MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

BUILDING PERFORMANCE

# Whole-of-Life Embodied Carbon Emissions Reduction Framework

Building for climate change programme

August 2020

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New Zealand Government

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

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# 1. Problem Definition

New Zealand has committed to net zero carbon emissions by 2050. The Building and Construction Sector needs to play its part in meeting this goal as the Sector currently accounts for around 20%[1] of New Zealand's carbon emissions, through the energy and materials used in buildings. The Government is developing an Emissions Reduction Plan, which will set out the changes needed to allow New Zealand to meet its climate change goals.

The Building System Performance (BSP) Branch of MBIE has been assigned to lead the Building and Construction Sector's contribution to the National Emissions Reduction plan, and produce a roadmap of how the Sector can and will reduce carbon emissions. This work will be carried out by the Building for Climate Change (BfCC) programme.

We are proposing two frameworks to achieve reductions of carbon emissions from the Building and Construction Sector:

| Mitigation Framework | Scope |
|---|---|
| **Transforming Operational Efficiency** | Carbon emissions directly and indirectly attributable to the operation of buildings: essentially the use of energy (for heating, cooling, hot water, lighting, ventilation, appliances etc) and water.<br><br>Water use.<br><br>Occupant health and wellbeing. |
| **Whole-of-Life Embodied Carbon Emissions Reduction** | All carbon emissions attributable to the building itself, i.e. the construction materials and products across the life cycle of the building. This includes emissions across the full supply chain of construction materials and products, construction processes (and the waste arising), repair and maintenance, and processes at the end-of-life of a building. |

This document sets out the strategic approach for the second of these frameworks, to address whole-of-life embodied carbon emissions.

1 This includes emissions from all energy and materials consumed in New Zealand, including imported materials.

# 2. Context

Emissions produced over the life cycle of a building are generally put into two groups, operational emissions and embodied emissions. **Operational carbon emissions**[2] occur only during the use stage of a building's life and are from the energy and other resources used when operating the building. Embodied carbon emissions are from the materials and products that form the building and can occur right across the building's life cycle.

Embodied carbon emissions are caused by $CO_2$ and other greenhouse gases from non-renewable energy sources or otherwise being released into the atmosphere as a consequence of activities associated with a particular material or product. Embodied carbon is assessed on a life-cycle basis; thus, emissions that arise at all points in the supply chain and over the lifetime of that material or product are considered.

For a building, typically the most significant embodied carbon emissions happen before the building is used, in the production of construction materials and products. However, embodied carbon emissions also occur during the building's operation due to maintenance activities, and also at the end of the life of the building due to demolition activities, and disposal or recycling of materials and products.

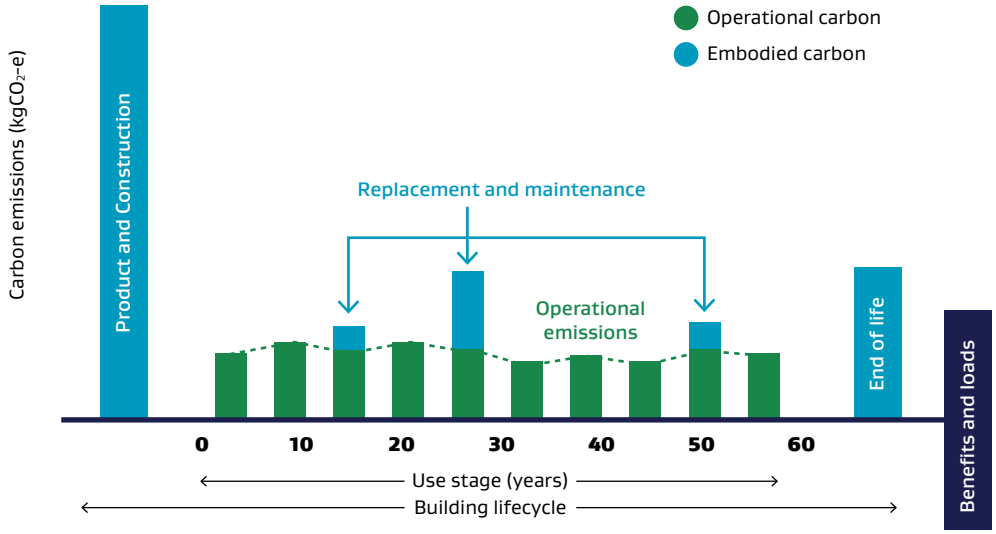


***Figure 1: Operational and embodied carbon emissions over the life cycle of a building***[3]***.***

2 The terms emissions, carbon emissions and carbon are used to represent all greenhouse gas emissions.
3 Adapted from LETI Embodied Carbon Primer, January 2020.

