the delivery and implementation of the MMC Roadmap to strengthen circular approaches to building processes.*

EDUCATION AND AWARENESS

G18. Incentivise the upskilling of construction enterprises. For example, through tailored support.

G19. Use the local enterprise offices network to strengthen lean, green, digital, and circularity supports and advice at the local/regional level.

G20. Review and update the content of the mandatory Climate and Circularity Leadership training for Public Principal Officers/Equivalents on a regular basis.

G21. *Review viability to fast-track updates to public sector BIM Mandate to focus on micro, small and medium businesses and adapt the mandate to include circularity strategies and processes.*

G22. *Fast-track implementation of digital skills with a specific focus on supporting micro, small and medium businesses through Education and Training Board (ETB) Centres of Excellence.*

G23. *Encourage knowledge sharing.*

INVESTMENT

G24. Invest directly through capital funds in building the supply chain for bio-based materials, secondary and reused materials, in the order of €200 -300 million up to 2030.

G25. Invest in pilot projects to demonstrate new circular business models, new circular tenure/typology models, materials, and construction methods through a capital fund open to public and private developers.

Construction Sector

PROCUREMENT

C1. All: Upskill on circularity, including EU Level(s) indicators 2.1-2.4 and ISO circularity standards.

C2. Designers: Start integrating circularity plans from the early concept stage on larger projects and engage with the supply chain to ensure they are aware of the requirements and can support them.

C3. Adopt mandatory circular procurement for public tenders.

C4. *Apply measurable indicators aligned with EU Taxonomy (including indicators EU Level(s) 2.1-2.4) and ISO 20887:2020 circularity standards on all construction projects.*

C5. *Promote measures to improve the durability and adaptability of built assets in line with the circular economy principles for building design and developing digital logbooks for buildings.*

EDUCATION AND AWARENESS

C6. Establish approved registers for contractors, consultants and specialist installers focusing on sustainability/circularity metrics and linked to continuous professional development and recognition of prior learning.

Actions in italics to happen closer to 2030

C7. Promote the sector as a sustainable career option, and participate in a public campaign on career opportunities within the construction sector, with a focus on emerging technologies, circular economy, digitisation, retrofit, zero-emission strategies and nature-based solutions.

C8. Introduce mandatory training on the EU Construction & Demolition Waste Management Protocol (including pre-demolition and pre-renovation audits of construction works) for all demolition contractors.

C9. Promote and facilitate participation in green procurement training at scale.

C10. *Support and participate in existing built environment networks to encourage the sharing of best practices, case studies and innovation to promote a greater culture of collaboration.*

C11. *Strengthen connections and share insights with education providers.*

C12. *Participate in regular lean, green, and digital training and adopt these principles into work practices.*

C13. *Support training initiatives for carbon and digital literacy to address current and forthcoming ESG requirements, as well as regulatory changes, e.g., EPBD, CPR, RED and EED.*

C14. *Ensure appropriate Quality Control principles are in place and actively implemented, including circularity metrics.*

C15. *Promote a culture of design and delivery for performance (not just for compliance) with a view to exceeding minimums and anticipating future requirements while adopting circularity approaches.*

C16. *Promote innovation through the application of alternative processes and the use of emerging technologies to deliver more sustainable buildings.*

C17. *Support and encourage green leadership within the industry to promote green cultures in organisations.*

DIGITAL ENABLERS

C18. Accelerate the adoption of digital solutions, including the use of digital twins, working in collaboration with Producers and solution providers.

C19. Implement the use of digital solutions such as Material Passports to enable data on products to be retained for future use.

Producers & Solution providers

PROCUREMENT

P1. Collaborate with supply chain, government and certification institutions to co-develop a similar collaborative model to the Dutch Green Deal.

P2. Integrate more information on circularity in EPDs and/or material passports for all products to support reuse.

P3. *Increase collaboration with the Government, standardisation institutions, Enterprise Ireland and R&D to develop a functioning innovation ecosystem.*

EDUCATION AND AWARENESS

P4. Support the upskilling of staff and engage with the supply chain regarding circularity strategies.

P5. Continue to support the upskilling of staff and engage with the supply chain regarding circularity strategies.

P6. *Adopt Circular economy tools and processes, e.g. EPR, PaaS, and Material Passports.*

DIGITAL ENABLERS

P7. Start work immediately to understand and implement the requirements of the CPR and ESPR, engaging in the standardisation of DPPs with all in the value chain, including authorities, ensuring easy interoperability of DPPs with BIM.

P8. *Producers of products where DPP standards are already available to implement DPPs for all their products.*

Actions in italics to happen closer to 2030

Educators & Awareness Raisers

E&A1. Academia, the government, the construction industry, and producers to be open to the use of new digital tools to achieve a circular economy.

E&A2. *Invest in development of the circular economy for construction, including it in research, innovative pilot projects, and new business models such as PaaS and EPR, and the sharing economy.*

Finance, legal and insurance

PROCUREMENT

F1. Develop financial products fully aligned with the EU taxonomy, including the circularity criteria.

F2. Be aware of the changes to the SFDR from 2025 regarding the new category of 'transition investments' to enable 'brown to green' investments to address the previous issue in articles 8 and 9 of disincentivising financing improvements in existing property assets.

F3. Engage the finance sector to identify key risks for investors/lenders, help financial institutions better understand the needs of circular businesses to enhance lending, investment solutions, and financing options (e.g., microloans, low-interest loans, innovative leasing, etc.), and expand sustainable finance taxonomy work to include circular economy.

F4. *Use public/private procurement and development finance to drive demand for circular processes and materials by integrating circularity indicators aligned with EU taxonomy, such as DfA and DfD.*

F5. *Continue to develop financial products fully aligned with the EU Taxonomy's circularity criteria.*

F6. *Use EU Level(s) to integrate life cycle assessment in public procurement and the EU sustainable finance framework, and exploring the appropriateness of setting carbon reduction targets and the potential of carbon storage.*

EDUCATION AND AWARENESS

F7. *Support bioeconomy and circularity strategies within green finance offerings.*

Educators

EDUCATION AND AWARENESS

E1. Establish, monitor, and regularly update a coherent system of Train the Trainer programmes and pathways for supporting upskilling of trainers in Further Education and Training and Higher Education systems. This should cover current and emerging issues, such as zero-emission construction, MMC, circular economy, indoor air quality, digitisation, and digitalisation in the built environment.

