WORLD CONFERENCE ON TIMBER ENGINEERING 2025
BRISBANE, AUSTRALIA

Advancing Timber for the Future Built Environment

# GREEN PUBLIC PROCUREMENT AND TIMBER IN CONSTRUCTION FOR A CIRCULAR ECONOMY

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**ABSTRACT:** Green Public Procurement (GPP) serves as a strategic policy instrument for advancing the EU Circular Economy Action Plan within Ireland's construction sector. This research investigates the critical role and practical integration of Life Cycle Assessment (LCA) as an evidence-based decision-support tool within GPP frameworks to specifically promote the utilization of sustainable timber, including indigenous resources. By displacing carbon-intensive materials, this approach aims to align public building projects with national climate mitigation and circular economy objectives. Drawing upon a comprehensive literature review and detailed LCAs comparing timber-based systems against conventional construction in representative building typologies, this paper evaluates how embedding LCA within the procurement process enhances GPP effectiveness. The analysis demonstrates that LCA provides quantifiable metrics highlighting timber's advantages, such as significant embodied carbon reductions and enhanced material circularity. Furthermore, this methodology facilitates the establishment of robust sustainability benchmarks. Findings pinpoint critical intervention points and criteria within GPP to overcome market resistance and strategically drive demand for timber. This research offers an empirically validated framework and actionable guidance, demonstrating how LCA-informed GPP can accelerate Ireland's transition towards a sustainable, low-carbon, and circular built environment.

**KEYWORDS:** *Green Public Procurement, Circular Economy, Timber, Construction, Policy*

## 1 - INTRODUCTION

The global construction sector faces unprecedented pressure to reduce its substantial environmental footprint, which accounts for approximately 40% of global energy-related $CO_2$ emissions and 36% of final energy use [1]. Within the European Union, the building sector contributes significantly to economic activity—representing 5.5% of the EU's GDP in 2021—while simultaneously presenting critical challenges for climate mitigation and circular economy objectives. The European Green Deal and subsequent EU Circular Economy Action Plan have established ambitious frameworks for addressing these challenges, with GPP emerging as a strategic policy instrument for driving sustainable transformation in construction practices [2]. Timber, as a renewable, carbon-sequestering material with inherent circularity advantages, represents a compelling alternative that aligns with both climate mitigation objectives and circular economy principles [3], [4]. The integration of sustainable timber products into public procurement frameworks faces multiple barriers, including perceived cost premiums, technical specification challenges, fragmented supply chains, and limited empirical evidence demonstrating comparative environmental performance in the Irish context [5].

Existing research has primarily focused on either broad sustainability aspects of procurement or technical performance of timber systems, with limited attention to the intersection of LCA methodology, procurement processes, and material selection decision-making [6], [7]. This research addresses the knowledge gap in GPP implementation by examining its strategic role in promoting timber as a low-carbon, renewable material in Ireland's construction sector.

The research objectives are to: (1) evaluate LCA integration as a decision-support tool within GPP frameworks for sustainable timber specification; (2) quantify the environmental performance—particularly embodied carbon—of timber-based versus conventional construction systems in Irish building contexts; (3) identify strategic intervention points within the GPP cycle for

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https://doi.org/10.52202/080513-0641

incorporating LCA-based criteria; and (4) propose an evidence-based framework demonstrating how LCA can inform GPP to drive timber utilization.

The novelty of this work lies in its focus on the integration of LCA within GPP, providing actionable insights for policy development and industry implementation while maintaining a focused examination of embodied carbon in residential building typologies as representative cases for public construction projects.

## 2 - BACKGROUND

GPP represents a significant policy mechanism through which public authorities seek to procure goods, services, and works with reduced environmental impacts throughout their lifecycle compared to conventional alternatives[8]. As a demand-side policy instrument, GPP leverages public spending—which constitutes approximately 14% of GDP across the European Union [2] to stimulate market transformation toward more sustainable products and services.

The evolution of GPP has progressed from voluntary environmental considerations to increasingly structured approaches with defined criteria and implementation frameworks. The 2004 EU Public Procurement Directives established the legal basis for environmental considerations in procurement processes, while subsequent legislation—notably Directive 2014/24/EU—strengthened environmental externalities in tender evaluations [9]. The European Green Deal further elevated GPP's strategic importance, positioning it as a central mechanism for achieving climate neutrality and circular economy objectives [10].

