TOBIN

GALWAY HARBOUR EXTENSION – EIS

Carbon Life Cycle Assessment Report

Port of Galway
Calafort na Gaillimhe

BUILT ON KNOWLEDGE

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Table of Contents

List of Tables

List of Figures

1. APPOINTMENT AND SCOPE

1.1 PROJECT APPOINTMENT

TOBIN has been commissioned by the Galway Harbour Company (GHC) to provide professional services in respect to the Galway Harbour Extension. TOBIN are responsible for the design of the extension of the harbour, the preparation of an Environmental Impact Statement (EIS) and an Imperative Reasons of Overriding Public Interest (IROPI) Planning Application.

The Galway Harbour is located in County Galway, with the harbour office located in New Docks Road at 53°16'8.31"N; 9° 2'50.49"W (ITM coordinates: 530135 E; 724805 N). The harbour is located in the heart of Galway City and is approximately 300 m from the city centre (Eyre Square). The city has grown outwards from the harbour over the centuries. It is in a strategic location to support the economy of the northwest part of Ireland by acting as a distribution centre and providing leisure activities. The current harbour experiences a number of constraints that have made it no longer fit for purpose and less attractive to existing and potential customers. Development and extension of the harbour would allow for larger vessels and higher traffic, resulting in economic growth.

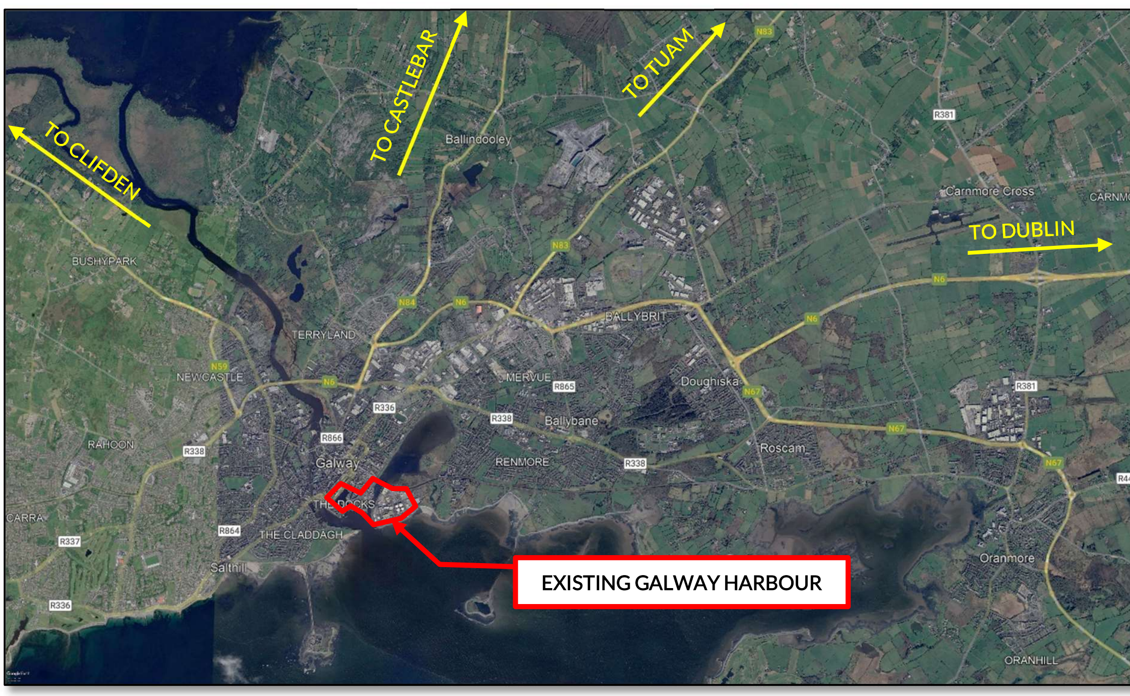

Figure 1-1: Existing Galway Harbour Location

1.2 CARBON ASSESSMENT REQUIREMENTS

The EIS was previously prepared in 2014 and an Oral Hearing took place in 2015. An Bord Pleanála issued a request that the EIS be updated due to the passage of time and that the circumstances may have changed. As part of the updates, it has been requested that the carbon footprint of the proposed harbour extension be determined to assess the sustainability of the project and to align with the sustainability goals of the country. In addition, there is increasing global pressures to implement sustainable solutions. It is therefore necessary to quantify and report on the carbon footprint of the proposed project.

