Whole Life Carbon Framework

National Grid Project ALPACA

National Grid

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Quality information

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1. Introduction

This report provides an overview of the whole-life carbon (WLC) framework proposed as part of National Grid Electricity Distribution (National Grid) Approach for Long-term Planning Accounting for Carbon Assessment (ALPACA) project. It includes context to the requirements for carbon reporting, the structure and underlying calculation methodology behind the reporting tool and carbon database being developed, as well as how whole life carbon reporting can be integrated into National Grid's existing processes at a project level. It is presented in a way that can inform and support the development of an effective WLC management process for National Grid, and it is intended that the high-level structure of this WLC management process will be of use to other Distribution Network Operators (DNOs).

1.1 Definitions

- **Embodied Carbon** – carbon emissions associated with production of materials/ goods.
- **Capital Carbon** – carbon emissions associated with production of materials/ goods (embodied carbon) as well as the upfront establishment/construction of an asset/scheme.
- **Operational Carbon** - carbon emissions associated with the operation and routine maintenance of an asset.
- **Whole Life Carbon** - carbon emissions resulting from the construction and use of an asset, including end of life considerations (demolition and disposal) (i.e. capital and operational carbon).
- **Greenhouse Gases (GHGs)** - gaseous constituents of the atmosphere, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds.
- **Carbon Dioxide Equivalent (CO_2e)** - unit for comparing the radiative forcing of a greenhouse gas to carbon dioxide.
- **Global Warming Potential (GWP)** - factor describing the radiative forcing impact of one mass-based unit of a given greenhouse gas relative to an equivalent unit of CO_2e over a given period of time.

1.2 PAS 2080:2016 – Carbon Management in Infrastructure

Publicly Available Specification (PAS) 2080: Carbon Management in Infrastructure provides a methodical, best practice approach for calculating WLC across a project's delivery, encouraging project managers to review carbon at each stage of the project. This guidance provides a modular approach (A, B, C, D) (as detailed in Figure 1), which combined will contribute to a project's whole-life cycle. Each of these modules is further broken down into specific areas of the project which have the potential to contribute to carbon emissions.

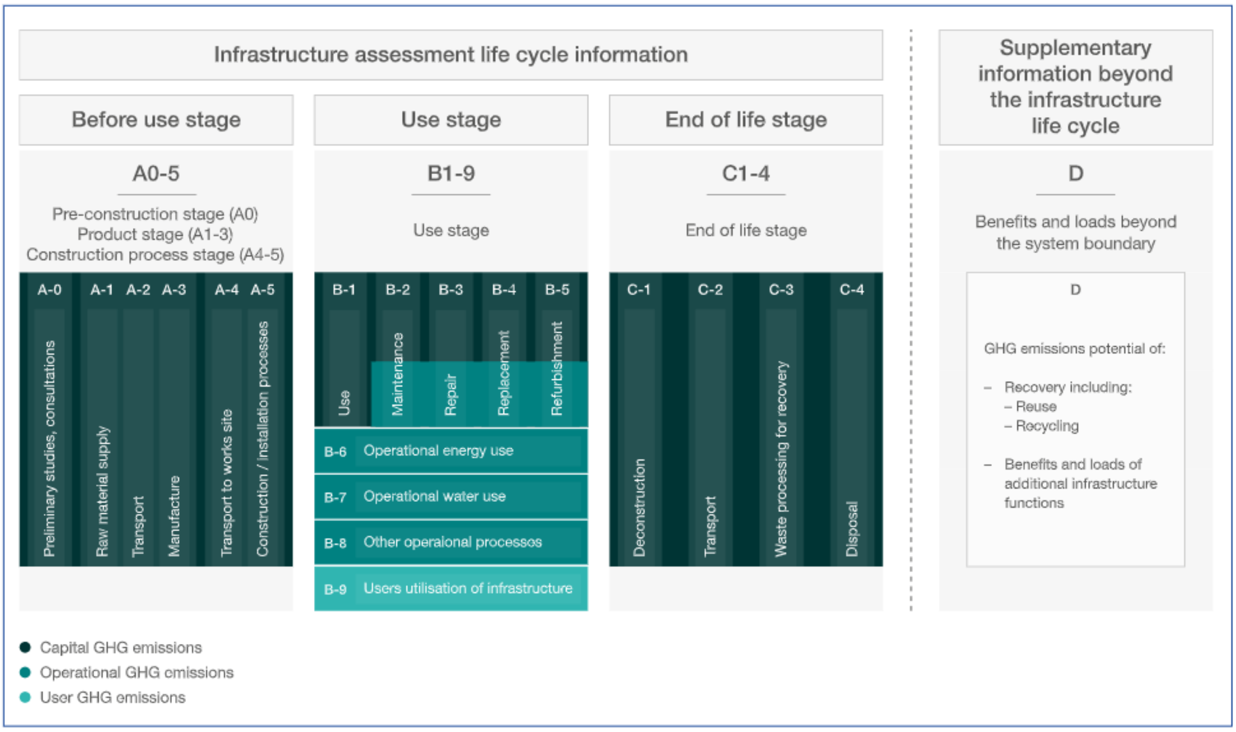


Figure 1 PAS 2080 modular approach showing the life cycle stages and individual modules for infrastructure carbon emissions quantification[1]