In Ireland, GPP implementation has developed through several policy iterations, beginning with the 2012 National Action Plan on GPP and continuing through the 2024 Climate Action Plan [11], which mandated green criteria in all public procurement. Despite these policy commitments, implementation has been characterized by significant variability across sectors and public bodies, with particularly limited adoption in building materials selection [12]. The EPA's guidance "Green Public Procurement: Guidance for the Public Sector" provides voluntary criteria addressing embodied carbon in construction materials [13].

### 2.1 Circular Economy Principles in the Built Environment

The circular economy paradigm presents a transformative approach to resource management that decouples economic growth from resource consumption through strategies that maintain materials at their highest utility and value [14]. Within the built environment, circular economy principles manifest through multiple strategies: designing out waste and pollution, keeping products and materials in use, and regenerating natural systems [15].

For construction specifically, key strategies include design for disassembly, adaptable building systems, material passports, and closed-loop recycling pathways [16]. The EU Circular Economy Action Plan explicitly targets the construction sector, acknowledging its significance as the largest consumer of raw materials in Europe and generator of approximately 35% of total waste [2].

The application of circular economy principles to procurement decisions requires consideration of multiple criteria, including durability, repairability, reusability, recyclability, and renewable material[17]. However, conventional procurement practices often prioritize initial capital costs over lifecycle considerations, thereby limiting the implementation of circular approaches[18].

The forestry-timber-construction value chain can operate as a renewable, bio-based system with potential for cascading use, whereby timber products are reused, remanufactured, or recycled before eventual energy recovery, thereby maximizing value retention[19]. Modern timber construction systems—including cross-laminated timber (CLT), glued laminated timber (glulam), and timber-frame construction—enable design for disassembly principles through mechanical connections that facilitate future material recovery and reuse [20].

Ireland has experienced significant forestry expansion over recent decades, with forest cover increasing from 1% in the early 20th century to approximately 11% currently [21]. Recent research has demonstrated the potential for Irish-grown timber in engineered wood products such as CLT and glulam, which could expand the application range for domestic timber resources [22].

### 2.2 Life Cycle Assessment (LCA) in Construction

LCA represents a standardized methodological framework for evaluating environmental impacts associated with products, processes, or services throughout their lifecycle. Governed by ISO 14040 and 14044 standards, LCA provides a systematic approach to quantifying resource use, emissions, and environmental impacts from raw material extraction through production, use, and end-of-life treatment [23].

The application of LCA has evolved significantly, with European standardization through EN 15978 establishing methodological approaches for assessing environmental performance[24]. This standard delineates the building lifecycle into modules (A-D), enabling analysis of environmental impacts from product manufacturing (A1-A3), transportation and construction processes (A4-A5), use phase (B1-B7), end-of-life (C1-C4), and potential benefits beyond the system boundary (D).

Recent studies demonstrate that timber-based construction systems typically achieve lower embodied carbon compared to functionally equivalent concrete or steel systems, with reductions ranging from 30% to 85% depending on building type, timber product, and system boundaries [25],[26].

### 2.4 Conceptual Framework

This research integrates the theoretical domains of GPP, circular economy principles, timber construction, and LCA

https://doi.org/10.52202/080513-0641

methodology within an interconnected conceptual framework that addresses both environmental assessment and policy implementation. This framework in Figure 1, positions LCA as a critical analytical bridge between material selection decisions and procurement criteria development, enabling evidence-based integration of environmental performance metrics into procurement frameworks.

The conceptual model acknowledges the multiple objectives that GPP must simultaneously address: (1) climate mitigation through embodied carbon reduction; (2) resource efficiency and circularity enhancement; (3) economic feasibility; and (4) technical performance requirements.

The framework further incorporates the policy implementation perspective by identifying potential intervention points within the procurement cycle: pre-procurement planning, technical specifications, selection criteria, award criteria, and contract performance clauses.

## 3 - LITERATURE REVIEW

The European Commission defines GPP as "a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured"[8]. This procurement approach has garnered increasing attention as a market-based mechanism to stimulate environmental innovation and foster sustainable production patterns [27].

Within the European Union, the legal foundation for GPP was established through Directive 2014/24/EU, which explicitly acknowledged environmental considerations as legitimate factors in public procurement decisions. Subsequent policy developments, including the European Green Deal and Circular Economy Action Plan, have further emphasized GPP's role in achieving broader sustainability objectives [10]. Testa et al. [28] analysed GPP implementation across EU member states, identifying significant variability in adoption rates and effectiveness, with northern European countries generally demonstrating more advanced implementation.