E2. Re-focus existing Nearly Zero Energy Buildings (NZEB) Education and Training Board Centres of Excellence (CoE) to focus on broader sustainability issues, and more specifically, circularity processes, covering topics such as the EU waste protocol and ZEB.

E3. Develop further CPD training programs for construction professionals, e.g. engineers, architects, energy advisers, planners, and ecologists, to address identified skills gaps such as circularity, lifecycle analysis, digitisation and digitalisation.

E4. Develop new training provisions on emerging technologies and processes, e.g. MMC and circular economy principles.

E5. Higher education institutes collaborate with education providers at the second level to promote new skills in construction as career opportunities (with a sustainability and circularity focus).

E6. Development of training and further education programmes for companies that promote circular thinking, abilities and competencies, in particular in seminars and workshops about eco-design, to support the development of new circular products, services and business models.

Actions in italics to happen closer to 2030

E7. Improve knowledge and capacity (within trades, engineering professions, architects, and inspectors) to support design for disassembly, deconstruction, and related practices from the beginning of a project, as well as the value of materials and resource recovery business models.

E8. There is a need to develop targeted training and education for architects and engineers on designing for circularity.

E9. *Utilise research outcomes to provide evidence and data to inform new programme development, as well as education and training pathways.*

E10. *Disseminate the work of relevant Government-supported initiatives such as the Digital Academy for the Sustainable Built Environment (DASBE) (HEA), Construct Innovate (Enterprise Ireland) and Build Digital (Project 2040 and the Construction Sector Group Innovation and Digital Adaptation) within the context of circularity approaches.*

9.7 ENABLE THE CIRCULAR TRANSITION 2030 INTERIM TARGETS

- Changes in the planning, regulatory and certification system start to facilitate greater integration of circularity.
- Procurement processes starting to be a driver of circular innovation systems.
- All in the construction industry have already started upskilling in circular solutions.
- Government and industry have started to invest in the transition to circularity.
- Digital solutions starting to enable traceability of components and materials, facilitating adaptation, repair, deconstruction and reuse.

Actions in italics to happen closer to 2030

APPENDICES

APPENDIX 01 - POLICIES AND REGULATIONS

European Policy	Description
1.European Green Deal	Published in 2021, the European Green Deal is the European Commission's strategy to achieve climate neutrality by 2050, decoupling economic growth from resource use. It has since led to the publication and update of various policies and pieces of legislation covering most sectors, including the built environment – See 1. a to 1.
1.a EU Circular Economy Action Plan	The Action Plan targets how products are designed, promotes circular economy processes, encourages sustainable consumption, and aims to ensure that waste is prevented and that resources used are kept in the EU economy for as long as possible. It includes a section on buildings mentioning the importance of durability and adaptability, of reducing soil sealing, measuring buildings' lifecycle global warming potential, the revision of the Construction Product Regulations (CPR), as well as the role of EU Level(s) as part of public procurement and the EU Sustainable Finance Framework.
1.b Energy Performance of Buildings Directive (EPBD) - Directive (EU) 2024/1275	The EPBD is the cornerstone of EU policies concerning the built environment. For the first time, the 2024 recast addresses the life-cycle global warming potential of buildings, with measurement requirements from 2028 for larger buildings, and targets and limits gradually introduced from 2030. This in turn should lead to greater resource efficiency.
1.c EU Level(s) framework	Level(s), the European Framework for Sustainable buildings is designed to provide standardised and comparable indicators that can be integrated into GPP, certifications, and regulations across Europe. For example, the 2022 revised working draft EU GPP criteria for the design, construction, renovation, demolition, and management of buildings (still to be released) is structured around the Level(s) indicators. The indicators are also an integral part of implementing the EU Sustainable Finance Package and the EPBD 2024 Recast. Level(s) contains 4 indicators for Resource-efficient and Circular Material life cycles: • 2.1: Bill of quantities, materials, and lifespans based on Unit quantities, mass, and years • 2.2: kg of waste and materials per m2 total useful floor area • 2.3: Adaptability score • 2.4: Deconstruction score. It provides detailed reporting frameworks, checklists and templates for reporting on these indicators.

European Policy	Description
	Many European certification tools, such as the Home Performance Index, are already aligned with the Level(s) and EU taxonomy indicators. Level(s) are also referenced in Ireland's National Policy on Architecture. Level(s) recognises that procurement of buildings is different from that of other goods, in that the design forms an integral part of the procurement process. Therefore, it sets out indicators at three levels that can be applied at the different stages of a project: - Level 1- a qualitative assessment that can be applied in early concept design; - Level 2 - a more detailed quantitative assessment at the advanced design and tender stage when it is possible to measure; - Level 3 assessment, which can be based on the actual performance of the project. This makes it possible to set reporting requirements at each stage of a project.
1.d Ecodesign for Sustainable Products Regulation (ESPR)	The ESPR aims to significantly improve the sustainability of products placed on the EU market by improving their circularity, energy performance, recyclability and durability. Although most construction products are covered under the CPR, specific circumstances may justify targeted intervention on construction products under the ESPR. This will be the case, for example for intermediate products (except for cement) and energy related construction products, which are already regulated under the previous version of the Ecodesign Directive. E.g., heaters, boilers, heat pumps, water and space heating appliances, fans, cooling and ventilating systems, and photovoltaic products.
1.e Construction Products Regulation (CPR)	CPR lays down harmonised rules for the marketing of construction products in the EU. It is a set of rules to ensure that construction materials are safe, perform well, and contribute to sustainability. The new CPR introduces the concept of Digital Product Passports, and establishes by default, mandatory declaration of a number of environmental characteristics, the priority being given to GWP for construction products from the end of 2025. As environmental standards evolve, additional metrics such as recyclability, resource efficiency, and toxicity will be phased in to provide a full lifecycle profile for each product.
1.f Critical Raw Materials Act (CRMA)	The objective of the CRMA is to ensure secure and sustainable supply of critical raw materials for Europe's industry, hence lowering the EU's dependency on imports from single-country suppliers. It promotes the recycling of raw materials and the transition to a strong secondary market. It covers a number of raw materials needed to support the green transition, including renewables.
1.g EU Sustainable Finance Package	The EU's Sustainable Finance Package is a comprehensive package of measures to improve the flow of investment towards sustainable activities, including greener buildings. Relevant pieces of legislation includes the EU Taxonomy, and the Corporate CSRD. Together, they create a cohesive framework that ensures investors are furnished with the requisite information to make well-informed decisions.

