Guide to calculating a base case carbon footprint for land transport infrastructure projects

June 2024

Version 2

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NZ TRANSPORT AGENCY
WAKA KOTAHI

Te Kāwanatanga o Aotearoa
New Zealand Government

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More information

NZ Transport Agency Waka Kotahi
June 2024

Version 2

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This document is available on NZTA's website at www.nzta.govt.nz

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1 Introduction and background

1.1 Background

NZ Transport Agency Waka Kotahi (NZTA) has an Environmental and Social Responsibility Policy[1] (ESR policy) that includes a commitment to reduce emissions and mitigate the effects of land transport on the environment and public health. To implement this policy we seek to use resources sustainably and efficiently, reduce waste and transition to low-carbon infrastructure and services that support a circular economy. Our policy commitment to reduce greenhouse gas emissions is further reiterated in the Climate Change Policy for Land Transport Infrastructure Activities.[2]

Toitū Te Taiao, Our Sustainability Action Plan,[3] was released in April 2020. As part of Toitū Te Taiao, we developed a Te Hiringa o Te Taiao – Our Resource Efficiency and Waste Minimisation Strategy[4] and an accompanying Resource Efficiency Policy. The strategy and policy identify the following focus areas for improving resource efficiency when delivering infrastructure:

1. sustainable sourcing and use of resources
2. waste minimisation
3. reduced energy and greenhouse gas (GHG) emissions.

To assist with meeting the requirements of Toitū Te Taiao and the Resource Efficiency Policy this document provides guidance for how NZTA projects should develop a base case carbon footprint (base case). A base case is an inventory of embodied and operational carbon from materials and energy-related GHG emissions (refer to section 2.1 for a full definition). It provides a baseline against which emission reductions achieved during design and/or construction can be calculated. A base case allows projects to report against carbon reduction targets in accordance with the Resource Efficiency Policy. This information will also contribute to Carbon Neutral Government Programme (CNGP) emission reduction planning across NZTA.

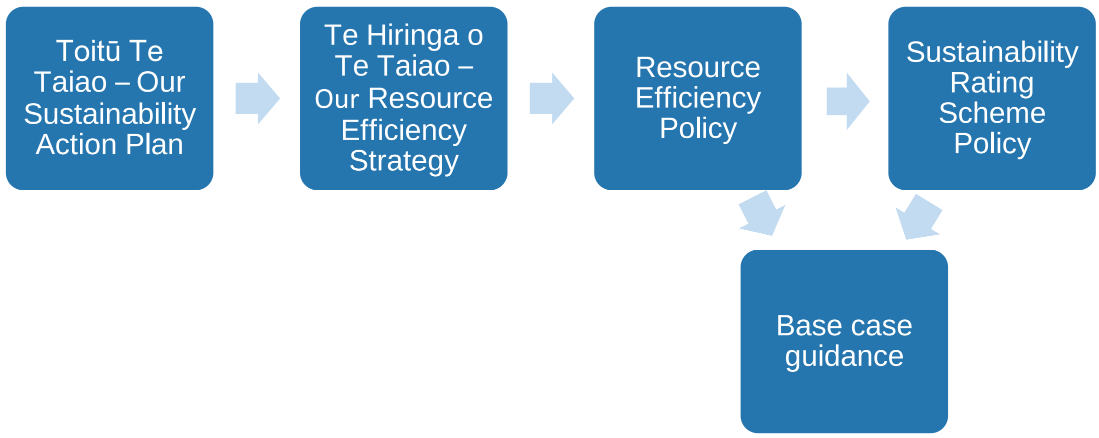

Figure 1: Policy and strategy drivers for the NZTA base case guidance

[1] Environment and Social Responsibility Policy
[2] Climate Change Policy for Land Transport Infrastructure Activities
[3] Toitū Te Taiao – Our Sustainability Action Plan
[4] Te Hiringa o Te Taiao -– Our Resource Efficiency Strategy

1.2 Purpose of this guide

The purpose of this guide is to:

- provide a nationally consistent approach for projects on how to meet the base case reporting requirements for the Resource Efficiency Policy for Infrastructure Delivery and Maintenance
- support projects calculating base cases required for an Infrastructure Sustainability (IS) rating
- support projects to understand the impacts of design and construction decisions on GHG emissions
- assist projects to identify carbon hotspots for GHG emissions reduction.

This guide is intended for use by:

- consultants, contractors, project managers and stakeholders who participate in the planning, design, construction, and maintenance of our transport networks
- NZTA staff whose work and actions impact the design, construction, and maintenance of transport networks.

1.3 Context

A range of policies and specifications inform this base case guidance. In some cases, there may be overlap with the NZTA Sustainability Rating Scheme Policy and/or the Resource Efficiency Policy for Infrastructure Delivery and Maintenance, and their accompanying specification requirements. These documents are intended to complement each other, not compete.

1.3.1 Resource Efficiency Policy for Infrastructure Delivery and Maintenance

The Resource Efficiency Policy for Infrastructure Delivery and Maintenance[5] and associated *Resource efficiency guideline for infrastructure delivery and maintenance*[6] require projects to consider resource efficiency across a project lifecycle. In the context of the policy, 'resource efficiency' relates to:

- reduced energy consumption (which will also reduce GHG emissions)
- increased uptake of recycled, re-used and alternative materials
- reduced use of virgin and high carbon intensity materials
- reduced waste
- reduced water consumption.

The *Resource efficiency guideline* contains requirements for calculating a base case and setting resource efficiency GHG emission reduction targets. Setting targets is mandatory for tier 1[7] projects only, however tier 2 and 3 projects can consider setting targets, as it will improve visibility of resource efficiency outcomes. Tier 1 projects are required to submit a detailed carbon estimate (covering 90% of the total project footprint) and tier 2 projects are required to complete a basic carbon estimate (covering 70–80% of the total project footprint). Section 2.5 of this guide outlines the guiding principles to ensure consistency amongst base cases.