In Ireland specifically, GPP policy has evolved through several iterations. Despite the policy framework, Flynn et al. [12]found that implementation remains inconsistent across public sector organizations, with barriers including procurement officials' environmental expertise, perceived costs, and supplier capacity.

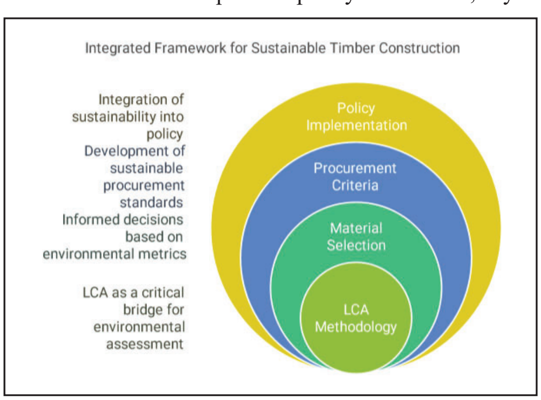

Figure 1: Integrated Framework for Sustainable Timber Construction

Circular economy principles have increasingly influenced GPP frameworks, shifting focus from single-attribute environmental considerations to more comprehensive lifecycle perspectives[29]. Adams et al.[18] identified key circular economy strategies relevant to construction procurement, including design for disassembly, material passport systems, and closed-loop supply chains. Nußholz et al.[17]further examined how circular economy principles can be operationalized within procurement practices, highlighting the importance of material circularity indicators and end-of-life considerations. Sönnichsen and Clement[30]conducted a systematic review of circular public procurement research, identifying that building projects offer significant potential for circular criteria due to their material intensity and long-life cycles.

### 3.1 Timber as a Sustainable Construction Material

The environmental credentials of timber as a construction material have been extensively documented in comparative studies against conventional materials such as concrete and steel. Churkina et al.[3]conducted a comprehensive analysis demonstrating that increased wood utilization in urban construction could transform cities into carbon sinks rather than sources, with potential carbon mitigation of up to 0.9 gigatons annually by 2050. This finding aligns with earlier work by Leskinen et al.[31], who identified average carbon displacement factors of 2.1 tons of carbon emissions avoided per ton of wood products used when substituting for non-wood materials in construction. This carbon storage function, combined with generally lower embodied energy compared to conventional materials, positions timber as a strategic material for decarbonizing the built environment [31]. The sustainability advantages of timber extend beyond carbon sequestration to encompass broader ecological and circular economy benefits. Ramage et al.[32] examined timber's renewable characteristics, highlighting its potential for sustainable forest management practices and multiple cascading uses throughout its lifecycle. Røyne et al. [33] noted timber's favourable end-of-life scenarios, including reuse, recycling, and energy recovery, which enhance its circularity credentials compared to conventional materials.

O'Ceallaigh et al.[22] evaluated the mechanical properties of Irish-grown Sitka spruce for structural applications, identifying both limitations and opportunities for increased domestic utilization. Harte[34] reviewed the challenges facing Ireland's timber industry, noting that despite significant forest resources, structural applications remain constrained by strength grading issues and limited production capacity for engineered wood products.

Modern engineered timber products offer significant potential for expanding timber applications in construction. Skullestad et al.[25] analysed the carbon benefits of substituting cross-laminated timber (CLT) for concrete in mid-rise buildings, finding potential carbon reductions of


https://doi.org/10.52202/080513-0641

34-84% from material production and construction. Similarly, Hafner and Schäfer[26] documented embodied carbon reductions of 35-56% when utilizing timber-frame construction compared to masonry alternatives for residential buildings.

Bouwer et al.[35] analysed GPP criteria for buildings across seven European countries, finding that while environmental considerations were increasingly incorporated into procurement frameworks, specific criteria promoting timber or biobased materials remained limited. This aligns with findings from Rainville [36], who identified that procurement officials often lack the technical expertise to evaluate environmental claims related to construction materials, resulting in limited uptake of innovative alternatives like timber systems.