1.3 Ofgem requirements

The Office of Gas and Electricity Markets (Ofgem) regulates much of the energy sector, including the monopoly companies which operate the gas and electricity networks. Following the commitment made by the UK government in 2019 for a net zero greenhouse gas emissions target by 2050, in early 2020, Ofgem published its decarbonisation action plan.[2] This plan highlights the need for increased investment in renewable and low-carbon electricity. This will include the expansion of the electrical infrastructure that National Grid and other DNOs provide in order to continue to reliably supply energy when and where consumers need it.

As part of RIIO-ED2 guidance[3], Ofgem requires that all DNOs start reporting the embodied carbon associated with all new projects and developments. This new requirement will allow National Grid to establish a baseline and set targets to reduce embodied carbon from RIIO-ED2 (2023 – 2028) onwards.

[1] BSI (2016). '*PAS 2080:2016 Carbon Management in Infrastructure*'.
[2] Ofgem (2020). '*Ofgem decarbonisation programme action plan*'. Available at: https://www.ofgem.gov.uk/sites/default/files/docs/ofg1190_decarbonisation_action_plan_revised.pdf [Accessed on: January 2022]

[3] Ofgem (2020). '*RIIO-ED2 Methodology Decision: Annex 1 – Delivering value for money services for consumers*'. Available at: https://www.ofgem.gov.uk/system/files/docs/2020/12/riio_ed2_ssmd_annex_1_delivering_value_for_money_services _for_customers.pdf [Accessed on: July 2022]

2. National Grid's Requirements

To help meet Ofgem's RIIO-ED2 requirements National Grid is seeking to develop a WLC framework, and associated calculation tool, to assess and measure the carbon impact of new projects across their lifetime. 'Whole-life' incorporates procedures to determine not only the embodied carbon of an asset, but also the carbon associated with its installation activities and lifetime operation.

The development of the framework follows a five step plan, as presented in WPD's Environment Action Plan[4] (now part of National Grid):

1. **Defining the goal** – determine key requirements of the system in terms of how it can meet RIIO-ED2 requirements and aid project designers in making more sustainable decisions.
2. **User requirements** – understand tool use, beneficial outputs, available data, decision making process and categorisation of different projects.
3. **Project categorisation** – understand different types of projects, design processes, decision responsibilities and project commonalities.
4. **Proof of concept calculations** – demonstrate that the calculation methodology is appropriate.
5. **Consolidation of method** – analyse different options and solution optimisation.

2.1 Defining the goal

The WLC framework aims to provide a clear methodology for calculating WLC on a project-by-project basis. Key requirements of the framework and tool are to:

- Enable reporting of embodied carbon and capital carbon figures, as required by Ofgem for RIIO-ED2.
- Demonstrate carbon savings across baseline design (baseline), detailed design (design) and as built stages of an individual project.
- Provide a central database of projects and documented carbon saving opportunities which can be used by the design teams.
- Align reporting of carbon impact and savings with PAS2080.

2.2 User Requirements

Depending on the type of project, the users of the WLC tool, that this framework will inform, will vary.

For projects in networks under 33 kV, there are two stages at which the project carbon footprint will be calculated, and therefore there are two instances where data will need to be uploaded to the WLC tool: design and as-built stage.

For projects over 33 kV, there are likely to be three stages at which the project carbon footprint is calculated: baseline, design, and as-built stage.

2.3 Project Categorisation

Project categorisation is key to allow National Grid to analyse the outputs of the WLC methodology, and therefore the following project categorisation details will be required inputs:

1. Voltage – this has been selected as the primary classification because the capacity of equipment broadly dictates the size of installation and in turn, the amount of material and the embodied carbon associated with the project. There are five voltage classifications: LV, 11KV, 33KV, 66KV, 132KV.
2. Project value – this categorisation splits projects by cost. As such, the user will also be asked to input the total project cost. This will allow for the split between projects that are likely to have a significant carbon impact on their own, and projects that probably do not but are undertaken in very high volumes throughout the year, leading to a significant cumulative carbon footprint (e.g., cable laying, customer connections, planned maintenance activities).

[4] WPD (2021). '*RIIO-ED2 Environmental Action Plan*'. Available at: https://www.westernpower.co.uk/downloads/354538#:~:text=The%20WPD%20RIIO%2DED2%20Environmental,and%20decarbonising%20our%20business%20activities. [Accessed on: July 2022]

3. Licence Area – for each project the user will be asked to select the relevant licence area: West Midlands, East Midlands, South Wales, South West. This categorisation will allow National Grid to analyse the total WLC from projects across each of the areas they operate in.

