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BUILDING ENERGY CONSULTING

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GLOVER COURT REDEVELOPMENT

Sustainability approach – summary report

Abstract

This document outlines the assessment of the sustainability of the design for the Glover Court redevelopment which will be carried out in accordance with EN 15978. The approach will focus on consideration of material selection in the context of their EPD values as well as other wider material selection factors. In addition, the operation carbon of the building will be calculated using output values from DEAP analyses.

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INTRODUCTION

The Glover's Court development will consist of 53 apartment units which will achieve an A3 BER rating at a minimum, with an A2 rating targeted. The units will be heated via air-source heat pumps with ventilation provided via heat recovery ventilation. The decision was made to retrofit the existing block and provide new bookending construction to extend the habitable space and also provide improved connection between the two blocks.

Figure 1: Proposed landscaping plan – whole site

The design will undergo a whole lifecycle carbon assessment in accordance with EN 15978 in accordance with the RICS methodology. The assessment period is 50 years. The lifecycle carbon assessment includes two distinct aspects of any project:

1. The embodied carbon content: this is a measure of the global warming potential and equivalent carbon emissions based on materials which are demolished and removed from site, and those which are specified and newly-installed. This is discussed in more detail later. The unit of measurement is $kgCO_2eq$. Under the revised Energy Performance of Buildings Directive (EPBD), accounting for embodied carbon and achievement of upper limits on embodied carbon for new and retrofit projects will shortly become a requirement. Embodied carbon is very much under the control of the design team, however there are a number of other factors which influence which materials can be applied to any project, including but not limited to;

    a. Compliance with Technical Guidance Document D – Materials & Workmanship. It is a requirement that all materials are compliant with the Construction Products

Regulation, have a CE mark and European Technical Approval (ETA), or NSAI Agrement certification, at a minimum. Materials must be fit for the purpose for which they are intended to be used and tested against any relevant standards to ensure suitability.

b. Lead times – availability of materials has been somewhat of an uncertainty as global issues challenge supply chains. It is imperative that construction programmes are not affected insofar as possible, with consideration to material availability given.

c. Compliance with all other aspects of the Technical Guidance Documents and second schedule of the building regulations. In any retrofit scheme a number of elements and challenges need to be considered, including Part B and means of escape, which is affected by available corridor widths and can affect thickness of external wall insulation systems for example, as well as building height and material combustibility. In addition, condition and design of existing staircases and access, suitability for disability access & Part M,

CLIMATE ACTION PLAN

Ireland's Climate Action Plan aims to significantly reduce the country's greenhouse gas emissions by 51% by 2030 and achieve net-zero emissions by 2050. A key component of this strategy is retrofitting the existing building stock to improve energy efficiency. Retrofitting involves upgrading insulation, heating systems, and other structural elements to reduce energy consumption and carbon emissions. This is crucial in Ireland, where a large portion of buildings are older and energy inefficient. By enhancing the energy performance of homes, offices, and public buildings, retrofitting not only helps reduce emissions but also lowers energy bills, improves comfort, and reduces reliance on fossil fuels. It is a critical step in creating a sustainable, low-carbon future while supporting job creation in the green economy.

LIFECYCLE ASSESSMENT – EN 15978

Life Cycle Assessment (LCA) is a systematic method for evaluating the environmental impacts of buildings across their entire lifecycle. For retrofit projects, this assessment is particularly critical as it provides insights into the sustainability and energy performance of existing buildings, and allows examination of the importance of retaining existing elements and the selection of materials to be newly added to the construction. This document outlines the application of LCA in accordance with EN 15978: Sustainability of construction works – Assessment of environmental performance of buildings for the Glover's Court, Dublin, project ensuring compliance with Irish Building Regulations.

EN 15978 provides a framework for assessing the environmental performance of buildings by considering their entire life cycle, from raw material extraction to demolition and disposal. The

standard evaluates key environmental impacts, such as energy consumption, resource use, emissions, and waste production.

