INFRASTRUCTURE VICTORIA

September 2023

Opportunities to reduce greenhouse gas emissions of infrastructure

Advice to the Victorian Government

About us

Infrastructure Victoria is an independent advisory body with 3 functions:

- preparing a 30-year infrastructure strategy for Victoria, which we review and update every 3 to 5 years
- advising the government on specific infrastructure matters
- publishing research on infrastructure-related issues.

Infrastructure Victoria also helps government departments and agencies develop sectoral infrastructure plans.

Infrastructure Victoria aims to take a long-term, evidence-based view of infrastructure planning, and we inform community discussion about infrastructure provision.

Infrastructure Victoria does not directly oversee or fund infrastructure projects.

Front page: Image of the Bolte Bridge and two buildings in Melbourne.

Acknowledgement

Infrastructure Victoria acknowledges the Traditional Owners of Country in Victoria and pays respect to their Elders past and present, as well as Elders of other First Peoples' communities. We recognise that Victoria's infrastructure is built on land that has been managed by Aboriginal people for millennia.

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If changes are not made to reduce the greenhouse gas emissions of future public infrastructure investments, achievement of the Victorian Government's emission reduction targets will be at risk. This will require a big shift in how the government thinks about meeting the state's infrastructure needs. The government should first look to solutions which get more out of Victoria's existing infrastructure. When building new infrastructure is unavoidable, projects should aim to reduce emissions at every stage.

Up to 70% of Australia's annual greenhouse gas emissions relate directly or indirectly to the lifecycle of infrastructure through operational, enabled, and embodied emissions. The scale of the climate challenge, the cost of inaction, and the risks of more extreme weather require a swift and system-wide change in how governments and businesses plan, build, maintain and repurpose infrastructure.

Valuing carbon emissions can lead to better productivity outcomes in addition to reducing carbon. If Victoria gets this right, it has opportunities to achieve its emission reduction ambitions, save money, deliver infrastructure more efficiently, promote innovation in the economy and grow jobs. But if it doesn't, Victoria's infrastructure will cost more than necessary, it will not be fit-for-purpose in future decades, and Victoria will miss the opportunity for a more diverse economy with high quality jobs. It will also put Victoria's global competitiveness at risk as countries introduce restrictions on high emissions materials and sustainability disclosure requirements for businesses.

Action to limit or eliminate infrastructure-related greenhouse gas emissions, also known as decarbonising infrastructure, is a complex task. To create change, government's guidelines and procedures need to make carbon emissions count in infrastructure decision-making. All Victorian Government departments and agencies need consistent policies to account for, reduce and manage carbon emissions.

Government and industry stakeholders are looking for leadership, consistency and guidance on how to proceed. The Victorian Government has significant purchasing power that can influence the types of materials used in infrastructure, the way infrastructure is designed, and how – or whether – it is built. Industry bodies are ready to respond to clear direction from the Victorian Government about the level and pace of infrastructure decarbonisation. This will allow them to innovate and make appropriate investment decisions.

Other jurisdictions in Australia are making rapid progress to decarbonise infrastructure. Alignment and consistency are helpful in this rapidly evolving area. Victoria can match their pace and align its decarbonisation approach to these jurisdictions.

Our advice

In March 2023, the Victorian Government requested Infrastructure Victoria's advice on opportunities to reduce greenhouse gas emissions of future public infrastructure investments the government will plan, own, or manage.

The request asked us to consider how policies and guidelines can better account for greenhouse gas emissions produced in the design, investment, construction, maintenance, and decommissioning of Victoria's infrastructure.

In addressing the terms of reference of the advice request, this report identifies 3 overarching principles and makes 10 recommendations, each with clear actions, to guide how the Victorian Government plans, sources, delivers and maintains its infrastructure on the path to net zero.

Three overarching principles should guide decarbonisation efforts in Victoria

Drawing on the experience of leading jurisdictions and the current state in Victoria, we propose 3 principles to guide decarbonisation efforts:

Prioritise non-build or low build solutions. Aim to get better use from existing infrastructure or modify it to meet changing needs before considering a new build. Use construction techniques like offsite or modular construction wherever possible in new builds.

Non-build or low build solutions which minimise new construction can avoid emissions associated with constructing and operating new infrastructure, and usually have lower lifecycle carbon emissions. For example, the Department of Transport and Planning's Smarter Roads project is improving operation of the traffic light network to optimise road performance rather than building new roads.[1] When undertaking new construction, options to build more efficiently by using offsite or modular construction can reduce both cost and carbon while improving productivity.

Victorian guidelines already require departments and agencies to consider non-build options when developing business cases. However, project teams in government agencies told us that the business case stage is often too late for thorough consideration of alternatives. The existing culture prioritises new build solutions and does not incentivise these teams to thoroughly prepare options that meet service needs while avoiding a new build project.

Ministers and senior executives of Victorian Government departments and agencies should explore and fully consider viable, non-build or low build alternatives well before business case development. Clear direction from ministers about more intensely searching for non-build or low build solutions, supported by a demonstrated willingness to select and fund these options, would give departments and agencies confidence to bring more of these options forward.

Align approaches with other governments and industry best practices.

Victoria can reap many benefits by aligning its approach with other Australian governments and industry best practices. Victoria can more rapidly adopt proven approaches and move quickly towards meeting decarbonisation targets. Using existing tools, research and administrative resources reduces the need for more investment in developing new solutions.

Harmonising these approaches between jurisdictions also reduces the administrative burden on industry, allowing businesses to focus on implementing effective decarbonisation strategies. By promoting consistency between jurisdictions, Victoria is also helping to build capability and expertise within industry.

There may be some situations in which a Victorian-specific approach is useful, however these should be considered carefully and weighed against the benefits of broader alignment.

Clarify the scale and pace of infrastructure emissions reduction to give confidence to industry.

Immediate and sustained action is needed to reduce greenhouse gas emissions produced by Victorian Government infrastructure. While the government has set ambitious emissions reduction targets for the economy, industry and government representatives that we consulted were not clear on the government's commitment to, or timeline for, decarbonising infrastructure.

Without this clarity, it is difficult for either to propose or take up options to reduce carbon in the significant pipeline of infrastructure projects underway. Industry is willing to act but requires policy certainty. Immediate engagement with industry on decarbonisation timelines will provide certainty and facilitate a smoother transition, minimising potential disruptions to projects. By involving suppliers in the early stages of policy development, the government can gather valuable insights and proactively address concerns.

Our 10 recommendations create the foundation for decarbonising infrastructure

Building on these principles, Infrastructure Victoria makes 10 recommendations for the Victorian Government. If fully implemented, these recommendations allow the Victorian Government to reduce the carbon footprint of public infrastructure further, faster and with more benefits than business as usual.

1. Adopt a carbon management standard like *PAS 2080:2023 Carbon management in buildings and infrastructure* to measure and manage carbon emissions and modify as needed to embed in Victoria.

The Victorian Government has minimal guidance for infrastructure projects on carbon reduction. The guidance does not address the lifecycle of infrastructure assets. And it addresses carbon emissions as one sustainability opportunity among many, such as reducing water use and waste.

A carbon management standard would clarify Victoria's approach to decarbonising infrastructure, and how existing and new Victorian guidelines, requirements and frameworks will collectively reduce emissions throughout the infrastructure lifecycle.

The United Kingdom's PAS 2080 *Carbon management in buildings and infrastructure* standard is a globally recognised approach to managing carbon. Adopting a carbon management standard like PAS 2080 in Victoria will clarify the state's direction, including carbon governance and responsibilities, to drive consistent practice in government infrastructure programs and projects. It will also allow tracking of emissions reductions in all projects by consistently quantifying and reporting them throughout the infrastructure lifecycle. Victoria will need to fill gaps in existing government guidance to implement a standard. An adopted standard may also need some modification to the local context to be fully embedded in Victoria.

2. Implement the same carbon measurement approach as New South Wales and deliver training across the Victorian Government.

Our research found that where departments and agencies have started to estimate carbon emissions, they use different methods and data sources to do so. There is no single source for

reliable emissions data in Victoria, so they use data that is inconsistent and sometimes inaccurate, or not sufficiently detailed. Easy-to-use, non-proprietary tools, including a comprehensive open-source database of standard values for embodied emissions in materials can help government and industry to consistently quantify and report emissions. This will also allow accurate and comparable emissions data across government to better inform decisions.

Our research has not clearly identified a single tool that is the best option to adopt in Victoria. Existing tools, such as the Transport for New South Wales' Carbon Emissions Reduction Tool (CERT), Green Star, the National Australian Built Environment Rating System (NABERS), and the Infrastructure Sustainability (IS) rating tool, can be used. Each have their own advantages and drawbacks, and many are evolving rapidly to address limitations raised. As there is not a single leading tool, the Victorian Government should apply the principle of aligning the carbon quantification approach with other governments and industry best practices.

Infrastructure New South Wales is identifying key areas of alignment for carbon measurement and developing a measurement guidance approach that will be used as the basis for a national approach. Adopting their recommended carbon quantification approach will support both large and small companies operating in both jurisdictions to understand and use their preferred tools consistently. This guidance is expected to be available by the end of 2023.

Victorian departments and agencies should use the tool that best meets their needs at the time of assessment, as long as it meets the requirements of the agreed carbon quantification approach.

Once the government has implemented an approach to carbon measurement, including adopting a comprehensive database of emission factors, it must address the knowledge and skills gap of government staff and industry partners to realise emissions reductions.

3. Initially adopt a carbon value of *at least* $123 per tonne and then update to reflect values required to achieve Victorian emissions reduction targets.

Carbon emissions impose costs on the community. Valuing emissions will ensure that infrastructure project decisions account for climate change impacts alongside other costs and benefits.

Adopting a target consistent approach to carbon valuation as many other jurisdictions have done will align carbon values with Victorian emissions reduction policy objectives. To adopt this approach, the Victorian Government will need to calculate the carbon values that align to Victoria's specific targets.

While this work is in progress, it can adopt an interim carbon price. We recommend that the Victorian Government use the average European Union Emissions Trading Scheme 2023–24 market spot price converted to Australian dollars. This is *at least* $123 per tonne. The New South Wales Government adopted this carbon value and an escalating forward value for cost benefit analysis in February 2023 while it completes its evaluation of a target consistent carbon value.

4. Update business case guidelines and templates to integrate emissions reduction.

Considering carbon impacts at the early investment appraisal stages provides the greatest opportunity to reduce emissions. Infrastructure Victoria reviewed existing business case guidance for Victorian infrastructure projects and found it provides minimal direction on carbon emissions.

Incorporating lifecycle carbon estimation, assessment and valuation into existing business case guidelines and templates will address this gap. The guidance should define how to set an emissions baseline, how to measure carbon, and how to identify carbon reduction strategies.

Updating the *Investment lifecycle high value high risk guidelines* will enable project teams to better incorporate carbon considerations in developing options and designs and select materials that will contribute to meeting the government's legislated targets.

In Victoria's 2024–25 budget cycle, projects should be required to include a descriptive assessment of carbon in their business cases that explains how emissions have been estimated, with evidence provided. The estimates should include a high-level quantification of scope 1 and scope 2 emissions over the project's lifecycle and high-level estimates of scope 3 emissions. The descriptive assessment should include a carbon estimate using $123 per tonne to inform strategic planning and optioneering.