2.4 Proof of Concept

Figure 2 below outlines a proof of concept (POC), it demonstrates the WLC calculation methodology and associated inputs and outputs.

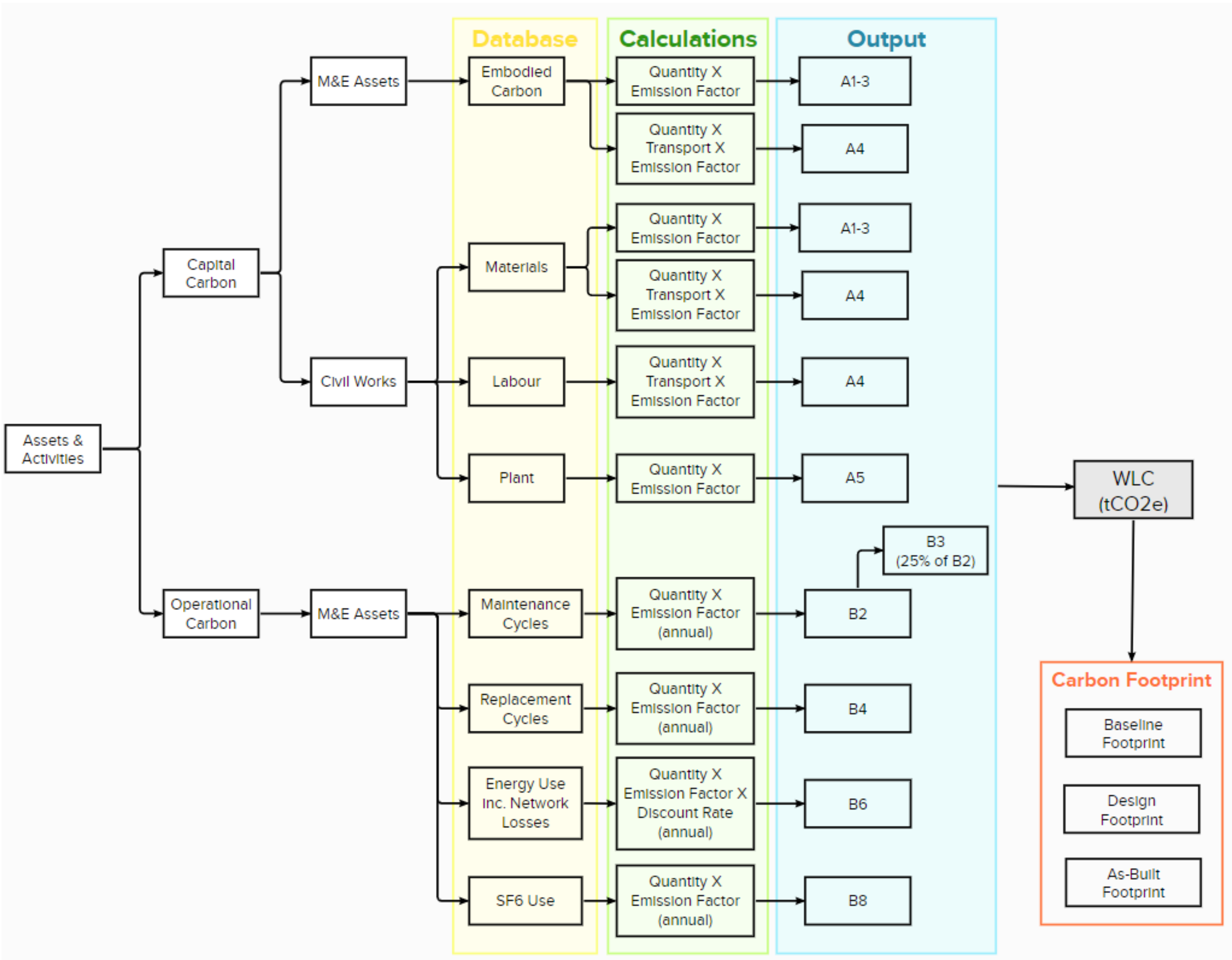


Figure 2 Whole Life Calculation Methodology

2.5 Consolidation of method

To implement the framework and methodology, the delivery of two different solutions was considered: an offline excel-based tool and an online cloud-based tool. Whilst the online cloud-based tool would be easier to update and it was thought to provide a more intuitive experience to the user, the main advantage of the offline excel-based tool lies with the fact that it would be available on any machine that has Microsoft Office installed, even without being connected to the internet. In addition, the offline excel-based tool, would not have any costs associated with ongoing use, whilst the online cloud-based tool would likely require an ongoing licence fee for hosting and maintenance of the tool.

Discussions of the various advantages and disadvantages of each option were held with National Grid, and it was agreed that an offline excel-based tool was the most appropriate for National Grid at this stage. This option also allows for the transition to an online tool in the future should that be appropriate. Full detail of the functionality and build-up of the tool will be included in the specification document accompanying the WLC tool.

2.6 Processes and policies

The successful implementation of the WLC framework, will rely on a seamless incorporation of it within existing processes and policies.