This process shall follow the main procedural requirement of PAS2080 and includes the following steps:

- Quantification and baselining of whole life greenhouse gas (GHG) emissions for design
- Design challenge and analyse to identify opportunities for whole life carbon reduction.
- The setting of minimum and achievable whole life carbon values (sum of all lifecycle stages).
- The monitoring and accounting of GHG emissions at design stage

The carbon footprint estimation shall include the following:

- both embodied and operational carbon;
- all project life cycle stages as per PAS 2080

2. LIFE CYCLE ASSESSMENT

2.1 BACKGROUND

Life Cycle Assessment (LCA) measures the environmental impact of a product or service. Life Cycle Assessment includes a number of metrics, as follows:

1. Global warming potential (GWP) (tCO_2-eq)
2. Acidification potential (tSO_2-eq)
3. Eutrophication potential (tPO_4-eq, tN-eq)
4. Ozone depletion potential (tCFC-eq)

The most common use of LCA is in estimating the *global warming potential (GWP)* of a product, construction or service, in terms of its *carbon footprint*.

Life Cycle Assessment is increasingly being used by Clients and their engineering designers to minimize embodied and operational carbon in engineering designs, to allow organisations meet their carbon reduction targets under the Climate Action Plan.

2.2 PROJECT LIFE CYCLE STAGES

Project Life Cycle stages are set out in ISO 21930 and EN 15804, from Stage A: Product/Construction, through Stage B: Use, to Stage C: End of Life/Decommissioning. The various sub-stages within each of these categories is shown in the graphic below.