The calculation of embodied carbon in buildings follows European Standards EN 15804 and EN 15978 and International Standard ISO 21930. A Life Cycle Assessment (LCA) is typically used to calculate embodied carbon emissions of a building, either by an LCA specialist, or by designers using software tools, which deal with the methodology specified by the standards, required to ensure conformity, and conceal some of the underlying complexities.

The standards for LCA in construction define life cycle stages for the purposes of embodied carbon according to a module framework, and are shown in figure 2:

- material extraction (module A1)
- transport to manufacturer (A2)
- manufacturing (A3)
- transport to site (A4)
- construction (A5)
- use phase (B1, e.g. concrete carbonation but excluding operational carbon),
- maintenance (B2), repair (B3), refurbishment (B4), replacement (B5)
- deconstruction (C1)
- transport to end of life facilities (C2)
- waste processing (C3)
- disposal (C4)
- Benefits beyond the system boundary (D): these are to be reported separately to modules A-C

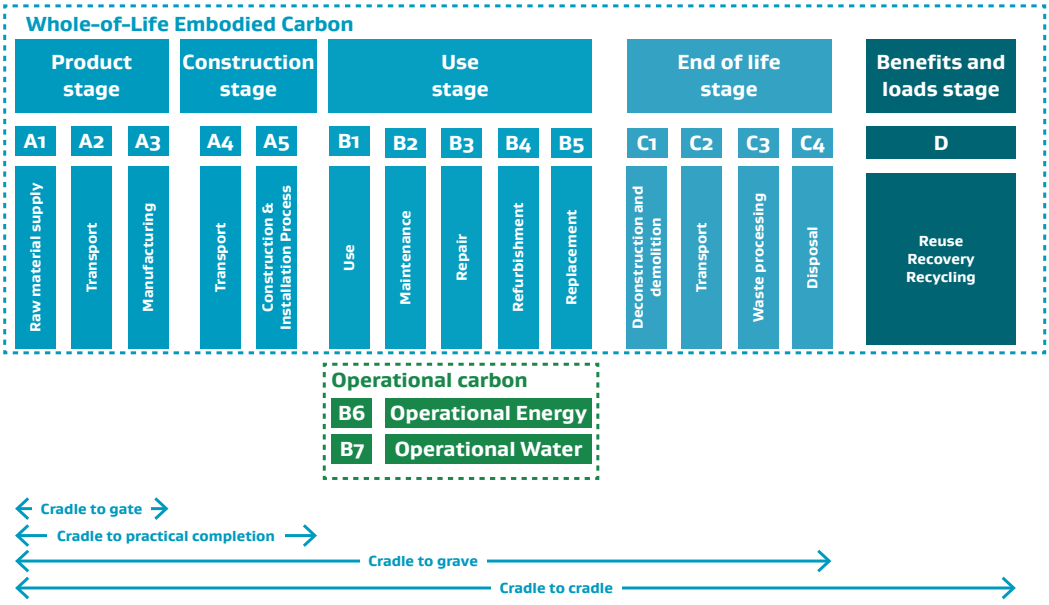


***Figure 2: Module framework for life cycle assessment of buildings.***

The scope of a Life Cycle Assessment may not include all life cycle stages: the following terms are used to describe the extent of an LCA:

- Cradle to Gate: Modules A1 to A3
- Cradle to Practical Completion: Modules A1 to A5
- Cradle to Grave: Modules A1 to A5 + B1 to B5 + C1 to C4
- Cradle to Cradle: Modules A1 to A5 + B1 to B5 + C1 to C4 +D

The activities at each life cycle stage of a building are shown in Figure 3:

