CIRCULAR BUILD

Building a Circular Ireland

A Roadmap for a Resource Efficient Circular Built Environment.

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Building a Circular Ireland

Roadmap

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1. Summary

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

This includes facilitating our transition to a net-zero carbon, resource-efficient and 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 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 to transition to circularity in construction, namely global resource constraints and the biodiversity crisis.

The “Building a Circular Ireland Roadmap” complements the “Building a Zero Carbon Ireland”. Similarly, the approach focuses more on strategies for prevention and reuse, better design, resource efficiency, and the added value of innovative business models rather than simply downcycling.

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

- Value what is already there.
- Optimise Resources.
- Create Circular material flows.
- Tools and Processes.
- Enablers for the 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 prepared on behalf of Environmental Protection Agency (EPA) by the IGBC in partnership with University of Galway (UA), Technological University Dublin (TUDublin), and Atlantic Technological University (ATU) including the horizon scan report. The process is disseminated in the methodology part of this document.

The 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.

What is meant by the Circular Economy?

The concept of circular economy has been developed in response to the negative impacts of our current linear economy, ‘take, make, and waste’ illustrated in Figure 1. The circular economy avoids using new materials and encourages a high degree of reuse of products, components, and materials (DGBC, 2021).

Figure Linear economy illustration (IGBC, 2022).

The European Parliament's definition (2023) states: "*The circular economy 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 2).

Figure 1 Circular economy illustration (IGBC, 2022).

Unlike the traditional 'take-make-waste' model, a circular economy enhances system health by progressively decoupling economic growth 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, upgradability, and simplifying disassembly and repair.

2. Introduction

We are experiencing environmental degradation, a climate emergency, significant biodiversity loss, pollution, extinction, and excessive consumption of natural resources. This underscores 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 (WGBC, 2023).

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 emissions from the production and transport of construction materials, construction processes, maintenance, repair, and disposal of buildings and infrastructure (IGBC,2022). The construction sector also accounts 50% of materials extracted in Europe and is responsible for over 35% of Europe's waste (van Eijk et al., 2021). Global tension and competition around the availability of resources, particularly critical raw materials, will intensify as demand grows for finite natural resources, leading to further increases in the price of construction materials. The European Commission has identified the need to ensure European supply chain security through the Critical Raw Materials Act (CRMA)[1]. Circularity is key to improving resilience in the supply chain, which is particularly important for an island nation like Ireland.

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 abundance of animal species since 1970. (WWF, 2024).

The urgency to 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 is clear. Shifting towards a circular economy in construction can help decouple economic growth from an increase in 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).

Ireland stands at a pivotal moment in its 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 and generating new jobs, particularly in design, reverse logistics, and investment sectors. Furthermore, Irish organisations can 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).

2.1. Circular Vision for Ireland

The circular economy has moved up Ireland's political agenda, largely due to initiatives from the European Commission, including the EU Green Deal and the Circular Economy Package (OECD, 2022).

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

[1] 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

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, 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, Wall, and Kinnane, 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.

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 necessitates recycling efforts (EPA, 2024). Furthermore, 35% of Ireland's total material footprint is associated with the construction industry (DETE, 2024). This footprint represents the total resources, including minerals, metals and wood needed to sustain our economy. Additionally, 97% of the materials utilised in Ireland are derived from "virgin" sources, i.e., newly extracted or produced rather than recycled, contributing to environmental degradation and resource depletion (CGR, 2024).

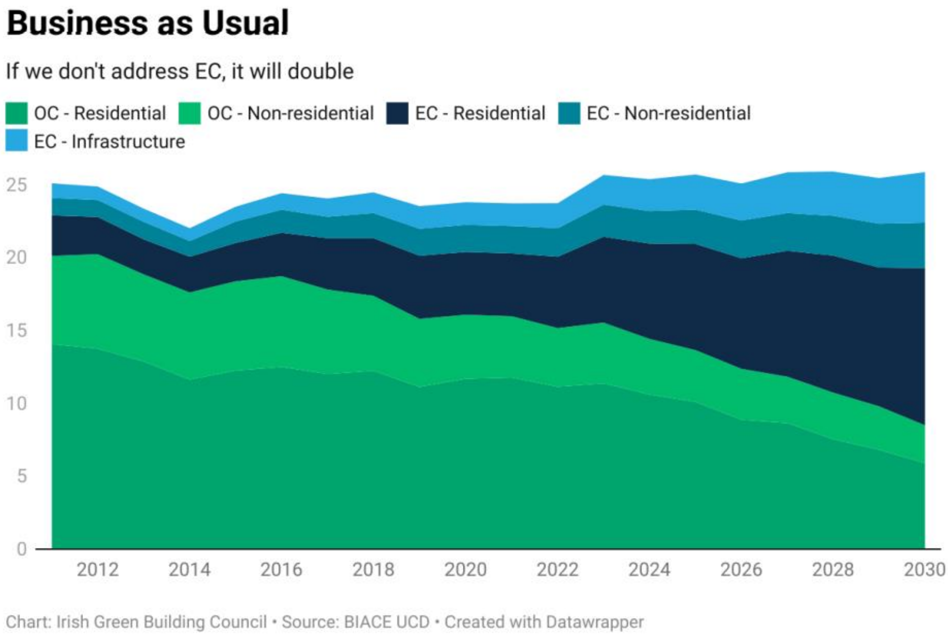

Figure 2 Chart of carbon emissions EC = Embodied Carbon. OC = Operational carbon. (IGBC, 2022).

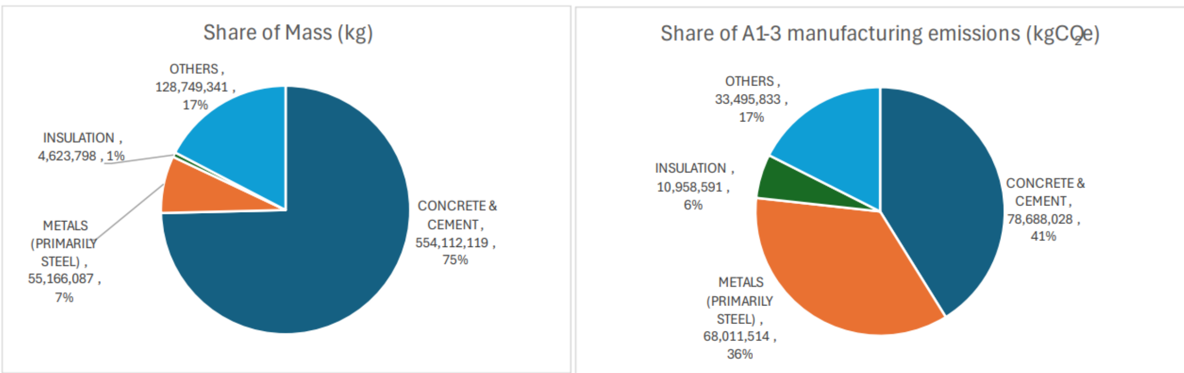

Figure 3 Share of Mass and Emissions – aggregate all material input across all assessments.

Based on an aggregated study of materials data from 51 recently constructed buildings in Ireland across all typologies, concrete made up by far the greatest mass used at 75% of all materials, representing 41% of CO_2e emissions in new construction (IGBC, 2024). 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[2].

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 its output by making crops and their by-products available for construction materials (Stegmann, Londo, Junginger, 2020). This, in turn, could contribute to reducing Greenhouse gas (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). The clinker content of concrete can be reduced beyond the use of Ground Granulated Blast-furnace Slag

[2] Indicate carried out Lyfe 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.

(GGBS) by-product, for example, with the addition of recycled glass powder, non-activated cement recovered from recycled concrete using smart crushers (Muhedin, and Ibrahim, 2023) and even biochar (Senadheera, 2023).

2.3. Summary of Recommendations

Value what is already there

Material and asset efficiency will be achieved through greater use of the existing stock and infrastructure optimisation.

- Government to enable derelict property and vacant space on upper floors throughout cities, towns, and villages to be brought back into use, through a comprehensive package of actions to include supporting local authorities with vacant building officers, requiring better data, providing additional fiscal and financial incentives, as well as expertise grants and addressing regulatory challenges.
- Government to incentivise the intensification of use of under-occupied dwellings and underutilised buildings (E.g., through sub-division and increased hours of usage) through fiscal and grant measures. Optimise resources

Radically reduce the quantum of materials, resources and costs needed to deliver our housing and infrastructure needs by following these actions.

National planning level

- Optimise the relationship between infrastructure, layout, density, typology, and height on material/resource/land use through planning strategy consistent with resource efficiency, shifting to a 3-dimensional design-led approach.
- Incentivise an optimum mix of buildings and home typologies in housing policy to enable optimal life stage usage, shifting focus from the number of units delivered to the number of people homed.
- Ensure optimal value and spatial efficiency at the planning stage through the right sizing of homes and other buildings, ensuring adaptability (versatility, convertibility, and expandability), and integrating shared facilities and amenities.
- Support a wider range of housing tenures through innovative/co-op/co-living/co-ownership models.

Material and component level.

- Drive leaner design of infrastructure, structure, and components, facilitating these actions through greater research and by streamlining certification.
- Integrate circularity indicators, including design for deconstruction into design and design for adaptability (DfA).

Create Material Circular flows

- Invest in the development of the bioeconomy for construction materials, with the Government driving simultaneously supply through support for growers, investment in production, as well as demand through procurement.
- Develop the market for secondary materials through collaboration between the Government and industry to streamline the implementation of articles 27 and 28 of ECOS Environmental Consultants, and re-certification, and develop physical and digital marketplaces, as well as targets for reused materials in procurement.
- Mandate pre-development audits to justify demolition and pre-demolition audits at the planning stage where demolition is permitted.
- Increase the use of technology and invest in R&D to enable recycled materials to move up the value chain, e.g., via innovative crushers for cement and building element recovery via smart demolition.

- Capture critical raw materials from the construction sector for secondary markets as required by the European Union (EU) Critical Raw Material Act (CRMs)[3].

Tools and Processes

- Increase collaboration between Government and industry to develop Extended Producer Responsibility (EPR) schemes for a range of construction materials.
- Drive the greater use of Product as a Service where appropriate.

Enablers

- Government to promote a supportive regulatory system that supports circular innovation, e.g., through the use of regulatory sandboxes[4].
- Invest in the development of the circular economy for construction, including in research, innovative pilot projects, and new business models such as Product as a Service (PaaS) and Extended Producer Responsibility (EPR), and the sharing economy.
- Use public and private procurement processes to support the development of an innovation ecosystem with Government, producers, and construction industry working in close collaboration.
- Use public/private procurement and development finance to drive demand for circularity processes and materials, through the integration of circularity indicators aligned with EU taxonomy, such as Design for Adaptability (DfA) and Design for Deconstruction (DfD).
- Drive awareness at all levels, including managerial, for integration of circularity into procurement, design, delivery, and finance of construction.
- Implement the use of digital solutions such as Material Passports to enable data on products to be retained for future use.

[3] 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

[4] 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/

3. Definitions & key concepts

Circular Built Environment

The Circular Economy for the construction and 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 (DHLGH, 2024). Technology, innovation, and new business models can facilitate the circular approach.

The roadmap uses two definitions. One defined by the European Commission (2024) 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 disassembly."*.

The second definition used in the roadmap was developed by the World Green Building Council (WGBC)(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 Costing (LCC) and readily available digital information (such as building material passports)*

The Circular Economy and 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 5 illustrates the Waste Hierarchy principles. These are further explained below.

Figure 4 Waste Hierarchy Pyramid Principles (European Comission, 2023)

Step 1: Prevention

Prevention is the first step and the first opportunity to reduce the overall material footprint and the amount of waste generated. It can be achieved by considering the end product before it is manufactured. By thinking of the full life cycle (and post-life) at the design phase, challenges that emerge later can be easily overcome.

Digital technologies can support life cycle decision-making by allowing real-time information exchanges among users, machines, and management systems. Circular applications of prevention include PaaS, EPR, and the Sharing Economy.

Step 2: Preparing for Reuse

Reuse is about creating products and building to be used or reused several times, and/or be easily refurbished or deconstructed. This can be achieved first by considering how the building is designed to enable change of use or adaptation, considering connections of how parts can be easily assembled and disassembled, and avoiding contaminants that could interfere with reuse.

Designing buildings that can be easily adapted to another use if economic or demographic change requires a different usage pattern eliminates the need for demolition. When designing (or re-designing) for reuse, every aspect must be considered, from how it will be used in the market to which raw materials can be most tailored to increase durability for the specific application. In this context, procurement has a crucial role to play as an enabler. It can lead organisations to transition from a linear to a circular economy and have a direct impact on suppliers' practices.

Digital technologies can also play a role in life cycle considerations and predictive maintenance by retaining information on performance.

To summarise, circular design and circular procurement are key in supporting reuse.

Step 3: Recycle

If unable to achieve the first two steps in the waste hierarchy, then recycling comes into play. Recycling is the act of giving the material a second life to be used again and again. There are numerous ways to recycle, but the most common is mechanical recycling. This is the process of collecting waste from various sources, crushing/grinding it together, and then washing, melting, and drying it into a new raw material that can be used in a new process.

Step 4: Energy recovery

Energy recovery steps in when a material cannot be recycled sustainably. Often referred to as energy-recovering recycling, this process allows the materials to be disposed of in a way that creates usable energy.

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 Product as a Service (PaaS), Extended Producer Responsibility (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 (EIT Climate KIC, 2019a, p. 11).

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 (EIT Climate KIC, 2019a, p. 11).

Circular Products

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

Circular Renovation & Retrofit

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

- **Minimise or prevent**, designing, using, and renovating smarter building (parts) so that no or as little as possible (new) material 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).

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 (EMF, 2024).

4. Value what is already there

- **Retain and enhance the (economic, social and cultural) value of existing buildings and infrastructure.**
- **Reduce vacancy and dereliction, increasing the vibrancy of our villages, towns, and cities.**
- **Intensify the use of existing buildings and infrastructure.** E.g., by encouraging sub-division of larger homes where appropriate.

Achieving carbon neutrality requires not only building more efficiently but also valuing existing buildings. Embracing circularity in existing buildings not only enhances their economic value but also contributes significantly to environmental sustainability and social well-being.

The concept of circularity in existing buildings, focuses on maximising their value through sustainable practices that mitigate resource depletion and environmental pollution while boosting overall asset worth (Dutch Green Building Council, 2021). This approach is increasingly recognised as essential for addressing the challenges of climate change and resource scarcity (Dutch Green Building Council, 2021). Reusing, upgrading and intensifying the use of the existing building stock, rather than demolishing and/or building new, also presents a valuable opportunity to rejuvenate urban and rural areas and improve living conditions. Prioritising the revitalisation of vacant and under-used properties can be crucial in addressing the housing crisis, restoring cultural and aesthetic value, and reducing environmental impact. Moreover, investing in the adaptive reuse, optimisation, and intensification of use of existing buildings is the most cost- and carbon-efficient method to deliver the homes and infrastructure we need. In this context, prioritising the reuse of vacant and under-used buildings preserves their value and that of their components by optimising their usage and reuse cycles.

