A Guide to Quantifying & Reporting Carbon Emissions

BE—ST

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1. Background

The built environment is a major contributor to the greenhouse gases (GHG) emitted into the atmosphere, accounting for 45% of UK carbon emissions discharged (source: UK Green Building Council). Around 10% of the country's carbon dioxide emissions are directly associated with construction activities. As part of the global effort to fight climate change, the Scottish Government has set an ambitious target to become 'net zero' by 2045, meaning the amount of GHG emissions we put into the atmosphere and the amount we are able to take out will add up to zero. Construction Scotland Innovation Centre's (CSIC) mission is to support the built environment sector contribute and transition to net zero. The majority of the projects supported by CSIC have the potential to reduce greenhouse gases emitted into the atmosphere through innovative approaches, products, processes and services.

As a publicly funded organisation, CSIC is required to monitor the GHG impacts of the support we deliver and understand and measure how these projects and initiatives contribute to the national drive towards Net Zero Carbon by 2045

To collate monitoring information, beneficiaries of CSIC funding support are expected to provide an estimation of carbon savings related to their project. CO2e savings are expected to be recorded for projects where there are quantifiable data and outcomes relating to energy and resource efficiency improvements, reduced raw material use, reduced waste, improved productivity, reduced transportation/freight movement or where any other environmental improvement can be identified.

As part of the application process for support, the beneficiary will be expected to report on their estimated carbon savings (in tonnes) from the completed project. This guide outlines the approach for estimating the forecasted carbon emissions for CSIC-supported projects. The methodologies presented here aim to estimate the projected carbon emissions for the project being supported and should not be confused with your business's current organisational emissions.

2. Step 1 - Identify Emission Sources

The first step is to determine the scope of your project and the emission sources to be quantified for reporting. As a minimum, the emission sources should include those that will result in significant emission reductions from the project intervention. Common carbon savings include lower carbon footprint materials, circular economy, reduced transportation/freight, energy efficiency, renewables, and fossil fuel removal.

Figure 1 outlines the lifecycle stages for construction-based projects and can be used to identify where your project may have positive carbon impacts. In this diagram, the individual lifecycle sub-stages make up each high-level life cycle stage (e.g., product stage) and are included to provide visibility of the typical functions involved in each life cycle stage together with the types of data to collect.

The beneficiary should identify the life cycle category (or categories) which apply to their project. As a minimum, beneficiaries should report on their operational carbon emissions related to the use phase of a product (if applicable), building or service.

Beneficiaries are encouraged to select more than one category to help build a picture and to demonstrate carbon savings across multiple categories. Further guidance on how to identify your project boundary is provided in Appendix A.

Once the boundary of your project has been identified, proceed to section 3.0 which provides guidance on how to quantify the emissions.