Figure 3 below outlines project processes and how the WLC framework reporting will be integrated within it. As indicated in the Figure, the three key project stages where input into the WLC tool is required are: project identification and inception, design, and project commission and close-out.

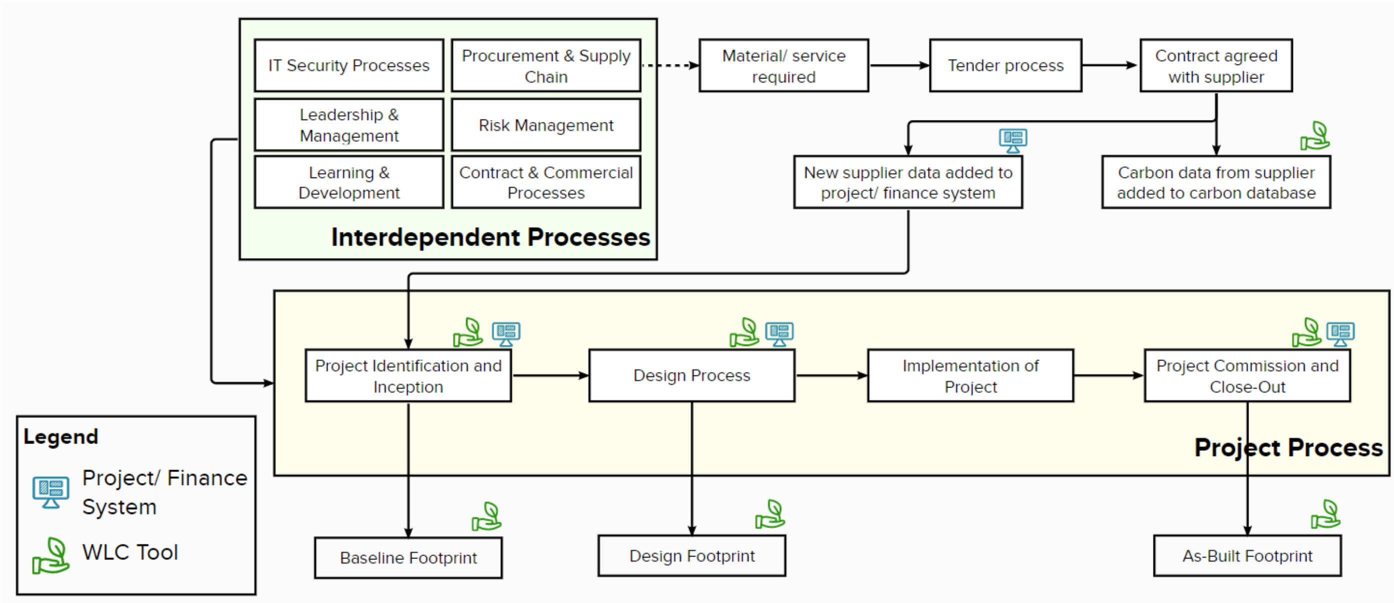


Figure 3 Project Process

3. Whole-Life Carbon Calculation Methodology

3.1 Overview

The calculation methodology, which is aligned with the GHG Protocol[5] and the Defra emission factors guidance[6], will follow the modular structure outlined in the PAS 2080 guidance described in the section 1.2). Therefore, the outputs will be organised as per a modular structure (see Figure 1): before use stage (A0 to A5) and use stage (B1 to B9).

The before use stage, which is also known as capital carbon, accounts for the upfront carbon emissions associated with the manufacture or production of materials/assets, the transport of these materials/assets to site, and construction activities. The use stage, also known as operational carbon, accounts for the emissions associated with the use of each asset during its entire life, which the user will be able to select (up to 60 years), and includes: maintenance cycles, repair activities, replacement cycles, energy use (including network losses) and fugitive emissions of sulphur hexafluoride (SF_6).

Table 1 provides a high-level overview of the input data, calculation methodology and outputs which will be added together to create an estimate of the WLC. The methodology for each activity is expanded on in the following sections.

Table 1 Data, calculation, and output for both capital and operational carbon (WLC emissions)

Inputs	Data Requirements	Emission Factors	Calculation	PAS2080
Capital Carbon				
Mechanical and Electrical (M&E) Assets	Asset type Breakdown of materials Weight (kg)	EPDs (if available) ICE, 2019	Asset quantity X emission factor	A1-3
Civil Activities	Material resources (type and weight) Mode of transport and distance	ICE, 2019 CESMM4, 2019	Weight of materials X emission factor	A1-3
		BEIS, 2022	Tonne.km (weight of materials X distance travelled) X emission factor	A4
	Labour hours Mode of transport and distance	BEIS, 2022	Days worked (hours divided by 8) X distance travelled X emission factor	A4
	Plant / fuel use (type and litres) (*can also be estimated by plant type and hours use*)	BEIS, 2022	Quantity (litres) X emission factor	A5
Operational Carbon				
M&E Assets	Maintenance activities and cycles	BEIS, 2022	Quantity X percentage of A1-5 Output (per maintenance cycle)	B2 & B3*
	Replacement cycles (M&E assets only)	n/a	Replacement quantity X A1-3 Output (per replacement)	B4
	Energy use (type and annual consumption)	BEIS, 2022	Energy consumption X emission factor (per year, *accounting for future emission factor projections*)	B6