Vidal and Sánchez-Pantoja [37]evaluated environmental certification schemes for timber products within public procurement, finding that forest certification (e.g., FSC, PEFC) provided necessary criteria for sustainability assessment. Toivonen and Määttänen[38]analysed Sweden's "Trästad" (Wood City) program, which demonstrated how targeted procurement practices could overcome market barriers to timber adoption in public buildings.

### 3.2 Methodological Foundations

LCA has emerged as a robust methodological approach for evaluating the environmental impacts of construction materials and buildings. Standardized through ISO 14040/44 and EN 15978, LCA provides a systematic framework for quantifying environmental performance across multiple impact categories throughout a building's lifecycle [23], [24]. Numerous studies have applied LCA methodology to compare timber with conventional construction materials, consistently demonstrating timber's environmental advantages, particularly regarding climate impact [39], [40].

For timber-specific assessments, methodological considerations include biogenic carbon accounting, forest management assumptions, and end-of-life scenarios. Mehr et al.[19] examined how different methodological choices significantly influence comparative outcomes between timber and conventional materials, highlighting the importance of transparent methodological reporting. Similarly, Røyne et al. [33] identified key methodological challenges in timber LCA, including allocation methods for multi-output forestry systems and temporal carbon dynamics.

Jelse and Peerens [41] proposed integrated assessment methods for procurement officials, combining environmental and economic metrics to support evidence-based decision-making. Nucci et al. [42] further demonstrated how these integrated approaches can enhance procurement outcomes by aligning environmental objectives with economic feasibility considerations.

Critical examination of the literature reveals several significant research gaps regarding the integration of LCA within GPP frameworks for promoting timber utilization in Ireland. First, while numerous studies have documented timber's environmental benefits using LCA methodology, limited research has examined how these benefits can be effectively translated into operational procurement criteria. Sönnichsen and Clement [43] noted this implementation gap between technical assessment and procurement practice as a significant barrier to sustainable material selection. Second, Ireland-specific research on timber-focused GPP remains notably limited. O'Connor et al. [5] identified procurement barriers to timber adoption but offered limited recommendations for GPP framework development. Third, existing literature lacks integrated frameworks demonstrating how LCA can be procedurally incorporated into different stages of the procurement cycle. Fourth, limited research has examined the specific barriers to LCA integration within Irish procurement processes. Rainville[36] identified general knowledge barriers among procurement officials regarding environmental assessment, but Ireland-specific challenges related to LCA implementation remain underexplored. Finally, existing literature lacks comprehensive cost-benefit analyses of timber utilization within Irish public construction projects. This economic gap perpetuates perceived cost barriers to timber adoption in public projects.

## 4 - METHODOLOGY

This study employed a mixed-methods research design that integrates qualitative policy analysis with quantitative environmental and economic assessment to examine the potential for GPP to promote sustainable timber utilization in Ireland's construction sector. This methodological approach aligns with recommendations from Creswell and Creswell [44], who advocate for mixed methods when addressing complex policy and environmental research questions that benefit from both numerical measurements and contextual understanding.

The research design comprised three interconnected components: (1) literature synthesis to establish the theoretical and policy context; (2) quantitative LCA of conventional versus timber-based construction systems; and (3) qualitative analysis of procurement processes to identify intervention points for integrating LCA findings. This triangulated approach addresses the multifaceted nature of sustainable procurement in the construction sector.

Residential building typologies were selected as case study for several strategic reasons. First, housing represents a significant proportion of public construction activity in Ireland, with substantial future investment planned through social housing programs[45]. Second, residential construction offers standardized typologies that facilitate comparative analysis across material systems. Third, previous research by Goggins et al. [46] established baseline environmental performance data for conventional residential construction in Ireland, providing valuable comparative benchmarks. Finally, residential buildings present significant opportunities for timber utilization through various systems (timber frame, mass timber) that are technically feasible within Irish building regulations and industry capabilities [5].

### 4.1 Data Collection

Data collection employed multiple methods to ensure comprehensive coverage of both environmental performance metrics and procurement processes. Primary data sources included:

- Literature sources: A comprehensive review was conducted using structured search protocols across academic databases (Scopus, Web of Science, Science Direct) and institutional repositories. Search terms combined key concepts (e.g., "green public procurement," "timber construction," "life cycle assessment," "embodied carbon") with geographic limiters (e.g., "Ireland," "European Union"). This process identified 127 relevant publications, which were screened for inclusion based on predefined criteria, resulting in 78 core references that informed the theoretical foundation and analytical framework.
- Industry and policy documents: Procurement guidelines, technical standards, EPDs, and policy frameworks were collected from relevant authorities, including the Office of Government Procurement (OGP), the Environmental Protection Agency (EPA), the Irish Green Building Council (IGBC), and European Commission repositories.
- Case study building data: Technical specifications, material quantities, and construction details were obtained for representative residential typologies, including a conventional concrete-block housing unit (Typology A) and equivalent designs using timber-frame construction and cross-laminated timber (Typology B).