This section outlines various interconnected strategies and recommendations aimed at enhancing the value of existing buildings. It addresses issues of vacancy, adaptive reuse, and the intensification of use, along with the associated challenges, opportunities, and recommendations.

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 (CIB, 2023).

The most recent census in Ireland indicate 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, 2022). In addition, according to the Geo-directory, 29,241 commercial units were vacant. These statistics highlight significant opportunities within the market for potential tenants and investors. Despite various national and local policies seeking to address vacancies, 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). This approach mitigates new construction's environmental impact and revitalises underutilised spaces, fostering economic and social benefits.

4.2. Support adaptive reuse

Adaptive reuse is the process of repairing and restoring existing spaces for new or continued use (Plevoets and 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 greenhouse gas (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 Indicate (Indicate, 2024) showed the 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. It 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).

This not only preserves the architectural heritage but also strengthens community identity. 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, public markets, or libraries.

4.3. Address underuse and support intensification of use

Underuse and intensification of use are two interconnected concepts. This 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, 2023). 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, O’toole, and Hauser, 2021).

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, O’toole, and Hauser, 2021). This involves intensifying the use of our existing building stock by increasing the use intensity or subdividing them, 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 third highest in Europe (McQuinn, O’toole, and Hauser, 2021). With the decline in family size, many larger dwellings built particularly since 2000, the Central Statistics Office (CSO) 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]. Under-utilised office spaces could facilitate the use of meeting rooms, catering, gyms, or other facilities.

4.4. Challenges and Opportunities

[5] A good example is a new university building in Amsterdam 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.

Challenges

- **Financial Viability:** The financial costs of renovating vacant buildings may outweigh the potential returns in specific locations. This perception is exacerbated by the high initial renovation costs, which vary significantly based on location and building conditions.
- **Access to Funding:** Accessing funding for renovation projects, including mixed-use buildings, remains a challenge, with many surveyors indicating that it is more difficult for borrowers to secure financing for renovations than new builds.
- **Policy Implementation:** Comprehensive guidelines and coordinated policy interventions are still missing to support re-use. (CSG, 2024)
- **GHG Reduction Targets:** Embodied carbon emissions from construction account for 14% of Ireland's national emissions. Ireland's Climate Action Plan emphasises the importance of the circular economy in meeting our national greenhouse gas reduction targets.
- **Hidden Vacancies:** The quality of data on vacancy and under-use of buildings remains poor. For instance, many potential residential units above commercial properties are classified as non-domestic, leading to underreporting and misclassification of available spaces. This makes addressing vacancy more challenging.
- **Insurance:** Some insurance policies may need to be reviewed to support intensification of use. E.g., to make office spaces or schools available to community groups outside opening hours.

Opportunities

- **Reduced Environmental Impact:** Adaptive reuse reduces energy use associated with demolition and the need for new raw materials, contributing to a more sustainable built environment. Widespread adoption of circular economy principles like reuse and recycling could reduce Ireland's carbon emissions by up to 32% (CGR, 2024).
- **Sustainable Development Goals (SDGs):** Revitalising vacant buildings contributes to several SDGs, including decent work and economic growth, industry innovation and infrastructure, sustainable cities and communities, responsible consumption and production, and climate action (IAF, 2024).
- **Economic Benefits**: Transitioning to circularity in construction can unlock economic gains through material savings and job creation, especially in design, reverse logistics, and investment. Annual savings of €2.3 billion are achievable by boosting Ireland's circularity by eliminating wasteful practices (DECC, 2021).
- **Infrastructure Utilisation:** Adaptive reuse supports Ireland's move toward a low-carbon society and the regeneration of towns, especially in areas already serviced with infrastructure like shops, schools, and parks.
- **Embracing Circular Economy Principles:** Adaptive reuse embodies circular economy principles by eliminating waste and pollution through circulating products and materials (Choi, 2023).
- **Community Engagement**: Renovation projects can engage local communities, fostering a sense of ownership and pride in the neighbourhood's transformation.
- **Revitalising Urban Areas**: Renovating vacant buildings and intensifying the use of under-used units can contribute to revitalising urban areas, breathing new life into neglected spaces, and potentially attracting businesses and residents to the area.
- **Additional Housing:** Potential to create thousands of additional homes within a short time frame and with a lower carbon footprint.
- **Increased Property Values**: Renovating vacant buildings and intensifying the use of under-used buildings can increase property values in the surrounding area, benefiting property owners and the local tax base.
- **Changes to the Sustainable Finance Disclosure Regulation (SFDR)** from 2025 addresses the previous issue in Art. 8 and 9 of disincentivising financing improvements in existing property assets.

4.5. Recommendations

4.5.1 2026

Government

G1. Fund and coordinate vacant building officers across all local authorities to support “living above the shop,” building on the success of the newly established vacant home officers, who are already contributing to bringing vacant properties back into use.

G2. Consider the possibility of implementing a mixed-use property grant under the Vacant Property Refurbishment Grant.

G3. Support the development and delivery of industry-wide Continuing Professional Developments (CPDs) to address the perceptions of risk associated with the reuse of many of these properties. Topics to include conservation, fire safety and disability access.

G4. Build upon the “Expertise Grants” (available to advise owners bringing vacant traditional or protected houses back into use) to introduce a feasibility study for unprotected buildings falling under the “living above the shop” category.

G5. Make the full grant amount available for each unit brought back into use in these properties (as opposed to making it available at the property level).

G6. Review Ireland’s Technical Guidance Documents (TGDs), building regulations, and planning policies to prioritise the retrofit and adaptive reuse of existing buildings over demolition and new construction.

G7. Invest in developing a national, high-quality, dynamic digital 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.

G8 Develop guidance and standards for the sub-division of larger homes, offering grant support for each unit created and linking it to existing Sustainable Energy Authority of Ireland (SEAI) schemes for energy renovation.

Construction Sector

C1. Set up a working group to ensure policies, regulations, and financial incentives are fully aligned to make adaptation and reuse of existing buildings easier. These would be reviewed regularly to ensure they fully support Ireland’s carbon emissions reduction objectives.

C2. Orientates the construction sector towards renovation and adaptive reuse solutions, skills and experience.

Producers

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

Finance, legal and insurance

F1. Financial institutions act on the changes to the Sustainable Finance Disclosure Regulation (SFDR) from 2025 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.

Academic/ Research and Development (R&D)

R&D1. Support the development and delivery of industry-wide CPDs to address the perceptions of risk associated with the reuse of many of these properties. Topics to be covered include conservation, fire safety, and disability access.

4.5.2 2030

Government

G1. Implement changes to the Vacant Property Refurbishment Grant to better support “living above the shop” and mix-use re-use.

G2. Ensure that all policies, programmes, and projects introduced are subject to robust ex-ante and ex-post evaluations, with any assessments published on a Government Evaluation Portal to ensure transparency and value for money.

G3. Keep updating the national, high-quality, dynamic digital database and map of Ireland's existing building stock.

G4. Expand the scope of other existing infrastructure, such as SEAI's one-stop shops, to facilitate the reuse and exchange of best practices

G5. 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. Continue with the working group to ensure policies, regulations, and financial incentives are fully aligned to facilitate adaptation and reuse of existing buildings.

Producers

P1. Continue to develop specific solutions for renovation, adaptive reuse, and use intensification.

P2. Have a strategy in place for the reuse of the building components.

Finance, legal and insurance

F1. Deliver innovative finance mechanisms to ensure more vacant mixed-use buildings can be brought into use.

Academic/ Research and Development (R&D)

R&D1. Universities and training institutions to develop courses on adaptive reuse, renovation, and intensification of use.

R&D2. 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.

5. Optimise Resources

- **Transition to a resource-efficient and circular built environment.**
- **Embrace a more efficient approach to design, planning, and construction practices through five combined and interconnected strategies, i.e.,** spatial efficiency, sufficiency, leaner design, designing for adaptability and disassembly, and the sharing economy.

Optimising resource use (doing more with less) is key in supporting Ireland's transition to a "totally decarbonised, circular, resource-efficient built environment". It's also the most cost-effective way to deliver the homes and infrastructure we need while staying within the planet's ecological boundaries.

This section explores the critical importance of designing and constructing with long-term sustainability in mind by focusing on planning, durability, adaptability, and the integration of future-proof technologies. The aim is to create a built environment that can easily accommodate evolving needs and contributes to reducing the overall waste generation by keeping materials and components, longer in the market. This section is structured around the following interconnected strategies:

- **Compact urban growth** ensures efficiency of infrastructure needed 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.
- **Sufficiency** reduces suboptimal use of space and material by ensuring efficient building design, right-sizing of homes, leaner design, and the integration of a better mix of buildings and homes in every community, as well as tenure models that facilitate transition at different life stages.
- **Designing for adaptability** 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 buildings' economic and cultural value.
- **Leaner designs** are key in addressing carbon emissions and waste at the building level. This means using less by optimising building form factor, efficient structural design, and material use.
- **Designing for disassembly** 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.
- **Sharing economy.** For example, reducing home sizes by providing sharing facilities, such as laundries and guest bedrooms, reducing car needs through carsharing schemes and Products as a Service (PaaS) business models for components such as lifts and lighting.

It will also address the associated challenges, opportunities, and recommendations.

5.1. Compact urban growth

Compact growth is key in increasing resource efficiency (OECD, 2022). In Ireland, the Viable Homes research, which calculated the different carbon impacts of various housing typologies on infrastructure, 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 5 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.

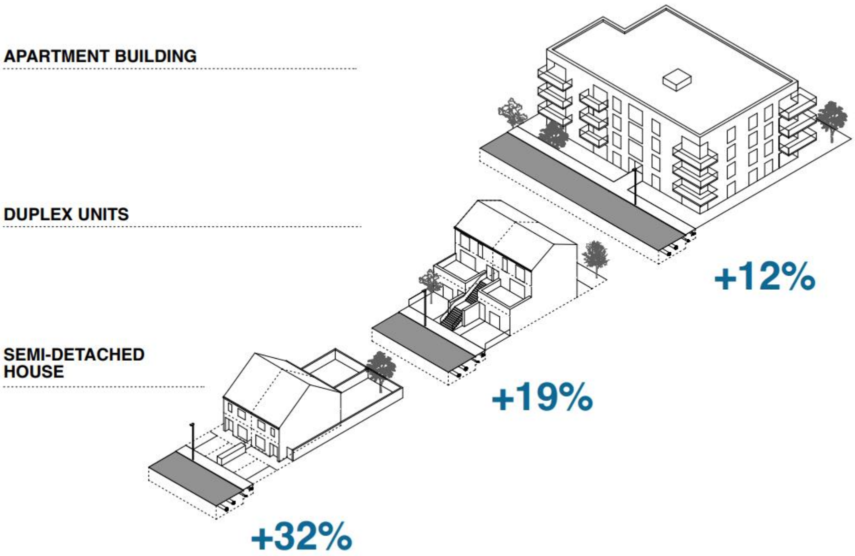

Figure 5 Additional embodied carbon due to landscaping and infrastructure per typology (Brady et al., 2024).

The research found that standard road design and water infrastructure details 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 ensuites, could mean less cost and resources used. Structured interviews with housing developers confirmed the motivation to build less dense homes, though costlier to build, was outweighed by greater profitability.

5.2. Spatial Efficiency and Sufficiency

To stay within the planetary ecological boundaries with a growing population, spatial efficiency is critical. It's the most cost-effective way to address building and transport emissions and the resource and biodiversity crises. But spatial efficiency is not only good for the planet, it's also good for people.

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. The trend of smaller households is likely to converge to the EU average over the next few years. The birth 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 (McQuinn, O'toole, and Hauser, 2021). 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, and water while delivering human well-being for all within planetary boundaries". According to Building Performance Institute Europe (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)[6] and right-sizing

[6] See the Value Existing Section for further information on this topic.

homes. Based on an analysis of CSO data in 2023, the average size of homes completed in Ireland was 118 sqm in 2023, despite an average household size of only 2.7 persons, and even this household size is possibly inflated by the challenges to new household formation due to limited availability of housing. New home size had declined due to the increase in apartment construction from 2011, when single detached homes formed the majority of completions. This is despite the fact that 67% of existing homes are underoccupied (McQuinn, O'toole, and Hauser, 2021). Nevertheless, new housing completions remain unaligned with actual housing needs. Further analysis of CSO figures for all housing stock shows that as dwelling size increases, the number of occupants per bedroom steadily decreases.

Average size new home completed 2023	Average household size in Ireland
$118m^2$	**2.7**
Average scheme home $117m^2$	

Figure 6 Average size of new homes built in 2023 vs Average household size (Ireland).

5.3. Leaner Design

Leaner design, or lean design, is a methodology focused on maximising value and minimising waste during the design and construction phases. It aims to enhance resource efficiency, decrease waste, and encourage sustainability across design and production processes.

Lean design emphasises removing 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 (Olanab, 2024). 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. This method resonates with circular economy ideals that stress keeping materials in circulation for as long as possible (EMF, 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 (Circulareire, 2024).

Integrating lean principles with circular practices enables businesses to attain operational excellence and support environmental stewardship. This combination minimises waste and fosters innovation and collaboration among industries, leading to a more sustainable future (Circulareire, 2024).

5.4. Design for Adaptability (DfA)

Buildings must be designed for optimum use by facilitating alternative uses at different times[7] and over their life spans while retaining their 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 easily transition from a one-bed property to a three-bed home (and vice-versa)[8]. It also means considering if a building can be easily adapted to a new use. For example, can an office building be easily converted for accommodation? Designing homes for adaptability allows a quicker response to demographic changes, such as the trend toward smaller households.

[7] A good example is a new university building in Amsterdam designed to be used as a cinema theatre in the evenings and weekends.

[8] See the Urban Village case study for further information.

The Royal Institute of Architects of Ireland (RIAI) has been advocating for design adaptability through the concept of Design for Manufacture and Assembly (DfMA) (RIAI, 2022). This concept focuses on two often-overlooked practical designs that can enhance production efficiency:

1. The methods of component manufacturing.
2. The assembly processes for the final product.

Originally, these terms applied mainly to components made in factories and put together into larger products for consumers (RIAI, 2022). However, recent advancements in manufacturing have revolutionized this approach, allowing for varying levels of product customization through mass customization. This evolution not only expands consumer options but also enhances the relevance of DfMA, which now applies to the design of all building types, from intricate structures to simpler ones (RIAI, 2022).

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.

Indicator 2.3 of Level(s) – the European Framework for Sustainable Buildings scores the adaptability of an asset together with ISO 20887 and provides a structured way of measuring adaptability.

5.5. Design for Deconstruction (DfD)

Design for Deconstruction 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 disassembly/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.[9] They provide a structure to collect information on a product's safety, environmental impact, and reusability.

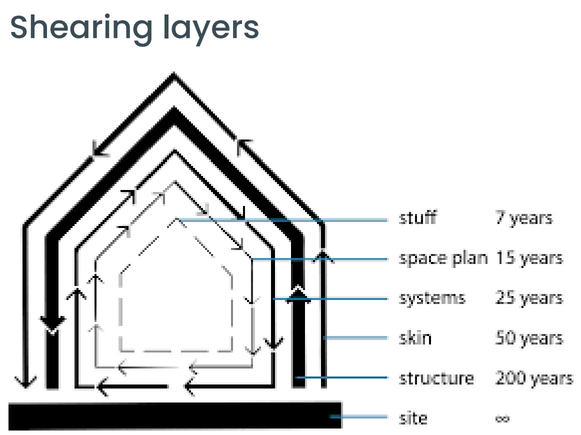

Figure 7 Shearing layers of Change (Brand, 1994).