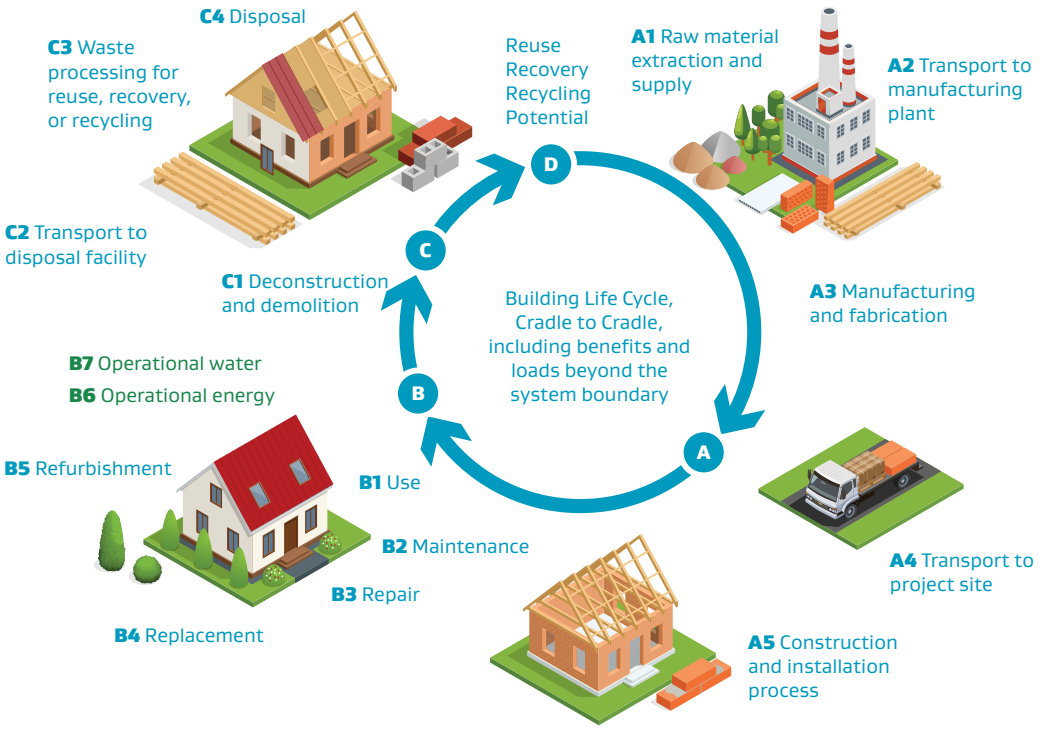


***Figure 3: Life cycle stages of a building and their associated LCA modules.***

# 3. Objectives

Embodied carbon emissions from buildings over their life cycle are determined as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| kg $CO_2$-e | = | $m^2$ | x | kg material/$m^2$ | x | kg $CO_2$-e/kg material |
| Whole-of-life embodied carbon | | Size of new building | | Use of construction materials & products | | Carbon emissions from the construction materials &products |
| | | **New build efficiency** | | **Material efficiency** | | **Carbon intensity** |

Therefore, to achieve reductions in whole-of-life embodied carbon, this framework has three objectives:

1. Maximise **New Build Efficiency**: ensure the size and quantity of new buildings are proportional to the need, upgrade existing buildings so they can be used effectively, and increase the longevity of new buildings and their components to reduce avoidable new build in the future.
2. Increase building **Material Efficiency**: use less material in new buildings, including reducing waste and minimising replacement over the building's life cycle.
3. Reduce the **Carbon Intensity** of the materials used in new buildings: either by making design choices to use low-carbon materials over high-carbon alternatives, and/or reducing the embodied carbon of the construction materials.

All the outcomes from this framework are intended to relate back to one of these objectives.

## 3.1 Objective 1: New build efficiency

New buildings use construction materials and products, the production of which causes embodied carbon emissions. We need to maximise the value derived from each new building by the end user to make sure the materials and products are used in the most efficient way. Factors to be considered in this objective include:

| Factor | Ways to reduce emissions |
|---|---|
| **Consider size of new buildings that will meet user needs** | When developing the brief for a new building, consider the efficiency of the new building being proposed, and alternative ways to meet the end user's needs. |
| **Repurposing existing buildings/value of heritage** | Make the use of existing buildings a viable alternative to building new, using retrofit or upgrade work if required. |
| **Flexibility and Resilience** | Ensure buildings will still be usable after earthquakes, the effects of climate change, and other potential changes over the design life, and are flexible enough to be adjusted with minimal impact if the user needs change, avoiding emissions from future rebuilds. |
| **Building to last** | Ensure building performance settings reflect the likely design life that can be achieved, enabling all the residual life of a building to be used. |

## 3.2 Objective 2: Material Efficiency

Using materials effectively and efficiently in buildings means not using more than is needed to meet requirements. Factors to be considered in this objective include:

| Factor | Ways to reduce emissions |
|---|---|
| **Appropriate performance requirements** | Stipulate realistic and reasonable performance requirements for the design of the building components to meet the end-user requirements.<br><br>Ensure excessive or multiple contingencies are not embedded in the design process. |
| **The efficient use of materials by designers** | Only specify as much material as required to meet performance requirements – and not more (lean design).<br><br>Consider material quantities at the concept design stage of a building, to ensure its form is conducive to high material efficiency. |
| **Reduce construction waste** | Reduce waste of materials in construction and upstream processes to minimise production to only as much as is required. This will reduce production and transportation emissions, as well as sector economic efficiency.<br><br>Apply manufacturing methodology to the supply chain for construction products. |
| **Long lasting construction materials and products** | Reuse construction materials and products in new buildings where they outlive the design life of their original building.<br><br>Design buildings for deconstruction to enable efficient recovery of components for reuse.<br><br>Consider a model of building owners 'leasing' construction materials and products, rather than buying them, enabling them to be used for other buildings in future with appropriate foresight. Embodied carbon emissions can therefore be shared across multiple buildings. |