2. Step 1 - Identify Emission Sources

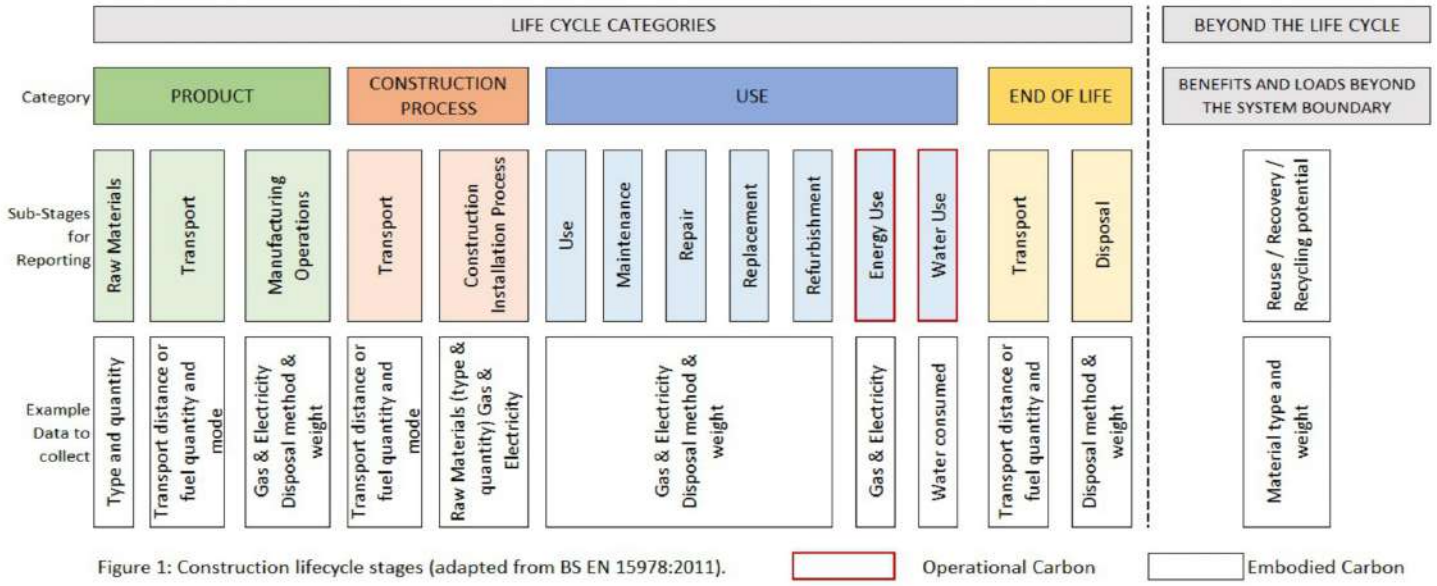

Figure 1: Construction lifecycle stages (adapted from BS EN 15978:2011).

3. Step 2 - Quantifying Emissions

3.1 Estimating Carbon Savings Overview

The carbon savings of your project shall be calculated as the difference between:

- The emissions from the project activity; and
- The emissions that would occur in the absence of the project.

The procedure for calculating the emissions saved is as follows:

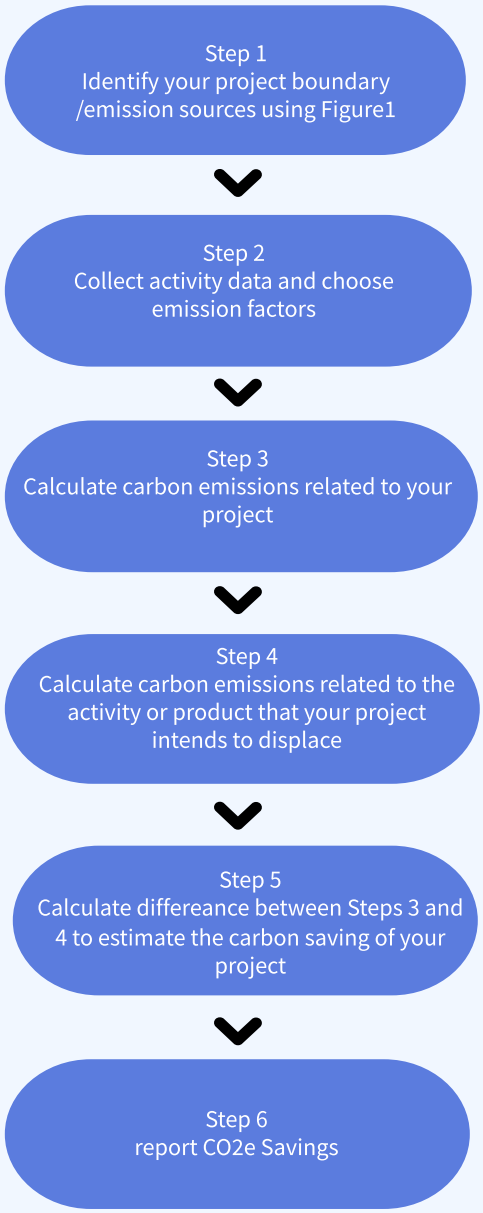

FIgure 2: Process flow for quantifying the carbon savings of a project.