1.3.2 Sustainability Rating Scheme Policy

The Sustainability Rating Scheme Policy[8] outlines the requirements for NZTA projects to gain an IS Rating certification. It requires projects over $15 million in capital value to consider the merits of ISC, and all projects over $100 million to complete an ISC certification for Design and As-Built.

To achieve an IS rating for the energy, materials, and water credits, a base case must be prepared that is used consistently for all three credits. This guidance relates to materials and energy; however, the same principles can be used to calculate a water base case.

This guidance supports the Sustainability Rating Scheme Policy and its accompanying specifications. Projects undertaking an IS Rating should use this guidance as part of developing their base case, however

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[5] Resource Efficiency Policy for Infrastructure Delivery and Maintenance

[6] *Resource efficiency guideline for infrastructure delivery and maintenance*

[7] As defined in the *Resource efficiency guideline*, a tier 1 project is classified as over $15 million in capital value and a duration of more than 12 months (this includes alliance delivery models); a tier 2 project is classified as $2–15 million in capital value or more than $15 million and less than 12 months in duration; and a tier 3 project is classed as <$2 million in capital value (excluding property acquisition).

[8] Sustainability Rating Scheme Policy

they must also ensure they fulfil all requirements of the IS Rating Scheme. A set of business-as-usual (BAU) assumptions[9] underpin this base case guidance, outlining the approaches and technologies which are considered to be BAU on New Zealand projects for the purpose of calculating carbon reductions. This allows the comparison of the alternative construction materials and methods the project has chosen, against BAU, to demonstrate the reduced impact of these alternatives. Over time, BAU will change.

1.4 Scope

For the purpose of this guidance, a base case relates to materials and energy-related GHG emissions.

This guidance is suitable for projects calculating a base case and seeking to demonstrate performance against resource efficiency and GHG emission reduction targets. The scope excludes maintenance contracts and emergency works[10] (refer to section 2.5 for further details on the scope of base cases).

1.5 Structure of this guide

This document provides guidance in the following sections, intended to assist project teams developing a base case:

- Section 1 – Introduction and background
- Section 2 – What are base cases?
- Section 3 – How to calculate a base case.
- Appendix A – Case studies that illustrate scenarios that may occur on projects needing to create a base case carbon footprint.

[9] A spreadsheet containing information on the latest set of BAU assumptions is available on request from environment@nzta.govt.nz

[10] Emergency works are those that require an immediate response for public safety or to provide vital access, and reinstatement of customer levels of transport service.

2 What are base cases?

2.1 Base case

A base case, for the purposes of this document, is an inventory of embodied carbon from materials (such as asphalt and concrete) and energy-related GHG emissions, that has been derived from an early design, for example a reference, tender or consent design, that is based on BAU practices. A base case provides a baseline against which emission reductions achieved during the design and/or construction process can be calculated.

To inform the development of the base case, NZTA has developed a set of BAU assumptions for the purposes of calculating emissions reductions. [11] The assumptions comprise current standard practices, materials and technologies used within the New Zealand transport sector. NZTA will review the BAU assumptions at least annually, or when changes in standard practices occur. The use of consistent BAU assumptions across all NZTA project base cases allows an equivalent, transparent, and repeatable quantification of 'savings' to be made.

Note: the underlying assumptions of these BAU assumptions may need to be updated if there are specific project constraints – further guidance should be sought from NZTA subject matter experts should this be the case.

Section 2.5 outlines the scope of GHG emissions (generally expressed as tonnes of carbon dioxide equivalent (tCO_{2e})) included in a base case. The base case relates to the embodied, construction and operational[12] emissions associated with a project; it excludes the emissions from vehicle use of the infrastructure[13]. The base case will allow the identification of components and activities that have the largest carbon footprint – the carbon 'hotspots'. These carbon hotspots can be used to direct the project team's carbon reduction efforts.

2.2 Actual case

For the design phase, an actual case is the issued for construction (IFC) design. For the construction phase, the actual case is the 'as built design' at the end of construction. The actual case must reflect the carbon reductions and/or resource efficiency initiatives implemented. It should illustrate and justify any reductions in GHG emissions in accordance with the resource efficiency and rating scheme policies.

2.3 PAS2080:2023 – Carbon management in buildings and infrastructure

PAS2080:2023[14] is an international standard that provides a systematic way for managing whole-of-life carbon in infrastructure delivery. It establishes a collective understanding and approach for managing whole of life carbon within the infrastructure sector. It has an aim to reduce carbon through improved planning, design, construction, and use of assets (refer to Figure 2).

[11] A spreadsheet containing information on the latest set of BAU assumptions is available on request from environment@nzta.govt.nz

[12] Operational emissions are the GHG emissions associated with the operation of the infrastructure, for example energy used for street lights.

[13] IS technical manual version 2.1 currently excludes energy related to user carbon.

[14] Revised PAS 2080:2023

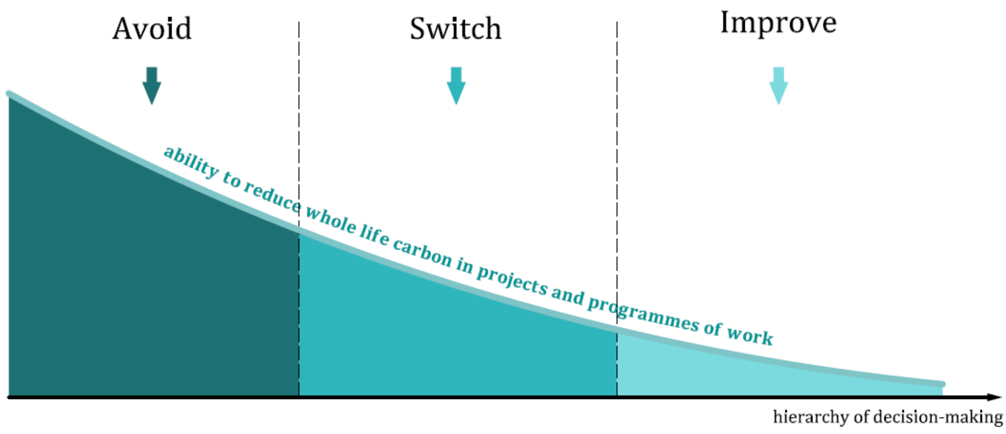

Figure 2: PAS2080:2023 – carbon hierarchy (source: PAS2080:2023)

PAS2080:2023 contains useful guidance for quantifying base cases and it has informed the development of this guidance.