## 3.3 Objective 3: Carbon Intensity

Reducing the carbon emissions associated with materials and products used in construction will reduce the embodied carbon of buildings. Factors to be considered in this objective include:

| Factor | Ways to reduce emissions |
|---|---|
| **Reduce emissions from materials/products without affecting properties** | Improve energy efficiency of production processes to reduce emissions, or substitute constituent parts of a construction product with low carbon alternatives (e.g. cement replacements).<br><br>Greater visibility and understanding of embodied carbon will encourage competition among manufacturers to do this. |
| **Sourcing materials and products as close as possible to site** | Reduce carbon emissions from transportation. |
| **Increased use of low carbon materials** | Use appropriate data and tools in the design process to highlight the benefits of low carbon alternatives to traditional materials and products, e.g. biobased or recycled/reused products. |

# 4. Current Status

The Building and Construction Sector in New Zealand currently has a relatively immature understanding of the embodied carbon impacts of its activities, and there is no regulation or incentives requiring it to be considered. This is not unexpected or very different to the situation in other countries around the world. To date, the focus on reducing the environmental impact of buildings has been only to increase their operational efficiency.

However, there is a growing interest in reducing embodied emissions of buildings, both in New Zealand and around the world. This has been driven by an increasing scrutiny on carbon emissions from building materials and products, not just the operation of buildings, and the realisation that when buildings are operated more efficiently, the relative significance of embodied emissions from buildings increases (see figure 4).

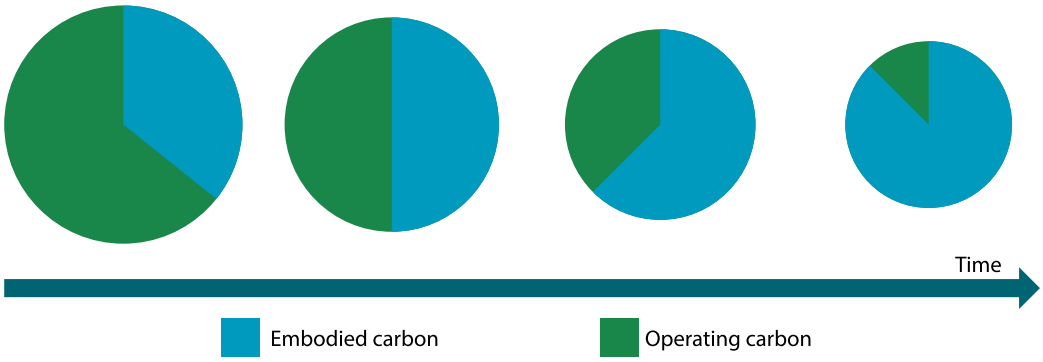


***Figure 4: As building operational emissions decrease over time, embodied emissions make up a greater proportion of emissions over the whole life of a building.***

# 5. Vision

By 2050, carbon emissions in New Zealand associated with construction products and materials are significantly less than they are today. This has been achieved by efficient design of new buildings and using our existing buildings more effectively, being efficient with the construction products and materials we use in new buildings, and reducing the carbon associated with those products and materials.

The Building and Construction Sector can confidently account for and quantify its climate change impacts: including emissions associated with the construction products and materials that occur at all life cycle stages of a building.

All stakeholders in the Sector will have a good understanding of the total embodied emissions of a building at all stages of its life cycle, and be able to measure and mitigate the emissions associated with the design, construction, operation and deconstruction of buildings.

Consequently, consideration of embodied carbon is a standard part of every new building design process, and decision making at all stages of a building's life cycle, including maintenance/ refurbishment and demolition, as well as initial design and construction.

As a result, carbon emissions from the building and construction sector will have been significantly reduced compared with 2020 levels, and have contributed to New Zealand achieving net zero carbon emissions.

# 6. Approach

To achieve the vision set out above, whole-of-life embodied carbon considerations will become mandatory for buildings in New Zealand, in order to deliver the carbon emissions reductions we need to achieve.