3. Step 2 - Quantifying Emissions Continued

3.2 Data Collection

The data needed to estimate the carbon savings of your project fall into the following categories:

- **Activity Data**: refers to quantities of inputs and outputs (materials, energy, wastes, etc.). This also include information on transportation (e.g., distance travelled, vehicles used, etc.). Activity data can be obtained from either:
  - *Primary sources:* first-hand information from the specific activity in question, collected internally or from the supply chain. For instance, electricity usage in kWh from invoices or meter readings, recorded transport miles or litres of fuel consumed, purchasing records for materials; or
  - *Secondary sources*: the average, or typical information about a general activity from a published study/academic paper, online statistical data on the activity to be measured, the theoretical or conceptual model developed for the project, historical data from similar projects (such as kWh of energy, quantity of raw materials etc.), or other source.
- **Emissions Factors:** these are values that convert activity data quantities into equivalent carbon emissions. Section 7.0 provides a list of useful sources for emission factors. These are a starting point but are no means a definitive list of available resources. Note: we have not provided these within the document itself to ensure the latest values are use in your calculations. Please note your source of emission factors.
- **Benchmarking**: is data that allows for comparison of the project against a scenario, product, operation, or service to be replaced. For instance, to compare a new build project to a traditional build, benchmarking could be performed based on surface area (ft^2 or m^2).

The use of primary data generally improves the accuracy of the carbon emissions calculated as the numbers used relate directly to real life activities (e.g., production process). Secondary data is usually less accurate as it will relate to processes which are only similar to the one that actually takes place, or an industry average for that process.

3. Step 2 - Quantifying Emissions Continued

The choice between primary and secondary data should be guided by the information available to the beneficiary at the point of submission for support. It should be re-evaluated at the end of the project once more accurate or additional information is available.

3.3 Calculation Method

The most common approach used to calculate GHG emissions is to apply documented[LB1] emission factors to the activity data from the expected project outcomes. Activity data is the information used to calculate carbon emissions from electricity use, combustion, disposal, or other processes. For example, this could be the miles travelled by delivery vehicles or the kWh of energy consumed.

The general calculation is:

Activity Data x Emissions Factor = GHG Emissions

Worked examples are provided below:

Transport

Activity Data: 1,215 miles

Data source: UK Government conversion factors for delivery vehicles (category: HGV (all diesel), All HGVs, average laden)

Calculation:

1,215 miles x 1.39273 kgCO2e per mile = 1,692 kgCO2e

Conversion to tonnes:
1,692 kgCO2e ÷ 1000 = **1.7 tCO2e**

3.4 Quantification Approach

3.4.1 Basic Quantification Approach – Operational Carbon

The standard approach for reporting shall be basic quantification. This approach can be used for projects where there is limited data or resources available to allow the beneficiary to calculate a more comprehensive carbon assessment of their project.

For basic quantification, the following approaches can be used for reporting:

- A targeted approach whereby areas of the project that will result in the **greatest** carbon reductions are selected for quantification. For example, reporting on transport only or for complex construction projects where multiple materials are used the top three materials used shall be quantified: or

- Operational use of a product, building or service (e.g., energy efficiency and/or water use only).

3. Step 2 - Quantifying Emissions Continued

Raw Materials

Activity data: 150 Kg of insulation (containing recycled content).

Data source: UK Government conversion factor for material use (insulation material, closed-loop).

Convert to tonnes.
150 Kg ÷ 1000 = 0.15 tonne

Calculation:
0.15 tonne x 1,852.10 kgCO2e per tonne of material = 277.8 kgCO2e

Conversion to tonnes:
277.8 kgCO2e ÷ 1000 = **0.28 tCO2e**

3.4.2 Advanced Quantification Approach – Embodied Carbon

The advanced quantification involves a more detailed estimation of the project's carbon savings and considers the emissions generated throughout the lifecycle of a product or material (ref. Figure 1). This is also known as **embodied carbon.**

Electricity

Activity data: 13,564 kWh

Data source: UK Government conversion factor for UK grid electricity.

Calculation:
13,564 kWh x 0.23314 kgCO2e per kWh = 3,162.3 kgCO2e

Conversion to tonnes:
3,162.3 kgCO2e ÷ 1000 = **3.2 tCO2e**

4. Reporting Requirements

4.1 Applications for CSIC Support

The estimated carbon emissions saved from the commercialisation of the project shall be reported in **tonnes of CO2e**. The total cumulative carbon must reflect the forecasted sales or productivity levels across a five-year period. The five year period usually commences at point of commercialisation of a product, start of construction, point of adoption of a new process etc.