PAS2080:2023 encourages setting a base case at an early stage, even if there is limited data available at the initial work stages. It highlights the assumptions required to complete the calculations (refer to section 2.3 for further details on the timing of calculating a base case).

Figure 3 illustrates work stages of infrastructure delivery and where the quantification of GHG emissions can occur. There is less accuracy of assessment during the early design stages, but these stages have the largest ability to influence whole of life carbon reductions.

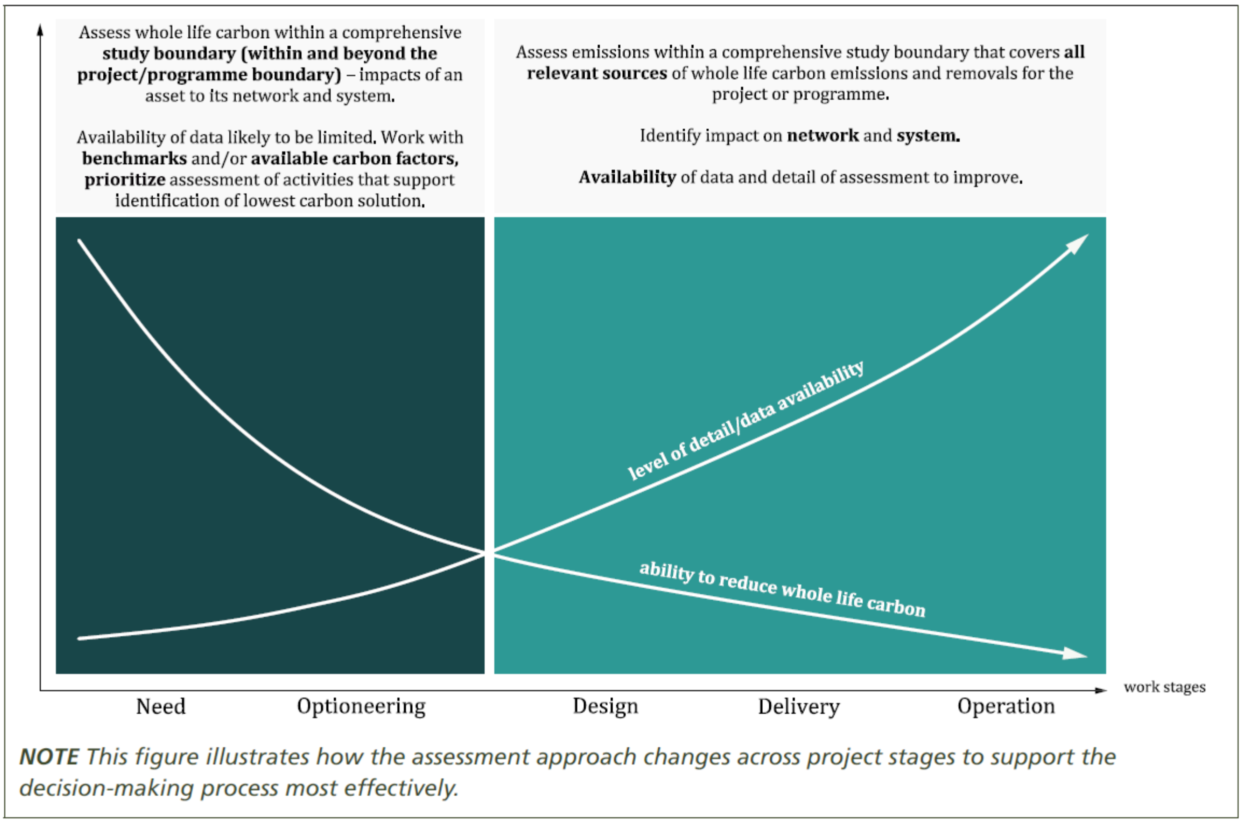

Figure 3: PAS2080:2023 – degree of accuracy and data availability in whole life carbon assessments across work stages (source: PAS2080:2023)

2.4 Emission factors

An emission factor represents the quantity of GHG emissions (CO_{2e}) released to the atmosphere during an activity that produces emissions. Emission factors can be referred to as 'global warming potentials' (GWPs), particularly in environmental product declarations (EPDs).

Emission factors need to be obtained from appropriate sources. Tools available for selecting emission factors include the Project Emissions Estimation Tool (PEET), the Life Cycle Assessment of Pavements Tool

(LCAP) and the IS Materials Calculator (required for all IS projects); these are described further in section 3.1. Emission factors should only be sourced from EPDs where the exact product and supplier has been confirmed.

When using emission factors from other sources, such as EPDs or industry reports, it is important to consider the following factors:[15]

- the geographic context of the source data – emission factors should be relevant to the New Zealand context, particularly when manufacturing processes use grid electricity
- the applicable time-period and age of the reported emission factor – datasets should be based on background data no older than 10 years
- the scope of the study and what lifecycle modules are applicable
- whether the global warming potential values are based on the Intergovernmental Panel on Climate Change (IPCC) sixth assessment (AR6) – we recommend using the latest IPCC report (AR6), however, this may not be possible in all cases, and project teams should consider this when reviewing an emission factor.

Any emission factors used under this guidance should exclude biogenic carbon emissions.[16] Project teams should only use carbon emissions from fossil fuel-derived sources, to avoid accounting for sequestered carbon in natural products (such as timber beams) that is destined to be reemitted at the product's end of life. In EPDs, and similar documentation, emission factors that exclude biogenic carbon are labelled 'global warming potential – fossil (GWP_{fossil})'.