This approach of using an interim carbon value will help projects to better consider options to avoid, reduce and minimise carbon emissions.

5. Measure carbon in infrastructure cost benefit analysis and make decisions that reduce emissions.

The Victorian Government should integrate the measurement and value of carbon emissions into decision-making processes. This will ensure that cost benefit analyses adequately consider all impacts of carbon alongside other monetised impacts.

As Victorian Government departments, agencies, contractors and suppliers become familiar with carbon estimation and quantification, all projects with emissions that meet the materiality threshold identified when implementing recommendation 1 should be required to include carbon in their cost benefit analyses.

When infrastructure cost benefit analyses exclude carbon emissions, project proponents focus on reducing financial costs, and de-prioritise opportunities to reduce carbon emissions. It also means Victoria is not adequately measuring its climate impacts.

6. Update procurement frameworks and guidance to embed carbon reduction in tenders.

Current procurement guidance for major infrastructure projects lacks detail about emissions reduction. It is combined with other sustainability and social procurement guidance in the government's *Social procurement framework*, diluting the focus on reducing carbon. Staff at some departments and agencies are unsure of the best approaches to encourage carbon reduction in procurement documents.

Even when project proponents understand and include these approaches in tendering documents, tender evaluation teams are not clear on how to evaluate proposals that include carbon reduction measures.

The government should update the Department of Treasury and Finance's *Investment lifecycle and high value high risk guidelines: Procurement* and associated procurement templates to clearly specify a requirement to reduce carbon emissions. The updated guidelines should require projects to integrate minimum decarbonisation requirements, communicate carbon reduction expectations and request alternative carbon reduction offers in tender documents.

Carbon emissions reductions should be removed from the *Social procurement framework* when procurement guidance is updated, to avoid duplication

7. Update standard form contracts to include carbon reporting, abatement requirements and further reduction opportunities.

The government should include requirements in standard form contracts to set clear expectations for suppliers, ensuring that they align their practices with decarbonisation goals. These requirements should initially include mechanisms for suppliers to consider additional carbon reduction options, establish descriptive carbon management plans and carbon reporting requirements.

Over time, the government should create a baseline performance level that all suppliers must meet to create a level playing field and require the development of quantitative carbon management plans to drive progress towards decarbonisation. The government should design mechanisms to provide incentives within contracts for suppliers who exceed baseline performance, with appropriate checks and balances to avoid suppliers creating inflated baseline estimates. For example, contracts can include a positive obligation on the supplier to propose variations where new innovations and technologies facilitate further emissions reductions.

Enforcing these commitments through legally binding contracts provides a foundation for new approaches within the industry, encouraging suppliers to seek out, use and adopt low carbon materials and methods.

8. Establish carbon management prequalification requirements for government contracts.

Prequalification requirements for government projects encourage industry to align with the Victorian Government's decarbonisation goals. This will help to promote a market that consistently works towards lowering carbon emissions in government infrastructure projects.

As industry suppliers and contractors become more familiar with the Victorian Government's carbon reduction requirements, the government should establish prequalification requirements that show contractors have the necessary experience for, knowledge of, and commitment to decarbonisation. It should engage with industry stakeholders to identify appropriate prequalification requirements related to decarbonisation and determine what level of prequalification requirements should apply to projects of different sizes. A similar approach in the UK applies to contracts with an estimated value exceeding £5 million (about AUD$9 million). Signalling future changes to industry will give suppliers time to adapt and prepare for the new criteria.

9. Support industry to develop zero or low emissions solutions by testing alternative materials and adopting performance-based standards.

Projects with short timelines can find it challenging to test and pilot new materials and solutions. The Victorian Government can help to lower barriers to adopting alternative materials by testing and piloting materials. The government should collaborate with industry to update the way it describes and uses standards and specifications to reflect the required performance or outcome. This will support the use of alternative low carbon materials in infrastructure projects.

Expanding demand for sustainable materials can lead to economies of scale, reducing the cost of low carbon materials and increasing contractor familiarity with alternative materials and construction techniques.

10. Update assurance processes to include carbon emissions.

The government should update project assurance checks in the Department of Treasury and Finance's *High value high risk framework.* The update should incorporate the changes introduced through recommendations 1 to 9 and require carbon emissions to be reported in benefit management plans.

Experts external to the project carry out assurance checks to review plans and progress at important decision points. Aligning assurance processes means projects monitor and manage the impact of carbon emissions and evaluate carbon emission reduction benefits after completion. Including carbon emissions in assurance processes makes infrastructure investment decisions more transparent and accountable.

Implementation timing

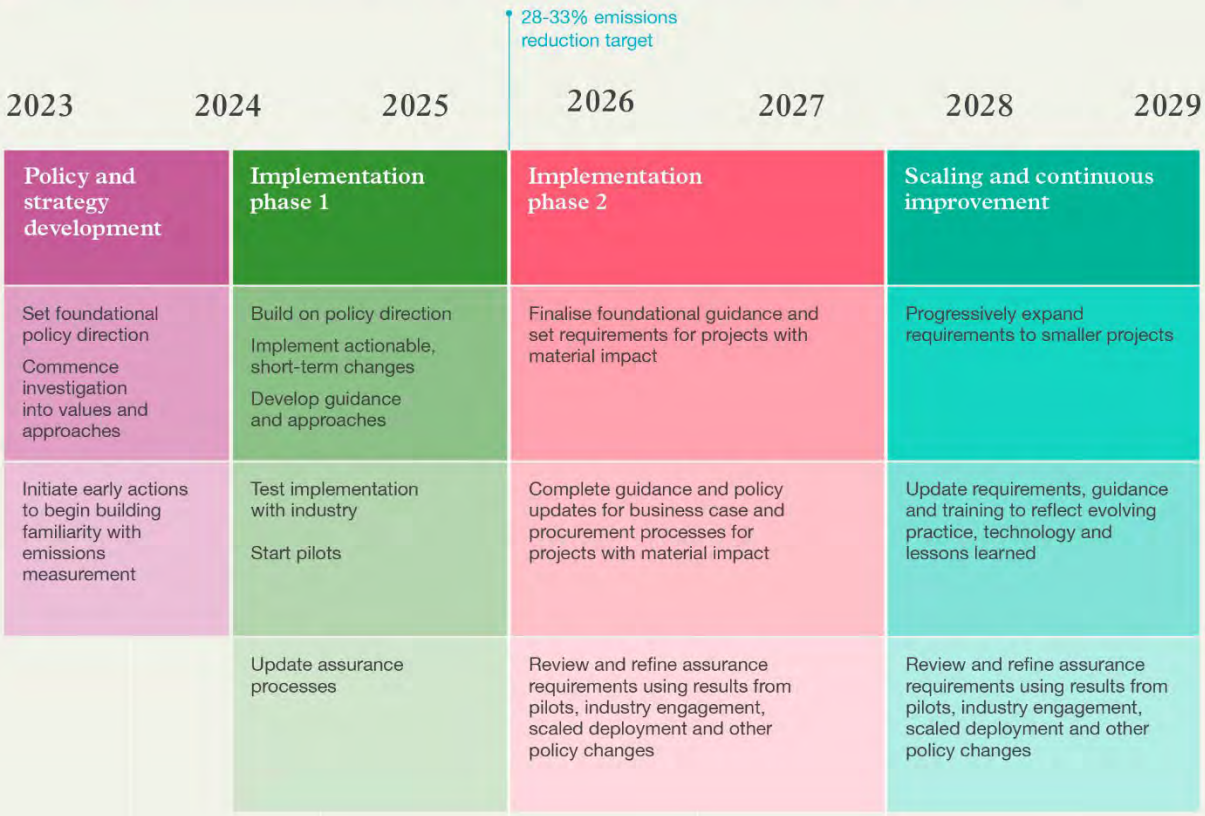
We recommend the Victorian Government clearly communicate its intent to align its approach with other jurisdictions' timing in reducing carbon emissions of future public infrastructure through new policies and practices.

During our consultations, government and industry stakeholders were clear that one of the most helpful things the Victorian Government could do is to set out an achievable and defined timeline for reducing carbon emissions related to the public infrastructure it plans, commissions, or operates.

Work is already underway in other jurisdictions. To catch up with the leaders in Australia, the Victorian Government will need to take decisive action within 6 to 12 months of receiving this advice. The proposed timing will allow Victoria to join with and progress at the same pace as other jurisdictions.

Figure 1

Proposed implementation timeframe towards infrastructure decarbonisation



The Victorian Government can take the following immediate actions to develop policy, requirements and guidance.

Immediate actions for an aligned approach

1.1 Identify the preferred carbon management standard for Victoria.

1.2 Adopt PAS 2080 as interim guidance on carbon management for voluntary use by Victorian Government departments and agencies. (optional)

2.1 Agree to adopt carbon measurement approach and standard emissions factors.

2.2 Evaluate skills gap and training requirements for government and industry.

2.3 Establish a Victorian Government community of practice on infrastructure decarbonisation to facilitate knowledge-sharing and collaboration. (optional)

3.1 Initially adopt interim carbon value of $123 per tonne.

3.2 Calculate the carbon values required to achieve Victoria's specific emissions reduction targets by using a target consistent approach.

4.1 Require business cases to include a descriptive estimate of carbon emissions, assess the impact using the interim carbon value and outline emission reduction options in line with the carbon reduction hierarchy.

6.1 Determine how to change the current public infrastructure procurement frameworks to effectively consider carbon emissions.

Terms of reference

In March 2023, the Treasurer formally requested that Infrastructure Victoria provide advice on the opportunities to reduce greenhouse gas emissions of Victorian Government infrastructure.

The Victorian Government asked for advice on options to help reduce greenhouse gas emissions caused by future infrastructure investment, or in business case assessment and procurement processes. When developing the advice, the government asked Infrastructure Victoria to consider:

- the Victorian Government's options to reduce the greenhouse gas emissions of the public infrastructure it plans, commissions and/or operates
- opportunities to reduce the costs and/or increase the productivity of infrastructure while also reducing emissions
- the Victorian Government's ability to influence emissions reduction by private firms that design, construct and operate public infrastructure — such as designers, suppliers, manufacturers, construction companies and capital markets.

The scope of the advice requested included the following areas:

- Opportunities to identify, prioritise, quantify, incentivise, and track reductions in embodied, operational and enabled infrastructure emissions at early strategic planning and investment decision-making stages including business case assessment.
- Options to update the Victorian Government's existing investment guidelines, procurement policies, regulatory tools, standards, frameworks and/or guidelines to reduce emissions.
- Innovative approaches that the Victorian Government can use to incentivise private industry to increase production and adoption of low carbon materials and/or methods in procurement.
- Enablers and barriers to implementation of any recommendations and their ramifications for reducing the emissions of infrastructure delivery, increasing productivity and reducing costs. This could include any impacts on costs and benefits, and how these could be equitably distributed across stakeholders and over the life of infrastructure.
- Timing and stages to implement options for the best long-term outcomes which minimise transitional costs for the government, the industry and the community.

