

# Decarbonising Infrastructure Delivery Policy

Reducing Upfront Carbon in Infrastructure

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# Glossary of terms

Term	Definition
<b>Agency</b>	All infrastructure delivery agencies.
<b>Assets</b>	All non-financial assets recognised by the agency including, but not limited to, land and buildings, plant and equipment, infrastructure systems, leased assets, works in progress, cultural and heritage collections, ICT systems and digital services. Note that this Policy is focused on capital assets including buildings and other infrastructure assets and systems.
<b>Baseline (or reference case)</b>	A business as usual scenario for the level of carbon emissions in the absence of additional measures to reduce emissions levels. It should be based upon consistent as-built data sets from prior project or comparable projects that reflect the time, scale, and scope. <sup>1</sup>
<b>Benefit-Cost Ratio (BCR)</b>	The ratio of social benefits to costs that is obtained by dividing the total value of social benefits by the costs to achieve such benefits. The BCR highlights the relationship between the expected gains, and the resources expended to achieve those benefits. <sup>2</sup>
<b>Building sector projects</b>	Refers to capital expenditure developments such as schools, hospitals, prisons, and other structures as described in the <i>Environmental Planning and Assessment Act 1979</i> .
<b>Capital expenditure</b>	A form of expenditure that is incurred when money is spent to buy, construct, renovate or acquire an asset. Capital expenditure is clearly assigned to the acquisition and maintenance of capital assets including property, raw materials, or technology.
<b>Carbon</b>	Carbon dioxide equivalent for all greenhouse gas emissions. <sup>3</sup>
<b>Carbon emissions</b>	Emissions of greenhouse gases, measured in kilograms or tonnes of carbon dioxide equivalent emissions (CO <sub>2</sub> -e).
<b>Carbon management</b>	Assessment, reduction and removal of carbon emissions during the planning, optioneering, design, delivery, operation, use, end of life (and beyond) of new, or the management of existing assets, networks and/or systems. <sup>4</sup>
<b>Carbon Management Plan</b>	<p>A carbon management plan is a framework designed to identify and manage greenhouse gases (in the form of CO<sub>2</sub>-e) for the identified project, asset or organisation. It is intended to be a living document that is revised and updated over the project lifecycle. It allows agencies and their delivery partners to:</p> <ul style="list-style-type: none"> <li>• define their approach to and opportunities for carbon management and reduction at procurement, design and construction stages</li> <li>• demonstrate who will be responsible for driving, tracking and reporting carbon reductions achieved at various stages of project delivery</li> <li>• document the methodologies used to assess carbon reductions.</li> </ul>

1 British Standards Institution, [PAS 2080: 2023 Carbon management in infrastructure](#), BSI Standards Limited, 2023.

2 NSW Treasury, [TPG23-08 NSW Government Guide to Cost-Benefit Analysis](#), NSW Government, 2023.

3 British Standards Institution, [PAS 2080: 2023 Carbon management in infrastructure](#), BSI Standards Limited, 2023.

4 British Standards Institution, [PAS 2080: 2023 Carbon management in infrastructure](#), BSI Standards Limited, 2023.

Term	Definition
<b>Carbon management principles</b>	The four principles from this Policy that guide agencies' carbon management activity for construction delivery: <ul style="list-style-type: none"> <li>• Apply the Carbon Reduction Hierarchy</li> <li>• Assess the upfront carbon impact</li> <li>• Engage with the market</li> <li>• Develop a Carbon Management Plan.</li> </ul>
<b>Carbon Reduction Hierarchy</b>	A decision-making process to minimise carbon emissions in the development of new, or the refurbishment of existing, assets or networks. <sup>5</sup>
<b>Carbon sequestration</b>	The capture and storage of carbon emissions from the atmosphere. <sup>6</sup>
<b>Circular economy</b>	An economy that is restorative and regenerative by design, and which aims to keep products, components and materials in circulation through processes like reuse, refurbishment, and recycling (as opposed to a linear “take-make-dispose” model). <sup>7</sup>
<b>Design life</b>	The period of time during which an asset element is expected by its designers to function within its specified parameters.
<b>Early market engagement</b>	The process of engaging with potential contractors and suppliers during the development of a project and generally prior to procurement. Early market engagement can be undertaken using a variety of methods, including market sounding, supplier briefing sessions and early contractor involvement practices.
<b>Embodied carbon</b>	The greenhouse gas emissions and removals associated with the creation and end-of-life disposal of an asset. This includes the emissions associated with the production and transportation of materials, construction related emissions, end-of-life emissions. In-use stage material-related emissions associated with maintenance, repair, replacement and refurbishment over the asset life are considered part of embodied carbon.  Note: this aligns with definitions in PAS 2080:2023 and RICS <i>Whole life carbon assessment for the built environment</i> <sup>8</sup> , excluding in-use stage emissions relating to operational expenditure, which is part of operational carbon (see definition below).
<b>End-of-life carbon</b>	Carbon associated with the deconstruction, transport, waste processing, and disposal of capital assets and the end of their useful life. This forms part of embodied carbon. <sup>9</sup>
<b>Foundational capability</b>	Agencies with foundational capability have limited or no experience quantifying carbon emissions on their projects.
<b>Maturing capability</b>	Agencies with maturing capability have experience quantifying carbon emissions on its projects and the capability to set targets.
<b>Net Present Value (NPV)</b>	The difference between the present value of benefits and present value of costs.
<b>Operational carbon</b>	Emissions generated during the use of the asset and can include operational energy, operational water, other operational processes and user's utilisation of the asset.

5 Adapted from British Standards Institution, [PAS 2080: 2023 Carbon management in infrastructure](#), BSI Standards Limited, 2023.

6 Green Building Council Australia (GBCA), [A practical guide to upfront carbon reductions](#), GBCA, 2023.

7 International Organization for Standardization, ISO 20400:2017 Sustainable Procurement - Guidance, (2017), Section 3.1, ISO, 2017

8 Royal Institute of Chartered Surveyors (RICS), *Whole life carbon assessment for the built environment* (2nd Ed.), Glossary, RICS, 2023

9 British Standards Institution, [PAS 2080: 2023 Carbon management in infrastructure](#), BSI Standards Limited, 2023.

Term	Definition
<b>Other infrastructure projects</b>	Refers to other capital expenditure developments not covered by the <i>building sector projects</i> definition, such as roads, rail, bridges, dams, etc.
<b>PAS 2080:2023 Carbon management in buildings and infrastructure</b>	Specifies requirements for the management of whole life carbon in buildings and infrastructure –in the provision, operation, use and end-of-life of new projects or programmes of work as well as the management or retrofit of existing assets and networks.
<b>Supply chain</b>	A network of organisations that convert raw materials into finished products and deliver them to the consumer.
<b>Upfront carbon</b>	The carbon emissions and removals associated with the creation of an asset, network or system up to practical completion. This includes the emissions associated with the production and transportation of materials and construction related emissions. It excludes emissions generated during the use and end-of-life phase of an asset.
<b>Value chain</b>	The organisations, agencies, and industry stakeholders involved in creating, operating, and managing assets and may include government and policy makers, asset owners and managers, designers, constructors and builders, product and material suppliers and lenders. <sup>10</sup>
<b>Whole life carbon (or whole of life carbon)</b>	The total greenhouse gas emissions and removals associated with the creation, operation, maintenance and end-of-life disposal of an asset. This includes upfront carbon as well as in-use emissions (from maintenance, repair, refurbishment and operation of the asset), end-of-life disposal, and benefits and loads beyond the system boundary (e.g. avoided material production from utilisation of recycled or reused products).

<sup>10</sup> British Standards Institution, [PAS 2080: 2023 Carbon management in infrastructure](#), BSI Standards Limited, 2023.

# Executive summary

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This Policy provides guidance to NSW Government infrastructure delivery agencies on expectations for managing upfront carbon in public infrastructure projects, ensuring upfront carbon is a key consideration in early project stages.

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Upfront carbon is the emissions generated during the production of materials and the construction of infrastructure assets. While this Policy focuses on upfront carbon, agencies should seek to reduce whole life carbon emissions where they have the capability to do so. Future iterations of this Policy will expand to encompass a whole life carbon approach.

This Policy provides guidance on carbon management proportionate to an agency's capabilities. Agencies should self-assess whether they are foundational or maturing in their capabilities:

- **Foundational:** the agency has limited or no experience quantifying carbon emissions on its projects.
- **Maturing:** the agency has experience quantifying carbon emissions on its projects and the capability to set targets.

The NSW Government acknowledges carbon management capability will mature over time. It is anticipated that agencies will implement an increasing number of the optional actions outlined in this Policy over time as their capability grows. The ambition is for agencies to increase their capability and set targets for carbon reduction.

This Policy applies to all NSW Government infrastructure delivery agencies. It will apply to projects over the following thresholds:

**\$50 million**

for building sector projects

**\$100 million**

for all other infrastructure types

While this Policy does not apply to public non-financial corporations (including state owned corporations), public financial corporations or local government authorities, all NSW Government entities are strongly encouraged to adopt the Policy's approach.

Consistent with business case expectations, the level of detail provided under this Policy is expected to be proportionate to the size of the project.

Agencies must, at a minimum, quantify the impact of upfront carbon at three project stages:

1. Business case
2. Planning approval, design, and procurement
3. Project completion.

Agencies with maturing carbon management capability should also set a baseline (or a reference case) and an upfront carbon reduction target in accordance with or beyond industry standards.

**Part 1** describes the background to the Policy, including its purpose, scope, context and implementation timeframe.

**Part 2** outlines the principles to be applied in the measurement, assessment and management of upfront carbon.

A summary of the Policy requirements is provided in the following section.

This document is to be read in conjunction with the *NSW Government Business Case Guidelines* (TPP 18-06), the *NSW Guide to Cost-Benefit Analysis* (TPG23-08)<sup>11</sup>, and the *NSW Government Procurement Policy Framework*. Carbon measurement and reporting is to be undertaken in accordance with the NSW Government *Technical Guidance: Embodied Carbon Measurement for Infrastructure* (the Measurement Guidance), which supports this Policy.

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11 Including a companion Department of Planning and Environment (DPE) [Framework for Valuing Green Infrastructure and Public Spaces](#), NSW Government, 2023.

# Summary of actions

Table 1 provides a summary of the actions agencies must undertake to comply with this Policy. It also includes some optional actions that are recommended for agencies with maturing capability (note these are not mandatory). The table is structured by project phase, with actions grouped according to four carbon management principles. Refer to **Part 2** of this document for additional information about the carbon management principles.

**Table 1: Summary of mandatory and optional Policy actions**

Principle	Actions
<b>Carbon management principles</b>	
<b>Apply the Carbon Reduction Hierarchy</b>	Minimise upfront carbon emissions early, by considering options to build nothing or augment existing assets, as well as options to build efficiently. <sup>12</sup> Where possible, agencies are strongly encouraged to challenge the requirement to build new infrastructure.
<b>Assess the upfront carbon impact</b>	Quantify the upfront carbon of projects as part of the options assessment process.
<b>Engage with the market</b>	Engage with the market at the earliest possible stage to enable innovation and carbon reduction practices.  Define the activities in the project lifecycle through which the agency can control or influence the amount of upfront carbon emissions relative to other members of the value chain.
<b>Develop a Carbon Management Plan<sup>13</sup></b>	Document the governance, accountability, monitoring and reporting activities related to managing upfront carbon. The Carbon Management Plan is to be a live document that is updated as the project progresses from planning into delivery and completion. This requirement may be met through existing environmental reporting (see Part 2 Principle 4 for more information).
<b>Problem definition</b>	
<b>Apply the Carbon Reduction Hierarchy</b>	<b>Mandatory action (all agencies):</b> 1. Provide sound reasons in project inception and registration documentation for why new infrastructure is required to address the problem or service need, including consideration of upfront carbon.
<b>Assess the upfront carbon impact</b>	-
<b>Engage with the market</b>	-
<b>Develop a Carbon Management Plan</b>	-

<sup>12</sup> Definition informed by [PAS2080:2023 Carbon management in buildings and infrastructure](#) but tailored to NSW context for upfront carbon.