European Policy	Description
	The EU Taxonomy provides a definition of what characteristics economic activities must possess to be classified as environmentally sustainable, while the CSRD modernises, standardises and improves how sustainability is reported in business, and puts it on an equal footing with financial reporting. The transition to a circular economy is covered under both pieces of legislation.
2. EU Competitiveness Compass	Published in January 2025, the EU's Competitiveness Compass sets out areas to act regarding clean and affordable energy access, especially for energy-intensive industries such as steel, metals, and chemicals. Policy frameworks associated with this objective include the Clean Industrial Deal, the Affordable Energy Action Plan, and a new State Aid Framework.
2.a EU Clean Industrial Deal	Launched in February 2025, the Clean Industrial Deal it aims at helping industries decarbonise and to boost the clean tech sector amid US and Chinese competition. It includes a number of actions relevant for circularity in the built environment: - A Circular Economy Act should be published in Q4 2026, aiming to boost the uptake and free movement of secondary materials, and increasing the diversion of waste from landfill. - An Industrial Decarbonisation Accelerator Act to be published in Q4 2025. This proposes measures to reduce permitting bottlenecks for industrial and energy decarbonisation, and the development of a voluntary label on the carbon intensity of industrial products (part of a pledge to "simplify and harmonise carbon accounting methodologies") – e.g., label for cement under the CPR. - A revision of the EU Procurement Directive in 2026 to introduce sustainability, resilience and European preference criteria in public procurement.

National Policy	Description
Circular Economy Act - 2022	For the first time, the act defines the circular economy in Irish law. Among other things, it also improves Ireland's national regulatory processes, to encourage the safe and sustainable reuse of materials instead of treating them as waste. The act puts the Circular Economy Programme (2021-2027), and the Whole of Government Circularity Strategy (2021) on statutory footing. The next version of the strategy is now overdue (Q4 24), and should set out targets and metrics in respect of various sectors, including construction and electronic equipment.
Waste Action Plan for a Circular Economy (WAPCE)	The 'Waste Action Plan for a Circular Economy' goes beyond the management of waste and addresses how we look at resources more broadly, capturing and maximising the value of materials that may in the past have been discarded. The plan commits to fully embracing the opportunities towards becoming a circular economy in the decade ahead. It includes a target of reducing Construction & Demolition Waste by 12% by 2030.
Green Public Procurement Strategy and Action Plan 2024-2027	The Department of the Environment, Climate, and Communications has introduced the GPP Plan 2024–2027, updating Ireland's approach to GPP. The plan aims to align procurement strategies with environmental and sustainability goals. It emphasises green and circular procurement to promote resource-efficient, low-carbon, and less polluting solutions. It sets requirements for the integration of GPP criteria into directly procured publicly funded projects in accordance with EPA GPP criteria for office buildings, which is based on the EU GPP guidance from 2016 and overdue for update. There is now a requirement to use low-carbon processes and procure low-carbon cement. A minimum proportion of construction materials procured by public bodies under new contract arrangements must comprise recycled materials from 2025. – See Targets and actions supporting *Circular Procurement below*
Articles 27 and 28 of the Waste Framework Directive (as transposed into Irish law)	Article 27 on "by-products" allows an "economic operator" to decide, under certain circumstances, that a material is a by-product and not a waste. To simplify this process, national by-product criteria have been developed for 'site-won' asphalt (BP-N001/2023) and greenfield soil & stone (BP-N002/2024). Article 28 on "end-of-waste" gives waste holders the opportunity to demonstrate a waste material can be fully recovered, and used as a secondary resource (e.g., no longer defined as a waste). To simplify the process, national end-of-waste criteria have been developed for Recycled aggregates (EoW - N001/2023).

National Policy	Description
Ireland's Building Regulations & Technical Guidance Documents (TGDs)	The Building Regulations 1997 (as amended) apply to the design and construction of buildings. The minimum performance requirements that a building must achieve are set out in the Second Schedule to the Building Regulations. In general, building regulations apply to the construction of new buildings, to major renovation and to extensions and material alterations to existing buildings. In addition, certain parts of the regulations apply to an existing building where a material change of use takes place. Guidance on compliance with the various parts of the Building Regulations is given in the associated TGDs. Where works are carried out in accordance with the TGDs, this will, prima facie, indicate compliance with the Building Regulations. However, the adoption of an approach other than that outlined in the guidance is not precluded, provided that the relevant requirements of the regulations are complied with. Parts of the Building Regulations that are specifically relevant to resource efficiency include TGD D on Materials, and M on Adaptability.
Planning & Development Act 2024	Under the Planning and Development Act 2024, development includes the carrying out of works (for example, construction, demolition, alteration) on, in, over or under land, or the making of any material change of use of land or any structure on land. Generally, planning permission is required for any development of land or property unless the development is specifically exempted. Planning regulation can impact reuse, adaptative reuse and intensification of use.