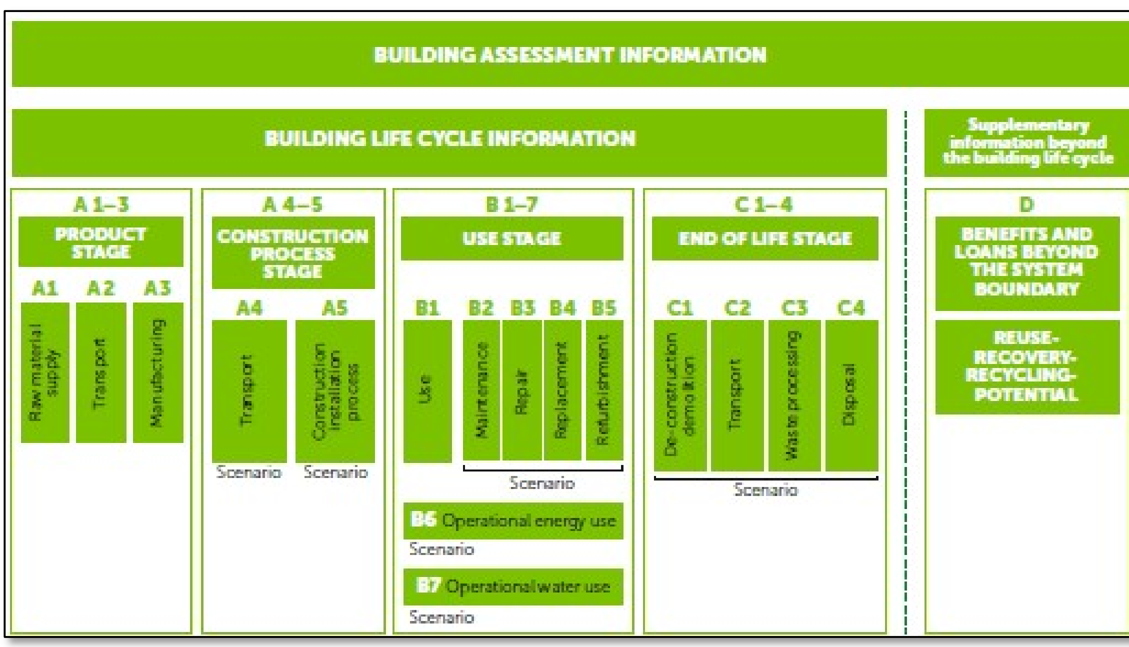

Figure 2-1: Project Life Cycle Stages

2.3 Embodied Carbon

Embodied carbon is the carbon footprint of the typically the Product stage (A1-A3) and Construction stage (A4-A5) of a project, stated in tonnes CO_2 equivalent (tCO_2e), or sometimes kg CO_2 equivalent ($kgCO_2e$). A contribution to embodied carbon is made from the End of Life Stage (C1-C4), where the decommissioning and disposal of assets, or parts thereof, takes place.

To estimate embodied carbon, the designer needs to estimate material quantities and types, and needs to know the carbon equivalent of each material. The carbon equivalent needs to be determined from reference databases or through detailed knowledge of the production of the product. The latter is not usually possible as it is complex to determine and, for this reason, reliance is on environmental product declarations (EPDs) of suppliers, who have undertaken studies to determine the carbon equivalent, or from estimations of carbon equivalent by specialists.

2.4 Operational Carbon

Operational carbon is the carbon footprint of the Use stage (B1-B7) of a project, stated in tonnes CO_2 equivalent (tCO_2e), or sometimes kg CO_2 equivalent ($kgCO_2e$).

To estimate the operational carbon, the designer needs to calculate the total energy consumption in kWh during a stated calculation period (X number of years) depending on the expected life of the built element. The operational carbon is derived from the energy consumption by application of a conversion factor to carbon equivalent. These conversion factors are usually available from the energy producers and is based on the nature, and blend, by which their energy is produced (e.g., fossil fuels, nuclear, wind, solar, hydroelectric, etc.).

For built elements that incur a high energy consumption, where a long calculation period such as 50 years is chosen, the operational carbon will dominate the whole life carbon assessment.

In addition to energy consumption, operational carbon can include all other materials and consumables that will routinely be used during operation of project. This can include items such as water consumption, fuel consumption for machinery, cleaning products or materials used for repairs. Depending on the type of project, these may be relatively minor compared to the energy consumption but could be significant on some projects.

Particular to the nature of this Project is that the operation of the asset involved the movement of vehicles and good. Therefore, it was deemed necessary to quantify the carbon impact of these movements.

2.5 ISO Standards for LCA

Life Cycle Assessment (LCA) is incorporated into the ISO14000 suite of standards, as ISO 14040 (Principles and Frameworks) and ISO 14044 (Requirements and Guidelines), as shown below.

Figure 2-2: Applicable ISO Standards

2.6 METHODOLOGY FOR LCA

The standardised methodology for Life Cycle Assessment is set out in *PAS2080 Carbon Management in Buildings and Infrastructure*.

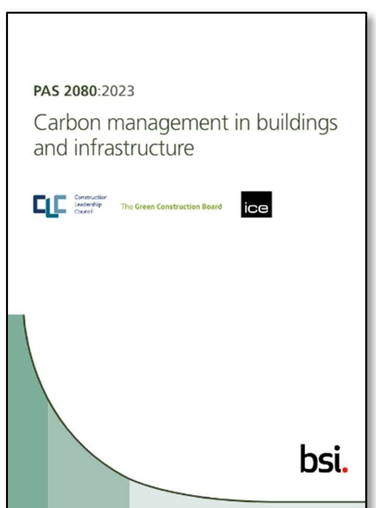

Figure 2-3: Standard for LCA Methodology

2.7 SOFTWARE

TOBIN have invested in industry-leading Carbon Life Cycle Assessment (LCA) software, namely OneClickLCA®, which enables the development and comparison of designs with the aim to minimize the carbon footprint of our designs through all phases of a project, from the product stage, through construction and operation, to end of life/decommissioning.

OneClickLCA® is used by many large engineering consultants and by 80% of construction companies in the UK.