<sup>13</sup> Carbon Management Plan requirements may be combined with existing requirements for environmental management plans. Refer to [Part 2 – Principle 4](#) for more information.



Principle	Actions
<b>Business case</b>	
<b>Apply the Carbon Reduction Hierarchy</b>	<p><b>Mandatory actions (all agencies):</b></p> <ol style="list-style-type: none"> <li>2. On an “if-not-why-not” basis, the business case options analysis must consider:               <ol style="list-style-type: none"> <li>a. build nothing option(s)</li> <li>b. upgrades or repurposing of existing infrastructure</li> <li>c. using assets for multiple purposes</li> <li>d. low carbon design and construction methods (at the Final Business Case stage).</li> </ol> </li> <li>3. Business cases must include clear rationale for proceeding with any new infrastructure options.</li> </ol>
<b>Assess the upfront carbon impact</b>	<p><b>Mandatory action (all agencies):</b></p> <ol style="list-style-type: none"> <li>4. Business cases must consider carbon as part of options analysis in line with the <i>NSW Guide to Cost-Benefit Analysis (CBA Guide)</i>.<sup>14</sup> The agency must:               <ol style="list-style-type: none"> <li>a. estimate the upfront carbon associated with each option using the Measurement Guidance, which has provisions for maturing and foundational capabilities</li> <li>b. include carbon emissions as a criterion when assessing preliminary options in the multi-criteria analysis.<sup>15</sup> Where feasible, this should include whole life carbon</li> <li>c. for the preferred option in the Final Business Case, identify the main sources of upfront carbon, and use this to inform carbon reduction objectives for market engagement.</li> </ol> </li> </ol> <p><b>Optional actions (agencies with maturing capability):</b></p> <ol style="list-style-type: none"> <li>5. Set an upfront carbon reduction <b>objective</b> as part of the broader SMART (Specific, Measurable, Achievable, Realistic, Timely) project objectives set for the Strategic Business Case. This will be revised to a <b>target</b> in the Final Business Case.</li> <li>6. As part of target setting, the agency should first define a baseline for the preferred option in the Final Business Case. This means:               <ol style="list-style-type: none"> <li>a. identifying comparable projects or sector benchmarks that can inform the baseline, such as interjurisdictional examples or sub-asset level benchmarks<sup>16</sup></li> <li>b. adjusting or tailoring the baseline to suit the context of the project with supporting justification.</li> </ol> </li> <li>7. The agency should set an upfront carbon reduction target. In setting the target, agencies should consider alignment with reduction ambitions set by government or comparable organisations, industry bodies, or projects, while having regard for trade-offs between carbon reduction and additional costs. The agency should:               <ol style="list-style-type: none"> <li>a. identify an ambitious upfront carbon reduction target for the project</li> <li>b. compare the target to those set for comparable projects in the same sector</li> <li>c. consider how value chain perspectives may be incorporated (e.g. via market sounding process)</li> <li>d. identify and consider any trade-offs that the upfront carbon reduction target may produce across the asset lifecycle. See <a href="#">Table 5</a> for examples of whole life carbon trade-offs.</li> </ol> </li> <li>8. Both the baseline and the target should be revisited following procurement to reflect any further carbon reductions proposed by the successful bidder.</li> </ol>

14 The CBA Guide requires the cost of whole life carbon emissions, or benefits of reduced whole life carbon emissions, to be included in CBA where the cost or benefit is likely to materially affect the Net Present Value (NPV) or Benefit-Cost Ratio (BCR).

15 Multi-criteria analysis is often used to narrow down options to a list to be assessed using CBA. CBA is required for options analysis in business cases and considers whole life carbon emissions.

16 Over time, completed project emissions data collected under this Policy will allow for benchmarks to be set. These can help agencies with target setting in the future.

Principle	Actions
<b>Engage with the market</b>	<p><b>Optional actions (agencies with maturing capability):</b></p> <ol style="list-style-type: none"> <li>9. Include requirements to capture all reasonable decarbonisation opportunities (such as in materials, structure, and construction emissions) in the brief for concept design. This should draw on the major sources of carbon identified in action 4c.</li> <li>10. Following concept design, the agency should test these opportunities with the market as part of early engagement processes. The agency should:               <ol style="list-style-type: none"> <li>a. consider a variety of market engagement methods</li> <li>b. allow adequate time in the project schedule for meaningful market engagement that is proportionate to the size of the project and its risks</li> <li>c. understand market appetite and ability in relation to decarbonisation</li> <li>d. encourage low carbon initiatives by contractors, such as in materials, structure and construction methods.</li> </ol> </li> </ol> <p><b>Note:</b> if the requirements under 9 and 10 are not carried out prior to Final Business Case, the stakeholder engagement plan should outline how these requirements will be met under action 19.</p>
<b>Develop a Carbon Management Plan</b>	<p><b>Mandatory actions (all agencies):</b></p> <ol style="list-style-type: none"> <li>11. The agency must prepare a Carbon Management Plan as part of a Final Business Case. The level of detail should reflect the project’s size and risks. Alternatively, a standard organisation-wide carbon management plan can be used where agency procedures do not vary across projects.</li> <li>12. The Carbon Management Plan must document:               <ol style="list-style-type: none"> <li>a. the expected supply chain participants and opportunities for control and influence to reduce carbon</li> <li>b. the roles and responsibilities for upfront carbon management and measurement (both in the project team and across the value chain members)</li> <li>c. how the procurement strategy seeks to promote early engagement and innovative decarbonisation approaches</li> <li>d. how and when supply chain participants can be involved as part of early engagement, for example in relation to the application of low carbon methods, and reflect this in the stakeholder engagement plan</li> <li>e. results of carbon quantification for the preferred option in accordance with the Measurement Guidance</li> <li>f. key risks related to achieving upfront carbon reductions for input into the risk register.</li> </ol> </li> </ol> <p><b>Optional action (agencies with maturing capability):</b></p> <ol style="list-style-type: none"> <li>13. Include carbon reduction targets and metrics in project objectives assigned to respective value chain members or roles, aligning with the overall reduction target.</li> </ol>
<b>Planning approval, design, and procurement</b>	
<b>Apply the Carbon Reduction Hierarchy</b>	<p><b>Mandatory action (all agencies):</b></p> <ol style="list-style-type: none"> <li>14. On an “if-not-why-not” basis, incorporate low carbon design and construction methods into procurement requirements.</li> </ol> <p><b>Optional action (agencies with maturing capability):</b></p> <ol style="list-style-type: none"> <li>15. Allow tenderers to challenge the brief to provide innovative ways to reduce carbon.</li> </ol>

Principle	Actions
<b>Assess the upfront carbon impact</b>	<p><b>Mandatory actions (all agencies):</b></p> <p>16. Include contractual performance requirements for contractors to provide as-built data to enable reporting on upfront carbon in accordance with the Measurement Guidance.</p> <p>17. Quantify the upfront carbon impact of the proposed project to support planning approval, procurement and / or detailed design process.</p> <p><b>Optional action (agencies with maturing capability):</b></p> <p>18. Baseline and target-setting activities should inform tender requirements, which should require bidders to reduce carbon beyond the target set at the Final Business Case. The baseline may be updated prior to procurement to improve accuracy and better inform contributions to carbon reduction opportunities.</p>
<b>Engage with the market</b>	<p><b>Mandatory actions (all agencies):</b></p> <p>19. If not covered in any engagement completed at the business case stage, the agency should, on “if-not-why-not” basis:</p> <ol style="list-style-type: none"> <li>include decarbonisation as part of market engagement</li> <li>understand market appetite and ability in relation to decarbonisation.</li> </ol> <p><b>Optional actions (agencies with maturing capability):</b></p> <p>20. Include low carbon design and construction methods in tender evaluation criteria.</p> <p>21. Include the following in tender documentation:</p> <ol style="list-style-type: none"> <li>carbon management requirements consistent with roles and responsibilities identified in the governance framework</li> <li>outcomes of market engagement undertaken at the business case stage, allowing tenderers to reflect the findings in their bids</li> <li>opportunity to offer innovative low carbon options for delivery of the project, such as in materials, structure, and on-site emissions</li> <li>carbon management requirements as an evaluation criterion.</li> </ol> <p>22. To ensure upfront carbon reduction targets are carried through to project delivery, agencies should:</p> <ol style="list-style-type: none"> <li>translate the upfront carbon reduction target from the successful bid into components for specific work packages in negotiation with preferred supplier(s)</li> <li>make it clear to engaged members of the value chain their respective responsibilities for delivering upfront carbon reduction targets via the appropriate risk allocation mechanism</li> <li>ensure the combined allocation of upfront carbon reduction targets equate to the overall project or program target in line with the successful bid.</li> </ol> <p>23. Agencies able to set targets should also:</p> <ol style="list-style-type: none"> <li>include upfront carbon reduction target in the tender documentation</li> <li>make it clear to members of the value chain that achievement and improvement on upfront carbon reduction targets will form part of the tender evaluation process.</li> </ol>
<b>Develop Carbon Management Plan</b>	<p><b>Mandatory action (all agencies):</b></p> <p>24. Ensure alignment between carbon management roles and responsibilities in the project governance framework and tender proposals.</p>

Principle	Actions
<b>Construction and practical completion</b>	
<b>Apply the Carbon Reduction Hierarchy</b>	-
<b>Assess the upfront carbon impact</b>	<p><b>Mandatory action (all agencies):</b></p> <p><b>25.</b> Report the upfront carbon at practical completion in accordance with the Measurement Guidance.</p> <p><b>Optional actions (agencies with maturing capability):</b></p> <p><b>26.</b> Through the detailed design and construction process, agency and their delivery partners should:</p> <ol style="list-style-type: none"> <li>a. continue to seek and implement upfront carbon reductions as part of value engineering</li> <li>b. monitor, track and report upfront carbon reductions achieved through the design and delivery activities</li> <li>c. report these activities and the carbon reduction outcomes in the Carbon Management Plan or project plan.</li> </ol> <p><b>27.</b> Where a target for carbon reduction was set, assess whether this was achieved and if not, the barriers that prevented this.</p>
<b>Engage with the market</b>	-
<b>Develop a Carbon Management Plan</b>	<p><b>Optional action (all agencies):</b></p> <p><b>28.</b> Document lessons learnt to support continuous improvement in NSW Government carbon management practices.</p>

# 01

## Policy overview

The NSW Government has committed to net zero emissions by 2050, including a 50% reduction on 2005 levels by 2030 and a 70% reduction by 2035.

## Policy purpose and context

The *Decarbonising Infrastructure Delivery Policy* (the Policy) is a key step towards realising the NSW Government's net zero ambitions in the construction of public infrastructure, consistent with the broader targets set out in the *Climate Change (Net Zero Future) Act 2023* (NSW). It provides guidance to NSW Government agencies about the expectations for managing upfront carbon in public infrastructure projects, ensuring this is a key consideration from the early project stages. It:

- brings forward considerations of, and decisions relating to, the upfront carbon implications of a project
- achieves consistency in the measurement and reporting of upfront carbon across NSW Government infrastructure projects
- shifts behaviour and uplifts capability in the management of upfront carbon by embedding this into the investment decision-making process in NSW Government.

While the Policy focuses on upfront emissions, agencies should consider whole life carbon where they have the capability to do so. There are likely to be trade-offs between reducing upfront and operational emissions in some circumstances. Reducing whole life emissions should be prioritised in these cases.

