C3 - Sensitive

RECOMMENDATION ON A NATIONAL GLOBAL WARMING POTENTIAL (GWP) CALCULATION METHODOLOGY

Final Report

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1 EXECUTIVE SUMMARY

The objective of this report is to develop recommendations on a technical methodology for the calculation of the life cycle Global Warming Potential (GWP) of buildings to enable national alignment with the requirements outlined within Article 7(2) of the recast Energy Performance of Buildings Directive (EPBD). The EPBD acknowledges that "*buildings are responsible for greenhouse gas emissions before, during and after their operational lifetime*". Developing a consistent framework and approach to calculating the GWP of a new building at design stage and completion, will identify the areas which are most carbon intensive in a building, and ultimately influence designers to adopt lower carbon materials and processes.

The report recommends a methodology that Ireland should adopt to calculate new building's GWP, covering:

- **Technical aspects** which will be consistent across all building typologies, covering the time frame for calculations, floor area, and reporting metrics
- **Scope aspects** which identify the physical site boundary included in the calculation and which LCA stages (in accordance with EN 15978) require to be included. They system for classifying building components is also addressed to align with the ICMS 3 standard for carbon and cost accounting.

The recommendations are based on findings from a review of existing legislation and policy influencing buildings and GWP calculation, an international review of existing GWP methodologies, and consultation with selected national and international stakeholders.

An assessment framework based on identifying areas of *compliance*, areas of *general agreement,* and areas of *divergence* – which are open for interpretation across policy and GWP methodologies internationally – was applied to develop the recommendations. The priority was to ensure compliance with EPBD requirements, and then to apply the following criteria in addressing areas open for interpretation:

- Importance or quantum of GWP associated with a particular LCA stage;
- Availability of data to enable a meaningful calculation;
- Knowledge gaps or lack of methodology;
- Convergence with international practice.

The following table presents the LCA stages which are recommended to be included as a minimum, with mandatory reporting denoted (x) and optional reporting (o).

	Raw material	Transport	Manufacturing	Transport	Construction	Use	Maintenance	Repair	Replacement	Refurbishment	Energy Use	Water Use	Deconstruction	Transport	Waste disposal	Disposal	Beyond system (benefits + loads)
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Ireland	X	X	X	X	X	X			X		X		O	O	X	X	O

The study team also reviewed existing LCA tools used to undertake GWP calculations. The overall recommendation is that the market should be open to using any tool, so long as it complies with the Irish methodology. Better integration of GWP calculation with BIM and digital design tools needs to be achieved. It is also recommended to develop a freely available Irish tool, to enable a low-cost robust tool with which LCA practitioners can gain GWP experience in the short term.

The IGBC's WLC tool was reviewed and identified as being generally robust and reasonably well aligned, subject to further development, with the methodology recommendations.

Further recommendations are presented highlighting the need for **resources**, the need for the SEAI to be **responsive** in what is a dynamic market and regulatory landscape and topics for further **research**.

The recommendations of this report are designed to integrate with a separate study the SEAI have commissioned on the development of EPD and carbon factor database for the Irish market.

Section One
Introduction and Policy Context

2 INTRODUCTION

2.1 Objective and Background

The objective of this report is to develop recommendations on a technical methodology for the calculation of the life cycle Global Warming Potential (GWP) of buildings which can be applied in Ireland and support national alignment with the requirements outlined within Article 7(2) of the recast Energy Performance of Buildings Directive (EPBD) (EU/2024/1275). Life cycle GWP, often referred to as Whole Life Carbon (WLC) is an indicator which quantifies the global warming potential of a building caused by carbon emissions along its full life cycle, including both operational and embodied emissions.

The recast EPBD mandates Member States to calculate and disclose the whole life cycle carbon emissions – operational emissions plus embodied emissions – for all new buildings with useful floor area over 1,000m^2 from 2028 and all new buildings from 2030. Added to this, Member States will have to set whole life carbon limits for buildings from 2030, progressively lowering these limits over time. It has been designed to help Europe achieve a fully decarbonised building stock by 2050, in support of the European Union's (EU) wider aim to have a decarbonised economy and be fully climate-neutral by 2050. Achieving this target will require significant greenhouse gas (GHG) emissions reductions across all sectors and industries.

Across the EU, buildings are responsible for 36% of total GHG emissions, which mainly stem from construction, usage, renovation and demolition.[1] In Ireland, the built environment is estimated to account for 37% of the overall annual GHG emissions in a standard year.[2] Just under two-thirds (23%) of these emissions come from the energy used in the day-to-day operation of a built asset – operational emissions – while the other third (14%) comes from the manufacture, transport, installation, maintenance, deconstruction and disposal of building material components themselves – the embodied carbon emissions.

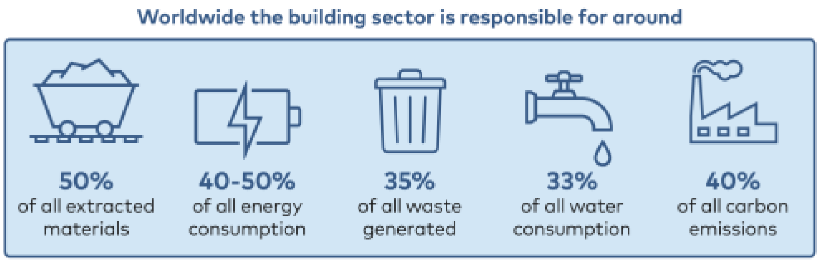


Figure 1: Global environmental impacts of the building sector. (Source: European Commission)

It is estimated that embodied carbon typically contributes 10-20% of EU building's carbon footprint,[3] depending on factors including building type, national building regulations etc. In recent times, the legislative and regulatory drivers for improving building performance at European level has focused primarily on the operational performance of buildings. As more buildings are constructed and renovated to higher energy efficiency standards reducing their operational emissions, the relative and absolute levels of embodied emissions within buildings are likely to increase – high-performance buildings which consume less energy typically require more materials and services. As such, addressing the embodied carbon emissions of a building at the earliest possible stage is paramount for delivering a decarbonised building stock.

A recent international review of low-carbon procurement in construction[4] concluded that 'solid foundations' – including common standards for data collection and life cycle assessments (LCA), project and product calculators and databases – were essential foundations for carbon reduction in the built environment. This report seeks to provide recommendations on how Ireland can begin developing these harmonised and consistent 'solid foundations' by outlining recommendations on how Irish companies can assess the GWP of

[1] European Commission, 2020

[2] IGBC, 2022

[3] Building Performance Institute Europe (BPIE), 2022

[4] Mission Possible Partnership, 2022

buildings they are deigning in a consistent and harmonised manner, ultimately supporting the long-term decarbonisation of the built environment.

> “*Buildings are responsible for greenhouse gas emissions before, during and after their operational lifetime. The 2050 vision for a decarbonised building stock goes beyond the current focus on operational greenhouse gas emissions. The whole-life-cycle emissions of building should therefore progressively be taken into account, starting with new buildings. Buildings are a significant material bank, being repositories for resources over many decades, and the design options and choices of materials largely influence the whole-life-cycle emissions both for new buildings and renovations.”*
>
> - *Energy Performance of Buildings Directive EU 2024/1275, Para. 7*

2.2 Report Methodology and Structure

A four-phased approach was followed when developing recommendations on a national approach for assessing the GWP of buildings, as outlined in Figure 2. This approach informs the structure of following report.

The report begins by reviewing the policy and regulatory framework within which the recommendations for a national methodology for GWP calculations are developed. The purpose of this section is to understand the nature of current regulations and identify the key features within the complex regulatory framework which must be followed within the Irish approach.

Section two outlines the findings from a review and assessment of different GWP calculation methodologies employed internationally. These findings, combined with the necessary features outlined within the various regulatory tools (Section One), and along with knowledge and insight gained from discussions with various stakeholders, inform a series of recommendations for a national GWP calculation methodology.

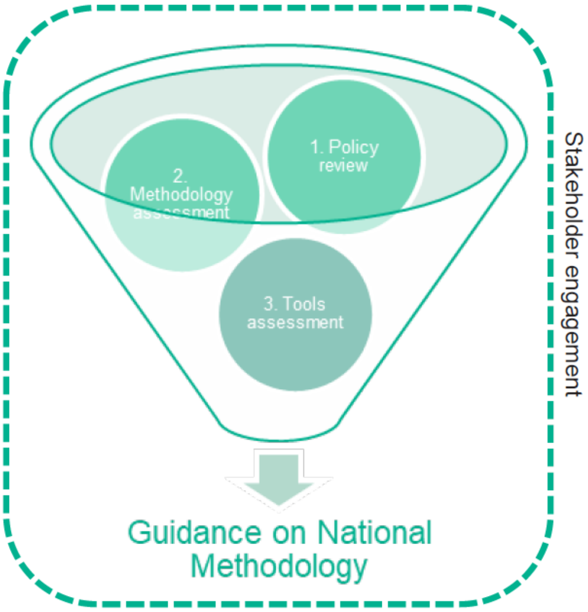


Figure 2: Four-phased project approach

Section three presents the findings from a multi-criteria analysis process which reviewed a non-exhaustive list of Life Cycle Assessment (LCA) tools, including the Irish Green Building Council’s (IGBC) Upfront Calculator tool, and compared them across multiple aspects to outline common features and assess their potential to support the Irish GWP methodology and meet the needs of the Irish market. While it is not the purpose of this report to develop or recommend a national LCA calculation tool at this juncture, this high-level review of various LCA tools helps inform the pathway on how an Irish methodology can be brought to market in an efficient and quick manner.

The final section, Section Four presents a series of additional recommendations for the SEAI which support would support the implementation of a national GWP methodology. These additional recommendations are based upon findings from the literature, policy and international methodology review and informed by experiences shared throughout the stakeholder consultation. These additional recommendations highlight the need for resources, the need for the SEAI to be responsive in what is a dynamic market and regulatory landscape and topics for further research.

2.3 Stakeholder Consultation

A central element to the development of recommendations for an Irish GWP methodology was consultation with Irish and international stakeholders. As highlighted in Figure 3, the experience from a broad range of European countries in applying GWP methodologies has informed the development of an Irish approach. Key themes and findings emerging from the stakeholder consultation included:

Transparency	Clarity	Practicality	Phasing	Communication
• Be transparent in what is both included and not included for measurement.	• Provide clarity to industry on requirements for assessment and reporting.	• The final methodology needs to be user-friendly and usable across the entire sector.	• Start with a methodology which is manageable and progressively improve over time	• Clearly communicate requirements and expectations of industry over time.

The evolution of the regulatory framework was also highlighted as an area for continuous monitoring in the coming years. The recast EPBD is still quite new and therefore its implementation is still in flux – this is highlighted by the fact that different countries are moving at different paces when implementing its requirements. To that end, the proposed Delegated Act to amend Annex III of the EPBD, due in 2025, is expected to bring clarity on a host of topics. Similarly, a proposed review of Level(s) Indicator 1.2 is also expected in order to align with the Delegated Act, providing further clarity for Member States. However, stakeholders noted that there are likely to remain topics which will take considerable time and further discussion at European level to resolve. As such, the situation will continue to evolve over the coming years and developing a methodology or approach which is agile and can respond to this evolution was recommended. Similarly, it was highlighted that differences in approaches across different Member States at this juncture is to be expected, but as more data, experience, and regulatory clarity become available, convergence across Member States' approaches is likely over time.

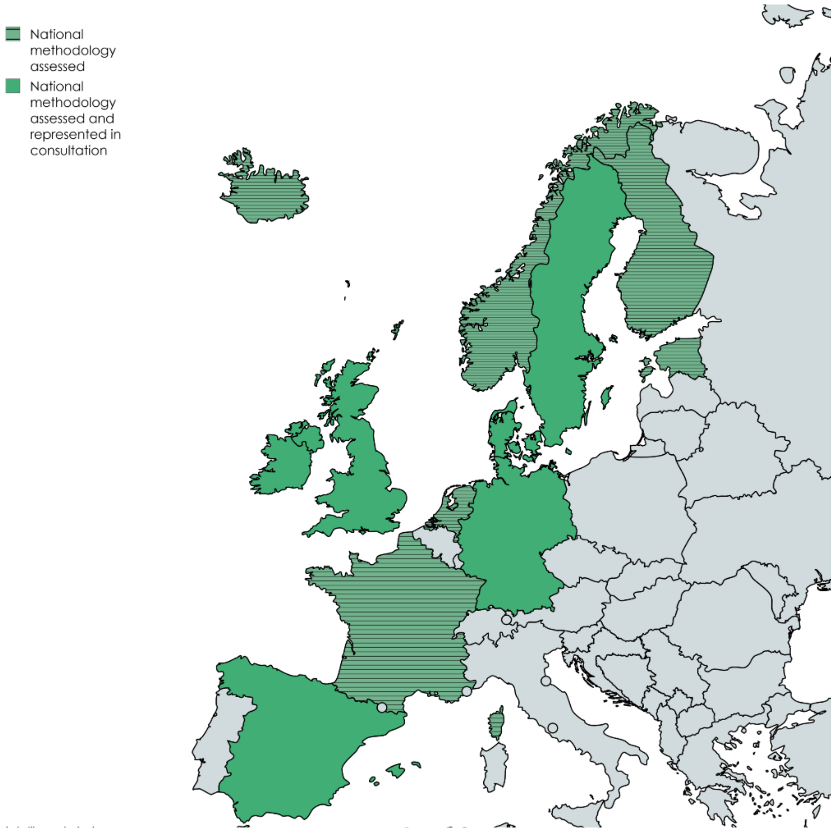


Figure 3: National methodologies assessed and represented in consultation.

3 POLICY CONTEXT

This section provides a brief overview of the different policies, regulations, frameworks, and standards with which the national GWP assessment methodology must take into consideration.

3.1 European Framework relating to Building LCA

At European level, the number of policy and regulatory instruments designed to increase the rate of decarbonisation of buildings, the materials used within them, and their performance, has increased over recent years. The European Green Deal Communication[5] is the catalyst for most of these policy and regulatory changes seen in recent times. Published in December 2019, the European (EU) Green Deal established an action plan for moving to a clean, circular economy whilst restoring biodiversity, cutting pollution, and reaching climate neutrality by 2050.

The most relevant EU Green Deal policy initiatives to this study are the 'Fit for 55' package and the Circular Economy Action Plan (see Section 3.2.1). Under the "Fit for 55" package of legislation, which aims to cut the Union's carbon emission by 55% by 2030, a revision to the Energy Performance of Buildings Directive (EPBD) was progressed and adopted in April 2024. Member States will have until May 2026 to incorporate its requirements within national law.

As shown in Figure 4, the recast EPBD Article 7(2) sets the regulatory framework under which a national GWP calculation methodology must be developed. Within the EPBD, the EU Level(s) framework, specifically Indicator 1.2, is identified as the framework under which the scope of building elements and technical equipment requiring GWP assessment is defined.

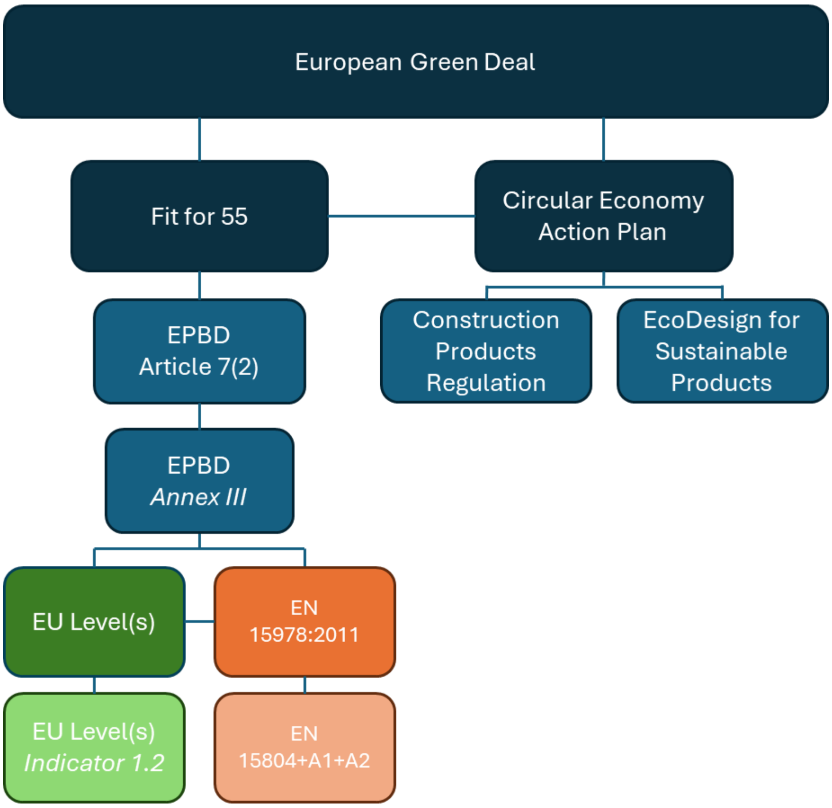


Figure 4: Guiding EU policies, frameworks and standards for compliance

[5]Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, the European Green Deal, COM (2019) 640.

Similarly, EN 15978:2011 (*Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method*) is identified as the methodology by which the data selection, scenario definition and calculations employed in a GWP assessment shall be evaluated.

Taken together, both EU Level(s) Indicator 1.2 and EN 15978:2011 describe the process and boundary for the assessment of environmental performance at building level.

The standard EN 15804:2019 (*Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products*) governs the methodology for producing Environmental Product Declarations (EPDs) at the product level, typically providing the environmental data for products which fits into the assessment at building level.

The following sections detail specific features within these policies and standards in more detail.

3.1.1 Energy Performance of Buildings Directive (EPBD)

The revised EPBD puts Europe on track to achieve a fully decarbonised building stock by 2050. By making zero-emission buildings the new standard for new buildings, it upgrades the existing regulatory framework (agreed in 2018) to reflect a higher climate ambition coupled with social action whilst providing Member States with the flexibility needed to account for the differences in the maturity and performance of building stock and industries across Europe.

The aim of the directive is to promote and mandate the adoption of low-carbon materials and renewable energy solutions within buildings across the continent. The directive provides a range of ambitious measures aimed at reducing energy emissions, both operational emissions and embodied carbon emissions, from buildings across the EU and requires governments to assess and limit all new buildings' emissions from 2030. This includes a focus on the upfront embodied carbon emissions from construction materials used, and the operational carbon emissions which typically arise from heating, cooling and lighting. While it has the potential to be transformative for the built environment industry, it should be noted that it also has the potential to increase the regulatory load for building owners, developers and other stakeholders, and will be a consideration for buildings which are currently in their design stage.

The calculation of life cycle GWP for buildings pursuant to Article 7(2) is described in Annex III of the EPBD, where it notes that the data selection, scenario definition and calculations shall be carried out in accordance with EN 15978. It identifies further that the scope of building elements and technical equipment is as defined in the Level(s) common EU framework for Indicator 1.2. Added to this, there are several additional Articles within the recast EPBD which relate to life cycle GWP methodology and therefore are relevant to this study, see Table 1 below:

Table 1: Articles relating to life cycle GWP within recast EPBD

Article	Text
Article 7(2)	Member States shall ensure that the life-cycle GWP is calculated in accordance with Annex III and disclosed in the energy performance certificate of the building: From 1 January 2028, for all new buildings with a useful floor area larger than 1000m^2 From 1 January 2030, for all new buildings.
Article 7(3)	The (European) Commission is empowered to adopt delegated acts in accordance with Article 32 to amend Annex III to set out a Union framework for the national calculation of life-cycle GWP with a view to achieving climate neutrality. The first such delegated act shall be adopted by 31 December 2025
Article 7(5)	By 1 January 2027 Member States shall publish and notify to the Commission a roadmap detailing the introduction of limit values on the total cumulative life-cycle GWP of all new buildings and set targets for new buildings from 2030, considering a

	progressive downward trend, as well as maximum limit values, detailed for different climatic zones and building typologies. These maximum limit values shall be in line with the Union's objective of achieving climate neutrality.
Annex III (shortened)	For the calculation of the life-cycle GWP of a new building […], the total life-cycle GWP is […] for each life-cycle stage expressed as $kgCO_2eq/(m^2)$ (of useful floor area) calculated over a reference study period of 50 years, the data selection, scenario definition and calculations shall be carried out in accordance with EN 15978:2011 […]. The scope of building elements and technical equipment is as defined in the Level(s) common EU framework for indicator 1.2. Where a national calculation tool or method exists […], that tool or method may be used to provide the required disclosure. Other calculation tools or methods may be used if they fulfil the minimum criteria established by the Level(s) common EU framework. Data regarding specific construction product calculated in accordance with Regulation (EU) No 305/2011 […] shall be used when available.

Member States must transpose the recast EPBD in their national legislation by 29 May 2026. The mandatory nature of these calculations and their disclosure must be laid down in the national building legislation, ensuring that the life cycle GWP calculation of new buildings has to be carried out from the dates stated in Article 7(2). However, more technical details related to the calculation methodology can come later in national legislation.

Figure 5 below illustrates the relationship between, and timeline for the introduction of the aforementioned Articles under the EPBD. From 2030, as outlined under Articles 7(5) and 7(2), Member States will need to have maximum GWP limit values in place alongside the requirement for a GWP calculation and disclosure to happen on all new buildings. Prior to Member States developing these limit values, pursuant of Article 7(5), a roadmap on the introduction of these limits will need to be developed by 2027. The development of this roadmap will be informed by a Delegated Act developed at EU level and which will be adopted by 2026 to amend Annex III of the EPBD. As indicated below, the development of a national GWP calculation methodology as part of this study is one of the first steps on this journey to having mandatory limits and calculation of GWP of buildings in Ireland.

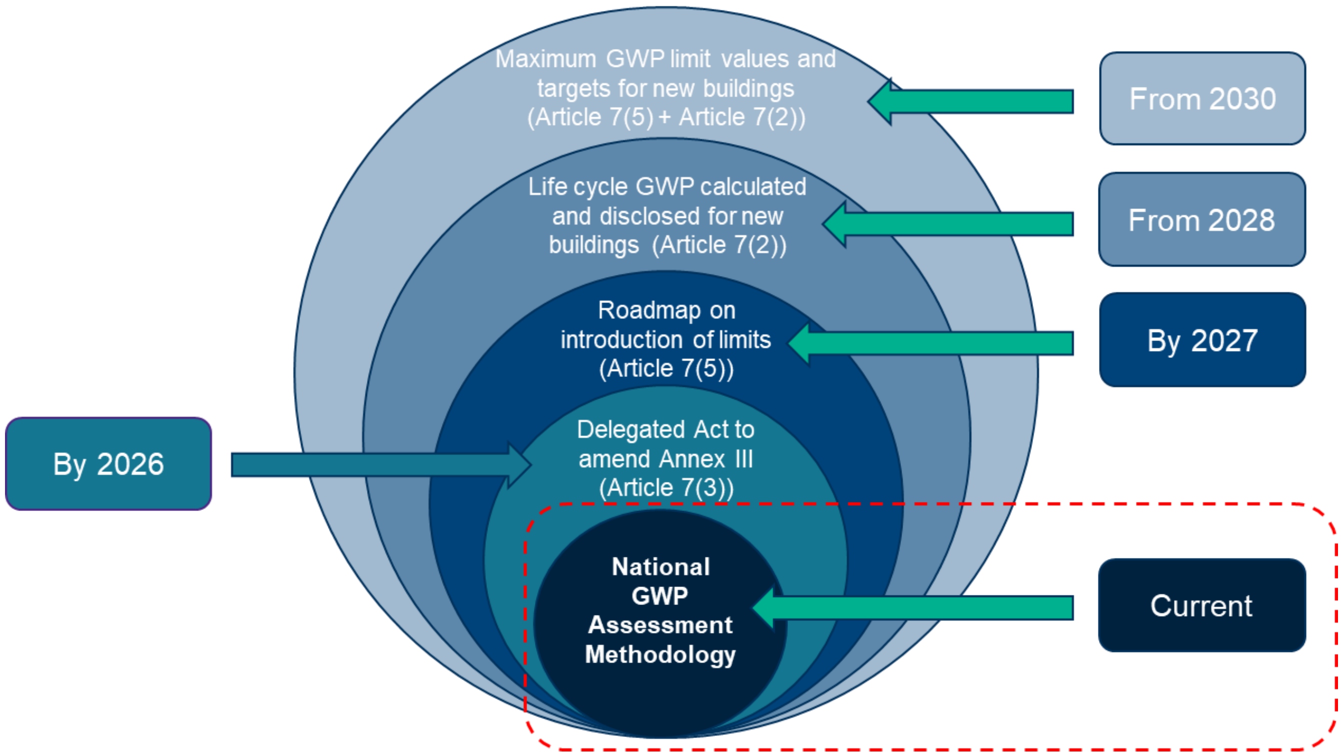


Figure 5: Timeline for introduction of EPBD GWP Articles

3.1.1.1 Delegated Act and Evolution of the EPBD

As detailed in EPBD Article 7(3), the European Commission will look to adopt a Delegated Act amending Annex III of the EPBD by 31 December 2025. The delegated act is expected to be designed to create a uniform framework that will form the basis for all official national tools or methods. The current landscape is varied among the Member States regarding the methodology for national calculations. Certain Member States have already established an official methodology for national calculations and the delegated act will recognise the existence of these national methods as they seek to establish common principles for both official national exiting methodologies and those that will be developed in the future.