This framework proposes that:

- Initially, whole-of-life embodied carbon of buildings will only be required to be reported (in kg $CO_2$-e/$m^2$ of building) as part of the building consent process,
- Subsequently, buildings will also be required to meet a mandatory cap on their whole-of-life embodied carbon in order to obtain a building consent,
- The cap will be tightened in a series of steps over time according to a transparent schedule to deliver the increasing reductions in emissions required by the National Emissions Reduction Plan,
- The cap levels will be set considering best practice and in consultation with the Sector to ensure they are ambitions but achievable, and will be reviewed at each step,
- The scope of the framework (outlined in the next section) will be reviewed and expanded over time as the Sector becomes more familiar with the concepts of calculating embodied carbon emissions,
- Data on the embodied carbon from buildings, collected from the reporting stages, is stored in a repository and made publicly available, in the interests of sharing information in a transparent and open way, for the benefit of the collective knowledge of the Sector,
- Public sector agencies with property portfolios provide an opportunity for Government to take the lead in establishing the methods and processes to make the big changes that will be required, one step ahead of private sector buildings,
- Pilot projects with public sector clients working with Building Consent Authorities will demonstrate how whole-of-life embodied carbon for a building will be calculated, reported, managed and reduced.

Setting a cap for whole-of-life embodied carbon will allow the Sector to adopt best practice using the materials and methods available to make informed decisions and encourage sector innovation.

By avoiding constraints in specific areas, including requirements for particular products or processes, we will allow the Sector to identify the most efficient way to reduce whole-of-life embodied carbon emissions when considering cost and other implications.

Reporting will give the Sector suitable time to get the level of skills and understanding required in place for when the first cap will come into force. Reporting will also allow the cap to be set at levels that are achievable but necessary to meet our overall emissions reductions targets.

The proposed steps for how this will occur are shown below. The timeline for these changes will be developed in consultation with the sector.

| Step 1 | Step 2 | Step 3 | Step 4 | Step 5 |
|---|---|---|---|---|
| New public sector buildings to report Whole Life Embodied Carbon. | All new buildings to report Whole Life Embodied Carbon. | All new buildings to meet Whole Life Embodied Carbon initial caps. | All new buildings to meet Whole Life Embodied Carbon intermediate caps. | All new buildings to meet Whole Life Embodied Carbon caps that achieve net zero emissions for New Zealand. |
| New public sector buildings to report Whole Life Embodied Carbon. | New public sector buildings to meet Whole Life embodied carbon initial caps. | New public sector buildings to meet Whole Life embodied carbon intermediate caps. | | |

**Scope of the whole-of-life embodied carbon framework increases over time**

To support the Sector to make the changes that are needed to achieve the reductions in whole-of-life embodied carbon emissions required under this framework, we will be making changes to the building regulatory system. These will be developed with the Sector and will include the creation of incentives as well as the removal of barriers to practices that align with the objectives of this framework.

In addition we will work with New Zealand educational institutions and professional bodies to develop the knowledge, skills and tools within the Sector to enable the delivery of the reductions in whole-of-life embodied carbon required under this framework.

The details of how the framework will be implemented will be developed with input from the Sector. Initial proposals covering some of the aspects of this are outlined below:

## 6.1 Methodology

A methodology for building designers to calculate whole-of-life embodied carbon will be developed to ensure fair comparisons can be made between the data reported on different buildings. This will cover:

- recommended sources of embodied carbon data, appropriate for the New Zealand context,
- methods for determining how to report material quantities,
- assumptions and exclusions,
- how to manage issues such as rates of material waste, biogenic carbon content of natural materials, emissions from transport and construction processes.

The methodology will be developed over time as the scope of the framework expands.

## 6.2 Data Quality

Data sources for the material quantities and the embodied carbon coefficients will be reported, in order to ensure the results can be compared fairly across different buildings. Currently there are gaps in the data available for whole-of-life embodied carbon for construction materials and products in New Zealand.

Guidelines will be provided on how to source the data required to make reporting easier. Initially, generic as well as product-specific embodied carbon data would be accepted for some materials.

When the first caps on whole-of-life embodied carbon come into force, rules on the data quality will be in place to allow enforcement of the regulations in a fair environment. This will be more feasible when the Sector is more familiar with the reporting process, and there will be better quality data available, as suppliers will have been incentivised to develop information on their materials and products.

## 6.3 Use of software/tools

Tools and software packages for calculating the embodied carbon of buildings are currently available and are becoming more common. These range from simple calculation templates, many associated with databases of embodied carbon data for construction materials and products, through to software packages that take quantity data from digital models of buildings and automate embodied carbon calculations for a variety of methodological options, such as inclusion of different life cycle stages.

There are tools available that are specific to the New Zealand context, as well as some developed overseas that can be applied here.

This framework proposes that the embodied carbon calculations can be carried out using the tools that are most appropriate for each building, providing the data is presented in a simple way that allows comparison between buildings, and the methodology. Assumptions and data sources that have been used will need to be stated clearly, in an open and transparent way. A building's area, quantity of key materials used and the carbon intensity of those materials will be the primary figures reported, in line with the objectives of this framework.