The standard is structured around four major stages:

Key Elements for the LCA According to EN 15978:

- **Product Stage (A1-A3)**: This stage accounts for the raw material supply, transport, and manufacturing of materials used in the retrofit. It is essential to assess whether more sustainable materials can be utilized during the retrofit of Glovers Court flats.
- **Construction Process Stage (A4-A5)**: Includes the transport of materials to the site and the energy used during the construction process. Emphasis should be placed on minimizing transportation emissions and energy consumption during the retrofit.
- **Use Stage (B1-B7)**: For a retrofit, the focus is on how the new materials and installations will improve energy efficiency, reduce water use, and enhance the overall environmental performance of the building. In the case of Glovers Court, improving the insulation and heating system would be critical to reducing the operational energy demands.
- **End-of-Life Stage (C1-C4)**: Involves the deconstruction or demolition of materials, including recycling and disposal. The goal should be to ensure that materials used in the retrofit can be easily recycled or reused, minimizing landfill waste.
- Additionally, D stage considers potential benefits and loads beyond the building life cycle, such as recovery, reuse and recycling.

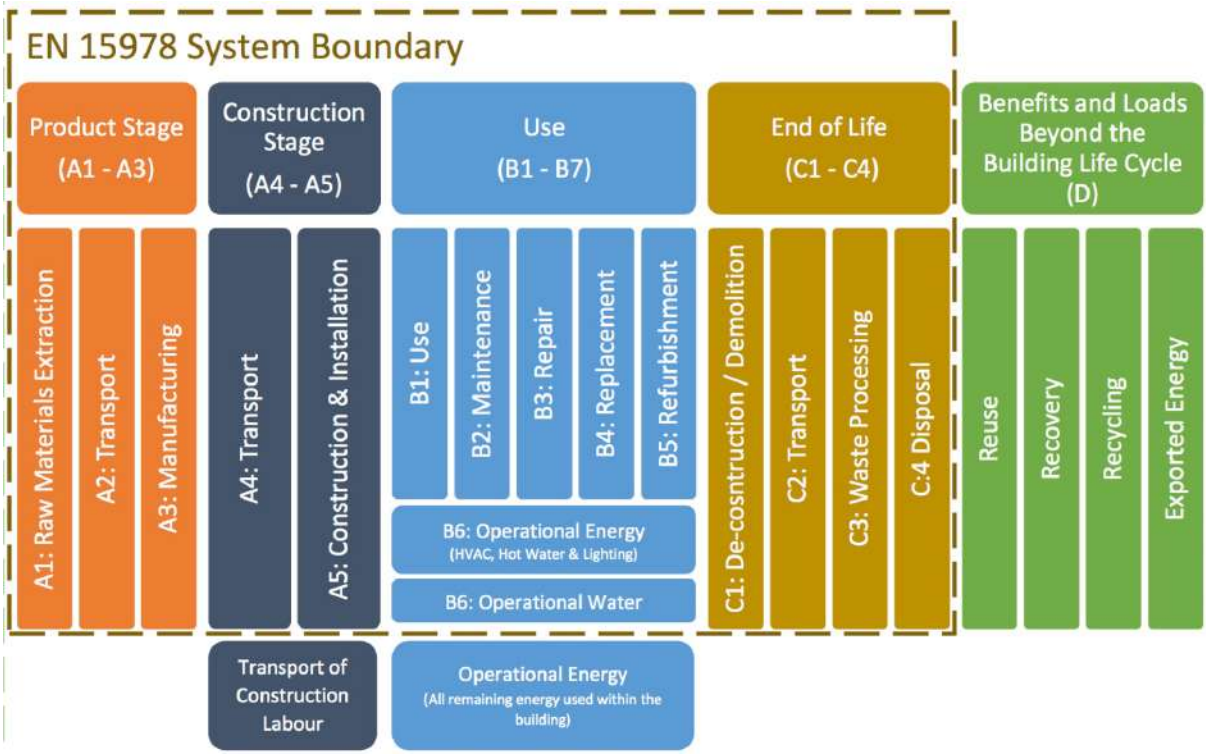

Figure 2: EN15978 system boundaries

Goal and Scope Definition

The goal of the LCA for Glover's Court is to evaluate the environmental impacts associated with the retrofit of the building in compliance with Irish regulations, focusing on both operational and embodied energy performance, as well as the design and specification of materials and systems for the small extension to the building and changes to access decks and stairs.