While it is not yet fully known the full extent of what will be included in the Delegated Act, below is a series of possible areas which have emerged from the literature and stakeholder consultations which may be addressed as part of the process:

- Clarification on legal terms and technical terms related to Article 7(2) and Annex III
  - This may include further detail related to the scope of which types of buildings to be included in calculations;
  - Clarity on how to calculate GWP where the reference service life for buildings with a shorter expected lifetime than 50 years;
  - Reference and clarity on EN 15978:2011 and how calculations are undertaken until the revised prEN15978 is adopted (see Appendix G for more detail on the prEN 15978);
  - Establish clear minimum requirements on national methodologies and tools (if they are developed);
  - Further clarity on construction product data and the interplay between EPDs and the incoming Construction Product Regulation (see Section 3.2.1 for more detail on the CPR).
- Clearly define a minimum harmonised framework so that results can be reasonably compared across jurisdictions.
  - Seek to outline minimum modules as per EN 15978 (and sub-modules as per prEN 15978) which need to accounted across all countries, and a description of approaches within these modules;
  - Provide further clarity the scope of building elements which need to be accounted for, including the reasonable cut-off criteria for elements which may not require calculation (or not), for example, by mass, by value, or by type of products such as screws.
- Clarity around certain methodological approaches and other clarifications, including:
  - A common definition of floor area to be calculated (See Section 5.1.3 for further detail). While each Member State will have autonomy to have their own approach, the Delegated Act may seek to require Member States to align more closely with the International Property Measurement Standards (IPMS) floor area definitions;
  - Clarification on expectations of when GWP calculations for a project shall be submitted, for example, a Design-Level LCA and an As-Built LCA at project handover;
  - Further resolution on how detailed the reporting of GWP should be (i.e., combination of modules, per module, per sub-module etc.);
  - Further clarity for Member States on how to approach issues relating the accuracy and completeness of their GWP assessments (e.g., linking carbon calculations to bill of quantities reporting via ICMS 3 (see Section 3.2.2)).

While the above areas have been noted through consultation as potential areas the Delegated Act may seek to address, it is worth noting that the aim of the Delegated Act is no to provide a detailed step-by-step methodology for undertaking a GWP assessment, but to provide a framework for a method. Member States will have autonomy in how they design their calculation methodologies in a host of areas, allowing for the national and regional building circumstances they are operating under.

Figure 6 below illustrates the regulatory scope of influence the Delegated Act will have.

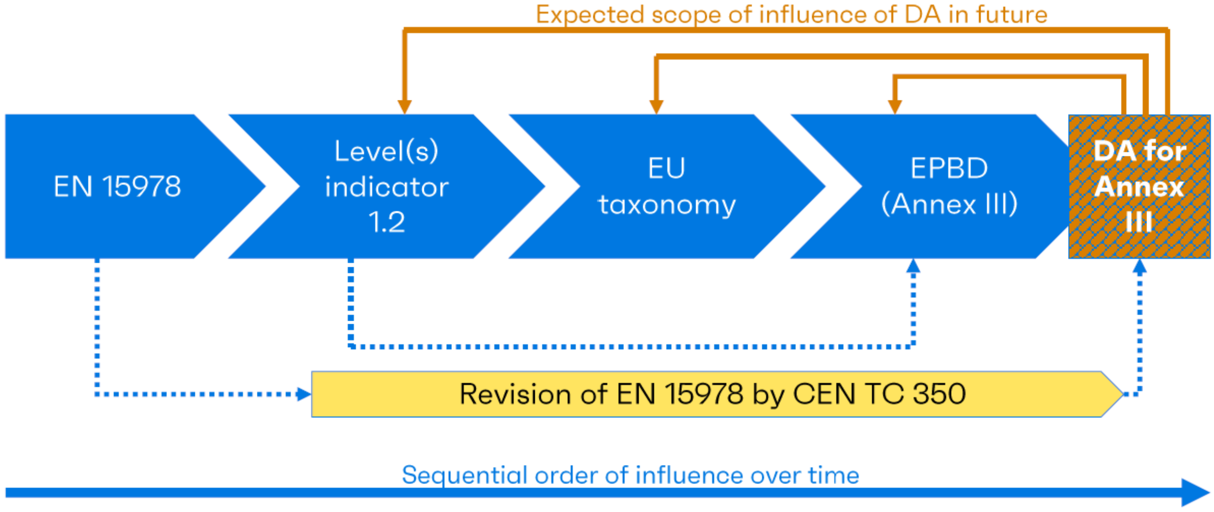


Figure 6: Scope of influence of Delegated Act, (Source: Viegand Maagoe, 2024)

3.1.2 EU Level(s) Framework and Indicator 1.2

The EU Level(s) is a voluntary reporting framework designed to improve the sustainability of buildings. It is central to delivering the EU's overall ambition of climate neutrality by 2050 as it provides a set of common indicators and metrics for measuring the environmental performance of office and residential buildings, considering their full life cycle. As a common EU framework, it provides the three main project actors (i.e., project design team; clients and investors; and public policy makers and procurers) with a common language to assess, compare, optimize, and report the sustainability of their buildings. The framework can be applied to residential and office buildings, both new and renovated, at different project stages - from design until operation.

The framework focuses on six areas: GHG emissions; resource efficiency; water use; health and comfort; resilience and adaptation; and cost and value.

EU Level(s) Indicator 1.2 specifically focuses on GHG emissions and aims to quantify the GWP of a building along its lifecycle from 'cradle to grave', i.e. the system boundary as described by EN 15978 (see Figure 7). It proposes to do so at 3 different stages:

- Level 1 – Conceptual design;
- Level 2 – Detailed design and construction, and;
- Level 3 – As-built and in-use.

The **unit of measurement is kgCO_{2eq}/m^2** of useful internal floor area over a **reference period of 50 years**. Measuring a building's GHG emissions across its life cycle and at various stages provides critical data and informs sustainable building practices, policy-making and public awareness, and enables stakeholders to make informed decisions that can contribute to reducing GHG emissions in line with EU and national climate goals.

3.1.2.1 EU Taxonomy and Level(s)

The EU Taxonomy is a system that categorises economic activities deemed environmentally sustainable, providing a framework to determine how investments can be classified as sustainable. It is crucial for companies that make large investments as it allows them to quantify how their capital supports sustainable practices and is particularly relevant for large asset owners. By defining sustainable investments, it aligns corporate strategies with broader EU environmental goals such as reducing greenhouse gas emissions, promoting a circular economy, and protecting biodiversity and water resources.

As Level(s) is a reporting framework which provides indicators to measure the environmental performance of buildings, it is a critical tool for implementing the EU Taxonomy as it offers a structured way to report on sustainable construction activities. Data gleaned from following the Level(s) framework feeds directly into the EU Taxonomy, allowing for accurate reporting on the sustainability of construction projects.

3.1.3 European Standard EN 15978:2011

EN 15978:2011 (*Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method*) provides a standardized methodology for calculating the life cycle environmental impact of buildings, both for new construction and renovation.

The calculation methodology splits the life cycle into 'stages' including material extraction (sometimes known as 'upfront carbon'), through construction, use, and end-of-life phases. The methodology also allows for the inclusion of additional information beyond the construction works life cycle such as Biogenic carbon. These stages are further sub-divided into modules, as illustrated in Figure 7. The standard provides a detailed method for quantifying the environmental impacts using Life Cycle Assessment (LCA) methodologies and includes guidance on setting system boundaries, selecting appropriate data, and ensuring consistency and transparency in reporting.

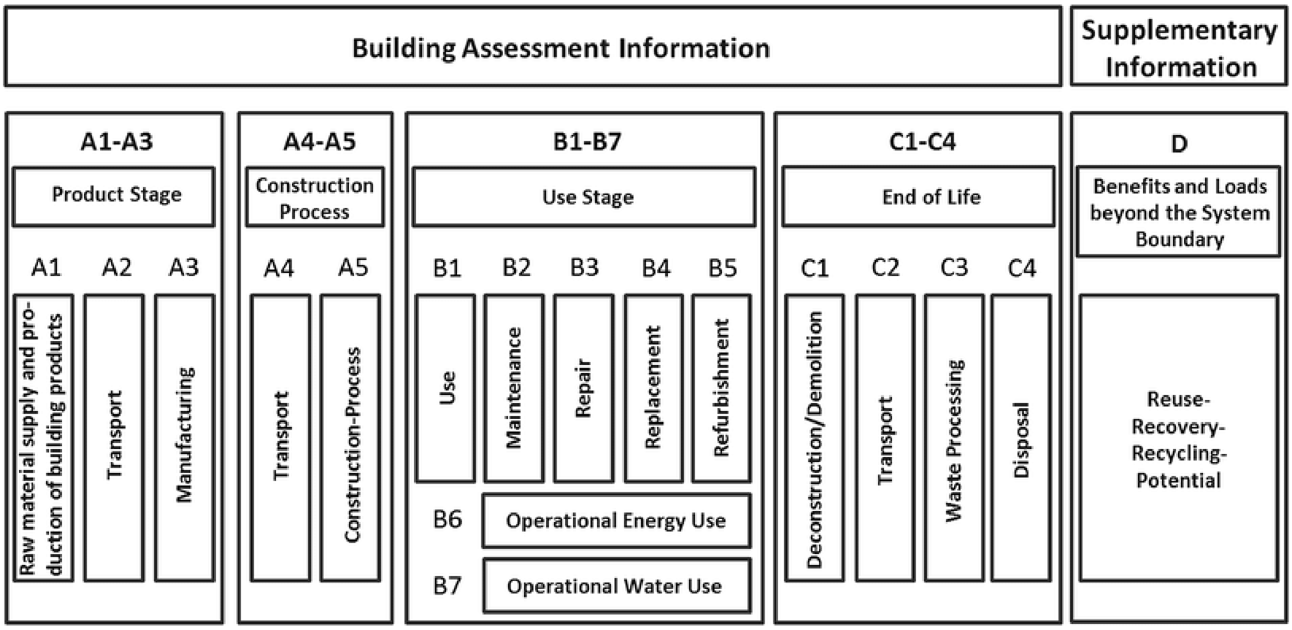


Figure 7: Building and infrastructure life cycle stages and modules (Source: EN 15978:2011)

Appendix A provides further detail on the specific breakdown or requirements and consideration for each of the stages and modules.

3.1.3.1 EN 15978:2011 and EN 15804:2019

EN 15978:2011 emphasises the importance of data quality in environmental assessments. It is used in combination with EN 15804:2012+A2:2019 (*Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products),* which defines and provides core rules for developing Environmental Product Declarations (EPDs) specifically for construction products and materials.

EN 15804 establishes a consistent framework for assessing and reporting a product's environmental performance, following the same LCA methodology outlined in EN 15978 (see Figure 7). Furthermore, EN 15804 details the specific impact categories that must be reported on (e.g., GWP, ozone depletion, acidification etc.). By providing a common format, EN 15804 helps ensure that environmental information is presented in a standardised, credible and comparable way across construction products, allowing architects, designers, builders and other stakeholders to make more informed and sustainable choices.

Both standards work together to provide a comprehensive framework for assessing the environmental performance of construction products and buildings. EN 15804 focuses on standardising the environmental data for individual construction products through EPDs, while EN 15978 uses this standardised data to assess the environmental impacts of buildings across their entire life cycle. This integrated approach allows for consistency, reliability, and comparability in environmental assessments, facilitating more sustainable construction practices and informed decision-making in the built environment.

Over time, it is expected that EPDs will be phased out as the disclosure of environmental information of building products will be replaced under the Construction Products Regulation (CPR) (see Section 3.2.1 below).

3.2 Additional supporting Policies and Standards

Alongside the policies, frameworks and standards referenced above, there are a host of additional legislative and measurement tools with which any national methodology should have consideration of – see Appendix B. The following selection looks at three particularly relevant regulations and standards.

3.2.1 EU Circular Economy Action Plan (CEAP)

The European Commission adopted the new circular economy action plan in March 2020. It is one of the main building blocks of the European Green Deal. The new action plan announces initiatives along the entire life cycle of products. It 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. The Construction Products Regulation (CPR) and the EcoDesign for Sustainable Products regulation (ESPR) are two measures within CEAP that have influence on how life cycle GWP of buildings will be calculated.

Construction Products Regulation (CPR)

The revised CPR was adopted in April 2024. The intention of the CPR is to further develop the construction market in Europe towards more digital and environmentally friendly concepts, while maintaining a level playing field, and broadly it focuses on three key areas: the promotion of sustainability and sustainable materials; an enhanced emphasis on standardisation; and, increased focus on digitalisation within and of the construction sector.

Central to the revised CPR is that a construction product sold within the EU will be required to disclose its GWP information and manufacturers need to include environmental data in their performance declarations and promote the reuse of materials. Additionally, Digital Product Passports (DPPs) shall be utilised and will consist of declarations of performance (DoP) which are expected to provide comprehensive detail on the construction products such as performance characteristics, safety specifications and environmental footprint. Along with an increased rate of standardisation and promotion of additional green public procurement rules, the revised CPR is expected to equip engineers, architects and developers with the necessary legally actionable environmental information so they can make more informed and sustainable design decisions.

Annex III of the EPBD notes that "*Data regarding specific construction products calculated in accordance with Regulation (EU) No 305/2011 […] shall be used when available",* noting explicitly that environmental data on construction products arising from the updated CPR is going to supersede Environmental Product Declarations (EPDs) when available. However, as the CPR sets out a harmonised assessment method for environmental characteristics for different product categories and families, of which there are many, it will take some time before it comes into effect. Until that point, EPDs according to EN 15804 shall be acceptable.

Ecodesign for Sustainable Products Regulation (ESPR)

The Ecodesign for Sustainable Products Regulation (ESPR) is a significant part of the European Green Deal and the European Commission's Circular Economy Package. The main objective of this regulation is to build on existing successful ecodesign rules, improve the functioning of the internal market and reduce the negative life cycle environmental impacts of products. ESPR establishes a comprehensive framework for setting ecodesign requirements for products and is aimed at enhancing traceability, circularity, energy performance, and overall environmental sustainability. The regulation covers almost all categories of physical goods in the EU market, with specific exceptions such as food and feed. ESPR will set sustainability requirements for a wide range of products, including construction products, and adapting to these new regulations will require coordinated efforts from construction product manufacturers.

A key innovation under ESPR, and which links the ESPR with the CPR, is the introduction of the Digital Product Passport. This digital tool provides comprehensive information on a product's environmental sustainability, easily accessible through scanning a data carrier. Attributes covered include durability, reparability, recycled content, and spare part availability, aiming to facilitate informed consumer choices, support repairs and recycling, and enhance transparency on environmental impacts throughout a product's life cycle.

3.2.2 International Cost Management Standards (ICMS 3)

ICMS 3, the third edition to the International Cost Management Standard (ICMS), is a global standard for benchmarking and reporting of construction project cost and carbon, providing a consistent method for carbon life cycle reporting across construction projects, from buildings and bridges to ports and offshore structures. Mandated for use in Ireland since January 2024, ICMS 3 enables and allow decisions to be made on the basis of the total cost (both in terms of financial and carbon cost) of project construction and building ownership and operation – including the environmental impacts of decisions with respect to material selection, design and energy use and production. By providing a common reporting framework for life cycle costs and carbon emissions, ICMS allows their interrelationship to be explored, and provides the opportunity to make decisions about the design, construction, operations and maintenance of the built environment to improve environmental sustainability.

ICMS 3 also acts as a classification system for building components, providing a clear and structure system for identifying and supporting calculation of carbon emissions across different construction and material components within a building project. As it is a globally recognised standard, ICMS 3 provides an opportunity for industry alignment on classification systems and cooperation between industry standards organisations.

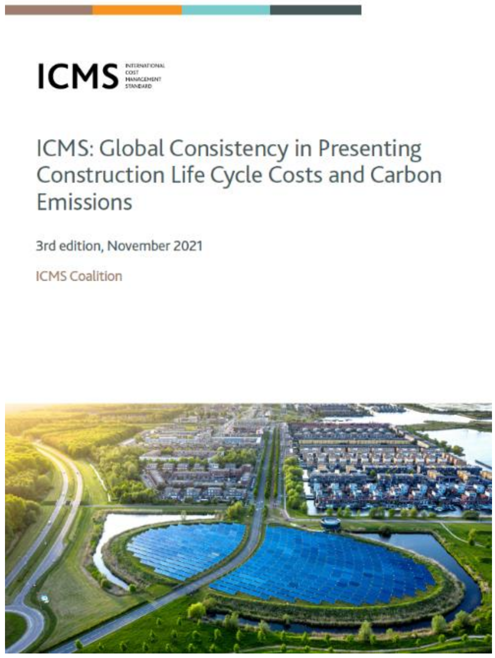


Figure 8: International Cost Management Standard 3rd Edition (ICMS 3)

ICMS 3 also supports greater digitalisation within the construction industry by encouraging integration with digital tools such as Building Information Modelling (BIM). Combining the data handling capacity of BIM and the availability of greater levels of information on materials and building components, developers and contracting authorities and their project teams will have additional capacity to review a project's environmental impact at different stages of its delivery life cycle and understand the consequences of decisions across multiple aspects. ICMS 3 will formalise report at the key decision points. Furthermore, the harmonised classification ICMS 3 offers creates a potential for increased output comparability across different markets.

ICMS 3 includes a detailed breakdown of typical construction project components, and therefore the extent to which the GWP methodology aligns with this breakdown is an important question for this study as regards future alignment. Greater alignment between BIM software and GWP calculation tools will also be beneficial.

Section Two
National GWP Methodology Recommendations

4 REVIEW AND ASSESSMENT OF GWP METHODOLOGIES

4.1 Introduction and Approach

Following the publication of the latest EPBD in April 2024, work is underway in various EU Member States to bring their own policies and practices into alignment with the EPBD. While some countries are at the beginning of this process, many calculation methodologies and tools have been employed across different countries for several years. This section presents a series of recommendations to inform the development of an Irish GWP assessment methodology.

This section reviews available literature on a series of international methodologies and assess various criteria within them to determine their applicability for the Irish context. This international review is supplemented by insights gained from consultation with various stakeholders throughout this study.

The international review and stakeholder consultation process has taken place across Q3 and Q4 2024, and as such, the findings reflect the information and the context available in this period. New publications are anticipated in the coming months and a Delegated Act which amends Annex III of the EPBD is expected by the end of 2025. This review, and resultant recommendations, are therefore based on information which has been published up to August 2024 and is currently available. The robustness and alignment of the included recommendations may be subject to monitoring and change as further information emerges.

4.1.1 Stages in the process

Three over-arching principles inform the development of recommendations an Irish national GWP assessment methodology. Recommendations needs to be:

- Legally valid and compliant;
- Comprehensive and robust; and,
- Technically deliverable and implementable in the Irish context.

Figure 9 below presents the step-wise approach which was followed to develop the recommendations for an Irish national GWP methodology.

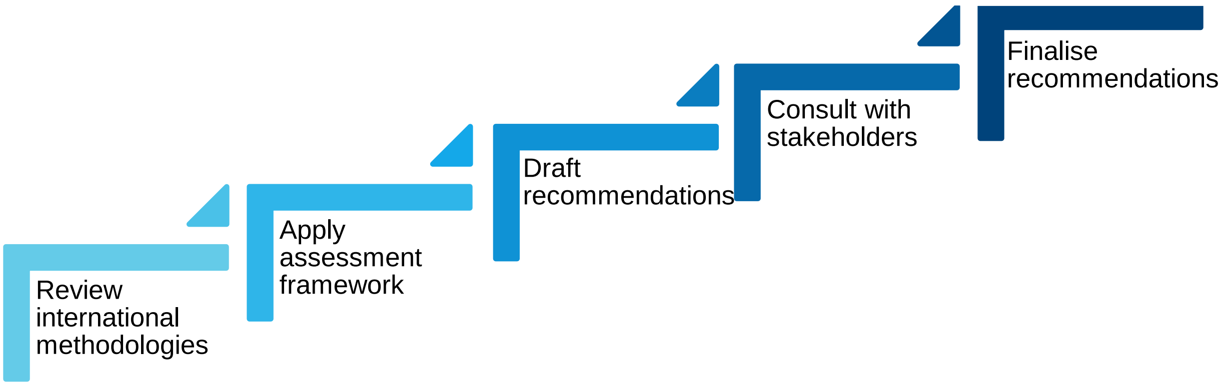


Figure 9: Approach to development of recommendations

4.2 Review of International Methodologies

The methodologies reviewed are listed in Table 2 below. The review primarily considers those most recently published assessment methodologies. It is expanded to also include other key methodologies used. For a subset of the international methodologies, direct translations or primary resources were not always accessible, in which case secondary sources of information are cited.

Table 2 presents a summary of the current international methodologies outlining which modules of EN 15978 are included in the scope of the method.

Table 2: List of reviewed documents, regulations and methodologies

Regulation/ Methodology	Rationale for inclusion
Primary Data	
Energy Performance of Buildings Directive (EPBD) *EPBD, 2024. Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (recast).*	Overarching piece of EU legislation
EN 15978 (2011) *IS EN 15978, 2011. Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method. NSAI.*	Cited methodology for GWP declaration in the EPBD and current overarching EN standard.
EU Level(s) UM1, 2 and 3. Indicator 1.2 *(Dodd et al., 2021a, 2021b, 2020)*	Cited in the EPBD and developed to be the common framework to be used across Europe.
UK – RICS WLC 2nd Edition *RICS, 2024. Whole life carbon assessment for the built environment. Global. 2nd Edition, September 2023. Version 3, August 2024. Effective from 1 July 2024.*	A very comprehensive methodology used in Europe with claims to be a global standard.
Denmark – BR18 *Bygningsreglementet (BR18)*	The Danish were one of the pioneering countries to adopt whole life carbon declaration. Additionally, they have a robust foundation of scientific research used to inform the process. For example (Balouktsi and Birgisdottir, 2023)
Nordics (Finland, Denmark, Norway, Sweden, Iceland, Estonia) *Erlandsson, M., Görman, F., Thrysin, Å., Häkkinen, T., Eckerberg, K., Pesu, J., Dalborg, M., Asplund, J., 2024. Nordic View on Data Needs and Scenario Settings for Full Life Cycle Building Environmental Assessment. Nordic Innovation.*	This is not a regulation. It is comprehensive report from a group of influential members across the Nordics. It is one of the most current documents and, importantly, has been published after the EPBD April 2024.
Secondary Data	
Norway – Tek 17 *Tek 17 in accordance with NS3720:2018*	The method used in Norway is NS3720. This is derived from EN 15978 and is required by TEK17.
Sweden – Klimatdeklaration *https://www.boverket.se/sv/klimatdeklaration/*	Climate declarations are enforced in Sweden since the beginning of 2022 using the Klimatdeklaration av byggnader tool.
France – RE202 *Réglementation environnementale 2020.*	The RE2020 has been in force since January 2020.
The Netherlands - MilieuPrestatie Gebouwen - MPG *https://www.rvo.nl/onderwerpen/wetten-en-regels-gebouwen/milieuprestatie-gebouwen-mpg*	The Netherlands were the first European nation to require life cycle GWP declaration using the MilieuPrestatie Gebouwen (translates to "Environmental Performance of Buildings") methodology.

As indicated in Table 2, many calculation methodologies and tools have been employed across different countries for several years. Denmark, Norway, France, the Netherlands, and Sweden are considered among the most advanced countries which have already established reporting requirements and methodologies (including for embodied carbon) for new building projects.

In an ideal scenario there would be a single standard which would comprehensively cover all criteria of an LCA. While EN 15978 provides an overarching framework for undertaking a building LCA, there are several 'grey areas' in this standard, and hence scope for varying project-level assumptions. This lack of harmonisation across methodologies is illustrated in Table 3 below, which presents the LCA modules covered, as per EN 15978, by each of the aforementioned countries and compares it with the explicit disclosure requirements set out within both EN 15978 and Level(s).