This *Decarbonising Infrastructure Delivery Policy* sits alongside other key policies aimed at reducing emissions:

- *State Environmental Planning Policy (Sustainable Buildings SEPP) 2022*
- *Net Zero Plan Stage 1: 2020-2030*
- *NSW Waste and Sustainable Materials Strategy 2041*
- *Transport for NSW Net Zero and Climate Change Policy*
- *Transport for NSW Net Zero Cities Action Plan*
- *Circular Design Guidelines for the Built Environment*
- *Government Resource Efficiency Policy*
- *Transport for NSW Sustainable Infrastructure Program.*

# Policy scope

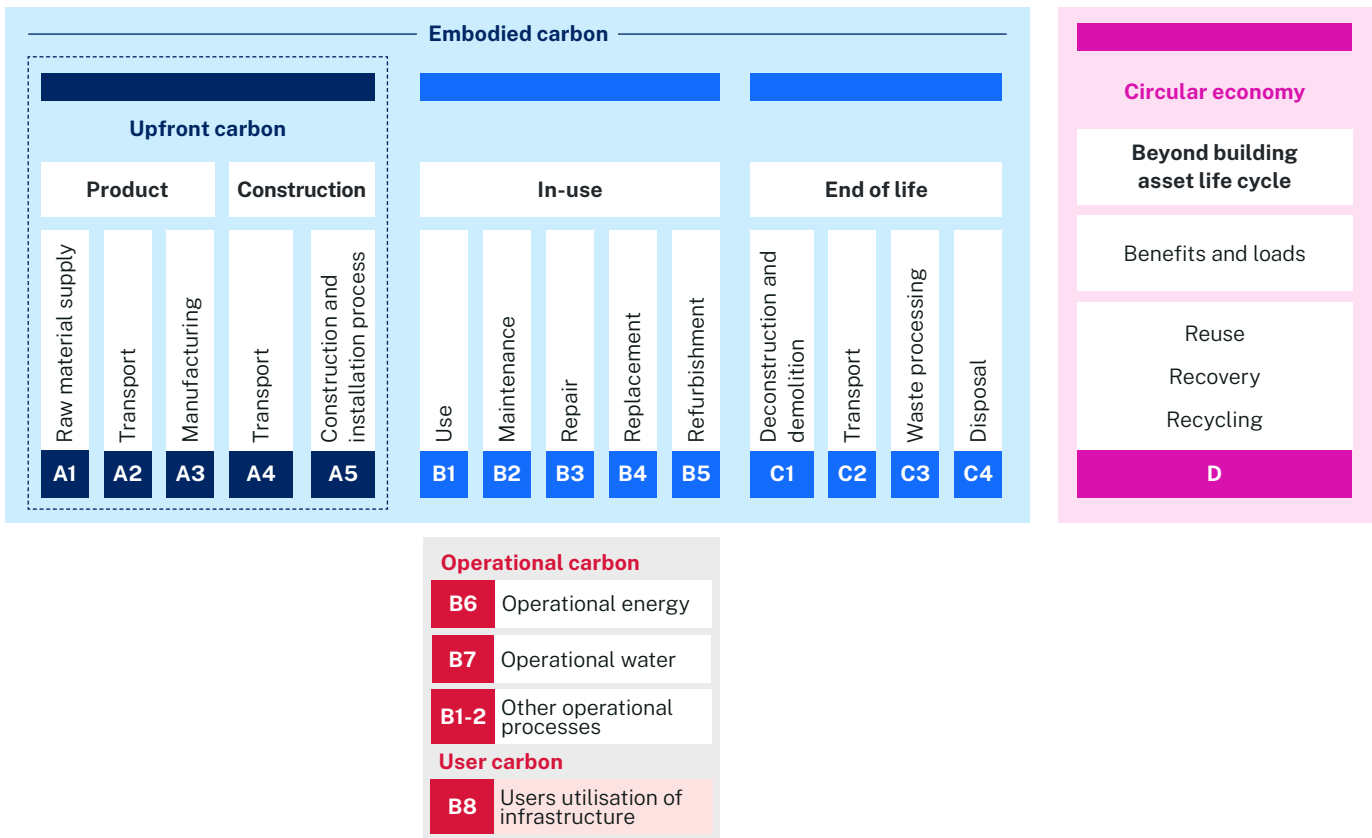
The minimum scope of this Policy is upfront carbon emissions. That is, emissions generated during the production of materials and construction activities prior to use (see stages A1-A3 and A4-A5 in Figure 1).

Future iterations of this Policy, along with other policy and guidance documents, will expand the Policy scope to address a whole life carbon approach, which covers all stages: upfront carbon (A1 to A5), use stage embodied carbon (B1 to B5), end of life carbon (C1 to C4), and Circular Economy (D).

For agencies that have the capability to assess other lifecycle stages, the requirements of this Policy should be embedded as part of that assessment. The Measurement Guidance provides information about how to measure all embodied emissions and consider trade-offs across the lifecycle stages.

**Figure 1: Sources of whole of life carbon emissions and illustration of definitions used in this document (adapted from PAS2080:2023 and modules in EN 17472:2022)**

## Whole of life carbon



This Policy applies to all NSW Government infrastructure delivery agencies. It will apply to all projects requiring an investment decision after the initial transition period of 12 months. That is, it will not apply retrospectively to projects that obtained an investment decision prior to the Policy's commencement, or to business cases that have already been in development prior to the Policy's operation. It will apply to projects over the following thresholds:

- \$50 million for building sector projects
- \$100 million for all other infrastructure types.

This Policy provides guidance on carbon management proportional to an agency's current capabilities. Agencies should self-assess whether they are foundational or maturing in their capabilities:

- **Foundational:** the agency has limited or no experience quantifying its carbon emissions on projects.
- **Maturing:** the agency has experience quantifying carbon emissions on its projects and the capability to set targets.

The expectation is that all projects will comply with the mandatory actions set out in Table 1 of this Policy. The Policy does not mandate the setting of carbon reduction targets but encourages agencies to do so where they have the capability (refer to the optional actions in Table 1).

The NSW Government acknowledges the capability to manage carbon will mature over time. It is expected that agencies will work towards implementing an increasing number of the optional actions in this Policy and that they will do so for an increasing share of their projects.

The ambition is for NSW Government agencies to increase their capability to manage carbon across the project lifecycle and set targets for carbon reduction. As capability across NSW Government increases, the Policy is likely to be updated to require all agencies to set carbon reduction targets.

This document is to be read in conjunction with the *NSW Government Business Case Guidelines* (TPP 18-06), and the *NSW Guide to Cost-Benefit Analysis* (TPG23-08). Carbon measurement and reporting is to be undertaken in accordance with the Measurement Guidance, which supports this Policy.



## Relationship between this Policy and PAS 2080

This Policy seeks to align upfront carbon management practices of NSW Government agencies with *PAS 2080:2023 – Carbon Management in infrastructure* (PAS 2080:2023). PAS 2080:2023 is an internationally recognised standard, which provides guidance for management of whole life carbon. This includes the management of carbon in the provision, operation, use and end of life of new projects and/or programmes of work, as well as the management or retrofit of existing assets and networks. This Policy ensures incorporation of international best practice by aligning with the PAS 2080:2023 requirements on embodied emissions.

### Verification

Agencies are not expected to seek independent verification against PAS 2080:2023 to comply with this Policy. While this does not restrict agencies seeking verification, agencies are encouraged to assess whether the benefits of accreditation outweigh the costs.

If an agency chooses to seek independent verification, it is essential to consider that compliance with this Policy does not guarantee verification to the international standard. Conversely, accreditation to the international standard does not guarantee compliance with this Policy.

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Agencies are encouraged to start implementing the Policy as early as possible and to provide feedback to Infrastructure NSW on challenges and opportunities for improvement.

## Relationship between this Policy and other financial reporting requirements

NSW Government agencies are required to make climate-related disclosures commencing from the financial year 2024–25 under the NSW Treasury Policy and Guidelines – Annual Reporting Requirements (TPG 23-10) and related Annual Reporting Regulations.

The Australian Accounting Standards Board are developing Australian Sustainability Reporting Standards – Disclosure of Climate-related Financial Information (AASB Climate Standards). The AASB expects to align their Climate Standards with the International Financial Reporting Standard S1 and S2 2023 with adjustments for the Australian context. The AASB may consider an obligation to disclose scope 3 emissions within this standard.<sup>17</sup>

Measurement of the upfront or embodied emissions of NSW Government infrastructure under this Policy can support an agency's efforts to measure and report their scope 3 emissions, and will assist agencies to identify, track and manage their transition risks and opportunities. This can support agencies in making their climate-related disclosures.

### Implementation timeframe

The Policy will commence 12 months from the release date. This transition period is to allow agencies time to embed the new Policy into capital expenditure processes. However, agencies are encouraged to start implementing the Policy as early as possible and to provide feedback to Infrastructure NSW on challenges and opportunities for improvement.

### Measurement requirements

Measurement will be undertaken in accordance with the Measurement Guidance.

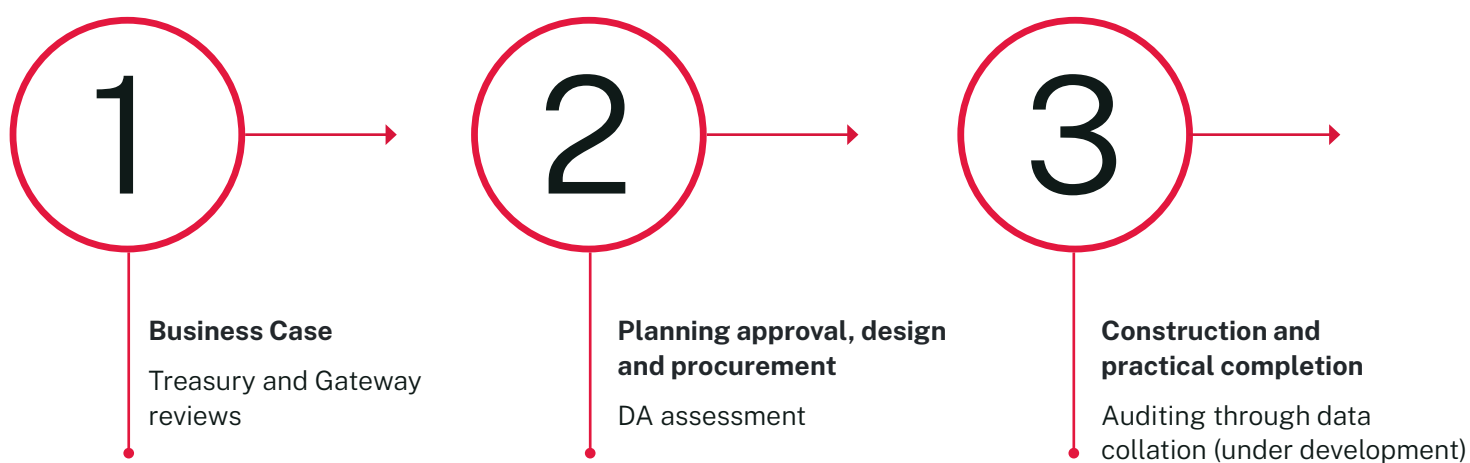
### Review of carbon reporting

Carbon data will be verified at practical completion as part of the data collation process and this process is still in development. However, usual business case review and Development Approval (DA) processes are expected to provide additional checks.

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<sup>17</sup> Refer to IFRS S2 [Climate-related Disclosures](#) for additional information and definitions relating to scope 3 emissions.

**Figure 2: Review processes by project stage**



Larger projects subject to Green Star or Infrastructure Sustainability Council (ISC) ratings will also have data verified through these rating schemes.

## Review of the Policy

The Policy will be reviewed against key performance indicators one year after its commencement.

The final key performance indicators and other implementation matters, such as supporting materials and provision of templates, will be considered during the transition period, in close consultation with NSW Government agencies.

Further, Infrastructure NSW and the NSW Environment Protection Authority (EPA) are working to develop the Protection of the Environment Policy (PEP). The PEP will complement the Policy by establishing a reporting framework.