The **scope** covers the four life cycle stages as defined by EN 15978:

- **System boundaries:** The retrofit project, from extraction of raw materials to end-of-life considerations, as outlined in the table in the previous section.
- **Functional unit:** The performance of the building after retrofit, considering energy efficiency, comfort, and durability.
- **Impact categories:** Global warming potential, ozone depletion, acidification, eutrophication, and resource depletion.

Inventory Analysis (LCI)

The **inventory analysis** collects data on the inputs and outputs of the retrofit project, including:

- **Material inputs:** Insulation, windows, HVAC systems, renewable energy systems.
- **Energy inputs:** Operational energy use post-retrofit. Note this project will not include any use of fossil fuels post-retrofit.
- **Water use:** Assessments of water consumption, particularly where water-saving technologies are installed.
- **Waste generation:** Quantities of demolition waste, construction waste, and material recycling potential.

This phase requires data on:

- **Material manufacturing:** Energy and emissions data for materials such as insulation, windows, and mechanical systems. (included in EPD)
- **Transport:** Emissions from transporting materials to the construction site (included in EPD and localised to the site)
- **Installation processes:** Emissions associated with equipment and labor used during retrofit (included in EPD)
- **Operational phase:** Energy consumption during the use phase post-retrofit, including heating, cooling, and electricity. This data is collected from DEAP assessments as carried out by the BER assessor.

Interpretation

This phase of the LCA involves interpreting the results to guide decision-making for the retrofit project:

- **Identifying key environmental hotspots:** For example, if a retrofit introduces materials with high embodied energy or contributes significantly to waste generation.
- **Comparing scenarios:** By evaluating alternative retrofit solutions (e.g., different insulation materials or heating systems), the most sustainable choices can be identified.

- **Recommendations:** Providing recommendations for improving the environmental performance of the building, such as optimizing material selection, maximizing reuse, or enhancing energy efficiency.

There are a wide range of results which are output from process. Of most interest however to most users/building owners/clients is the global warming CO2 emissions for each life-cycle stage, as shown in the below example.

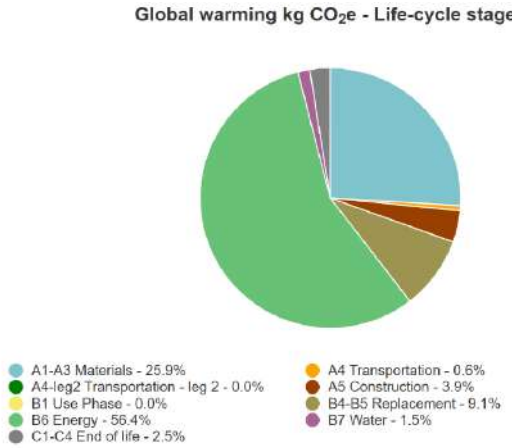

Figure 3: carbon emissions per lifecycle stage

COMPLIANCE WITH IRISH BUILDING REGULATIONS

Irish Building Regulations provide a robust framework for energy efficiency and environmental performance, particularly in Technical Guidance Documents Part L (Conservation of Fuel and Energy) and Part F (Ventilation). An LCA under EN 15978 can ensure compliance in the following areas:

- **Energy Performance Certificate (EPC):** The operational energy calculations from the LCA align with Ireland's requirements for Energy Performance Certificates, providing transparent data on the building's efficiency after retrofit.
- **Embodied Carbon Targets:** Although not yet as regulated as operational energy, embodied carbon considerations will become more prominent in Irish regulations in accordance with the requirements of the updated Energy Performance of Buildings Directive (EPBD). Using LCA allows for the proactive reduction of embodied carbon through material selection and lifecycle planning.

DATA COLLECTION AND TOOLS

To conduct an LCA for a retrofit project in Ireland, reliable data sources and tools are critical:

- **Data Sources:** The inventory data should be sourced from reputable Environmental Product Declarations (EPDs), material manufacturers, and energy suppliers.

- **Software Tools:** The assessment will be carried out using OneClick LCA which is validated in accordance with EN 15978.

MATERIAL SELECTION IN REDUCING EMBODIED CARBON

Material selection plays a crucial role in minimizing embodied carbon, which refers to the greenhouse gas (GHG) emissions associated with the production, transportation, installation, maintenance, and disposal of building materials. For retrofit projects, such as the refurbishment of Glovers Court flats in Dublin, selecting low-carbon materials is essential for reducing the overall environmental impact, particularly during the product and construction stages defined by **EN 15978**.