Table 3: EN 15978:2011 Module coverage across various international methodologies

	Raw material	Transport	Manufacturing	Transport	Construction	Use	Maintenance	Repair	Replacement	Refurbishment	Energy Use	Water Use	Deconstruction	Transport	Waste disposal	Disposal	Beyond system (benefits + loads)
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
EPBD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
EN 15978 (2011)	x	x	x	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Level(s)	x	x	x	o	o	o	o	o	o	o	o	o	o	o	o	o	o
UK - RICS WLC 2nd edition	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	o
Denmark - BR18	x	x	x						x		x				x	x	o
Sweden - Klimatdeklaration	x	x	x	x	x												
Norway - NS 3720	x	x	x	x					x								
France - RE2020	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
The Netherlands - MPG	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x

(*(x) explicitly cited. (o) optional module*)

While there is some harmonisation underway in the Nordic states, no two countries have taken exactly the same approach to GWP assessment at this point in time. An objective of the EU Level(s) framework, as part of a bigger project, is to further tighten the requirements of EN 15978 in terms of scope definition. However, the EU Level(s) User Manuals (UMs) themselves leave scope for different interpretations in relation to certain technical matters. Furthermore, it was highlighted through the stakeholder consultation that affording Member States flexibility for different interpretations of the assessment requirements in order to develop a methodology which responds to the context of their built environment sector is a key part and intention of the EPBD. Similarly, the Delegated Act which will be introduced to amend Annex III of the EPBD in 2025, while it will provide further clarifications on features within a national GWP methodology, it is not expected nor intended to provide a detailed step-by-step methodology for doing an actual GWP calculation.

4.3 Apply Assessment Framework

In order to fully evaluate the different approaches outlined in the various published methodologies, an assessment framework was designed to support the identification and assessment of the key criteria which influence the GWP of buildings.

In the first instance, a four-phased conceptual framework, illustrated in Figure 10, was adopted which informed how the various international methodologies were reviewed. This conceptual framework is described below:

- **Phase 1. Policy Compliance** – Here the 'non-negotiable' criteria for assessment were identified. This covers both what the EPBD states explicitly and what might be interpreted from it. Criteria cited in EN 15978 and in Level(s) Indicator 1.2 are included here since both are cited in the EPBD.
- **Phase 2. General Agreement** – Here the criteria where there is strong general agreement among national and EU-level methodologies were identified.
- **Phase 3. Criteria of divergence** – In this phase, the key criteria where there is divergence among current methodologies, or where agreement/compliance is not clear were identified.
- **Phase 4. Recommendations and rationale** – This section summarises the recommendations and rationale following the research conducted in the three preceding phases.

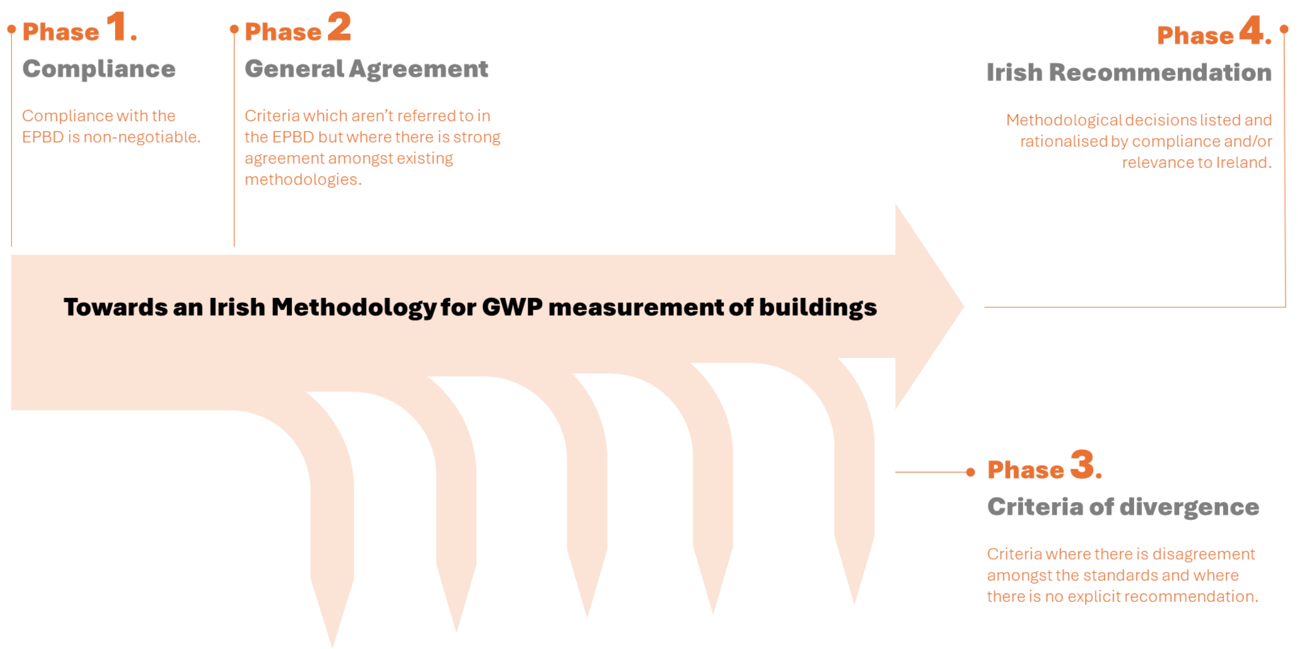


Figure 10: Phased approach used to understand the development of a national methodology

A total of fifteen separate but common criteria for assessment were identified as playing a central role in determining and impacting the GWP of buildings, outlined in Table 4. These criteria have been derived following the review of the different assessment methodologies (Table 2) alongside an assessment of the different requirements set out within the EPBD, EN 15978 and the Level(s) framework. While it is not an exhaustive list of criteria, it is considered they cover methodology aspects which most impact the final result.

Table 4: Criteria for review and assessment

Technical Information
1.1 – Reference study period
1.2 – Declared metric
1.3 – Floor Area
1.4 – Biogenic carbon accounting
1.5 – Specified Tools
1.6 – Specified database
1.7 – Data quality / uncertainty
Scope
2.1 – Site boundary
2.2 – LCA stages A1 – A3
2.3 – LCA stages A4 – A5
2.4 – LCA stage B
2.5 – LCA stage C
2.6 – LCA stage D
2.7 – Component – classification
2.8 – Component – coverage

In broad terms, the criteria for assessment were split into two categories: Technical Information and Scope.

- **Technical Information –** Refers to decisions or choices on the approach to certain framing matters in the methodology and governing considerations that will apply to building GWP assessments, regardless of the type, subject project, or scope of what is included in the assessment. Much of the technical information is either explicit or implied within the regulatory context governing the GWP assessment of buildings and it is anticipated and expected that approaches across the EU will converge and be broadly aligned over time.
- **Scope –** By scope, we are referring to what physical elements of a building are included in a GWP assessment, the physical extent of the site, and what modules (as per EN 15978) of the building life-cycle area are covered. Most of the divergence among international methodologies occurs in the scope of the project. The following Figure 11 illustrates the concept of Scope for this report. Depending on recommendation in this regard, the extent of the GHG assessment required in Ireland will be narrower or wider.

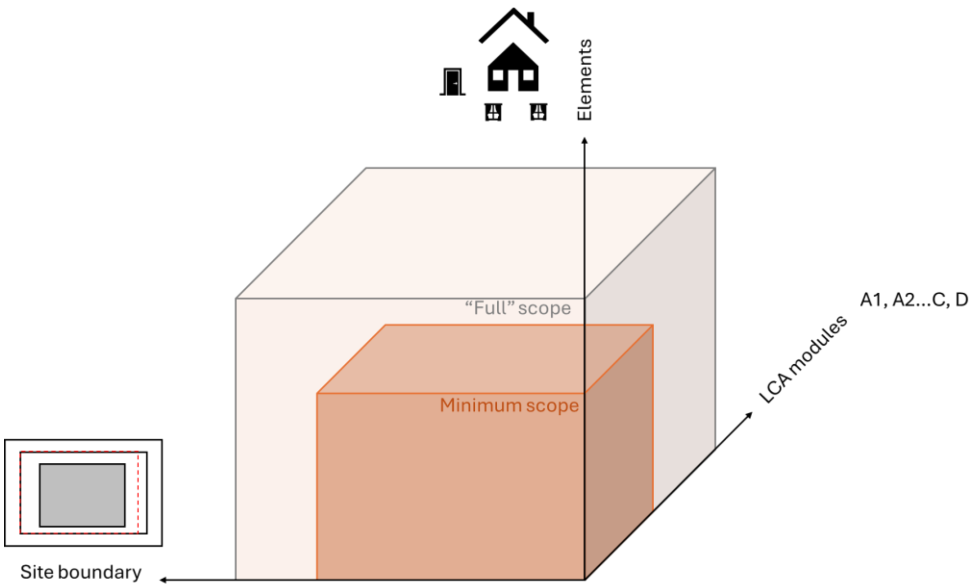


Figure 11: Interpretation of Scope of elements which will inform a building GWP assessment

Table 5 below, provides an overview and maps the assessment criteria identified to the phase they are captured in within the conceptual framework noted in Figure 10. As it relates to Technical Information, several features are explicitly outlined within the EPBD, while other specific features can be derived from the existing regulatory framework. There is more divergence noted across different methodologies when reviewing approaches to databases, data quality and project scope. Table 5 below informed the structure and content of the consultation with key stakeholders as it identified key areas of divergence across methodologies and underpins the complexity of developing a methodology which delivers on the over-arching principles noted in the outset of the research study.

Table 5: Overview of where methodology criteria are considered under our approach

	Phase 1 - Compliance	Phase 2 - General agreement	Phase 3 - Criteria of divergence
Technical Information			
Reference study period	x		
Declared metric	x		
Floor area	(x)		
Biogenic carbon accounting	(x)		
Specified Tools		x	
Specified database			x
Data quality / uncertainty			x
Scope			
Site boundary			x
LCA stages A1 – A3		x	
LCA stages A4 – A5			x
LCA stage B			x
LCA stage C			x
LCA stage D			x
Component – classification			x
Component – coverage (interpretation)	(x)		

In the table, (x) denotes an *implied* rather than an *explicit* reference to the EPBD.

These areas where there is divergence exist due to the autonomy that the EPBD and associated regulations provide Member States to design their own methodology. Noted by several stakeholders, there is an anticipation that over time, as the knowledge base grows, more countries adopt methodologies, and further clarifications on criteria which are open for interpretation provided, there will be fewer areas where there are divergences across an approach and more areas where there is general agreement across approaches.

4.4 Emerging recommendations and stakeholder discussions

Following the international review and taking into account the current status of GWP assessment in Ireland, including policy and research developments, the project team developed an emerging position in relation to the technical information and scope criteria listed in Table 5 above. The team then identified a shortlist of stakeholders in Ireland and EU for consultation, with a view to teasing out specific topics of interest, learning from experience to date in other countries, and considering Ireland's alignment with international practices.

Table 6 below highlights the key topics that were discussed in the course of the stakeholder consultation process. The discussions were informed by the emerging positions and findings from the international review. Discussions were tailored towards each of the stakeholders based on their experience and background.

Table 6: Overview of topics discussed during stakeholder consultation

Stakeholder	Consultation Themes
Irish EPD Database Assessment Consultancy Team (Martin Blumberg (Ramboll), Andreas Sorensen (Ramboll), Pernille Ohms (Ramboll), Jane Anderson (Various))	Data requirements (i.e., full LCA data or GWP data only) for building components. Approach to Module B6 operational carbon and relationship with the BER. Reference service life period and EPDs. Approach to data quality and effectiveness of penalisation factor. Discussion on whether a singular national database or access to multiple databases for calculations is preferable. Discussion on physical scope of the LCA – whether it is the entire building or includes external works.
Martin Erlandsson (IVL Svenska Miljöinstitutet)	Practical experience to LCA methodology in Sweden and across Nordics. The need to have a clear purpose, aim and goal, and how this gives the market/ industry a clear signal and confidence. Need for digitalisation across the industry and how that can support calculations and limit setting. Scope of elements that should be covered by EPDs – main material elements in a building versus EPDs for every element. Approach to Biogenic carbon. Potential challenges posed by the forthcoming CPR and environmental data. Approach to data quality, uncertainty and penalisation and how the market in Sweden responded to their approach. Reflection on other additional (and perhaps better) legislative tools available to policymakers to support carbon assessments.
Irish Green Building Council (Pat Barry, Stephen Barrett)	Practical experience in LCA in Ireland to date Overview/ findings of Indicate research project. Discussion on methodology details, including availability of data, current practices. Direction of travel for building LCA including agreement on tool-agnostic approach. Integration of ICMS 3 and Level(s) and the support that will provide to the industry.
JRC Consultancy Team (Shane Donatello, Viegand Maagoe)	Reference study period and how discussions relating to buildings design for less than 50 years are ongoing at EU level. Quantification of biogenic carbon. Declared metric and emphasis on transparency and comparability of numbers over accuracy. Tool-agnostic approach favoured. Coverage of data across the EU and access to suitable databases. Resourcing required across EU to get up to speed.

	Module coverage, and the uncertainty/ scenario-dependent factors across several modules which may not improve a building's design. Link between the site boundary and declared metric. Delegated Act considerations. Likely updates to Level(s).
Endrit Hoxha (Associate Professor, Aalborg University)	Reference study period and declared metric and impact on final GWP. Importance of language when discussing data uncertainty and quality. Phasing of limit rules in Denmark. Approach to Biogenic carbon. Danish quantification tool and access to representative data and databases. Evolution of methodology requirements across different building typologies. Training and communication needs for the market and experience in Denmark.
Office of Government Procurement (OGP) (Charles Mitchell)	Alignment with ICMS 3. How ICMS 3 can support material and component classification Integration with BIM and wider digital assets.

4.5 Finalising Recommendations

The underlying requirement is to ensure EPBD compliance, therefore this is the primary consideration in finalising recommendations. Another important over-arching consideration is alignment of the methodology with other EU policy and legislation, for example in support of circular economy in the built environment.

The stakeholder engagement summarised above has given useful insights and has led to a number of the 'emerging recommendations' to be revised to better align with current practices in EU member states, and also to align with emerging or changing regulations. In making recommendations with response to technical and scope criteria outlined above, the project team aimed to resolve the following considerations:

- **Importance - Quantum of GWP**: In other words, to what extent this element or LCA module will impact on total GWP? The largest contributions should be included. This will guide and influence the design process with a view to reducing GWP.
- **Availability of Data** – If the basic information to enable a meaningful calculation is not available, this weighs against including the element or module.
- **Knowledge gaps or lack of methodology** – for some LCA modules, there may be a lack of agreement among the technical/ research community on how to calculate GWP. This makes it impractical to include as a mandatory requirement at the present time.
- **Convergence with international practice** – How well would we align with what other countries are doing, so that Irish data can form part of wider EU-wide reporting and knowledge development.

Developing recommendations on individual criteria:

- Importance/ Quantum of GWP
- Availability of data
- Understanding & Knowledge gaps
- Convergence with international practice

There may also be room for the methodology to evolve or expand in the coming years, as knowledge improves, and more practical experience is developed in building LCA in Ireland and Internationally. Section 10 of this report sets out some areas where research would be beneficial in this regard.

5 GWP METHODOLGY RECOMMENDATIONS

5.1 Technical Information

5.1.1 Reference study period

Over what period should GWP be calculated for a building?

The reference study period of a building GWP assessment is explicitly referenced in the EPBD.

EPBD (April 2024)	EN 15978 (2011)	Level(s) (Indicator 1.2)
The EPBD states that: "…*the total life-cycle GWP is communicated as a numeric indicator for each life-cycle stage expressed as kgCO_2eq/(m^2) (of useful floor area) calculated over* ***a reference study period of 50 years***."	This standard gives several examples. Not tied to 50 years.	50 years cited several times in all the User Manuals related to Level(s) indicator 1.2.

There is also general agreement on this 50-year reference period across methodologies employed in different European countries (e.g. Denmark, Sweden, Norway, France). The UK approach is to use a 60-year reference study period for buildings and provides guidance on assets with longer service lives e.g. Infrastructure projects (RICS, 2024).

It should be noted that there is an arbitrary nature to the shorter reference periods. A period of 50 years does not favour those more durable longer lasting buildings. For buildings designed to have reference study periods beyond 50 years, this could be noted separately.

Furthermore, discussions are ongoing at European level on how to calculate for buildings with a design-life less than 50 years. This is an area which will require monitoring as there may be further insight within the upcoming Delegated Act.

Criterion 1.1 – Reference study period:

Primary recommendation	Secondary recommendation
Report for a 50-year reference study period, as cited in the EPBD.	If designed for a lifetime beyond 50 years this should be noted separately in supplementary report. Monitor European-level discussions and emerging recommendations on accounting for buildings with design-life less than 50 years.

5.1.2 Declared metric

What is the reporting unit for GWP of a building?

The declared metric by which a building shall disclose its GWP is explicitly referenced in the EPBD.

EPBD (April 2024)	EN 15978 (2011)	Level(s) (Indicator 1.2)
The EPBD explicitly states that the life-cycle GWP needs to be disclosed in **$kgCO_2eq/(m^2)$**.	EN 15978 (2011) does not require disclosure per m^2. It requires that the total emissions are reported in **$kgCO_2eq$**.	The Level(s) user manuals cites both metrics while also introducing an annualised metric in UM2: **$kgCO_2e/m^2/a$** in User Manual 2 (Dodd et al., 2021b) **$kgCO_2e/m^2$** in User Manual 3 (Dodd et al., 2020)

Our recommendation is to follow this explicit requirement cited in the EPBD. This is the approach also cited in several other European standards as well as the UK approach (RICS, 2024).

There are however other metrics used. The Danish approach for example is to annualise the embodied carbon by dividing the $kgCO_2eq/(m^2)$ by the reference study period of 50 years. The metric they therefore use is **$kgCO_2e/m^2/a$**.

Criterion 1.2 – Declared Metric Recommendation:

Primary recommendation
Report using **$kgCO_2eq/(m^2)$** as per the EPBD Annex III.

5.1.3 Floor area definition

For what floor area should GWP be calculated for a building?

The approach to determining the floor area to be calculated within a GWP assessment is implied within the EPBD and associated documents.

EPBD (April 2024)	EN 15978 (2011)	Level(s) (Indicator 1.2)
"useful floor area" is explicitly cited in Annex III of the EPBD. This definition is however left open for interpretation.	EN 15978 (2011) lacks explicitness and cites "***gross floor area***".	Level(s) cites the IPMS-3 approach for offices and IPMS-3B approach for residential buildings. Level(s) UM2 also provides a summary table (Table 10) of these requirements (Dodd et al., 2021b).

The lack of explicitness in EN 15978:2011 in relation to the floor area has resulted in the use of different floor area definitions in each EU Member State. A 2023 study conducted by Astle et al. (2023) of Ramboll rigorously compares each of these definitions, highlighting inconsistencies in the scope of inclusion of items such as basements, attics and plant rooms. The basement is excluded for example in the Netherlands' BVO definition, while the external wall thickness is not captured in the UK or Finland (Astle et al., 2023).

Although the Level(s) criteria for floor area is not explicitly cited in the EPBD, it is interpreted that, since it is cited separately in relation to scope, the Level(s) approach is the implied method of floor area definition i.e. the International Property Measurement Standard (IPMS) (2023). The IPMS approach is cited in the UK's latest guidance from RICS as the method which now supersedes older terminology.

In Ireland the Society of Chartered Surveyors Ireland (SCSI) provide guidance for measurement and building cost estimates. The IPMS standard is also the recommended guidance for SCSI members. Members can diverge if directed by the client. The guide is posted in the SCSI's website (IPMS, 2023).

2 Technical definitions

2.1 IPMS core definitions

IPMS: Office Buildings and *IPMS: Residential Buildings* avoid using the various existing descriptions that have different interpretations between countries and even within a country. The comparison between IPMS for offices and residential and the generic descriptions for area bases contained within the current edition of RICS' *Code of measuring practice* are shown below:

- IPMS 1 – which equates closely to the former GEA (gross external area).
- IPMS 2 – Office, which equates closely to the former GIA (gross internal area).
- IPMS 2 – Residential, which equates closely to the former GIA (gross internal area) and net sales area (NSA).
- IPMS 3 – Office, which equates somewhat to the former NIA (net internal area).
- IPMS 3A – Residential, which equates somewhat to the former GEA (gross external area).
- IPMS 3B – Residential, which equates somewhat to the former GIA (gross internal area).
- IPMS 3C – Residential, which equates somewhat to the former EFA (effective floor area).

Property Type	Measurement Application	Building Cost Estimation
Office	IPMS*	IPMS*
Retail	NIA	GIA
Retail Warehousing	GIA	GIA
Motor Showroom	GIA	GIA
Drive-thru Restaurant	NIA	GIA
Industrial	GEA	GIA
Leisure-plex/Leisure Centre	GIA	GIA
Crèche Facility	GIA	GIA
Nursing Home	GIA	GIA
Hospital	GIA	GIA
Cinema	GIA	GIA
Hotel	GIA	GIA
Public House	GIA	GIA
Guesthouse	GIA	GIA
Hostel	GIA	GIA
School	GIA	GIA
Funeral Home	GIA	GIA
Residential	GIA	GIA
Land	Site Area	

Figure 12: (left) IPMS core definitions taken from (RICS, 2018). (right) Definitions taken from (SCSI, 2020)

Criterion 1.3 – Floor Area Recommendation:

Primary recommendation
Use IPMS 3 for offices and IPMS 3B for residential, as cited by Level(s). For all other buildings refer to the SCSI's definitions and guidelines for internal areas.

5.1.4 Biogenic carbon accounting

Should we report both biogenic carbon and fossil carbon when reporting GWP of a building?

EPBD (April 2024)	EN 15978 (2011)	Level(s) (Indicator 1.2)
No reference	No reference	Level(s) UM 3 cites three different sources of GWP in the suggested reporting format, namely: • GWP – Fossil • GWP – Biogenic • GWP – Land use and land use change

Historically, the GWP of buildings and construction products was captured under one value for GWP ($kgCO_2e$), as per EN 15804 +A1 (EN 15804 +A1, 2013). This method however failed to capture the differences between fossil-derived and biomass-derived (i.e. biogenic) carbon emissions. The latest version of EN 15804 +A2 now requires the separate reporting of fossil and biogenic carbon emissions. Therefore, in future there will be greater availability of this data at product level.

Fossil-derived carbon emissions can be thought of as one-directional, within the context of building LCA. They are emitted via the combustion of fossil fuel (or calcination of limestone) and thus have a positive GWP. Biomass-derived carbon is emitted by burning or decomposing biomass. These are fundamentally different and are explained in Box 1.

While some methodologies either don't explicitly disclose a difference between biogenic and fossil-based carbon, or merge biogenic with fossil-based carbon, the emerging agreement is to count both emissions separately. This is the approach suggested in Level(s), as presented in the Indicator 1.2 (Figure 13) and used in the latest core rules for construction products (EN 15804 +A2, 2021).

Indicator 1.2 reporting format

Global Warming Potential for each life cycle stage

Indicator	Unit	Product (A1-3)	Construction process (A4-5)	Use stage (B1-7)	End of life (C1-4)	Benefits and loads beyond the system boundary (D)
(1) GWP - fossil	kg CO_2 eq					
(2) GWP - biogenic	kg CO_2 eq					
GWP – GHGs (1+2)	kg CO_2 eq					
(3) GWP – land use and land use change	kg CO_2 eq					
GWP – overall (1+2+3)	kg CO_2 eq					

Notes:
Impacts referred to the use of 1 m^2 of useful internal floor per year for a default reference study period of 50 years[1].

Figure 13: Level(s) indicator 1.2 (GWP) reporting format

This reporting format also includes the GWP impacts of land use and land use change, which refers to the emissions associated with change in land and vegetation relating to the construction product. At present, there is relatively little knowledge or reliable data on how land use change will influence the GWP of a construction product, although it would appear that this will be a relatively small component of the overall carbon impact. LULUC should be included as a mandatory requirement in later updates to the methodology when sufficient data and understanding is available.

Criterion 1.4 – Biogenic Carbon Recommendation:

Primary recommendation	Secondary recommendation
Report fossil-based and biogenic carbon separately. The final number should represent fossil-based carbon. Biogenic carbon should be reported separately as an estimation of the biogenic carbon stored over the building's lifetime.	Given the uncertainties of the LULUC GWP, we recommend this not be counted and only included as an optional / separate inclusion. All items here can be reported in a supplementary material (Module D) section.