[5] Greenhouse Gas Protocol (2022). '*Greenhouse Gas Protocol – Home*'. Available at: https://ghgprotocol.org/ [Accessed on: July 2022]
[6] GOV.UK (2020). '*Environmental reporting guidelines: including Streamlined Energy and Carbon Reporting requirements'.* Available at: https://www.gov.uk/government/publications/environmental-reporting-guidelines-including-mandatory-greenhouse-gas-emissions-reporting-guidance [Accessed on: July 2022]

Inputs	Data Requirements	Emission Factors	Calculation	PAS2080
	Network losses	BEIS, 2022	Energy lost X emission factor (per year, *accounting for future emission factor projections*)	B6
	Annual SF_6 leakage	GWP	Annual leakage X emission factor (per year)	B8

* B3 will be assumed to be 25% of B2[7]

For all projects, the whole-life period of a scheme (i.e., the period that WLC operational emissions will be estimated for), can be set up to a maximum of 60 years.

It has also been determined that, not all stages as defined in PAS2080 are relevant for National Grid projects and therefore the following stages have been scoped out:

- Preliminary Studies (A0) – Excluded as emissions from preliminary studies are not material.
- Use (B1) – Excluded as there are no emissions associated with use (emissions associated with network losses have been included under energy use.
- Refurbishment (B5) – Excluded as for National Grid projects refurbishment is captured as part of the maintenance cycle (B2).
- Water Use (B7) – Excluded as there is no water use for the defined assets.
- User Use (B9) – Excluded as there are no emissions associated with user use.
- End of Life Stage (C1 to C4) – Excluded as most of the assets have a lifespan in excess of 60 years and it is challenging to accurately estimate the future decommissioning impacts.

3.2 Capital Carbon

3.2.1 Materials (A1-3)

Carbon emissions associated with the assets and materials will be calculated using:

M&E: Asset quantity X emission factor / Civil: Weight of materials X emission factor

The material database will be organised by asset and each of them will have an associated weight, material type, unit of measure, and any assumptions that have been applied (as detailed on Table 1 above). Based on the materials of each asset, this database will pull through the relevant emission factors (e.g., CESSM4, ICE[8]) from the Emission Factor Library and multiply it by its weight or unit, in this way estimating and holding the embodied carbon for each SWE per unit of measure. Where possible, for complex assets (M&E), such as transformers, embodied carbon data will be extracted from publicly available Environmental Product Declarations (EPDs).

Availability of activity data for an asset's embodied carbon

To facilitate different types of data being available for different assets and activities, four methods for estimating embodied carbon emission factors are being considered. These range from low uncertainty/ high data requirements to high uncertainty/ low data requirements, as depicted in Figure 4[9]. Further details regarding these four levels of estimation are included in Appendix A.

[7] RICS (2017). '*Whole life carbon assessment for the built environment*'. Available at: https://www.rics.org/globalassets/rics-website/media/news/whole-life-carbon-assessment-for-the--built-environment-november-2017.pdf [Accessed on: July 2022]

[9] Anthesis (2021). '*Methodology for Estimating the Embodied Carbon of New Projects – Western Power Distribution*'.