**Table 2: Indicative key performance indicators**

Intended Policy outcome	Key performance indicator	How we will measure it
Infrastructure projects report data on embodied carbon	% of projects reporting upfront carbon at business case, planning and completion stage	Dashboard collated by data owner (with data on number of projects to be developed and agreed through the implementation period).
Upfront carbon is considered in options analysis	% of projects that demonstrate upfront carbon was a factor in options analysis	Agency reporting, to be developed and agreed through the implementation period.

# 02





## Decarbonising infrastructure principles

# Carbon management principles

A set of carbon management principles have been defined to guide carbon management activities. Table 3 describes each principle, with these explained in further detail in Part 2 of this document.

The Policy's mandatory and optional actions in Table 1 guide agencies on how to implement these principles across the project lifecycle.

**Table 3: Principles of upfront carbon management**

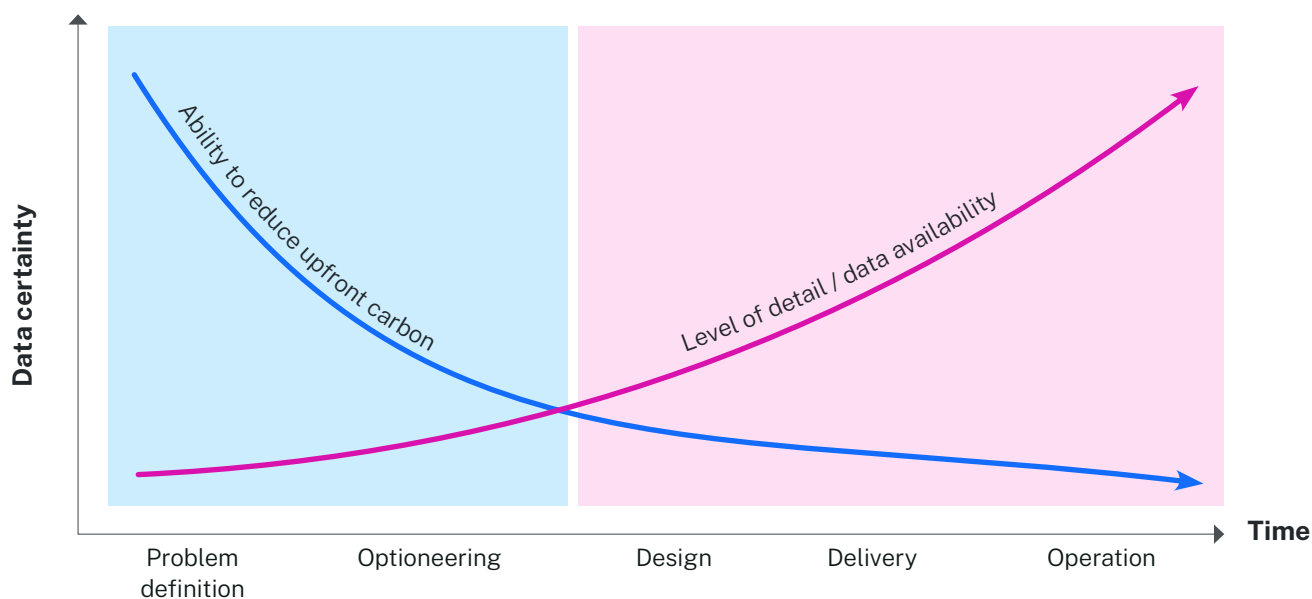
	Principle	Description
1. 	<b>Apply the Carbon Reduction Hierarchy</b>	Minimise upfront carbon emissions early by considering options to build nothing or augment existing assets, as well as options to build efficiently. <sup>18</sup> Where possible, agencies are encouraged to challenge the requirement to build new infrastructure. However, it is acknowledged that considering an option to build nothing may not be appropriate in all circumstances.
2. 	<b>Assess the upfront carbon impact</b>	Quantify the upfront carbon of projects throughout the project lifecycle. Agencies that are further along in carbon management maturity should also set a baseline and upfront carbon reduction target in accordance with or beyond industry standard.
3. 	<b>Engage with the market</b>	Engage with the market at the earliest possible stage to enable innovation and carbon reduction practices. Define the activities in the project lifecycle through which the agency can control or influence the amount of upfront carbon emissions relative to other members of the value chain.
4. 	<b>Develop a Carbon Management Plan</b>	Document the governance, accountability, monitoring and reporting activities related to managing upfront carbon. The Carbon Management Plan is to be a live document that is updated as the project progresses from planning into delivery and completion.

<sup>18</sup> Definition informed by PAS2080:2023 Carbon management in buildings and infrastructure but tailored to NSW context for upfront carbon.

## The ability to reduce carbon is greatest early in a project's life

Certainty over a project's emissions will increase as it progresses through the lifecycle stages. This is similar to cost and benefit estimation, where certainty is lowest at the earliest stages of a project's development. However, the ability for agencies to reduce embodied carbon is highest at the earliest stages, as shown in Figure 3. As such, the sooner upfront carbon is considered, the greater the opportunity to make informed decisions.

**Figure 3: Degree of accuracy and data availability in whole of life carbon assessments across work stages<sup>19</sup>**



<sup>19</sup> Adapted from PAS2080:2023 s.7.1 Figure 7.

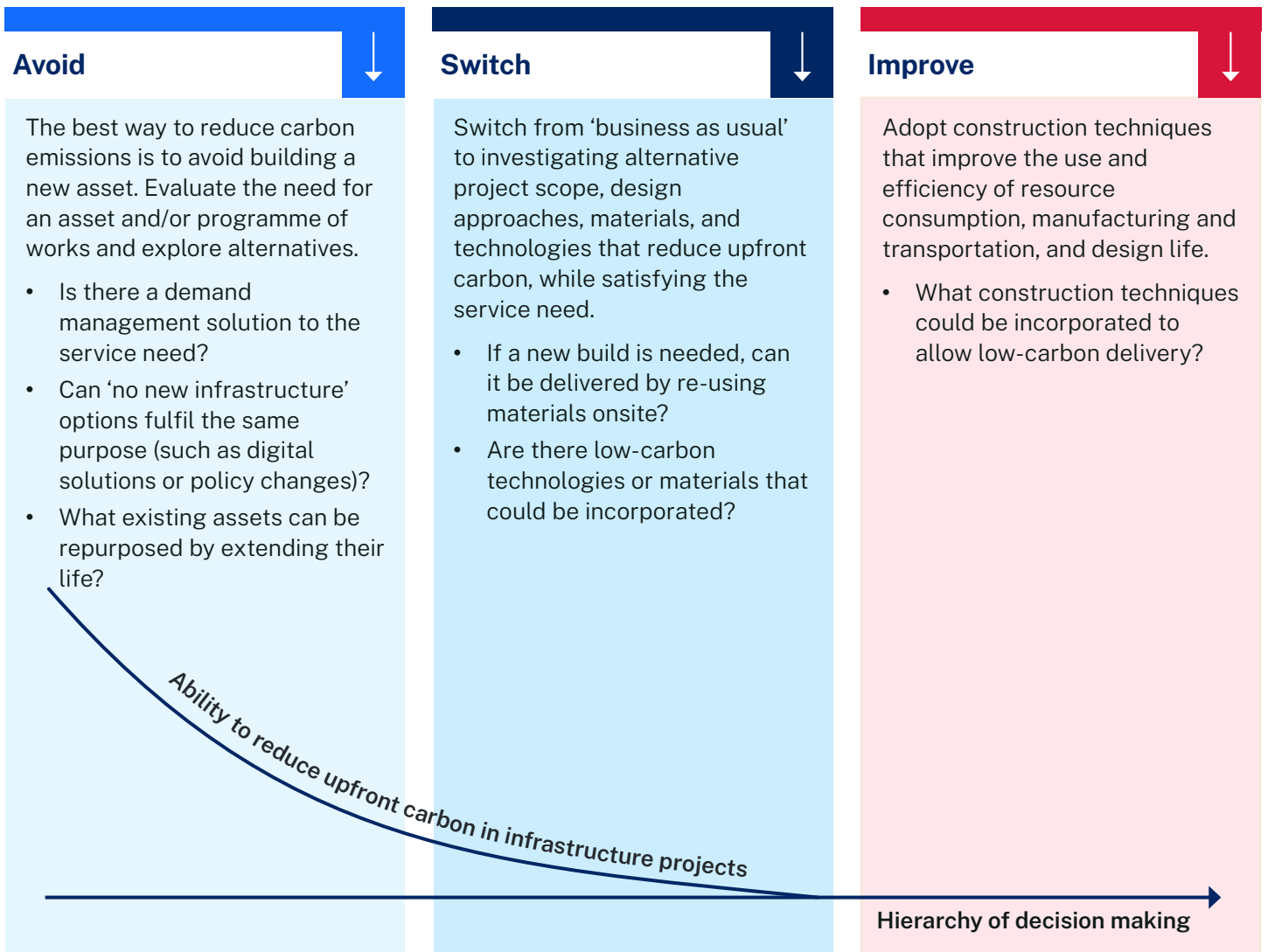
# Principle 1: Apply the Carbon Reduction Hierarchy

**The Carbon Reduction Hierarchy is a framework for reducing carbon, described in PAS 2080:2023 and shown in Figure 4. It demonstrates that the opportunity to reduce carbon is greatest in the early stages of a project.**

Agencies will adhere to and apply the Carbon Reduction Hierarchy (in the order of priority shown) when identifying potential opportunities to reduce carbon. It is acknowledged that considering an

option to build nothing may not be appropriate in all circumstances. To support implementation of this principle, Appendix 1 provides a summary of design initiatives that should be considered by agencies when developing detailed project options. Measures to reduce embodied carbon through avoiding construction will also have other environmental benefits such as reducing embodied water use.

**Figure 4: The Carbon Reduction Hierarchy<sup>20</sup>**



<sup>20</sup> Adopted from PAS2080:2023 s.4.4 Figure 5 and PA2080:2016 s.6.1.4.

## Actions for applying the Carbon Reduction Hierarchy

Table 4 below sets out mandatory and optional actions by project phase that relate to the Carbon Reduction Hierarchy principle. Agencies must demonstrate that the mandatory actions have been met in their business case/relevant documentation or provide sound reasons for why they have not.

Appendix 1 provides further guidance on suggested initiatives, interventions and considerations to reduce upfront carbon in planning, design, and construction in applying the Carbon Reduction Hierarchy.

**Table 4: Actions for applying the Carbon Reduction Hierarchy**

Stage	Actions
Problem definition	<p><b>Mandatory action (all agencies):</b></p> <ol style="list-style-type: none"> <li>1. Provide sound reasons in project inception and registration documentation for why new infrastructure is required to address the problem or service need, including consideration of upfront carbon.</li> </ol>
Business case	<p><b>Mandatory actions (all agencies):</b></p> <ol style="list-style-type: none"> <li>2. On an “if-not-why-not” basis, the business case options analysis must consider:               <ol style="list-style-type: none"> <li>a. build nothing option(s)</li> <li>b. upgrades or repurposing of existing infrastructure</li> <li>c. using assets for multiple purposes</li> <li>d. low carbon design and construction methods (at the Final Business Case stage).</li> </ol> </li> <li>3. Business cases must include clear rationale for proceeding with any new infrastructure options.</li> </ol>
Planning approval, design, and procurement	<p><b>Mandatory action (all agencies):</b></p> <ol style="list-style-type: none"> <li>14. On an “if-not-why-not” basis, incorporate low carbon design and construction methods into procurement requirements.</li> </ol> <p><b>Optional action (agencies with maturing capability):</b></p> <ol style="list-style-type: none"> <li>15. Allow tenderers to challenge the brief to provide innovative ways to reduce carbon.</li> </ol>
Construction and practical completion	-

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## Case study:

### Low Crosby Flood Risk Management scheme

The UK Environmental Agency applied the Carbon Reduction Hierarchy in a recent project to reduce flood risk in the village of Low Crosby.