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 targeted for new business models linked to their lifespan and the frequency of change.

Indicator 2.4 of the European Framework for Sustainable Buildings, Level(s) scores the Deconstruction of an asset together with ISO 20887 and provide a structured way of measuring the adaptability of an asset.

[9] See the Materials circular flow section for further information on this topic.

5.6. Challenges and Opportunities

Challenges
• **Cultural acceptance**: E.g., Alternative housing tenure models, moving to smaller dwellings and sharing economy. • **Finance**: E.g., the willingness of financial institutions to offer finance for non-traditional forms of housing. • **Data**: Poor knowledge of current use of buildings and infrastructure. • **Insurance**: E.g., opening school playgrounds /offices to community groups at the weekend. • **Regulatory**: Planning and change of use. • **Cost of materials** • **Consumption society**
Opportunities
• A **more cost-effective way to deliver the homes, buildings and infrastructure we need**/and to adapt to demographic changes. • **Sustainability assessment tools and certifications** can support this transition. • **Existing policies and regulatory changes** (e.g., EU Taxonomy, Corporate Sustainability Reporting Directive (CSRD), Circular Economy and Miscellaneous Provisions Act 2022) support this transition. • A way to **deliver the homes/ infrastructure we need with a tight labour force** (labour shortages). • **Creating/supporting more vibrant and healthier communities** (supporting mixed-use, intensification of use, and local jobs). • **Social buy-in**: Making the sharing economy "cool". • **Business opportunities and jobs creation:** E.g., the creation of local shops and jobs across the country (sharing economy).

5.7. Recommendations

5.7.1 2026

Government

G1. Put resource efficiency and the circular economy at the heart of national planning policies and guidance, and require development plans to transition to a design-led three-dimensional approach over developer-led two-dimensional zoning.

G2. Use a multi-departmental/multi-agency approach to understand how integrated sustainable mobility/planning/policy/buildings regulations all impact resource use in the built environment, e.g. integrated mobility planning on parking/ road infrastructure, water efficiency limits on water infrastructure, and housing guidance on spatial efficiency and housing mix.

G3. Infrastructure bodies, TII, Uisce Eireann, ESB and others to revise their standards and specification in line with reduction in resource use and ensure resource efficiency in co-ordination of activities in housing and other developments.

G4. Incentivise developers to build the most affordable and resource efficient homes through housing policy, including fiscal incentives.

G5. Work with housing developers and financial Institutions to launch a pilot program to test and demonstrate the viability of Co-Op housing models in Ireland.

G6. Review Limerick County’s housing initiatives, particularly the rightsizing scheme, to understand the challenges faced in engaging with communities and share best practice across local authorities and community engagement agencies.

G7. Facilitate adaptation and deconstruction design through Green Public Procurement (GPP).

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. 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. Utilise modular design techniques that allow for components to be easily disassembled and re-used

Producers

P1. Enhance equipment performance, reduce energy consumption, and improve resource efficiency (e.g., to minimise water usage for cooling systems) through data-driven optimisation techniques.

P2. Integrate key aspects such as modularity, component recovery, ease of disassembly, quality standards, and maintenance simplicity as part of products design. By prioritising these factors, products can be designed for longer lifecycles, easier repair, and efficient end-of-life recovery.

P3. Understand the implications of the Eco-design for sustainable products directive as well as of Digital Product Passports, and their implications for business development.

Finance, legal and insurance

F1. Review current offerings to enable alternative forms of housing. E.g., to allow co-operative housing to be financed by standard mortgages.

F2. Fully consider the future adaptability and flexibility of assets they lend, through offering discounted loans on buildings and homes certified under green schemes taking these aspects into consideration. E.g., the Home Performance Index for residential developments.

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

Academic/Research and Development (R&D)

R&D1. Investigate further how circular materials can contribute to the efficiency of comprehensive solutions in the built environment, including land use, density, infrastructure, and mobility. E.g., through the Viable Homes Construct Innovate Initiative.

R&D2. Develop more robust indicators to enable investors and financial institutions to assess the level of resource efficiency and sharing.

5.7.2 2030

Government

G1. 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.

G2. Continue to support behavioural change at the community level to drive the transition to the sharing economy.

G3. Start implementing the transition towards integrated digital 3-dimensional design-led planning based on an evidential assessment of the local housing and service needs.

Construction Sector

C1. Continue to develop and share more innovative forms of development:

- **C1.1.** Greater levels of shared space use.
- **C1.2.** Greater levels of adaptability.
- **C1.3.** Greater levels of resource sharing, cars, tools, etc.
- **C1.4.** Pilot housing and space as a service.

C2. Use standard templates developed to show compliance with the EU taxonomy and Home Performance Index for all projects.

C3. Ensure that all developments are based on circularity principles and comply with the circularity criteria outlined in the EU Taxonomy.

Producers

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

Finance, legal and insurance

F1. Enable alternative forms of housing, such as cooperative housing, to be financed by standard mortgages.
F2. Provide green development loans/green mortgages aligned with the EU taxonomy's circularity criteria.
F3. Offer bridging finance to facilitate the right sizing for homeowners/buyers.

Academic/Research and Development (R&D)

R&D1. Implement fundamental changes to **3rd-level qualifications for planners similar to the Building Change program for architectural education to orientate around design-led** 3-dimensional integrated planning for climate and circularity.

6. Materials

- **Create demand and a robust supply chain to transition to more efficient use and reuse (including repurposed) of materials.**
- **Support the development of low-carbon construction materials and bioeconomy in Ireland as a key component in addressing multiple environmental and socio-economic challenges.**

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, 2024). 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.

Agriculture is a significant industry in Ireland and diversifying beyond dairy and beef farming 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, 2020).

This section outlines various interconnected strategies and recommendations aimed at enhancing the Materials. It addresses materials circular flow, regenerative and bio-based materials, primary and secondary raw materials, critical raw materials (CRMs), and waste, along with the associated challenges, opportunities, and recommendations.

6.1. Materials Circular Flow

In a circular economy, material circular flow is central to maintaining resource use for as long as possible, minimising waste, and promoting sustainability. This flow operates through two distinct cycles: the bio-cycle and the techno-cycle (EMF, 2019).

Bio-Cycle

The bio-cycle refers to the natural regeneration of organic materials, which includes items such as food, wood, and other biological resources that can reintegrate into ecosystems. This cycle aims to safely return organic materials to the environment after their use, allowing them to be composted or biodegraded. These processes enhance soil health and promote nutrient cycling (TREASoURcE, 2024).

Central to the bio-cycle is the focus on sustaining healthy ecosystems while ensuring that consumption practices do not introduce harmful substances into these systems. By facilitating the reuse of organic materials through natural processes, the bio-cycle fosters sustainability and contributes to the overall well-being of the environment (EMF, 2019).

Techno-Cycle

The techno-cycle revolves around technical or synthetic materials, including metals, plastics, and fossil fuels. These materials are finite in nature, with limited availability and recreation challenges. Rather than allowing these resources to be consumed and discarded, the techno-cycle emphasises the importance of keeping them in circulation.

After their initial use, materials are recovered from residual flows and restored to their original value through processes such as recycling, remanufacturing, or refurbishment. Effective management of stocks within the techno-cycle is essential to prevent the depletion of these finite resources and to promote their sustainable use.

The material circular flow is fundamental to achieving a sustainable circular economy. Figure 8 illustrates the flow of materials in the circular economy.

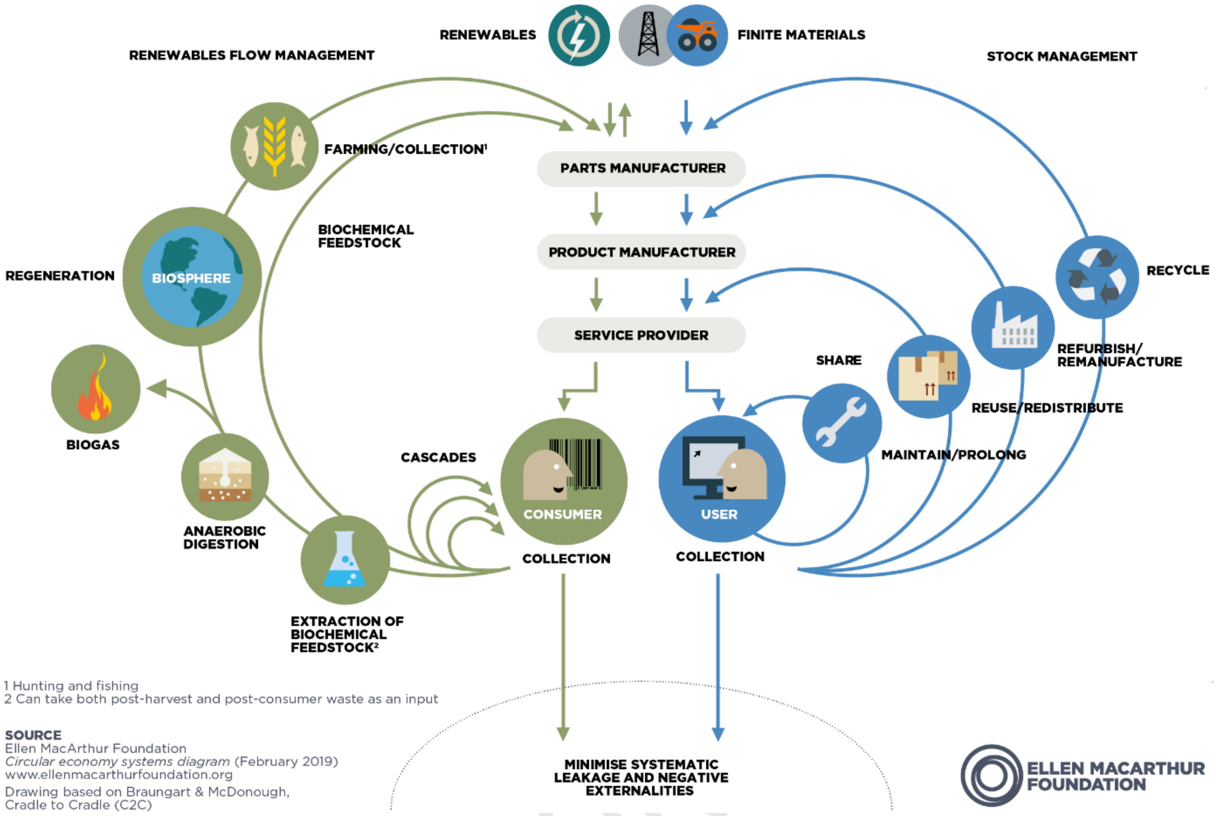

Figure 8 Butterfly diagram (EMF, 2021)

6.2. Regenerative & Bio-based Materials

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

France has mandated all new public buildings to be built from at least 50% timber or other bio-based materials such as wood, hemp or straw (EC, 2020). The city of Stuttgart also provides additional funding for homes built with products with green certifications, such as “Nature Plus” and “Blauer Engel”. See Appendix 02 for more detail.

The Improving Energy Efficiency in Traditional Buildings Report (DHLGH, 2023) highlights the benefits of bio-based materials in the retrofit of these buildings. In addition, fast-growing bio-based materials used for building and renovation hold biogenic carbon taken up during plant growth for the duration of the building’s life. 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) (DHLGH, 2023).

The integration of synthetic glues, binders (up to 20% in insultations) and other contaminants means that they generally cannot re-enter the bio-cycle (DHLGH, 2023). To address this, alternative biobased adhesives and binders are entering the market and are being developed and investigated as part of research projects such as NXTGENWOOD (University of Galway et al , 2024) with the aim to address end of life (EoL) uses and CRESTIMB (Tukasiewicz, n.d.) which looks at extending the life span of timber buildings.

The European Council recently greenlighted the EU certification framework for permanent carbon removals, carbon farming and carbon storage in products (European Commission, 2024). 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.

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). However, there is also an opportunity to develop materials from other rapidly renewable agri-crops that should be explored.

For instance, insulations and other construction materials can be created from hemp, wool, straw, wood fibre, reeds, verge grass, elephant grass, seagrass, flax, and mycelium. They can also form complementary materials for timber construction, for example, for use with timber frames and Modern Methods of Construction (MMC). Panel board alternatives to plywood can be made from straw[10] and miscanthus[11].

They also offer the economic benefits of creating alternative agricultural crops, helping create jobs in rural areas whilst replacing imported materials. Certain crops can even be used as break crops, helping improve soil structure. (Teagasc, 2017).

The Circular Reno Interreg project's[12] State of Play research into agri-crop biobased 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 9 illustrates the proposed concept mapping of potential agri supply chains in Ireland for the project.

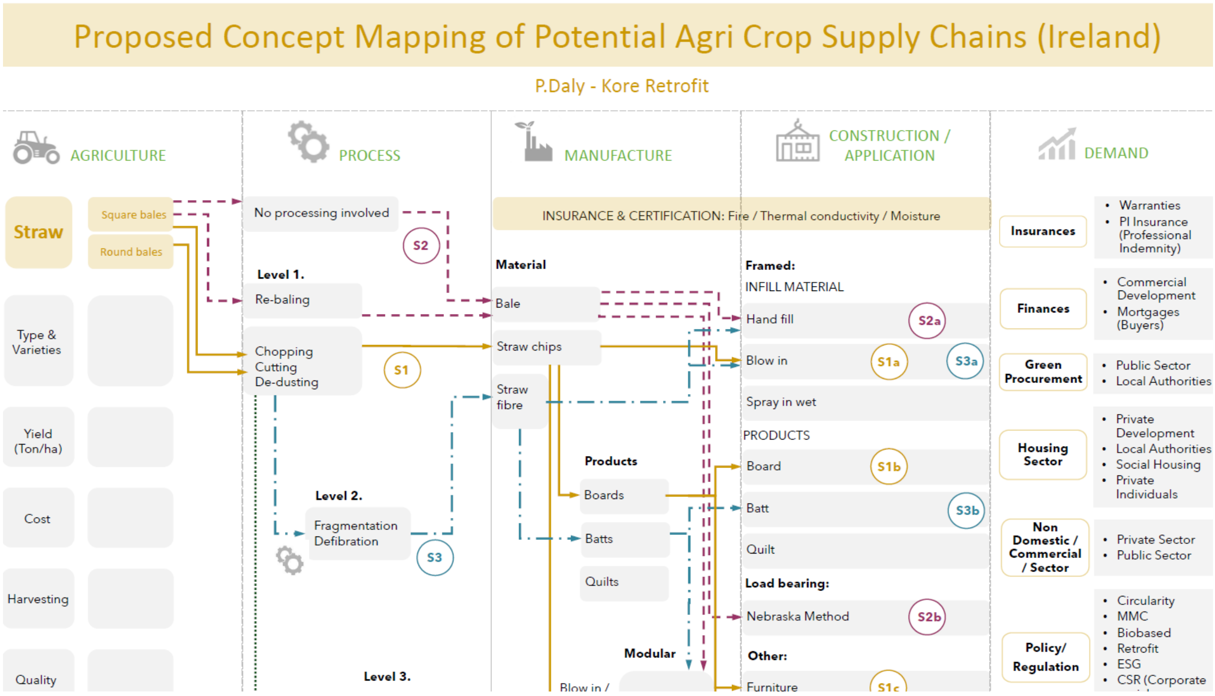

Figure 9 Proposed Concept Mapping of Potential Agri Crop Supply Chains (Ireland)(Daly, 2024).