Glossary

In this report, we use the terms ‘carbon emissions’, ‘carbon’ and ‘carbon pollution’ to refer to greenhouse gas emissions, which is measured in tonnes of carbon dioxide equivalent (tCO_2e). Greenhouse gases are made up of carbon dioxide (68%), methane (27%) and other gases (5%).[2]

Carbon dioxide equivalent (CO_2e) is a measure used to compare the emissions from different greenhouse gases by converting amounts of other gases to the equivalent amount of carbon dioxide with the same potential to contribute to global warming.

We also use the terms ‘decarbonisation’ and ‘decarbonising infrastructure’ throughout this advice. Decarbonisation refers to actions that can be taken to reduce carbon emissions.

Decarbonisation of infrastructure involves reducing or eliminating greenhouse gas emissions during the life of infrastructure assets, including the materials used, how the infrastructure is designed, constructed, operated and maintained, and how it is eventually decommissioned.

Other terminology used in this report includes:

Term	Definition
assurance	A process or system designed to make sure intended outcomes are achieved from solutions proposed.
benefit management plan	A document which specifies the benefits expected from a project, how they will be delivered and measured, and when they will be realised.
carbon footprint	The total amount of greenhouse gas emissions produced directly or indirectly by an individual, organisation, or activity.
carbon management	A systematic approach to identify, avoid, track, and reduce carbon emissions.
digital engineering	Using digital tools and processes to design, analyse and optimise the asset lifecycle, from design and development to testing and maintenance.
discount rate	A percentage rate used to convert future costs and benefits into present values to allow costs and benefits occurring at different points of time to be compared.
embodied emissions	The type of greenhouse gas emissions associated with materials used in construction, maintenance and disposal of infrastructure. This includes the emissions from the extraction, manufacturing, transportation, installation, maintenance, renovation and disposal of the materials used in these processes.
emissions factor	A representative value of a pollutant (such as greenhouse gas) that is released into the atmosphere associated with an activity or product.
enabled emissions	The greenhouse gas emissions created when people use an infrastructure asset, for example, driving a petrol-fuelled vehicle on a road.
environmental product declaration	An independently verified and registered document summarising the lifecycle environmental impact of a product.
global warming	A long-term gradual increase in the average global surface temperature,

	particularly one associated with an increase in greenhouse gases.
infrastructure lifecycle	The process from the beginning of design through to the end of the asset's life, including planning, development, construction, use, and decommissioning.
low build options	Infrastructure project delivery alternatives that involve constructing or developing infrastructure or assets to a lesser extent, such as smaller scale projects, reduced building or materials footprint, or using more efficient design.
low carbon solutions	Options that include technologies or resources that produce minimal greenhouse gas emissions or have a significantly reduced carbon footprint compared to conventional alternatives.
materiality test	A process to determine if the impacts of a project or program meet a pre-determined threshold of a financial or non-financial nature (such as greenhouse gas emissions). Impacts exceeding the threshold are considered significant enough that they need to be quantified accurately and valued in decision-making.
net zero emissions	A state where the amount of greenhouse gas emissions produced by human activities is equal to the amount of emissions removed from the atmosphere.
non-build options	Opportunities to resolve service delivery issues that do not involve constructing new infrastructure or assets, but instead focusing on utilising or optimising existing infrastructure.
operational emissions	The greenhouse gas emissions produced by operating an asset, primarily from energy usage.
scope 1 emissions	The direct greenhouse gas emissions from sources that are owned or operated by the organisation reporting the emissions, for example, burning diesel fuel in company-owned vehicles or in on-site generators.
scope 2 emissions	The indirect greenhouse gas emissions associated with using energy from another source, for example, using coal-fired electricity from the grid.
scope 3 emissions	All other indirect greenhouse gas emissions that are a consequence of the activities of an organisation but occur from sources that are not owned or controlled by the organisation, for example, greenhouse gas emissions from the extraction and production of metals and plastics used to build the asset, or from shipping and distributing those materials.
standard form contract	A contract often used by government to set a range of standard contractual requirements that need to be met by contractors.
supply chain	A network of industry participants, resources, and processes involved in the creation and delivery of a product or service, from raw material sourcing to the final delivery to customers.
target consistent approach	An approach for valuing carbon emissions that uses a relevant policy target and determines the cost of emissions abatement required to achieve that target.
value engineering	A systematic, organised approach to analyse the functions of various components and materials in a project design to lower the cost of goods, products and services used.

Why decarbonising infrastructure matters

Why decarbonising infrastructure matters

Climate change threatens Victoria's future

Long-term trends show that Victoria's climate and water resources are changing due to the influence of both natural variability and global warming.

Victoria is already experiencing the early effects of a more severe climate, including more frequent heatwaves, droughts, floods, and an increase in the length and severity of dangerous fire conditions.[3] The latest Commonwealth Scientific and Industrial Research Organisation and Bureau of Meteorology's *State of the Climate 2022* report finds that extreme climate events are happening at an increasing pace in Australia.[4]

Extreme climate events are expensive. The Climate Council estimates that the financial, economic and social costs of extreme weather events were $10 billion in Victoria between 1970 and 2019.[5] If extreme climate events keep increasing in future, these costs will rapidly escalate.

A 2019 study estimated that with no further global action, the cost of damages caused by climate change in Victoria would be $150 billion by 2050 and $986 billion by 2100.[6] These estimates include the costs of lower agricultural and labour productivity, loss of arable land due to sea level rise, some health impacts and infrastructure damage.[7] They do not include all the costs associated with floods, bushfires, biodiversity loss and pollution. As such, they may understate the potential costs to Victoria.[8]

Victoria has a strong policy commitment to emissions reduction

Victoria is one of Australia's leading states in targeting reductions to address the climate challenge. The Victorian Government has existing policies to deliver more renewable energy, better energy efficiency measures and sustainable transport initiatives. For example, the Victorian Renewable Energy Target and programs such as Solar Homes increased renewable energy from 5% of Victoria's electricity generation in 2009 to 35% in 2022.[9]

It was one of the first jurisdictions in the world to legislate a net zero emissions target. In 2017, the Victorian Parliament passed the *Climate Change Act 2017*, which set in law a net zero emissions target by 2050. By 2021, the state's emissions had fallen by 32% below 2005 levels.[10]

And in May 2023, the Victorian Government committed to emissions reduction targets of 80% compared to 2005 levels by 2035 and net zero emissions by 2045.[11] These are the most ambitious emissions reduction targets in Australia.

Reducing embodied emissions will become increasingly important

Up to 70% of Australia's annual emissions can be directly or indirectly attributed to the lifecycle of infrastructure.[12] We can classify infrastructure emissions as operational, enabled, and embodied emissions:

- **Operational emissions** are generated when an asset is in use, such as electricity to power a building. Operational emissions were estimated to be 9.1% of Australia's emissions in 2018.
- **Enabled emissions** are generated when people or organisations cause emissions by using infrastructure. For example, roads enable people to drive vehicles powered by petrol or diesel. Enabled emissions were estimated to be 55% of Australia's emissions in 2018.

- **Embodied (also known as embedded) emissions** are generated by the activities and materials used in infrastructure construction, maintenance and disposal. Embodied emissions were estimated to be 5.9% of Australia's annual emissions in 2018.

The preferred method to quantify infrastructure-related emissions is still evolving in Australia, particularly for embodied emissions. Most jurisdictions are in the early stages of developing approaches to measure carbon. Infrastructure Australia is currently leading efforts to estimate embodied carbon in the existing project pipeline. We expect that this will produce estimates for both national and Victorian emissions by the end of 2023.

However, a 2021 study reported that the embodied carbon emissions of all materials used in Australian buildings and infrastructure amounted to 30 to 50 million tonnes of carbon dioxide equivalent (Mt CO_2e) per year.[13] This is 5 to 10% of the total national emissions, consistent with above estimates.

Over time, operational and enabled emissions are likely to decline due to the increasing uptake of renewable energy and energy efficient technologies, such as electric vehicles.[14] As Australia's electricity grid decarbonises and transport moves away from internal combustion engines, embodied carbon will replace operational and enabled carbon as the dominant source of emissions.[15]

Reducing infrastructure emissions requires global solutions

The Victorian Government cannot reduce infrastructure-related emissions alone.

Victoria's emission reduction targets do not include emissions originating from materials manufactured outside Victoria, known as scope 3 emissions in the *National Greenhouse and Energy Reporting Act 2007*.[16] Estimates from one of Victoria's major transport projects indicate that only 4.6% of the total embodied emissions are from materials sourced in Victoria. About 95% of the embodied emissions are from materials sourced in other parts of Australia (91%) and overseas (4.4%).[17] The most emission intensive parts of cement and steel production are not located in Victoria. The state's emissions reduction targets consequently do not capture a significant proportion of embodied emissions generated by Victoria's infrastructure construction program.

Similarly, Australia's national greenhouse gas accounting does not include carbon emissions from overseas processing of materials mined and exported from Australia. Domestic greenhouse gas emissions were 464.8 million tonnes of carbon dioxide equivalent in 2020–21. But Australia's global carbon footprint is much greater.[18] For example, in 2022, emissions from offshore processing of exports in metallic iron ore alone were more than 900 million tonnes of carbon dioxide equivalent, or about 180% of Australia's total domestic emissions.[19]

Climate change is a global issue and requires global solutions. Because of this, other jurisdictions have started to introduce carbon tariffs to avoid importing products that have a large carbon footprint and account for economic impacts of imported carbon.

The European Union has implemented a carbon border adjustment mechanism, which adds fees to imported goods based on their greenhouse gas emissions.[20] From 1 October 2023, it will apply to a wide range of carbon intensive goods, such as cement, iron, steel, aluminium and fertilisers.[21] The fee will be determined from the market price of the European Union Emissions Trading Scheme.[22]

In August 2022, the United States Government also passed legislation to introduce a tax on imports from countries without aggressive climate change policies.[23] Australia's major trading partners in Asia have also set net zero targets for either 2050 or 2060 and, in early 2022, Japan was also reported to be considering a carbon tariff for imported carbon intensive goods.[24] As of 31 March 2023, 73 global carbon pricing initiatives have been implemented including carbon taxes and emissions trading systems.[25]

As even more countries introduce policy initiatives to decrease their emissions, jurisdictions that do not respond to and control carbon emissions are increasingly at risk of losing international competitiveness in trade and investment.[26]

Products manufactured in Australia and exported to other jurisdictions will increasingly be subject to extra fees if they have high embodied emissions. Some experts warn that these changes will impact Australia's resource industry and advise that the government and business community must plan for them now.[27] The Victorian Government can help reduce infrastructure's carbon emissions, regardless of source, by introducing clear policies on emissions reduction in its infrastructure projects.

There are clear benefits of avoiding carbon now before it becomes more costly

Global and local efforts to reduce carbon are gathering pace. In Victoria, major projects are already required to report scope 1, 2 and 3 emissions in their Environmental Effects Statements, and to demonstrate how they will reduce carbon in their construction and operational stages.[28,29] The Environment Protection Authority is becoming more focused on greenhouse gas emissions. A new general environmental duty has been included in the *Environment Protection Act 2017*. It is an offence to breach the general environmental duty. Recent guidance suggests that projects and their delivery partners may be at risk of delays and rework if they do not take reasonably practicable action to reduce the risk of pollution from carbon emissions.[30]

Careful consideration of carbon reduction strategies at the outset of a project offers a much greater potential to reduce carbon impact, before materials and contracts have been locked in. As infrastructure projects are typically constructed and operated over a long period of time, they need to consider how evolving regulatory requirements will impact on their projects. For example, infrastructure projects are not currently required to offset carbon in Australia. But if this changes, projects will need to find new budget funding to offset carbon emissions that are already committed in their plans.