Using this software, TOBIN can advise clients on the choice of materials and methods to minimize embodied carbon and can generate reports summarizing the carbon footprint of a range of design options. This will allow clients to meet their carbon reduction targets under the Climate Action Plan.

The software draws on the EcoInvent database for construction materials, maintained by BioNova, and includes over 150,000 construction materials. Data on carbon for these products is generally taken from the Environmental Product Declarations (EPD) for each product.

The software is fully integrated with BIM software, such as Revit, and is able to draw information directly from the software. The software can be used to select low carbon materials to minimize the embodied carbon in a design.

For concept designs, where the specific manufacturer of a product is not yet known, the software contains generic data typical to that type of product that can be used for the estimation of the carbon footprint.

3. CARBON ASSESSMENT

3.1 DESIGN INCLUDED IN THE ASSESSMENT

For this project (Galway Harbour Extension), the proposed design was assessed in terms of its carbon footprint and, where possible, it is advised how to optimise the designs and reduce the carbon footprint. The resulting assessments of the carbon footprint would allow the Client (Galway Harbour Company) to make an informed decision of the solution to be implemented.

This study limits its scope of assessment to the immediate area being developed the operation thereof. It does not extend to the wider impact on the Galway area or the larger industry of Ireland.

3.2 PROJECT ELEMENTS

Figure 3-1 provides an overview of the proposed Galway Harbour Extension. The proposed scope of works for the extension of the Galway Harbour is the development an area of 82.89 ha, which comprises of the following:

- Land development area (28.07 ha)
- Breakwaters and Revetment area (3.04 ha)
- Dredging of the approach route and turning circle area (46.48 ha)
- Working Area (Dredge / Marine Construction) (5.30 ha)
- Land to be reclaimed from sea (23.89 ha)
- Existing Galway Harbour Enterprise Park land to be redeveloped (4.18 ha)
- 660m of quay berth to –14.9m O.D. depth
- Port development serviced by a channel to -10.9m O.D.
- A 400m turning circle to -10.9m O.D.
- 660m of sheltered quays.
- Western Marina with 216 No. berths.
- Fishing Pier
- Nautical Centre Slipway
- Freight rail link to enable freight and cargo to be efficiently transported to and from the harbour to allow positive road traffic and environmental benefits.
- Commercial Port back up Yard Areas (6.45 ha)
- Commercial Quay Areas (1.72 ha)
- Harbour Company Warehouse Yards (1.53 ha)
- Future Oil and Bitumen Yard Areas (1.86 ha)
- ESB, Security Yard & Fire Water Storage Area (1.08 ha)
- Marina Boat Yard, Quay and Village Area (1.83 ha)
- Fishing Pier and Yard Area (0.55 ha)
- Roads and Access Area (3.97 ha)
- Rail Line and Embankment Area (2.20 ha)
- Nautical Yard & Slipway Area (0.82 ha)
- Passenger Terminal Yard Area (0.34 ha)
- Landscaped Area (5.44 ha)
- Wave Wall Area (0.28 ha)
- Dry bulk cargos:

  - Coal Yard
  - Waste Export
  - Steel Import Yard
  - Scrap Metal Yard
  - Ship Chandlers
  - Roll on/Roll off Yard
  - Container Yard
  - Project Cargos – Ocean Energy Development & Servicing
  - Biomass Storage & Handling
- Parklands and landscaping areas
- Renmore Promenade
- Marina Promenade

Figure 3-1: Proposed Galway Harbour Extension

3.3 ASSUMPTIONS

In order to provide an estimation of the carbon footprint of the proposed options, it was necessary to make some assumptions. These assumptions include:

- A high-level estimate of material quantities was required for input information. This was limited to the main construction materials only, including:
  - Earthworks and mass hauling