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, and MediteSmartply. Given the need to decarbonise construction and the implementation of the Energy Performance of Buildings Directive (EPBD) this offers an opportunity for Irish farmers regarding diversification (DHLGH, 2024).

[10] For more information about straws, see the Durra Panel website.
[11] Miscanthus is known as silver grass and is known for its carbon sequestration properties. For more information, see the Innovation Centre for Applied Sustainable Technologies website.
[12] Circular Reno project website: https://www.koreretrofit.com/circular-reno-project

6.3. Primary and Secondary Raw Materials

In the circular economy, both primary and secondary raw materials play crucial roles, but there's a growing emphasis on increasing the use of secondary raw materials to reduce environmental impact and resource depletion.

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).

Secondary Raw Materials (SRM) are recycled materials that can be used in manufacturing processes instead of or alongside virgin raw materials. 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 their 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. SRMs are classified into metallic (like recovered aluminium and iron) and non-metallic (such as wastepaper and plastics) materials, and they undergo a quality evaluation to ensure suitability for production (SPI, 2021).

Ireland's material consumption has steadily increased, conflicting with its 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 10 below shows some figures comparing Irish data with European and global data, and Figure 10F presents figures related to the construction and built environment.

	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 10 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 11 Industries contributing to Ireland's footprints (Circle Economy, 2024).

Countries are already using GPP to support a greater use of secondary raw and recycled materials. For instance, Italy has a minimum of 15% of recycled materials in the total construction of the building to support circularity.

While the circular economy aims to maximise the use of secondary raw materials, primary raw materials will continue to play a role in the foreseeable future. The key lies in balancing their use, increasing recycling rates, and reducing overall material consumption to achieve a more sustainable and circular economic model.

6.4. Critical Raw Materials (CRMs)

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.

In the circular economy, CRMs support resource efficiency, recycling, and reduced consumption. However, recycling alone is insufficient. A comprehensive Circular Economy approach—integrating design, reuse, repair, remanufacturing, and consumption reduction—is vital to addressing supply challenges and environmental impacts (Suarez, C, M., 2024).

By embedding CRMs into a robust CE framework, Europe can reduce import reliance, minimise waste, and advance the goals of the European Green Deal and Circular Economy Action Plan. Continuous innovation and tailored policies are essential for securing a sustainable, resilient future (EC, 2015).

Other ways of reducing the demand for raw materials inputs would be to optimise new buildings and to increase the high-value recycling of building materials (steel, concrete and timber, for example) and components (raised access floor tiles, for example). (Suarez, C, M., 2024).

6.5. Waste

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. 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).

The latest data available indicates that 81% of treated C&D was backfilled. The majority of this was soil and stone, though this percentage may fall in 2024 or 2025 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 see greater quantities of soil and stone diverted from backfill. More efficient planning and increased density could also minimise the use of greenfield sites for construction and the loss of some of our most carbon-rich, fertile soil to backfill.

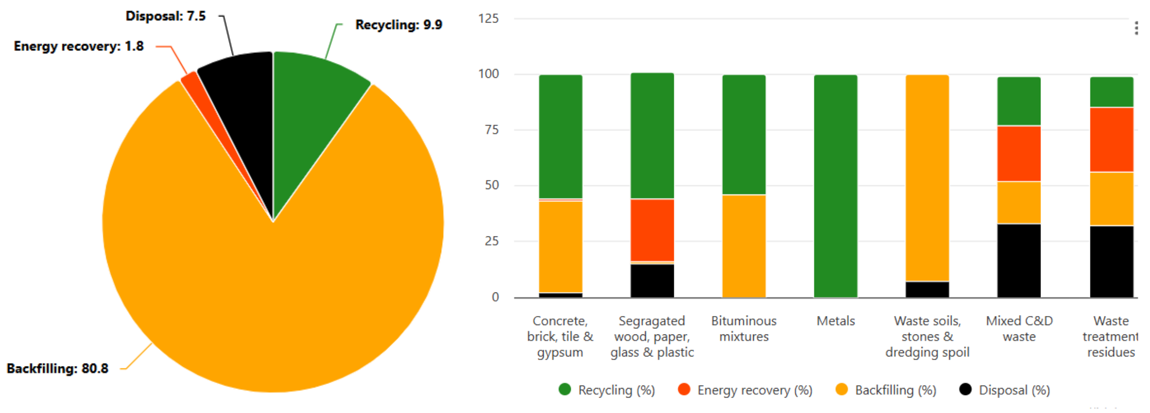

Figure 12 Treatment of C& D Waste in Ireland 2022 (IGBC, 2024).

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 (McCarthy et al., 2022).

Figure 13 below shows the different waste treatments over the decade (2010-2020).

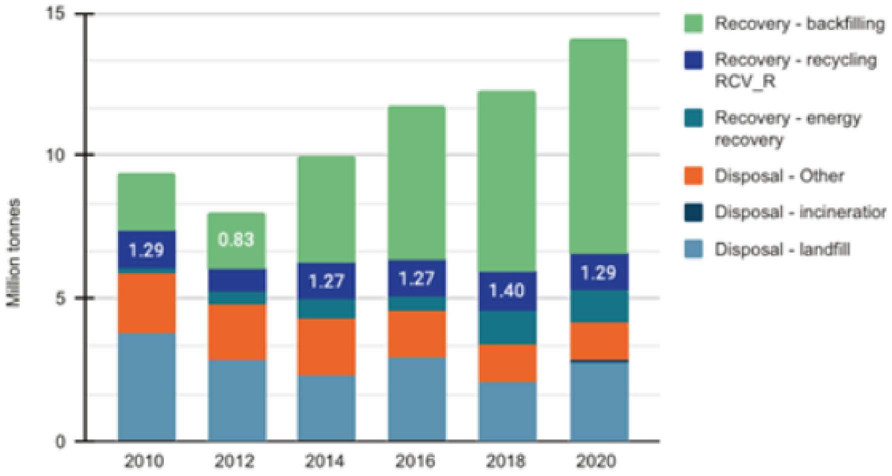

Figure 13 Waste Treatments in Ireland (McCarthy et al., 2022).

Backfilling, however, does not count toward Circular Material Use Rate (CMUR) targets, with construction and demolition activities driving most of this growth (McCarthy et al., 2024). Enhancing the implementation of articles 27 and 28 of the Waste Framework Directive is key to addressing these challenges. Figure 14 shows a comparison between Ireland and a few EU member states in terms of waste treatment and recycling.

CDW category	Ireland	Austria	Netherlands	Croatia
Waste soils				
Treated (Mt)	7.3	40.95	7.98	0.49
Recycled (%)	1	9	99	29
Mineral wastes from construction and demolition				
Treated (Mt)	0.55	10.7	20.26	0.42
Recycled (%)	39	86	99	76

Figure 14 Treatment and recycling of CDW in four EU countries (McCarthy et al., 2024)

The "Recovery and Recycling model" offers a way to rethink production and consumption by repurposing waste into reusable materials. By breaking down products into their components, it 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 its 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.

6.6. Challenges and Opportunities

Challenges

Primary & Secondary Raw Materials

- **Certification** process and timelines for innovative/bio-based materials to be put on the market.
- **Financial:** Insufficient / lack of grant offerings for innovative/bio-based materials.
- **Quality Assurance:** To date, primary materials are backed by warranties and industry standards, providing greater assurance of quality and reliability, compared to less structured supports for secondary materials.
- **Infrastructure:** Lack of physical or digital marketplaces for secondary materials.
- **Cultural:** Perceived quality concerns can contribute to favoring primary construction materials.

Regenerative & Bio-based Materials

- **Cultural:** Minimal transition by farmers to agri-based crops /forestry due to cultural reasons.
- **Awareness:** Lack of awareness of the benefits of transitioning to a greater use of these products.
- **Financial:** Insufficient financial support to support this transition / broader environmental benefits are not fully taken into account as part of agricultural schemes.
- **Economics:** Justifying supporting and growing the agri-crops for the biomaterials market while demand is still limited.
- **Infrastructure:** No large-scale production facilities for processing bio-based materials for construction in Ireland other than timber Department of Agriculture, Food, and Marine (DAFM).
- **Regulatory:** The current, limited use of these products does not justify the costs or the time involved in achieving specific Irish certification. *Note: Ireland currently imports a range of bio-based insulations in small quantities, including wood fibre, hemp, wool, and grass, from a range of European countries, including Scotland, Netherlands, France, and Germany.*
- **Economics:** The scaling of crop fibre would be dependent on the development of stable markets, significant capital investment to increase processing capacity, and collaboration with all stakeholders along the supply chain. A recent report by the Department of Agriculture, Forestry, and the Marine suggested this should be led by industry (DAFM, 2022).

Waste

- **Scale:** Many construction activities are highly waste intensive, accounting for half of all waste generated in Ireland.
- **Regulatory:** Compliance with waste regulations often incurs additional expenses, further tipping the balance in favour of primary materials, which are frequently more affordable and easier to source.
- **Economics:** Perceived and actual higher costs of certain recycled and secondary materials compared to primary materials.

Opportunities

Primary and Secondary Raw Materials

- **Environmental:** Transitioning to low-carbon materials is critical to decarbonise the construction industry and reach Ireland's climate targets (IGBC, 2022).

Regenerative and Bio-based Materials

- **Economics (1):** Supporting the development of bio-based materials could offer complementary opportunities for farmers, producers, and construction, supporting local jobs across the country.
- **Good practice:** The government, through the TiCWG and the National Forest Strategy,[13] is already working to increase both the supply and demand for one bio-based material in construction, i.e., timber.
- **Policy:** Expand the focus of the Bioeconomy Action Plan, 2023-2025 (DAFM, 2023), to include actions to support the development of bio-based materials for the construction sector.
- **R&D:** Irish-based construction materials companies are already researching the use of bio-based materials, though production and sourcing still occur outside of Ireland.
- **Economics (2):** Many low-tech, inexpensive solutions that require more simplified processing and manufacture should be supported. For example, straw processing to chips has potential application in construction. (Interreg project Circular Reno project; Food Vision 2030 Tillage Group report).
- **Economics (3):** The introduction of the EU certification framework for permanent carbon removals, carbon farming, and carbon storage in products where carbon is sequestered for a minimum of 35 years, if applied to the construction industry could potentially generate additional income for farmers.
- **Supply Chain:** Multiple regenerative materials are recognised as suitable for use in the construction industry and already available as by-products of straw, grass presscake, wool, etc. (Home - Gramitherm, and Biorefinery Glas[14])
- **Quality Assurance:** European Producers of MMC straw-based solutions suggested that there should be no issues with the quality of Irish straw.
- **Market opportunities**: Industrial hemp for construction fibre/hurd uses, though requiring additional infrastructure in production facilities and harvesting equipment, grows well in Ireland. According to one potential producer, the production equipment to produce fibre was in the range of €300,000 for used equipment to €2 million for new equipment, and is considered viable to produce based on current prices.

Waste

[13] For more information about the National Forest Strategy, see the Government of Ireland website.
[14] For more information, see the Gramitherm and Biorefinery Glass websites.

- **Environmental (1):** Reducing pressure on natural resources.
- **Economics (1):** Developing new recycling industries and markets in Ireland (and associated jobs).
- **Economics (2):** Integrating process innovations into business models to design out harmful waste and extend product lifetimes.
- **Environmental (2):** Potential for increased recovery and use in backfilling for land restoration

6.7. Recommendations

6.7.1 2026

Regenerative & Bio-based Materials

Government

G1. Enable greater use of Irish timber in construction through prompt completion of the work of the Timber in construction working group.

G2. Support the development of a broader range of biobased materials for use in construction, focusing on agri-crop by-products, such as straw, grass press cake, wool, and industrial hemp, by developing a comprehensive cross-departmental strategy similar to the Timber in Construction Working Group.

G3. Introduce an initial seed fund (€5-10m) open to all 3 parts of supply/production/demand to kickstart support for farmers, the development of small-scale production facilities, and the development of pilot projects to build capacity in the industry.

G4. Support construction projects with new capital funding using innovative low-carbon products to cover any additional design team costs in piloting innovative products and enabling the sharing of outcomes and learning.

G5. Develop a public procurement strategy for bio-based materials to support demand (i.e., Minimum % requirements for biomaterials).

G6. Introduce GWP limit values ahead of the EPBD deadlines to drive demand for bio-based materials.

G7. Review existing licensing process for industrial hemp production.

G8. Consider financial support through grants/reduction in Value Added Tax (VAT) for innovative low-carbon materials, including biobased materials.

G9. Streamline certification process and develop open-source certification of biobased products.

G10. Act on 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).

Construction Sector

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

C2. Integrate bio-based materials options within the specification for projects.

C3. Always consider a bio-based construction option at the early design stage.

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 the technical knowledge, application and use of biobased materials.

Producers

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

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 biobased 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.

Academic/Research and Development (R&D)

R&D1. Integrate the structural design of timber, best practice design for durability and fire performance of timber and biobased materials into all undergraduate construction courses.

R&D2. A facilitator organisation develops, tests, and certifies solutions based on international best practice examples and on an open-source basis, making these available to the industry to develop products and systems.

R&D3. Invest in R&D in biobased materials in construction with a particular focus on fire, thermal, and hydrothermal performance.

Primary & Secondary raw materials

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 re-use.

G3. Ensure the EPA have sufficient resources to process art. 27 & 28 applications quickly and smoothly and the fee for doing so is not prohibitive.

G4. Support the development of secondary raw materials depots and marketplaces to facilitate re-use (publicly operated and/or facilitated).

G5. Provide further certainty to the industry on Technical Guidance Documents (TGDs) document D (Section 1.1 Fitness of Materials) and how the re-use of materials can be supported.

G6. Develop a legal framework for a Digital Building Logbook to capture and centralise data, hence facilitating re-use, with potential for cross-referencing to other legislative requirements, such as the Energy Performance of Building Directive (EPBD) and the Construction Product Regulation (CPR).

G7. Support circular projects through innovative funding mechanisms.

G8. Leverage financial incentives for pre-demolition audits, pre-renovation audits and local recycling.

G9. Pilot the concept of Regulatory Sandboxes for circular construction.

G10. Broaden Building Information Modelling (BIM) mandate to address circularity metrics and minimum requirements.

G11. Support new 'circular' business model, through the creation of an action plan in accordance with the EU Eco-design for Sustainable Products Regulation and the CPR, integrating circular economy principles.

Construction Sector

C1. Work in close collaboration with the Government to develop re-certification standards to support re-use. E.g., on raised access flooring.