### 4.2 Life Cycle Assessment (LCA) Framework

The LCA methodology employed in this study adhered to international standards ISO 14040 and ISO 14044, with specific application to buildings following EN 15978 guidance.

The functional unit was defined as "one square meter of internal floor area providing residential accommodation in compliance with Irish building regulations, with a reference service life of 60 years."

The system boundaries followed a cradle-to-grave approach (modules A-C according to EN 15978), encompassing raw material extraction (A1), transport to manufacturing (A2), manufacturing processes (A3), transport to construction site (A4), construction installation (A5), use phase (B1-B7), and end-of-life processes (C1-C4). Module D (benefits beyond system boundary) was calculated separately to maintain methodological transparency regarding recycling benefits and avoided impacts.

Two representative building typologies were analysed:

- Typology A (Conventional): Single or Two-story semi-detached housing unit with concrete block walls, concrete ground floor slab, timber joist first floor, and timber roof trusses
- Typology B (Timber Frame): Functionally equivalent housing unit utilizing timber frame construction with mineral wool insulation, maintaining identical spatial arrangement and thermal performance

These typologies were selected to represent both current construction practices (Typology A) and technically feasible alternatives (Typology B) that could be specified within Irish public procurement processes.

### 4.3 Inventory Analysis

Material quantities were derived from detailed bills of quantities for each typology, with material properties and manufacturing data sourced from:

- EPDs specific to Irish or European contexts where available
- The Ecoinvent 3.8 database for background processes

For biogenic carbon accounting, the study followed the approach recommended by Hoxha et al.[47], which addresses the temporal aspects of carbon sequestration and release through explicit accounting of biogenic carbon flows.

The analysis mapped standard Irish public procurement stages against potential opportunities for incorporating LCA-based criteria and benchmarks. The procurement cycle was divided into five key stages (Figure 2):

- Pre-procurement planning: Strategic needs assessment and market engagement
- Technical specifications: Minimum requirements for materials and systems
- Selection criteria: Supplier qualification requirements
- Award criteria: Evaluation metrics and weighting systems
- Contract performance clauses: Monitoring and verification requirements

For each stage, the analysis identified specific mechanisms for integrating environmental performance metrics derived from the LCA results.

## 5 - CASE STUDY: COMPARATIVE ASSESSMENT

The selection of appropriate case studies followed a multi-criteria approach to ensure relevance, representativeness, and data reliability. Primary selection parameters included: (1) structurally similar building typologies and spatial dimensions, (2) comprehensive material inventories and construction documentation, (3) geographical proximity to minimize climate and regulatory variability, and (4) accessibility of detailed cost data spanning the building lifecycle. The residential housing project in County

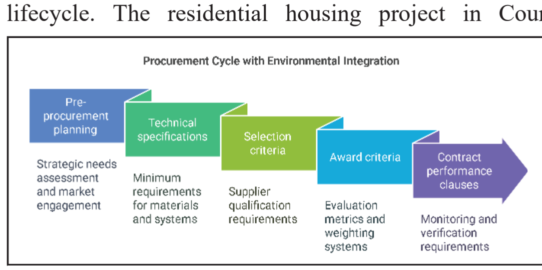


Figure 2: Procurement Cycle


https://doi.org/10.52202/080513-0641

Galway, Ireland, was ultimately selected as it fulfilled these criteria while representing typical construction practices in the region.

Multiple construction methodologies were compared and two of these are presented here: (1) a conventional design utilizing concrete masonry blocks with reinforced concrete foundations and (2) an alternative timber-based design incorporating cross-laminated timber (CLT) wall panels and glulam structural elements with timber flooring. Both designs maintained identical spatial layouts and functional specifications to ensure valid comparative analysis of environmental impacts. The LCA included the structural elements, architectural fixtures, insulation and fittings. It should be noted that cost was not considered here - it is expected to influence the material choice.