The Environment Agency collaborated with their designer to assess and manage whole life carbon throughout the need and optioneering project stages, with an ambition to reduce whole life emissions. Rather than implementing a hard engineered solution, such as a flood wall, a 'build less' approach was adopted, which satisfied the whole life project objectives and performance requirements.

The solution was to remove a 3km embankment on the opposite bank of the River Eden. This removed a local restriction to the flow of floodwater, resulting in significantly reduced water levels at Low Crosby.

The project required extensive community engagement, as the embankment provided protection to high-grade arable farmland within the River Eden floodplain.

Returning the floodplain to its natural state enhanced the natural environment and allowed for other long-term natural capital benefits, including carbon sequestration of about 30,000 tonnes of carbon (tCO<sub>2</sub>e) over a 100-year assessment period.

As well as achieving primary objectives related to flood-risk management, the solution offered the lowest whole life carbon when compared with the other construction options. The avoidance of a hard engineered flood wall significantly reduced the potential whole life carbon emissions of the scheme by approximately 1,900 tCO<sub>2</sub>e. The 'build less' approach further minimised emissions by keeping 100% of existing embankment material in situ.

The Environment Agency's Carbon Impacts Tool was used to calculate an overall value of carbon avoided from reducing flooding risks, against emissions from constructing and maintaining an alternative solution. The estimated net carbon value for Low Crosby is 1,300 tCO<sub>2</sub>e over the 100-year assessment period. (Source: Institute of Civil Engineers, Guidance document for PAS2080).

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The 'build less' approach further minimised emissions by keeping 100% of existing embankment material in situ.



## Case Study:

### Albion Park Rail Bypass

Transport for NSW has applied the Carbon Reduction Hierarchy by using recycled materials in major projects. In particular, the Albion Park Rail Bypass adopted a circular economy approach to keep materials in use for longer. The project, which received grant funding from the NSW EPA through the Civil Construction Market Program, represents best practice in circular infrastructure, successfully reusing approximately:

**500,000**

tonnes of coal wash, a low-grade mining waste

**300,000**

tonnes of tunnel spoil

**130,000**

tonnes of recycled Select Material Zone (SMZ) material

**180,000**

tonnes of Heavily Bound Base (HBB)

**6,000**

tonnes of Recycled Crushed Glass (RCG) used in asphalt

To replace sand used in asphalt, the Albion Park Rail bypass used recycled crushed glass that is the equivalent of 30 million glass bottles. The base asphalt layer used on the Albion Park Rail bypass is made up of 25% recycled material, including 10% recycled crushed glass and 15% reclaimed asphalt pavement.

#### Key takeaways

- Early commitment by asset owner/manager to a low-carbon approach as part of project objectives.
- Consultation with value chain, including local community, captured broader benefits in scope.
- Carbon reduction opportunities influenced options assessment, including nature-based solutions.
- Government intervention can influence industry uptake of lower-carbon materials.

## Principle 2: Assess the upfront carbon impact

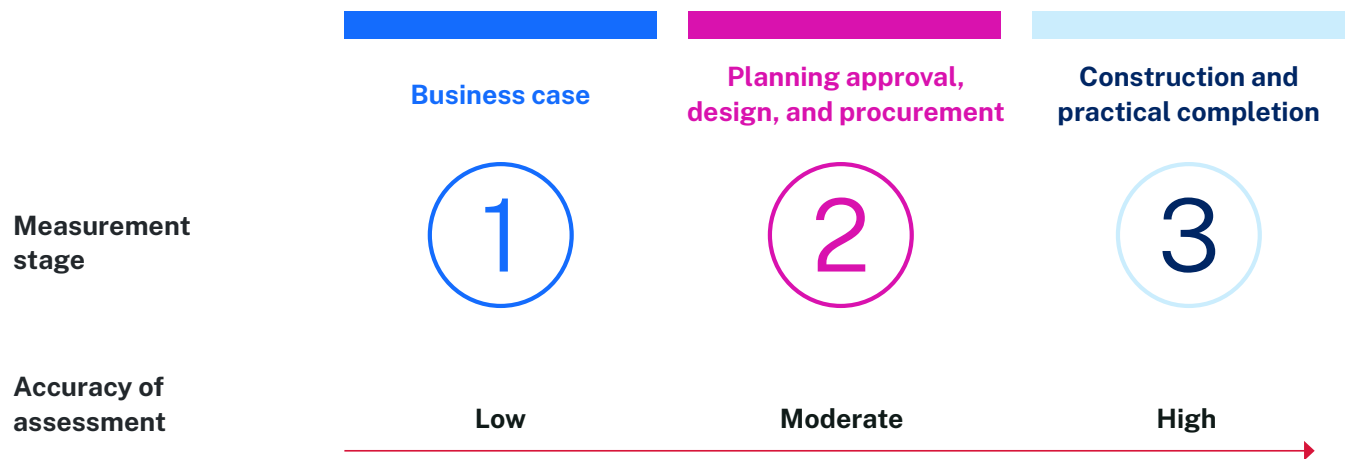
Agencies must, at a minimum, quantify the impact of upfront carbon at three project stages:

- **Business case**
- **Planning approval, detailed design, and procurement**
- **Project completion.**

Agencies with maturing carbon management capability should also set a baseline (or a reference case) and an upfront carbon reduction target in accordance with or beyond industry standard.

The Measurement Guidance details the approach to measurement required under this Policy, while recognising that data availability is very low at early project stages and gradually increases.

**Figure 5: Three stages for measurement of carbon emissions**



### Foundational capability

Quantification of emissions at the three stages will support better carbon management and investment decision making.

**At business case stage:** all agencies must estimate the relative upfront carbon impact of each business case option that is subject to cost-benefit analysis requirements. This is in line with an existing requirement of the NSW Government Guide to Cost-Benefit Analysis.

**At planning approval, design, and procurement stage:** all agencies must quantify the upfront carbon impact of the proposed project to support planning approval, procurement and/or the detailed design process. This will already be expected of many projects under existing reporting requirements, such as the Sustainable Buildings State Environmental Planning

Policy or Secretary's Environmental Assessment Requirements.

**At construction and practical completion stage:** all agencies must assess the upfront carbon impact of projects by quantifying and reporting emissions. This is a new requirement that will enable NSW Government to track progress towards net zero emissions and develop an evidence base to support benchmarking and future target setting.

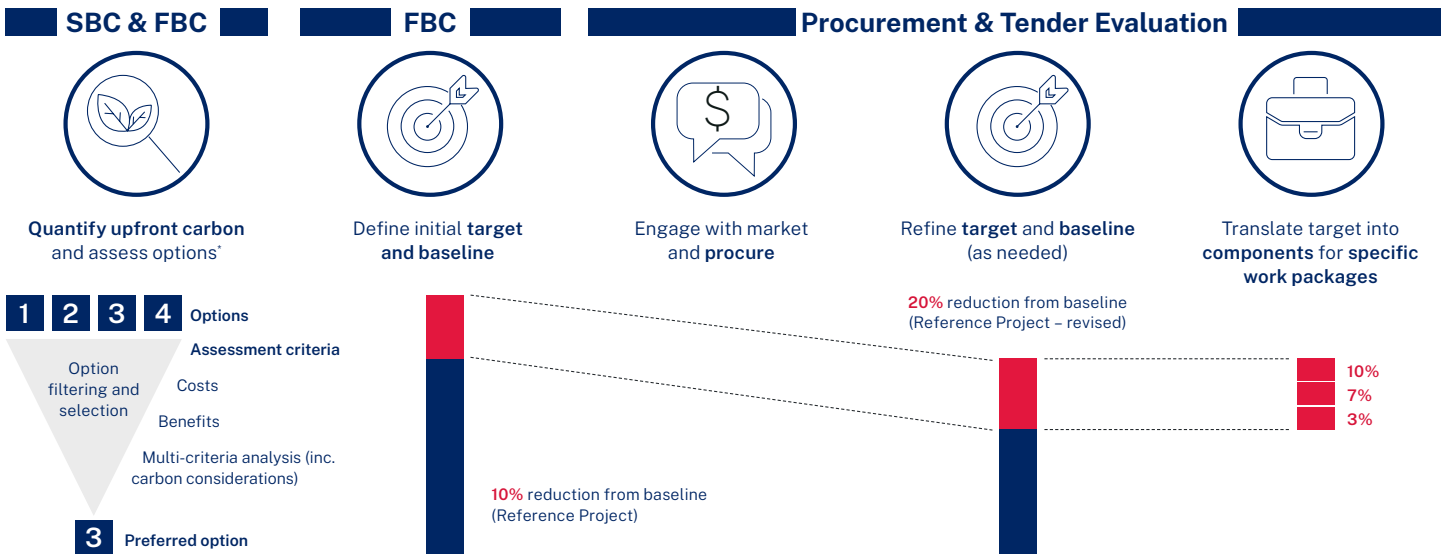
The entity responsible for data collation and the precise process for receiving the data are being developed as part of implementation process, while the Measurement Guidance provides a set of templates to support minimum levels of consistency.

# Maturing capability

Agencies with maturing capability should also:

Project stage	Optional action for mature agencies
As part of the Final Business Case	<ul style="list-style-type: none"> <li>• <b>Define</b> a baseline of upfront carbon relative to a Reference Project, based on consistent as-built datasets from prior projects or comparable projects as early as possible.</li> <li>• <b>Define</b> a target for upfront carbon reduction, with reference to government policy, industry standards, sector specific targets or comparable projects.</li> </ul>
As part of procurement and tender evaluation activities	<ul style="list-style-type: none"> <li>• <b>Refine</b> baseline and target for upfront carbon reductions as scope and data certainty increases over time.</li> <li>• <b>Translate</b> target into sub-targets relevant to specific work packages and translate to delivery phase / procurement.</li> </ul>

Figure 6: Baseline and target setting for maturing agencies, refining with data and scope certainty<sup>21</sup>



\* The quantification and assessment process will occur as part of the Strategic Business Case (SBC) and the Final Business Case (FBC).

Note: Percentage values provided in the figure above are indicative only

21 Adapted from Infrastructure Partnerships Australia (IPA), [Decarbonising Construction: Putting Carbon in the Business Case](#), IPA, 2022.

## Consideration of whole life carbon

While this Policy focuses on upfront emissions, there are likely to be trade-offs between reducing upfront and operational emissions in some circumstances. Reducing whole life carbon should be prioritised in these cases.

The table below provides examples of potential whole life carbon trade-offs that could occur. Agencies that do not have the capability to consider these quantitatively are encouraged to do so qualitatively. The Measurement Guidance provides further information about how to consider trade-offs.

**Table 5: Examples of whole life carbon trade-offs**

Trade-off example	Description
<b>Building insulation and operational energy performance</b>	The addition of insulation or the selection of façade materials with better insulating properties may increase material demand (higher upfront carbon) but reduce operational energy demand (use phase operational carbon).
<b>Rigid vs flexible road pavement</b>	Flexible asphalt pavements have lower upfront carbon compared to rigid concrete pavements. However, flexible asphalt pavements require more frequent refurbishment and replacement of asphalt (use phase embodied carbon). Deflection and roughness of flexible pavement may also result in greater fuel consumption and carbon emissions from vehicles (B8 –user’s utilisation).
<b>Electrified vs nonelectrified railway</b>	Electrified rail networks require more infrastructure such as cabling, overhead wiring, and gantries (higher upfront carbon). However, these will generally have a lower operational emission intensity (use phase operational carbon) compared to diesel rail networks.
<b>Water treatment process complex use phase emissions</b>	A certain secondary treatment process may have smaller tank structures (lower upfront carbon). However, it may also require greater operational energy (use phase operational carbon) and treatment chemicals (use phase embodied carbon).