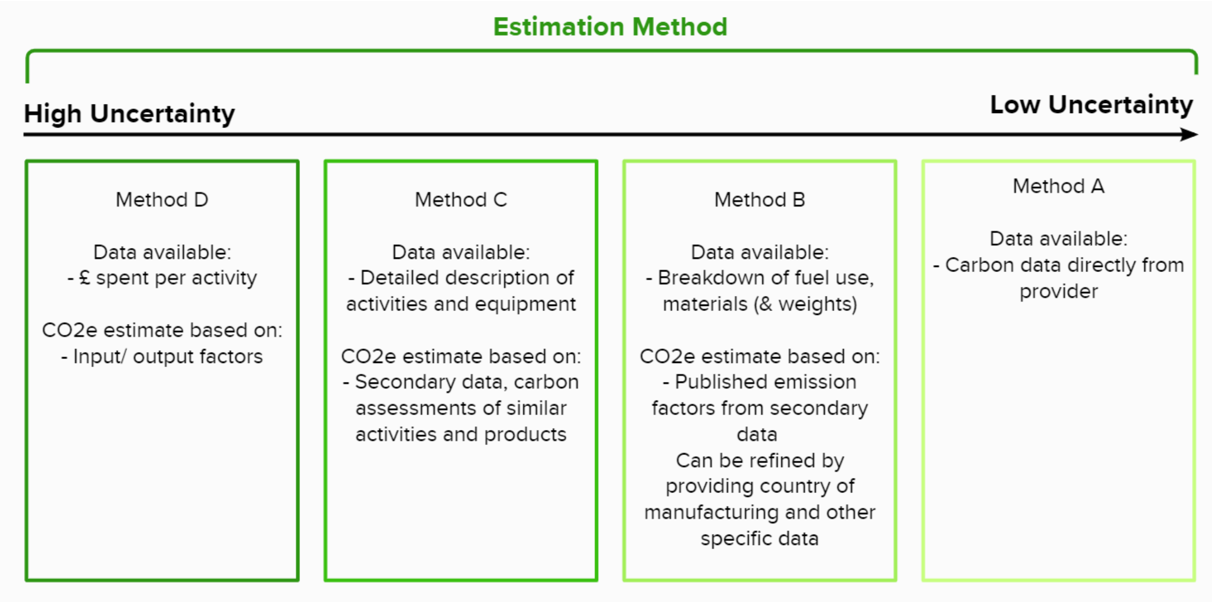


Figure 4 Hierarchy of estimation methods[9]

It is important to highlight that availability and reliability of data is likely to improve over time, so the database of carbon factors must be a constantly evolving, dynamic document.

3.2.2 Transport of assets and materials to site (A4)

Carbon emissions associated with the transport of assets and materials to site will be calculated using:

Tonne.km (weight of materials X distance travelled) X emission factor

We recognise that in most cases the tool user is unlikely to know the distance from supplier to site for assets and materials, the tool will therefore be set up to enable this to be estimated based on the selection of 'local', 'regional', 'national' and 'international' transportation. Distance assumptions will be built into the tool for these selections. The mode of transport will also be available for the user to select from: van, HGV, freight train and air freight. If any of the information above is unknown by the user, as a default, the tool will populate the transport of assets and material to site as regional distance travelled with an HGV.

The calculations that will be happening in the background will pick up this information from the input tabs and multiply them by emission factors sourced from UK Government[10] (Emission Factor Library), presenting the emissions associated with transport of materials to site in the Project Dashboard.

3.2.3 Transport of labour to site (A4)

Carbon emissions associated with the transport of people to site will be calculated using:

Days X distance travelled X emission factor

For each project activity that requires labour, a labour database will detail the duration (in hours) required of each labourer involved in each activity. Assuming that each labourer works an 8-hour day, the number of required site visits is then estimated by dividing the total person-hours by 8 (see example in Table 2).

[10] BEIS (2022). '*Greenhouse gas reporting: conversion factors 2022*'. Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2022 [Accessed on: July 2022]

Table 2 Example of estimation of the number of site visits required for a project

Number of labourers	Site work duration (hours)	Person-hours	Total site visits required for the project
1	100	1 X 100 = 100	Assuming all labourers work an 8-hours day = 100 / 8 = 13 site visits

For this category, the distance travelled is assumed as 'local' (i.e. 20 km), and the mode of transport as a diesel car. The emission factor associated with travelling in a diesel car will be sourced from UK Government[10] (Emission Factor Library).

3.2.4 Construction Processes – Plant Use (A5)

Carbon emissions associated with the use of plant will be calculated using:

Quantity (litres) X emission factor

For each project activity that requires the use of machinery, a plant database will hold the plant and fuel type and the total quantity of fuel consumed per activity. These emissions will be estimated by multiplying the amount of fuel used by the emission factors (fuel specific) sourced from BEIS[10], which are listed in the Emission Factor Library.

3.3 Operational Carbon

3.3.1 Maintenance (B2)

With regards to maintenance activities, based on existing maintenance policies for certain assets, each asset that requires maintenance will be assigned a frequency as to when that asset requires routine, minor and major maintenance, which will be held in the Maintenance database. Carbon emissions associated with each of the tree levels of maintenance activities (routine, minor, or major) will be calculated using:

Routine maintenance trips (per lifespan of asset) X 0.1% of the A1-5 Output

Minor maintenance trips (per lifespan of asset) X 1% of the A1-5 Output

Major maintenance trips (per lifespan of asset) X 5% of the A1-5 Output

The total emission from each level of maintenance will be added together to present the total carbon emissions associated with maintenance activities.

Where an asset has been selected as an input within the capital delivery part of the tool (A1-5), the carbon emissions associated with maintenance will be generated simultaneously with no additional inputs required from the user.

3.3.2 Repair (B3)

On the basis that it would be a challenge to predict accurate repair emissions during project design or inception, it is planned that as per the Royal Institute of Chartered Surveyors (RICS) WLC assessment guidance, repair emissions will be assumed to be *25%* of the maintenance emissions[7].

3.3.3 Replacement (B4)

Carbon emissions associated with the replacement of assets throughout the whole-life of the project (60 years), will be calculated using:

Asset quantity X A1-5 Output X replacement quantity (per lifespan of asset)

The replacement cycle of each asset (i.e., how many years the asset will be in good working condition until it must be replaced), will be held in the Operational Carbon – Replacement database. Since the emission associated with the replacement of an asset are likely to be very similar to the emissions associated with the original installation of the asset, the carbon emissions associated with asset replacement will be assumed to be the same as its capital carbon (A1-5).