APPENDIX 02 – PROCUREMENT

Key Actions and Targets in Ireland

Targets and actions supporting Circular procurement (DECC, 2024)	
The Built Environment - Target 1	From 2025, a minimum proportion of construction materials procured by public bodies under new contract arrangements comprises recycled materials (*). (*) This target will be updated following further data analysis and publication of the 2nd Whole of Government Circular Economy Strategy, which will include sectoral targets in relation to the construction sector. (Expected Q4 2024)
Social Enterprise and Community-Based Organisations, Reuse and Repair - Target 12	By the end of 2027, where possible and available, a minimum proportion of annual procurement by public sector bodies shall include used or repaired goods or materials.
Energy-related products, Heating Equipment, Indoor and Outdoor Lighting - Target 8	From January 2025, 100% of all tenders for the public procurement of energy-related products, heating equipment, or indoor and outdoor lighting to include a requirement for tenderers to specify recommendations and options for the product when the product or components of the product come to the end of life, that consider environmental sustainability, including options for reuse, repair, and recycling.
Research and Innovation - Action 53	By 2026, in consultation with key stakeholders, the EPA to develop a mechanism for the collection of data on GPP impacts and establishment of ongoing analysis and reporting on the impacts of GPP implementation in Ireland (e.g., emissions savings, energy savings, waste prevented, reduced material consumption, material reuse, reduced water consumption, air quality impacts). Initial focus on large-scale activities (e.g., construction) or specified priority sectors.

GLOSSARY

Adaptive reuse: It is the process of repairing and restoring existing spaces for new or continued use. This practice is similar to concepts such as retrofitting, refurbishing, and renovating, which involve updating a structure to accommodate different functions while considering usability and design solutions (Conejos, et al., 2012).

Bio-based Materials: Bio-based products are wholly or partially derived from materials of biological origin, including plants, animals, enzymes, and microorganisms such as bacteria, fungi, and yeast. Ranging from everyday essentials to groundbreaking innovations, these products are transforming industries and driving the shift toward a more sustainable economy (European Commission, 2015).

Critical Raw Materials (CRMs): are essential resources that are both economically and strategically vital to the European economy but face significant supply risks. These materials play a crucial role in various industries, including environmental technologies, consumer electronics, healthcare, steel production, defence, space exploration, and aviation. Beyond their importance for key industrial sectors and future innovations, CRMs are fundamental to ensuring the sustainable resilience of the European economy (European Commission, 2024a).

EU Taxonomy: is a green classification system that translates the EU's climate and environmental objectives into criteria for specific economic activities for investment purposes (European Commission, 2015). Design and construction should demonstrate Design for Deconstruction and adaptability, using, e.g. ISO 20887 or other standards.

Deleterious materials: Refer to substances or construction methods that pose health risks, negatively impact the environment, often fail in real-world applications, or may deteriorate over time (SUMMIT, 2019).

Digital Enablers, such as Material Passports and traceability tools, consolidate data on product components, environmental performance, and lifecycle stages. They enable informed decisions about material reuse, recovery, and recycling while supporting transparency and circular economy practices. Integrated with technologies like BIM, they drive resource efficiency and sustainable design (OECD, 2022).

Downcycling is the transformation of products and materials into products and materials of lower quality and/or value. This is the least preferable option in the waste hierarchy, but can still be better than standard practice for certain products. (FULL CIRCLE, FULL POTENTIAL, British Land's Approach to the Circular Economy)

Eco-modulated fees: Eco-modulated fees are a key component of EPR schemes, designed to incentivise more sustainable packaging practices. These fees vary based on the environmental impact and recyclability of packaging materials that producers place on the market (Eumonia, 2020)

Level(s): is a set of indicators and was developed by the EU to provide a common language for assessing and reporting on the sustainability performance of buildings. It is intended as a simple entry point for applying circular economy principles in our built environment (European Commission, 2020).

Primary Raw Materials (PRMs): Primary raw materials are virgin resources directly extracted from nature, including minerals, metals, fossil fuels, and biomass. These materials remain essential in today's economic landscape, particularly for emerging economies and the transition to low-carbon technologies. However, their extraction and utilisation can lead to considerable environmental impacts. Despite ongoing efforts to promote circularity, projections indicate that the demand for primary metals and minerals may continue to rise in the coming decades (SPI, 2021).

Regenerative Materials: Regenerative Materials and Construction promote sustainable development by reducing environmental impact, enhancing well-being, and supporting the local economy. They include bio-based materials like bamboo, straw, and hemp, as well as wood and earth-based solutions. The approach also integrates recycled and upcycled materials, repurposing construction waste and industrial byproducts. By transforming these resources, regenerative construction fosters ecological restoration and circular economy principles. This ensures safer, more resilient, and environmentally responsible building practices (EPA, 2024).

Regulatory Sandboxes: A regulatory sandbox is a general framework that innovators can apply to test their innovative products, services, and methodologies for a certain period. It may imply a derogation from standard regulations, subject to conditions imposed by the regulator, and in some emerging cases, derogation may not be necessary (European Commission, et al., 2023).

Secondary Raw Materials (SRMs): 'Secondary raw materials' are recycled materials that can be used in manufacturing processes instead of or alongside virgin raw materials. (European Parliament, 2024). They are derived from waste that has undergone recovery processes, enabling them to perform the same function as primary raw materials (SPI, 2021). SRM are sourced from post-consumer and post-industrial waste and processed to restore its functional value. They reduce the need for primary raw materials, conserve natural resources, and typically result in lower carbon emissions and energy usage compared to virgin materials. SRMs also enhance material supply security due to their local sourcing and can decrease production costs while increasing profit margins as consumers prefer sustainable options.

Sufficiency: A set of measures and daily practices that avoid demand for energy, materials, land and water while delivering human well-being for all within planetary boundaries (IPCC, 2023).

Vacancy: Primarily refers to vacant, derelict, or unoccupied properties. A building being classified as vacant for Census purposes does not necessarily imply that it is available for reuse. Census vacancy is a measure of vacancy, which may focus more on longer-term vacancy". Holiday homes are not part of the vacant dwellings count, nor are dwellings under construction or derelict properties (SCSI, 2023).