## Actions for assessing the upfront carbon impact

The table below sets out mandatory and optional actions by project phase that are relevant to assessing the upfront carbon impact.

**Table 6: Actions for assessing the upfront carbon impact**

Stage	Actions
<b>Problem definition</b>	-

Stage	Actions
Business case	<p data-bbox="421 255 831 288"><b>Mandatory action (all agencies):</b></p> <ol style="list-style-type: none"> <li data-bbox="421 300 1347 714">4. Business cases must consider carbon as part of options analysis in line with the <i>NSW Guide to Cost-Benefit Analysis</i> (CBA Guide).<sup>22</sup> The agency must:               <ol style="list-style-type: none"> <li data-bbox="480 412 1318 501">a. estimate the upfront carbon associated with each option using the Measurement Guidance, which has provisions for maturing and foundational capabilities</li> <li data-bbox="480 517 1326 607">b. include carbon emissions as a criterion when assessing preliminary options in the multi-criteria analysis.<sup>23</sup> Where feasible, this should include whole life carbon</li> <li data-bbox="480 622 1342 714">c. for the preferred option in the Final Business Case, identify the main sources of upfront carbon, and use this to inform carbon reduction objectives for market engagement.</li> </ol> </li> </ol> <p data-bbox="421 730 1091 763"><b>Optional actions (agencies with maturing capability):</b></p> <ol style="list-style-type: none"> <li data-bbox="421 775 1374 909">5. Set an upfront carbon reduction <b>objective</b> as part of the broader SMART (Specific, Measurable, Achievable, Realistic, Timely) project objectives set for the Strategic Business Case. This will be revised to a <b>target</b> in the Final Business Case.</li> <li data-bbox="421 920 1378 1167">6. As part of target setting, the agency should first define a baseline for the preferred option in the Final Business Case. This means:               <ol style="list-style-type: none"> <li data-bbox="480 999 1362 1088">a. identifying comparable projects or sector benchmarks that can inform the baseline, such as interjurisdictional examples or sub-asset level benchmarks<sup>24</sup></li> <li data-bbox="480 1104 1378 1167">b. adjusting or tailoring the baseline to suit the context of the project with supporting justification.</li> </ol> </li> <li data-bbox="421 1178 1378 1637">7. The agency should set an upfront carbon reduction target. In setting the target, agencies should consider alignment with reduction ambitions set by government or comparable organisations, industry bodies, or projects, while having regard for trade-offs between carbon reduction and additional costs. The agency should:               <ol style="list-style-type: none"> <li data-bbox="480 1357 1342 1391">a. identify an ambitious upfront carbon reduction target for the project</li> <li data-bbox="480 1402 1342 1464">b. compare the target to those set for comparable projects in the same sector</li> <li data-bbox="480 1476 1334 1538">c. consider how value chain perspectives may be incorporated (e.g. via market sounding process)</li> <li data-bbox="480 1550 1362 1637">d. identify and consider any trade-offs that the upfront carbon reduction target may produce across the asset lifecycle. See Table 5 for examples of whole life carbon trade-offs.</li> </ol> </li> <li data-bbox="421 1648 1342 1738">8. Both the baseline and the target should be revisited following procurement to reflect any further carbon reductions proposed by the successful bidder.</li> </ol>

22 The CBA Guide requires the cost of whole life carbon emissions, or benefits of reduced whole life carbon emissions, to be included in CBA where the cost or benefit is likely to materially affect the Net Present Value (NPV) or Benefit-Cost Ratio (BCR). The CBA Guide provides the carbon values to be used in NSW business cases: [Technical note to NSW Government Guide to Cost-Benefit Analysis TPG23-08](#) and [Supporting Technical Note](#). Further, the DPE [Framework for Valuing Green Infrastructure and Public Spaces](#), a companion to the CBA Guide, highlights the importance of valuing carbon benefits.

23 Multi-criteria analysis is often used to narrow down options to a list to be assessed using CBA. CBA is required for options analysis in business cases and considers whole life carbon emissions.

24 Over time, completed project emissions data collected under this Policy will allow for benchmarks to be set. These can help agencies with target setting in the future.

Stage	Actions
<b>Planning approval, design, and procurement</b>	<p><b>Mandatory actions (all agencies):</b></p> <p><b>16.</b> Include contractual performance requirements for contractors to provide as-built data to enable reporting on upfront carbon in accordance with the Measurement Guidance.</p> <p><b>17.</b> Quantify the upfront carbon impact of the proposed project to support planning approval, procurement and / or detailed design process.</p> <p><b>Optional action (agencies with maturing capability):</b></p> <p><b>18.</b> Baseline and target-setting activities should inform tender requirements, which should require bidders to reduce carbon beyond the target set at the Final Business Case. The baseline may be updated prior to procurement to improve accuracy and better inform contributions to carbon reduction opportunities.</p>
<b>Construction and practical completion</b>	<p><b>Mandatory action (all agencies):</b></p> <p><b>25.</b> Report the upfront carbon at Practical Completion in accordance with the Measurement Guidance.</p> <p><b>Optional actions (agencies with maturing capability):</b></p> <p><b>26.</b> Through the detailed design and construction process, agencies and their delivery partners should:</p> <ul style="list-style-type: none"> <li>a. continue to seek and implement upfront carbon reductions as part of value engineering</li> <li>b. monitor, track, and report upfront carbon reductions achieved through the design and delivery activities</li> <li>c. report these activities and the carbon reduction outcomes in the Carbon Management Plan or project plan.</li> </ul> <p><b>27.</b> Where a target for carbon reduction was set, assess whether this was achieved and if not, the barriers that prevented this.</p>

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## Case study

### London Power Tunnels

For maturing organisations, the practical application of setting and achieving carbon reduction targets starts at the strategic level.

Organisation-level targets have been set by the UK National Grid:

- reduce combined Scope 1 and 2 GHG emissions by 80% by 2030, by 90% by 2040, and to net zero by 2050 compared with their 1990 emissions of 21.6 million tonnes.
- reduce Scope 3 emissions by 37.5% by 2034 from 2019 emissions of 33.2 million tonnes and to net zero by 2050.

In 2020, National Grid embarked upon a seven-year, £1 billion project, to rewire South London via deep underground tunnels. In total, 32.5km of 3m diameter tunnels are being constructed deep below the road network between Wimbledon and Crayford, which will carry high voltage electricity cables.

Project-specific targets were set, including a project-wide 8% carbon emissions reduction target and a 5% reduction in carbon emissions from construction activities (i.e. at the work package level), compared with pre-project baseline.

The shared responsibility of achieving these targets required collaboration with its design and delivery partners. (Source: National Grid Press release: National Grid completes record-breaking pour of cement-free concrete at London Power Tunnels).

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## Case Study

### Sydney Metro

#### **Sydney Metro is tackling upfront emissions.**

On the City & Southwest project, its emissions are tracking at 27% below business as usual through initiatives such as design, alternative fuels, renewable electricity, recycled materials, and effective waste management.

Cranes at Martin Place are using B20 biodiesel containing at least 20 per cent waste products, such as used cooking oil and animal fats (tallow). By using this biodiesel mix, the project will reduce its fuel-related emissions and exceed requirements by 15 per cent. Biodiesel fuel was also used at Westmead demolition works site as part of early works associated with the Sydney Metro West project.

All Sydney Metro projects have set renewable electricity targets to reduce emissions during construction. On the Sydney Metro City & Southwest project, all delivery partners are required to use at least 25% renewable electricity. Several delivery partners have taken the initiative to exceed this target to achieve 100% through a mixture of on-site solar, Large-Scale Generation Certificates, and GreenPower. Sydney Metro West has embedded a 25% renewable energy requirement into construction packages with further opportunities being explored for the project.

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The Sydney Metro–Western Sydney Airport project committed to a 100 per cent offset requirement as part of its Station Boxes and Tunnelling contract

**(Source: Sydney Metro, Sydney Metro Sustainability Report 2022).**

#### **Key takeaways**

- Project is guided by and contributing to organisation-level carbon reduction targets.
- Collaboration across the value chain is driving outcomes.
- Innovative market-based solutions tested and deployed during design and delivery.
- Target carbon reductions and achievements tracked and reported at work package level.
- Carbon reductions tracked and reported against relevant baseline measures.



## Principle 3: Engage with the market

**The NSW Government has the opportunity to reduce upfront carbon in its infrastructure projects by collaborating with the market to implement decarbonisation solutions. Decarbonisation should form one of the matters considered during early market engagement, alongside other matters related to design, construction, cost, and delivery.**

There are a range of methods for early market engagement (such as market sounding and industry briefing sessions) and many agencies take a portfolio, rather than project-specific, approach to engagement. The extent of early market engagement should be proportionate to the size of the project.

### Scope of control and influence

Reducing upfront carbon in the delivery of public infrastructure is a shared responsibility between government and industry. Agencies deliver projects in partnership with a supply chain ranging from designers, through to materials producers and constructors (see Figure 7), each with different capacities to control or influence the upfront carbon in infrastructure projects.

Agencies can identify meaningful opportunities to reduce upfront carbon by clarifying where they can directly control versus influence emissions. Agencies will be able to directly control aspects such as optioneering and procurement processes. They can encourage innovation by engaging the market early in project planning, where there is a significant opportunity to reduce upfront carbon. The insights gained from early market engagement can be used by agencies to set expectations for the market in tender documentation and facilitate collaboration to achieve desired upfront carbon reduction outcomes (and targets, for agencies with maturing capability).

In contrast, agencies will indirectly influence the selection of materials and processes used in construction, in most cases. Broader market engagement objectives should encourage tangible low carbon initiatives by contractors, such as in materials, structure, and construction emissions. These initiatives should be sought both at the project level and across agencies' portfolios, where feasible.

The business case and the Carbon Management Plan should articulate the roles and responsibilities for upfront carbon reduction as part of standard practice in identifying accountabilities and responsibilities in project planning.

**Figure 7: Scope of control and influence**

Value chain participant	Control	Influence
<b>Society, Users and Occupiers</b>	<ul style="list-style-type: none"> <li>Consumption choices relating to different products and services and their relative carbon impact</li> </ul>	
<b>Government and Policy Makers</b>	<ul style="list-style-type: none"> <li>Set policies, legislative requirements and incentives to accelerate transition to net zero</li> </ul>	<ul style="list-style-type: none"> <li>Promote and engage with industry on policies and incentives to drive decarbonisation behaviours and investment</li> <li>Communicate successes and share lessons learnt to promote continuous improvement</li> <li>Promote and participate in early contractor engagement</li> </ul>
<b>Asset Owners and Managers</b>	<ul style="list-style-type: none"> <li>Set organisation-level and project-level targets relative to baseline and reference projects, respectively</li> <li>Incorporate carbon impact into options analysis and assessment process to inform investment decisions</li> <li>Set carbon reduction ambitions as part of procurement evaluation criteria</li> <li>Include mechanism (e.g. pain/gain share) to incentivise carbon savings</li> <li>Establish and implement accountability for targets</li> </ul>	<ul style="list-style-type: none"> <li>Communicate expectations to the market early in planning and procurement processes</li> <li>Promote continuous improvement by incentivising innovation and data sharing between value chain</li> <li>Encourage use of carbon reduction hierarchy by delivery partners across project lifecycle</li> <li>Encourage and incentivise collaboration across value chain</li> </ul>
<b>Designers</b>	<ul style="list-style-type: none"> <li>Set requirements for supply chain to meet carbon reduction ambitions of asset owner/manager</li> <li>Measure reductions from baseline</li> </ul>	<ul style="list-style-type: none"> <li>Encourage use of carbon reduction design methodologies</li> <li>Encourage cross-discipline coordination and innovation across design process</li> <li>Support broader value chain with capability uplift</li> </ul>
<b>Constructors and Builders</b>	<ul style="list-style-type: none"> <li>Challenge clients and supply chain to innovate and propose carbon reduction opportunities</li> <li>Commit to and deploy low carbon construction methods</li> <li>Measure reductions from baseline</li> </ul>	<ul style="list-style-type: none"> <li>Promote and participate in early contractor engagement from asset owner/manager</li> <li>Support supply chain that demonstrates their commitment to carbon reduction</li> </ul>
<b>Product / Material Suppliers</b>	<ul style="list-style-type: none"> <li>Use low carbon production methods</li> <li>Challenge clients and supply chain to innovate and propose carbon reduction opportunities</li> <li>Communicate carbon reduction savings from products</li> </ul>	<ul style="list-style-type: none"> <li>Encourage and communicate low carbon processes, practices and materials with supply chain</li> </ul>
<b>Insurers</b>	<ul style="list-style-type: none"> <li>Price risk of stranded assets in net zero carbon economy</li> </ul>	

## Actions for engaging with the market

Table 7 below sets out mandatory and optional actions by project phase that are relevant for engaging with the market.