2.5 Carbon base case scope

The base case methodology within this guidance is directed by PAS2080 and a life cycle assessment (LCA) approach to assess embodied carbon, illustrated in Figure 4. The embodied carbon is the sum of the GHG emissions[17] that occur at each stage of its life cycle. Emissions are measured in units of kilograms or tonnes of CO_{2e}.[18] For this guidance, emissions should be reported as CO_{2e}.

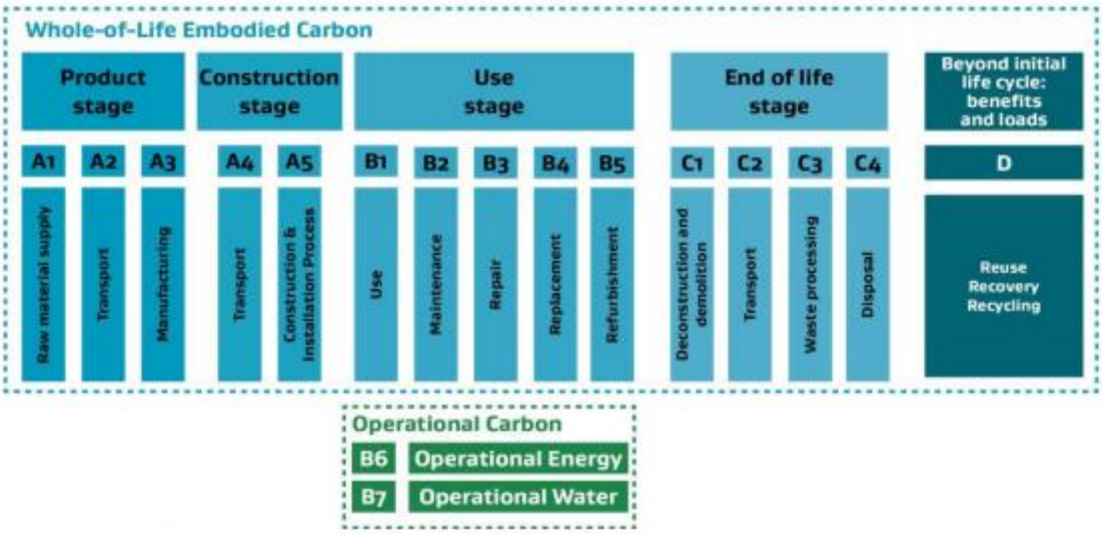

Figure 4: The module framework set out in international standard (EN15804) for life cycle assessment

To calculate a base case for an NZTA project, the *Resource efficiency guideline* provides a range of guiding principles to ensure consistency amongst the base cases:

[15] Measuring emissions: a guide for organisations

[16] Biogenic carbon refers to emissions that are removed by or emitted from biomass as part of the biogenic carbon cycle. The approach of excluding biogenic emissions from emission factors is consistent with EN 15804+A2 and other carbon footprint methods.

[17] Including CO_2, methane and other gases that have a warming effect.

[18] The equivalent quantity of CO_2 that has the same warming effect as that amount of GHG emissions over a 100-year period.

- The design life of the asset and key structures/pavements needs to be clearly defined. A whole-of-life approach should be taken when evaluating the design life of an asset, including end-of-life replacement, decommissioning and deconstructing.
- The project boundary should be clearly stated as it relates to the quantities being provided (for example, clarity on the scope of the project, including any scope changes, and what is and is not included).
- Material quantity estimates should be taken from the design for permanent works and not include temporary works (A1 to A3 of the lifecycle module framework). A materiality threshold must be applied, such that the sum of all emissions excluded should not exceed 5% of the total carbon footprint[19] (refer to sections 3.1 and 3.2 for further information on the materials available within the tools and the categorisation of materials).
- Operational phase material replacement, electricity/energy and use of fixed assets should be estimated for useful forecast life of asset (B2 and B6 of the lifecycle module framework).
- Construction fuel and electricity use should be estimated where data is not available during early design phases (A5 of the lifecycle module framework).
- The emissions associated with the transport of materials to site[20] (A4 of the lifecycle module framework).

The lifecycle modules that are excluded from this guidance include B1, B3–B5, C1–C4, D and B7.

2.6 Base case timing

A project has the ability to create a base case during different project stages. This guidance focuses on two different approaches:

1. creation of a base case early in the design phase, and
2. back-casting from 100% detailed or issued for construction (IFC) design.

Each approach has opportunities and challenges, which will be explored in the following sections. Refer to Figure 7 to understand which base case approach is appropriate for each project.

2.6.1 Early base case

A base case can be created early within the design phase, using a reference, consent, or tender design (or similar design level based on a project's procurement model). Creating a base case early in the design phase provides the following opportunities:

- providing an understanding of project's carbon footprint early in the design phase
- allowing early identification of carbon hotspots
- allowing the calculation and tracking of carbon reductions against the base case as the design progresses.

However, creating a base case early in the design phase can present various challenges, including:

- Limited data availability can require early estimates and a range of assumptions to be made. This may result in a base case which is too high, meaning carbon reductions are over-estimated.
- Materials quantities may be challenging to capture if pricing has been based on rates.
- When a less accurate base case is created which has significant gaps, focus on carbon reduction may not be aimed at the right 'hotspots'.
- It is important to record scope creep or change of scope in the base case as the project progresses. For example, if an additional lane is added to the project scope, it should also be added to the base case. Conversely, if a lane is removed from the project scope, it must also be removed from the base case, to reflect the actual scope.

There is an opportunity to update the early base case as the project progresses and more data becomes available. However, if the project has had significant scope changes, it may be more appropriate to follow the back casting approach.

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[19] The recommended tools described in section 3.1 consider the most significant emission sources in a project life cycle. Materials that contribute less than 5% to the total carbon footprint will vary depending on project scope, however, they may include signage, fencing, lighting, traffic signals and road marking.

[20] Within the *Resource efficiency guideline*, this is only required for tier 1 projects.