Vacant Homes: A vacant home is defined as any residential property that does not have anyone living in it (Citizens Information, 2023). This includes:

- Rental properties that are not currently rented out.
- Properties for sale that remain unoccupied.
- Homes that are undergoing refurbishment.
- Properties in probate following the owner's death

BIBLIOGRAPHY

Andersen, H. S. et al., 2014. *Housing and Housing Policy in the Nordic Countries*, s.l.: Secretary of the Nordic Council of Ministers Nordic Council of Ministers.

ASBP, 2023. *Mass Timber Insurance Playbook*, s.l.: The Alliance for Sustainable Building Products (ASBP).

Barrett, S. et al., 2024. *Benchmarking Embodied Carbon Baselines for Building in Ireland*, Galway: Construct Innovate.

Bertino, G. et al., 2021. Fundamentals of Building Deconstruction as a Circular Economy Strategy for the Reuse of Construction Materials. *Applied Sciences*, 11(3), p. 939.

Bocconi University, Ellen MacArthur Foundation, Intesa Sanpaolo, 2021. *The circular economy as a de-risking strategy and driver of superior risk-adjusted returns*., s.l.: Bocconi University, Ellen MacArthur Foundation, Intesa Sanpaolo.

BPIE, 2024. *Prioritising existing buildings for people and climate. Sufficiency as a strategy to address the housing crisis, achieve climate targets and protect resources*., s.l.: BPIE (Buildings Performance Institute Europe).

Brady, G. et al., 2024. *Viable Homes: Guidelines for planners on the design and building of low carbon, low rise, medium density housing in Ireland*, Dublin: s.n.

Brand, S., 1994. *How buildings learn: What happens after they are built*. New York: Viking.

British Land, 2024. *Full Circle, Full Potential*. British Land's Approach to the Circular Economy, s.l.: British Land.

BUSI2030, 2024. *National Upskilling Roadmap 2030*, s.l.: Technological University of the Shannon.

Cabeza, L. F. et al., 2022. *IPCC Sixth Assessment Report: Working Group III, Mitigation of Climate Change. Chapter 9: Buildings*., Cambridge, UK and New York, NY, USA: Cambridge University Press.

CCL, 2025. *Cork Community Land Trust is a New CLT for Cork City!*. [Online]
Available at: https://www.cclt.ie/
[Accessed 14 April 2025].

CGR, 2024. *The Circularity Gap Report Ireland*, Dublin: Circularity Gap Reporting (CGR).

Circle Economy, 2024. *Impact Report 2024*, s.l.: Circle Economy.

Circular Buildings Coalition, 2025. *Beyond the Fine Print: Contract Guidelines for Product-as-a-Service*. [Online]
Available at: https://www.circularbuildingscoalition.org/latest/beyond-the-fine-print-contract-guidelines-for-product-as-a-service
[Accessed 21 April 2025].

CIRCULÉIRE, 2024. *Circularity is a new way to design, make and use goods and materials*, s.l.: s.n.

Citizens Information, 2023. *Vacant homes*. [Online]
Available at: https://www.citizensinformation.ie/en/housing/vacant-homes/vacant-homes/
[Accessed 22 January 2025].

CityLoops, 2023. *Circular procurement in Europe: handbook for local and regional governments*, s.l.: CityLoops Project.

Conejos, S., Langston, C., Chan, E. H. W. & Chew, M. Y. L., 2016. Governance of heritage buildings: Australian regulatory barriers to adaptive reuse. *Building Research & Information*, Volume 44, pp. 507-519.

Conejos, S., Langston, C. & Smith, J., 2012. Designing for Future Building: Adaptive Reuse as a Strategy for Carbon Neutral Cities. *The International Journal of Climate Change: Impacts and Responses,* 3(2), pp. 33-52.

CSG, 2024. *Supporting the circular economy transition in the Irish Construction Sector*, s.l.: CSG.

CSG, 2024. *Supporting the Circular Economy Transition in the Irish Construction Sector Report*, s.l.: CSG Innovation and digital delivery subgroup sustainability and climate action consultative committe.

CSO, 2023. *New Dwelling Completions Q4 2023*. [Online]
Available at: https://www.cso.ie/en/releasesandpublications/ep/p-ndc/newdwellingcompletionsq42023/
[Accessed 22 01 2025].

CSO, 2024. *Census of Population 2022 - Summary Results*. [Online]
Available at: https://www.cso.ie/en/releasesandpublications/ep/p-cpsr/censusofpopulation2022-summaryresults/populationchanges/
[Accessed 18 February 2025].

DAFM, 2022. *Report on consultation on the potential for growing fibre crops and whether these crop have a viable market*, s.l.: Department of Agriculture, Food, and the Marine.

Daly, P. & Barril, P. G., 2024. Biobased Construction from Agricultural Crops: Paper 2 -Supply Chain Dynamics of European Case Studies. *International Journal of Architectural Engineering Technology.*, 18 September, Volume 11, pp. 36-59.

DETE, 2024. *Government approves public procurement guidance to promote the reduction of embodied carbon in construction*, Dublin: Department of Enterprise, Trade and Employment.

DGBC, 2021. *Framework for Circular Existing Buildings - Circular indicators for BREEAM (-NL) in use*., Copenhagen: Dutch Green Building Council (DGBC).

Dodd, N., Donatello, S. & Cordella, M., 2020a. *Level(s) indicator 2.3: Design for adaptability and renovation, User manual: Overview, instructions and guidance*, s.l.: European Commission.

Dodd, N., Donatello, S. & Cordella, M., 2020b. *Level(s) indicator 2.4: Design for deconstruction user manual: introductory briefing, instructions and guidance (Publication version 1.1)*, Seville: European Commission.

Ellen MacArthur Foundation, *2019. Annual Report 2019*, s.l.: Ellen MacArthur Foundation.