3.3.4 Energy Use (B6)

Carbon emissions associated with energy use, including network losses, will be calculated using:

Energy consumption X emission factor (per year, accounting for future emission factor projections) X asset's lifespan

An Operational Carbon – Energy Use database will detail how much electricity the asset consumes annually, and that will be multiplied by the conversion factors. To accurately account for electricity that the asset will use over its lifetime, the future electricity consumption will be multiplied by the projected emission factors that are also published by BEIS[11] and account for the grid decarbonisation over time, which are listed in the Emission Factors – Electricity Decarbonisation Library.

Emission associated with network losses are also included within this category, and will be calculated using:

Energy lost X emission factor (per year, accounting for future emission factor projections) X asset's lifespan

An Operational Carbon – Losses database will detail how much electricity the asset will lose on average every year, and that will be multiplied by the conversion factors that BEIS[10] publishes as explain above.

3.3.5 Other Operational Processes (B8)

The carbon equivalent impact associated with fugitive emissions of SF_6 use will be calculated using:

Annual leakage X emission factor (GWP) (per year)

An Operational Carbon SF_6 database will detail how much sulphur hexafluoride each asset holds when is commissioned, and with the assumption that the asset is sealed for life, the leakage annual rate will be 0.1%[12]. For each asset the annual leakage rate will be multiplied by the GHG global warming potential (GWP) of sulphur hexafluoride which is 23,500.

[11] BEIS (2021). *Table 1: Electricity emissions factors to 2100, kgCO2e/kWh*. Available at: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal [Accessed on: May 2022]

[12] Th European Association of the Electricity Transmission and Distribution Equipment and Services Industry (2018). *'T&D Europe Technical report on alternative to SF_6 gas in medium voltage & high voltage electrical equipment'.* Available at: https://www.beama.org.uk/asset/35AC6550-E506-4417-8FDB33E7C3C854F6/ [Accessed on: July 2022]

4. Database Structure

4.1 Capital Carbon

The Capital Carbon Database will be made up of three levels of data, as detailed in Figure 5. Level 1 details all assets. Subsequently at Level 2 each asset is associated with its relevant material, labour activity and plant use, which are organised in individual Capital Carbon Emission Factor Databases – Level 3.

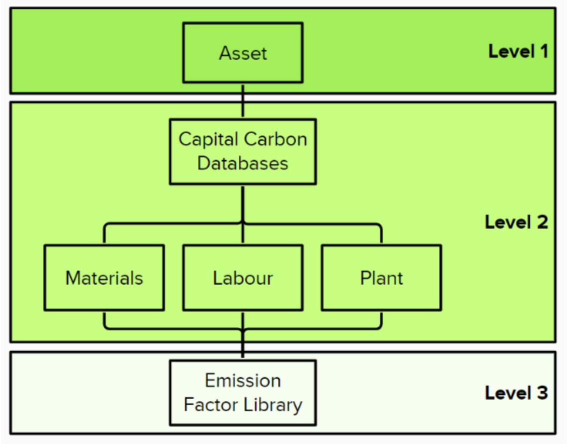


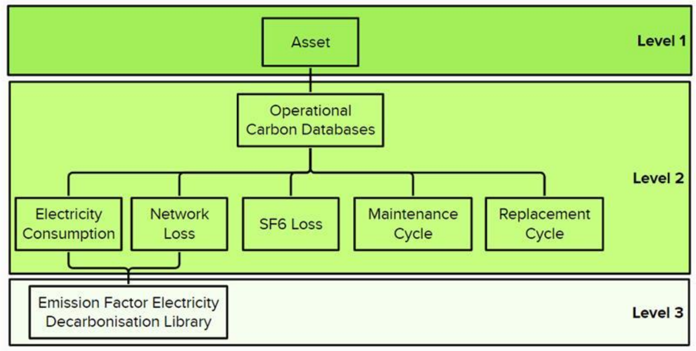
Figure 5 Capital Carbon Databases structure

4.2 Operational Carbon

As demonstrated in Figure 6, the Operational Carbon Database is made up of three levels of data. Level 1 is the asset. At Level 2, similarly to the Capital Carbon Databases, there are individual databases that hold the operational data for each asset:

- Energy Use Database: Annual Electricity Consumption (kWh)
- Losses Database: Annual Network Loss (kWh) per unit
- SF_6 Database: % SF_6 loss per year
- Maintenance Database: Maintenance Cycle (years)
- Replacement Use Database: Replacement Cycle (years)

Level 3 holds the Emission Factor – Electricity Decarbonisation Library, which holds the projected emission factors that are published by BEIS[13] and account for the grid decarbonisation over time.