**Table 7: Actions for engaging with the market**

Stage	Actions
Problem definition	-
Business case	<p><b>Optional actions (agencies with maturing capability):</b></p> <ol style="list-style-type: none"> <li>9. Include requirements to capture all reasonable decarbonisation opportunities (such as in materials, structure, and construction emissions) in the brief for concept design. This should draw on the major sources of carbon identified in requirement 4c.</li> <li>10. Following concept design, the agency should test these opportunities with the market as part of early engagement processes. The agency should:               <ol style="list-style-type: none"> <li>a. consider a variety of market engagement methods</li> <li>b. allow adequate time in the project schedule for meaningful market engagement that is proportionate to the size of the project and its risks</li> <li>c. understand market appetite and ability in relation to decarbonisation</li> <li>d. encourage low carbon initiatives by contractors, such as in materials, structure, and construction methods.</li> </ol> </li> </ol> <p>Note: if the requirements under 9 and 10 are not carried out prior to Final Business Case, the stakeholder engagement plan should outline how these requirements will be met under action 19.</p>

Stage	Actions
<b>Planning approval, design, and procurement</b>	<p><b>Mandatory action (all agencies):</b></p> <p><b>19.</b> If not covered in any engagement completed at the business case stage, the agency should, on “if-not-why-not” basis:</p> <ul style="list-style-type: none"> <li>a. include decarbonisation as part of market engagement</li> <li>b. understand market appetite and ability in relation to decarbonisation.</li> </ul> <p><b>Optional actions (agencies with maturing capability):</b></p> <p><b>20.</b> Include low carbon design and construction methods in tender evaluation criteria.</p> <p><b>21.</b> Include the following in tender documentation:</p> <ul style="list-style-type: none"> <li>a. carbon management requirements consistent with roles and responsibilities identified in the governance framework</li> <li>b. outcomes of market engagement undertaken at the business case stage, allowing tenderers to reflect the findings in their bids</li> <li>c. opportunity to offer innovative low carbon options for delivery of the project, such as in materials, structure, and on-site emissions</li> <li>d. carbon management requirements as an evaluation criterion.</li> </ul> <p><b>22.</b> To ensure upfront carbon reduction targets are carried through to project delivery, agencies should:</p> <ul style="list-style-type: none"> <li>a. translate the upfront carbon reduction target from the successful bid into components for specific work packages in negotiation with preferred supplier(s)</li> <li>b. make it clear to engaged members of the value chain their respective responsibilities for delivering upfront carbon reduction targets via the appropriate risk allocation mechanism</li> <li>c. ensure the combined allocation of upfront carbon reduction targets equate to the overall project or program target in line with the successful bid.</li> </ul> <p><b>23.</b> Agencies able to set targets should also:</p> <ul style="list-style-type: none"> <li>a. include upfront carbon reduction target in the tender documentation</li> <li>b. make it clear to members of the value chain that achievement and improvement on upfront carbon reduction targets will form part of the tender evaluation process.</li> </ul>
<b>Construction and Practical Completion</b>	<p>-</p>

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## Case study

### Supplier Sustainability Week and Decarbonisation Club

CRH is a global provider of building materials and services, including road construction via one of its UK-based companies – Tarmac. With a commitment to reach its net-zero commitment before 2050 and achieve a 25% absolute reduction in Scope 1 and 2 emissions by 2030, Tarmac has demonstrated the need to work collaboratively with its supply chain to drive decarbonisation and align with UK Government’s net zero requirements.

In 2021, Tarmac held its first Supplier Sustainability Week, attended by more than 800 suppliers, with a clear focus on encouraging collaboration, supporting suppliers to embrace change, and identifying opportunities to reduce carbon collectively.

During this inaugural week, the Tarmac Decarbonisation Club was created, which now comprises 16 suppliers that contribute towards 30% of Tarmac’s Scope 3 emissions. This forum is an example of progressive procurement that is focused on developing practical and deliverable solutions for Tarmac and supply-chain partners to implement across construction and infrastructure projects.

To date, 120 recommendations have been generated and 60% of these ideas use technology that is either currently available or will be within the next two years. The recommendations have been mapped on a marginal abatement cost (MAC) curve and judged against three main criteria – cost, timescales to implement and potential carbon savings – to help Tarmac and its partners to understand projects that can deliver sustainable change. (Source: Institute of Civil Engineers, Guidance document for PAS2080).

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## Case study

### Net Zero Highways Net Zero Strategy

National Highways is one of the UK's largest buyers of construction materials, required to operate, maintain and future proof England's strategic road network. In 2020, emissions from the maintenance and construction of the network amounted to ~734,000 tonnes of CO<sub>2</sub>e.

In 2021, National Highways published a Net Zero Strategy setting out an ambitious program for reducing their carbon impact over the next 30 years. They hope to achieve:

- Net zero for their own operations by 2030
- Net zero for maintenance and construction by 2040
- A significant contribution to reduce road user emissions and deliver net zero transport on the UK roads by 2050.

Decarbonising the most carbon intensive materials (concrete, steel, and asphalt) is vital to delivering on this commitment.

National Highways worked with an engineering consortium to develop decarbonisation roadmaps for concrete, steel, and asphalt. These roadmaps describe how National Highways, and their supply chain, can reduce emissions through decarbonising the raw materials, the manufacturing process of the materials and the decarbonising of transport and construction emissions.

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Engaging closely with the supply chain, National Highways was able to understand what actions have been committed to, or are technically feasible, to decarbonise the materials.

(Source: Mott McDonald).

#### Key takeaways

- Proactive engagement with the value chain acknowledges shared responsibility and solidifies commitment to change.
- When presented with the opportunity, value chain members collaborate effectively.
- Acknowledgement of organisation-wide contribution to national challenge.
- Identified priority elements of the project lifecycle to focus on reducing carbon.
- Enhanced understanding of what is feasible now and in the future.

## Principle 4: Develop a Carbon Management Plan

**A Carbon Management Plan must form part of the suite of implementation plans that accompany a Final Business Case.**

The extent of detail provided in the Carbon Management Plan should be proportionate to the size of the project. For some agencies, carbon management responsibilities and actions do not vary across projects. In these cases, an organisation-wide carbon management plan may be appropriate.

Table 8 provides an example table of contents for a Carbon Management Plan for a large project, informed by actual projects delivered in other jurisdictions.

A Carbon Management Plan will be a living document and will be updated over the project lifecycle as certainty increases. Delivery partners will define their

approach to upfront carbon management as part of the procurement process and update the plan as the project advances through design and construction.

A Carbon Management Plan allows agencies and their delivery partners to:

- define their approach to and opportunities for upfront carbon management and reduction at procurement, design, and construction stages
- demonstrate who will be responsible for driving, tracking and reporting upfront carbon reductions achieved at various stages of the project delivery
- document the methodologies used to assess upfront carbon reductions.

**Table 8: Example Carbon Management Plan (table of contents)**

### **1 Introduction**

- 1.1 Scope of the Carbon Management Plan

### **2 Policy context and guidance**

- 2.2 NSW Government policies driving requirements of this Carbon Management Plan
- 2.3 Organisation-specific policies and commitments
- 2.4 [If applicable] Industry standards and guidance documents

### **3 Objectives and targets**

- 3.1 Project objectives and targets
- 3.2 [If applicable] Upfront carbon reduction baseline and target
- 3.3 [If applicable] Work package-specific targets

### **4 Roles and responsibilities**

- 4.1 Scope of control and influence (via Responsible, Accountable, Supportive, Consulted, and Informed framework)

### **5 Approach to upfront carbon management**

- 5.1 Procurement
- 5.2 Design
- 5.3 Construction

### **6 Carbon assessment**

- 6.1 Monitoring and reporting schedule
- 6.2 Carbon assessment tool and calculations

### **7 Key actions and opportunities**

- 7.1 Upfront carbon hotspots
- 7.2 Opportunities for upfront carbon reduction
- 7.3 Design

## Actions for developing a Carbon Management Plan

Table 9 below sets out mandatory and optional actions by project phase relevant to developing a Carbon Management Plan.

**Table 9: Actions for developing a Carbon Management Plan**

Stage	Actions
Problem definition	-
Business case	<p><b>Mandatory actions (all agencies):</b></p> <ol style="list-style-type: none"> <li>11. The agency must prepare a Carbon Management Plan as part of a Final Business Case. The level of detail should reflect the project's size and risks. Alternatively, a standard organisation-wide carbon management plan can be used where agency procedures do not vary across projects.</li> <li>12. The Carbon Management Plan must document:               <ol style="list-style-type: none"> <li>a. the expected supply chain participants and opportunities for control and influence to reduce carbon</li> <li>b. the roles and responsibilities for upfront carbon management and measurement (both in the project team and across the value chain members)</li> <li>c. how the procurement strategy seeks to promote early engagement and innovative decarbonisation approaches</li> <li>d. how and when supply chain participants can be involved as part of early engagement, for example in relation to the application of low carbon methods, and reflect this in the stakeholder engagement plan</li> <li>e. results of carbon quantification for the preferred option in accordance with the Measurement Guidance</li> <li>f. key risks related to achieving upfront carbon reductions for input into the risk register.</li> </ol> </li> </ol> <p><b>Optional action (agencies with maturing capability):</b></p> <ol style="list-style-type: none"> <li>13. Include carbon reduction targets and metrics in project objectives assigned to respective value chain members or roles, aligning with the overall reduction target.</li> </ol>
Planning approval, design, and procurement	<p><b>Mandatory action (all agencies):</b></p> <ol style="list-style-type: none"> <li>24. Ensure alignment between carbon management roles and responsibilities in the project governance framework and tender proposals.</li> </ol>
Construction and practical completion	<p><b>Optional action (all agencies):</b></p> <ol style="list-style-type: none"> <li>28. Document lessons learnt to support continuous improvement in NSW Government carbon management practises.</li> </ol>



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## Case study

# Carbon Management Training Suite and integrating carbon as a project risk

Transport for London (TfL) is exploring different ways to build expertise on decarbonisation, carbon management and the integration of carbon into decision-making. As part of this initiative, it is rolling out a Carbon Management Training Suite: an internal set of training modules and accreditation of carbon management competency, taking project staff from 'awareness' up to 'expert'. An expert-level practitioner with experience will be able to create internal carbon standards, manage carbon at a system level and produce carbon assessments independently.

The suite is available to all staff and will enable wider awareness of expertise, democratise 'green skills' and improve staff mobility. Alongside internal training programmes, TfL has been trialling a range of decarbonisation initiatives on projects. One involved the Piccadilly Line upgrade, a multibillion-pound programme supporting the introduction of new rolling stock to the London Underground service. At project inception, the lack of carbon management was highlighted as a program risk. To address this issue, carbon has been integrated within the program risks and the project's risk-management process, with risks being assigned a cost, schedule, and carbon impact. More widely, the TfL decarbonisation initiative involves:

- projects identifying carbon hotspots from whole life carbon assessments
- workshops to discuss quantified carbon reduction opportunities and threats in response to their hotspots and the carbon impacts of existing risks in project registers
- the carbon impacts of the risks being quantified and entered in the project's risk register. These are reviewed continually at workshops, alongside cost, and schedule risks.