  - Concrete
  - Reinforcement for concrete
  - Combi-Walls
  - Imported aggregates (rock)
  - Roadworks and surfacing
  - Pipelines
- The distance for materials transportation was estimated using the average distance of the local suppliers that could be identified and are suitably capable of servicing a project of this scale.
- Operational carbon of the pump stations and treatment plants associated with the water and wastewater networks was not included in this study.
- The conversion of energy consumption to carbon emissions were based on Irish grid electricity mix of 2021, as this was the most current information available in OneClickLCA®.
- Operational carbon calculations do not take into account any renewable energy solutions that may be planned for the development, as this would be the worst case scenario.
- The calculation of the carbon footprint does not take into account any biogenic carbon storage of landscaping/biodiversity enhancements.
- As the point of origin or destination are not know for the transport of goods and personnel, the following assumptions have been used to generate the carbon emissions of the transport:
  - Shipping, rail and heavy goods vehicles (HGVs) is assumed as a 50 km radius.
  - Light goods vehicles (LGVs)/cars and buses is assumed as a 10 km radius.
- The life cycle assessment calculation period is 30 years.

3.4 Inputs

The embodied carbon for the options was calculated using the material quantities provided in Table 3-1.

Table 3-1: Material Quantities

Material	Unit	Quantity
Earthworks & Mass Hauling		
Imported Fill Material	m^3	850,000
Imported Capping Material	m^3	220,000
Stone Underlayer for Breakwater / Revetments	m^3	18,400
Reinforced Concrete		
Reinforced Concrete Structures	m^3	26,250
Reinforcement	tonnes	3,150
Rock Armour		

Material	Unit	Quantity
1 Tonne rock Armour	m^3	4,150
2 Tonne Rock Armour	m^3	40,400
10 Tonne Rock Armour	m^3	6,400
Steel Piles and Bearing (Combiwalls)		
Steel Piles and Bearing (Combiwalls)	tonnes	42,200
Roadworks & Surfaces		
Asphalt Surfaces	m^2	42,820
Pipelines		
HDPE Watermain	m	4,350
HDPE Foul	m	2,150

For the purposes of this project, the operational carbon was considered to comprise of energy consumption, water use, fuel use, transport of goods and transport of individuals. The estimated quantities of the operational inputs are provided in Table 3-2.

Table 3-2: Operational Inputs

Description	Unit	Quantity
Electricity (operations)		
Harbour Office	kWh/year	54,750
Cruise Terminal	kWh/year	54,750
Harbour Store	kWh/year	27,375
Marina Building	kWh/year	27,375
Control Building	kWh/year	9,125
Foul Sewer Pump Station	kWh/year	21,900
Foam/Water Pump	kWh/year	80
Saltwater Pump	kWh/year	80
Lighting	kWh/year	265,252
Water (operations)		
Harbour Office	m^3/year	2,839
Cruise Terminal	m^3/year	5,055

Description	Unit	Quantity
Harbour Store	m^3/year	548
Marina Building	m^3/year	251
Control Building	m^3/year	164
Fuel (mobile plant)	**m^3/year**	**91**
Good Traffic		
Shipping Traffic	tonnes/year	1,932,000
Rail	tonnes/year	193,200
HGV	tonnes/year	1,738,800
Personnel Traffic		
Buses	km/year	262,800
LGV	km/year	1,788,500

3.5 Carbon Assessment Results

Table 3-3 and Figure 3-2 below provide the overall results of the carbon assessment for the proposed design, broken down by life cycle stages. The results show that the largest contributor to the GWP of the project is Use stage (B1-B7), making up 80.8 % of the GWP from the combined goods transport, energy use and water use. The Product stage (A1-A4) is the second largest contributor, making up 18.1 % of the GWP, followed by the End of Life stage (C1-C4) only making up 1.0 % of the GWP. The Construction stage (A5) only making up of 0.5% of the overall GWP.