C2. Support the re-use of materials through existing mechanisms, e.g. TGD D (Section 1.1 Fitness of Materials), and share best practices and application findings.

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

Producers

P1. Develop circular business models, promoting repair and reuse, implementing take-back schemes, and enhancing product recyclability.

Finance, legal and insurance

F1. Support compliance with EU Taxonomy, CSRD and other relevant legislation.

Academic/Research and Development (R&D)

R&D1. Engage in innovative research and pilot projects to support the transition to circularity in construction.

6.7.2 2030

Regenerative & Bio-based Materials

Government

G1. Increase funding to support the development of biobased materials in Ireland, including export potential.

G2. Develop national standards or a range of standards to promote and develop bio-based materials and processes.

Construction Sector

C1. Increase targets for using a significant percentage of locally produced bio-based materials.

Producers

P1. Investing in R&D, including to ensure carbon storage benefits are not lost at the end of life.

P2. Support the development of processing and production facilities for a variety of different types of bio-based construction materials.

Finance, legal and insurance

F1. Invest in low-carbon biobased solutions, ensuring additional benefits such as carbon storage and end-of-life benefits are optimised.

F1. 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.

Academic/Research and Development (R&D)

R&D1. Invest in research and development to ensure Ireland is one of the leading centres in the production of bio-based materials.

Primary & Secondary raw materials 2030

Government

G1. Support circular processes through innovative funding mechanisms and certification processes.

Construction Sector

C1. Specify and install materials, products and components with enhanced recovery routes at the end of life.

Producers

P1. Optimise existing materials, processes and components for reuse

P2. Produce EPD and/or a material passport for materials/products to better facilitate re-use and support lifecycle assessments.

P3. Ensure new generation of materials, products and components are available with enhanced recovery routes at the end of life.

P4. Set targets and implementation actions towards net zero carbon and fully circular products.

Finance

F1. Develop an insurance playbook for Ireland to address issues including re-insurance of reused materials.

Academic/Research and Development (R&D)

R&D1. Support circular projects through innovative research.

7. Tools and Processes

- **Design for Disassembly (DfD), is facilitated by greater uptake of digital tools such as BIM and material passports.**
- **Establishment of Extended Producer Responsibility (EPR) schemes for construction materials, to reduce levels of construction and demolition waste and enable the industry to retain control of the materials and ensure recovery for reuse is priced in.**
- **Uptake of Product as a Service (PaaS) business models to retain ownership and control of products for reuse to ensure efficiency of use.**

This section introduces the importance of three main concepts, related opportunities, and challenges, and highlights key recommendations for stakeholders to follow to enhance the circular economy in the Irish construction and built environment. The concepts are defined as follows.

- **Digital Enablers like 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.
- **Extended Producer Responsibility (EPR)** shifts the environmental costs of products onto producers, ensuring accountability across the product lifecycle. By encouraging sustainable design and promoting secondary markets for materials, EPR aligns with the "Polluter Pays" principle. Successful implementations, such as individual EPR schemes for construction materials in Europe, demonstrate its potential to reduce waste and foster circularity.
- **Product as a Service (PaaS)** emphasises access over ownership, with models like pay-per-use and leasing. Retaining manufacturer responsibility for maintenance and end-of-life management reduces waste and promotes lifecycle innovation. Digital tools like Material Passports and BIM enhance efficiency, while PaaS fosters customer-focused solutions and sustainable practices, aligning business goals with environmental responsibility.

It will also address the associated challenges, opportunities, and recommendations.

7.1. Digital Enablers

Recording information on all the components in a building can assist in retaining their value as products. In this context, Material Passports serve as a useful resource for sharing a product's environmental performance and detailing the specific characteristics of the materials used in products throughout their design, production, use, and sale.

The passports offer designers, manufacturers, specifiers, architects, and users access to a digital database containing information about a product's components, performance, maintenance and service history, usage, and environmental credentials. This enables informed decisions regarding the product's value for recovery and its potential for circularity.

7.2. 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)

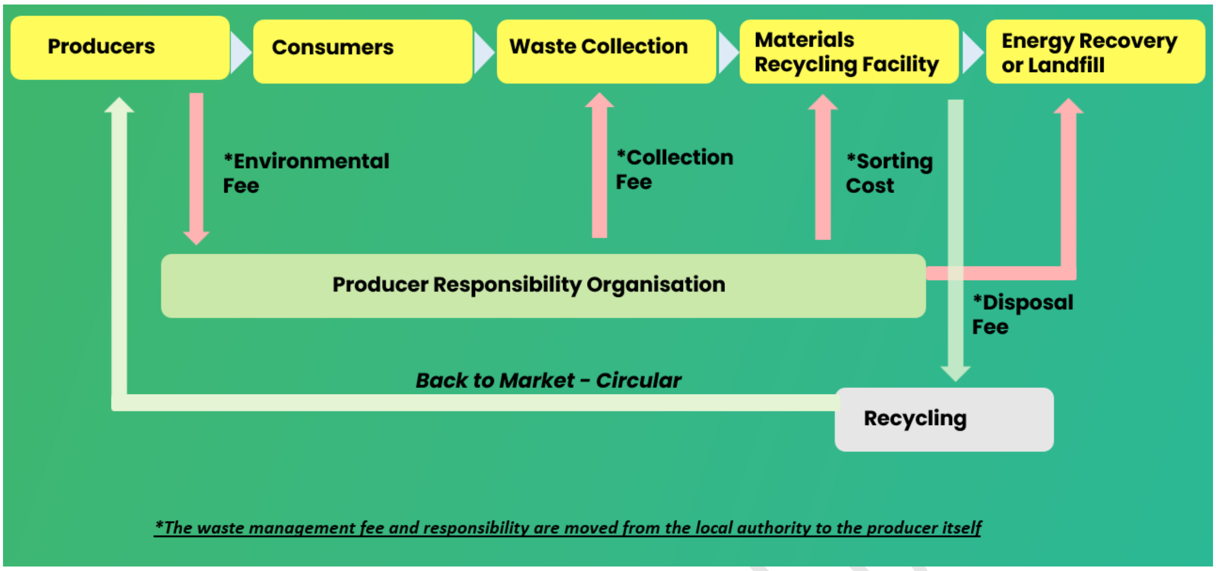

Figure 15 Fees and Responsibilities - Adapted from Ramasubramanian et al, 2023.

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).

A fundamental principle of EPR is the responsibility placed on producers. They are accountable for managing their products once they reach the end of their useful life. In the context of EPR, the term "producer" includes manufacturers, importers, and distributors—i.e., any party that introduces a product to the national market (BPIE, 2024).

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 & Demolition waste : (1) inert waste, and (2) other materials and products, such as rock and glass wool, plastics and bio-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[15]
- Stonewool Insulation UK[16]
- Timber construction products[17]
- Bricks[18]
- bitumen roofing[19], or
- interior fittings, such as floor panels, wooden doors, or partition walls[20].

[15] Plasterboard manufacturers, see Gyproc Saint-Gobain website.
[16] The Recovery, Recycling Technology Worldwide magazine focuses on recycling strategies worldwide; see the recovery website.
[17] DERIX is a group of companies specialising in timber engineering. See Derix website.
[18] Wieneberger is an Austrian brick maker, leading manufacturer of roof tiles, see Wieneberger website.
[19] Derbigum is a roofing company which offers waterproofing solutions, see Derbigum website.
[20] The Linder group is an Austrian agricultural machinery manufacturer, see Linder website.

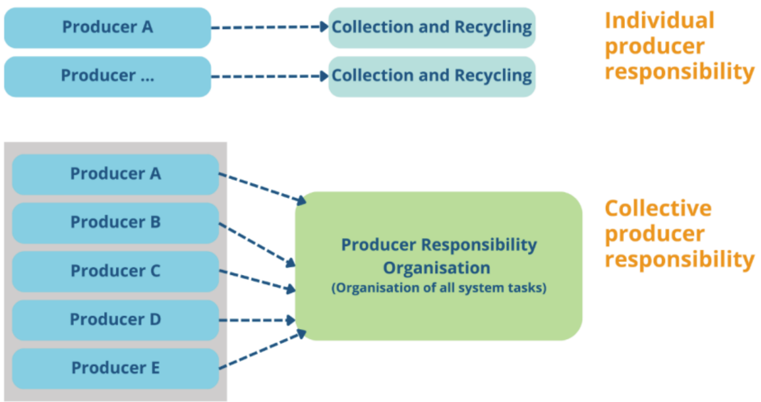

Figure 16 Individual and collective Producer Responsibility schemes (BPIE, 2024)

Manufacturers need to satisfy consumer appetite for new circular products while keeping upfront costs low to maximise the target market. To do that, the approach to the design of products needs to take a longer term perspective. In addition to attracting customers and making margins on new sales, products must retain their value, and the creation of waste and liabilities over time must be avoided by being designed with more than one user and lifecycle in mind.

By deliberately designing products for multiple lifecycles and users, companies are incentivised to keep transformation and transfer costs minimal. This approach also promotes innovation and the development of new business models. For instance, if replacing components and parts is easy and cost-effective, it will encourage the continuous development of new upgrades. Additionally, activities such as tracking, tracing, maintaining, upgrading, remanufacturing, and recycling products can yield valuable data on customer behaviour, and preferences. Companies can leverage these insights in their product development processes, leading to innovation and new offerings.

EPR and compliance schemes related to key resource management regulations currently available in Ireland are listed in Table 2. 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, 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 schemer are regulated by local authorities

Table 2 Extended Producer Responsibility Organizations (PRO) operating in Ireland (Impoco et al, 2021).

7.3. Product as a Service (PaaS)

The Product-as-a-Service (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 A., 2024).

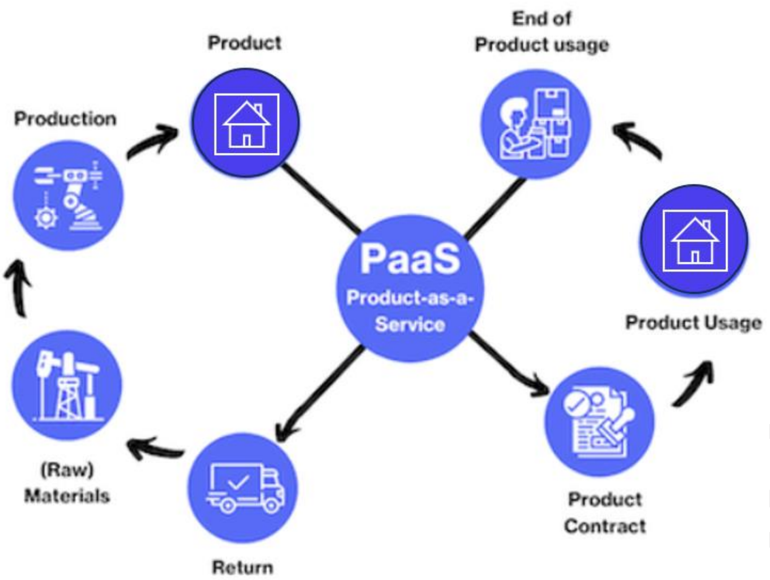

Figure 17 Product as a Service stage -Adapted from Olsen (2024)

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.

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

Key Stages for Delivering Product-as-a-Service (PaaS) to Customers

- **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.
- **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:** Finalize 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.
- **Execution and Delivery of Contracts**
    - Implement and manage the PaaS offering efficiently, focusing on meeting contract specifications and customer expectations.
- **Long-Term Management**
    - Continuously monitor and optimize the contract lifecycle, emphasizing service quality, customer satisfaction, and performance enhancements.
- **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.
    - **Optimized Maintenance Schedules:** Outline proactive maintenance plans to sustain system performance and longevity.

7.4. Challenges and Opportunities

Challenges

- **Cultural:** Resistance to change in the construction sector, driven by historical practices and norms (Workshop D2).
- **Regulatory:** To scale up disassembly practices, buildings must undergo product testing and certification to ensure that components meet CE marking standards and other regulatory requirements (Workshop D2).
- **Skills:** Concerns regarding airtightness and the complexities of handover between different building elements could pose challenges in Ireland at this stage (Dublin WP1).
- **Financial:** Ensuring a balance between lower mortgages and Property Owners Association contributions while considering impacts on accessibility and tax deductibility to maintain financial viability for apartment owners may be challenging (Circle Economy, 2021)
- **Data** availability and process: Design for Disassembly (DfD) requires significant data collection and analysis of numerous disassembly failures and components (Formentini G. et al., 2023).
- **Technological (1):** Designing buildings and components that can easily adapt to changing needs over time presents challenges in terms of flexibility, functionality, and maintaining structural integrity (Houses of the Oireachtas Commission, 2024).
- **Technological (2):** Existing methods for Design for Disassembly (DfD) do not account for end-of-life failures that affect the disassembly process, limiting their effectiveness in improving product circularity. This creates challenges in assessing the feasibility of circularity strategies like reuse, remanufacturing, and recycling (Formentini G. et al., 2023).

Opportunities

- **Economics (1):** Shifting ownership and responsibility for products incentivise circular value by promoting durable, efficient equipment that minimises maintenance and replacement costs, maximising overall value (SET Alliance, 2024).
- **Policy (1):** Recent reports from Oireachtas committees highlight support for embedding eco-modulation fees in supply chains to incentivise durable and reusable materials, fostering sustainable and resilient practices in the building industry (Houses of the Oireachtas Commission, 2024).
- **Policy (2):** Expanded and revised EPR schemes focus on the reuse, repair, and refurbishment of critical construction and renewable energy materials, aligning with the European CRMA.
- **Economics (2):** Leasing building components as a service is best suited for long-term commercial ownership, particularly for items with shorter lifespans like façades and solar panels (Dublin WP2).
- **Economics (3):** Companies and investors in circular business models are well-suited to the services layer of buildings, including mechanical, electrical, and plumbing systems like smart energy, lighting, cooling, and heating (SET Alliance, 2024).
- **R&D:** Linking product design with end-of-life status and disassembly effort, to offer a deeper understanding of how design choices impact circularity and disassembly.
- **Societal:** Designing homes and components for adaptability would allow Ireland to respond more quickly and efficiently to demographic changes, such as the trend toward smaller households. This, in turn, will support vibrant communities and neighbourhoods. (Houses of the Oireachtas Commission, 2024)

7.5. Recommendations

7.5.1 2026

Government

G1. Review the current regulatory process to ensure it can keep pace with new business models by investigating approaches such as the Dutch Green Deal and Regulatory Sandboxes, and replicating the process of the Austrian Federal Government. (Winnovation, 2024)

G2. Ensure flexibility within contracts to incentivise sustainable innovation and promote advanced models like PaaS.

G3. Facilitate the establishment of EPR for construction materials through a licensed, approved body (SI 149, 2014, Part 4, pages 45 to 47) organisation if an industry consortium wants to have control of their materials /end-of-life Products.

G4. Set clear responsibilities and obligations for companies and manufacturers who bring construction products to market, with regard to end of life.

Construction Sector

C1. Asset managers (including public ones) 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 fitouts to enhance flexibility.

C2. Define and map who is legally the “producer”, and clearly define the role and responsibilities of the procurer/developer and the contractor.