Box 1

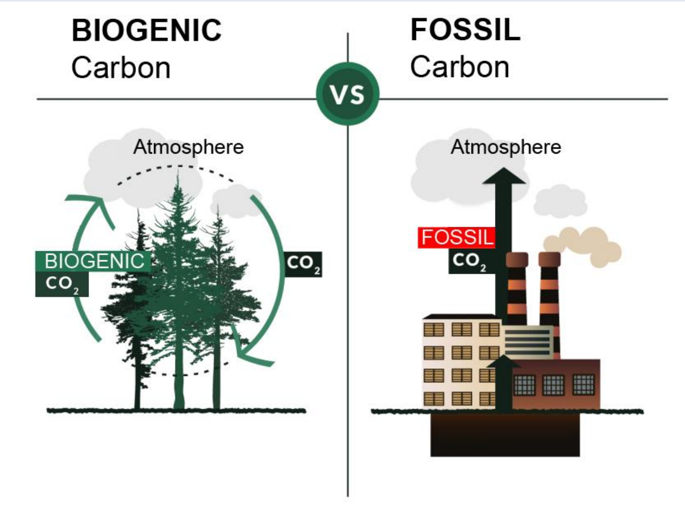


Figure 14: Biogenic vs fossil-derived carbon. (Source: https://cayaki.com/wp-content/uploads/2019/09/biogenic-carbon-6.jpg/)

From a building's perspective, biogenic carbon differs in that there can be both positive and negative emissions within similar time frames to the building itself. In simple terms:

- As trees grow, they sequester carbon (negative biogenic GWP).
- As trees are cut, harvested for timber, and processed there is a small increase in biogenic carbon from the left-over biomass (slightly positive biogenic GWP).
- During the lifetime of the building there is negligible biogenic carbon movement. Carbon is not sequestered by timber during the building's life, the timber stores carbon that was previously sequestered by the trees in their past-lives (biogenic GWP neutral).
- At the end of life, as the timber is either burned or decomposes, there is an increase in biogenic carbon (positive biogenic GWP), the rate and magnitude of which depends on whether the biomass is burned or decomposed over time.

Overall, when sourced from a sustainably managed forest it is assumed that the net impact of timber construction materials is biogenic carbon neutral.

Given the short time periods between emissions and sequestration, at specific points in time, and under some assumptions, GWP-biogenic figures can be negative. This is a concerning approach since this carbon accounting does not robustly capture the end-of-life impact of timber, or indeed the impacts of the forests from which the timber is sourced. The appropriate accounting mechanism for biogenic carbon in building LCA is also a hot-topic throughout the academic literature (Andersen et al., 2024, 2021; Arehart et al., 2021; Hawkins et al., 2021; Hoxha et al., 2020).

5.1.5 Specified tools

When calculating GWP of a building, should we restrict calculation to a single tool, or allow multiple tools?

Across different Member States, most methodologies are tool-agnostic, that is, the LCA practitioners are responsible for identifying a suitable tool which will enable compliance with an overarching methodology. An additional layer of rigor is applied in the French (RE2020) and Dutch (MPG) approaches where they require the tools to be third-party verified (OneClick LCA, 2022).

The Dutch and UK approach is to allow the use of any tool, but that tool must comply with the national methodology and enable fully transparent reporting.

Several tools are available to LCA practitioners at all stages of the design process. Different LCA teams will have different workflows and systems, and hence, will have different tool requirements. As LCA becomes common practice, a progressive approach will be required which will update the LCA as the project progresses through the different work stages.

Constraining teams to a specific tool is not recommended. The use of a single tool wouldn't necessarily guarantee consistency since other assumptions occur in the back end (e.g. material quantities/ scope) and a single mandatory tool could discourage innovative approaches used in the design stage.

Notwithstanding the recommendation on a tool-agnostic approach, it is recommended that an Irish-specific LCA calculation tool is developed in the medium-term to support the domestic market and practitioners. This approach will provide all market participants with a tool with which they can calculate the GWP of a building, however organisations with greater or more complex needs, can choose to develop their assessment with more complex calculation tools. The key criteria for any tool used in the Irish market is that it complies with the Irish methodology.

We do however recommend a consistent reporting template and a verification process to ensure methodology is consistent.

See also Section 3 of this report, dealing with tool assessment.

Criterion 1.5 – Specified Tools Recommendation:

Primary recommendation	**Secondary recommendation**
A tool-neutral approach should apply. The tool used should be reported in the submitted LCA. Any tool used should, as a minimum, meet the recommendations of the overarching Irish methodology. The method used by the tool should clearly be described and verified.	A freely available national tool can potentially enable wide participation and be accessible to SMEs and other companies. It should not be the singular tool or be mandatory.

It is envisaged that eventually a register of 'Approved Tools for EPBD compliance' can be developed and maintained.

5.1.6 Specified carbon database

What database should be used to provide information on the GWP of construction products?

One of the most considerable criteria of divergence among different methodologies internationally is the *embodied carbon intensity database* used to when calculating the embodied carbon of a building. This question is being addressed by SEAI in a separate project, but we note some general points here:

- As the CPR develops, and GWP declaration becomes mandatory, most key construction products will have an associated GWP figure which should make the embodied carbon calculation exercise simpler. However, in the absence of this, product specific EPDs and, as a fall-back, generic data will continue be used.
- Different types of embodied carbon intensity data will be required at different stages of an LCA.

There are two primary methods of disclosing the embodied carbon intensity of products:

- **Generic embodied carbon intensity figures** – these will be applicable at early stages of project design, and if a product EPD does not exist.
  - There are several nationally derived open-source databases, for example many of the Nordic countries have these (Erlandsson et al., 2024).
  - Equally there are popular licensed data bases such as *Gabi* and *Ecoinvent* which are typically used in popular software programs such as OneClick LCA. For the latter, payment of some form is required to access the data. The paid nature of these licensed databases could become problematic for national disclosure – for example, it may not be possible to disclose the detail of all carbon intensity data used, were it to share the database information. A way to avoid any such concerns would be to develop an open-source national database.
- **Product specific carbon intensity figures** – EPDs should be prioritized where possible to get the best possible representation of the data.

Alongside carbon intensity data related to construction products, there is also data related to activity and processes (e.g., transport, waste treatment, and operation of buildings) which is required for the life cycle GWP calculation of a building. In order to ensure consistent calculations both at construction product level and building level, Member States also need to define the carbon emission factors for: (i) transport modes for construction materials; (ii) transport modes for waste; (iii) grid electricity, and (iv) gaseous, liquid and solid fuels.

The separate project being undertaken by SEAI will make recommendations on this question. The following comments are made based on our research.

Criterion 1.6 – Specified Database comment:

Primary comment	Secondary comment
An open-source database for national-average data is required. Access to product-specific database(s), containing GWP information on construction products used in the Irish market, will also be beneficial.	Ireland needs to develop its own database. This should be designed to be flexible to account for future data and studies. Full transparency on the data or database used in an LCA is required.

5.1.7 Data quality / uncertainty

When the information we have on the embodied carbon in construction products is not accurate, how do we deal with this in the calculation of Building GWP?

Data quality accounts for the fact that not all data used in an LCA is of equal accuracy or representativeness. For example, a product-specific EPD for a specific steel component, versus a global generic carbon intensity for steel in general would have different 'data quality' scores.

Different methodologies are applied in different member states to account for this. For example, in Level(s) (Dodd et al., 2020), a Data Quality Index (DQI) needs to be calculated following equation below, and the DQI value must be greater than 2. This method cites a data quality limit, and the overall rating can be reported separately.

The RICS method used in the UK is described in detail in Section 4.10 of the standard (RICS, 2024). The approach is comprehensive and detailed and provides for different levels of granularity in the calculation and reporting of results, depending on the project stage that the assessment is conducted.

Level(s)	RICS

• Data Quality Index (DQI) calculation >2
• **DQI = ((TeR+GR+TiR)/3+U)/2**
  • **TeR** =Technological representativeness of data (e.g., cement vs CEM II A-L)
  • **GR** = Geographical representativeness of data (e.g., generic concrete figure from Spain vs Ireland)
  • **TiR** = Time-related representativeness of data (e.g., using 5 year old EPD vs new one)
  • **U** = Uncertainty of data (Qualitative expert judgement or relative standard deviation expressed as a percentage.
	• Derived from the summation of the following three sources:
	• Contingency factors (e.g., early stage (RIBA 0-2)) 15% applied
	• Carbon Factors (similar to Level(s))
	• Material source quality score (e.g., 0% uncertainty for delivered data)

Other simpler broad-stroke methods are used to address data quality. For example, Finland penalises the use of generic data by applying a correction factor of 20%. Sweden and Norway apply a similar principle but are even more stringent, applying a 25% correction factor. This approach is simple and aimed to encourage the use of specific EPDs but could lead to issues downstream as the GWP figures reported are expected to be quite conservative and not an accurate reflection on the actual figure.

Criterion 1.7 – Data Quality / Uncertainty Recommendation:

We recommend that data quality should be reported as a mandatory requirement. This will improve transparency of reporting, and will gradually encourage practitioners to seek improved data quality in order to avoid low quality scores.

Primary recommendation	**Secondary recommendation**
The Level(s) data quality approach is proposed here whereby the most important elements (80% coverage) are assessed for technological, geographical and time representativeness. See Level(s) L2.4.	A simple assessment could include % coverage of building (in $kgCO_2e$) which is covered by product specific EPDs. There may be benefit in developing an Irish specific methodology to manage this aspect of GWP declaration. In the absence of this Level(s) is recommended.

5.2 Scope

Most of the divergence among international methodologies occurs in the approach to project scope. The relevant subsets can be broadly grouped as: site boundary (physical scope), LCA modules, and component coverage (as per Figure 11).

5.2.1 Site boundary

Where do I draw the line when defining the physical extent of the building to be included in the GWP calculation?

An area with potential for variable interpretations is that of the physical site boundary.

Annex III of the EPBD states: "*scenario definition…shall be carried out in accordance with EN 15978*", while section 7.1 of EN 15978 states: *"The object of assessment is the building, including its foundations and external works within the curtilage of the building's site, over its life cycle. The curtilage used to characterize the site shall be consistent with the definition and intended use of the building."*

The "*intended use*" implies some flexibility to the LCA practitioner to set the boundaries, but it is not clear what this means in practice.

Table 11 of Level(s) Indicator 1.2 includes 'parking areas', 'landscaping' and 'utilities', which would suggest a broader interpretation of 'building' might be applicable. However, stakeholder consultation revealed that many if not all countries are focussing on the building only and are likely to exclude any external works when implementing EPBD. The Nordics have interpreted EPBD reporting of GWP to apply to the building only.

It also appears that following publication of the Delegated Act, there will be better alignment between EPBD and a revised Level(s) framework, whereby elements external to the building would no longer be included in the GWP calculation.

We therefore recommend the narrower interpretation of physical scope to include just the building footprint. The ICMS 3 standard offers a harmonised classification of the relevant building components which should be captured within the building footprint, see Appendix D. In the interests of clarity and transparency, we also recommend as optional the separate reporting of any external works. This additional reporting would be beneficial in comparison of projects.

Criterion 2.1 – Site Boundary Recommendation

Primary recommendation	**Secondary recommendation**
Include the building only. The relevant building components falling within the definition of the building under ICMS 3 is included in Appendix D.	Items outside the edge of the building's walls can be reported separately as an optional input.

This question should continue to be monitored at European level.

5.3 LCA Stages

The EPBD requires reporting of “each life cycle stage” and refers to EN 15978. EN 15978 itself does not explicitly cite mandatory LCA modules nor does Level(s). However, EN 15978 does refer to EN 15804 which itself cites the reporting of A1 – A3 stages as an absolute minimum. Further, the mention of “each life cycle stage” can be interpreted as including Stage A, Stage B and Stage C – or at least a subset of each of these.

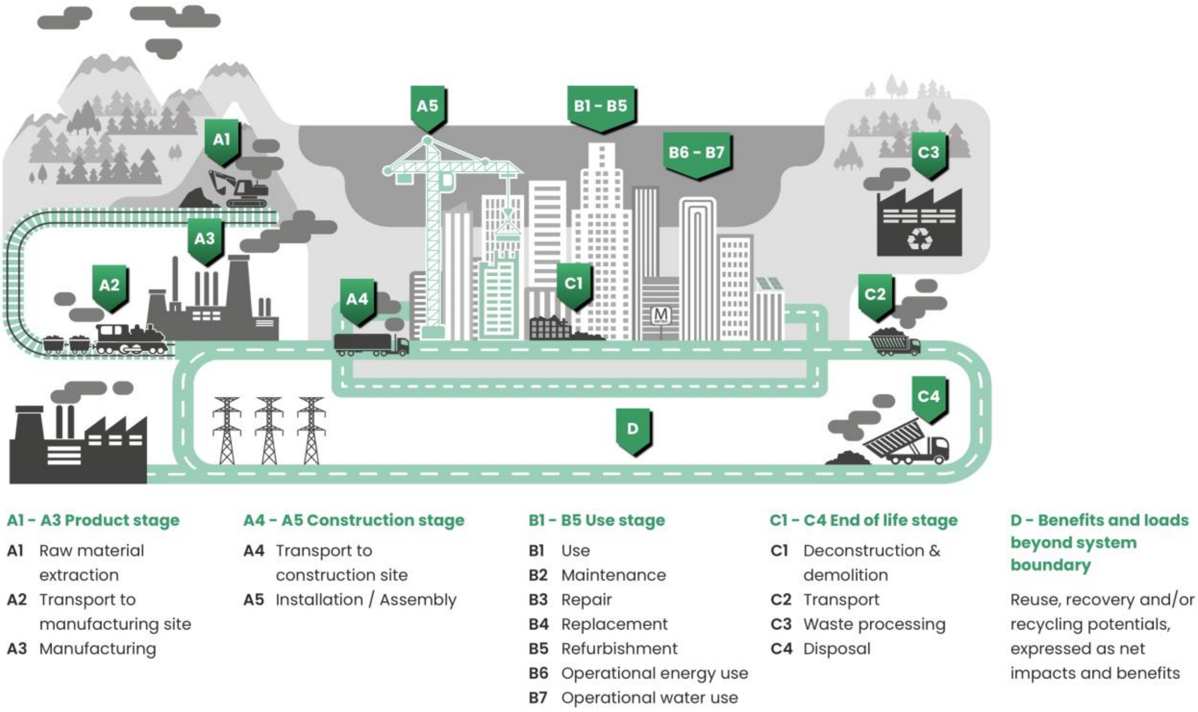


Figure 15: Sources of embodied carbon according to EN 15978 across the construction life cycle (Source: OneClick LCA).

We note that in the proposed revision to EN 15978, there is some change in the Modules (including a new Module B8) and a further level of granularity in certain module components (subheadings for A5 and B1, for example). Where appropriate, these emerging changes have been taken into account and are referred to below. See Appendix G for a breakdown of proposed sub-headings within various Modules under the prEN 15978. Where there is specific reference to external methodologies including TM65, RICS, or Level(s) Indicator 1.2, the specific text element is included in Appendix C.

Table 7 below documents the different lifecycle stages and modules which are explicitly cited or implied for disclosing and reporting across different methodologies employed across Europe.

Table 7: LCA module coverage by current standards and methodologies. (x) explicitly cited. (o) implied/ additional module

	Raw material	Transport	Manufacturing	Transport	Construction	Use	Maintenance	Repair	Replacement	Refurbishment	Energy Use	Water Use	Deconstruction	Transport	Waste disposal	Disposal	Beyond system (benefits + loads)
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
EPBD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
EN 15978 (2011)	x	x	x	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Level(s)	x	x	x	o	o	o	o	o	o	o	o	o	o	o	o	o	o
UK - RICS WLC 2nd edition	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	o
Denmark - BR18	x	x	x						x		x				x	x	o
Sweden - Klimatdeklaration	x	x	x	x	x												
Norway - NS 3720	x	x	x	x					x								
France - RE2020	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
The Netherlands - MPG	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x

***((x) explicitly cited. (o) optional module*)**

5.3.1 LCA Stages A1 – A3

Should we include the GWP of the construction materials used to create the building?

Embodied carbon associated with raw materials is normally a significant element of the overall GWP result. All methodologies internationally require the reporting of Stages A1 – A3 at a minimum (see Table 7 above). This includes the embodied carbon in the resource extraction, transport and manufacturing of an individual construction product, sometimes referred to as the ‘cradle to gate’ emissions.

Criterion 2.2 – LCA Stage A1 – A3 Recommendation:

Primary recommendation
Declare A1 – A3 boundaries.

Certain product suppliers are exploring the use of ‘Mass Balance Credits’ or other mechanisms that enable the GWP of a particular product to be averaged across different manufacturing processes or manufacturing locations, or other similar carbon accounting methods when developing EPDs. This can lead to a lack of transparency on what the GWP of the specific product is. We recommend a cautious approach as regards the use of Mass Balance Credits in the Irish methodology, pending further consideration and harmonisation of the allowable approaches at EU level. Similarly, the use of emerging accounting methodologies such as Contractual Instruments and consideration of Carbon Capture and Use or Storage is not recommended for inclusion in the Irish methodology at this point.

Figure 16: Construction at Barrow St, Dublin

5.3.2 LCA stage A4 – A5 (Construction process)

Should we include the GWP of the emissions associated with the construction stage?

Most national assessment methodologies require the reporting of both A4 (transport to site), and A5 (installation works on site) modules as illustrated in Table 7. An older version of the Danish methodology, however, does not include these stages – the logic being that the quality of data is weak (if it is even available) and therefore the addition of these LCA stages does not offer much value. Work is currently being done in Denmark to include these modules (Balouktsi and Birgisdottir, 2023).

For most construction companies, there is now a need to report on their own GHG emissions for corporate reporting purposes (for example, the CSRD will apply to larger contracting companies). Construction companies typically already track energy use associated with construction site activity (e.g. use of fuel in construction plant, or use of electricity). This means data collection and reporting systems will be available or readily developed on order to track A5 emissions, and these can feed into the GWP calculation.

A5.1	• Pre-Construction demolition works
A5.2	• Emissions associated with construction activities
A5.3	• Emissions associated with construction waste and waste management
A5.4	• Transport of construction workers

With reference to the proposed sub-components of A5 listed above, we recommend that the A5 module should cover:

- A5.1 Pre-construction demolition works,
- A5.2 Emissions associated with construction activities, and
- A5.3 Emissions associated with construction waste and waste management.

The guidance presented in RICS on modules A5.1 – A5.3 is useful in applying a consistent approach. We do not recommend inclusion of A5.4 Transport of Construction Workers to Site, on the basis that this is unlikely to be a major component of overall GWP and may be challenging in terms of data collection/ availability.

For GWP calculations carried out at design stage, a modelling exercise will be required to estimate the likely A4 and A5 stage emissions. The RICS WLC 2nd edition guidance in Section 5.1.3 is recommended. Although this is not Irish-specific, it offers a relatively representative breakdown of transport distances, and is favoured over the default values used in the existing EPD Ireland PCR. Further research would be beneficial to develop an understanding of current transport patterns and construction stage emissions from energy consumption and waste management, which will inform the development of generic data that can be applied to complete A4-A5 GWP estimates. It is anticipated that SEAI will provide default figures for A4 and A5 in any future methodology manual.

Criterion 2.3 – LCA Stage A4 – A5 recommendation

Primary recommendation	Secondary recommendation
Report on both A4 and A5 LCA stages. For completed projects, data on A4 and A5 should be provided by the contractor. For consistency in Module A5.1 - 5.3, refer to RICS guidance (RICS, 2024).	Where generic data is used, an upper benchmark should be selected as default. The RICS guidance in Section 5.1.3 for typical transport scenarios is recommended (RICS, 2024). Where generic data is used this should be noted clearly in the supplementary section of the reporting template.

5.3.3 LCA stage B

What elements of the operational phase of the building over its lifetime should we include the GWP calculation?

In the methodologies reviewed, there is a low level of agreement on what should be recorded in LCA stages B and C.

It is important to note that all reporting in LCA stage B is based on a 'scenario analysis'. In other words, it represents a prediction of what will happen in the future. The definition of that 'scenario' should therefore be defined by Member States and ideally it should be consistent at EU level.

The scenario should be defined to put emphasis and value on those impactful decisions made during the building design stages. For example, the specification of durable/ quality components with longer service lives will result in lower emissions due to replacement over the building life cycle. This type of design option should be credited, and the resultant reduced embodied carbon should be captured in module B4 Replacement.

As per Table 7, there is little agreement internationally at present on what should and should not be included in modules B and C. There is also uncertainty throughout all methodologies on what the key differences are between some of these modules, such as between modules B2 (maintenance) and B3 (repair).

- **Module B1 – Use**
  - B1.1: Fugitive emissions of refrigerants. This can be a significant component of GWP in particular for buildings with air conditioning systems and heat pumps.
  - B1.2: Emissions from materials and carbonation. Carbonation of concrete can result in a negative GWP component for concrete structures.

The results of GWP calculation for both subsets of B1 are highly 'scenario dependent'.

In relation to Module B1.1, guidance can be taken from CIBSE TM65 on refrigerant leakage declaration.

For carbonation GWP impacts of concrete (Module B1.2), a study conducted by Fitzpatrick *et al.* (2015) found that 16% of the cement emissions due to calcination/ carbonation are sequestered during the 100-year lifetime of concrete. This would be 8% over the 50-year period and assuming 50% of cement's emissions are due to calcination this would drop to 4%. For concrete this might be approximately 3%. Further research is required here. EN 16757 provides guidance on how this can be calculated. Reporting of any carbonation GWP is recommended for inclusion as supplementary material and cited as a GWP -1 i.e. a negative fossil emission given that it is a 'geological type' sequestration.

- **Module B2 – Maintenance**
- **Module B3 – Repair**
- **Module B4 - Replacement**
- **Module B5 – Refurbishment**
  - These modules all relate to embodied carbon impacts associated with the physical fabric of a building over its operational life. At present, based on the international research, there is insufficient clarity on how to develop meaningful GWP estimates modules B2, B3 and B5. The 'scenario definition' that would enable reasonable estimates has not been advanced. These three categories are also typically considered to have a relatively minor impact.
  - Module B4 however, is important in that elements and materials requiring multiple replacements can significantly impact the lifecycle embodied carbon emissions. The B4 module is captured by multiplying the number of replacements required during the lifetime of a building by the embodied impacts of that component being replaced as per guidance in EN 15978. There are reasonably well defined scenarios that can be applied to estimate GWP from replacement over the building lifecycle.

In relation to Modules B2 - B5, more research is required for this stage to better estimate and quantify the service lives of average Irish building components and their required maintenance and repair needs. For specific details on product service life calculations, guidance should be taken from EN 15978 in the interim; the standard allows some flexibility (clause 9.3.3) in relation to replacement of components close to the end of the modelled building service life.

- **Module B6 – Operational energy use**
  - Module B6 should align with requirements to consider building energy capability as calculated for the Building Energy Rating (BER) certificate. A key difference between the BER and the interpretation of a B6 module is the BER rates the performance potential at a single point in time, whereas the B6 module aims to simulate the energy use (and subsequent environmental impacts) over time (50 years under EPBD). This would include applying (or devising) grid decarbonization scenarios.

In relation to Module B6 Operational Energy, while it does not from part of an embodied carbon assessment, its inclusion is required for a 'Whole Life' GWP figure. This will enable the design team to review design decisions that impact operational and embodied carbon, and explore the optimum balancing of these. SEAI publishes a 'grid decarbonisation scenario' projecting the rate at which the carbon intensity of Ireland's electricity grid will reduce. This is quite optimistic and assumes that all of the Climate Action Plan actions will be implemented on time. This, combined with modelled energy demand based on BER calculations can form the basis for the scenario to be used for B6 calculation. The BER calculation does not currently include 'well to tank' emissions for fossil fuels, and the GWP calculation will require this to be addressed.

- **Module B7 – Operational water use**
  - B7 is concerned with operation of water. It is considered that relative to other contributions, operation water use will contribute a very small amount to overall GWP and therefore is not recommended for inclusion at this point in time.
- **Proposed Module B8 – Building related users' activities not covered in B1-B7**
  - Three subsets of this new module proposed under the emerging prEN 15978 have been defined, namely:
    - B8.1 – Transport of persons to and from the building
    - B8.2 – Charging of EVs within the building site
    - B8.3 – Others – such as use of consumables and equipment not fixed to the building
  - The application of B8 module is not practised in the international methodologies, and there appears to be limited benefit for its inclusion at this stage of EPBD implementation, in that the management of these GWP impacts fall mainly to the future occupants of a building rather than the design team. B8 is therefore not recommended for inclusion at this time.

Criterion 2.4 – LCA Stage B recommendation

Primary recommendation	Secondary recommendation
Report on B1.1, applying CIBSE TM65 scenario assumptions. Do not report on Modules B2, B3 and B5. Report on B4 in line with service lives using default figures from Level(s). Report on B6 using BER and SEAI electricity grid decarbonisation to develop a future scenario.	Module B1.1 - Carbonation of concrete -should be reported separately in the supplementary materials section.

5.3.4 LCA stage C – End of Life

When the building reaches its end of life, how do estimate the associated emissions for inclusion in the GWP calculation?

Stage C (End of life) is also based on a 'scenario analysis'. And like Stage B, several different approaches are adopted throughout Europe (Table 7).

The Norwegian and Swedish methodologies currently exclude this life cycle stage altogether. There is logic to this exclusion given the long time-horizons until their potential impacts are realised.

However, a form of disclosure is required as per requirements of the EPBD to cover each stage. Also, it is preferable to recognise the benefits of more 'circular' building design approaches within the GWP methodology. For example, if a building is designed such that its components can be easily reused or recycled, resulting in fewer emissions, that can be reflected in the GWP estimate.