The general calculation for this is:

* The estimated carbon emissions shall be reported against each year. For example, Year 1 = X tCO2e, Year 2 = X tCO2e, Year 3 = X tCO2e etc, with the cumulative being the sum of all emissions saved across a five-year plan.

The carbon emissions saved shall be reported on the application form along with a brief explanation of how the estimates have been made. The rules outlined below shall be followed as a minimum:

- all estimates should clearly state any assumptions made and the reasoning for the assumption.
- all sources (e.g., databases, literature) for activity numbers and conversion factors used for the estimation should be identified. Online links to the sources are acceptable.
- any uncertainties or limitations of the results should be explained through a short statement; and
- identification of whether a basic or advanced quantification method has been applied.

It is acknowledged that beneficiaries may not have access to all the necessary information needed to quantify the carbon emissions related to the project. However, every effort should be made by the beneficiary to source / estimate the data relating to their project.

4.2 Ongoing Carbon Reporting

The requirements for further reporting will be agreed at the outset of project support and will be based on the level of funding and/or support awarded, the scope of the project and quality of the emissions data reported within the application form.

This is typical for projects where larger funding grants are awarded and/or

4. Reporting Requirements Continued

where data is collected as part of the project scope which can be used to quantify carbon emissions.

4.3 Project Completion

In some instances, Beneficiaries will be required to report (or revise) their forecasted carbon emissions at the point of project completion. This is typical particularly important for projects where the data needed to quantify carbon emissions will be available at project completion and allows for a more accurate carbon estimate to be noted.

5. References

ISO 15978:2011 Sustainability of construction works. Assessment of environmental performance of buildings. Calculated method.

PAS 2050:2011 Specification for the assessment of life cycle greenhouse gas emissions of goods and services.

RICS QS & Construction Standards, Methodology to calculate embodied carbon of materials. 1st Edition, information paper (IP 32/2012)

Guidance on how to measure and report your greenhouse gas emissions. DEFRA, September 2009.

6. Terminology

Beneficiary: The person or company receiving funding or support from CSIC.

Benchmarking: Using the consumption or use of one asset as a proxy to estimate the consumption of another asset.

Operational Carbon: Carbon emissions associated with the in-use phase of a building, service, or product.

Embodied Carbon: In the building life cycle, embodied carbon is the carbon dioxide equivalent (CO2e) associated with the non-operational phase of a product. This includes emissions caused throughout the life cycle of the product from extraction, manufacture, transportation, assembly through to maintenance, replacement, deconstruction, and disposal. Embodied carbon is often determined at the design stage and is usually expressed in kilograms of CO2e per kilogram of product or material.

7. Data Sources

7.1 Activity Data

Data Category	Example Data to Gather
Raw Materials	Type of material and quantity (tonnes) of procured products.
Transport	Transport miles, mode (e.g., air, sea, road) and type of transport (e.g., HGV, van); or Litres of fuel consumed and type of fuel.
Electricity	Electricity use (kWh) associated with the project.
Gas	Gas use (kWh) associated with the project.
Water	Water use (m^3) associated with the project.
Disposal	Type of waste, quantity (tonnes) and waste management method (e.g., landfill, recycling, incineration).

7.2 Example Statistical Sources

- UK Government, Energy Performance of Building Certificates
- UK Government Monthly Statistics of Building Materials and Components
- Office for National Statistics
- CIBSE The Energy Benchmarking Tool

7.3 Emissions Factors

The latest CO2e conversion factors published by the Department for Business, Energy & Industrial Strategy is recommended. Other sources for carbon conversion factors and databases are listed below:

- The Greenhouse Gas Protocol List of Life Cycle Databases
- RICS Building Carbon Database
- European Reference Life Cycle Database (ELCD)
  Greenhouse Gas Protocol Scope 3 Calculator
- Carbon Leadership Forum EC3 Tool
- University of Bath Inventory of Carbon and Energy (ICE Database).
- Embodied Carbon in Construction Calculator, Building Transparency.
- Ecoinvent (subscription required)
- BRE Centre for Sustainable Products: The IMPACT database (subscription required)
- OneClick LCA (subscription required)