Key Aspects of Material Selection in Embodied Carbon Reduction:

1. **Manufacturing Emissions**: The manufacturing process of materials like concrete, steel, and glass is energy-intensive and contributes significantly to embodied carbon. Alternatives like timber, recycled steel, and lower-carbon concrete mixes can dramatically lower emissions during the **product stage** (A1-A3 in EN 15978).

2. **Transport Emissions**: Locally sourced materials have lower transportation emissions compared to those imported from distant locations. Transport emissions contribute to the **construction process stage** (A4), and selecting nearby materials can reduce carbon footprints.

3. **Durability and Lifespan**: Choosing durable materials that require less frequent replacement contributes to lower **lifecycle impacts** by reducing the need for future embodied carbon costs associated with repairs and replacements (B3-B5). For example, selecting high-quality insulation or weather-resistant cladding materials in the Glovers Court retrofit can reduce long-term carbon emissions.

4. **Recyclability**: Materials that can be recycled or reused at the end of their life cycle, such as metals or certain types of plastics, contribute to minimizing the environmental burden during the **end-of-life stage** (C1-C4) and provide potential benefits in the **D stage** by feeding materials back into the supply chain.

Figure 4: Material lifecycle

AVAILABILITY OF ENVIRONMENTAL PRODUCT DECLARATIONS (EPDS)

Environmental Product Declarations (EPDs) are standardized documents that provide transparent and verified information on the environmental impacts of materials across their life cycle. They are essential tools for architects, engineers, and sustainability professionals conducting LCA in retrofit projects.

Typical Outputs from an Environmental Product Declaration (EPD)

1. Global Warming Potential (GWP): This metric quantifies the total greenhouse gas emissions, often referred to as the product's carbon footprint, expressed in kilograms of CO_2 equivalents. It includes emissions from raw material extraction, manufacturing, transportation, use, and end-of-life disposal.

2. Ozone Depletion Potential (ODP): The ODP measures the potential of substances used in the product to deplete the ozone layer. It is expressed in kilograms of CFC-11 equivalent. This is critical for identifying materials that might contribute to long-term atmospheric damage.

3. Acidification Potential (AP): Acidification potential is the product's contribution to acid rain formation, measured in kilograms of sulfur dioxide (SO_2) equivalent. This metric helps assess the environmental impact of emissions that contribute to soil and water acidification.

4. Eutrophication Potential (EP): Eutrophication refers to nutrient enrichment in water bodies, which can lead to algal blooms and oxygen depletion, harming aquatic ecosystems. The EPD reports this in kilograms of phosphate (PO_4^{3-}) equivalent, enabling the evaluation of a product's potential to contribute to water pollution.

5. Photochemical Ozone Creation Potential (POCP): POCP, also known as “smog formation potential,” is a measure of a product's contribution to ground-level ozone (smog) formation, expressed in kilograms of ethene equivalent. This helps assess the role of volatile organic compounds (VOCs) and other emissions in degrading air quality.

6. Abiotic Depletion (Fossil Fuels and Elements): This measure accounts for the depletion of non-renewable resources like fossil fuels and minerals, expressed in megajoules (MJ) or kilograms of antimony (Sb) equivalent. This indicates the extent to which a product depends on finite resources.

7. Water Use: Water use quantifies the amount of freshwater consumed during the product's lifecycle, expressed in cubic meters. This helps in assessing a material's contribution to water scarcity, especially important in regions where water resources are limited.

8. Waste Generation: This section provides information on the quantity of waste generated, both hazardous and non-hazardous, during the lifecycle stages of the product. Waste is typically categorized into materials sent to landfill, incineration, or for recycling.

9. Energy Use: EPDs break down energy consumption into different sources, such as non-renewable and renewable energy use, typically expressed in megajoules (MJ). This provides insight into the total energy demand of the product throughout its lifecycle, influencing decisions on energy efficiency.

10. Impact on Resource Depletion (Material Inputs and Recycled Content): The percentage of recycled materials used in the product's composition and the amount of renewable versus non-renewable material inputs are also key outputs. This data helps assess the product's alignment with circular economy principles.