Current demolition and waste management practices can be used to inform this stage, but carbon intensity factors are unlikely to be the same 50 years from the time of declaration and this adds a further degree of uncertainty.

The modules of life cycle stage C are:

- **C1 – Deconstruction and demolition.**
  - This covers all activities required to take the building down.
- **C2 – Transport of demolition waste.**
  - This covers the transport of the demolished (or disassembled) building and its parts to its destination e.g. landfill or reclamation site.
- **C3 – Waste processing**.
  - This covers the impacts associated with the preparation for a product for reuse, recycling or recovery.
- **C4 – Disposal.**
  - This covers the impacts from any processing prior to disposal and the disposal itself. Assumptions need to be made of whether a product is disposed or recycled.

Evidently, there is an infinite number of scenarios which could be derived to arrive at a figure for Stage C. Furthermore, the impacts of different construction methods and materials at end of life are not well documented and hence there is a lack of data to make robust decisions.

The logic for Stage C should therefore prioritise ***consistency*** and ***transparency*** over precision, but also the methodology should try to credit good practices at the design stage. This stage is highly dependent on scenarios 50 years from now and is also a small impact relative to other modules.

Figures reported in Stage C of a product's EPD should only be included in a building LCA if it aligns with the scenario definition. Component EPD assumptions are not particularly helpful here from a consistency perspective.

C3 (waste processing) and C4 (disposal) are recommended as the only mandatory C stages. These should be estimated using Table 27 and Table 28 of RICS (2024). The proposal is to report only the GWP fossil as the primary number. Biogenic carbon is to be captured overall throughout this methodology and hence the carbon emissions impact of wood captured in Table 28 should not be included in this calculation. (Since biogenic storage is not captured as a negative emission, neither should the end-of-life biogenic emissions be included as a positive GWP).

The C stage is prone to large uncertainties as the time of demolition is a considerable time away from the LCA completion. Some national level data is already available from EPA waste statistics, presenting at a high-level current disposals routes for construction and demolition waste. More research is required here to develop some scenario assumptions which are informed by current practice, and which are constantly updated. By developing typical GHG emissions relating to conventional end of life practices in Ireland, a generic figure to account for Stage C, based for example on material type, could be applied.

Criterion 2.5 – LCA Stage C recommendation

Recommendation	Secondary recommendation
This stage is highly dependent on scenarios 50 years from now and is also a small impact relative to other modules. **C3 (waste processing)** and **C4 (disposal)** are recommended as the only mandatory C stages so as to be compliant with the EPBDs requirement. For C3 and C4 the RICS guidance (Table 27 and Table 28) is recommended. See Appendix C.	**C1 (deconstruction and demolition impact)** and **C2 (transport)** are highly scenario-dependent. Further research is needed in order to develop reasonable assumptions. These can be reported separately if a calculation methodology is developed.

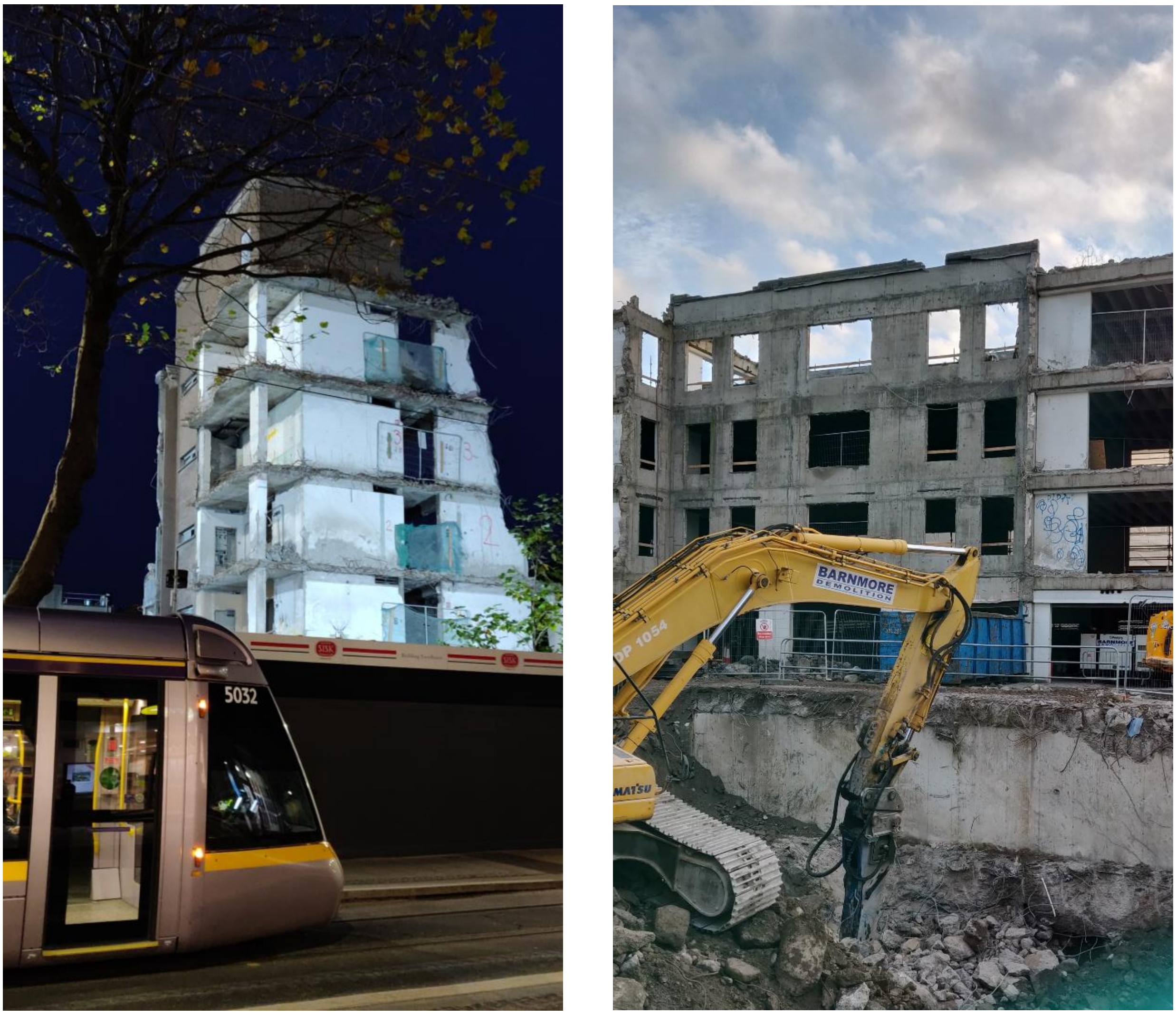


Figure 17: Construction project demolition

5.3.5 LCA stage D

Should we take into account any wider benefits accruing as a result of the materials reuse/recycling of building components at end of life, or as a result of excess energy generated by a building during its operation?

Module D covers benefits and loads beyond the system boundary. Including information in Module D is typically an optional rather than mandatory part of the LCA process. Two countries, Netherlands and France, include some mandatory requirements.

The RICS methodology summarises Module D requirements as:

> *"Module D1 covers the potential loads and benefits from reusing or recycling materials and components at end of life, or from any energy recovered from them at end of life (e.g. energy from waste, incineration or use of captured landfill gas)"*

While the EPA in Ireland collect and present national level waste statistics, there is limited information available currently on reuse and recycling of building components at end-of-life stage, making it difficult to quantify GHG benefits or loads for the purpose of LCA. Some construction waste generated from demolition of Irish buildings is conceivably treated by means of Waste to Energy (incineration) or by energy recovery in cement kilns following processing to form refuse derived fuel (RDF). Module D effectively examines 'systems level' benefits or loads, for example a contribution made to decarbonisation of a national electricity grid. Further research would be required to assess system level loads and benefits from construction waste.

> "Module D2*: If a building generates more energy than it uses over the course of the year, this 'exported' energy is reported as part of module B6 for buildings. For infrastructure that generates energy or produces other utilities, these are reported as exported utilities as part of B8. For both buildings and infrastructure assets, any benefit from these exported utilities (e.g. the avoided impact of grid electricity generation for exported electricity) is reported in D2".(*RICS, 2024).

There are relatively few buildings at present that export energy in the form of heat or steam, although some buildings exist with CHP plants that export energy. Many buildings completed in the last five years have solar PV arrays at rooftop level and it is likely that some of these already feed excess energy to the electricity grid. A methodology would be required to measure how such a contribution to the level of renewable energy on the grid could be quantified. This would require some scenarios on the likely levels of export of energy (which will depend on weather conditions, energy consumption within the building) and an assessment of the contribution that a small local energy contribution makes to overall grid decarbonisation.

Overall, the GWP benefits or loads relating to D1 and D2 will be difficult to quantify at present, but can be included as optional elements to include in the methodology. Following further research and development of methodologies appropriate for Ireland, these modules should become mandatory in future iterations of the methodology.

Criterion 2.6 – LCA Stage D recommendation

Primary recommendation
Benefits beyond the system boundary in Modules D1 and D2 should be captured separately in the supplementary material section, following RICS methodology (pending development of Irish methodology). These can be qualitative notes in the absence of more detailed energy sector methodologies.

5.3.6 Component - Classification

What system should we use when reporting the GWP of a building, in order to enable assessment and comparison of results, and to maximise the usefulness of the information?

While Level(s) cites the minimum scope of components to be included in the assessment, it does not define the *classification system* to be reported to.

Different classification systems for building components are used across Europe and are likely to continue to be used. Annex 3 of Erlandsson et al. (2024) provides a 7-page mapping table between several different classification systems used across Europe including:

- The proposed prEN 15978
- IEC/ISO 81346
- CoClass (Sweden)
- Talo2000 (Finland)
- IFC ISO 16739: 2024
- NS 3451 (Norway)
- ICMS 3 (UK and Ireland)

The ICMS 3 system has recently been adopted by the Office of Government Procurement (OGP) in Ireland in relation to cost control and carbon reporting (Office of Government Procurement, Ireland, 2024).

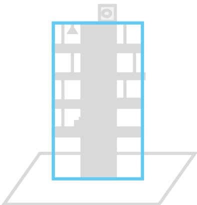
Figure 18 below compares the ICMS 3 component classification against Level(s) Indicator 1.2 Table 11 (see Figure 19) and NRM3. Note, ICMS 3 section 2.04 is captured twice in the framework presented below as it includes both external and internal features.

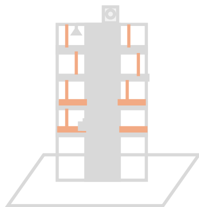
See ICMS 3 Appendix D for full detail, with options to break down material categories further (ICMS, 2021)

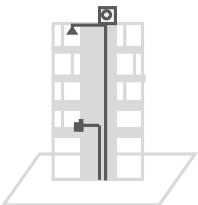
A benefit of alignment with ICMS 3 for GWP calculation methodology will be alignment with BIM systems, which will also be required for public sector projects. Increasingly, integration of digital design tools and workflows with GWP assessment will be used as a way to improve efficiency of carbon assessment and enable more informed consideration of whole life carbon when making investment decisions (see Box 2, Section 3).

Criterion 2.8 – Component Classification Recommendation

Primary recommendation
Report according to the ICMS 3 component classification system.







	ICMS 3	Level(s)	NRM3
Site	2.01 - Site preparation	Parking facilities	0.1 Treatment and demolition works
	2.06 - Surface and underground drainage	External works: Utilities	7. Works to existing buildings
	2.07 - External and ancillary works	Landscaping	
Structure	2.02 - Substructure	Foundations (substructure)	1.0 Substructure
	2.03 - Structure	Load bearing structural frame	2.1 - 2.4 Superstructure (Frame, floors, roof, stairs)
			6 Prefabricated Units
Skin	2.04 - Architectural works | Non - structural works	Facades	2.5 - 2.6 Superstructure (Ext envelope, windows, ext. doors)
		Roof	
Internal plans and finishes	2.04 - Architectural works | Non - structural works	Non-load bearing elements	2.7 - 2.8 Super structure (Internal wall partitions and internal doors)
			3.0 Finishes
Services	2.05 - Services and equipment	Core (fittings, furnishings and services)	4 FF&E
			5.1 Sanitaryware
		Fittings and furnishings	
		In-built lighting system	5.2 HVAC
		Energy system	5.3 Electrical
		Ventilation system	5.4 On site renewables
		Sanitary systems	5.5 Systems (e.g. lift and fire safety systems)
		Other systems	

Figure 18: Comparison of ICMS 3, Level(s) and NRM3 classification systems

5.3.7 Component coverage

What elements of the building need to be included in the GWP assessment?

Component coverage refers to the decision on what elements or components of a building are to be included in the GWP calculation under EPBD.

EPBD (April 2024)	EN 15978 (2011)	Level(s) (Indicator 1.2)
Annex III of the EPBD states that: "*The scope of building elements and technical equipment is as defined in the Level(s) common EU framework for indicator 1.2.*"	No explicit guidance provided. Reference made to "…*intended use of assessment*".	Level(s) UM2 (Dodd et al., 2021b) lists the minimum scope of building parts and elements to be included in a building's LCA, as presented below.

Following this train of reference from the EPBD to Level(s), the minimum scope appears to be quite explicit in that it must follow Level(s). The list of parts cited in Level(s) is copied below in Figure 19.

Despite this, key stakeholders from the Nordic countries have interpreted this differently, citing how:

> "*Since the EPBD directive only covers the building, external works can be considered to be excluded from the inventory scope of the EPBD climate declaration.*" (Erlandsson et al., 2024)

We do not share this interpretation and instead consider Table 11 of Level(s) UM2 (including external works) as the minimum scope. The components included would include parking, utilities and landscaping.

We do however recommend a different *classification* system as the system of classifying components and elements is not mandated, only the minimum scope (see Section 5.3.6).

A further consideration is buildings for which information cannot yet be made available upon completion. For example, it is likely that the full scope of materials will not be always available (e.g. an office building is leased without internal fittings and partitions). In some cases – for example an industrial or warehouse building – the end user is not known when the building is completed.

If the approach is to use a single figure for declaration, then each missing component needs to be filled with generic data. To arrive at this point a generic database for Ireland would be required on estimated material quantities per building typology. Where generic data is used it should be penalised on data quality and this should be clearly stated. An alternative approach might be to declare the GWP as a matrix of results of scope and LCA module.

Criterion 2.9 – Component Coverage Recommendation:

Primary recommendation	Secondary recommendation
Where a single GWP figure is declared, that figure should cover all components reported in Table 11 of Level(s) User Manual 2 except for External works. (see "Component – Classification" for more detail.) See Appendix D which maps all mandatory items for inclusion in the GWP assessment against ICMS 3.	Where information regarding the building fit out (or other component) is not known, this should be completed using generic data (to which a penalty for uncertainty is applied).

Table 11. Level(s) minimum scope of building parts and elements[8]

Building parts	Related building elements
Shell (substructure and superstructure)	
Foundations (substructure)	Piles Basements Retaining walls
Load bearing structural frame	Frame (beams, columns and slabs) Upper floors External walls Balconies
Non-load bearing elements	Ground floor slab Internal walls, partitions and doors Stairs and ramps
Facades	External wall systems, cladding and shading devices Façade openings (including windows and external doors) External paints, coatings and renders
Roof	Structure Weatherproofing
Parking facilities	Above ground and underground (within the curtilage of the building and servicing the building occupiers) [9]
Core (fittings, furnishings and services)	
Fittings and furnishings	Sanitary fittings Cupboards, wardrobes and worktops *(where provided in residential property)* Ceilings Wall and ceiling finishes Floor coverings and finishes
In-built lighting system	Light fittings Control systems and sensors
Energy system	Heating plant and distribution Cooling plant and distribution Electricity generation and distribution
Ventilation system	Air handling units Ductwork and distribution
Sanitary systems	Cold water distribution Hot water distribution Water treatment systems Drainage system
Other systems	Lifts and escalators Firefighting installations Communication and security installations Telecoms and data installations

External works	
Utilities	Connections and diversions Substations and equipment
Landscaping	Paving and other hard surfacing Fencing, railings and walls Drainage systems

Figure 19: Table 11 from Level(s) UM 2

6 RECOMMENDATIONS SUMMARY

6.1 Summary of criteria considered

Table 8: Recommendations for an Irish national GWP methodology

Technical Information	Recommendation and rationale	Secondary Recommendation
1.1 – Reference study period	Report for a **50-year reference study period**, as cited in the EPBD.	If designed for a lifetime beyond 50 years this should be noted separately in supplementary report. Monitor European-level discussions and emerging recommendations on accounting for buildings with design-life less than 50 years.
1.2 – Declared metric	Report using **$kgCO_2eq/(m^2)$** as per the EPBD Annex III.	
1.3 – Floor area definition	Use **IPMS-3 for offices** and **IPMS-3B for residential,** as cited by Level(s). For all other buildings refer to the SCSI's definitions and guidelines for internal areas.	
1.4 – Biogenic carbon accounting	**Report fossil-based and biogenic carbon separately**. The final number should represent fossil-based carbon. Biogenic carbon should be reported separately as an estimation of the biogenic carbon stored over the building's lifetime.	Given the uncertainties of the LULUC GWP, we recommend this not be counted and only included as an optional / separate inclusion. All items here can be reported in a supplementary material section.
1.5 – Specified Tools	**A tool-neutral approach** should apply. Any tool used should, as a minimum, meet the recommendations of the overarching Irish methodology**.** Whatever tool is used, the method used by the tool must be clearly described, verified, and reported in the submitted LCA. The tool used should be reported in the submitted LCA. A **national tool** is also recommended to be developed to assist SMEs and other companies.	A freely available national tool can potentially enable wide participation and be accessible to SMEs and other companies. It should not be the singular tool or be mandatory.
1.6 – Specified database	An **open-source database** for national-average data is required. Access to **product-specific database(s)**, containing GWP information on construction products used in the Irish market, will also be beneficial.	Ireland needs to develop its own database. This should be designed to be flexible to account for future data and studies. Full transparency on the data or database used in an LCA is required.
1.7 – Data quality / uncertainty	**Data quality** to be reported separately. The Level(s) data quality approach is proposed here whereby the most important elements (80% coverage) are assessed for technological, geographical and time representativeness. See Level(s) L2.4.	A simple assessment could include % coverage of building (in $kgCO_2e$) which is covered by product specific EPDs. There may be benefit in developing an Irish specific methodology to manage this aspect of GWP declaration. In the absence of this Level(s) is recommended

Scope	**Recommendation and rationale**	**Secondary Recommendation**
2.1 – Site boundary	Include the **building only**. The relevant building components falling within the definition of the building under ICMS 3 is included in Appendix D.	Items outside the edge of the building's walls can be reported separately as an optional input.
2.2 – LCA stages A1 – A3	**Declare A1 – A3 boundaries.** Minimum requirement in all methodologies.	
2.3 – LCA stages A4 – A5	**Report on both A4 and A5** LCA stages. For completed projects, data on A4 and A5 should be provided by the contractor. For consistency in Module A5.1 - 5.3, refer to RICS guidance (RICS, 2024).	Where generic data is used, an upper benchmark should be selected as default. The RICS guidance in Section 5.1.3 for typical transport scenarios is recommended (RICS, 2024). Where generic data is used this should be noted clearly in the supplementary section of the reporting template.
2.4 – LCA stage B	**Report on B1.1**, applying CIBSE TM65 scenario assumptions. Do not report on Modules B2, B3 and B5. Report on B4 in line with service lives using default figures from Level(s). Report on B6 using BER and SEAI electricity grid decarbonisation to develop a future scenario.	Module B1.1 - Carbonation of concrete - should be reported separately in the supplementary materials section.
2.5 – LCA stage C	This stage is highly dependent on scenarios 50 years from now and is also a small impact relative to other modules. **C3 (waste processing)** and **C4 (disposal)** are recommended as the only mandatory C stages so as to be compliant with the EPBDs requirement. For C3 and C4 the RICS guidance (Table 27 and Table 28) is recommended. See Appendix C.	**C1 (deconstruction and demolition impact)** and **C2 (transport)** are highly scenario-dependent. Further research is needed in order to develop reasonable assumptions. These can be reported separately if a calculation methodology is developed.
2.6 – LCA stage D	Benefits beyond the system boundary in Modules D1 and D2 should be captured separately in the supplementary material section, following RICS methodology (pending development of Irish methodology). These can be qualitative notes in the absence of more detailed energy sector methodologies.	
2.7 – Component – classification	Report according to the ICMS 3 component classification system.	
2.8 – Component – coverage	Where a single GWP figure is declared, that figure should cover all components reported in Table 11 of Level(s) User Manual 2 except for External works. (see "Component – Classification" for more detail.) See Appendix D which maps all mandatory items for inclusion in the GWP assessment against ICMS 3.	Where information regarding the building fit out (or other component) is not known, this should be completed using generic data (to which a penalty for uncertainty is applied).

Table 9: Recommended Irish LCA module coverage.

	Raw material A1	Transport A2	Manufacturing A3	Transport A4	Construction A5	Use B1	Maintenance B2	Repair B3	Replacement B4	Refurbishment B5	Energy Use B6	Water Use B7	Deconstruction C1	Transport C2	Waste disposal C3	Disposal C4	Beyond system (benefits + loads) D
EPBD																	
EN 15978 (2011)	x	x	x	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Level(s)	x	x	x	o	o	o	o	o	o	o	o	o	o	o	o	o	o
UK - RICS WLC 2nd edition	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	o
Denmark - BR18	x	x	x						x		x				x	x	o
Sweden - Klimatdeklaration	x	x	x	x	x												
Norway - NS 3720	x	x	x	x					x								
France - RE2020	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
The Netherlands - MPG	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x
Ireland	**X**	**X**	**X**	**X**	**X**	**X**			**X**		**X**		**O**	**O**	**X**	**X**	**O**

((x) explicitly cited. (o) optional module)

Section Three

Review and Assessment of GWP Calculation Tools

7 GWP TOOLS ASSESSMENT

7.1 Introduction

In order to calculate the GWP of a building, a Life Cycle Assessment (LCA) tool or model, which aligns to the specific methodology for the calculation, is used. The following section presents the findings from a high-level review of LCA tools currently available and widely used in the market to assess their compatibility for use in the Irish market.

Figure 20 illustrates the difference between a GWP methodology and the function of an LCA tool. While a GWP methodology presents the framework and rules on how a calculation should be undertaken and the specific parameters within that calculation, the LCA tool is the calculation software which delivers the numerical results within the methodological framework.

There are dozens of LCA calculation tools in the market which are available for practitioners. While the functionality of these tools can vary in complexity, at its core what the tools are delivering are reasonably simplistic – quantify the building component inventory and multiply each input by its relevant carbon factor (Modules A1 – A3), assumed replacement cycles (Module B5), and disposal pathways (Module C) using credible sources (generic or specific/ EPDs) and assumptions.

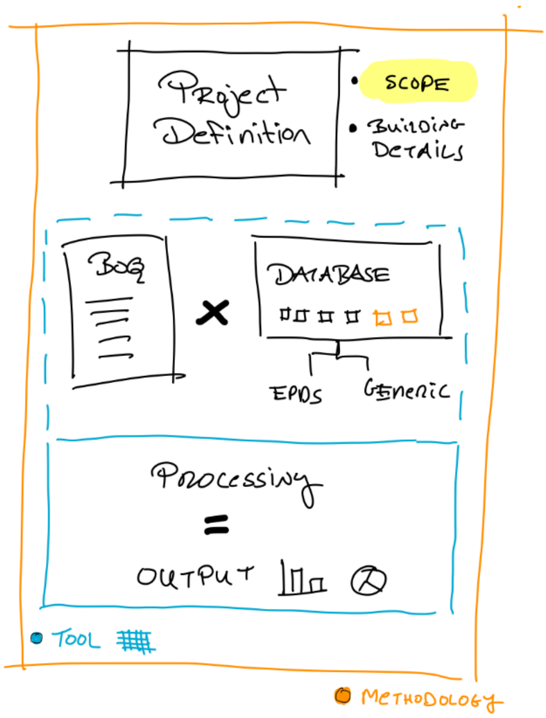


Figure 20: Different functions of a GWP methodology and Tool

Following a review of different national GWP methodologies and from consultation with various stakeholders, it is recommended that a tool-agnostic approach is taken when developing an Irish GWP methodology. This would allow LCA practitioners to use any LCA tool which meets their requirements so long as it complies within the Irish methodology.

It is also recommended that, notwithstanding this tool-agnostic approach, an Irish-specific LCA calculation tool be developed to support the domestic market and practitioners. This approach will provide all market participants with a tool with which they can calculate the GWP of a building, however organisations with greater or more complex needs, can choose to develop their assessment with more complex calculation tools. The key criteria for any tool used in the Irish market is that it complies with the Irish methodology.

This section outlines the key findings from a high-level review and comparison of a selection widely employed LCA tools. Analysis of this review and comparison of the various tools identifies a series of key features or attributes which are recognised as being preferable within any tool which is used in the Irish context.