C3. Use the Configure, Price and Quote (CPQ) system to evaluate service performance, carbon, and circular materials. This will allow contractors to benchmark the best economic value and improve the suppliers' selection process.

C4. Design buildings for optimum use by facilitating alternative uses at different times and over their life spans while retaining their value.

C5. Establish a connection between product design choices and their EoL status, focusing on disassembly efficiency and circularity to enhance decision-making and long-term product sustainability.

C6. Develop strategies to address challenges around data availability and complexity in disassembly analysis. E.g., streamline data collection processes and enhance systems for handling and processing disassembly-related data.

Producers

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 Design for Disassembly (DfD) methodology to streamline data collection and improve design and disassembly processes.

P3. Embed lean and sustainability principles in the initial design and conceptualisation phases, addressing both economic and environmental goals from the outset.

P4. 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.

P.5. Start to implement EU Construction Product Regulation (No.305/2011) and the Ecodesign for Sustainable Products regulation into the National Waste Policy.

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.

Academic /Research & Development (RD&D)

F1. Research new business models with the industry to help identify solutions and overcome legal and other barriers.

F2. Business schools to modify curricula to encompass new business models.

7.5.2 2030

Government

G1. 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.

Producers

P1. Include warranty period or recertification with extended to end-of-life conditions for reuse.

8. Enablers

- **An agile planning and regulatory system that anticipates and facilitates innovation whilst ensuring safety.**
- **Procurement as a driver and enabler of a circular innovation ecosystem involving and supporting suppliers and contractors at the right stage of the process.**
- **Shared measurable indicators are widely used providing a common language between procurer and supply chain enabling setting and achievement of ambitious targets.**
- **All in the value chain, including procurers, design professionals, contractors, and building operatives, have the awareness of what needs to be done and skills to do it.**

This section explores key areas in which Ireland can enhance its circular economy transition, focusing on regulatory systems, procurement strategies, and developing skills and awareness. It will also address the associated challenges, opportunities, and recommendations. 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 following sections detail these critical areas and their role in advancing circularity in Ireland.

8.1. Regulatory system

The planning and regulatory system can create real or perceived barriers to the faster uptake of circularity. Examples include the application of articles 27 and 28 of the Waste Framework Directive, planning requirements such as minimum car parking space, and the TGD D of the building regulations. As the circular economy develops, there will likely be additional issues as yet not identified. It is hence important that the regulatory system is able to deal with and anticipate issues which could act as barriers. There are several ways to do this. For instance, under the Dutch Green Deal (Van Langen, 2021) The government undertook to review the regulations, which act as barriers. Regulatory sandboxes are another good example. These offer a general framework that innovators can apply to test their innovative products, services, and methodologies for a certain period (European Commission, 2023).

8.2. 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 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 also leverage it to drive this transition. 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, level(s) – as part of the brief, and requirements for reporting at each design stage, enable 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. Emphasize market dialogue to encourage collaboration and innovation (SPP Regions, 2017).

8.3. Skills and Awareness

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 CMEX material exchange platform, showed a lack of awareness of all levels of hierarchy, with interviews conducted with architects in 2024 confirming a lack of priority.

General upskilling recommendations for the construction sector were made in the National Upskilling Roadmap 2030 (IGBC, 2022). 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 Government to mandate Fundamentals Training across the sector for life cycle analysis and circular economy principles applied to design, construction and operations 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, digitalisation, 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 & systems level - Policy makers, Planners, Regulators, and Infrastructure Providers:** Systems 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 related to water, infrastructure, mobility, housing typology and density are 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 business model development, including Product as a Service (PaaS), and new tenure models and typologies, will need to be understood.
- **Procurement - Procurers (Public & 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 of digital tools such as material passports and BIM for sharing of data on products and materials used within buildings.
- **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 (EU, 2024). 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 recovery of higher-value materials.

- **Construction - Contractors:** Skills in construction designed for disassembly.

8.4. Challenges and Opportunities

Challenges

- **Scale:** The scale of the challenge is substantial. Solutions will need to be multi-faceted across numerous sectors and impacted by and for policy, education, and industry stakeholders, while keeping high standards of quality control.
- **Awareness & skills (1):** Lack of understanding of innovation procurement amongst procurers prevents them from engaging and supporting Small and Medium-sized Enterprises (SMEs) and innovators through the procurement process[21].
- **Procurement (1):** Lack of engagement from senior management (on both buyer and supplier sides). Procurement responsibilities are often delegated to lower levels and are not integrated into early project decision-making.
- **Procurement (2):** Lack of targets in GPP. Targets in GPP would ensure that circular principles—such as renovation over demolition, design for disassembly, and building adaptability—are considered from the outset.
- **Procurement (3):** A culture that procurement is the responsibility of the contractor rather than the procurer. This results in circularity and associated targets being considered too late in the design, and not integrated into the whole process (including at the needs assessment stage and prior to the appointment of the design team).
- **Skills (1):** Insufficient provision of incentives to upskill (including lack of policy drivers and statutory accreditation for green skills) and facilitate participation for an already stretched workforce.
- **Labour shortages**: There is a need to attract more people across a broad, diverse range into this sector.
- **Skills (2):** To date, the focus remains largely on energy efficiency and retrofit. This needs to be extended to fully reflect other issues regarding de-carbonisation (embodied & operational), digitalisation, circularity, biodiversity, and social value.
- **Skills & Quality control:** There needs to be a greater emphasis on 'Training the Trainers' and establishing quality data of education programmes to ensure that the correct skills are taught, monitored, and continually improved.
- **Awareness:** Lack of awareness of among design professionals of design for disassembly and design for adaptability principles, including Level(s) indicators 2.1-2.4 and aligned ISO standards for circularity.
- **Awareness & skills (1):** Lack of knowledge and awareness of the updated EU Construction & Demolition Waste Management Protocol (EU, 2024) which includes guidelines on pre-demolition and pre-renovation audits.
- **Skills (3):** Lack of emphasis in business schools on circularity business models such as PaaS.

Opportunities

- **Procurement (1):** In Ireland, the public sector procurement accounts for 20% of the built environment purchases and can thus influence specifications. By embedding sustainability criteria into procurement processes innovative design solutions can be encouraged, leading to outcomes aligned with circular economy principles. Technical specifications for circularity in public building design and renovation should be mandated.
- **Procurement (2):** Likewise, engagement with the market before tender exercises can foster innovation. E.g., suppliers should be asked how they can contribute to circular economy goals at the outset of the procurement process.
- **Procurement (3):** Public procurement can also be used to create demand for secondary raw materials.
- **Procurement (4):** GPP should mandate the use of BIM for managing environmental information and tracking the lifecycle of materials. BIM can serve as a repository for environmental data, including the recycled content of materials and their locations within the building. This could be complemented by the use of Digital Product Passport.
- **Skills:** These actions will require developing green public procurement skills within the public sector. This presents the additional benefit of stimulating demand for green skills throughout the sector.
- **Labour shortages & Job creation:** Attracting up to 100,000 additional new entrants to the construction sector on a pro-rata basis over the coming 5 years, including younger people into trades and construction in general, and women into construction roles, particularly as new roles emerge. The transition to circular construction should support the creation of sustainable jobs across the country.
- **Environmental:** Transition to low embodied carbon, resource-efficient construction processes and technologies.

[21] The European Commission's Guidance on Innovation Procurement points out that member states that rolled out national policy frameworks for innovation procurement were also at the forefront of innovation.

8.5. Recommendations

8.5.1 2026

Government

Procurement

G1. Fully integrate measurable circularity indicators based on Level(s) into the Capital Works Management Framework (CWMF). I.e., Level(s) indicators 1.1-1 1.2 and 2-2.1-2.4. and ISO standard 20887:2020

G2. Strengthen GPP mandate and implementation, i.e.,

- Ensure Office of Government Procurement (OGP)/local authorities immediately implement circularity, LCA, and LCC.
- Establish minimum criteria on biobased /reused materials and products.
- Switch focus to the total cost of ownership using LCC indicators over upfront cost.

G3. Develop a strategy for collaboration models with industry around circular procurement - such as the Dutch Green Deal approach.

G4. 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[22].

G5. 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.

G6 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.

Education and Awareness

G1. Incentivise upskilling of construction enterprises. E.g. through tailored support.

G2. Use the local enterprise offices network to strengthen lean, green, digital, and circularity supports and advice at the local/regional level.

G3. Review and update the content of the mandatory Climate & Circularity Leadership training for Public Principal Officers/Equivalents on a regular basis.

Construction Sector

Procurement

C1. All: Upskill on circularity, including 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.

Education and Awareness

C1. 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.

C2. 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, digitalisation, retrofit, zero-emission strategies and nature-based solutions.

C3. 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.

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[22] Structured interviews by IGBC with nearly 26 Irish architectural firms in 2024 revealed 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.

C4. Promote and facilitate participation in green procurement training at scale.

Producers

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 re-use.

Education and Awareness

P1. Support the upskilling of staff and engage with the supply chain regarding circularity strategies.

Research and Development (R&D)

R&D1: Investigate and adopt circular economy tools and processes, e.g. EPR, PaaS offering, and material passports.

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 Sustainable Finance Disclosure Regulation (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.

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 the 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 Zero Emission Building (ZEB).
E3. Develop further Continuing Professional Development (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 to collaborate with education providers at the second level to promote new skills in construction as career opportunities (with a sustainability and circularity focus).

8.5.2 2030

Government

Regulatory

G1. Support fast-tracking certification processes to encourage innovation.

Procurement

G1. Mandate circularity benchmarks with year-on-year improvements for projects over 5,000 sqm.
G2. 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.

G3. Develop open-source digitised tools to focus on the total cost of ownership and use to favour circularity models, Office of Government Procurement (OGP).

G4. 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. E.g., require Environmental Product Declarations (EPDs) and Declarations of Performance and Conformance (DoPCs) for all materials.

G5. Expedite delivery and implementation of the MMC Roadmap to strengthen circular approaches to building processes.

Education and Awareness

G1. 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.

G2. 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.

G3. Encourage knowledge sharing.

Construction Sector

Procurement

C1. Apply measurable indicators aligned with EU Taxonomy (including indicators Level(s) 2.1-2.4) and ISO 20887:2020 circularity standards on all construction projects

Education and Awareness

C1. 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.

C2. Strengthen connections and sharing insights with education providers.

C3. Actively participate in regular lean, green, and digital training and adopt these principles into work practices.

C4. Support training initiatives for carbon & digital literacy to address current and forthcoming Environmental, Social, and Governance (ESG) requirements, as well as regulatory changes, e.g., EPBD, CPR, and EED.

C5. Ensure appropriate Quality Control principles are in place and actively implemented, including circularity metrics.

C6. 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.

C7. Promote innovation through the application of alternative processes and the use of emerging technologies to deliver more sustainable buildings.

C8. Support and encourage green leadership within the industry to promote green cultures in organisations.

Producers

Procurement

P1. Increase the level of collaboration with the Government, standardization institutions, Enterprise Ireland and R&D to develop a functioning innovation ecosystem.

Education and Awareness

P1. Continue to support the upskilling of staff and engage with the supply chain regarding circularity strategies.

P2. Adopt Circular economy tools and processes, e.g. EPR, PaaS, and Material Passports.

Finance, legal and insurance

Procurement

F1. Continue to develop financial products fully aligned with EU Taxonomy's circularity criteria.

Education and Awareness

F1. Support bioeconomy and circularity strategies within green finance offerings.

Educators

Education and Awareness

E1. Utilise research outcomes to provide evidence and data to inform new programme development, as well as education and training pathways.

E2. 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 Adaption) within the context of circularity approaches.

Appendices

Appendix 01 - Optimise Resources

Case Studies

Case study 1 - Faelledby 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 18 Henning Larson (2018)

Case study 2 - Amsterdam, a proactive approach to the sharing economy (Ellen MacArthur Foundation, 2019)

Amsterdam has developed a proactive approach to the sharing economy to support the goals of its 'living' Sharing Economy Action Plan, which is designed to enable the city, businesses, and residents to reap the benefits from sharing platforms while identifying and mitigating unintended risks. The plan sits alongside the city's circular economy activities, recognising that the sharing economy opens opportunities to make better use of materials and resources.

The Action Plan looks into multiple activities, including housing, office space, and product sharing opportunities, as well as individual and integrated sharing-mobility modes, all of them visible to the citizens and visitors through sharing platforms. This has allowed to: 1) make use of public and private assets that would otherwise be underused; 2) open new business opportunities and revenue streams for individuals and businesses; 3) and create connections between residents and visitors that may not otherwise arise. Multiple innovations have sprung from the initiative, too.

Case study 3 – Nagaya tower, Kagoshima, Japan - The health benefits of shared living (Fornell, 2023)

The project was based on the vision of Dr. Haruhiko Dozono, who realised the impact of social isolation and loneliness on mental health. With support from the government, he developed a pilot scheme bringing together intergenerational living with shared common spaces encouraging interaction. Older people may pay an additional fee for life support services with younger people receiving discounted rent if they get involved in community chores, with the idea of mutual support.

Case study 4 - Limerick City and County - A rightsizing scheme for older people (Limerick City and County Council, 2021) Limerick city and county established a scheme to enable those living alone over 55, in a home that exceeded their requirements to access their own stock of rental homes suitable for the needs of older people. The Local authority would purchase the dwellings, and the cost of the rent was deducted from the purchase price up to 25%.
Case Study 5 - Impact of Car Sharing on Construction in Ireland Car sharing (e.g., Gocar and Yuko) is the best-known example of a sharing economy concept impacting construction efficiency in Ireland. Rather than owning a car users pay by the hour for use. Its impact on construction particularly in Dublin has been through enabling changes to car parking requirements by planning authorities. By offering an alternative to car ownership it allowed developers to argue successfully, that its presence nearby or on-site should allow reduced parking requirements in new developments, mitigating the need to build carbon-intensive and costly underground car parks. The concept has existed since the 1980's but digitalization and technology have enabled widespread uptake across Europe and the US. It was introduced in Ireland in 2008 and illustrates that disruptive circular business models that impact the construction sector can come from outside the sector.

Appendix 02 - Materials

Policies

Policy	Description
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 the resources used are kept in the EU economy for as long as possible.
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.
Construction Products Regulation (CPR)	The Construction Products Regulation (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.
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 re-use of materials instead of treating them as waste.
Circular Economy Programme 2021-2027	Placed on statutory footing by the Circular Economy Act, the programme sits under the whole of government Circular Economy Strategy and supports this strategy. Applying the waste hierarchy priority order is central to the Circular Economy Programme.
Waste Action Plan for a Circular Economy	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.
Ireland's National Waste Policy 2020–2025	Inform and give direction to waste planning and management in Ireland.
Article 27 of the Waste Framework Directive	Allows an "economic operator" to decide, under certain circumstances, that a material is a by-product and not a waste.
Article of the Waste Framework Directive	Achieving end-of-waste status for recovered materials enables their recycling and beneficial reuse, ensuring these processes do not harm human health or the environment.
Ireland's Building Regulations: E.g., Technical Guidance Documents D	TGD D of the Second Schedule to the Building Regulations states that all works covered by the regulations must use appropriate materials and be executed in a workmanlike manner.
Manual for the Reuse of Existing Buildings	The *Bringing Back Homes Manual* provides guidance for repurposing old and vacant buildings into homes. It outlines housing policy, regulations, technical guidance, and available schemes and supports while showcasing successful case studies to inspire reuse efforts

Case Studies

Case Study – Treasury Building, Dublin – Re-using 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 50kgCO2e/m² compared to 2,450kgCO2e/m² 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, 2018)

Case Study – Stabilizing 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

Patrick Daly and Paula G analysed the following case studies.Barril[23].