11. End-of-Life Scenarios: The EPD often includes information on what happens to the product at the end of its life—whether it can be recycled, reused, or sent to landfill. This is particularly useful in evaluating the long-term sustainability of materials in retrofit projects.

The figure below shows the environmental impacts across all EN 15978 stages for a Gyproc gypsum 12.5mm plasterboard

Environmental indicators	PRODUCT STAGE	CONSTRUCTION STAGE		USE STAGE							END OF LIFE STAGE				REUSE, RECOVERY RECYCLING
	A1 / A2 / A3	A4 Transport	A5 Installation	B1 Use	B2 Maintenance	B3 Repair	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / demolition	C2 Transport	C3 Waste processing	C4 Disposal	D Reuse, recovery, recycling
Climate Change (total) [kg CO2 eq.]	1,51E+00	1,61E-01	4,85E-01	0	0	0	0	0	0	0	3,73E-02	2,82E-02	2,64E-01	3,88E-01	-4,08E-02
Climate Change (fossil) [kg CO2 eq.]	2,13E+00	1,58E-01	2,22E-01	0	0	0	0	0	0	0	3,72E-02	2,77E-02	2,40E-02	3,57E-02	-4,53E-02
Climate Change (biogenic) [kg CO2 eq.]	-6,27E-01	2,03E-03	2,63E-01	0	0	0	0	0	0	0	5,05E-05	3,56E-04	2,40E-01	3,52E-01	3,78E-03
Climate Change (land use change) [kg CO2 eq.]	3,90E-03	8,89E-04	2,63E-04	0	0	0	0	0	0	0	3,94E-06	1,56E-04	3,83E-05	5,04E-05	7,45E-04
Ozone depletion [kg CFC-11 eq.]	3,49E-09	9,55E-15	1,03E-09	0	0	0	0	0	0	0	7,96E-09	1,67E-15	4,61E-09	1,11E-08	1,01E-08
Acidification terrestrial and freshwater [Mole of H+ eq.]	4,54E-03	1,92E-04	4,39E-04	0	0	0	0	0	0	0	3,87E-04	3,44E-05	1,54E-04	3,17E-04	4,64E-04
Eutrophication freshwater [kg P eq.]	3,95E-05	4,76E-07	7,61E-06	0	0	0	0	0	0	0	1,15E-06	8,34E-08	2,70E-06	2,52E-06	1,10E-04
Eutrophication marine [kg N eq.]	1,92E-03	6,84E-05	1,86E-04	0	0	0	0	0	0	0	1,72E-04	1,24E-05	5,68E-05	1,05E-04	1,91E-04
Eutrophication terrestrial [Mole of N eq.]	1,98E-02	7,99E-04	1,67E-03	0	0	0	0	0	0	0	1,88E-03	1,45E-04	5,86E-04	1,15E-03	1,12E-03
Photochemical ozone formation - human health [kg NMVOC eq.]	4,60E-03	1,69E-04	5,01E-04	0	0	0	0	0	0	0	5,16E-04	3,04E-05	1,76E-04	3,32E-04	3,80E-04
Resource use, mineral and metals [kg Sb eq.][1]	9,88E-07	1,33E-08	3,88E-07	0	0	0	0	0	0	0	1,92E-08	2,34E-09	1,52E-07	6,32E-08	6,68E-07
Resource use, energy carriers [MJ][1]	3,34E+01	2,13E+00	2,45E+00	0	0	0	0	0	0	0	5,09E-01	3,73E-01	3,78E-01	8,77E-01	-1,46E-01
Water deprivation potential [m³ world equiv.][1]	6,89E-01	1,43E-03	7,74E-02	0	0	0	0	0	0	0	1,25E-03	2,51E-04	8,53E-03	3,61E-02	8,25E-02

Figure 5: Environmental indicators for Gyproc gypsum 12.5mm plasterboard

CERTIFICATION STANDARDS FOR EPDS

1. ISO 14025: ISO 14025 is an international standard that defines the principles and procedures for developing Type III environmental declarations, of which EPDs are an example. It establishes rules for the transparent and comparable reporting of environmental data, ensuring credibility and reliability in the marketplace.