A separate analysis of the Irish Green Building Council’s Whole Life Carbon Upfront Calculator (v2.17) is also undertaken, with that tool measured against the identified preferable features in order to assess its current applicability for use within the Irish market.

7.2 Approach to comparative analysis of LCA Tools

A thorough review of international LCA software and databases was undertaken in 2020 by the European Commission Joint Research Centre[6] as part of the development of Level(s) Indicator 1.2. The research analysed 39 different LCA tools and their characteristics to provide Level(s) users with practical, user-orientated information about their scope, cost and accessibility.

It is not the aim of this study to reproduce that same analysis. Instead, this chapter has selected a relevant shortlist of LCA tools, including tools already in use for building level LCA in UK and Ireland, and tools already in use for infrastructure carbon assessment. This is a representative sample that allows for evaluation of alternative approaches and their potential suitability for the Irish market in relation to EPBD compliance.

Similar to the indicative list of LCA software and databases assessed for use with Level(s) Indicator 1.2, the tools for comparison have been classified and assessed according to a defined list of characteristics and criteria. These characteristics and criteria, outlined in comparative analysis tables found in Appendix E, have been identified to, at a high-level, present the existing features of common LCA tools and assess their usability. This non-exhaustive comparative analysis can help LCA practitioners assess the suitability of different tools for meeting their specific requirements alongside any requirements which may form part of an Irish methodology.

The key characteristics have been assessed across three overarching themes:

- the focus and user-friendliness of a tool;
- it's robustness and comprehensiveness; and
- their facility to support additional integration with building and design information and the quality of their outputs.

The ability of a tool to allow for multiple GWP assessments to occur over the design life of a building, increasing in accuracy over time is also an important feature. As per Figure 21, the greatest opportunity to influence the whole life carbon of a structure is at the earlier design phases.

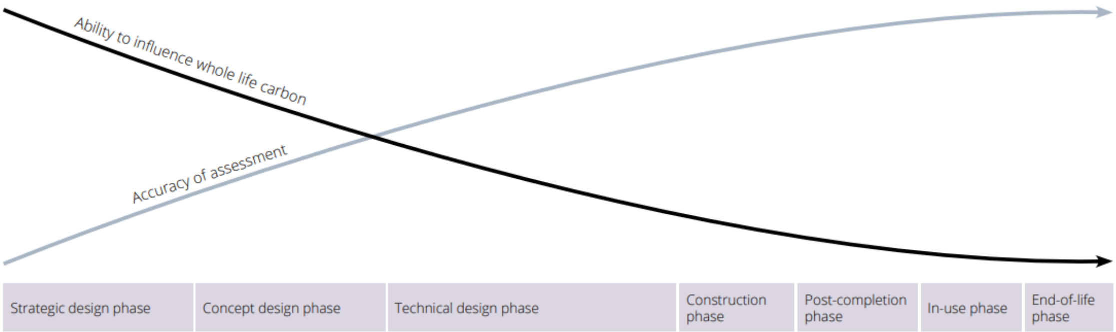


Figure 21: Relationship between influence on WLC and accuracy of assessment over time (Source: RICS)

Over time and as the design of a building becomes more defined, the focus shifts towards ensuring that the accuracy of the GWP assessment is as high and robust as possible.

The analysis of the selected tools across the various comparison indicators are outlined in Appendix E. Note that this comparative analysis should not be read as a ranking system, but as a means for supporting the identification of tool characteristics which may best meet the needs of specific LCA practitioners with different requirements. Analysis of the tools is based on a combination of project team and stakeholder feedback on their user-experience and a review of user manuals and guides.

[6] Indicative list of LCA software and databases for use with Level(s) Indicator 1.2 (2020)

7.3 Tools selected for comparison

Table 10 below lists the various LCA tools which are reviewed as part of this assessment. Tools relating specifically to infrastructure only are highlighted in grey.

Table 10: LCA tools analysed in this study

Tool	Tool Developer
One Click LCA	One Click LCA – Finland
Athena (1E4B)	Athen Institute – North America
Embodied Carbon in Construction Calculator (EC3)	Building Transparency – USA
The Structural Carbon Tool (TSCT)	Institute of Structural Engineers (IStructE) – UK
Cerclos (e-tool)	Cerclos – Australia/ UK
Carbon Designer for Ireland	Irish Green Building Council (IGBC) & One Click LCA
TII Carbon Assessment Tool	Transport Infrastructure Ireland (TII) – Ireland
National Highways Carbon Tool	National Highways – UK

7.4 Comparative Analysis Findings

The following sections provide a high-level summary of the findings from the review of the multiple GWP tools across a variety of criteria linked to the user-friendliness of the tool, the tool's robustness and comprehensiveness, and their capacity to support integration and present detailed outputs.

The review highlights that there are many different GWP assessment tools available on the market, each with varying levels of complexity and sophistication and designed to meet different requirements. For example, the Cerclos (e-Tool) and OneClick LCA products are both very detailed subscription-based platforms which can provide very detailed and comprehensive LCAs and GWP assessments for buildings and infrastructure. These may be suitable programs for operators who undertaking multiple complex LCAs for different large-scale projects and require detailed analytical outputs. On the other hand, the IStructE tool is less complex and more focused tool which offers practitioners an opportunity to develop quality high-level GWP assessments but without the additional functionality or breadth of the subscription-based tools.

7.4.1 Focus and User-Friendliness a tool

This section examined the focus of the tool (i.e., buildings or infrastructure), assessed the tools accessibility (i.e., is it an online or offline tool, software-based or Excel-based), identified if the tool is free to access or if it must be purchased, the level of sophistication of the tool (i.e., ease of use and the range of applications it has) and whether training and support is provided by the tool developer.

The One Click LCA and Cerclos tools are both online web-based licensed software packages while the other tools are free to use and are a mixture of offline Excel-based or online web-based tools. The licensed software packages were found to have a broader range of applications within their software, and dependent on the software package purchased, a varying range of continuous training and support available to practitioners, whilst the free tools, being narrower in range, typically had more static user guides and online videos available to help practitioners utilise the tools.

7.4.2 Tool Robustness

This section compared different tools according to the capabilities they have, including what LCA stages and modules they allow quantification across, what databases the various sources they draw their environmental information from, how often these are updated, how each of the tools allows and enables generic data input, and across how each of the tools enables transparency within their reporting.

Most of the tools assessed allow for some form of whole life carbon assessment including module B. However, the IStructE tool excludes module B from it's calculations, while the Athena tool allows for calculation of sub-module B4 - Replacement only. All the tools allow for the use of generic data alongside specific EPDs, however the OneClick LCA and Cerclos tools provide access to the largest and most geographically diverse range of databases. In relation to transparency and verification, the nature of the tools dictates to what level transparency is supported. For example, The Cerclos tool allows for a user to upload or create an EPD where one may not be available and include it on their calculations, while the IStructE tool, as it is Excel-based, allow for a selection of EPDs from a database and generic data where an EPD is not available. Furthermore, the Excel-based tool doesn't allow for manual verification of the environmental values within an EPD.

7.4.3 Tool Integration and Outputs

Here the tools were assessed on their integration and compliance capabilities including assessing how they support the import and export of LCA and design information (e.g., BIM integration, including modelling software such as REVIT), whether they are aligned with the requirements set forward under EU Level(s) and the ICMS 3 reporting standard, and further compared across the nature of the outputs of the LCA information.

The Athena, EC3 and IStructE tools were found, as they were developed outside of the European Union, not to be compliant at the time of analysis with the requirements set out under the EU Level(s) framework. None of the tools assessed supported classification configuration in line with the ICMS classification system. In relation to supporting BIM integration, the Cerclos, One Click LCA, EC3, Athena and Carbon Designer for Ireland (which is hosted by One Click LCA software) all supported a certain degree of BIM integration. One Click LCA seemed to be the most advanced tool in this regard, providing functionality to add integration with over 20 BIM software programmes.

All tools assess provided comprehensive outputs to inform the user of the overall GWP of a building and allow identification of potential carbon hotspots. There is variance across the complexity of the outputs, for example the National Highways tool provides summary graphs while Once Click LCA allow for carbon identification across full coverage of the EN 15978 indicators. The IStructE tool allows for comparison to other projects provided they used the same tool, whilst One Click LCA allow the same comparison function. Highways England maintain records of the results from the use of the National Highways tool for further internal analysis and potential publication as required. A public disclosure of a comparison using the Athena tool requires peer review, whilst public disclosure of results under EC3 requires values be altered slightly and the data is anonymised.

8 OPTIONS FOR AN IRISH-SPECIFIC GWP TOOL

It is recommended that the Irish GWP assessment methodology follows a ‘tool-neutral’ or ‘tool-agnostic’ approach, whereby no individual GWP tool is mandated for use in the Irish market. Instead, it is recommended that any tool employed is fully compliant with the Irish methodology. This recommendation is in line with many methodologies internationally (e.g., UK and the Netherlands) where they allow the use of any tool, but stipulate that whatever tool is employed, it must comply with the local methodology and enable fully transparent reporting.

This approach is favoured by the international stakeholders consulted as part of this study who felt that in the short-term, proprietary software can readily be adapted to conform with an Irish methodology. These software programmes can be validated to ensure they comply with the methodology. Ensuring the correct databases are used will be part of this validation process as necessary. Investment and resourcing will be required to validate third-party calculation tools and determine their suitability for the Irish context, ensuring they comply with the Irish calculation methodology.

There are multiple tools available to LCA practitioners at all stages of the design process. Different LCA teams will have different workflows and systems, and ultimately there will be different requirements for what a tool can offer. LCA practitioners will maintain responsibility for selecting a suitable tool which supports their workstream and enables compliance with the overarching Irish methodology.

A further recommendation is a standardisation and consistent reporting template is employed alongside a harmonised verification process. See Appendix F for an example of a potential reporting template. The methodology used by the chosen tool should be clearly described, accessible, and verifiable.

It is also acknowledged that the development of a robust GWP tool with wide application for design stakeholders would be beneficial for the Irish construction sector. A generic, free-to-use tool with wide applicability which aligns with the Irish GWP methodology requirements would support and harmonise reporting while improving comparability and consistency across different projects and designs. Such a tool could bring the following benefits:

- Accessible and affordable,
- Enable familiarisation of the design and construction market with the new Irish GWP methodology,
- Start influencing design decisions at an early stage, without having to wait for EPBD compliance timelines.

Furthermore, an Irish based tool might be able to support multiple assessments across the lifetime of a project to ensure that the accuracy of assessment can improve as the project develops, see Figure 22. The point (or points) in the process at which EPBD compliance is confirmed will be determined by SEAI.

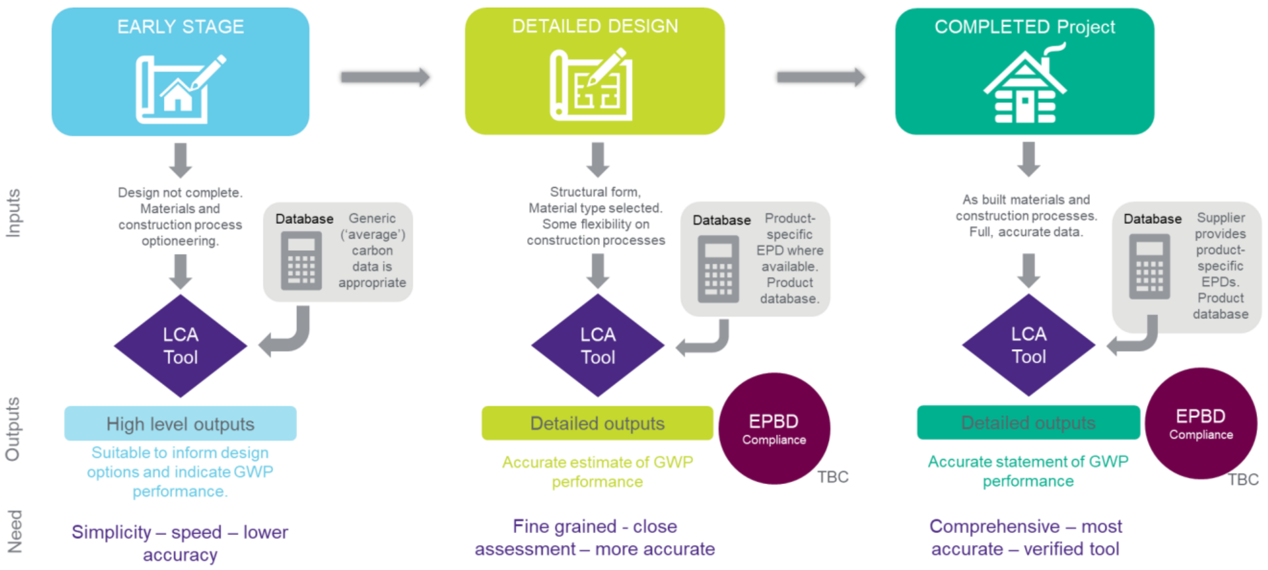


Figure 22: Evolution of LCA Tool requirements during stages of project development

8.1 General Guidance on Tool Attributes and Management

Any tools which would be developed to suit the Irish market and align with the Irish methodology should include several key features, as set out below and represented in Figure 23 below:

1. Transparency should be at the core of any tool which is employed in the Irish context. Tool features such as the databases used – both generic databases and specific EPDs - modelling assumptions and data quality methods should be transparent, verifiable, trackable, easily attainable, and understandable.
2. The tool should be flexible and allow for the changing nature of GWP assessments which would occur at different stages of the building design and development lifecycle. As a building design gets more detailed over time, the tool should accommodate the increased specificity which occurs. Generic databases should be used to support calculations at the earlier design stages to develop consistent figures before a supplier is known.
3. A tool should ultimately support the integration of digital design software and tools (e.g., BIM) and LCA information where possible. The capacity for data exchange using an online software-based tool would likely be more advanced than with an Excel-based tool. The capacity for integration with emerging artificial intelligence capabilities should be considered on an ongoing basis.
4. Third party verification and national authority validation of a tool are recommended.
5. A prerequisite for any tool is that it is fully compliant with the EPBD and Level(s) requirements. Furthermore, configuration and alignment with the reporting structure outlined within ICMS should be a central feature of any tool. This would help ensure consistent reporting, enabling comparability across projects and integration with the Capital Works Management Framework (CWMF), enabling benefits of a low-carbon design are captured downstream in public procurement contracts.
6. Adequate resourcing and support should be provided for the ongoing upkeep and maintenance of any tool. An online software-based tool can update their databases more routinely, with updates having an immediate effect, while Excel-based tools typically require a user to ensure that they have the most recent version of the tool downloaded. The Excel-based tool however would likely require less resources and funding to keep up to date than an online software-based tool, which could potentially be more resource intensive.

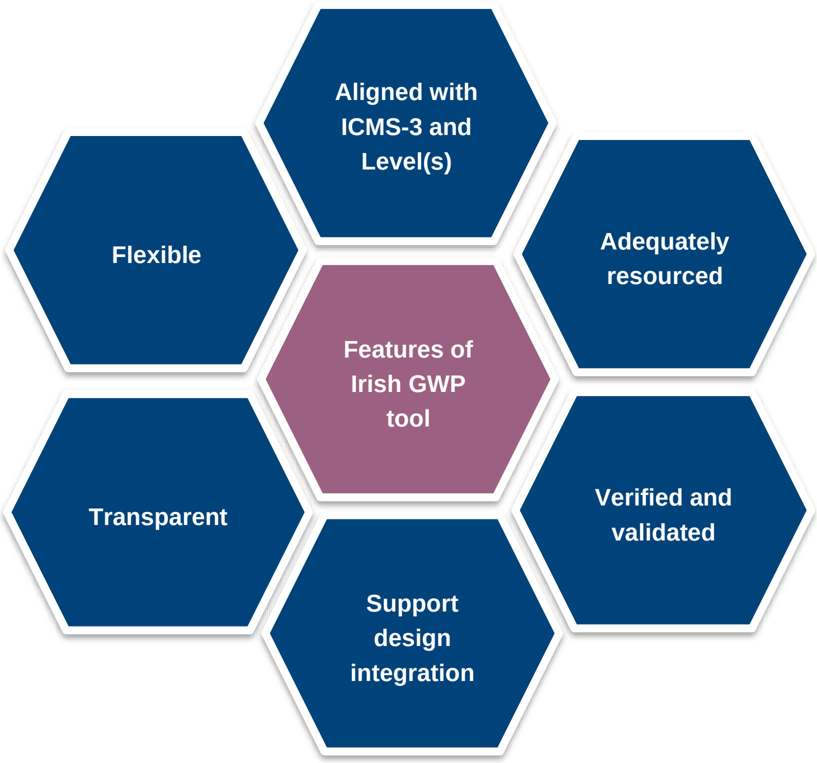


Figure 23: Preferable features within an Irish GWP tool

GWP Calculation, BIM and ICMS 3

The digitalisation of the built environment is crucial to unlocking data that can inform carbon assessments and quantification. The rise of the technology used in the building design industry – and the corresponding data it generates – is foundational to eliminating guess work, informing carbon assessments, and delivering data-driven whole life carbon insights.

BIM, as a digital tool to create and communicate building information in three dimensions, is rich in building data. Organisations often use BIM as a repository of itemised building elements, but underutilise its capacity to inform building carbon quantification. However, it is beginning to emerge as a critical technology to inform carbon assessments.

BIM data typically follows a project's regional needs and a design firm's internal workflows which differ from designer to designer, and currently these often don't align with carbon reporting or calculation frameworks. This creates a need for an additional step in mapping BIM data to requisite carbon reporting structures, and often is a task which occurs late in a design documentation process, and can result in time-consuming data processing and increased likelihood of errors.

Widespread adoption of the ICMS classification system, as a method for life cycle cost and carbon assessment within a project, can harmonise the data input and outputs from BIM and support reliable and consistent quantification of building GWP.

ICMS is a principles-based international standard that sets out how to classify, define, measure, record, analyse, present, and compare construction project life cycle costs and carbon emissions in a structured and logical format. It provides a consistent interpretation of the classification of construction life cycle costs and carbon emissions and is designed to be used with BIM and other building digital twins.

9 REVIEW OF IGBC WHOLE LIFE CARBON CALCULATOR TOOL

The Whole Life Carbon (WLC) Calculator Tool has been developed by the IGBC in collaboration with Construct Innovate and University of Galway. A review of the functionality and methodology of the tool has been carried out, as per the approach in Section 7.2 above, based on the 2.17 version of the tool.

Key characteristics of the IGBC Tool are set out below:

Tool	Focus	Accessibility	Cost	Ease of use	Range of Applications	Training and support
IGBC WLC Tool	Buildings	Offline, Excel-based tool	Free to use	Basic	Narrow	N/A

Tool	EN 15978 Lifecycle Modules	Data Quality and Databases	Generic Data	Transparency & verification
IGBC WLC Tool	A1-A5, B1-B5, C1-C4	Multiple databases, including generic databases. EPDs can be added, QI score allocated depending on data source (e.g., specific EPD, industry EPD etc.).	Generic factors from the National Inventory of Generic Construction Data (NIGCD), Inventory of Carbon and Energy (ICE)	Results of a project to be fully completed and disclosed, including disclosure of completeness and data quality and publicly displayed for verification.

Tool	LEVEL(s) aligned?	BIM Integration	ICMS-3 aligned?	Data indicators and outputs
IGBC WLC Tool	Yes – allows for breakdown per building element as defined in Level(s)	No	In the process of developing ICMS 3 aligned output	Data expressed across embodied, operational, and building element.

The IGBC's WLC tool allows for GWP assessment and calculation over time, indicating the level of "completeness" of the assessment which increases as more data is input into the Excel programme. It allows for a detailed assessment to be taken; however, it notes that "fundamentally the methodology is quite simple – quantify the inventory and multiply each input in the inventory by its relevant carbon factor and assumed replacement cycles and disposal pathway, using credible sources to determine these carbon factors and assumptions". To that end, the "credible source" utilised within the tool are transparent and verifiable. The material carbon factors are drawn from the IGBC Irish Generic Database and assumptions are specific to the Irish context, while the tool allows the assessor to include EPDs if and where they are available. The results emerging from the tool are aligned with the ICMS 3 reporting framework.

Perhaps where the IGBC Tool faces challenges is the import and export of design information. The input data is derived from a Bill of Quantities (BoQ). While a BoQ is a detailed assumption on the materials required in a building at the start of a project, it does not accurately capture the total materials used at the end of a contract. Developing a function to integrate BIM or as-built drawings would give wider functionality and help increased the accuracy of an assessment. Unlike commercial software tools, there is currently no integration with a deeper EPD database. Neither is there a web-based dimension, to enable seamless collection of completed LCA studies in order to develop a national profile of buildings.

In summary, the IGBC WLC Tool represents a simple and robust tool accessible to a wide usership. Alignment with the SEAI recommended national GWP methodology could easily be achieved.

The option is available to use this tool as the starting point for a more sophisticated tool, with wider functionality and better integration.

Section Four
Additional Recommendations to support an Irish national GWP Methodology

10 IMPLEMENTATION OF THE GWP METHODOLOGY

The purpose of this study was to provide guidance and recommendations on the development of a national GWP methodology for the Irish context which complies with the requirements outlined within the EPBD. The recommendations in Table 8 are founded upon a comprehensive policy review, an assessment of international methodologies and approaches, a review of LCA tools, and consultation with national and international stakeholders.

In the course of the research and consultation additional recommendations were developed which can support the wider industry as it adapts to the new requirements of the EPBD. Broadly, the recommendations can be split into three categories, as illustrated in Figure 24:

Figure 24: Additional recommendations themes

10.1 Resources to support GWP assessment

Adopting a national GWP methodology is the first step towards the mandatory disclosure of GWP of all new buildings and the establishment of GWP limits for buildings from 2030. Developing a coherent framework for GWP assessment in the Irish context will require significant resourcing to undertake the necessary development, operational, and compliance work required.

As set out in Figure 25 below, the adoption of a standard WLC methodology is an important foundation stone for EPBD compliance in Ireland. There are several other dimensions to successful implementation of the requirement for whole life carbon assessment, including:

- Development of a database for construction products (this topic is subject of a separate study for SEAI by Ramboll team).
- Development of a suitable tool to enable early implementation of the methodology, and establishing a verification process to enable further tools to be used for EPBD compliance.
- Development of a reporting and data collection system to manage the ‘certification’ of EPBD compliance for completed new buildings.

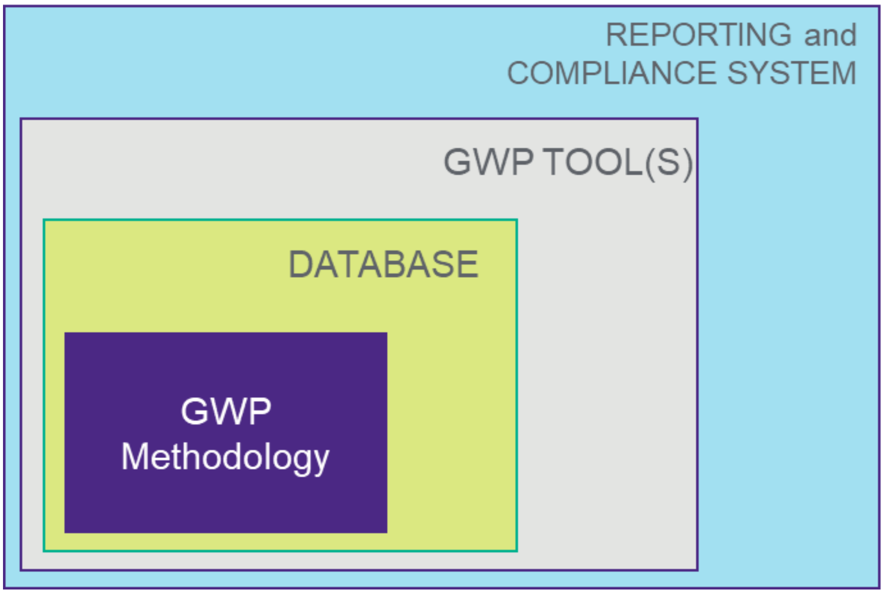


Figure 25: Elements of EPBD compliance for GWP

- As noted, the SEAI have engaged consultants to develop recommendations on an Irish national EPD database in support of a GWP methodology and the wider industry requirements. Dependent on the recommendations of that work, it may require both database development and operational resources, ensuring the database is managed into the future in a suitable manner that supports the Irish industry and product manufacturers. Furthermore, adaptation of a database within the context of the CPR will likely be a consideration in the coming years, demanding further resources.
- While the recommendation in this report is not to mandate a single GWP tool for use in the Irish market, it is recommended that an Irish GWP calculation tool specific to the Irish market be developed to support smaller enterprises who may not have the need or resources for proprietary software packages to undertake assessments in line with the Irish methodology. Development, maintenance, the provision of training, and the ongoing upkeep of such a tool, particularly within the evolving regulatory landscape the EPBD operates, will likely require skilled resources, both in the early tool development stages but ongoing into the future to meet the needs of Irish industry.
- Furthermore, independent third-party GWP calculation tools will need to be verified to ensure they align with the Irish methodology, similarly, data inputs and outputs will require scrutiny from a compliance aspect.
- Additional resourcing will be required for development and management of the necessary reporting and compliance systems to ensure that the Irish GWP assessment framework conforms to European requirements. The depth and expertise of resources to ensure ongoing regulatory compliance of project GWP assessment will be quite significant.