LCA methodology following EN 15978 standards was applied to quantify environmental impacts across both designs. System boundaries encompassed raw material extraction, manufacturing, transportation, construction, maintenance, and end-of-life scenarios (cradle-to-grave). Inventory data was sourced from EPDs and the Ecoinvent database (v3.8).

The timber-based design demonstrated substantial environmental benefits across all impact categories. Most notably, a 25.5% reduction in carbon emissions was achieved, primarily attributable to the carbon sequestration properties of timber and reduced cement content.

The quantified environmental benefits demonstrated in this case study provide compelling evidence for integrating sustainability metrics within public procurement frameworks. These findings underscore the necessity for procurement policies that incorporate embodied carbon assessment alongside traditional cost metrics, thereby capturing the comprehensive value proposition of timber-based construction alternatives.

## 6 - RESULTS

The comparative LCA conducted on the County Galway residential housing project yielded quantifiable evidence of environmental benefits when substituting conventional materials with timber-based alternatives. As demonstrated in Table 1, timber-based designs consistently outperformed conventional construction in terms of Global Warming Potential (GWP) showed an average reduction of 19.0%,

*Table 1: Comparative LCA Results for Conventional vs. Timber-based Construction*

| Unit Type | Reduction in Emissions achieved by Timber Frame (Percentage) |
|---|---|
| Type A | 19.06 % |
| Type B | 16.95 % |
| Type B1 | 25.50 % |
| Type C | 17.02 % |
| Type R | 16.28 % |

indicating the comprehensive ecological advantages of timber systems beyond carbon considerations. A detailed examination of embodied carbon across life cycle stages revealed that the most significant carbon reductions occurred in the product stage (A1-A3), which encompasses raw material extraction, transport to manufacturing facilities, and manufacturing processes. Figure 3 illustrates the distribution of embodied carbon reductions across the building life cycle.

The distribution of embodied carbon reductions highlights that 72% of the total carbon savings were achieved during the product stage (A1-A3), primarily due to the substitution of carbon-intensive materials such as concrete and steel with sustainably sourced timber products. The use stage (B1-B7) accounted for 12% of the reductions, primarily attributed to lower maintenance requirements and reduced operational energy demands associated with the thermal properties of timber systems.

An examination of biogenic carbon storage revealed that the timber design sequestered an average of 118 $kgCO_2e/m^2$ over the building lifecycle, enhancing the overall carbon performance beyond the avoided emissions from conventional construction materials.

Based on these findings, the following evidence-based sustainability criteria were developed for integration into procurement frameworks:

- Carbon Performance Thresholds: Establish maximum embodied carbon limits ($kgCO_2e/m^2$) by building typology, with tiered reduction targets over time (recommended initial threshold: 650 $kgCO_2e/m^2$ for residential construction based on this LCA study).
- Material Circularity Requirements: Incentivize designs that facilitate future material recovery and reuse.
- Supply Chain Verification: Require EPDs and chain-of-custody certification for structural timber elements to ensure sustainable forest management practices.
- Technical Requirements: Develop performance-based specifications rather than prescriptive material requirements, focusing on durability, fire safety, and acoustic performance.
- Integration of Findings into Procurement Frameworks

Based on the quantitative and qualitative assessment results, specific procurement levers were identified that could effectively promote timber adoption in public construction projects. Technical capacity building and

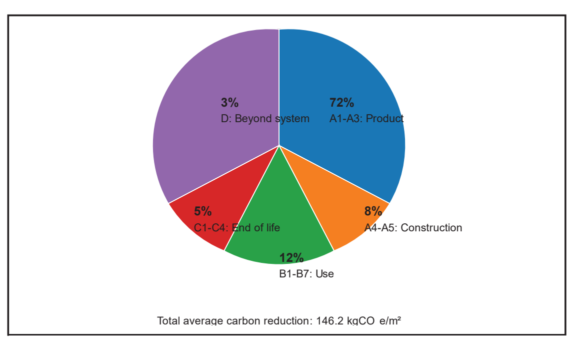


Figure 3: Embodied Carbon Reduction by Life Cycle Stage

material circularity requirements present favourable feasibility-to-impact ratios and could serve as initial implementation priorities.