2. EN 15804: EN 15804 is the European standard that provides core rules for creating EPDs for construction products. It ensures consistency in the environmental impact categories, calculation methods, and presentation of data, enabling a fair comparison between similar products. It is particularly relevant for products used in retrofitting buildings, where performance and sustainability must be balanced.

Both standards ensure that EPDs are reliable, verified by third parties, and adhere to internationally recognized protocols. By following these standards, the environmental impact of building materials can be transparently compared, allowing architects, engineers, and contractors to make informed decisions about material selection during retrofit projects.

The figure below shows a comparative assessment of similar material types, which can inform the design discussion on material selection.

Sustainable alternatives in Ireland and neighbouring countries

No.	Full name		Performance ranking:	GWP CO_2 / KG
Current	Precast concrete block, 700-2100 kg/m3 (BPCF)	?	33 / 91 See full ranking:	0.091
1.	Concrete masonry unit, hollow, for concrete filling, including the filling concrete, béton classes B40/B60, 200x200x200-250m	?	1 / 91 See full ranking:	0.017
2.	Concrete masonry units (CMU) from pumice, ready wall, 500 x 200 x 200 ou 500 x 200 x 250 (L x ép. x h en mm), 180kg/bloc, R =	?	2 / 91 See full ranking:	0.018
3.	Concrete masonry unit, hollow, for concrete filling, excluding the filling concrete, béton classes B40/B60, 200x200x200-250mm	?	3 / 91 See full ranking:	0.044
4.	Concrete block, masonry, B40, 200x500x200/250 mm (CERIB)	?	5 / 91 See full ranking:	0.05

Figure 6: Comparative assessment of materials

- **EPD Databases**: Numerous EPD databases, such as the International EPD System and EPD Ireland, provide easy access to EPDs for a wide range of building materials, making it easier to select low-carbon options for retrofits.
- **Transparency**: EPDs ensure that data on materials' carbon footprints are transparent, making them indispensable for accurately assessing the embodied carbon of products used in retrofits like Glovers Court. By incorporating materials with low EPD values, the design team can significantly reduce the building's overall environmental impact.

For the retrofit of Glovers Court flats, accessing EPDs for insulation materials, concrete alternatives, and window products will be key to minimizing embodied carbon and achieving compliance with both EN 15978 and Irish Building Regulations. Material selection driven by EPDs not only ensures lower carbon emissions but also supports the long-term sustainability of the building.

CALCULATION OF OPERATIONAL CARBON FROM DEAP ANALYSIS

In the context of retrofit projects like Glovers Court flats, reducing operational carbon—the carbon emissions produced by energy use during a building's operational phase—is as critical as managing embodied carbon. To calculate operational carbon in compliance with Irish building regulations, the Dwelling Energy Assessment Procedure (DEAP) is used. DEAP is Ireland's official methodology for calculating the energy performance and CO_2 emissions of dwellings, providing the necessary

framework for evaluating operational energy performance and compliance with the Building Energy Rating (BER) system.

The Dwelling Energy Assessment Procedure (DEAP) is a standardized calculation tool used to assess a building's energy efficiency. It helps determine a building's energy consumption, heat loss, and carbon emissions based on factors such as insulation levels, heating systems, and ventilation. The outputs from DEAP form the basis for a building's Building Energy Rating (BER), which ranges from A1 (most efficient) to G (least efficient).

For retrofits, DEAP assesses the effectiveness of energy efficiency measures such as:

- Upgraded insulation
- High-performance windows
- Energy-efficient heating systems
- Renewable energy technologies (e.g., solar panels or heat pumps)

By using DEAP, it is possible to calculate how much operational carbon is reduced due to energy efficiency improvements.