10.2 Responsiveness

10.2.1 Early Implementation

Updating or adapting a simple GWP calculation tool to operate the new national methodology will be beneficial in many ways. It will enable LCA practitioners across architecture, engineering and surveying professions to become familiar with the process. It will also enable feedback on where data or knowledge gaps exist. By applying the methodology across some typical building typologies, it will also inform the process of setting GWP limits in an Irish context. Work already completed by IGBC and Construct Innovate under the INDICATE project is an example of how collaboration with LCA practitioners in industry can relatively quickly develop a database of useful baseline information at relatively low cost.

10.2.2 Methodology Development

LCA methodology development and implementation is still at a relatively early stage across the EU. There are many knowledge and data gaps in terms of practical experience of GWP implementation, availability of environmental data for construction products and projects, and verification and assessment of GWP disclosures. These knowledge and data gaps all exist in the context of an evolving regulatory landscape. Over the coming months and years, policies and regulations will evolve, systems will improve, and most likely more harmonisation will occur between EU member states.

Evolution of practices in the UK is also relevant to Ireland given the extent to which design practices and construction companies are intertwined in both countries, not to mention the extensive supply chain exchanges across the Irish Sea for construction products and construction professionals.

Figure 26 below illustrates that the GWP methodology is not necessarily fixed, but can evolve over time to respond to external changes, feedback from LCA users, and research activities that will provide better data and knowledge.

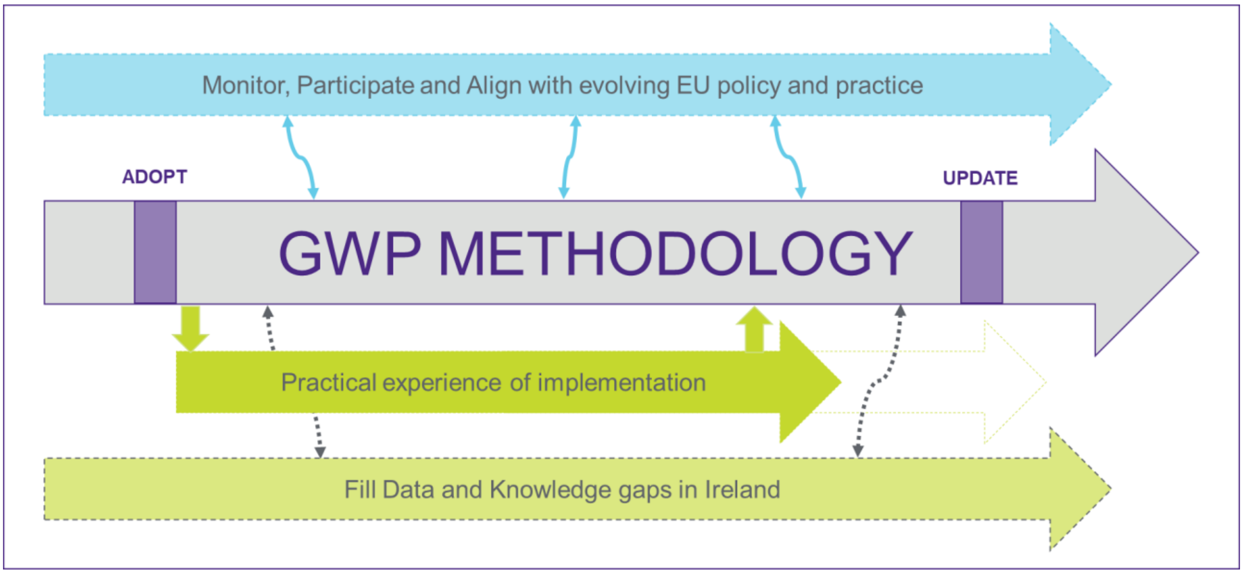


Figure 26: GWP methodology evolution over time

With adequate resources and investment, and the resulting benefit of time, knowledge, data and regulatory clarification, the GWP methodology and supporting structures (i.e., databases, calculation tools and reporting and compliance system) will evolve into a robust and coherent structure which supports Ireland's built environment decarbonisation targets.

10.2.3 Communication and Engagement

Implementing the GWP requirements of the revised EPBD represents a significant change for the Irish construction sector. At this point, awareness of the need for GWP assessments and what the process will require is relatively low. As SEAI develop and implement the necessary changes, this will require a communication plan in order to support the transition in the sector. SEAI can draw on its extensive experience from successful implementation of the national BER rating system,

As well as 'getting the message out' to the sector, the SEAI will need channels for feedback to ensure a two-way dialogue. The existing umbrella bodies for the sector – such as Engineers Ireland, ACEI, RIAI, SCSS IGBC and Construct Innovate – can be important partners in the roll-out of the new GWP requirements including in relation to training and awareness measures.

10.3 Research requirements

Areas to for further research and development in order to enhance the accuracy and completeness of the GWP methodology assessment of buildings are set out in Table 11 below. These are set out in the same order as the main recommendations in Section 2 and are not in order of priority.

Table 11: Recommended Research Topics to improve GWP assessment in Ireland

Topic/ Aspect	Gap to be filled	Comment
Reference Study Period	Develop approach for temporary buildings with a short-intended life span	This gap is currently under consideration at EU level.
Biogenic Carbon Accounting	Improve the limited current understanding of Land Use and Land Use Change Aspects	
Data Quality	Review requirement for an Irish-specific data quality index or methodology	Gain further experience in the use of Level(s) approach and review its effectiveness and benefit.
LCA Stages A4 (Transportation to Site)- and A5 (Construction)	Develop generic data/ methodology for transportation to site and construction stage emissions, that can be applied for early-stage GWP assessment for Irish buildings.	Generic data applicable to module 5.2 (construction activities) will be applicable to all buildings. Modules 5.1 and 5.3 will be applicable in many cases. This can build on work to date by IGBC and Construct Innovate.
LCA Stage B1 Use Module B1.1	Review current practices for calculation of GWP related to carbonation of concrete, and develop Irish-specific approach if necessary.	
LCA Stage B1 Use Module B1.2	Review current practices for calculation of GWP related to fugitive emissions of refrigerants, and develop Irish-specific approach if necessary.	This can be a significant component of the overall GWP and further understanding would be beneficial, particularly in light of the current transition towards electrification of heat and greater use of heat pumps.
LCA Stage B4 Replacement of Building Components	Review the appropriateness of applying Level(s)/ RICS generic recommendations for Reference Service Life of building components in Ireland.	
LCA Stage B6 Operational Energy Use	Process to report complete GWP related to energy use Review the robustness and accuracy of 50-year operational energy scenarios	Expand the current BER operational carbon value to include upstream GHG emissions. B6 emissions represent a significant element of overall GWP, but there is potential for inaccuracy in the current approach which leans heavily on pre-occupancy BER. The anticipated in-service building

		energy performance, and pace of decarbonisation of electricity grid etc.). are areas for further consideration.
LCA Stage B7 Operational Water Use	Develop generic GWP values that can be applied to water use in Ireland for various typical building typologies.	
LCA Stage C – End of Life (also relates to Stage A5.1 and A5.3 – waste from construction/ demolition process)	Improve baseline understanding of waste generation and management on Irish building construction sites (including demolition works) and develop generic GWP factors that can be applied. Develop appropriate scenarios for future waste generation and management taking into account circular economy policies and likely future practices in building design and resource management.	While national level data exists for overall waste flows, waste generation and management pathways at building level is not particularly well documented at present. This gap likely to be addressed at EU level. Irish-specific consideration will also be needed.
LCA Stage D – Benefits and Loads beyond the System Boundary Module D1 Module D2	(Building on work carried out under LCA Stage C above) Methodology for calculating GWP benefits and loads from reuse, recovery and energy recovery of building components/ materials. Methodology for calculating GWP benefits and loads from energy (or other utilities) exported from the building (e.g. excess renewable electricity or heat).	This topic likely to be further developed at EU level. Irish-specific consideration will also be needed.
Component Coverage	Develop approach/ generic data for GWP associated with 'fit out' of buildings to be applied when building completion does not include fit out	Will be necessary for speculative buildings: e.g. a building for which the future tenant is not known at completion stage.

References and Appendices

Appendix A – EN 15978 Stages and Modules Breakdown

Below is a description of rules for each of the EN 15978:2011 modules and sub-modules as set forward within Level(s) Indicator 1.2

Table 12: Description of EN 15978 sub-modules as per Level(s) Indicator 1.2

Life cycle stage	Modules	Description and rules
Production stage	**A1-3**	The boundary for modules A1 to A3 covers the 'cradle to gate' processes for the materials and services used in the construction; the rules for determining their impacts and aspects are defined in EN 15804.
	A3-4	The construction process stage covers the processes from the factory gate of the different construction products to the practical completion of the construction work.
Use stage	**B1-5**	The use stage covers the period from the practical completion of the construction work to the point of time when the building is deconstructed/demolished. The system boundary includes: – the use of construction products and services for protecting, conserving, moderating or controlling the building; – scenarios for maintenance including cleaning, operation and replacement of machinery; – impacts and aspects of the building-integrated technical system and building-related furniture, fixtures and fittings.
	B6	The boundary shall include energy used by building-integrated technical systems during the operation of the building.
	B7	The boundary shall include all water used and its treatment (pre- and post-use) during the normal operation of the building (excluding during maintenance, repair, replacement and refurbishment),
End of life stage	**C1-4**	The end-of-life stage of a building starts when the building is decommissioned and is not intended to have any further use. At this point, the building's demolition/deconstruction may be considered as a multi-output process that provides a source of materials, products and building elements that are to be discarded, recovered, recycled or reused [4].
Benefits and loads beyond the system boundary	**D**	Components for reuse and materials for recycling and energy recovery are considered as potential resources for future use. Module D quantifies the net environmental benefits or loads resulting from reuse, recycling and energy recovery resulting from the net flows of materials and exported energy exiting the system boundary.

Appendix B - Additional relevant policies, frameworks and standards

Table 13 below provides a brief overview of multiple additional standards, policies, frameworks and guidance documents which are considered as part of the development of the national methodology for GWP assessment. The below list policies and standards referenced is not exhaustive, but reflects the scale, breadth, and interconnected nature of the regulatory landscape influencing the generation of national GWP assessment methodology.

Table 13: Additional policies and regulations influencing building GWP

Title	Relevance to GWP Methodology
Energy Efficiency Directive (EU 2023/1791)	The Energy Efficiency Directive (EED) is a cornerstone for how the EU aims to fully decarbonise the European building stock along its entire lifecycle. Together, the EED and the EPBD promote policies that will help achieve a highly energy efficient and decarbonised building stock by 2050 and create a stable environment for investment decisions. Furthermore, the EED's 'energy efficiency first' principle which is focused on reducing overall energy demand, will influence the design of buildings and the components and materials used.
Waste Framework Directive	The Waste Framework directive sets the concepts and definitions related to waste management. Within this, the end-of-waste criteria specify when certain wastes cease to be waste and becomes a product or a secondary raw material. Understanding the material streams used in buildings and how they are classified at the end of their life can materially influence both the design of a building and its total lifecycle GWP.
Emissions Trading Scheme (ETS) and Carbon Border Adjustment Mechanism (CBAM)	The EU ETS affects building GWP calculation through its influence on the carbon intensity and cost of materials and energy used in building construction and operation. It incentivises reductions in both embodied and operational carbon by imposing regulatory and financial pressure on high-emissions industries (e.g., cement, steel, aluminium) and energy producers. For GWP assessments, this means lower embodied carbon materials and operations,. And more accurate emissions data which enable better informed decisions which can reduce a building's overall footprint. The CBAM applies a carbon price on imports of high-emissions goods and materials which are imported from non-EU countries which don't have comparable carbon pricing mechanisms. Introduced to discourage the shifting of the production of goods to non-EU countries where there is a lower or no carbon cost associated with their production, the CBAM requires imported of affected goods to reported the embodied emissions of those products, increasing the availability of more accurate emissions data to inform GWP assessments.
Green Public Procurement Rules	Green Public Procurement is a voluntary instrument which is increasingly employed across Member States to support decarbonisation in public sector projects and stimulate the evolution towards resource-efficient economies. In Ireland, new GPP rules introduced by the Department of Enterprise, Trade and Employment related to the procurement of cement and concrete for public sector projects have been designed to drive adaptation of practices in the private sector. Rules introduced in 2024 require the State to purchase cement and concrete products with lower embodied carbon emissions and supporting EPDs, and from 2025, specific projects will be required to undertake a whole life carbon assessment as part of project delivery.
ISO 14040 – *Environmental management – Life cycle*	ISO 14040 describes the principles and framework for the life cycle assessment of any product or service while ISO 14044 provides

assessment – Principles and framework and ISO 14044 – *Environmental management – Life cycle assessments – Requirements and guidelines*	requirements and guidelines for LCA and life cycle inventory (LCI) studies, describing the practical implementation of ISO 14040. Together the ensure that LCAs are performed consistently, reliably and in alignment with international standards.
EN 17472:2022 - *Sustainability of Construction Works – Sustainability assessment of civil engineering works – Calculation methods*	EN 17472:2022 establishes the requirements and specific methods for the assessment of environmental, economic, and social performances of civil engineering works. It provides a method of assessment of sustainability that is based on a life cycle approach. The environmental performance is based on data obtained from Environmental Product Declarations (EPD) and additional indicators.
EN 15941:2024 - *Sustainability of construction works. Data quality for environmental assessment of products and construction work. Selection and use of data*	EN 15941:2024 supports the development of Environmental Product Declarations (EPDs) according to EN 15804. It defines the data quality requirements for the data used to calculate the LCA-based results of the EPD and for construction works when applying the EPD. It is intended to describe the criteria, hierarchy and sources of data when using primary and secondary (i.e., generic) data for EPDs.
EN 15643:2021 - *Sustainability of construction works - Framework for assessment of buildings and civil engineering works*	EN 15643:2021 provides a high-level framework for evaluating and improving the sustainability of buildings and civil engineering works, focusing on environmental, social and economic dimensions across their lifecycle. It provides principles and methodologies for assessing sustainability without prescribing specific indicators or performance levels (which can be found in related standards such as EN 15978).

Appendix C – Details on LCA Modules

The following section presents the specific text referenced within Level(s) Indicator 1.2, the RICS Methodology and CIBSE TM65 methodology as outlined within Section 5.3 LCA Stages within Section 2 of this report.

C.1 Reference to Level(s)

C.1.1 Data quality scoring – Level(s) Indicator 1.2 UM3

Calculation of the Data Quality Index

Since this indicator at Level 2 may be used for reporting the building's environmental performance in the public domain, data quality becomes an important issue. A data quality index is to be calculated according to the method set out below and shall accompany any reporting in the public domain. The overall data quality index shall score above 2. For transparency reasons, data sources shall moreover be reported.

The rating has a matrix form, which is adapted from the European Commission's Product Environmental Footprint method's (PEF) data quality evaluation methodology. The rating is presented as look up table 2.3 and is based on four parameters:

- Technological representativeness of data (TeR)
- Geographical representativeness of data (GR)
- Time-related representativeness of data (TiR)
- Uncertainty of data (U)

A rating level is to be evaluated for each parameter according to the matrix in Table 5. The overall rating is equal to the Data Quality Index (DQI), which can be calculated from the individual ratings as follows:

DQI = ((TeR+GR+TiR)/3+U)/2

The rating shall be calculated for each hot spot of the environmental impacts identified from the life cycle GWP calculation [9]. Hot spots may be related to a building's life cycle stages or modules, processes, components

[9] Hot spots are points in the life cycle of a product which have the highest impacts/importance in the overall life cycle GWP result .

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(elements, structural parts, products, materials) or elementary flow – or combinations thereof, for example the installation and replacement of a façade in life cycle modules B1-3 and B5. The rules for the identification of hot spots can be found in L2.4 – Checklist item 10.

The overall data quality shall then be calculated as the contribution-weighted average of the data quality for each hot-spot:

DQI overall = Σi (DQI hot-spot,I x Contribution hot-spot,i) / Σi (Contribution hot-spot,i)

Table 5 Data quality evaluation matrix

Rating aspect	*Brief description of each aspect*	Rating score			
		0	1	2	3
Technological representativeness	Degree to which the dataset reflects the true population of interest regarding technology (e.g. the technological characteristics, including operating conditions)	No evaluation made	The data used does not reflect satisfactorily the technical characteristics of the system (e.g. Portland Cement, without other specifications)	The data used reflects partially the technical characteristics of the system (e.g. Portland Cement type II, without further specifications)	The data used reflects the technical characteristics of the system (e.g. Portland Cement type II B-M)
Geographical representativeness	Degree to which the dataset reflects the true population of interest regarding geography (e.g. the given location/site, region, country, market, continent)	No evaluation made	The data used refer to a totally different geographic context (e.g. Sweden instead of Spain)	The data used refers to a similar geographic context (e.g. Italy instead of Spain)	The data used refers to the specific geographic context (e.g. Spain)
Time-related representativeness	Degree to which the dataset reflects the specific conditions of the system being considered regarding the time/age of the data (e.g. the given year compared to the reference year of the analysis)	No evaluation made	There are more than 6 years between the validity of the data used and the reference year to which the data applies.	There are between 2 and 4 years between the validity of the data used and the reference year to which the data applies.	There are less than 2 years between the validity of the data used and the reference year to which the data applies.
Uncertainty	Qualitative expert judgment or relative standard deviation expressed as a percentage.	No evaluation made	Modelled/similar data is used. Accuracy and precision of the data has been estimated qualitatively (e.g. by expert judgment of suppliers and process operators)	Modelled/similar data is used which is considered to be satisfactorily accurate and precise with the support of a quantitative estimation of its uncertainty (e.g. representative data from trade associations for which a sensitivity analysis has been carried out).	Site specific and validated data is used which is considered to be satisfactorily accurate and precise (e.g. window system for which a verified EPD is available) The allocation hierarchy has been respected.

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C.2 Reference to RICS

C.2.1 Module A5.2

Construction activities (A5.2)

Construction activity impacts include impacts from any construction activities and installation processes on-site, including temporary works, energy consumption for site accommodation and use of plant, machinery and equipment. These should be monitored during construction to contribute to an accurate as-built embodied carbon calculation at project completion.

In order to ensure consistency across projects, contractors should scope out what accounts for 80% of their anticipated impacts on site and identify a methodology for how it can be reduced prior to works commencing on site. Example actions may include removing diesel or using hydrogen for tower cranes.

Key temporary works required to enable construction should be captured in the WLCA, as they form part of the works related to the built asset. Such works are captured under the relevant element categories: facilitating works, preliminaries, etc. Particularly for large projects, temporary works may be significant. Examples may include formwork, hoarding posts, tower crane grillage, scaffolding, piling mats, temporary sheet piling, temporary cofferdams, temporary props and retaining structures such as struts and walers. Impacts

should cover the material impact, the transportation of items between temporary storage facilities and the site, and their disposal.

Where temporary works are reusable, an estimate of their reuse should be made so that the project accounts for the appropriate proportion of the impacts, in line with its use. Use of timber in temporary works should be assessed as described in section 4.11.1, and reusable steelwork formwork may be assumed to be used 20 times in the absence of more accurate information.

It is recommended that the embodied carbon of key temporary hired equipment, such as lifting platforms, scaffolding, struts and support steel frames, are estimated and captured accordingly, so that the project accounts for the appropriate proportion of the impacts in line with its use of the temporary equipment. For example, if the average lifespan of scaffolding components is 20 years and it is being used on a project's construction site for 2 years, then the fraction of embodied impacts that can be attributed to the project is 2/20, so 10% of the total embodied carbon (A1–A5, plus C1–C4) of the scaffolding used.

Baseline building-specific impacts related to construction activities in the UK are anticipated to be 40 $kgCO_2e/m^2$ GIA. Assessments in other countries may use this default figure but should use a national equivalent if available; the assessment should then make clear what source has been used.

The $kgCO_2e/m^2$ value suggested should be superseded with site-specific data when available.

In the case of modern methods of construction (MMC) or any other prefabricated elements, any offsite-related activities are considered part of the fabrication process to be reported under A1–A3 (see section 5.1.2). The Centre for Window and Cladding Technology also provides some guidance on this.

C.2.2 Module A5.3

Waste and waste management (A5.3)

The embodied carbon from the production and transport of products that will be wasted, and any impacts associated with waste treatment, should be included in the calculations in this sub-module. Installation and deconstruction impacts can be assumed to be zero, as the wasted material is not being installed. The waste treatment of packaging waste is also included in A5.3. Packaging waste in the UK can be assumed to be 32% of the total mass of construction waste if no other data is available. Assessments in other countries may use this default figure but should use a national equivalent if available; the assessment should then make clear what source has been used.

Waste and waste management impacts should be calculated as follows:

A5.3 = waste rate (a) x site waste treatment embodied carbon factor (b)

Waste rate (a): the waste rate (WR) is a percentage of the quantity of materials brought to the site that are wasted.

The WRs outlined in Table 18 are based on traditional forms of construction in the UK; therefore, WRs associated with offsite manufacture would be expected to be lower. For MMC

that involve prefabrication, any manufacturing waste at offsite facilities should be captured in the A1–A3 carbon of the respective products; see the guidance from the Centre for Window and Cladding Technology.

Material/product	WR (waste rate)
Concrete in situ	5%
Concrete precast (floor, beams and frames)	1%
Concrete (sprayed)	10%
Steel reinforcement	5%
Steel frame (beams, columns, braces)	1%
Concrete blocks (lightweight AAC)	10%
Concrete blocks (dense/medium density)	5%
Brickwork (clay)	6%
Stone (cladding)	5%
Stone (landscaping)	10%
Mortar and render (internal and external)	4%
Screed	8%
Floor finish (tile)	6%
Floor finish (carpet)	6%
Timber frames (beams, columns, joists, braces)	2%
Timber floors (boards)	10%
Timber formwork	10% (in addition to end-of-life usage rates, see section 4.11.1)
Aluminium sheet	1%
Aluminium extruded profiles/frames	1%
Plasterboard	4%
Insulation	7%
Aggregate	10%
Glass	1%
Coatings (paint, intumescent coatings)	6%

Material/product	WR (waste rate)
Sprayed cementitious fire protection to steel	10%
Asphalt	6%
Bitumen	6%
Roof cladding	5%

Table 18: Recommended waste rate data, primarily from BRE Global Product Category Rules (PCR) for Type III EPD of Construction Products to EN 15804+A2 (2023) or SmartWaste

Any site waste data from EPDs should be superseded by the rates from Table 18 for consistency purposes in the UK. This is due to the generalisation in EPD site waste rates. Assessments in other countries may use these default figure but should use national equivalents if available; the assessment should then make clear what source has been used. These rates should subsequently be refined by substitution with project-specific information and/or site monitoring data provided by the contractor and subcontractors as these become available. At project completion, actual wastage rates should be documented.

Site waste disposal embodied carbon factor (b): The site waste disposal embodied carbon factor is informed by the principles outlined for the product and transport stages (A1–A3 and A4), and the end-of-life stages (C2–C4). The factor varies based on the disposal scenario, as shown in Table 19.

Disposal to landfill/incineration	Reuse or recycling on-site	Reuse or recycling offsite
[A1–A3] + [A4] + [C2] + [C4]	[A1–A3] + [A4] + [C3]	[A1–A3] + [A4] + [C2] + [C3]

Table 19: Calculating the construction waste embodied carbon factor for different site waste disposal scenarios

End-of-life scenarios should be established (and aligned with the recommendations of section 5.6.1) in accordance with the impacts calculated using the formulas in Table 19. The selection of on-site or offsite reuse/recycling scenarios for the different items should be based on project-specific information.

C.2.3 Module B1.2

Particular attention should be paid to any emissions arising from refrigerants and insulation blowing agents with GWP over the life cycle of the project.

Annual refrigerant leakage from MEP equipment must be accounted for, as detailed in CIBSE TM65.

The equation for calculating the accidental release of refrigerants with GWP from mechanical equipment (B1.2) is:

B1.2 = refrigerant charge x refrigerant GWP x annual leakage rate x RSP

C.3 Reference to CIBSE TM65

Table 4.4 Refrigerant leakage scenarios

Product	Annual leakage rate, to be used in B1 (use)	End of life recovery rate, to be used in C1 (deconstruction)
Package heat pump or chiller, where no refrigerant is managed on site (type 1)	2%	99%
Heat pump or chiller where some works to refrigerant pipework are carried out on site (type 2)	4%	98%
VRF systems where a large amount of refrigerant pipework is installed and filled on site (type 3)	6%	97%

C.3.1 Module C3

5.6.4 Waste processing for reuse, recycling or other recovery (C3)

When materials and/or components are intended to be reused, recycled or recovered after the RSP of the asset, any impacts associated with their preparation for reuse, waste treatment and recovery prior to reaching the end-of-waste state must be included in module C3.