## 7 - DISCUSSION

The LCA reveals compelling evidence for the integration of timber-based construction systems within GPP frameworks. The consistent embodied carbon reductions observed across all housing typologies (ranging from 16.28% to 25.50%, with a mean reduction of 19%) demonstrate the significant potential of material substitution as a climate mitigation strategy in the built environment.

These findings challenge the conventional procurement focus on initial capital expenditure, highlighting the necessity for whole-life carbon emission methodologies in public procurement evaluation processes. The research findings illuminate several strategic opportunities for leveraging LCA methodologies within GPP frameworks to accelerate timber adoption.

The detailed analysis of life cycle stages reveals that 72% of carbon reductions occur during the product stage (A1-A3), with significant contributions from the use stage (12%) and end-of-life phase (5%). This distribution pattern suggests that procurement strategies should prioritize material selection considerations while maintaining awareness of operational performance and decommissioning implications.

LCA information can be strategically incorporated into procurement processes at multiple points:

- Pre-tender phase: Through market engagement activities that communicate environmental performance expectations to potential bidders, establishing clear sustainability benchmarks.
- Technical specifications: By setting maximum embodied carbon thresholds and minimum circularity scores that bidders must demonstrate compliance with through verified EPDs and material circularity assessments.
- Award criteria: By allocating significant weighting (recommended 30-40%) to environmental performance metrics beyond minimum requirements, thereby incentivizing innovation and environmental excellence.
- Contract performance clauses: By requiring ongoing verification of environmental performance through post-completion assessments and commissioning protocols.

The comprehensive assessment of environmental, economic, and circularity performance establishes evidence-based benchmarks that can guide procurement criteria development. The research findings hold significant implications for policy development at national and regional levels. The projected national-scale impacts demonstrate that achieving 50% market penetration of timber construction in the residential sector could reduce annual carbon emissions and this substantial climate mitigation potential underscores the strategic importance of timber procurement policies as instruments for achieving national climate targets, particularly Ireland's legally binding commitment to a 51% reduction in greenhouse gas emissions by 2030. In addition, by incorporating circularity metrics within procurement frameworks, policymakers can simultaneously advance climate and resource efficiency objectives, creating policy synergies rather than competing priorities.

While countries such as France (RE2020) and the Netherlands (MPG requirements) have successfully implemented embodied carbon regulations in building codes, Ireland's regulatory landscape would require significant adaptation to accommodate similar approaches. The procurement-focused strategy outlined in this research offers an alternative pathway that leverages public spending influence rather than regulatory mandates, potentially achieving similar outcomes through market mechanisms. British Columbia (Canada) and Baden-Württemberg (Germany) have demonstrated the efficacy of public procurement as a market transformation tool.

Technical knowledge gaps among procurement professionals and specifiers emerged as a significant barrier to timber adoption. As evidenced by successful initiatives in countries such as Finland and Austria, where similar capacity building efforts have accelerated timber adoption in public construction.

Data availability presents another significant barrier. The proposed requirement for EPDs addresses this barrier directly by standardizing environmental impact reporting and creating transparent databases for decision support. International experience, particularly from Sweden's Trafikverket (Transport Administration), demonstrates that mandatory EPD requirements in procurement quickly stimulate market development of environmental declarations, addressing data scarcity barriers within 2-3 procurement cycles.

The research findings indicate that LCA-informed procurement can effectively drive market transformation through several mechanisms. First, by creating consistent demand for low-carbon timber products, procurement frameworks can provide market certainty that stimulates investment in domestic manufacturing capacity and supply chain development while creating rural economic development opportunities. Second, by establishing clear performance benchmarks and verification methodologies, LCA-informed procurement creates market recognition for environmental excellence, driving continuous improvement and innovation. The technical standardization of assessment methods addresses market fragmentation challenges and reduces transaction costs associated with sustainability demonstration, particularly benefiting smaller enterprises that often face disproportionate compliance burdens. Finally, by integrating circular economy principles within procurement frameworks, public agencies can stimulate market development of reuse and recycling pathways for timber products, addressing end-of-life concerns that often inhibit material adoption. The remarkably high reusability potential of timber elements presents opportunities for innovative business models focused on material recovery and remanufacturing, supporting broader circular economy objectives.


https://doi.org/10.52202/080513-0641

In conclusion, this research demonstrates that LCA-informed GPP represents a powerful policy instrument for accelerating timber adoption in construction while advancing climate, circularity, and economic objectives. The integration of environmental performance metrics within procurement frameworks creates market mechanisms that recognize timber's comprehensive sustainability advantages, overcoming traditional barriers while stimulating industry innovation.