As a baseline, we will develop a simplified calculation tool that can be used for small buildings that are likely to use standard forms of construction.

## 6.4 Compliance Process

The framework proposes the reporting and ultimately capping of whole-of-life embodied carbon for buildings is carried out as part of the building consent process. To ensure compliance, Building Consent Authorities will be required to process the information provided with the building consent application, and have ways to ensure it is fit for purpose and of an acceptable quality standard. A basic reporting format will be used to make this process as simple as possible, and having the data publicly available will allow auditing of the data to ensure the reporting is adequately representative of the buildings.

When caps on embodied carbon are introduced, Building Consent Authorities will need to have the confidence that the data provided is sufficiently robust in demonstrating the whole-of-life embodied carbon is below the cap, in order to award the consent.

# 7. Scope

There are many complex issues associated with whole-of-life embodied carbon calculation and assessment. To make the transition to mandatory consideration of embodied carbon as easy as possible we are proposing to limit the scope of framework initially, targeting the areas where changes would have the greatest reduction in emissions for the effort required. Over time the scope of the framework will increase.

The effort required, potential for emission reductions, and a proposed delivery mechanism for each scope level of four key areas (life cycle stages, building components, building projects and building classification) are detailed in the sections below. In some cases we're proposing that the framework will initially only cover some of the scope levels, (as indicated). Over time these will extend to the higher scope levels that although are more complex in nature, will nevertheless deliver further emissions reductions.

## 7.1 Life cycle stages

Assessing the embodied carbon of a building becomes more complex when you include more stages of the building life cycle in the scope.

| | Scope Level | Resource/effort | Potential for reductions | Delivery Mechanism |
|---|---|---|---|---|
| Included in initial scope | **Production stage only (Modules A1-A3, 'cradle to gate')** | **Medium:<br>(relatively) simple to implement carbon reporting for construction projects, using existing data from EPDs.** | **High:<br>captures the bulk of emissions from structural elements.** | **Material data for embodied carbon and quantities reported in building consent application.<br><br>Education, training and guidance to be provided.** |
| | **Production and construction stages (Modules A1-A5, 'cradle to practical completion')<br><br>(May also include some maintenance impacts during operation phase, Modules B1-5)** | **Medium:<br>some additional complexity from transport and construction emissions.** | **Additional gains: low/medium.<br>Transportation emissions could be significant for imported materials and will capture construction waste.** | **In addition to above, this will require additional activity data covering transport and construction processes, ideally NZ specific to be meaningful.** |
| Excluded from initial scope | Everything up to the end-of-life: Production, construction, maintenance, demolition and waste stages ('cradle to grave', Modules A1-A5, B1-B5 and C1-C4) | Medium/High:<br>data are provided by some EPDs already, but requires estimates for what happens at end-of-life, potentially 50 years' time (scenario planning). | Additional gains: High.<br>Important for fair comparison of timber products that end-of-life impacts are considered. Will encourage recycling considerations at design stage. | In addition to above, this will require ability to evaluate end-of-life scenarios. |
| | Everything up to the end-of-life, including benefits of reuse in future buildings, to reduce their impact ('cradle to cradle', Modules A1-A5, B1-B5, C1-C4 and D) | High:<br>More circular economy thinking, adds complexities but will incentivise waste reduction and other related initiatives. | Additional gains: High.<br>Will incentivise design of reuse thinking. | In addition to above, this will require consideration of deconstruction/reuse/recycling of building components. |

Calculating and reporting of whole-of-life embodied carbon at consent stage will mean that material data (quantities and embodied carbon factors) will be taken from design information, rather than as-built data. We will consider if further requirements are needed for updated data at practical completion stage, as a condition of receiving a Code Compliance Certificate. Doing so would ensure the information reflects the actual material embodied carbon and quantities used, including construction waste, and transport and construction processes are captured accurately.

## 7.2 Building Components

The purpose of limiting the components of a building that are to be included in this framework is to capture the products and materials that are most significant in terms of their carbon emissions, and exclude the many components with lower emissions that would be onerous to report.

| | Scope Level | Resource/effort | Potential for reductions | Delivery Mechanism |
|---|---|---|---|---|
| Included in initial scope | **Structural elements (frame, floors, foundations)** | **Low:**<br>**details of structural elements already closely examined at consent stage to demonstrate compliance.** | **High:**<br>**bulk of emissions for most buildings.** | **Simple report declaring structural material quantities and carbon data including references to their sources.** |
| | **As above + envelope (roof, cladding, windows)** | **Medium:**<br>**would require examination of additional components.** | **High:**<br>**would capture significant emissions from housing and large buildings with complex facades.** | **As above, with additional reporting to cover more components.** |
| Excluded from initial scope | As above + internal fittings (finishes, building services, fixed furniture | High:<br>as-built and consented products may vary, these elements have a shorter design life than the building, so replaced often, not considered under the Building Act. | Low:<br>but would be significant in fit-out/ refurbishment projects. | Fit-out/refurbishment projects could be captured under change of use consents/exemptions process. |