Implementing strategies to reduce carbon in infrastructure as quickly as possible can help projects to be ready for future regulatory changes.

Construction and materials businesses and other governments are preparing to decarbonise

Industry and business sectors are calling for governments to address embodied carbon in infrastructure as the next step to achieve net zero emissions targets.[31]

Industry bodies recognise the urgency of action because they fear their members will become uncompetitive, as governments and markets increasingly demand low carbon products. In 2022, the Business Council of Australia, among others, called for governments and infrastructure advisory bodies to identify and assess embodied carbon emissions in business case development and procurement of infrastructure projects. They also recommended finding ways to use more low carbon materials in public infrastructure projects.[32]

Infrastructure Partnerships Australia[33] and the Infrastructure Sustainability Council of Australia[34] also released policy papers calling for a nationally consistent approach to reducing greenhouse gas emissions in infrastructure projects. The Australasian Procurement and Construction Council also released *Pathway to green construction procurement*, a best practice guide advocating for carbon assessment across all project phases.[35] And in August 2023 the Infrastructure Net Zero initiative was launched, a national collaboration of industry peak bodies and the federal government committed to decarbonising Australia's infrastructure.[36]

The Australian Government's *Climate Change Act 2022* set national greenhouse gas emissions reduction targets. This means that all jurisdictions seeking federal funding for infrastructure projects must now address carbon emissions. To clarify this requirement, Infrastructure Australia issued interim guidance in September 2022.[37] Final guidance is expected in 2024.

In October 2022, Infrastructure New South Wales released guiding principles and timelines for action on decarbonisation, with a particular focus on embodied emissions.[38] A policy roadmap followed, setting out detailed actions the government will complete by 2026.[39]

In June 2023, state and national infrastructure and transport ministers set up a Decarbonisation of Transport Working Group to oversee development of a national transport decarbonisation work plan.[40]

Capital markets are prioritising investment in businesses that demonstrate sustainability-related performance

Globally, capital markets are also responding rapidly to sustainability and climate change.

In June 2023, the International Sustainability Standards Board (ISSB) issued two new standards designed to enable companies to publicly report on the sustainability and climate-related risks. The Australian Accounting Standards Board (AASB) will be responsible for formally establishing the detailed disclosure standards in Australia, which is expected to align as far as practicable with the final standards developed by the ISSB. The AASB's consultation on climate disclosure standards is expected to take place in the second half of 2023.[41]

These sustainability standards are likely to be incorporated into the Australian Accounting Standards and Commonwealth regulation of financial disclosures under the *Corporations Act*. Corporate regulators will require companies to credibly and accurately report upon their sustainability credentials, including the emissions impacts of infrastructure they fund, build or operate.

The Australian Department of Treasury's *Climate-related financial disclosure consultation paper,* released in June 2023 proposes a three-phased approach for mandatory reporting on greenhouse gas emissions. It would first apply to a relatively limited group of very large entities in the 2024–25 financial year and would expand over the next two years to apply to progressively smaller entities.[42]

These requirements will not apply to government directly but will have implications for companies that build infrastructure on behalf of government. The government should carefully consider how selected tools and guidance for measuring carbon emissions will be implemented in private sector disclosure of carbon emissions. It is desirable that there be rigour and consistency in the tools and guidance used for measuring and reporting on emissions. If this can be achieved in the efforts of Australian Governments to decarbonise infrastructure and implement climate-related disclosure standards for companies, this will assist the objectives of both reforms and reduce regulatory burdens on industry.

In coming years, capital markets are likely to become increasingly reluctant to allocate capital to companies or projects that do not disclose satisfactory sustainability-related performance. Businesses which cannot demonstrate sustainability outcomes may incur higher borrowing rates, higher operating costs, and increasing challenges in raising capital. For example, major institutions including the Australian Prudential Regulation Authority, Reserve Bank of Australia and Moody's have recently raised the issue of worsening capital situations for businesses with assets at risk of stranding or rapid devaluation.[43] This may hinder the growth of Victorian companies, their ability to partner with the government to deliver infrastructure, and the willingness of investors to be involved in emissions-intensive projects.

If the Victorian Government fails to provide clear policy direction and a timeline for reducing emissions from the infrastructure it commissions, companies involved in delivering infrastructure may struggle to fulfill their sustainability-related financial disclosure obligations.

The Victorian Government can help build more low carbon infrastructure sooner

The Victorian Government has significant purchasing power in the infrastructure supply chain. In its 2023–24 budget, the Victorian Government's total infrastructure project portfolio was estimated at $201 billion for current and new infrastructure projects.[44] With capital expenditure forecast to reach $22.5 billion in both the 2022–23 and 2023–24 financial years there is a significant opportunity for the government to influence emissions in the supply chain.[45]

New infrastructure projects usually consume enormous amounts of energy and materials. Mining, manufacturing, and construction are directly responsible for around 34% of Australia's emissions. This increases to 50% if electricity use is included.[46] Carbon emissions generally increase with the amount of materials and energy used to build an infrastructure project. Every stage of the infrastructure design and delivery process can potentially reduce energy and materials use, and carbon emissions.

Collaboration from the public and private sectors can consider carbon emissions at each decision point and during the life of an asset. Reducing embodied emissions in a systematic way considers avoiding and reducing material use by using innovative upfront design solutions, re-using and recycling materials and reducing waste at the end of an asset's life. This includes embodied emissions generated in processing and transporting minerals, materials, and other goods.

Australia has a significant opportunity to develop low or zero carbon construction materials. This is especially attractive for Victoria because it is a major importer of construction materials. Low carbon construction materials are usually manufactured in a different way to standard materials, and produce fewer emissions by using renewable energy, using different material inputs, or using different manufacturing processes.

For example, Brickworks Tasmania have manufactured Australia's first certified carbon neutral bricks. The zero carbon building material uses sawdust, a timber industry by-product, as a renewable fuel source instead of fossil gas in kiln firing. Remaining operational emissions are reduced by efficiency upgrades and offsets.[47]

Some materials, like cement and steel produce emissions that can be difficult to reduce. Producing these materials is energy intensive and involves chemical reactions that release carbon emissions.[48] Alternatives, such as using hydrogen in processing iron ores to make steel are being tested but are not widely available. Until alternative technology becomes available at a commercial scale, it can be very expensive to use substitutes for these materials.[49]

Cement manufacturing is estimated to be responsible for 7% of global emissions.[50] Most cement is used to make concrete. Concrete that contains approximately 70% less embodied carbon than traditional cement-based concrete is commercially available.[51] Builders are also using timber as a low carbon alternative to steel and concrete in Australian buildings, producing up to an 85% reduction in emissions in the material supply, transport and construction stages.[52]

Reducing carbon can reduce cost and improve productivity

The Victorian Government noted in the 2023–24 budget that the economy is 'navigating a challenging period with high inflation, rising interest rates, and weakening national and global growth.'[53] In this context, reducing carbon emissions from infrastructure can lead to cost savings by design and material innovation.

The United Kingdom Treasury's *Infrastructure carbon review* concluded that 'reducing carbon reduces cost' when decarbonisation is prioritised early and over the long term.[54] The 2013 study concluded that carbon reductions are not only achievable but have a substantial commercial upside. It found that reductions in carbon of up to 39% by supply chains achieved average reductions in capital expenditure of 22%.[55] Research by the Clean Energy Finance Corporation suggests that material and design innovation can reduce costs by up to 3% and achieve a 5% to 18% reduction in embodied carbon.[56]

Our research identified that stakeholders from both government and private sectors are concerned that decarbonisation will add another layer of complexity to infrastructure delivery, potentially leading to a further decline in productivity in the construction sector. However, the evidence we reviewed demonstrates that decarbonising infrastructure opens new opportunities to improve infrastructure-related productivity.

Higher productivity means creating more outputs with the same inputs or maintaining the same output with fewer inputs; in simple terms: doing more with less.[57] Higher productivity can also be framed as achieving the same outcomes with lower costs, as cost is a good proxy for the inputs of labour, materials and time.

Australian infrastructure sector's productivity in the global context

The Australian infrastructure and construction sector's productivity growth has been lower than other sectors for several decades.[58] This is significant, given the infrastructure sector accounts for nearly 20% of Australia's gross domestic product.[59]

During the 30 years since 1990, the construction industry experienced productivity growth of 6.2%.[60] In the same period, other industries including agriculture, mining and financial services, have experienced productivity growth of 31.4%.[61]

Globally, low productivity growth in the infrastructure sector is not isolated to Australia.[62]

Case study

Upgrade of Elephant and Castle Station planned with emissions in mind

Redesign reduces costs and carbon

An underground station in the Elephant and Castle neighbourhood in London is being upgraded to improve public transport access. The upgrade will accommodate an extra 27,000 commuters at peak time each day.[63]

The carbon impact of the station upgrade was considered in the project planning. This led to a redesign of the escalators, overbridges, and retaining walls. The redesign achieved a 25% reduction in emissions and a 27% projected cost saving compared to the original design.[64]

Image below: Elephant and Castle Station design Source: Transport for London Press images

A 2013 review by McKinsey & Company identified 3 key actions to improve infrastructure productivity that could lower global infrastructure spending by 40%, saving up to US $1 trillion a year. These actions align closely with the good practice for infrastructure decarbonisation, such as:[65]

- choosing the right combination of projects to address clearly defined needs
- streamlining delivery by investing heavily in the early stages of project planning and design and structuring contracts to encourage time and cost savings
- making the most of existing infrastructure by boosting asset utilisation, optimising maintenance planning, and using more demand management measures.

Reducing carbon emissions can be a catalyst to drive these actions and achieve associated productivity gains. The United Kingdom's Department of Transport notes in its *Whole life carbon management* guidance that better strategic planning that prioritises avoiding carbon emissions should first explore alternative solutions to building new infrastructure.[66] Infrastructure Australia has also identified better strategic planning as a reform to improve infrastructure productivity.[67]

McKinsey's work notes that using viable alternatives such as demand management, better asset management and optimising network performance is often more productive than addressing capacity problems by building new physical capacity.[68]

The Productivity Commission, Infrastructure Australia and Australian Constructors Association have all identified several procurement processes to improve productivity that would also benefit decarbonisation, including:

- adopting a standardised contract approach that provides certainty about the government's requirements[69]
- adopting standard forms of contract and minimising bespoke contracts and clauses[70,71]
- moving away from a heavily weighted price criteria in procurement and focusing on outcomes and value[72]
- promoting delivery innovation such as by using a digital engineering approach[73]
- collaborating with industry to identify innovations earlier in planning.[74]

While new carbon management requirements may add costs and time for government and industry before requirements become the norm, fit-for-purpose procurement processes can save projects time, labour and costs.[75] Conventional procurement approaches can constrain collaboration and innovation.[76] The greater use of performance-based specifications helps focus on project outcomes, which avoids waste in design and materials and thus improves productivity.[77,78] Similarly, this approach can avoid conservative designs that use extra materials, cost more and emit more carbon.