## 8 - RECOMMENDATIONS

Based on the empirical evidence presented in this study and the comprehensive analysis of timber's environmental, economic, and social performance in construction applications, the following recommendations are put forward to facilitate the integration of timber into GPP frameworks in Ireland.

- Phased Carbon Caps Implementation: Establish a progressive framework for maximum embodied carbon thresholds in public building projects, beginning with an initial cap of 650 $kgCO_2e/m^2$ for residential construction (based on LCA in our study) in 2026, decreasing to 550 $kgCO_2e/m^2$ by 2030. This sequential tightening of requirements provides market certainty while allowing industry adaptation.
- Mandatory LCA: Implement mandatory whole-building LCA reporting for all public construction projects exceeding €2 million in value, utilizing EN 15978 methodology with standardized system boundaries and functional units to ensure consistency and comparability.
- Bio-based Material Quotas: Establish minimum bio-based material content requirements for non-structural applications, increasing periodically, with technical exemptions protocols for applications where suitable bio-based alternatives remain unviable.

### 8.1 Practical Implementation Measures

- EPD Registry: Establish a national EPD database for construction products with mandatory inclusion requirements for suppliers to public projects, addressing data accessibility barriers while reducing compliance costs for industry stakeholders.
- Standard Technical Specifications: Develop standardized technical specifications for timber construction systems in public buildings, addressing fire safety, acoustic performance, and durability requirements to reduce technical barriers and design uncertainty.
- Procurement Templates: Create model tender documents incorporating evidence-based sustainability criteria with appropriate weighting schemas (recommended 30-40% allocation to environmental performance), adaptable for different project scales and building typologies.
- Cross-Departmental Coordination: Establish an interdepartmental working group comprising representatives from housing, environment, forestry, and finance departments to ensure policy coherence between timber demand creation and sustainable supply development.
- Verification Protocols: Implement standardized verification methodologies for environmental claims, utilizing third-party certification mechanisms and post-completion testing to ensure delivered projects achieve specified performance metrics.

By adopting an evidence-based approach to timber procurement that addresses identified barriers while leveraging demonstrated performance advantages, public authorities can accelerate the transition toward a low-carbon, circular built environment while supporting climate objectives and rural economic development.

## 9 - CONCLUSIONS

The analysis presented here reveals that when environmental impacts are systematically quantified using LCA methodologies, timber-based construction solutions consistently demonstrate superior performance in carbon sequestration, embodied energy reduction, and circular economy potential compared to conventional materials. Moreover, the research identifies critical intervention points throughout the procurement process where environmental criteria can be effectively incorporated without compromising cost-efficiency or regulatory compliance.

This work advances the scholarly discourse on sustainable procurement in several ways. First, it bridges the gap between theoretical sustainability frameworks and practical procurement implementation by providing a customized inventory of GPP criteria specifically calibrated for the Irish construction context. Second, it demonstrates how evidence-based procurement strategies can serve as market signals that stimulate innovation throughout the timber supply chain. Third, it establishes methodological protocols for ensuring that environmental claims are verifiable, comparable, and resistant to greenwashing through standardised EPD requirements.

Integrating LCA and EPDs into GPP processes not only provides a robust framework for assessing environmental performance but also empowers policymakers and industry stakeholders to make informed, sustainable decisions. Public procurement emerges as a pivotal mechanism for accelerating the transition to timber-based construction by creating market demand that stimulates supply chain innovation and fosters industry-wide adoption of advanced timber technologies. When deployed systematically across public construction projects, the timber-focused GPP framework developed in this study has the potential to transform material flows within the built environment, creating closed-loop systems that minimize waste, maximize resource efficiency, and optimize carbon sequestration. In this way, evidence-based procurement strategies can serve as catalysts for a broader market transition toward a sustainable, low-carbon, and circular built environment in Ireland.

## 10 - ACKNOWLEDGEMENTS

The authors wish to express their gratitude for the funding received as part of the Opps4GPP project (Project Ref: 2021-GCE-1039). This project is funded under the EPA Research Programme 2021-2030 in Ireland and co-funded by the Department of Agriculture, Food and the Marine.

The EPA Research Programme is a Government of Ireland initiative funded by the Department of the Environment, Climate and Communications.

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