2.6.2 Back casting

A back casting approach (also known as a reverse-calculated base case) allows projects to utilise their actual case from design as a starting point. Projects should use their final material and quantities from 100% detailed or issued for construction (IFC) design and add on the quantified material savings associated with any sustainability initiatives implemented during the design to determine the base case (refer to Figure 5). This enables projects to use a more accurate starting point from which they can calculate and quantify resource savings associated with sustainability initiatives.

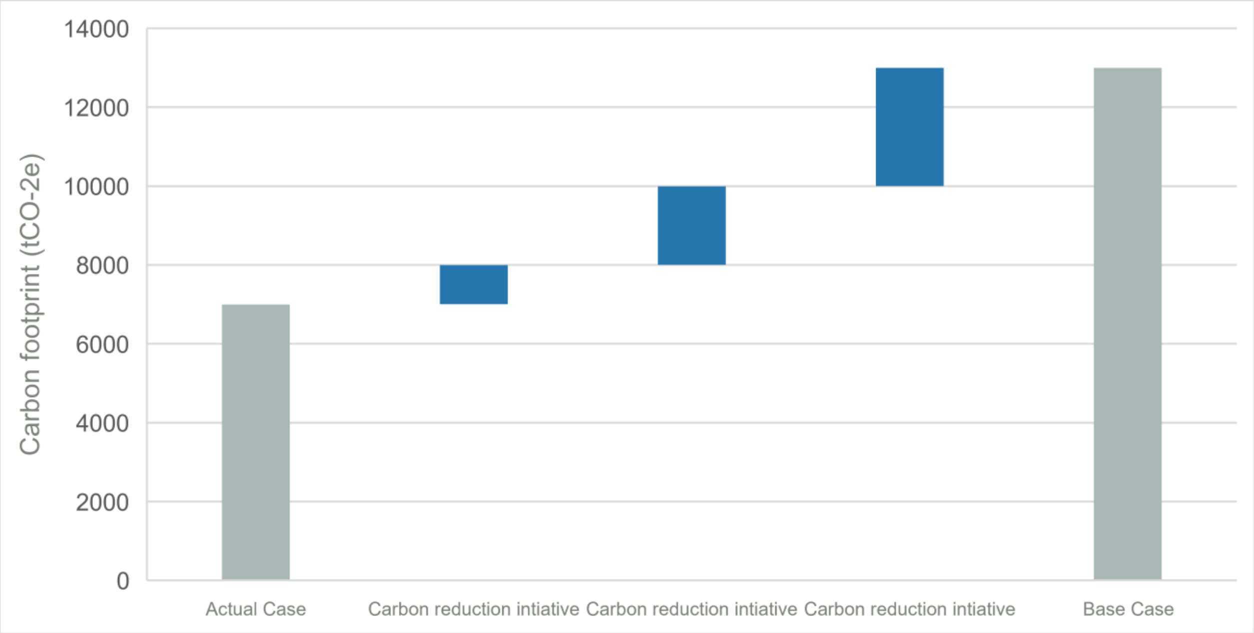

Figure 5: Example of the back casting methodology (source: Infrastructure Sustainability Council)

A back casting approach provides the following opportunities:

- It provides an accurate base case as final material types and quantities will be available.
- It allows the 'removal' of sustainability initiatives from the actual case to calculate the base case.
- It provides a means of creating a base case if a project does not have sufficient data early in design.

However, the back casting approach creates various challenges, including:

- It removes the ability to calculate and track reductions against the base case during design development.
- It removes the early identification of carbon hotspots during design, and it may impact the selection of sustainability initiatives for the project (refer to Figure 7 for further information).
- NZTA will experience delays in receiving base case data, which may delay their reporting requirements.

2.7 ISC projects

Projects undertaking an IS rating in accordance with the Sustainability Rating Scheme Policy will be required to submit a base case for materials, water and energy. This must cover the infrastructure's life cycle (construction and operational phases combined). While this guidance aims to assist projects undertaking an IS rating, it is important to note that IS rating requires energy-related GHG emissions and materials GHG emissions to be calculated separately to ensure the material and energy credit requirements are fulfilled in accordance with IS requirements.

3 How to calculate a base case

3.1 Recommended tools

The recommended tools below all provide useful data to develop a base case. Table 1 illustrates the scope and methods available within each tool. The tools are described in the section below. If a project team wishes to use an alternative tool, this should be agreed with NZTA.

Table 1 Scope of calculation available within the recommended tools

Tool	Material usage (embodied carbon[21])	Materials transport distances	Construction energy[22]	Operational energy[23]
Project Emissions Estimation Tool	✓	✓	✓	✓
Life Cycle Assessment of Pavements Tool	✓	✓	×	×
IS Materials Calculator (must be used for IS rating submission)	✓	✓	×	×
Bespoke spreadsheet (to be approved in consultation with NZTAi)	✓	✓	✓	✓

3.1.1 Project Emissions Estimation Tool (PEET)

PEET is a GHG emissions tool that has been developed to use in the early stages of a project. PEET uses standard design examples and industry research to provide a high-level estimation of the GHG emissions through the lifecycle of a project.

The tool breaks down its analysis into three stages of estimation, first order, second order and third order:

- The first order estimate is a very high-level analysis of a road or highway where only the length of the road and number of lanes is understood. *Note: this only provides high-level estimates and is not appropriate for a base case.*
- The second order estimate is slightly more detailed as it is broken into key elements such as structures, pavement surfacing, drainage, earthworks etc. This can be used to estimate the GHG emissions when element dimensions and quantities are known. *Note: this provides estimates appropriate for an early base case.*
- The third order estimate is more detailed as it includes the breakdown of energy and fuel use, material usage and the transport of materials to site. This can be used by projects where this level of detail is understood. *Note: this provides estimates appropriate for an early base case.*

The emission factors for PEET have been derived from the Ministry for the Environment's Emission Factors Workbook 2022, Building Research Association of New Zealand (BRANZ), EPDs, the IS Materials Calculator, and industry reports. The PEET hierarchy of emission factor sources in order of priority is outlined in Figure 6. PEET has endeavoured to select emission factors from the same source where possible.

[21] Embodied carbon is the sum of the GHG emissions that occur at each stage of the materials lifecycle.