Some suppliers of building materials and products already provide the Sector with information on the embodied carbon of their products, generally through commissioning a Life Cycle Assessment study to produce an Environmental Product Declaration (EPD). These can be used to calculate the whole-of-life embodied carbon under this framework where appropriate, i.e. if the EPD is prepared according to an accredited methodology, such as is set out in EN 15804, and applicable to the New Zealand context.

Although the quantity of EPDs has increased in recent years, gaps remain in the availability of data for construction materials and products, so they may not cover all the building components included in the scope of this framework. However, suppliers will be incentivised by this framework to publish EPDs, and demonstrate they are reducing the embodied emissions from their products.

## 7.3 Building Projects

This framework proposes to cover the assessment of whole-of-life embodied carbon for new buildings only, but there is potential for expanding to construction activities carried out to buildings at other life cycle stages.

| | Scope Level | Resource/effort | Potential for reductions | Delivery Mechanism |
|---|---|---|---|---|
| **Included in initial scope** | **New Build** | **Low:**<br>**reporting and requirement to meet caps would fit within consenting process for new buildings.** | **High:**<br>**captures the bulk of life cycle emissions.** | **Compliance with the requirement for embodied carbon to be demonstrated at consent stage.** |
| **Excluded from initial scope** | Refurbishment/fit-out | Medium:<br>not necessarily captured by consenting process. | Additional gains:<br>potentially high for commercial building fit-outs, and if the benefits of using existing buildings encouraged more refurbishment. | Compliance with the requirement for embodied carbon to be demonstrated at change of use/exemptions stage. |
| | Demolition | High:<br>currently little regulation for this. | Additional gains: potentially very high if demolitions had to be justified, and reuse/recycling of materials was required. | New consenting process required for demolition of buildings. |

To meet the new building efficiency objective of this framework, the embodied carbon assessment of refurbishment and fit-out projects is required to ensure existing buildings are being used effectively and valued appropriately, in the context of being an alternative to new buildings. This scope area of the framework will be expanded concurrently with the building components scope area, so that internal finishes and fittings, likely to be a significant factor in the embodied carbon of refurbishment projects, are adequately captured.

## 7.4 Building Type Classifications

The proposal is for the framework to apply to all building types. Requirements would apply to public sector buildings as a first step, before being applied to all buildings.

| | Scope Level | Resource/effort | Potential for reductions | Delivery Mechanism |
|---|---|---|---|---|
| Included in initial scope | **Housing, including communal residential** | **Low:**<br>**New builds for stand-alone and high density housing to be captured during consent process.** | **Medium:**<br>**many projects with low emissions reduction potential for each, would add up to significant total, with opportunities to develop good benchmarks.** | **Simplified tool made available for standard construction types used in small buildings.** |
| | **All other building types, including communal non-residential, commercial and industrial** | **Low:**<br>**Would be putting requirements on most design teams, so potentially lower education and training hurdles.** | **Medium:**<br>**fewer individual buildings in a given year, but with greater potential for emissions reductions in each.** | **Additional work for consent expected to be minor, especially for large commercial projects.** |

The framework proposes two categories of buildings:

- **small buildings** that are less than 3 storeys and 300m² gross external floor area,
- **large buildings** that are greater than 3 storeys or 300m² gross external floor area.

Small buildings will have the opportunity to use a simplified calculation tool, which will use some default material quantity and embodied carbon data where appropriate. This will reduce the effort involved in reporting for these buildings which are likely to have standard forms of construction and where owners are less likely to be able to access the resource or expertise necessary for full calculations.

For large buildings, the design team is likely to have access to more resources in this area, and so will be required to use project specific, rather than default information. They can chose to use more sophisticated tools and analysis that highlight opportunities to reduce embodied carbon, even engaging the services of Life Cycle Analysis practitioners to make detailed assessments of buildings. The way the embodied carbon data is reported will be the same across all buildings, so that the collective knowledge of the Sector on how reductions can be achieved will grow.

The proposed threshold for small and large buildings will be explored and tested with the Sector.

# 8. Glossary

In the context of this report, these terms have the following meaning:

**Carbon Dioxide equivalent (or $CO_2$-e):** a measure of the global warming caused by all greenhouse gases released by a specific activity. In addition to Carbon Dioxide ($CO_2$), it includes the impacts of other greenhouse gases, which are typically less significant than the impact of $CO_2$, but are included for completeness.