Ellen MacArthur Foundation, 2024. *Measurement and reporting for the circular economy*. [Online]
Available at: https://www.ellenmacarthurfoundation.org/topics/measurement/overview
[Accessed 18 02 2025].

eLSB, 2021. *Affordable Housing Act 2021*. [Online]
Available at: https://www.irishstatutebook.ie/eli/2021/act/25/enacted/en/html
[Accessed 17 April 2025].

EPA, 2024. *Construction & Demolition Waste Statistics for Ireland*. [Online]
Available at: https://www.epa.ie/our-services/monitoring--assessment/waste/national-waste-statistics/construction--demolition/#:~:text=The%20annual%20quantity%20of%20C%26D,decreases%20to%208.3%20million%20tonnes.
[Accessed 18 February 2025].

EPD Ireland, 2022. *PRODUCT CATEGORY RULES: PART A Implementation and use of EN 15804:2012+A1:2013, EN 15804:2012+A2:2019 and CEN TR 16970:2016 in Ireland for the development of Environmental Product Declarations*, s.l.: EPD Programme.

EU, 2024. *EU Construction & Demolition waste managment protocol*, s.l.: EU.

Eumonia, 2020. *What are modulated fees and how do they work?*. [Online]
Available at: https://eunomia.eco/latest-news/modulated-fees-and-how-they-work/
[Accessed 12 February 2025].

European Commission, 2015. *First circular economy action plan*, Belgium: European Commission.

European Commission, 2016. *EU Construction & Demolition Waste Management Protocol*, s.l.: European Commission.

European Commission, 2019. *Construction Products Regulation (CPR)*, s.l.: European Commission.

European Commission, 2020. *French public buildings to be built 50 % from wood and bio-based materials*. [Online]
Available at: https://ec.europa.eu/newsroom/eismea/items/670596/en
[Accessed 23 April 2025].

European Commission, 2023. *Waste Framework Directive*. [Online]
Available at: https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en
[Accessed 18 February 2025].

European Commission, 2024a. *Critical Raw Materials Act*, s.l.: Official Journal of the European Union.

European Commission, 2024b. *Energy Performance of Buildings Directive*, s.l.: Official Journal of the European Union.

European Commission, et al., 2023. *Regulatory sandboxes in the energy sector*, s.l.: European Union.

European Parliament, 2025. *Strategy for Secondary Raw Materials: In "New boost for jobs, growth and investment"*. [Online]
Available at: https://www.europarl.europa.eu/legislative-train/theme-new-boost-for-jobs-growth-and-investment/file-strategy-for-secondary-raw-materials#:~:text='Secondary%20raw%20materials'%20are%20recycled,or%20alongside%20virgin%20raw%20materials
[Accessed 12 March 2025].

European Union, 2008. *Waste hierarchy*. [Online]
Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=legissum:waste_hierarchy
[Accessed 22 March 2025].

European Union, 2024a. *European Union*. [Online]
Available at: https://data.europa.eu/en/news-events/news/eus-digital-product-passport-advancing-transparency-and-sustainability
[Accessed 28 April 2025].

European Union, 2024b. *Regulation (EU) 2024/3110 of the European Parliament and of the council*, s.l.: Official Journal of the European Union.

Fahy, K., Kelly, M. & Newell, S., 2024. *Circular interventions during the demolition and enabling phase: an Irish case study*. Galway, Civil Engineering Research in Ireland 2024 conference.

Fufa , S. M., Flyen, C. & Flyen, A.-C., 2021. How Can Existing Buildings with Historic Values Contribute to Achieving Emission Reduction Ambitions?. *Applied Sciences*, 11(13), p. 5978.

Government of Ireland, 2021. *Housing for All - A new Housing Plan for Ireland*, Dublin: Government of Ireland.

Government of Ireland, 2023. *Improving Energy Efficiency in Tradictional Buildings: Guidance for Specifiers and Installers*, Dublin: Government of Ireland.

Government of Ireland, 2024. *Global Policies Influencing the Greater Adoption of Timber in Construction*, Dublin: Department of Agriculture, Food and the Marine.

Halter, F. et al., 2023. Recyclable metal fuels as future zero-carbon energy carrier. *Applications in Energy and Combustion Science*, 13(2666-352X), p. 100100.

Hammink, H., 2017. *Circl: practical circular philosophy*. [Online]
Available at: https://www.cie.nl/Circl?lang=en
[Accessed 28 04 2025].

Hjortshøj, R., n.d. *Silo*. [Art] (Arch Daily).

IGBC, 2022. *Building a Zero Carbon Ireland: Roadmap to Decarbonise Ireland's Built Environment across its Whole Life Cycle, Dublin*: Irish Green Building Council .

IGBC, 2024. *Construction Material Exchange - Pilot in Ireland*, s.l.: Irish Green Building Council.

Impoco, G., Arodudu, O., Brennan, G. & McCormack, D., 2021. *EPA Research Report: A copy of the End of Project Technical Report is available on request from the EPA*, Wexford: Environmental Protection Agency.

International Standarsd, ISO 20887:2020, 2020. *Sustainability in buildings and civil engineering works — Design for disassembly and adaptability — Principles, requirements and guidance*, s.l.: s.n.

IPCC, 2023. *Climate Change 2023: Synthesis Report*, s.l.: Intergovernmental Panel on Climate Change.

ISO 20887:2020, 2020. *Sustainability in buildings and civil engineering works — Design for disassembly and adaptability — Principles, requirements and guidance*, s.l.: ISO 20887:2020.

Jacques, V., 2021. Extended producer responsibility (EPR) in France. *The journal of field actions*, Issue 23, pp. 22-25.

Jipa, A. et al., 2018. 3D-Printed Formwork for Prefabricated Concrete Slabs. Australia, ETH Zurich, Digital Building Technologies (ITA).

KPMG, 2024. *Circular Business Model Innovation: Product-as-a-Service: How Product-as-a-Service (PaaS) can unlock new revenue streams and increase customer satisfaction*. [Online]
Available at: https://kpmg.com/us/en/articles/2024/circular-business-model
[Accessed 05 04 2025].