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 19 for high level supply chain mapping.

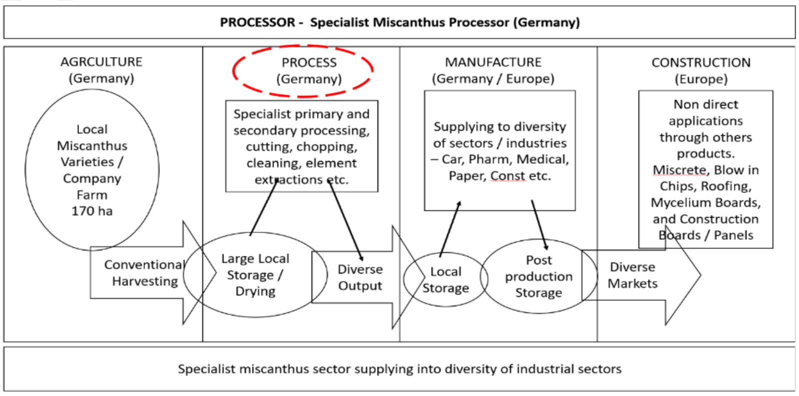

Figure 19 Presenting a high-level supply chain mapping of specialist miscanthus processor tailoring its processing to supply a range of sectors / industries with raw materials for third party manufacture including the construction sector (Daly P and Barril PG, 2024).

[23] More information about their research on the following link, https://doi.org/10.15377/2409-9821.2024.11.3

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 European Technical Assessments (ETA) and CE certifications for both product lines. See Figure 20 for high level supply chain mapping.

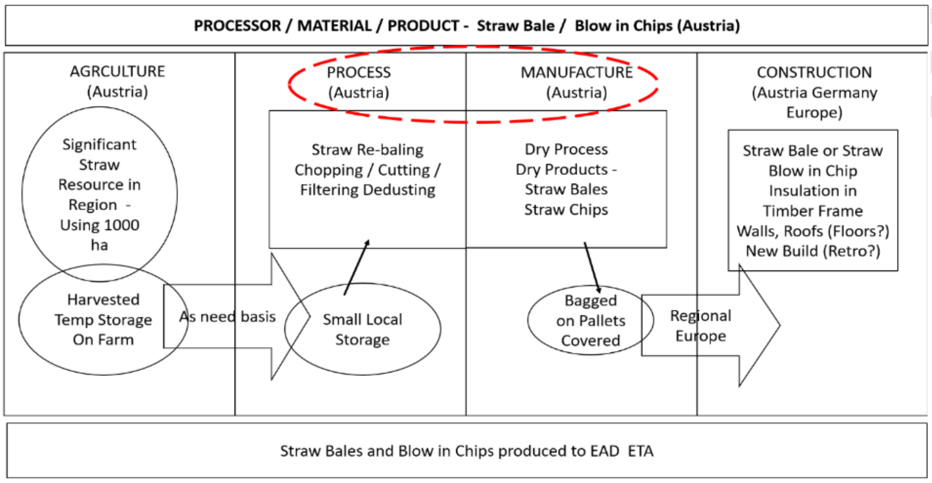

Figure 20 Presenting a high-level supply chain mapping of a straw bale / chip processor supplier for timber frame construction with either straw bales or a blow in straw chip insulation infill (Daly P and Barril PG, 2024).

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 minimize 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/m³), 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 harmonized standards. See Figure 21 for high level supply chain mapping.

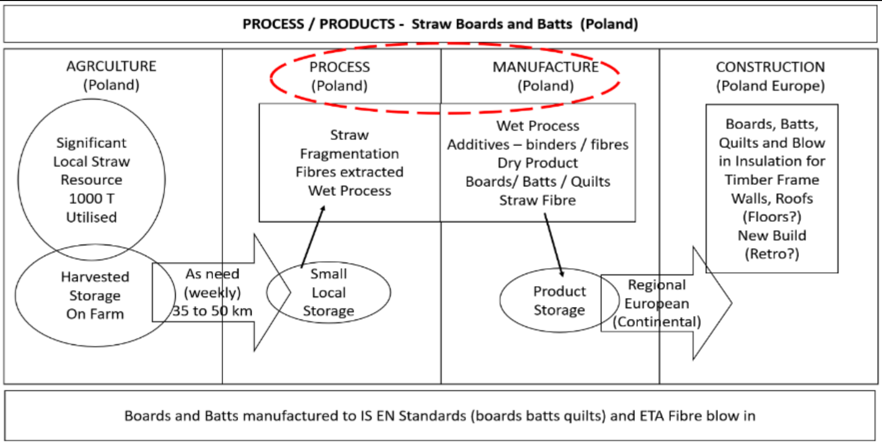

Figure 21 Presenting high level mapping of straw-based processor/product manufacturer with patented technology for fibre extraction of straw, manufacturing and supplying a range of boards and batts for timber frame construction and fibre blow-in insulative infill (Daly P and Barril PG, 2024).

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 22 presenting high-level mapping of this hemp product supply chain.

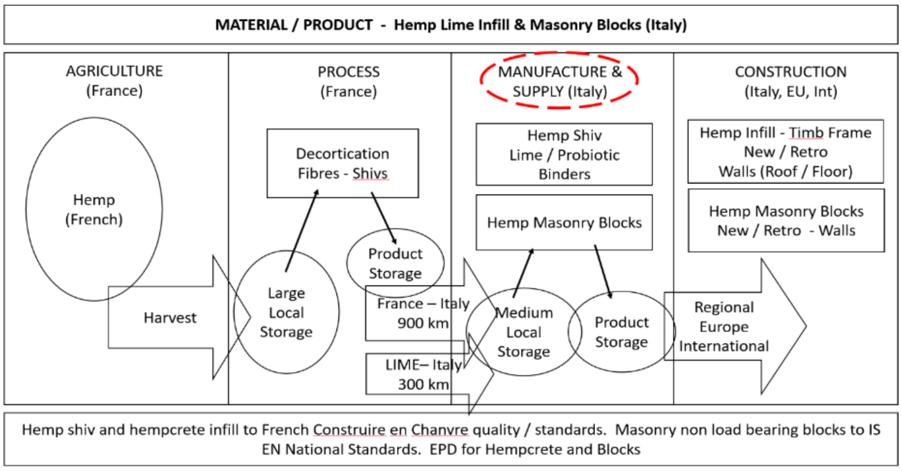

Figure 22 Showing a high-level supply chain mapping of this hemp lime supplier/manufacturer based on French hemp resource (Daly P and Barril PG, 2024).

Case Study – Hemp Based Modular Wall System

This case study examines a modular wall system manufacturer in northern France that specializes 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 performance testing. This case highlights the benefits of a mature hemp industry, resource proximity, drying challenges, and plans for growth. Figure 23 presenting high-level mapping of this hemp product supply chain.

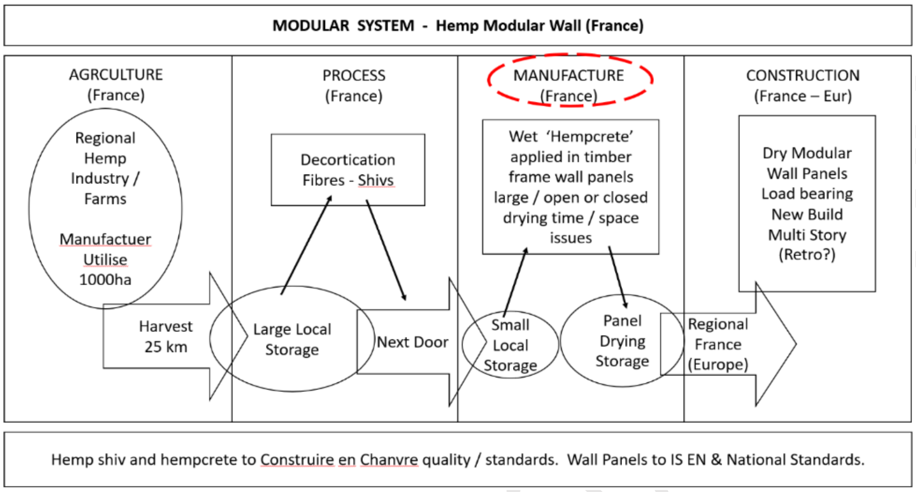

Figure 23 Presenting high-level supply chain mapping of this wet process hempcrete based modular wall panel manufacturer located adjacent to processor and seeking to develop several regional factories (Daly P and Barril PG, 2024).

Case Study – Straw Based Modular Wall System

This case details an innovative modular system manufacturer based in Lithuania and Slovakia, which utilizes automotive production and aims to establish additional factories across Europe. The modular system features compressed straw as insulative 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, dedusting, 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 onsite 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 optimize 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 24 presenting high-level mapping of this hemp product supply chain.

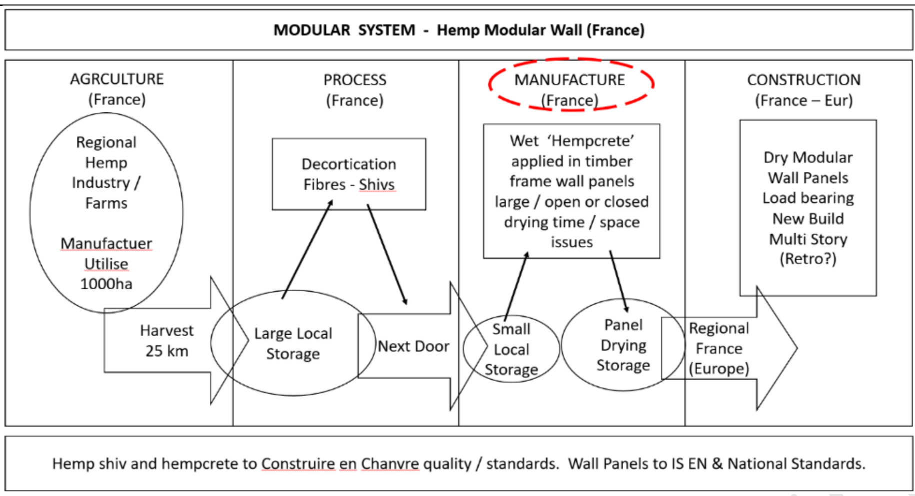

Figure 24 Presenting high-level supply chain mapping of this wet process hempcrete based modular wall panel manufacturer located adjacent to processor and seeking to develop several regional factories (Daly P and Barril PG, 2024).

Appendix 03 – Tools and Processes

Case Studies

Existing schemes primarily concentrate on managing end-of-life products, such as the Netherlands' scheme for flat glass and France's scheme for CDW.

The Netherlands - EPR for flat glass

This EPR scheme focuses on a single product category: Flat glass. Flat glass used in construction, is generally more polluting and harder to recycle. This prompted a group of producers to establish a voluntary system in 2002. Despite this effort, approximately 20,000 tons of unseparated flat glass still 'disappear' into other streams of construction and demolition waste annually. The goal of the Dutch EPR is now: 1) to increase the separate collection of flat glass waste, and 2) to ensure a level-playing field in the market by requiring equal financial contributions from all producers for the operation and maintenance of the waste collection system (BPIE, 2024).

France: EPR for Construction and Demolition Waste (CDW).

In 2023, France became the first country to implement EPR for CDW. This EPR initiative is part of a broader response to the significant reduction in landfill capacity, promoting 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 Organization (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 (Vernier,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, the invoices must break down the fee amounts. Each PRO is required to publish a price list that specifies the fees producers must pay (Vernier, 2021).

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 only pays for the actual 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, and reintegrates them into the production process and reuse 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).

Appendix 04 – Procurement

Policies

Procurement policies and initiatives	Description
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 Green Public Procurement (GPP) and replacing the earlier policy, Green Tenders – An Action Plan on GPP. With Ireland's public sector spending approximately €18.5 billion annually on goods, services, and works (excluding utilities), 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.
Reducing Embodied Carbon in Cement and Concrete through Public Procurement in Ireland,	This report, commissioned by the Department of Enterprise, Trade and Employment (DETE) on behalf of the Cement and Construction Sector Decarbonisation Working Group, provides technical and procedural recommendations for public procurement strategies aimed at significantly reducing the carbon footprint of public sector construction projects involving cement and concrete. Additionally, the report outlines steps to encourage the cement sector to invest in decarbonised products (DETE, 2024).
Green Procurement Guidance for the Public Sector	The Environmental Protection Agency (EPA) has released the GPP Plan 2024–2027, accompanied by ten criteria sets. These resources include the document *Green Public Procurement – Guidance for the Public Sector*, which provides detailed instructions on implementing GPP in procurement processes. The guidance outlines specific environmental criteria across ten key areas to help public sector bodies adopt sustainable, environmentally conscious procurement practices effectively.
GPP Criteria Search tool	The Office of Government Procurement provides an online GPP Criteria Search Tool that simplifies identifying, selecting, and downloading GPP criteria relevant to specific projects. This tool facilitates easier adoption of eco-friendly procurement practices.
Guidance on innovative procurement	The Office of Government Procurement offers guidance on innovation Procurement, which is key if innovative startups or solutions in the circularity are to be enabled to get their solutions to market.

Green Public Procurement (GPP) Monitoring and Reporting	The Environmental Protection Agency (EPA), in collaboration with the Department of the Environment, Climate and Communications and the Office of Government Procurement, has created a GPP Monitoring and Reporting Template. The tool is designed to assist government departments in tracking and reporting their GPP activities.
Public Procurement Guidelines for Goods and Services	These guidelines aim to encourage best practices and ensure consistent application of public procurement rules when purchasing goods and services. The document gives guidance on how to drive innovation in the procurement process. Innovation Partnerships are utilized when no existing goods or services on the market meet a contracting authority's needs. This approach allows authorities to collaborate with one or more partners engaged in separate research and development activities. The goal is to develop innovative goods, works, or services and subsequently procure them, provided they meet agreed performance standards and cost limits. A clear and documented rationale for choosing this method is required.
EU Level(s) framework	The Level(s) Framework for sustainable circular construction is designed to provide standardised and comparable indicators that can be integrated into GPP, and regulations across Europe. The 2022 revised working draft EU Green Public Procurement (GPP) criteria for the design, construction, renovation, demolition, and management of buildings, which is still to be released is structured around the Level(s) indicators. The indicators are also an integral part of implementing the EU taxonomy and 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. Level(s) provides detailed reporting frameworks, checklists and templates for reporting on these indicators. However, there is still little knowledge of Level(s) and its circularity indicators in the Irish industry. Notwithstanding, many European certification tools, such as the Home Performance Index, are already aligned with the Level(s) and EU taxonomy indicators. Level(s) is 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.
Implementation of Circularity, WLC and LCC in Public Construction Projects	This document issued by the IGBC in 2023 provides guidance on how procurers can integrate indicators into GPP. This follows the project timeline of the stages of the Capital works management framework (CWMF), suggesting levels of assessment which should be applied at each stage, and tools that can be used. The guidance document is accompanied by on demand courses to integrate the Level(s) indicators on circularity and report on them.