Using recycled materials can reduce carbon and benefit the economy

Using recycled materials can reduce demand for new materials and avoid the associated carbon emissions from extracting and processing them. For example, crushed recycled concrete recovered from demolition sites produces 65% fewer embodied carbon emissions than quarried materials.[79]

> "The use of recycled products in concrete reduces the need for natural resources and carbon emissions. The supply chain would benefit from greater visibility of where recycled product is available."

> Cement, Concrete and Aggregates Australia, submission to Infrastructure Victoria[80]

Infrastructure Australia estimates that, based on current technology and standards, about 27% of conventional road construction materials can be replaced with recycled alternatives.[81] They estimate that this could increase to between 43% and 59% with technological advancements and updates to the standards that govern what materials and methods are used to plan and construct roads.[82] Similarly, the National Transport Research Organisation has found that there are significant environmental benefits for most recycled material applications in road and rail infrastructure, with greenhouse gas emission reductions of 47% to 98%.[83]

Victoria has made significant progress in using more recycled materials in infrastructure projects. The Victorian Government set up EcologiQ to identify options for recycled materials to be used in major transport projects.[84] It also created the *Recycled first policy* to require contractors building Victorian transport projects to maximise their use of recycled and re-used materials.[85]

Reducing carbon by improving recycling can also benefit the Victorian economy, especially if recycled materials are sourced locally.

Infrastructure Victoria's previous *Advice on recycling and resource recovery infrastructure* found that recovering and re-using resources is more productive and higher-value than disposing of these resources. For every 10,000 tonnes of waste recycled, 9.2 jobs are generated compared to 2.8 jobs for landfill. Increasing Victoria's resource recovery rate to 90% could create 2,400 jobs by 2039 compared to business as usual.[86]

EcologiQ promotes recycled content in Victoria's infrastructure

EcologiQ is a Victorian Government initiative to integrate recycled and re-used content into Victoria's Big Build. Its priorities are to[87]:

- optimise the use of Victorian recycled and re-used materials on Victorian major transport projects
- pursue market development opportunities
- change the approach to technical standards and specifications.

By June 2023, Victoria's Big Build projects had committed to use over 2.5 million tonnes of recycled and reused materials.[88]

Deploying digital technology can enable significant carbon savings

Digital engineering is a more streamlined and productive way of planning, designing, constructing, operating, and maintaining assets during their lifecycle.[89] The Victorian Government's *Digital asset policy* and *Digital build* program aim to increase the use of digital engineering in infrastructure planning and delivery.[90]

Infrastructure planners can use digital engineering tools to model and cost alternative materials, including embodied carbon emissions. Engineers already use value engineering to identify options to reduce or substitute materials to lower build costs. The same approach can be deployed to examine carbon intensive areas of design and focus on options to reduce carbon.

Digital engineering improves project design and drives carbon savings

By visualising data from engineers, environmental specialists and construction planners on a common platform, the project team working on the $1 billion Cranbourne Line Upgrade in the Level Crossing Removal Project did a ‘virtual launch’ of a 63-metre, 340-tonne steel bridge structure.

The team was able to check every element of the design and construction before the real bridge launch occurred. This helped them to plan, identify conflicts between different teams, and resolve these virtually before they happened on site.[91]

In the Central Station Project in Sydney, the project team used a digital engineering model to reduce concrete use. This reduced the project’s concrete use by 465 cubic meters, which significantly lowered the project’s costs and emissions.[92]

Using a digital engineering model that proposed alternative materials and included new design options, the project team for the Timber Square Building in London reduced embodied carbon by 30%.[93]

Case study

Carbon Twin

Calculating and visualising embodied carbon

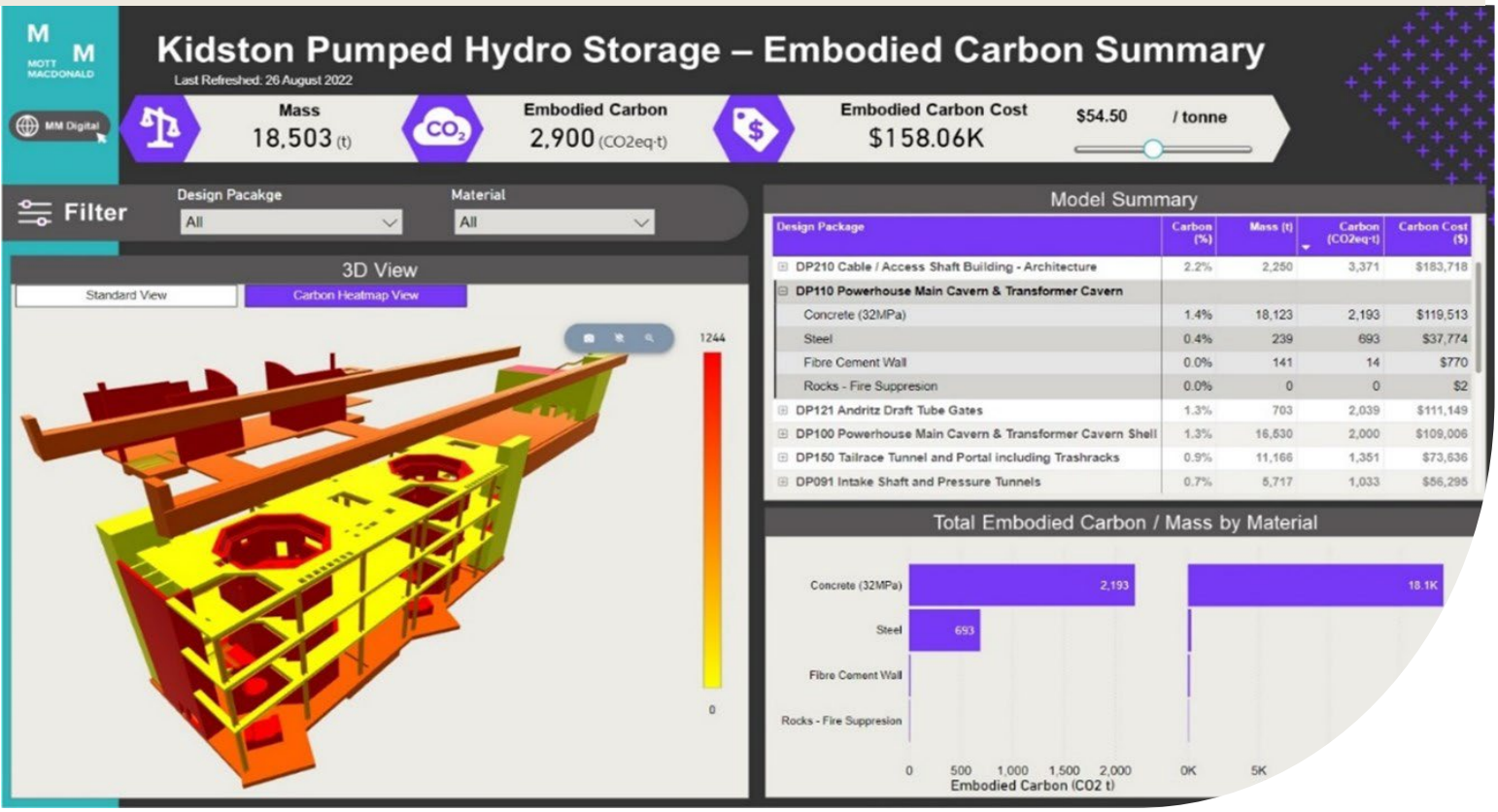
The energy supplier Genex commissioned McConnell Dowell and John Holland to create the Kidston pumped storage project as a component of a renewable energy hub.

The project is repurposing a redundant gold mine into a pumped-hydro storage facility to support co-located solar, and planned wind generation. The project, now under construction, will help Queensland achieve its target of 50% electricity from renewable resources by 2030.

Kidston is being used as a template to refine Mott Macdonald's Carbon Twin tool, which can visualise an infrastructure project's carbon intensity in the project design phase. The tool provides detailed information on different construction materials, their carbon emissions, and the costs involved. It reveals 'hidden' carbon within a design and offers interactive 3D visualisations to identify areas with significant carbon emissions.

Users can explore the entire asset and see the emissions associated with each part of the project.[94]

Image below: Kidston pumped storage hydro project *Carbon Twin Dashboard* (data is for demonstration purposes only)[95]



Our findings: the priorities for change in Victoria

Our findings: the priorities for change in Victoria

Our approach to the advice

Infrastructure Victoria undertook research and met with stakeholders between February and May 2023 to inform this advice. We:

- reviewed national and international policy and technical guidance, specifications and emissions requirements
- assessed existing guidance, specifications and requirements related to emissions in Victoria
- talked to other infrastructure bodies and agencies and attended joint consultation sessions with industry
- worked with consulting firm WSP Australia to produce a technical report which is published on our website
- interviewed Victorian Government departments and agencies and major stakeholders, who we list in Appendix A
- tested and refined our draft policy options with government and industry bodies in a series of 4 workshops
- received public submissions from 14 April 2023 to 14 May 2023
- reviewed the 14 submissions we received from industry and the community, and published them on our website if the author gave us permission. We list a summary of these submissions in Appendix B.

Current views on decarbonising infrastructure in Victoria

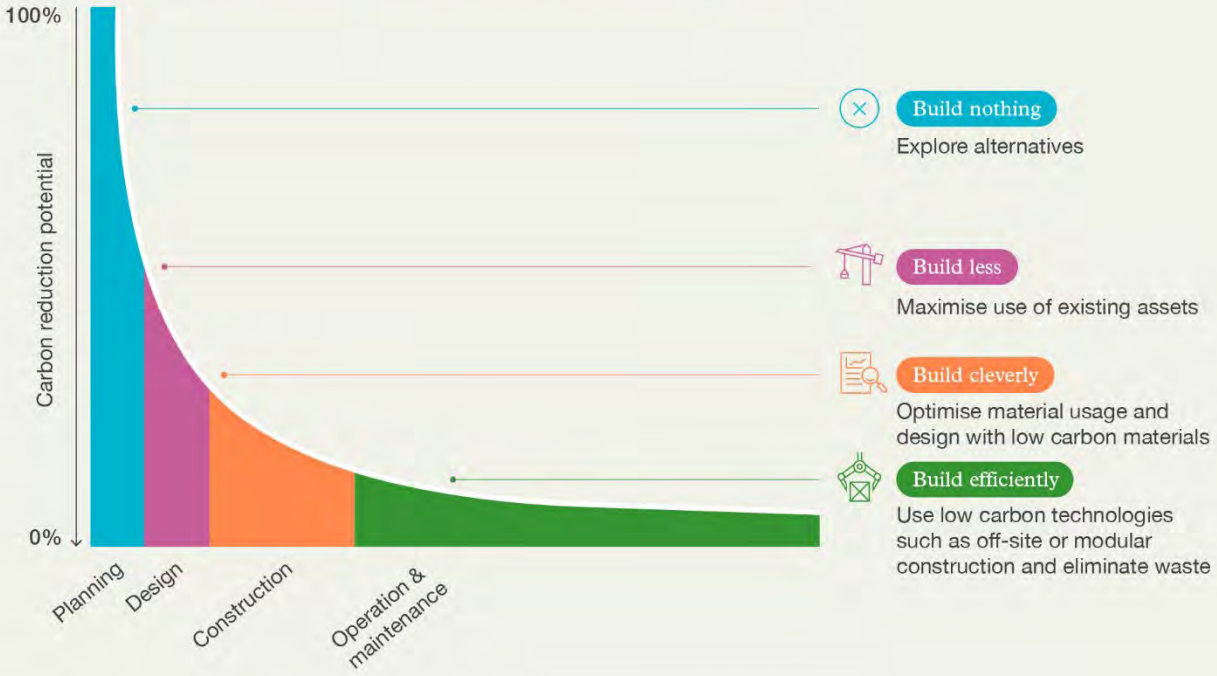
Stakeholders told us that:

- most staff working on infrastructure in Victorian Government departments and agencies are at an early stage of understanding how they can reduce carbon emissions in their day-to-day work
- while they understand government's ambition to reduce emissions, they do not have consistent and transparent ways to quantify, value, monitor and track carbon emissions at a project or portfolio level
- they are not clear about how their individual efforts are contributing to reducing the state's total emissions
- the Victorian Government's emissions reduction targets and policy statements have not yet clearly been translated into project decisions
- carbon reduction options put forward by contractors are often not agreed to by decision-makers due to concerns over cost implications
- they have concerns over potential resource pressures of complying with extra decarbonisation requirements in their project within existing budgets.