Table 3-3: Carbon Footprint Assessment Results from OneClickLCA® Software

Lifecycle Stage	GWP (tCO_2e)	% of Total
A1-A3 Product stage	60,931	16.0 %
A4 Transport - materials	513	0.1 %
A4b Transport - mass hauling	5,863	1.5 %
A5 Construction process	17,30	0.5 %
B1 Use	299,907	78.8 %
B6 Operational energy use	7,695	2.0 %
B7 Operational water use	72	0.0 %
C1-C4 End of life	2,073	0.5 %
C2 Waste transport	1,950	0.5 %
Total	**380,735**	**100.0 %**

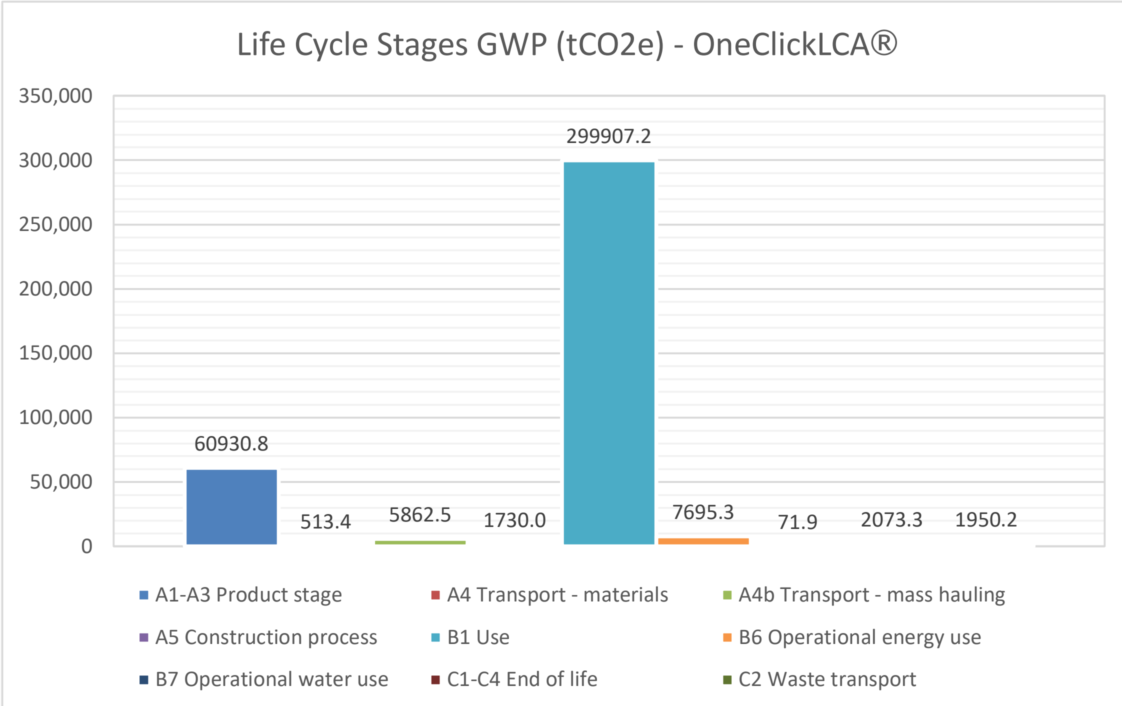

Figure 3-2: Carbon Footprint Assessment Results from OneClickLCA® Software

The above breakdown by life cycle stages does not allow for assessment of the distribution of the carbon emissions of the individual materials used on the project. In order to determine the carbon footprint of the materials used, as well as the embodied carbon, the results have been broken down by resource type. For the sake of clarity, the elements that make up the Use stage (B1-B7) have been omitted as these form the operational carbon. Table 3-4 and Figure 3-3 present the results broken down by resource type for the embodied carbon. This includes the Product (A1-A3) and Construction stages(A4-A5), as well as the End of Life stage (C1-C4). The results show that the largest contributor to the embodied carbon GWP is the steel products (59.8 %), followed by soils and aggregates (24.0 %) and concrete structures (10.3 %). The steel products, such as the Combi-Walls/King piles/sheet piles, make up a large component the project. Steel products tend to have high carbon emissions due to the energy intensive manufacturing process and this project would require a large mass, which also requires transport and handling with heavy equipment. The aggregates have lower carbon emissions from the manufacture, but this project would require large volumes to be transported and handled, which leads to the significant impact on this project.