[22] Construction energy is the GHG emissions associated with construction activities.

[23] Operational emissions are the GHG emissions associated with the operation of the infrastructure, for example energy used for street lights.

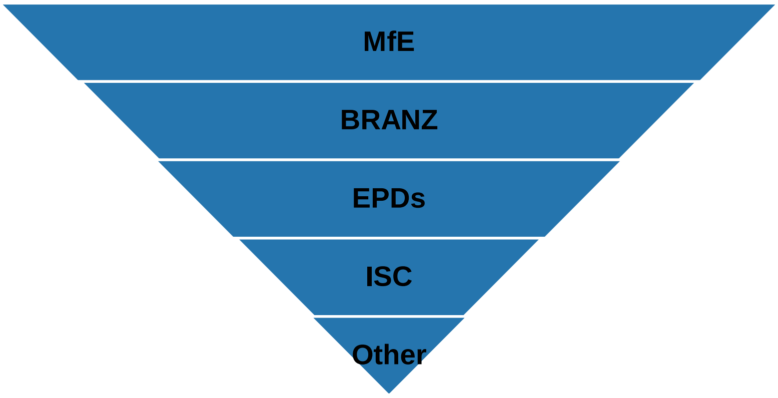

Figure 6: PEET emission factor sources hierarchy

It is recommended projects use PEET in these circumstances:

- during early phases of a project where only high-level information is available
- to understand an estimated construction emissions footprint (A5 of the lifecycle module framework)
- later in the design phase, where a more specific breakdown of material types and quantities are known (the third order estimate may be used if this information is available).

However, the limitations of PEET need to be understood and be clearly stated within any project base case documentation. The limitations include:

- The tool has not been developed to provide a detailed emissions analysis of every specific project element.
- If the material type is not included within PEET, projects will be required to categorise their materials into the most appropriate available. Please refer to section 3.2 for details on categorising materials.

The PEET tool can be accessed through the NZTA website: Project Emissions Estimation Tool (PEET); see also Project Emissions Estimation Tool (PEET) user guide.

3.1.2 Life Cycle Assessment of Pavements Tool (LCAP)

The LCAP tool enables users to model the environmental performance of multiple different pavement designs during all lifecycle phases. The tool is intended to help design, development and supply chain teams to identify key opportunities for increased environmental performance of pavements.

Certain parameters need to be known or reasonably assumed for this tool to be used. The parameters include:

- pavement layer thicknesses and material composition
- traffic flow volume
- maintenance schedule
- intended lifespan
- intended end-of-life treatment
- pavement roughness and rigidity.

The emission factors within the LCAP tool align with PEET as far as practical.

It is recommended the LCAP tool is used within the following circumstances:

- when a detailed understanding of the pavement layers is available.

The limitations of the LCAP tool need to be understood and clearly stated within any project documentation. The limitations include:

- If a project is within an early design phase, a significant number of assumptions may be required.
- Projects will be required to categorise their materials into the most appropriate material type available within the LCAP tool – not all materials are factored in to the LCAP tool. Please refer to section 3.2 for details on categorising pavement materials.

The tool can be accessed through the NZTA website: Life Cycle Assessment of Pavements (LCAP) tool.

3.1.3 Infrastructure Sustainability (IS) Materials Calculator (New Zealand version)

The IS Materials Calculator (New Zealand version) must be used by projects undertaking an IS rating.

The calculator considers the embodied environmental impacts and GHG emissions associated with materials used in a project. The emission factors within the New Zealand calculator are derived from EPDs and the Australian National Life Cycle Inventory Database (AusLCI), with adjustments made for the New Zealand electricity grid. The calculator considers the following:

- extraction and treatment of raw materials (A1 and A2 of the lifecycle module framework)
- product manufacturing (A3 of the lifecycle module framework)
- transport and distribution (A4 of the lifecycle module framework)
- maintenance (B2 of the lifecycle module framework).

The calculator excludes end-of-life impacts of materials. Energy use during the construction and operational phase is excluded from the calculator, which is considered within the IS energy credit. Projects using the IS Materials Calculator, will therefore need to submit their base case calculated using the IS Materials Calculator **as well as** that for IS energy credits (for which there is no pre-existing tool), in order to fulfil the Resource Efficiency Policy requirements.

The limitations of the IS Materials Calculator need to be understood and clearly stated within any project documentation. The limitations include:

- Projects will be required to categorise their materials into the most appropriate material type available within the IS Materials Calculator – not all materials are factored into the IS Materials Calculator. Please refer to section 3.2 for details on categorising materials.
- The calculator excludes the following life cycle modules (A5, B1, B3–B5, C1–C4, D, B6, B7).

3.1.4 Project bespoke spreadsheet

Projects may choose to create their own bespoke spreadsheet to calculate the base case if the other tools described are not appropriate – this should be done in consultation with NZTA. *Note: a bespoke spreadsheet is required for IS projects when calculating their energy footprint.*

If this method is chosen, please refer to section 2.4 to ensure appropriate emission factors are used.

Within the bespoke spreadsheet, projects will need to ensure the correct calculation methods to derive the base case footprint are followed. The calculation for each material type requires:

***Material type and quantity (t)* X *emission factor* = tCO_2e**[24]

The tCO_2e for each material will need to be added together to produce the project's base case footprint.

Alternatively, projects may use the calculations derived from any combination or all three of the tools described above, as appropriate. The calculations completed by each tool can be entered into a bespoke spreadsheet to illustrate the total carbon footprint.

3.2 Categorisation of materials

The categorisation of materials is an important step when using any of the tools described in section 3.1. A project will likely receive materials categorised by a cost estimator or designer, which does not align with the options available in a tool. If there is no direct match, choose the material that most closely aligns with an option available within the tool. The BAU assumptions can be used to inform the material choice. A conservative approach should be adopted in circumstances where there are multiple options to choose from – that is, the option with the highest carbon footprint should be selected.