Getting more use from existing infrastructure can reduce carbon

The World Green Building Council, among other organisations, has argued that the greatest potential to reduce carbon emissions comes in the early planning stage of new projects. This can be done by applying the carbon reduction hierarchy (see Figure 2) [96].

Figure 2
Carbon reduction potential across different project stages



Governments should thoroughly and seriously investigate other options before deciding to build new infrastructure, including building less by getting better use from existing assets. Portfolio-wide planning can help to better explore service delivery solutions and asset management options ahead of new construction projects.

If governments decide to proceed with new infrastructure, it can then be designed to avoid and reduce emissions during its lifecycle. Building cleverly and efficiently through a combination of innovative designs, low carbon materials and low carbon construction methods can reduce carbon emissions associated with new projects. [97]

Infrastructure Victoria's earlier research shows that demand management can feasibly and effectively solve capacity problems, thereby avoiding carbon emissions from new infrastructure. For example, our work has shown that changing the way people pay for transport, such as introducing cheaper off-peak fares for public transport, can promote better use of Victoria's existing public transport infrastructure. This is because cheaper off-peak pricing encourages people to travel outside of peak hours if they are able. This then reduces the requirement for new capacity at peak times. [98]

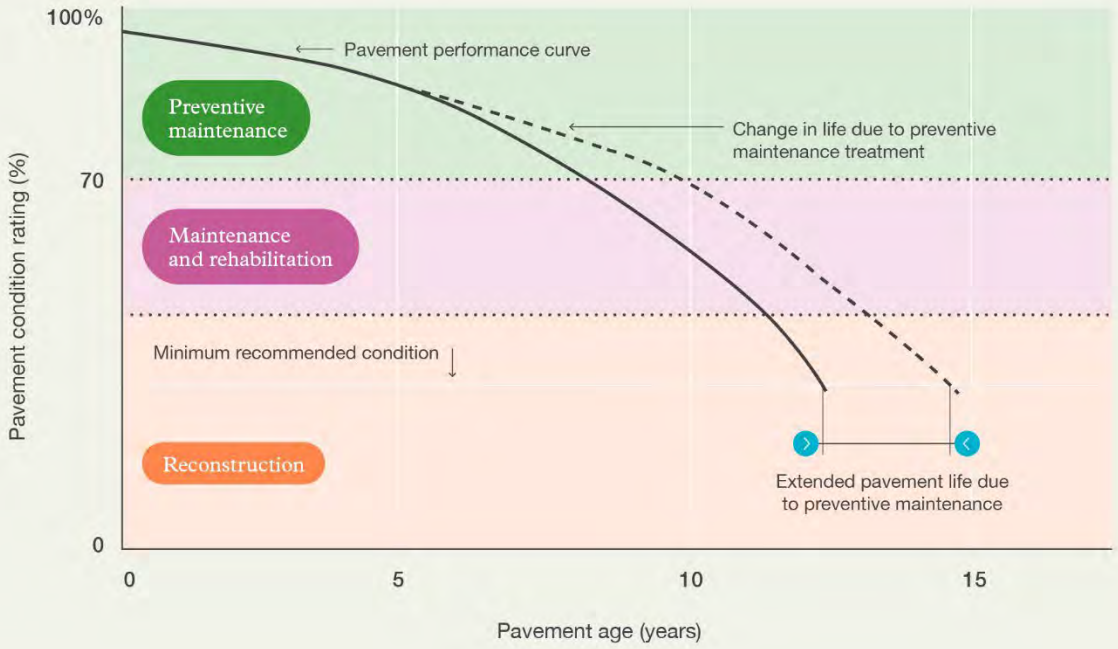
Places that introduce transport network pricing policies, such as London and Stockholm, realise multiple benefits, such as containing or even reducing traffic congestion despite growing populations. [99]

Government might find it challenging to seriously consider and implement non-build or low build solutions. But the Welsh Government has shown that prioritising non-build solutions that reduce carbon emissions can be done. In 2023, they cancelled 9 major road projects [100] and committed to

only consider future road investments that reduce carbon emissions and support a shift to sustainable transport modes.[101]

Extending the life of existing infrastructure can also reduce carbon and costs by avoiding new construction. For example, regular preventative maintenance of road surfaces can extend the number of years the roads can be used, as Figure 3 shows.[102]

Figure 3
Benefits of preventive maintenance to extend pavement life



In the United Kingdom, Anglian Water has continuously improved its asset planning and management.[103] For example, it avoided building new infrastructure by upgrading an existing water pipeline.[104]

Anglian Water – better use of existing assets to reduce carbon and cost

The United Kingdom water company Anglian Water planned to construct a new 37-kilometre pipeline. They expected it to cost £60 million and generate embodied emissions of 43,468 tonnes of carbon dioxide equivalent.

Using an innovative technique called flow reversal modelling, Anglian Water found that they could reverse the direction of flow in an existing pipe to supply water from another area.[105] By improving the use of existing assets using innovative and clever design, Anglian Water was able to reduce embodied carbon by 61%. This also reduced the cost of the project by £32 million.

In Victoria, the Department of Treasury and Finance's *Investment lifecycle and high value high risk guidelines* require projects to consider alternatives to building new infrastructure when developing business cases. However, in our discussions with senior staff at major Victorian Government agencies, there was clear feedback that strategic planning needs to happen much earlier and at a portfolio level to fully consider non-build solutions.

By business case stage, project teams told us that their task is to build a case for the new project, so it is too late for thorough consideration of non-build alternatives. The existing culture prioritises new build solutions and does not incentivise these teams to thoroughly prepare options that meet service needs while avoiding a new build project. This cultural change needs to be led by ministers and senior leaders in government.

Building efficiently can deliver productivity and carbon reduction benefits

Building efficiently, or using a low build approach, includes a range of offsite and modular methods of construction that involve assembling building components or modules in a controlled manufacturing setting.[106] This approach can deliver multiple benefits, such as:

- time savings: between 20% and 50% faster delivery than traditional techniques has been reported due to a more streamlined production[107]
- cost savings: 20% lower costs than traditional building techniques can be achieved due to reduced labour costs, efficient material procurement through centralised procurement and production, minimised on-site rework, and improved quality in a controlled manufacturing setting[108]
- carbon savings: a United Kingdom study found carbon emissions were reduced by 45% compared to onsite construction. This was a result of designing with less concrete and steel, and lowering emissions through reduced material transportation to the site. Prefabrication factories optimise material movements through assembly line robotics and other automated tools, improving efficiency and reducing both carbon and waste for the project as compared with onsite construction[109]
- waste reduction: waste reduction of greater than 40% was reported compared to onsite construction[110]
- productivity gains: more efficient material procurement through centralised procurement, coupled with streamlined and predictable pace of supply, delivery and installation.[111]

Globally, the modular and prefabricated construction market is expected to grow at a rate of 7.5% from 2023 to 2032 and reach USD$285 billion (around AUD$ 443 billion) by 2032.[112]

Victoria leads Australia's development of offsite construction, with more than 50% of industry capacity housed in the state.[113] The Office of Projects Victoria's *Offsite construction guide* aims for all projects to use offsite construction techniques where it is feasible and efficient to do so.[114]

Barriers that have been identified to introducing more offsite and modular construction include:

- the need for significant upfront investment in establishing manufacturing facilities and challenges in securing financing[115]
- the challenges in integrating this new construction method into the supply chain, such as logistical complexities involving transportation and site coordination[116]
- that current design practices often follow traditional building standards without considering the potential structural demands of modular construction[117]
- the absence of clear design guidelines for modular buildings[118]
- the shortage of skilled workers experienced in offsite and modular construction.[119]

Addressing these limitations will help Victoria reap the full potential in offsite and modular construction which delivers both productivity gains and decarbonisation benefits.

Case study

Fast delivery and reduced environmental impact

Permanent modular school buildings

Construction of the Warragul North Primary School's modules took just 8 weeks — 4 for factory build and 4 for installation.[120] The modular construction prioritised students' safety and well-being and was completed with minimal on-site work. These modular structures integrate technology and sustainability, leading to an overall reduction in environmental impact and costs.[121]

Image below: Two separate but connected modular buildings with an integrated courtyard replaced an old block of the Warragul North Primary School Source: Grove Group

Efforts to reduce carbon across the lifecycle are inconsistent

The Victorian Government currently has no integrated approach to manage carbon emissions over the infrastructure lifecycle.

Existing sustainability guidelines and frameworks, such as the *Social procurement framework* and the *Sustainable investment guidelines* consider carbon emissions among other sustainability considerations such as reducing water use and waste. As a result, carbon emissions reduction is considered one of many sustainability priorities, which is often overlooked in attempting to meet cost, quality and time requirements. While all sustainability considerations are important, reducing carbon emissions has clearly been identified as an urgent and immediate priority for all governments.

Infrastructure assessment and appraisal should include identifying, measuring, reducing and managing carbon over an asset's life.[122]

Existing infrastructure projects typically focus on reducing the carbon emissions of operating an asset[123] or energy use in building the asset, rather than the emissions generated through materials use, transportation of materials, asset maintenance or end-of-life decommissioning.[124]

Current guidance does not explain how to consider and manage carbon emissions throughout the infrastructure lifecycle.

Many stakeholders in our research identified PAS 2080 *Carbon management in buildings and infrastructure* as a leading example of a unifying approach to reducing carbon emissions.[125] PAS 2080 covers all parts of an asset's lifecycle carbon emissions.