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 comprise 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	By2026, 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.

Case Studies

Case study: Circular Renovation – 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 moveable 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 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).
Case Study: Integrating Circularity at the early design stage In 2021, the IGBC piloted the use of circularity statements with six design teams working on a range of public and private projects and exploring collaboration to integrate circularity from the early concept stage. Circularity statements set out how circularity has been integrated into a project, and these are now a requirement for the planning approval process in London for buildings over a certain size. In order to facilitate the process, a free cloud-based circularity tool developed by the University of Sheffield called Regenerate was used, and it prompted a comprehensive set of questions similar to the checklists provided by Level(s). Similarly to the Level(s) indicators 2.1-2.4, the set of questions was focused on the site itself, foundations, drainage, structure, building skin, the services, and the spaces, looking at design for adaptability, design for deconstruction, circular material selection and resource efficiency. It challenged each discipline of the design team to respond with solutions, from drainage capacity to façade design. This proved important as many of the aspects of circularity had not been considered by the design team before, and this prompted ideas and solutions. These included standardised window opening sizes, increasing fireproofing of partitions to facilitate a greater degree of adaptability in the future, reuse of components, avoidance of secondary finishes, and prefabrication off-site to avoid waste. Many of these strategies may not have been considered otherwise. The tool allowed the team to self-assess and score the degree of circularity integrated into the project. However, the pilot showed that it was really important to have an experienced team member or external facilitator to guide the process to ensure that responses are ambitious and substantive and avoid the tendency to use unambitious responses as sufficient to address some questions. The workshops need the members of the design team to bring a positive, open mindset and to collaborate in an open non, defensive way. While it is essential to start the process at an early design stage to ensure opportunities are not missed, it is essential to revisit the exercise at each subsequent stage of the design process with the full design team so that the strategies are tracked and iterated as the design develops.

Methodology

Workshop sessions

CircularBuild is committed to delivering the Circular Economy Roadmap in the Construction sector (as part of the Circular Economy Playbook, an EPA-funded project).

An initial scoping desktop review was conducted to analyse data on construction sector baselines and define key concepts related to the Waste Hierarchy. Following this, a stakeholder mapping exercise identified key stakeholders across the entire construction value chain who needed to contribute to the roadmap. Part of the initial research was through a series of 4 engagement in-person workshops with regional outreach: Two in Dublin and one each in Cork and Limerick. The focus was on value-creation concepts.

The workshops were structured around the waste hierarchy pyramid (European Commission, 2023) as shown in Figure 25. The focus was on Prevention and Preparing for Re-use, as highlighted in the Report Circular Economy Guidance for the Irish Construction Sector (2023). This is because recycling, recovery, and disposal are already established practices in Ireland, while prevention and Preparation for reuse are not.

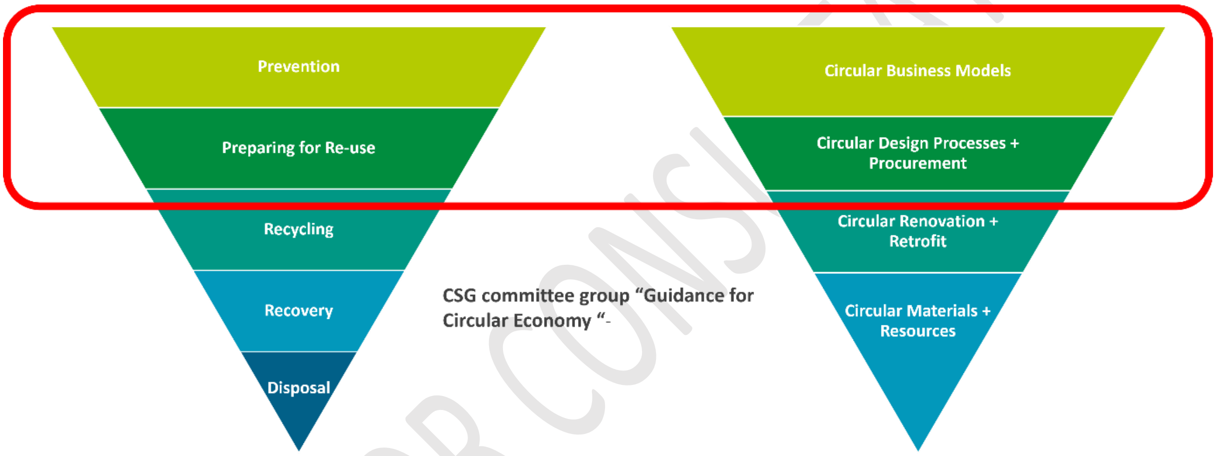

Figure 25 Building a Circular Ireland Waste Hierarchy based on (European Commission, 2023)(IGBC, 2024).

Figure 26 presents the Value Capture strategy currently employed in Ireland, where recycling serves as the primary catalyst for circularity. It is essential to avoid crossing the line—thus, the first step is prevention, followed by reduction, and lastly recycling, integrating waste management into the equation. Ideally, you want to minimise excessive costs, processes, and delays in implementing regulations.

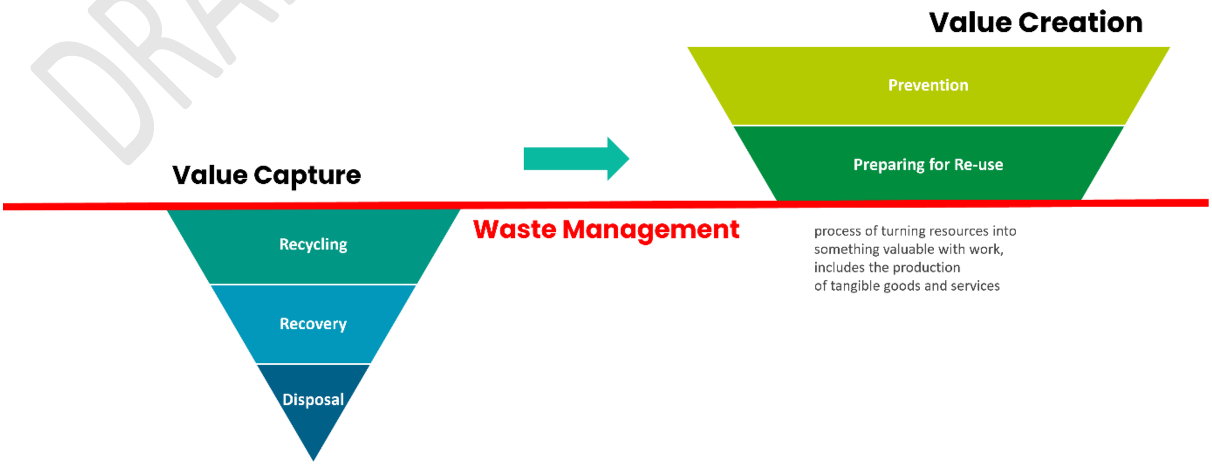

Figure 26 Value Capture and Value Creation approach (IGBC, 2024).

CircularBuild workshops were delivered as follows:

- Dublin, 3rd of November at Hibernia Real Estate – 36 participants
- Cork, 20th of November at University College Cork -Construction Department -27 participants
- Limerick, 26th of January at the NZEB Green Innovation Campus - 20 participants
- Dublin, 16th of February at the Enterprise Ireland Head Quarter -56 participants

The workshops aimed to bring together diverse stakeholders and professionals from across the entire construction value chain to discuss and provide feedback on the proposed Circular Economy Roadmap. Their collective expertise and insights were essential in identifying key challenges and potential solutions, and ensuring that all sector perspectives were considered to facilitate the transition to a circular economy.

Each workshop followed a structured format consisting of five key parts:

1. **Introduction to Workshop Structure and Key Concepts**

The workshop began with an overview of its structure and an introduction to key concepts. The first concept established a link between the Waste Hierarchy and Circular Building principles explored in the research, including Circular Business Models, Circular Design Processes, Circular Procurement, Circular Renovation and Retrofit, and Circular Materials and Resources. Given that the last two stages of the Waste Hierarchy—Recycling and Recovery—have already been extensively studied in Ireland by the Environmental Protection Agency (EPA) (Articles 27 and 28) and the CSG Committee Group for the Department of the Environment, Climate and Communications (DECC) through the report Supporting the Circular Economy Transition in the Irish Construction Sector, the workshops primarily focused on value creation within Circular Business Models, Circular Design Processes, and Circular Procurement.

2. **International Case Study Presentations**

A total of ten international experts presented case studies on Circular Construction to inspire and engage workshop participants.

3. **Thematic Discussion and Table-Based Questions**

Participants were assigned a series of thematic questions, with each table focusing on a different topic, including Circular Design, Circular Procurement, Product-as-a-Service, Extended Producer Responsibility, and the Sharing Economy.

4. **Feedback and Expert Commentary**

Insights and feedback from participants were gathered and subsequently presented to the international speakers for further discussion and expert commentary.

5. **Data Analysis and Roadmap Development**

All collected workshop data was analysed to identify emerging themes, which informed the development of recommendations for this roadmap.

Engagement activities

In parallel, the IGBC participated in other initiatives that were used to develop recommendations for this roadmap that fall outside or add to the value creation concepts. These include:

1. IGBC formed part of the Construction Sector Group (CSG) subcommittee on circularity (CSG, 2024).
2. IGBC participated in a workshop on the Circularity Gap report led by Circle Economy and the Department of the Environment, Climate and Communications (DECC), (Circle Economy, 2024)
3. Consultation workshops with IGBC members on EPA end-of-waste articles 27 and 28.
4. Workshop with the Housing department and Dublin City Council Councillors on the implementation of circularity in the retrofit of social housing vacant units in May 2024.

5. Structured interviews with IGBC members under the Building Life Project initially focused on architects, covering whole-life carbon and circularity.
6. IGBC carried out structured interviews (IGBC, 2024) to develop a white paper on scaling a Construction Materials Exchange (CMEX), which identified key challenges.
7. Research and development of Building Circularity 101 online courses (IGBC, 2023)
8. Participation in the World Green Building Council working groups on Circularity Accelerator and development of fact sheets and strategy documents (World Green Building Council , 2024)
9. IGBC participation in the Forestry Strategy and Timber in Construction working groups.
10. IGBC participation in the Government working group on the decarbonisation of materials chaired by the Department of Enterprise, Trade and Employment (DETE).
11. Workshop with the Department of Education School Building unit on integrating circularity into the school delivery system.
12. National Upskilling Roadmap, which included circularity and a range of other initiatives listed. (IGBC, 2024)
13. Report on the Circular Economy (Houses of the Oireachtas, 2024)

Focus groups sessions

A second layer of engagement was introduced through 10 different focus groups, where specialists per area were invited to attend

The focus group session ran from the 14th of November 2024 to the 29th of January 2025, and with a total engagement of a further 67 stakeholders/specialists.

- 14th of November – Bio-based materials focus group (14 attendees, specialised in the area)
- 21st of November – Extended Producer Responsibility, Product as a Service focus group (14 attendees, specialised in both areas)
- 28th of November - Circular Procurement focus group (14 attendees, specialised in the area)
- 18th of November and 4th December – Vacant properties focus group (9 attendees, specialised in the area)
- 12th of December – Sharing Economy focus group (16 attendees, specialised in the area)
- 29th of January – Financial and Insurance focus group
- October – January – Vacant to Vibrant task group met 4 times to inform recommendations in section 4.

A briefing paper explaining the topic and summarising relevant recommendations was prepared ahead of each focus group and sent to participants. Subsequently, focus groups meetings aimed to:

1. Identify gaps in recommendations for each topic.
2. Prioritise the most important key recommendation
3. Add detail and sharpness to the recommendation linking to or building on a current initiative, ensuring that they are realistic and implementable, and that the steps are in the right order.
4. Identify any questions that should be escalated to another group, experts, or international advisory panel.
5. Ensure the action has the correct owner, and the right stakeholders are involved in its implementation.

Furthermore, 2-3 specialists were invited for 1-2-1 interviews to add another layer of engagement and validate the recommendations/priorities.

As the final layer of engagement, on the 16th of January, the International Advisory Group was consulted to validate recommendations and fill the knowledge gap.

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

Critical raw materials: 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 (CRM Alliance, n.d.).

- **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, 2024). Design and construction should demonstrate design for disassembly and adaptability, using, e.g. ISO 20887 or other standards.

Eco-modulated fees: Eco-modulated fees are a key component of Extended Producer Responsibility (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 (eunomia, 2020)

Level(s): 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)

Re-generative 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. (ETH Zurich, n.d.)

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, 2023)

Secondary raw materials: 'Secondary raw materials' are recycled materials that can be used in manufacturing processes instead of or alongside virgin raw materials. (European Parliament, 2024)

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 re-use. 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 (CIB, 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

List of Acronyms

ATU	Atlantic Technological University
BIM	Building Information Modelling
BPIE	Building Performance Institute Europe
C&D	Construction and Demolition
CDW	Construction and Demolition Waste
CoE	Centres of Excellence
CO2e	Carbon Dioxide equivalent
CMUR	Circular Material Use Rate
CPD	Continuing Professional Development
CPQ	Price and Quote
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
DAFM	Department of Agriculture, Food, and Marine
DASBE	Digital Academy for the Sustainable Built Environment
DETE	Department of Enterprise, Trade and Employment
DfA	Design for Adaptability
DfD	Design for Disassembly
DHLGH	Department of Housing, Local Government, and Heritage
DoPCs	Declarations of Performance and Conformance
EC	Embodied Carbon
EIB	European Investment Bank
EoL	End of Life
EPA	Environmental Protection Agency
EPBD	Energy Performance of Buildings Directive
EPD	Environmental Product Declaration
EPR	Extended Producer Responsibility
ESG	Environmental, Social, and Governance
ETB	Education and Training Board
EU	European Union
EU Taxonomy	European Union Taxonomy
GGBS	Ground Granulated Blast-furnace Slag
GPP	Green Public Procurement
GWP	Global Warming Potential
IFFPG	Irish Farm Film Producers Group
IGBC	Irish Green Building Council
IPCC	Intergovernmental Panel on Climate Change
kgCO2e/m²	Kilograms of CO^2 per meter square
LaaS	Lighting as a Service
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
NZEB	Nearly Zero Energy Buildings
OGP	Office of Government Procurement
OP	Operational Carbon

PaaS	Product as a Service
PRO	Producer Responsibility Organization
R&D	Research and Development
SEAI	Sustainable Energy Authority of Ireland
SFDR	Sustainable Finance Disclosure Regulation
SMEs	Small and Medium-sized Enterprises
SRM	Secondary Raw Materials
sqm	Square metre
TGDs	Technical Guidance Documents
TiCWG	Timber in Construction Working Group
TUDublin	Technological University Dublin
VAT	Value Added Tax
WEEE	Waste Electrical and Electronic Equipment
WLC	Whole Life Carbon
ZEB	Zero Emissions Building

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