Küpfer, C., Bertola, N. & Fivet, C., 2024. Reuse of cut concrete slabs in new buildings for circular ultra-low-carbon floor designs. *Journal of Cleaner Production*, Volume 448, pp. 0959-6526.

Lacy, P., Long, J. & Spindler, W., 2020. *The Circular Economy Handbook: Realizing the Circular Advantage*. s.l.:palgrave macmillan.

McCarthy, J. et al., 2022. *A Critical Analysis of Ireland's Circular Material Use Rate (CAIR)*, s.l.: Environmental Protection Agency (EPA).

Mcquinn, K., O'Toole, C. & Hauser, L., 2024. *Quarterly Economic Commentary*, s.l.: Economic and Social Research Institute.

Minami, A. L., Ramos, C. & Bruscato Bortoluzzo, A., 2021. Sharing economy versus collaborative consumption: What drives consumers in the new forms of exchange?. *Journal of Business Research*, Volume 128, pp. 124-137.

Mont, O., Palgan, Y. V., Bradley, K. & Zvolska, L., 2020. A decade of the sharing economy: Concepts, users, business and governance perspectives. *Journal of Cleaner Production*, 269(0959-6526), p. 122215.

Muhedin, D. A. & Ibrahim, R. K., 2023. Effect of waste glass powder as partial replacement of cement & sand in concrete. *Case Studies in Construction Materials*, 19(2214-5095), p. e02512.

NikKhah, A., 2024. *The Role of Product-as-a-Service in Circular Economy*. [Online]
Available at: https://www.linkedin.com/pulse/role-product-as-a-service-circular-economy-amir-nikkhah-qc4if/

OECD, 2022. *The Circular Economy in Ireland*, Paris: Organisation for Economic Co-operation and Development.

O'Hegarty, R., Wall, S. & Kinnane, O., 2022. *Whole Life Carbon in Construction and the Built Environment Ireland*, Dublin: BuildingLife.

Olsen, D., 2024. *What is Product-as-a-Service (PaaS)?*. [Online]
Available at: https://www.firmhouse.com/blog/what-is-product-as-a-service-paas
[Accessed 22 01 2025].

One Planet Network, 2022. *Global Annual Report 2022*, s.l.: One Planet Network.

Ottenhaus, L.-M.et al., 2024. Design for adaptability, disassembly and reuse – A review of reversible timber connection systems. *Construction and Building Materials*, 400(0950-0618), p. 132823.

Pittau, F., Krause, F., Lumia, G. & Habert, G., 2018. Fast-growing bio-based materials as an opportunity for storing carbon in exterior walls. *Building and Environment*, Volume 129, pp. 117-129.

Plevoets, B. & Van Cleempoel, . K., 2019. *Adaptive Reuse of the Built Heritage, Concepts and Cases of an Emerging Discipline*. London: Routledge.

Ramasubramanian, B., Tan, J., Chellappan, V. & Ramakrishna, S., 2023. Recent Advances in Extended Producer Responsibility Initiatives for Plastic Waste Management in Germany and UK. *Materials Circular Economy*, 5(1), pp. 2524-8154.

ReBuilt, 2024. *Secondary Raw Materials and Situation on the Market*, s.l.: Interreg Central Europe.

RIAI, 2022. *RIAI Design for Manufacture and Assembly/DfMA Report*, Dublin: he Royal Institute of the Architects of Ireland (RIAI).

Salibi, J., Rodrigues, A., Lima, P. & Souza, F., 2022. Lean and the circular economy: A systematic literature review. *Journal of Lean Systems*, 7(4), pp. 23-46.

SCSI, 2023. *Real Cost of Renovation Report – Vacant and derelict properties for residential use*, s.l.: Society of Chartered Surveyors Ireland (SCSI).

Senadheera, S. S. et al., 2023. Application of biochar in concrete – A review. *Cement and Concrete Composites*, 143(0958-9465), p. 105204.

SPI, 2021. *Primary materials in the Emerging circular economy: Implications for upstream resource Producers and primary material exporters*, s.l.: Smart Prosperity Institute (SPI).

SPP Regions, 2017. *Best Practice Report*, s.l.: Regional Networks for Sustainable Procurement (SPP Regions).

Stegmann, P., Londo, M. & Junginger, M., 2020. The circular bioeconomy: Its elements and role in European bioeconomy clusters. Resources, Conservation & Recycling. *Resources, Conservation & Recycling: X*, 6(2590-289X), p. 100029.

Suarez, M. C., 2024. *Circular Innovation Lab*. [Online]
Available at: https://www.circularinnovationlab.com/post/circular-economy-roadmap-toolkit-for-emerging-economies
[Accessed 21 03 2025].

SUMMIT, 2019. *What are Deleterious Materials?*. [Online]
Available at: https://www.summitenvironmental.co.uk/deleterious-materials
[Accessed 12 February 2025].

Teagasc, 2017. *Agricultural Economics and Farm Surveys*. [Online]
Available at: https://www.teagasc.ie/rural-economy/rural-economy/agricultural-economics/
[Accessed 12 February 2025].

The Heritage Council, 2020. *Collaborative Town Centre Health Check (CTCHC) Programme*, s.l.: The Heritage Council.

The Housing Commission, 2024. *Report of The Housing Commission*, s.l.: The Housing Commission.

UKGBC, 2019. *Circular economy guidance for construction clients: How to practically apply circular economy principles at the project brief stage*, London: UK Green Building Council (UKGBC).

Van Capelleveen, G., Vegter, D., Olthaar, M. & Van Hillegersberg, J., 2023. The anatomy of a passport for the circular economy: a conceptual definition, vision and structured literature review. *Resources, Conservation & Recycling Advances*, 17(200131), pp. 2667-3789.

van Langen, S. K. & Passaro, R., 2021. van Langen, Sven Kevin & Passaro, Renato. (2021). The Dutch Green Deals Policy and Its Applicability to Circular Economy Policies. =13. 11683. 10.3390/su132111683.. *Sustainability*, Volume 13, p. 11683.

van 't Hoff, L., 2022. *Building a case for circular construction*. [Online]
Available at: https://northsearegion.eu/procirc/news/building-a-case-for-circular-construction/
[Accessed 22 March 2025].