The Royal Institution of Chartered Surveyors' *Whole life carbon assessment for the built environment* is another example of a consistent and detailed method for managing carbon emissions.[126]

PAS 2080:2023 – Carbon management in buildings and infrastructure

PAS 2080 is a globally recognised standard for managing carbon in buildings and infrastructure. It aims to help reduce carbon and costs through better design, construction and operations.[127]

PAS 2080 provides a framework for reducing carbon throughout the infrastructure lifecycle. It sets requirements for infrastructure projects, such as governance, planning or monitoring, and reporting, and offers practical guidance on meeting those requirements using various tools and techniques to quantify carbon, evaluate design and construction options, and manage project risks.[128]

Its key principles include:[129]

- **Carbon management:** Implementing a carbon management strategy that includes setting targets, monitoring emissions, and reporting progress.
- **Collaboration**: Encouraging collaboration between all stakeholders involved in an infrastructure project, including designers, contractors, and operators.
- **Lifecycle thinking**: Adopting a whole life approach to carbon management, considering emissions at all stages of the project lifecycle.
- **Performance-based approach**: Using a performance-based approach to carbon management, with targets and metrics that are linked to the specific infrastructure project and its intended purpose.

Quantifying carbon emissions needs standardised tools

Consistent carbon management guidance needs a unified approach to quantify carbon emissions.

Currently, carbon management approaches in Australia use different terminology, standards, and tools. The Materials and Embodied Carbon Leaders' Alliance has identified over 143 standards and tools used to manage embodied carbon in materials, buildings or infrastructure.[130] These are based on different methodologies, vary in complexity, and have numerous overlaps. Some tools, developed by industry, are proprietary and not publicly accessible. The use of different data sources and methods to estimate carbon emissions makes it hard to compare emissions reductions between projects.[131]

Government agencies currently use multiple approaches to estimate and report carbon emissions, in the absence of consistent carbon management guidance.[132] In Victoria, individual infrastructure projects have elected to use sustainability rating tools to help improve projects' sustainability performance, including reducing carbon emissions. For example, as part of its project-based sustainability approach, the agency for the Level Cross Removal Project applied the Infrastructure Sustainability (IS) Rating Tool developed by the Infrastructure Sustainability Council and included

minimum carbon reduction rates between 5% to 15% as key performance indicators and tender evaluation criteria.[133] Table D-3 in Appendix D shows a range of sustainability rating schemes and tools used by some of the Victorian major projects.

Infrastructure New South Wales has been leading work across Australia to develop a consistent measurement approach for all infrastructure types. This is expected be available by the end of 2023.[134] Victoria can align its approach with the outcomes from this assessment to remove unnecessary inconsistency and inefficiency across jurisdictions.

Infrastructure Sustainability (IS) Rating Scheme

The Infrastructure Sustainability Council developed the IS Rating Scheme to inform sustainability considerations in the design, construction and operation of new infrastructure.[135] In current practice, the IS rating tool has been predominantly used to assess a project's sustainability performance.[136]

In June 2023, the Infrastructure Sustainability Council released an updated version of their tool which supports project proponents in considering sustainability options and benefits in the strategic planning phase.[137]

Green star

Green Star is widely adopted by the private sector across all building classes and is also adopted by public sector agencies for government owned buildings and developments. Predominantly adopted in concept design, opportunities exist in the business case and planning phases for fundamental decision-making, such as eliminating fossil fuels and embodied carbon reductions through fundamental design and funding decisions.[138]

National Australian Built Environment Rating System (NABERS)

NABERS is a sustainability rating scheme for the built environment. It provides a rating from 1 to 6 for building efficiency in energy, water, waste and indoor environments. In December 2022, NABERS released a consultation paper for incorporating embodied emission in its rating.[139] This development is funded by the New South Wales Government and it is expected that the trial and release of this new rating tool will be over 2023 and early 2024.[140]

Carbon estimating and reporting tool (CERT)[141]

Transport for New South Wales has developed the CERT to consistently measure and report greenhouse gas emissions in compliance with its sustainable design guidelines. The excel-based tool includes in-built emissions factors for construction materials and processes that help streamline data entry and reporting.

The CERT is intended for use in all new transport projects in New South Wales with a value of at least $15 million to capture relevant scope 1, 2 and 3 emissions as identified through an emissions materiality assessment.[142]

Stakeholders want government to commit to decarbonisation

Industry stakeholders want governments to provide clear and consistent decarbonisation guidance for business case development, and to better consider it during procurement.

> "Many within industry and government have been calling for consistent cost benefit analysis and business case processes to better consider carbon and mitigation efforts."
>
> Green Building Council of Australia, submission to Infrastructure Victoria

Current procurement guidelines do not have clear carbon reduction targets.

Industry stakeholders that we spoke to want procurement processes to be open to considering offers to support carbon abatement, particularly by adding incentives into contracts that allow for and encourage further emissions reductions.

> "…setting minimum performance requirements related to outcomes and solutions will influence private industry to adopt low carbon products and services. Clients could identify opportunities to pay suppliers via advance payments with requirements in place that ensures part of the payment goes into investing in the production or adoption of new low carbon materials and services."
>
> Laing O'Rourke, submission to Infrastructure Victoria

Some major infrastructure project procurements have considered decarbonisation outcomes, although this varies between government departments and agencies. Stakeholders reported that when tender proponents identified carbon reduction opportunities, they found that decisions ultimately prioritised minimising financial costs and limiting changes to project scope. They felt that procurement processes did not seriously consider carbon reduction opportunities.

Industry desires greater policy certainty. But it is already acting to make carbon management more consistent in Australia. For example, the Materials and Embodied Carbon Leaders' Alliance is using innovative materials and systems to reduce embodied carbon.[143] Similarly, the infrastructure sector has widely adopted sustainability rating tools that include carbon management tools and frameworks (see Appendix D, Table D-3).

Infrastructure investment evaluation needs clear carbon values

Consistently using a suitable carbon value in investment decision-making is one of the most economically efficient mechanisms to achieve rapid decarbonisation for the lowest cost, especially in the construction and maintenance sector.

The Victorian Government's *Investment lifecycle and high value high risk guidelines* apply to all capital investments over $10 million.[144] The guidelines require major infrastructure project business cases to conduct a cost benefit analysis that estimates the project's economic, social, and environmental costs and benefits in monetary values. They do not specify carbon values for the analysis. They also do not advise on how to estimate, measure and report on emissions in infrastructure projects during the business case phase, or to account for carbon impacts during the infrastructure lifecycle.[145]

Victorian Government guidance on carbon values is out of date. The government's *Economic evaluation for business cases technical guidelines* refer to the repealed Australian Government's national carbon pricing scheme to estimate the monetary value of carbon emissions. The Department of Treasury and Finance has not updated the guidelines since 2013.[146]

Our research found that Victorian infrastructure business cases do include carbon emissions in their cost benefit analyses, but they use different monetary values in different projects. For example, the Suburban Rail Loop used a value of $46 per tonne carbon dioxide equivalent, but the

North East Link used a value of $52.40.[147] Other governments use much higher values, as shown in Table 1.

Victorian projects use fixed carbon values for the life of the project. International leading practices in cost benefit analysis use carbon values that escalate over time. This accounts for rising carbon abatement costs over time, after initial 'low cost' opportunities have been exhausted. For example, the Canadian Government started with a carbon price of CAD$20 per tonne in 2019 and increased it by $10 per tonne a year to CAD$50 in 2022. The Canadian carbon value will further increase by CAD$15 per tonne a year between 2023 and 2030.[148]

A mandatory requirement to use updated, escalating values for carbon in business cases would be a major change to Victoria's current practice. But leaving them out means infrastructure project decisions do not effectively and consistently evaluate options to reduce Victoria's carbon emissions. This makes the emissions reduction task more difficult.

Table 1: Examples of carbon values used in transport projects[149]

Jurisdiction	Body	Cost (AUS$/t CO_2-e) – indexed to FY2021-22	Indexation	Greenhouse gas policy commitments
European Union	European Commission	$150 (short term) $403 (long term)	N/A	55% reduction by 2030 on 1990 levels and net zero by 2050
United Kingdom	UK Government	$447 (2022) $681 (2050)	1.5% per annum	68% reduction by 2030 on 1990 levels and net zero by 2050
New Zealand	New Zealand Transport Agency	$88 (2022) $164 (2050)	2.25% per annum	50% reduction by 2030 on 2005 levels and net zero by 2050
United States of America	US Federal Government	$70	N/A	50 to 52% reduction by 2030 on 2005 levels and net zero by 2050
	New York State Government	$175	N/A	
Australia	Australian Government Department of Infrastructure (commonly known as ATAP[1] guidelines)	$65	0%	26 to 28% reduction by 2030 on 2005 levels and net zero 2050 (New South Wales is committed to 50% reduction by 2030)

The New South Wales Government updated its guide to carbon value in cost benefit analysis in February 2023 and requires the carbon values in Table 2 be used for cost benefit analyses between 2023 and 2032.[150] This approach uses the average European Union Emissions Trading Scheme market spot price, converted to Australian dollars using the average EUR/AUD exchange

[1] Australian Transport Assessment and Planning Guidelines

rate over the 2022 calendar year. The value for the 2022 calendar year is then increased by 2.25 per cent per annum for each year after FY2023.

Table 2: AUD carbon values (per tonne) for use in cost-benefit analysis by the New South Wales Government[151]

FY2023	FY2024	FY2025	FY2026	FY2027	FY2028	FY2029	FY2030	FY2031	FY2032
$123	$126	$128	$131	$134	$137	$140	$144	$147	$150

Transport for New South Wales and New South Wales Treasury are currently collaborating on research to identify carbon values using a target consistent approach, which they expect to complete by September 2023.[152] We expect the New South Wales Government will revise their carbon values after the research is finished.

Inconsistent guidance on carbon valuation in cost benefit analyses can misrepresent project benefits and disbenefits to decision-makers.

How carbon values impact on benefit cost analyses

Applying different carbon values changes benefit cost ratios and may change the project from a non-viable investment to a viable investment. For example, imagine two projects.

The first is estimated to create $1 million of economic value and emit 5,000 tonnes of CO_2e.

The second is estimated to create $2 million of economic value and emit 20,000 tonnes of CO_2e.

Using existing appraisal methods, the second project would be selected as the economic value is greater. But with a carbon value of $100 per tonne of CO_2e, the first project will create $500,000 of value ($1,000,000 economic value – 5,000 tCO_2e x $100 carbon value) and the second will create $0 of value.

The value used to evaluate carbon emissions ideally reflects their cost to society or society's willingness to pay to avoid the impact of emissions. Clear policy direction on carbon values that reflect the true economic cost of abating emissions can help Victoria prioritise decarbonisation in investment decision-making.

Our advice to the Victorian Government

Our advice to the Victorian Government

Reducing carbon emissions requires a fundamental shift in infrastructure decisions

Reducing emissions and achieving net zero requires the Victorian Government to fundamentally rethink how it decides to invest, build and manage infrastructure.

The scale of the climate challenge, including the cost of inaction and the risks of more extreme weather, calls for a swift and substantial shift in how infrastructure is planned and designed. This shift also presents opportunities to create new high value jobs in recycled or low carbon materials and increase productivity.

To reduce infrastructure costs and maintain competitiveness as other economies reflect carbon prices in the supply chain, decarbonising Victoria's infrastructure must start now.