For example, if the tool chosen does not contain the type of steel the project is using, then either:

- obtain the emission factor from an EPD that is from the confirmed supplier for the project, or
- select the closest type of steel available within the tool (this should be 'non-Australian' if you are using the IS Materials Calculator) – if there are two similar options, select the one with the highest emission factor.

[24] The units within the equation need to be consistent.

Another example is if the tool does not contain the specific material name, such as GAP65 or AP40, the material 'crushed rock'[25] should be selected within the IS Materials Calculator. Within the PEET tool it should be selected as 'aggregate'.

3.3 Design life

The design working life of infrastructure components need to be considered when calculating a base case. It should be used to inform maintenance requirements when calculating the life cycle emission impacts. Where the design life is less than 100 years, the number of replacements will need to be considered within the base case.

The design life requirements included in Table 2 should be used where project requirements are unknown. Where project specific design life requirements exist, these should be used.

Table 2: Design life requirements

Asset type	Design life requirement
Bridges[26]	100 years
Retaining walls[27]	100 years
Drainage systems[28]	100 years
Noise barriers[29]	50 years
Treatment swales[30]	50 years
Gantry components[31]	50 years
Pavements[32]	25 years (the NZTA default design life)
Pavements – epoxy-modified open graded porous asphalt (EMOGPA)	40 years (the expected pavement and surface life based on NZTA estimates)
Pavements – open graded porous asphalt (OGPA)	7 years (the expected surface life based on NZTA estimates)
Pavements – stone mastic asphalt (SMA)	12 years (the expected surface life based on NZTA estimates)
Signage[33]	25 years (large); 10 years (small)
Street furniture[34]	25 years
Lighting[35]	Columns: 40 years Luminaries: 20 years

3.4 Approaches for calculation

Before calculating a base case, project teams should understand the most appropriate approach for calculation. Figure 7 outlines two pathways available.

Both pathways require carbon reduction initiatives to be investigated, considered and calculated throughout design and/or construction.

[25] If a project requires ISC verification, the material categorisation will be subject to approval.
[26] *NZTA bridge manual*
[27] *NZTA bridge manual*
[28] P46 *Stormwater specification*
[29] *Highway structures design guide*
[30] P46 *Stormwater specification*
[31] *Highway structures design guide*
[32] *New Zealand guide to pavement structural design*
[33] *Highway structures design guide*
[34] *Highway structures design guide*
[35] M30 *Specification and guidelines for road lighting design*

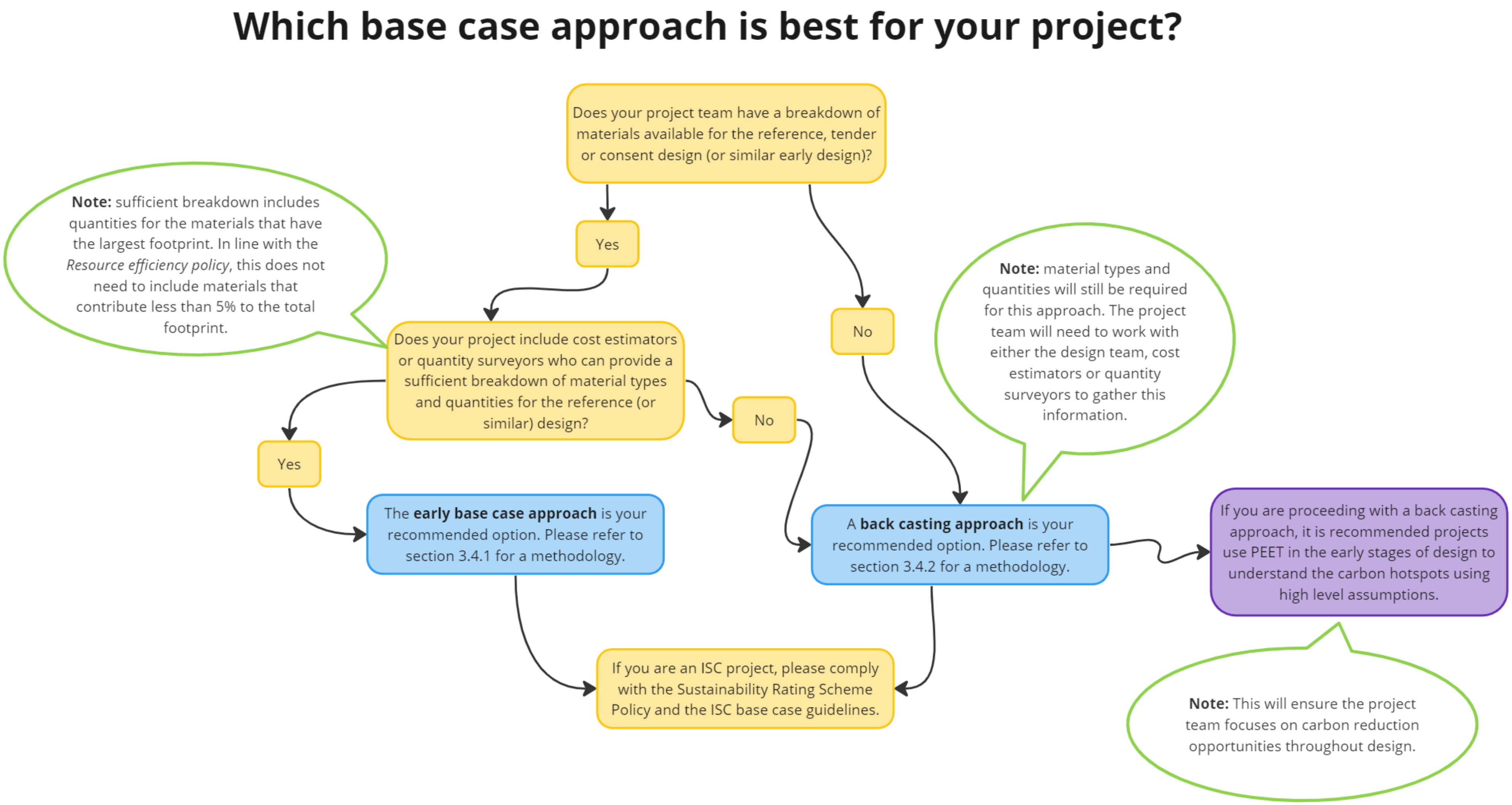

Figure 7: Selecting an approach for calculating a base case

3.4.1 Early base case

If Figure 7 suggested that an early base case was the appropriate pathway for a project, follow the steps outlined below.