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Integrating carbon opportunities and threats into project risk-management systems has resulted in greater awareness of carbon management, helping project managers to better understand their role in reducing carbon and relating this to cost and schedule.

**(Source: Institute of Civil Engineers, Guidance document for PAS2080).**

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## Case study

### Net Zero Highways Carbon Management system

A key workstream in decarbonising the National Highways' capital and operational infrastructure program was implementing a PAS 2080:2016 Carbon Management in Infrastructure compliant carbon management system.

Working with its engineering partners, National Highways identified a need to create stronger processes for managing carbon in the delivery of new projects and maintenance schemes. A system was developed and launched to support the estimation of carbon emissions, identification of emission reduction opportunities and the ability to record progress against targets.

These new systems, and processes established with their Net Zero Strategy, form an integrated carbon management process for National Highways. Overarching documentation summarises roles and responsibilities, tools, systems, and ongoing actions for driving carbon reductions from their construction and maintenance activities. This Carbon Management System document is accessible to all National Highways staff and their supply chain.

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This clear delineation of responsibilities, procedures and methodologies has enhanced the carbon management capabilities within National Highways and prepared them substantially for a PAS 2080 audit, in December 2022, where they became the world's first roads organisation to achieve this global carbon management standard.

**(Source: Mott McDonald)**

#### Key takeaways

- Meaningful carbon reduction requires a commitment to changing behaviours and evolving capabilities.
- Building awareness and knowledge across organisations helps drive significant change.
- More systematic approaches to carbon management help support external assurance and compliance requirements and promote leadership across industry.

# Appendix 1

## Design initiatives to reduce upfront carbon

The following provides a summary of design initiatives that should be considered by agencies when developing detailed project options. Design initiatives to reduce upfront carbon should be considered alongside other key criteria, such as cost, constructability, and compliance with building regulations and environmental planning instruments. Depending on the project development process, applying these initiatives may require early engagement with the market or specification in tender criteria and contracts. It is noted that this list is not exhaustive and may not apply to every infrastructure type. However, agencies are encouraged to use and adapt these initiatives where possible.

**Table 10: Examples of initiatives to reduce upfront carbon in planning, design, and construction, aligned to the Carbon Reduction Hierarchy<sup>25</sup>**

Approach	Aspect	Examples
Broadly applicable	Prioritise 'carbon hotspots'	<ul style="list-style-type: none"> <li>Based on upfront carbon assessment identify high carbon intensive components and materials. Prioritise initiatives in these elements.</li> </ul>
	Dematerialisation of project scope	<ul style="list-style-type: none"> <li>Challenge conventional design solutions and optimise design to consider innovative alternatives which significantly reduce the quantum of materials used.</li> <li>Design for durability and minimise the need for maintenance, repair, refurbishment, and replacement (in the use stage).</li> </ul>
	Select low carbon materials	<ul style="list-style-type: none"> <li>Challenge existing standards, guidance, and requirements, or equivalent, where relevant, to drive low-carbon solutions.<sup>26</sup></li> <li>Consider if different design solutions would allow the use of lower embodied carbon materials (e.g. timber).</li> <li>Early engagement with the supply chain to discover innovative materials and market availability.</li> </ul>
Avoid	Build nothing option(s) / 'no infrastructure' option(s)	<ul style="list-style-type: none"> <li>Challenge the need for new infrastructure and options for non-infrastructure options (e.g. technology or policy interventions).</li> <li>Consider broader system or network solutions / challenge project scope in terms of meeting 'needs'.</li> <li>Consider nature-based solutions as an alternative to 'grey' infrastructure.</li> <li>Maximise the use of existing infrastructure – reuse, repurpose, refurbish, and reduce new construction.</li> </ul>

<sup>25</sup> This table has been adapted from: Green Building Council Australia, [A practical guide to upfront carbon reductions](#), 2023, pp.28.

<sup>26</sup> British Standards Institution, [PAS 2080: 2023 Carbon management in infrastructure](#), BSI Standards Limited, 2023.

Approach	Aspect	Examples
	<b>Retain existing infrastructure (in entirety or in part)</b>	<ul style="list-style-type: none"> <li>Justify the need for demolition of existing infrastructure including structure and foundations through analysis and surveys.</li> <li>Consider remaining design life of asset components and potential for repurposing. Support with condition assessments and structural surveys, where feasible.</li> <li>Consider the adaptive reuse of heritage items.</li> </ul>
	<b>Site selection / optioneering</b>	<ul style="list-style-type: none"> <li>Prefer sites with infrastructure that can be reused / repurposed to avoid demolition and new construction.</li> <li>Avoid sites with complex ground conditions / undulating topography which require more complex foundations or structural design.</li> </ul>
	<b>Consider Strategic Engineering aspects / Architectural Concept Design</b>	<ul style="list-style-type: none"> <li>Consider structural and foundation strategy in relation to embodied carbon, for example optimising floor-to-floor heights, spans and spacing requirements.<sup>27</sup></li> <li>Assess opportunities in the design process for deconstruction and re-use of materials.</li> </ul>
<b>Switch – Design Optimisation</b>	<b>Optimise vertical and horizontal alignment of linear infrastructure</b>	<ul style="list-style-type: none"> <li>Optimisation of vertical and horizontal alignment of linear infrastructure can significantly reduce the amount of materials, extent of earthworks (and retaining structures / foundations), and allow for optimisation of drainage / bridges.</li> </ul>
	<b>Optimise structural design</b>	<ul style="list-style-type: none"> <li>Design to minimum loads (within code allowance), reduce structural grids, spans and transfer structures, use efficient structural forms.<sup>28</sup></li> <li>Consider options which allow future flexibility (e.g. by allowing a flexible floor plate). Assess opportunities in the design process for deconstruction and re-use of materials.</li> <li>Test and compare different structural grids options.</li> </ul>
	<b>Optimise foundations or basements</b>	<ul style="list-style-type: none"> <li>Consider alternative foundation options.</li> <li>Reconsider the need for basements or the extent of basements.</li> </ul>
	<b>Optimise superstructure</b>	<ul style="list-style-type: none"> <li>Consider timber for the superstructure.</li> <li>Prefer no transfer systems within structure. If not feasible, consider low load transfers systems.</li> <li>Floor systems that transfer loads through compression arches / other systems.</li> </ul>

<sup>27</sup> The Institution of Structural Engineers (ISE), [The Structural Plan of Work 2020](#), ISE, 2020.

<sup>28</sup> JJ Orr, M Cooke, T J Bell, C Smith and N Watson, [Design for Zero](#), ISE, 2021.

Approach	Aspect	Examples
	<b>Optimise other key structural and civil elements</b>	<ul style="list-style-type: none"> <li>Assess opportunities in the design process for deconstruction and re-use of materials. Design for disassembly and reuse (e.g. structural frame with timber walls and floors).</li> <li>Parametric design of depth and grade of concrete in flat slabs, post-tensioning, considering alternative conventional slab types.</li> <li>Consider drainage design options (nature-based solutions and water sensitive urban design, compare pipes/culverts and bridge solutions).</li> <li>Consider replacing steel bolts / fastenings with alternatives (e.g. glass-fibre-reinforced plastic (GFRP) bolts).<sup>29</sup></li> </ul>
<b>Switch - Materials</b>	<b>Consider alternative low carbon materials</b>	<ul style="list-style-type: none"> <li>Consider alternative materials, such as timber.</li> <li>Maximise onsite reuse of reusable materials.</li> <li>Consider recycled materials, many of which can provide like-for-like substitution, such as crushed glass for sand.</li> <li>Consider locally supplied materials (vs internationally sourced materials) or local processing facilities to recycle on site materials.</li> <li>Select products with third party certification, such as Climate Active, Environmental Product Declaration (EPD), Aluminium Stewardship Initiative-certified aluminium, ResponsibleSteel™, Australia Steel Institute's Steel Sustainability Australia certification program etc.</li> </ul>
	<b>Concrete</b>	<ul style="list-style-type: none"> <li>Challenge strength requirements and specifications to ensure the lowest carbon option is selected.</li> <li>Switch to lower grade strength concrete to reduce Portland cement.</li> <li>Engage with suppliers on available mixes and latest innovations (e.g. geopolymers concrete).</li> <li>Increase percentage of Substitute Cementitious Materials in concrete. Consider use of fly ash Ground Granulates Blast Furnace Slag (GGBFS) from stockpiles and widespread adoption of mixes that use limestone powder, calcined clay, and/or volcanic ash as SCMs.</li> <li>Use recycled aggregate and sand (e.g. recycled glass), where possible.<sup>30</sup></li> </ul>
	<b>Steel</b>	<ul style="list-style-type: none"> <li>Switch to higher grade strength steel to reduce steel quantity.</li> <li>Consider levels of recycling in rebar and innovative substitution materials and designs (e.g. fibre reinforced solutions).</li> </ul>
	<b>Asphalt</b>	<ul style="list-style-type: none"> <li>Consider a wider range of aggregate materials and options. Level of RAP (reclaimed aggregate pavement), virgin bitumen, and if warm or hot mix asphalt.</li> <li>Consider alternative asphalt design (e.g. EME2).</li> </ul>
	<b>Glass</b>	<ul style="list-style-type: none"> <li>Increase recycled content in glazing.</li> </ul>
	<b>Aluminium</b>	<ul style="list-style-type: none"> <li>Increase wall to window ratio to reduce aluminium framing.</li> <li>Use recycled aluminium products / select low embodied carbon aluminium products.</li> </ul>

<sup>29</sup> Austroads, [Sustainability in Road Tunnels: Updating the Guide to Road Tunnels](#), Austroads, 2022.

<sup>30</sup> Austroads, [Sustainability in Road Tunnels: Updating the Guide to Road Tunnels](#), Austroads, 2022.

Approach	Aspect	Examples
	<b>Pipes</b>	<ul style="list-style-type: none"> <li>Consider options for alternative pipe materials.</li> <li>Assess a variety of methodologies for below ground pipework and required construction materials (e.g. trenched verses non-trenched).</li> </ul>
	<b>Membranes</b>	<ul style="list-style-type: none"> <li>Work with and challenge suppliers to develop longer lasting composite plastic membranes.<sup>31</sup></li> </ul>
<b>Improve</b>	<b>Modular design / Design for Manufacture and Assembly (DfMA)</b>	<ul style="list-style-type: none"> <li>Consider which components or elements would be suitable for prefabrication and modularisation.</li> <li>Design to a 'kit-of-parts' or volumetric approach.<sup>32</sup></li> <li>Consider how DfMA might impact on the business case, including upfront carbon reduction target setting, tender design and evaluation criteria, carbon management, benefit realisation management.<sup>33</sup></li> <li>Design for DfMA to enable reuse of project components and reduce maintenance / future upgrade requirements (addresses End of Life and B1-8).</li> </ul>
	<b>Eliminate temporary construction elements</b>	<ul style="list-style-type: none"> <li>Consider construction phasing and programming to eliminate the need for temporary elements / materials.</li> <li>Use temporary elements in permanent design, where possible.</li> </ul>

31 Mott Macdonald, [ACWG Carbon Ambition – SRO low capital carbon alternatives](#), Mott Macdonald, 2022.

32 School Infrastructure NSW, [Modern methods of construction](#), NSW Government website, n.d.

33 Royal Institute of British Architects, [DfMA Overlay to the RIBA Plan of Work Mainstreaming Design For Manufacture And Assembly In Construction 2nd Edition](#), Royal Institute of British Architects, 2021.

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