Appendix A: Guidance to Identify Project Boundary

Stage	Example Projects captured in this Stage	Emission Boundaries
Product	The development or use of a product or material.	This stage covers the emissions generated from the manufacture of materials or products. The emissions arise from the extraction, processing, transportation of the raw materials and manufacture of the materials or product i.e. embodied carbon Emissions from this phase arise from the procurement and transportation of raw materials and manufacturing process such as energy and waste.
Construction Process	The construction of a building or other related development.	Emissions from this phase include energy and fuel consumption during construction. Emissions should account for the following activities (where applicable): ▪ The transportation of material to and from the site ▪ Enabling works, ▪ Remediation, ▪ Clearance, ▪ Removal/Demolition of existing, ▪ Structures, ▪ Ground improvements, ▪ Earthworks, ▪ Assembly. This phase should also include the raw materials used and their transport to the site (i.e., product stage).
Use	The operation of a building or service. The use of a developed product or material in operation.	The use carbon emissions from this phase are typically attributed to the operational requirements of a building or service. This can include the energy consumed for lighting, heating, ventilation, air conditioning etc and water use. For service and maintenance, this can include the waste generated through the activity. For projects which are developing a new product, this stage would normally include the energy related to the use of the product. This is otherwise known as "Operational Carbon"
End of Life	The development of a product or material. The construction of a building or other related development.	End of life emissions are those associated with energy consumed from the disposal of the product/material, or demolition of a building.
Benefits and loads beyond the system boundary.	The development of a product or material. The construction of a building or other related development.	Includes quantifying the carbon impacts beyond the lifecycle emissions. It acknowledges the 'design for reuse and recycling' and should be included in calculations for resource efficiencies to demonstrate the carbon savings of the project.

Summary & Next Step Recommendations

The proposed methodology and guidance have been designed to offer a degree of flexibility for the quantification of the carbon emissions associated with the commercialisation of innovation projects and is intended to provide guidance to beneficiaries in quantifying their emissions.

For some innovation projects, it is considered that that main challenge is in obtaining the activity data required to calculate the equivalent carbon emissions. Although access to data will vary depending on the project scope, information can typically be sourced from statistical references (such as those listed in section 7.2), historical data from similar projects, specifications or other online literature from the UK or other countries.

For more complex projects (such as construction developments) or where data is limited, a basic quantification approach is suggested whereby the beneficiary could focus on reporting the significant impacts of the project only. This could be by reporting the top three materials used and/or operational use as opposed to a full life cycle analysis which can consume time and resources. However, it is recognised that within the construction industry, life cycle analysis for products and materials is the recommended approach for quantifying carbon emissions and therefore, an advanced approach has been included to allow beneficiaries the option to provide a more detailed account of the carbon footprint/savings of their project.

The recommendations are summarised below:

Ref	Recommendations
1	Consider building into CSIC funding procedures the option for applicants to be 'exempt' from carbon reporting at the application stage on the condition that through their project, data is collected that can be used to quantify carbon emissions. This should be captured as and when information becomes available through project meetings or at the completion stage of the project. It is recommended that CSIC identify from their funders whether this would be acceptable.
2	Consider gathering information from funding beneficiaries at the project initiation (or close out) meeting to understand the restraints in carbon reporting to help refine the methodology and guidance.
3	Identify whether there should be a relationship between the level of funding provided and detail expected from the carbon reporting of a project. For instance, projects above a certain threshold are required to report a more detailed life cycle analysis (i.e., advanced approach).
4	Along with the total cumulative carbon savings, consider asking beneficiaries to report the projected carbon savings against each year across the five-year forecast plan within the application. This should allow CSIC to extract the necessary information required for Scottish Enterprise who require the estimated savings over three years.
5	Collaborative Innovation Funding / Project Overview – breakdown CO2 emissions savings data into year on year 5 year projections (like new jobs and new turnover)
6	Consider support to make robust carbon reduction calculations e.g. academic partner provides this as an eligible project cost (if a funding application) or provides it as an additional in-kind contribution; SE can provide for projects in which they are involved; use core CSIC monies??

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