STEPS TO CALCULATE OPERATIONAL CARBON USING DEAP

1. **Input Building Data**:
    - Basic dwelling characteristics such as **floor area**, **orientation**, and **window-to-wall ratio** are entered into DEAP.
    - Information about the building's thermal performance before and after retrofit (e.g., U-values of walls, windows, and roofs) is also inputted.
2. **Evaluate Energy Efficiency Measures**:
    - **Insulation Upgrades**: Adding insulation to walls, roofs, or floors reduces heat loss. DEAP calculates the energy savings based on improved thermal performance. Target U-values will be in line with section 2 of TGD L – Dwellings, and will be provided by the BER assessors.
    - **Window Replacement**: Installing double- or triple-glazed windows with low U-values further reduces heat loss and energy consumption. A maximum U-value of 1.6W/m^2K is allowable under TGD L section 2.
    - **Heating Systems**: Replacing outdated heating systems with more efficient ones such as air-source heat pumps lowers carbon emissions by reducing energy use. The efficiency of the heating system (such as Seasonal Performance Factor for heat pumps) is factored into the calculation.
3. **Calculate Energy Use**: DEAP estimates the building's energy consumption for space heating, hot water, and other electrical loads. This energy use is calculated in kWh/m².annum and is used to estimate operational energy demand.
4. **CO_2 Emissions Factor**:

- The operational energy demand is then multiplied by Ireland's specific **CO_2 emissions factors** for electricity, gas, or other fuels. These factors are regularly updated by the **Sustainable Energy Authority of Ireland (SEAI)** to reflect the evolving carbon intensity of the national grid.

- For example, renewable energy generation or the shift to cleaner electricity through grid decarbonisation will result in lower operational carbon emissions.

5. **BER and Operational Carbon Output**:

    - The final DEAP output provides a BER rating and the total annual operational carbon emissions in kilograms of CO_2 per year. The retrofit should aim to bring the BER rating to at least **A3** to comply with the project requirements.

The final results are presented in a variety of ways, depending on the interest of the target reader/user/client etc. The Level(s) system is used in Europe to provide comparison of the results of similar building types across the continent and provide the assessor/user group with a better understanding of how their building is performing in a wider context. Results are presented visually in a colour ranking system similar to that used in BER ratings. This can be confusing however, as many people's current understanding of building performance is that all new buildings should achieve an A rating. This is true from an energy perspective, however it may well not be the case for a carbon perspective. It is therefore to be expected that while a building may achieve an A-rated BER, it may well not achieve an A-rated carbon performance level.

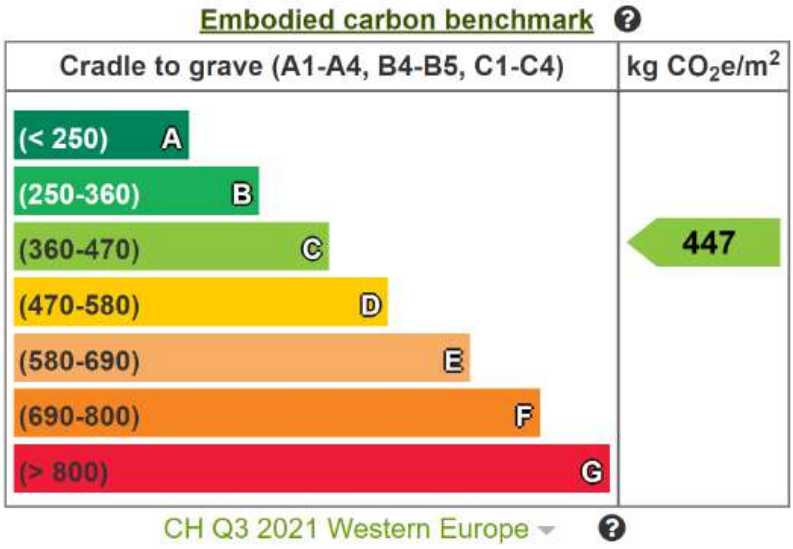

Figure 7: Sample carbon emissions results – cradle to grave

CONCLUSION

The integration of DEAP results for calculating operational carbon, coupled with the LCA framework from EN 15978 for embodied carbon, allows a comprehensive sustainability assessment of the project. Material selection guided by Environmental Product Declarations (EPDs), and an accurate calculation

of operational energy savings via DEAP, ensures that the retrofit of Glovers Court achieve optimal environmental performance while complying with Irish building regulations.

References

1. EN 15978: Sustainability of construction works – Assessment of environmental performance of buildings.
2. Irish Building Regulations – Technical Guidance Documents (TGDs), Parts L and F.
3. Climate Action Plan, Government of Ireland.
4. EPA Guidelines on Environmental Product Declarations (EPDs).
5. ISO 14040: Environmental Management – Life Cycle Assessment – Principles and Framework.