**Carbon emissions:** a shorthand term for emissions of all greenhouse gases, $CO_2$ and others, which cause global warming.

**Carbon footprint:** a measure of the carbon emissions derived from a Life Cycle Assessment (LCA) study, reported in the impact category of climate change or Global Warming Potential (GWP), measured in $CO_2$-e.

**Embodied carbon:** a shorthand term for whole-of-life embodied carbon. For construction materials or products, this is the amount of carbon emissions released throughout their supply chains, including raw material extraction and transportation, manufacturing process, construction site activities and material losses, repair, maintenance and replacement, as well as the end of life processing. For a building, the embodied carbon is the sum of the embodied carbon of all the constituent materials or products within the building.

**Environmental Product Declaration (EPD):** this is a third-party verified report of Life Cycle Assessment (LCA) results for a construction material product or material. It uses ISO and often also EN standards. It documents the actual environmental performance of the product or material across a number of impact categories, including embodied carbon, usually reported under 'Global Warming Potential' (GWP) in units of kg $CO_2$-e.

**Greenhouse gases:** gases that trap heat in the earth's atmosphere, contributing to global warming. The most prevalent ones are Carbon Dioxide ($CO_2$), Methane ($CH_4$), Nitrous Oxide ($N_2O$), and fluorinated gases (such as CFCs, HCFCs, HFCs etc. found in refrigerants). Of these, $CO_2$ causes the largest warming impact.

**Life Cycle Assessment (LCA):** a method of assessing the environmental impacts associated with all stages of a product's life, from raw material extraction to its processing, manufacture, distribution, use, repair, maintenance, and end of life treatment.

**Operational carbon:** carbon emissions attributable to the operation of buildings. See the Transforming Operational Efficiency framework.

# 9. Questions for consideration

Below are some question we would like you to keep in mind when reading this framework and considering your feedback. Your thoughts on these questions will really help us shape the ongoing Building for Climate Change work in a way that is meaningful to you and to others in the Sector.

There is a short survey covering the questions below as well as some extra questions on the MBIE Building for Climate Change website **www.mbie.govt.nz/building-and-energy/building/building-for-climate-change**. You are also welcome to provide feedback directly to the programme team (**bfcc@mbie.govt.nz**).

| Content | Questions |
|---|---|
| **Overarching BfCC approach** | What support do you think you or your business would need to deliver the changes proposed in the frameworks?<br><br>What barriers are currently preventing (or discouraging) you, or your business, taking action to reduce emissions?<br><br>What building classifications should be included in the Building for Climate Change work programme? |
| **1 (Sections 1 and 2)** | Should the Building for Climate Change work programme include initiatives to reduce whole-of-life embodied carbon in New Zealand buildings? |
| **2 (section 3.2)** | To meet our carbon emission reduction goals, a key objective of the framework is to increase building material efficiency, and reduce construction waste.<br><br>What measures, if any, do you think should be put in place to increase building material efficiency?<br><br>What measures, if any, do you think should be put in place to reduce construction waste? |
| **3 (section 3.3)** | Using low carbon construction materials and products is identified as another option to reduce whole-of-life embodied carbon emissions. How could we encourage the use of low carbon construction materials? |
| **4 (section 6)** | The Framework proposes introducing reporting requirements for whole-of-life embodied carbon in buildings, followed by a cap on whole-of-life embodied carbon for new building projects.<br><br>Would you support a cap on whole-of-life embodied carbon for new building projects?<br><br>Do you think a data repository of embodied carbon from buildings should be established?<br><br>If a data repository was established, do you think this information should be able to be accessed by the public? |
| **5 (section 6.1-6.3)** | What would make it difficult for people to report the whole-of-life embodied carbon of new buildings, and why?<br><br>What support is needed to make reporting embodied carbon a standard part of the design and construction process for every new building project in New Zealand? |
| **7 (section 7.1)** | Do you think that requirements for embodied carbon calculations should only include the initial building life cycle stages (product and construction stage)? |

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| **8 (section 7.2)** | The Framework proposes limiting the scope of building components that would be included in an embodied carbon assessment, excluding components with lower emissions (such as internal fittings).<br><br>Do you agree with this proposal?<br><br>Do you agree that the structural elements and building envelope should be in the scope of building components for calculating embodied carbon of a building? |
| **9 (section 7.3)** | Do you agree that the reporting and ultimately capping embodied carbon should apply to new building projects only, not refurbishment or demolition projects? |
| **10 (section 7.4)** | The Framework proposes that a simplified embodied carbon calculation tool could be used for small buildings but more detailed calculations would be required for large buildings. Do you agree with this proposal? |