[13] BEIS (2021). *Table 1: Electricity emissions factors to 2100, kgCO2e/kWh*. Available at: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal [Accessed on: May 2022]

Figure 6 Operational Database structure

Due to the fact that Operational Carbon will be reported not only as a total over the asset's lifetime, but also on an annual basis, each of the Operational Carbon databases will be structured in a similar way, demonstrating the emissions over a maximum lifespan period of 60 years.

4.3 Underlying Emission Factor Databases

The main data sources identified, which will make up the data in the Emission Factor Library are:

- **Inventory of Carbon and Energy (ICE) Database V3.0 from the University of Bath[14]** This relates to the main database for embodied carbon, presenting the carbon impact associated with a range of materials, based on market research, product life-cycle assessment and supplier Environmental Performance Declarations (EPDs).
- **M&E embodied carbon rates** Where possible EPDs and product life-cycle assessments through publicly available sources (Additional sources of data used will be referenced within the M&E asset database).
- **Government conversion factors for company reporting of greenhouse gas emissions** from BEIS[10], which will provide the carbon emission factors for fuels, electricity and vehicle use.
- **CESMM4 Carbon and Price Book[15]**, which includes estimates of embodied carbon values for civil engineering activities.
- **Energy and emission projections** derived from the UK Treasury Green Book[16], which provides projections to 2050.

[14] Circular ecology (2019). '*ICE Database V3 Launched'*. Available at: https://circularecology.com/news/ice-database-v3-launched [Access on: July 2022]
[15] ICE (2013). '*CESMM4 Carbon & Price Book 2013'*. Available at: https://www.icevirtuallibrary.com/isbn/9780727758125 [Accessed on: July 2022]
[16] BEIS (2012). '*Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal'*. Available at: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal [Accessed on: July 2022]

Appendix A Emission Factor Estimation Methods

Method A: Embodied carbon data provider directly by the suppliers

This is the ideal scenario in which suppliers of equipment, materials and services have done a GHG impact assessment of their product/ service. The results of this assessment can be used as input into the database, for each activity, material, or equipment, to calculate the assets embodied emissions. This approach allows for the most accurate results, as the inputs are specific to National Grid's project activities. These GHG assessments could come from the following sources:

- Life Cycle Assessment (LCA) of a product or process.
- EPD of a specific manufactured product.
- Some sub-contractors might be able to track their fuel consumption by project (transportation or on-site work) and produce carbon emissions reports.

When using data from these sources, it is important to ensure the scope and boundaries are aligned with the methodology for calculating embodied carbon.

Method B: Embodied carbon estimated from secondary data using material or fuel-level project data

If a breakdown of materials and energy used is available, the embodied carbon of the materials and emissions from fuel combustion can be estimated relatively accurately using published emissions factors. This method would require the availability of the following data:

- Description of materials and volumes/ mass per activity/ product/ project.
- Description of fuel and volumes/ mass per activity/product/project.
- Details on where the materials come from (location of extraction/ refining/ manufacturing), transportation distance and mode of transport.
- Material and fuel-level emission factors used in the calculations come from the following sources:
- Life cycle assessments (LCAs) and LCA databases (such as Ecoinvent4).
- DEFRA/BEIS or International Energy Agency (IEA) for energy emission factors.

Method C: Embodied carbon estimated from secondary data using activity or process descriptions

If data meeting the requirements for methods A and B is not available, embodied carbon can be estimated based on carbon assessments of similar activities that have been published. For this approach, the following level of information would be required as input:

- Detailed description of activities or materials purchased.
- If available and if applicable, equipment descriptions should include the function, size, main components, supplier/make, model, location of manufacture. Any additional details can be helpful to find secondary data that is as representative as possible.
- If there are no details available for on-site activities then detailed descriptions can be used for estimates (e.g., use of a 30-kW diesel generator on site for 8 hours).
- Sources for secondary data used in this approach mainly include published scientific literature on energy analyses or life cycle assessments on similar activities, as well as LCA databases such as Ecoinvent. This approach will require desk-based research to model processes based on description made available by National Grid.

Method D: Embodied carbon estimated from spend data

In the case where granular data required to follow methods A, B or C is not available, the cost of various activities or equipment purchased can be used as a proxy to estimate the carbon impact.

The carbon impact is estimated using Environmentally Extended Input-Output factors (EEIO factors). Life cycle GHG emissions of a sector are calculated by multiplying its direct and indirect economic purchases by related sectors' GHG emissions intensities. The GHG emissions intensity (in tonnes/million GDP) is calculated as the total quantity of GHG emissions pertaining to the activity of a certain sector divided by the economic output of the sector. This is a "top-down" approach, whereas and LCA for example takes a "bottom-up" approach.

EEIO models rely on:

- Economic data, or “Input & Outputs” (IO) by sector,
- Environmental data, used to create “Environmental Extensions” (EE) associated with sector output,
- A methodology to assign environmental extensions to sectors, characterize impacts (GWP), translate prices for purchasers & producers, etc.

This approach has a much higher uncertainty associated with it but can be used for a first screening to identify hotspots. These hotspots can then be further assessed using one of the first three estimation methods.

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