Table 3-4: Breakdown of Embodied Carbon Results from OneClickLCA® Software

Category	GWP (tCO_2e)	% of Total
Steel products	43,709	59.8 %
Aggregates (Rock)	17,549	24.0 %
Cast in-situ concrete	7,506	10.3 %
Sand, soil and gravel	3,493	4.8 %
Other precast concrete products	501	0.7 %
Pipes (water, heating, sewage)	302	0.4 %
Asphalt	43,709	59.8 %
Total	**73,060**	**100.0 %**

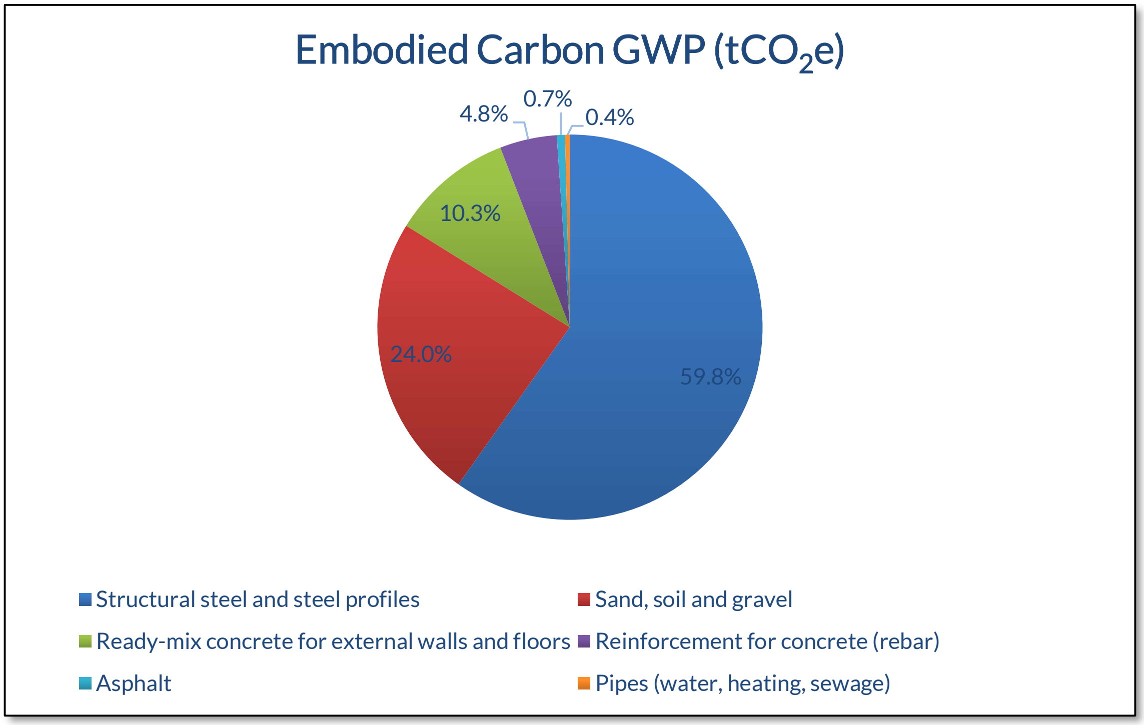

Figure 3-3: Breakdown of Embodied Carbon by Resource Type

Table 3-5 provides the results of the operational carbon for the proposed design.

Table 3-5: Operational Carbon Results from OneClickLCA®

Category	GWP (tCO_2e)	% of Total
Transport	299,907	97.5%
Energy Use	7,695	2.5%
Water Use	72	0.0%
Total	**307,674**	**100.0 %**

The above calculated operational carbon GWP shows the considerable impact of the goods transport compared to any other element of the project. Although this appears to be a significant carbon emission, it should be noted that the if the proposed extension of the Galway harbour did not take place and the current tonnage of goods received are projected over the calculation period (30 years), it is estimated that the resultant GWP would be 97,272 tCO_2e. If this is treated as the baseline, it would mean that the extension to the harbour would result in an increase to the GWP of the Galway harbour by 283,462 tCO_2e.