Vardopoulos, T., 2022. Industrial building adaptive reuse for museum. Factors affecting visitors' perceptions of the sustainable urban development potential. *Building and Environment*, 222(109391), pp. 0360-1323.

wbcsd, 2021. *The business case for circular buildings: Exploring the economic, environmental and social value*, s.l.: World Business Council for Sustainable Development.

World Economic Forum, 2020. *New Nature Economy Report 2: The future of nature and business*, Geneva: World Economic Forum.

World Economic Forum, 2022. *5 circular economy business models that offer a competitive advantage*. [Online]
Available at: https://www.weforum.org/stories/2022/01/5-circular-economy-business-models-competitive-advantage/
[Accessed 18 March 2025].

WorldGBC, 2023. *The Circular Built Environment Playbook*, s.l.: World Green Building Council (WorldGBC).

WWF, 2024. *Living Planet Report 2024: A system in Peril*, Gland: Living Planet Index.

BUILDING A CIRCULAR IRELAND ENGAGEMENT

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Department of the Environment, Climate and Communications: Vivienne Ahern

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Environmental Protection Agency: Joe Reilly

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The roadmap was also informed by the following groups in which IGBC participated

Construction Sector Group - Innovation and Digital Adoption subgroup– chaired by David Browne

Government Timber in Construction Steering Group – chaired by Professor Owen Lewis

Government Cement & Construction Sector Decarbonisation Working Group – chaired by Department of Enterprise Trade and Employment

National Repair and Reuse Network – chaired by Environmental Protection Agency / Department of Environment, Climate and Communications

We would also like to acknowledge in particular, advice from Patrick Moloney of Ramboll on the roadmap structure plus detailed input from CIRCULÉIRE working group and working diagrams from the Circular Reno project (Daly & Barril, 2024).

4no. Open Invitation Regional Workshops

Acara Concepts
Allianz
Arcology System
Arup
Atlantic Technological University
Association of Consulting Engineers of Ireland
Bus Éireann
Cairn Homes
Carbery Housing Association
Catalyst
CBRE Ireland
Cluid Housing
Construction Industry Federation
Cork City Council
CORA Consulting Engineers
Crown Paints Manufacture
Department of Environment, Climate and Communications
Department of Education and Youth
Department of Enterprise Trade and Employment
Department of Housing, Local Government and Heritage
Dublin Airport Authority
Ecocel
Ecological Building Systems
Ecopipe
ECOS
Embodied Carbon Reduction
EnergyElephant
EPA
ERP
Ethos Engineering
Fine Grain Property
Forbo Manufacturing
FreeFoam
Future Cast
Glenveagh Homes
Grangegorman Development Agency
Grian Homes
GS1 Ireland
Henry J Lyons Architects
Home Building Finance Ireland
IPUT
Irish Asphalt Producers Association
Irish Cement
Irish Center for High End Computing

Irish Life Finance
Irish Life Investment Managers
Jacobs
JV Tierney
Kerry County Council
Kingspan
Kore Retrofit Ltd
Land Development Agency
Limerick and Clare Education and Training Board
Kerry County Council
Maynooth University
Meehan Green Sustainability Consultants
Morehead Architects Ltd
Mott MacDonald
Munster Technological University
National Standards Authority of Ireland
O'Connor Sutton Cronin Engineers
Office of Public Works
Partel
PJ Hegarty
Rediscovery Centre
RetroKit
Rhatigan Architects
RKD Architects
Rothoblaas SRL
Savills
Scott Tallon Walker Architects
Shannon Airport
Sisk
Southern Waste Region
Strategic Banking Corporation Ireland
Technological University Dublin
Technological University of the Shannon
Transport Infrastructure Ireland
Trinity College Dublin
Tuath Housing Association
Uisce Eireann
University College Cork
University College Dublin
University of Galway
University of Limerick
Vision Contracting - Construction
Walls Construction
WEEE Ireland
Wicona

Focus Groups

Bio-based Materials Focus Group:

Ballymore
Connaught Fibre
Department of Agriculture, Food and the Marine
Department of Enterprise Trade and Employment
Department of Environment, Climate and Communications
EcoCocon
Ecological Building Systems
Irish Farmers Association
Kingspan
National Standards Authority of Ireland
Strategic Banking Corporation Ireland
Teagasc

Extended Producer Responsibility & Product as a Service Focus Group:

Arcology
CITA
ERP Ireland
Forbo
GS1 Ireland
Interface Flooring
Mott MacDonald
Repak
Saint Gobain
Scott Group
University of Limerick
WEEE Ireland

Circular Procurement Focus Group:

Cairn Homes
Construction Industry Federation
Ecocem
Future Planet
Grangegorman Development Agency
Harcourt Technologies
Henry J Lyons Architects
Office of Government Procurement
Phillip Lee Solicitors
Sisk
Southern Waste Region
Transport Infrastructure Ireland
Technological University Dublin

Vacant Properties Focus Group:

BID Dundalk
Dublin City Council
Dublin City Taskforce
Hardware Association of Ireland
Institute of Professional Auctioneers and Valuers
Irish Planning Institute
Mayo County Council
Philip Lee Solicitors
Royal Institute of the Architects of Ireland
Retail Forum
University College Dublin

Sharing Economy Focus Group:

Bus Éireann
Cairn Homes
Cork County Council
Cluid Housing
Codema
Department of Housing, Local Government and Heritage
Electricity Supply Board
Health Service Executive
Irish Planning Institute
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Allianz
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Banking & Payments Federation Ireland
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Home Building Finance Ireland
KPMG
Strategic Banking Corporation Ireland
Sustainability Works

Interviews:

Arcology
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ERP Ireland
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Office of Government Procurement
Scott Group
Teagasc

Building Circular Ireland Draft Roadmap and Survey:

60 responses

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