1. Consider the most appropriate tool to use:
    - PEET (refer to section 3.1.1)
    - LCAP (refer to section 3.1.2)
    - IS Materials Calculator (New Zealand version) (refer to section 3.1.3)
    - Project bespoke spreadsheet (refer to section 3.1.4)
      Note: remember that projects can use outputs from the three tools above and enter them into a bespoke spreadsheet.
2. Identify source(s) of appropriate emission factors if a project bespoke spreadsheet is being used (refer to sections 2.4 and 3.1.4).
3. Follow the instructions within the tool selected and enter the following information associated with the reference (or similar) design:
    - material types (using the categorisation guidance in section 3.2)
    - material quantities (the unit of measurement will be determined by the chosen tool)
      Note: ensure the measurement units are consistent if a bespoke spreadsheet is being used.
    - transport mode and distances from the manufacturer to project site
      Note: if a project does not have this information available, the default percentage available within PEET can be used or likely suppliers may be able to provide estimated values.
    - construction fuel and electricity usage
      Note: if a project does not have this information available, it is recommended you use the second order estimate within PEET to derive a total, or the design or construction lead may be able to provide estimated values (the activities with the largest electricity and/or fuel usage should be the focus).
    - operational electricity usage
      Note: if a project does not have this information available, it is recommended you use the second order estimate within PEET to derive a total, or the design or construction lead may be able to provide estimated values (the activities with the largest electricity and/or fuel usage should be the focus).
    - maintenance requirements (material types and quantities and fuel quantities).
      Note: where the design life is less than 100 years, the number of replacements must be considered within the base case (refer to section 3.3 for further information on design life requirements).
4. If a bespoke spreadsheet is being used, ensure the total tCO_2e from each of the tools is captured and enter the totals into the bespoke spreadsheet.
5. Determine the total tCO_2e associated with the base case footprint.
6. Use the material type of the design component to understand carbon hotspots within the base case design. This will allow the project team to understand where carbon reduction efforts should be focused.
7. Work with the project team to investigate and implement sustainability initiatives throughout the project life cycle.
8. Track and calculate sustainability initiatives associated with carbon reduction throughout the project life cycle (repeat steps 3 and 4 to calculate the carbon reduction initiatives).
9. Follow the reporting requirements within the *Resource efficiency guideline* and report the base case to NZTA.

Note: if a project is undertaking an IS rating, compliance with the reporting requirements within the Sustainability Rating Scheme Policy is required.

3.4.2 Back casting

If Figure 7 suggested that a back casting approach was the appropriate pathway for a project, follow the steps outlined below. To use a back casting approach, the project will need to identify measurable or quantifiable sustainability initiatives that have been implemented in design that have led to whole-of-life carbon reductions.

Note: the sustainability initiatives should be calculated against the BAU assumptions where there is a shift beyond BAU for methodology changes and/or material replacement.

1. Work with the project team to investigate and implement sustainability initiatives throughout the project life cycle.
2. Track and calculate sustainability initiatives associated with carbon reduction throughout the project life cycle (refer to steps 4–7 below to calculate the initiatives).
   Note: it is recommended that projects don't wait until completion to undertake the calculations – if left too late, the ability for the design team to provide support with quantifying the savings could be lost.
3. At completion of 100% detailed or issued for construction design, derive the material types and quantities from the final model or cost estimates.
4. Consider the most appropriate tool to use:
   - PEET (refer to section 3.1.1)
   - LCAP (refer to section 3.1.2)
   - IS Materials Calculator (New Zealand version) (refer to section 3.1.3)
   - Project bespoke spreadsheet (refer to section 3.1.4).
     Note: remember the outputs from the three tools above can be used and entered into a bespoke spreadsheet.
5. Identify source(s) of appropriate emission factors if a project bespoke spreadsheet is being used (refer to sections 2.4 and 3.1.4).
6. Follow the instructions within the tool and enter the following information associated with the 100% detailed or issued for construction design:
   - material types (using the categorisation guidance in section 3.2)
   - material quantities (the unit of measurement will be determined by the chosen tool)
     Note: ensure the measurement units are consistent if a bespoke spreadsheet is being used.
   - transport mode and distances from the manufacturer to project site
     Note: if a project does not have this information available, it is recommended you use the default percentage available within PEET, or estimates may be provided by likely suppliers with the design or construction lead.
   - construction fuel and electricity usage
     Note: if a project does not have this information available, it is recommended you use the second order estimate within PEET to derive a total, or the design or construction lead may be able to provide estimated values (the activities with the largest electricity and/or fuel usage should be the focus).
   - operational electricity usage.
     Note: if a project does not have this information available, it is recommended you use the second order estimate within PEET to derive a total, or the design or construction lead may be able to provide estimated values (the activities with the largest electricity and/or fuel usage should be the focus).

- maintenance requirements (material types and quantities and fuel quantities).
  Note: Where the design life is less than 100 years, the number of replacements will need to be considered within the base case (refer to section 3.3 for further information on design life requirements).

7. Determine the total tCO_2e associated with the actual footprint.
8. Add the quantified sustainability initiatives to the actual footprint to calculate the project's base case.
9. Follow the reporting requirements within the resource efficiency guideline and report the base case to NZTA.
   Note: if a project is undertaking an IS rating, compliance with the reporting requirements within the Sustainability Rating Scheme Policy is required.

Appendix A: Case studies

These case studies illustrate scenarios that may occur on projects needing to calculate a base case carbon footprint. They are provided as PDFs – click the title to view the document.

Sustainability initiatives and how this impacts a base case carbon footprint

Scope creep and how this impacts a base case carbon footprint

Scope changes and how this impacts a base case carbon footprint