It initially appears that in term of sustainability, not extending the harbour would be prefer due to the lower carbon emissions. However, this study takes into account the sustainability in terms of carbon emissions only. It does not consider the economic impact/sustainability of the development, which could have a larger influence on the region or country when viewed holistically. Although the scope of the study has been limited to the harbour development and its operation, in the interest of perspective, it has been considered what the impact on the shipping traffic would be should the development not proceed. Assuming that the projected tonnage of goods is required by the region or country and that the balance (projected tonnage less the current tonnage Galway harbour receives) of the projected tonnage of goods would have to be diverted to alternative ports, it may have increased travelling distances for the shipping of these goods. Based on the assumption of 50 % each of the balance of the shipping tonnage being diverted from the Galway Bay region to Shannon Foynes and Dublin ports, it is estimated that the GWP generated from the additional distances would be 327,191 tCO_2e. Combining the GWP of the baseline and the diverted shipping, the total GWP if the Galway Harbour is not extended could potentially be 424,464 tCO_2e, which is approximately 11 % higher than that of the total GWP of the extension, indicating that the proposed extension to the Galway Harbour could be a more sustainable approach. It is reiterated that is based on high level assumptions and would be highly dependent on actual shipping routes and tonnages of goods being transported.

The Galway Harbour extension is a large-scale project, and it would be expected that there would be a large carbon footprint associated with its construction and operation. Measures can be taken to reduce the carbon footprint which would need to target both the embodied carbon and operational carbon. Some such measures to reduce the carbon footprint include:

- Monitor carbon impact through the design and construction, taking consideration for the materials used and the potential for environmentally friendly equivalents (e.g. low carbon concrete, recycled steel products, etc.)
- Implement renewable energy solutions, such as solar PV on each building, and design buildings to be to “Green Buildings”
- Increase biogenic carbon storage by maximising landscaping with vegetation
- Promote the use of electric vehicles for transport
- Increase usage of rail for transport of goods
- Encourage ships to make use of wind propulsion technologies (e.g. eSAILs®) to reduce fuel consumption and carbon emissions.

In addition, it is worth noting that the extended harbour would offer increased opportunities to be a centre for receipt and distribution of wind turbine components. There are a limited number of ports able to receive shipments of these components due to their size and the size of the vessels required. The development of the Galway Harbour would be able to assist with the country achieving its renewable energy and sustainability goals.

4. CONCLUSION

Quantifying the carbon footprint of construction projects is becoming increasingly important as more focus is being placed on sustainability. In particular, it is becoming increasingly necessary for projects to be sustainable to align with, and support, Ireland's Climate Action Plan.

TOBIN has invested in software to quantify and assess the carbon footprint of construction projects. OneClickLCA® provides a means to estimate the carbon footprint of a project quickly and easily. Its database of reference EPDs is valuable in the estimation of embodied carbon and allows for the generation of results with simple inputs.

The material quantities have been quantified and the embodied carbon for the proposed design has been determined. Further, the operational carbon has been determined based on the energy usage, water usage and transportation of goods. The quantification of the carbon footprint of the proposed design provides a baseline value for the carbon footprint of the project, against which the project can be monitored through its delivery.

The resulting carbon footprint of the proposed design has been quantified as **380,735 tCO_2e**. An assessment of the carbon footprint should the development not proceed, indicated that there would be a baseline carbon footprint of 97,272 tCO_2e. and therefore the development with increase on this baseline by 283,462 tCO_2e. While this appears to be a significant increase, this was determined based on the limitation of the study to the Galway Bay environment and excludes broader impacts on carbon emissions. It has been briefly demonstrated by a high-level estimation of diverting shipping traffic in Section 3.5 that potentially the broader impact on carbon emissions from the Galway Harbour extension may be positive, or at least neutral. Any increase in carbon emissions due to the development of the Galway Harbour may be balanced in part by a reduction in shipping traffic currently accessing other port facilities that would be diverted to Galway due to it being a more economical (fuel efficient) route.

The carbon footprint can be reduced with careful design, appropriate material selection, monitoring of the carbon footprint through the design stages and construction, utilising carbon efficient construction methods, reducing energy consumption and reducing the carbon footprint associated with transportation of the goods.

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