The calculation of C3 should follow the end-of-life scenarios developed by the assessor for each item. Data for C3 from relevant EPDs should be used, adjusted to suit the selected end-of-life scenario. In the absence of specific information regarding the waste processing for items leaving the asset, the default emissions for disposal to landfill should be applied (see section 5.6.3).

Where materials are incinerated with energy recovery, the emissions should be recorded in C3. Energy recovery can only be considered where incinerators meet R1 status (where waste-to-energy incinerators meet the required Energy Efficiency Formula standard according to the Waste Framework Directive: 65% post-2008 and 60% beforehand). If it is not likely that the materials would be incinerated in an R1 facility, incineration should be treated as a disposal activity and reported in C4. Alternatively in the UK, for simplicity, use the following generic data for energy from waste in the UK and report it in C3.

Energy from waste type	Metric	Electricity output	Heat output
Biomass using recycled wood (Tolvik 2019)	Per tonne of waste wood*	880kWh	0
Energy from waste – not biomass (Tolvik 2020)	Per tonne of waste	560kWh	150kWh
	Per GJ net calorific value (NCV)*	61kWh	16kWh

Table 27: Generic energy from waste data for the UK

* This gives a typical actual efficiency of UK energy from waste plants using biomass of approximately 18%, and of 28% for energy from waste plants using other fuels, slightly below the standard required to achieve R1 status.

Assessments in other countries may use these default figures but should use national equivalents if available; the assessment should then make clear what source has been used.

See section 4.11.1 for information on how to report the transfer or emission of biogenic carbon in biobased materials considered in C3.

The types of activities undertaken as preparation for reuse in module C3 include:

- removal of coatings from timber and steel, including their disposal
- removal of mortar from bricks and masonry, including its recovery, and
- removal of joints and fixings from structural steel, including their recovery.

For material that is recycled, the end-of-waste state varies.

- For metals, it is when they have been collected as separate scrap metals.
- For concrete, masonry, stone and ceramics, it is when all components, materials and waste are processed/crushed and cleared from site, or repurposed as part of the site's reinstatement.
- For glass, it is when it has been crushed for use as cullet.
- For plastics, it is when they have been granulated.
- For timber, it is when it has been chipped for recycling or use as secondary fuel.
- For MEP products where no EPDs are available, follow the CIBSE TM65 methodology and local addendum assumptions if outside the UK.

C.3.2 Module C4

5.6.5 Disposal impacts (C4)

Module C4 captures impacts resulting from any processing required prior to disposal and from the degradation of landfilled materials, or incineration without energy recovery or in a plant without R1 status (Energy Efficiency Formula standard, according to the Waste Framework Directive, less than 65%). This is only applicable for items not being recovered for reuse, recycling or other recovery.

For elements not expected to be reused, recycled or recovered, but intended for final disposal either in landfill or incineration, an allowance for the impacts from their disposal must be included in C4.

The calculation of C4 should follow the end-of-life scenarios developed by the assessor for each item. C4 data from relevant EPDs should be used, adjusted to suit the selected end-of-life scenario. Where data for disposal is unavailable, default assumptions should be used. The default figures should utilise the most current government GHG conversion factors for company reporting. Table 28 refers to 2024 figures for UK construction waste to landfill.

Assessments in other countries may use these default figures but should use national equivalents if available; the assessment should then make clear what source has been used.

Material	$kgCO_2e$ per tonne
Asbestos	5.913
Aggregates, asphalt, bricks, concrete, insulation (not biobased)	1.234
Metals	1.264
Soils	19.52
Plasterboard	71.95
Wood and other biobased material*	925.2

Table 28: Default impacts figures for waste to landfill

For biobased materials, see section 4.11.1 for information on how to account for sequestered biogenic carbon in C4.

*The figure for **wood and other biobased material** in Table 28 shows the additional GWP emission from fugitive biogenic methane from landfill of biobased material, which must be added to the calculated emission of CO_2 based on the biogenic carbon content.

Example: One tonne of wood at 12% moisture used in a building contains 446kg biogenic carbon. In A1–A3, GWP-bio will be -1635kgCO_2e . At end of life, if the wood is landfilled, the calculated emission of biogenic carbon as CO_2 will be 1635kgCO_2e. From Table 28, there will be an additional emission of 925.2kgCO_2e to account for the fugitive biobased methane = 2560kgCO_2e as the total GWP-bio emission in C4.

The impacts associated with incineration of waste where the facilities do not have recovery status (R1) should be reported in C4. Potential energy recovery from waste incineration and landfill gas should be captured in module D.

For MEP products where no EPDs are available, follow the CIBSE TM65 methodology and local addendum assumptions if outside the UK.

Appendix D – Component Classification aligned with ICMS 3

Legend

x	Included
o	Optional
na	Not Applicable

Code		Description			Note	RPS/RKD
		Category (Level 2)	**CC | CE**	**RC | RE or MC | ME**		
		Group (Level 3)				
		Sub-Group (Level 4)				
2.		Construction Costs (CC) | Construction Carbon Emissions (CE)				
3.		Renewal Costs (RC) | Renewal Carbon Emissions (RE)				
5.		Maintenance Costs (MC) | Maintenance Carbon Emissions (ME				
		(CC | CE, RC | RE, and MC | ME share the same Groups below, so far as applicable. Those separated by ' | ' in [ ] are respective alternative terms.)				
	01.	Demolition, site preparation and formation				o
	01.010	Site survey and ground investigation				o
	01.020	Environmental treatment				o
	01.030	Sampling of hazardous or useful materials or conditions				o
	01.040	Temporary fencing				o
	01.050	Demolition of existing buildings and support to adjacent structures				o
	01.060	Site surface clearance (clearing, grubbing, topsoil stripping, tree felling, minor earthwork, removal)				o
	01.070	Tree transplant				o
	01.080	Site formation and slope treatment				o
	01.090	Temporary surface drainage and dewatering				o
	01.100	Temporary protection, diversion and relocation of public utilities				o
	01.110	Erosion control				o
	02.	Substructure				x
	02.010	Foundation piling and underpinning: • mobilisation and demobilisation • trial piles and caisson • permanent piles and caisson • pile and caisson testing • underpinning				x
	02.020	Foundations up to top of lowest floor slabs: • excavation and disposal • lateral supports • raft footings, pile caps, column bases, wall footings, strap beams, tie beams • substructure walls and columns • lowest floor slabs and beams (excluding and beyond basement bottom slabs) • lift pits • composite or prefabricated work				x

	02.030	Basement sides and bottom: • excavation and disposal • lateral supports • bottom slabs and blinding • sides • vertical waterproof tanking, drainage blanket, drains and skin wall • horizontal waterproof tanking, drainage blanket, drains and topping slab • insulation • lift pits, sump pits, sleeves • composite or prefabricated work		x
	03.	Structure		x
	03.010	Structural removal and alterations		x
	03.020	Basement suspended floors (up to top of ground floor slabs): • structural walls and columns • beams and slabs • staircases		x
	03.030	Frames and slabs (above top of ground floor slabs): • structural walls and columns • upper floor beams and slabs • roof beams and slabs • staircases • fireproofing to steel structure		x
	03.040	Tanks, pools, sundries		x
	03.050	Composite or prefabricated work		x
	04.	Architectural works | Non-structural works		x
	04.010	Non-structural removal and alterations		x
	04.020	External elevations: • non-structural external walls and features • external wall finishes except cladding • facade cladding and curtain walls • external windows • external doors • external shop fronts • roller shutters and fire shutters		x
	04.030	Roof finishes, skylights and landscaping (including waterproofing and insulation): • roof finishes • skylights • other roof features • roof landscaping (hard and soft)		x
	04.040	Internal divisions: • non-structural internal walls and partitions • shop fronts • toilet cubicles • moveable partitions • cold rooms • internal doors • internal windows • roller shutters and fire shutters • sundry concrete work		x
	04.050	Fittings and sundries: • balustrades, railings and handrails • staircases and catwalk not forming part of the structure, cat ladders • cabinets, cupboards, shelves, counters, benches, notice boards, blackboards • exit signs, directory signs • window and door dressings • decorative features • interior landscaping • access panels, fire service cabinets • sundries		x
	04.060	Finishes under cover: • floor finishes (internal and external) • internal wall finishes and cladding • ceiling finishes and false ceilings (internal or external)		x

	04.070	Builder's work in connection with services: • plinth, bases • fire-proofing enclosure • hoisting beams, lift pit separation screens, lift shaft separator beams • suspended manholes • cable trenches, trench covers • sleeves, openings and the like not allowed for in 'Fittings and sundries'		x
	04.080	Composite or prefabricated work		x
	05.	Services and equipment		x
	05.010	Heating, ventilating and air-conditioning systems/air conditioners: • seawater system • cooling water system • chilled water system • heating water system • steam and condensate system • fuel oil system • water treatment • air handling and distribution system • condensate drain system • unitary air-conditioning system • mechanical ventilation system • kitchen ventilation system • fume and smoke extraction system • anaesthetic gas-extraction system • window and split-type air conditioners • air-curtains • fans • related electrical and control systems • submissions, testing and commissioning		x
	05.020	Electrical services: • high-voltage transformers and switchboards • incoming mains, low-voltage transformers and switchboards • mains and submains • standby system • lighting and power • uninterruptible power supply • electric underfloor heating • local electrical heating units • earthing/lightning protection and bonding • submissions, testing and commissioning		x
	05.030	Fitting out lighting fittings		x
	05.040	Extra low voltage electrical services: • information and communications technology system • staff paging/location • public address system • building automation • security and alarm • close circuit television • communal aerial broadcast distribution and the like • submissions, testing and commissioning		x
	05.050	Water supply and drainage above ground or inside basement: • cold water supply • hot water supply • flushing water supply • grey water supply • cleansing water supply • irrigation water supply • rainwater disposal • soil and waste disposal • planter drainage disposal • kitchen drainage disposal • related electrical and control systems • submissions, testing and commissioning		x

	05.060	Supply of sanitary fittings and fixtures (installation included in 'Water supply and above ground drainage' unless not separable from costs of 'Fittings and sundries')		x
	05.070	Disposal systems: • refuse • laboratory waste • industrial waste • incinerator • submissions, testing and commissioning		x
	05.080	Fire services: • fire hydrant and hose reel system • wet risers • sprinkler system • deluge system • gaseous extinguishing system • foam extinguishing system • audio/visual advisory system • automatic fire alarm and detection system • portable hand-operated appliances and sundries • related electrical and control systems • submissions, testing and commissioning		x
	05.090	Gas services: • coal gas • natural gas • liquid petroleum gas • medical gas/laboratory gas • industrial gas/compressed air/instrument air • vacuum • steam • submissions, testing and commissioning		x
	05.100	Movement systems: • lifts | elevators • platform lifts • escalators • travellators | moving walkways • conveyors • submissions, testing and commissioning		x
	05.110	Gondolas		x
	05.120	Turntables		x
	05.130	Generators		x
	05.140	Energy-saving features		x
	05.150	Water and wastewater treatment equipment		x
	05.160	Fountains, pools and filtration plant		x
	05.170	Powered building signage		x
	05.175	Audio/visual entertainment system		x
	05.180	Kitchen equipment		x
	05.190	Cold room equipment		x
	05.200	Laboratory equipment		x
	05.210	Medical equipment		x
	05.220	Hotel equipment		x
	05.230	Car park or entrances access control		x
	05.240	Domestic appliances		x
	05.250	Other specialist services		na
	05.260	Builder's profit and attendance on services		na
	06.	Surface and underground drainage		o
	06.010	Surface water drainage		o
	06.020	Storm water drainage		o
	06.030	Foul and wastewater drainage		o
	06.040	Drainage disconnections and connections		o

	06.050	CCTV inspection of existing or new drains		o
	06.060	Buried Process Pipe		o
	07.	External and ancillary works		o
	07.010	Permanent retaining structures		o
	07.020	Site enclosures and divisions		o
	07.030	Ancillary structures		o
	07.040	Roads and paving		o
	07.050	Landscaping (hard and soft)		o
	07.060	Fittings and equipment		o
	07.070	External services: • water supply • gas supply • power supply • communications supply • external lighting • utility disconnections and connections		o
	08.	Preliminaries | Constructors' site overheads | general requirements	(j)	na
	08.010	Construction management including site management staff and support labour		na
	08.020	Temporary access roads and storage areas, traffic management and diversion (at the Constructors' discretion)		o
	08.030	Temporary site fencing and securities		o
	08.040	Commonly shared construction plant		o
	08.050	Commonly shared scaffolding		o
	08.060	Other temporary facilities and services		o
	08.070	Technology and communications: telephone, broadband, hardware, software		o
	08.080	Constructor's submissions, reports and as-built documentation		na
	08.090	Quality monitoring, recording and inspections		na
	08.100	Safety, health and environmental management		na
	08.110	Insurances, bonds, guarantees and warranties		na
	08.120	Constructor's statutory fees and charges		na
	08.130	Testing and commissioning		na
	08.140	Extras for extreme climatic or working conditions (if priced separately according to local pricing practice)		na
	09.	Risk Allowances	(j), (k)	na
	09.010	Design development allowance	(l)	na
	09.020	Construction contingencies	(m)	na
	09.030	Price Level Adjustments: • until tendering • during construction	(n)	na
	09.040	Exchange rate fluctuation adjustments		na
	10.	Taxes and Levies	(j)	na
	10.010	Paid by the Constructor		na
	10.020	Paid by the Client in relation to the construction contract payments		na
	11.	Work and utilities off-site (including related risk allowances, taxes and levies)		na
	11.010	Connections to, diversion of and capacity enhancement of public utility mains or sources off-site up to mains connections on-site: • electricity • transformers • water • sewer • gas • telecommunications		na
	11.020	Public access roads and footpaths		na
	12.	Production and loose furniture, fittings and equipment (including related risk allowances, taxes and levies)		na

	12.010	Loose production, process and operating furniture, fittings and equipment not normally provided before completion of construction		na
	12.020	Fixed production, process and operating furniture, fittings and equipment installed before completion of construction • production (including process and operating) equipment (including furniture and fittings) • related instrument and control systems • related safety and environmental control systems • related storage and transfer systems • services and equipment as described in Group 05 but dedicated to serve production equipment • surface and underground drainage as described in Group 06 but dedicated to serve production equipment • testing and commissioning • licences and certifications to start production • risks allowances • taxes and levies		na
	13.	Construction-related consultants and supervision (including related risk allowances, taxes and levies)		na
	13.010	Consultants' fees and reimbursable: • architects (architectural, landscape, interior design, technical, etc.) • engineers (geotechnical, civil, structural, mechanical, electrical and plumbing, technical, etc.) • project managers • surveyors (quantity surveying, land surveying, building surveying, cost engineering, etc.) • specialist consultants (environmental, traffic, acoustic, facade, BIM, etc.) • value management studies		na
	13.020	Charges and levies payable to statutory bodies or their appointed agencies (in connection with planning, design, tender and contract approvals, supervision and acceptance inspections)		na
	13.030	Site supervision charges (including their accommodation and travels)		na
	13.040	Payments to testing authorities or laboratories		na

Appendix E – GWP Tools Comparison

The following section details the specific assessment rationale and results of the tools comparison.

E.1 Focus and User-Friendliness

In this section, we examine the focus of the tool (i.e., buildings or infrastructure), assess the tools accessibility (i.e., is it an online or offline tool, software-based or Excel-based), identify if the tool is free to access or if it must be purchased, the level of sophistication of the tool (i.e., ease of use and the range of applications it has) and whether training and support is provided by the tool developer.

Tool	Focus	Accessibility	Cost	Ease of use	Range of Applications	Training and support
One Click LCA	Buildings, Infrastructure	Online, Web-based tool	Licensed Software	Medium	Wide	Continuous training available
Athena (1E4B)	Buildings, Infrastructure (Pavement)	Offline, Proprietary Software	Free to use	Medium	Narrow	User guide online videos available
EC3	Buildings	Online, Web-based tool	Free to use	Medium	Narrow	User guide online videos available
IStructE tool	Buildings	Offline, Excel-based tool	Free to use	Basic	Narrow	User guide online videos available
Cerclos (e-tool)	Buildings (residential and non-residential tools), Infrastructure	Online, Web-based tool	Licensed Software	Medium	Wide	Continuous support (package dependent)
Carbon Designer for Ireland	Buildings	Online, Web-based tool	Free to use	Basic	Narrow	Continuous training available
TII Carbon Assessment Tool	Infrastructure (Roads, greenways, light rail)	Online, Web-based tool	Free to use (on request)	Medium	Narrow	User guide online videos available
National Highways Carbon Tool	Infrastructure (Roads)	Offline, Excel-based tool	Free to use	Difficult	Narrow	User guide

E.2 Robustness

In this section we compare different tools according to the capabilities they have, including what LCA stages and modules they allow quantification across, what databases the various sources they draw their environmental information from and how often these are updated, how each of the tools allows and enables generic data input, and across how each of the tools enables transparency within their reporting.

Tool	EN 15978 Lifecycle Modules	Data Quality and Databases	Generic Data	Transparency & verification
One Click LCA	A1-A5, B1-B8, C1-C4, D	EPD databases, generic databases, manufacturer-specific data, Country specific data (INIES, etc)	Yes (OneClick)	Allows export of all EPDs, inputs and assumptions
Athena (1E4B)	A1-A5, B4, C1-C4	Proprietary LCA and LCI Data	Yes (Generated Proxy Data)	Option to generate Project Report containing relevant inputs, results and credential information including underlying data and methods.
EC3	A1-A4, C1-C4 (Operational can be included if available).	Third-Party EPD Databases (Climate Earth, Smart EPD, NRMCA, NAPA, etc)	Yes (Industry-wide averages based on reported EPDS - uncertainty weighted)	Verify and Audit function provided to confirm EPD accuracy and amend as required.
IStructE tool	A1-A4, C2-C4, A-C, excluding B (whole life carbon)	Based on 'How to Calculate Embodied Carbon' The Institution of Structural Engineers	UK Average data provided where specific products are unknown or undefined	As the tool is Excel based, it is possible to see EPD values and inputs used, however verification of EPD values is not possible.
Cerclos (e-tool)	A1-A5, B1-B8, C1-C4, D	Multiple regionally specific LCI databases, EPD library and function to add EPDs	Yes	Users can create new EPDs, add EPD to designs, compare EPD with the materials in the inventory, make comparison between different EPDs and also understand how specific products correlate with the whole project performance.
Carbon Designer for Ireland	A1-A5, B1-B5, C1-C4	EPD databases, generic databases, manufacturer-specific data, Country specific data (INIES, etc)	Yes (OneClick)	Allows export of all EPDs, inputs and assumptions
TII Carbon Assessment Tool	A-C, including B	Multiple databases including ICE, CESMM4, Highways England Carbon Tool, SEAI Conversion Factors, UK Government GHG Reporting Conversion Factors	Generic Data options are available where specific details are not available.	Manually develop reference list
National Highways Carbon Tool	A1, A4 (from purchase), A5. (Construction)	ICE & BEIS (UK)	Some general data points available, however the tool does not rely on specific EPDs	The tool has been designed for internal use and does not produce transparency or verification as the outputs are designed to be submitted to Highways England.

E.3 Integration and Outputs

Tools are assessed on their integration and compliance capabilities including assessing how they support the import and export of LCA and design information (e.g., BIM integration, including modelling software such as REVIT), whether they are aligned with the requirements set forward under EU Level(s) and the ICMS 3 reporting standard, and further compared across the nature of the outputs of the LCA information.

Tool	LEVEL(s) aligned?	BIM Integration	ICMS-3 aligned?	Data outputs
One Click LCA	Yes	Yes (add-on integration w/ 20+ BIM softwares)	Not stated explicitly but could be configured manually.	Full coverage of Indicators set in EN 15978:2011. Outputs held by OneClick while report including assumptions also generated.
Athena (1E4B)	No	Partially (although a Bill of Materials from BIM can be used for LCA calculations)	Not stated explicitly but could be configured manually.	Outputs not published or held by Athena - Public disclosure of a comparison requires peer review (ISO14040/44)
EC3	No	Yes (Possible to import quantities from BIM Model)	Not stated explicitly but could be configured manually.	Data can be shared publicly (anonymised and values altered slightly). Several reports can be generated also, including graphs and comparisons.
IStructE tool	No	No	Not stated explicitly but could be configured manually.	Output in form of graphs generated and can be compared to iterations and other projects (internally, with same tool origin).
Cerclos (e-tool)	Yes	Yes	Not stated explicitly but could be configured manually.	Automatically generated comprehensive reporting output, including graphs, in multiple document formats. Cloud-based private intra-organisation sharing available.
Carbon Designer for Ireland	Yes	Yes	Not stated explicitly but could be configured manually.	Automatically generated reports (populated template) including graphs.
TII Carbon Assessment Tool	Yes	No	Not stated explicitly but could be configured manually.	Not currently shared - Potential for TII to develop outputs.
National Highways Carbon Tool	No	No	Not stated explicitly but could be configured manually.	Summary graphs are generated; however, the tool is designed to be issued directly to Highways England. Highways England maintain records for further analysis and publication as required.

Appendix F – Example Reporting Template

Below is an illustrative example of a potential reporting template which could be utilised for GWP assessments, linking in with ICMS 3 component classification.

Assessment description	
Item	*Example*
Building typology	*Office*
Floor area	*XX m^2*
Tool used	*IGBC's WLC*
Database used	*ICE Database*
Verifier	*XXX*
Completion status	*Shell and Core + Cat A*
Additional results	
Item	*Example*
Data quality score	*X/100*
Building weight	*Kg/m^2*
Generic data use	*X %*
Refrigerant leakage	*x $kgCO_2e/m^2$*
Biogenic carbon stored during lifetime	*x $kgCO_2e/m^2$*
Carbonation during lifetime	*X $kgCO_2e/m^2$*
Supplementary material (optional) *Examples*	

- *List of exclusions (e.g. screws bolts etc)*
- *Design life of building is 60 years*
- *Module D scenario likelihood…*
- *Measures taken to ensure design…*
- *External works embodied carbon ($kgCO_2/m^2$)*
- *….*

Table of declaration version 0.1 (XX.XX.2024)				
	Stage A A1-A5	Stage B B1, B4, B6	Stage C C3-C4	Total
Site ICMS 2.01, 2.06, 2.07				
Structure ICMS 2.02, 2.03				
Skin ICMS 2.04				
Interior layout and finishes ICMS 2.04				
Services ICSMS 2.05				
Total				

Appendix G – EN 15978 and prEN 15978 proposed sub-headings

EN15978:2011	prEN15978:2024
	A0: pre-construction
A1: Raw material supply	A1: Extraction and upstream production
A2: Transport	A2: Transport to factory
A3: Manufacturing	A3: Manufacturing
A4: Transport	A4: Transport to site
A5: Construction installation process	A5: Construction installation process A5.1: Pre-construction demolition A5.2: Construction activities A5.3: Waste and waste management A5.4: Transport of construction workers
B1: Use	B1: Use B1.1: Emissions from materials and carbonation B1.2: Fugitive emissions of refrigerants
B2: Maintenance	B2: Maintenance
B3: Repair	B3: Repair
B4: Replacement	B4: Replacement of building components
B5: Refurbishment	B5: Refurbishment
B6: Operational energy use	B6: Operational energy use B6.1: Regulated building-integrated systems (services). B6.2: Non-regulated building-integrated systems (services) B6.3: Other energy use related to building user activities
B7: Operational water use	B7: Operational water use

	B7.1: Essential building-integrated systems (toilets, showers, bathrooms, heating, cooling, ventilation, humidification, and irrigation) B7.2: Other building-integrated systems (swimming pools, saunas etc.). B7.3: Non-building-integrated systems (e.g. dishwashers, washing machines etc.).
	B8: Building integrated users' activities, not covered in B1-B7 B8.1: Transport of persons to and from the building. B8.2: Charging of electric vehicles within the building site B8.3: Others, such as use of "consumables" like paper for offices, or furniture and equipment not fixed to the building.
C1: Deconstruction	C1: Deconstruction / Demolition
C2: Transport	C2: Transport to waste processing or disposal
C3: Waste processing for reuse, recycling and/or recovery	C3: Waste processing for reuse, recycling and/or recovery
C4: Disposal	C4: Disposal of waste
D: Benefits and loads beyond the system boundary	D: Benefits and loads beyond the system boundary D1.1: Reuse D1.2: Recycling D1.3: Energy recovery D2: Potential benefits and loads from exported utilities (e.g. electrical energy, thermal energy, potable water).

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