Leading governments, including the United Kingdom and New South Wales, show that rapid policy development is achievable. Victoria can align its approach to these jurisdictions, to quickly build on their practices and accelerate the decarbonisation of its infrastructure.

Ministers and leaders of relevant portfolios need to show strong leadership and demand clear accountability to embed decarbonisation into infrastructure decisions. Clear Victorian Government direction about the level and pace of decarbonisation for infrastructure will also encourage private industry to make new choices and different investment decisions.

The Victorian Government has already set clear emissions reduction targets. But stakeholders report that the government has not yet clearly translated these targets into different decisions about infrastructure projects. To do so, the government must build capability and capacity, quantify and measure carbon emissions, and encourage emissions reduction in procurement.

The government will need to make hard choices at each decision point of the infrastructure lifecycle to prioritise decarbonisation outcomes among many competing considerations. It cannot avoid these decisions if it is committed to acting on climate change and realising the benefits this can bring, including meeting its own emission targets.

Three overarching principles should guide decarbonisation efforts in Victoria

This advice makes 10 recommendations with clear actions. These recommendations will be best supported if guided by an overarching commitment to 3 overarching principles.

Drawing on the experience of leading jurisdictions and the current state in Victoria, the 3 principles we propose are:

- **Prioritise non-build or low build solutions. Aim to get better use from existing infrastructure or modify it to meet changing needs before considering a new build. Use construction techniques like offsite or modular construction wherever possible in new builds.**

  Non-build or low build solutions which minimise new construction can avoid emissions associated with constructing and operating new infrastructure, and usually have lower lifecycle carbon emissions. For example, the Department of Transport and Planning's Smarter Roads project is improving the operation of the traffic light network to optimise road performance rather than building new roads.[153] When undertaking new construction, options to build more efficiently

by using offsite or modular construction can reduce both cost and carbon while improving productivity.

Victorian guidelines already require departments and agencies to consider non-build options when developing business cases. However, project teams in government agencies told us that the business case stage is often too late for thorough consideration of alternatives. The existing culture prioritises new build solutions and does not incentivise these teams to thoroughly prepare options that meet service needs while avoiding a new build project.

Ministers and senior executives of Victorian Government departments and agencies should explore and fully consider viable, non-build or low build alternatives well before business case development. Clear direction from ministers about more intensely searching for non-build or low build solutions, supported by a demonstrated willingness to select and fund these options, would give departments and agencies confidence to bring these options forward.

- **Align approaches with other governments and industry best practices.**

  Victoria can reap many benefits by aligning its approach with other Australian governments and industry best practices. Victoria can more rapidly adopt proven approaches and move quickly towards meeting decarbonisation targets. Using existing tools, research and administrative resources reduces the need for more investment in developing new solutions.

  Harmonising these approaches between jurisdictions also reduces the administrative burden on industry, allowing businesses to focus on implementing effective decarbonisation strategies. By promoting consistency between jurisdictions, Victoria is also helping to build capability and expertise within industry.

  There may be some situations in which a Victorian-specific approach is useful, however, these should be considered carefully and weighed against the benefits of broader alignment.

- **Clarify the scale and pace of infrastructure emissions reduction to give confidence to industry.**

  Immediate and sustained action is needed to reduce greenhouse gas emissions produced by Victorian Government infrastructure. While the government has set ambitious emissions reduction targets for the economy, industry and government representatives that we consulted were not clear on the government's commitment to, or timeline for, decarbonising infrastructure.

  Without this clarity, it is difficult for either to propose or take up options to reduce carbon in the significant pipeline of infrastructure projects underway. Industry is willing to act but requires policy certainty. Immediate engagement with industry on decarbonisation timelines will provide certainty and facilitate a smoother transition, minimising potential disruptions to projects. By involving suppliers in the early stages of policy development, the government can gather valuable insights and proactively address concerns.

Our 10 recommendations can deliver actionable change

Infrastructure Victoria makes the following 10 recommendations to reduce greenhouse gas emissions in Victorian Government infrastructure:

1. Adopt a carbon management standard like *PAS 2080:2023 Carbon management in buildings and infrastructure* to measure and manage carbon emissions and modify as needed to embed in Victoria.

2. Implement the same carbon measurement approach as New South Wales and deliver training across the Victorian Government.

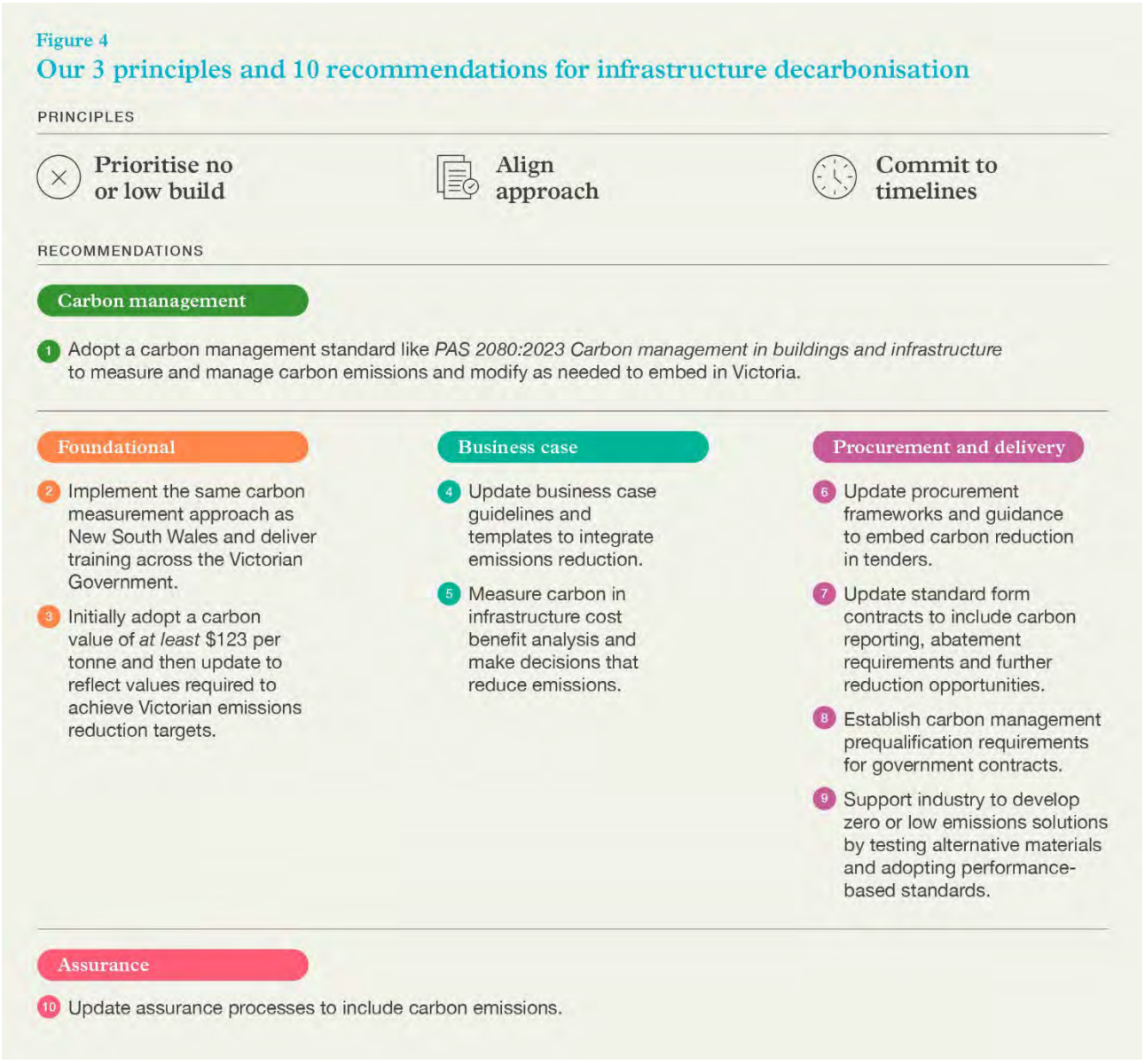
3. Initially adopt a carbon value of *at least* $123 per tonne and then update to reflect values required to achieve Victorian emissions reduction targets.

4. Update business case guidelines and templates to integrate emissions reduction.
5. Measure carbon in infrastructure cost benefit analysis and make decisions that reduce emissions.
6. Update procurement frameworks and guidance to embed carbon reduction in tenders.
7. Update standard form contracts to include carbon reporting, abatement requirements and further reduction opportunities.
8. Establish carbon management prequalification requirements for government contracts.
9. Support industry to develop zero or low emissions solutions by testing alternative materials and adopting performance-based standards.
10. Update assurance processes to include carbon emissions.

Figure 4 summarises the 3 overarching principles and 10 recommendations.

Figure 4

Our 3 principles and 10 recommendations for infrastructure decarbonisation



Staging of delivery

Each of our 10 recommendations has clear actions.

These include *critical actions*, which are crucial for Victoria to achieve its decarbonisation objectives, and *supplementary actions* which can enhance outcomes and enable faster emissions reduction.

These actions build on each other.

The government can start by making the most important decisions about its approach to decarbonisation and issue foundational guidance in a first stage of policy and strategy development. These include:

1.1 Identify the preferred carbon management standard for Victoria.

1.2 Adopt PAS 2080 as interim guidance on carbon management for voluntary use by Victorian Government departments and agencies. (optional)

2.1 Agree to adopt carbon measurement approach and standard emissions factors.

2.2 Evaluate skills gap and training requirements for government and industry.

2.3 Establish a Victorian Government community of practice on infrastructure decarbonisation to facilitate knowledge-sharing and collaboration. (optional)

3.1 Initially adopt interim carbon value of $123 per tonne.

3.2 Calculate the carbon values required to achieve Victoria's specific emissions reduction targets by using a target consistent approach.

4.1 Require business cases to include a descriptive estimate of carbon emissions, assess the impact using the interim carbon value and outline emission reduction options in line with the carbon reduction hierarchy.

6.1 Determine how to change the current public infrastructure procurement framework to effectively consider carbon emissions.

Actions in implementation phase 1 include developing detailed guidance and starting to apply recommendations for pilot projects.

In implementation phase 2, the government can expand and refine decarbonisation practices, and then scale and continuously improve these practices through ongoing application and extension.

Appendix F shows the implementation and interdependencies of actions for all 10 recommendations in 4 implementation stages.

Our recommendations and actions

Recommendation 1: Adopt a carbon management standard like *PAS 2080:2023 Carbon management in buildings and infrastructure* to measure and manage carbon emissions and modify as needed to embed in Victoria.

Identify a carbon management standard to use across the infrastructure lifecycle.

The Victorian Government has minimal guidance for infrastructure projects on carbon reduction. The guidance does not address the entire lifecycle of infrastructure assets. And it addresses carbon emissions as one sustainability opportunity among many, such as reducing water use and waste.

The main business case policies, guidance and frameworks relevant to infrastructure are summarised in Appendix C. An overview of standards, rating schemes, tools, and carbon values commonly used in procurement and delivery can be found in Appendix D.

Victorian Government departments and agencies cannot systematically and consistently consider reducing carbon emissions of infrastructure without an endorsed standard approach.

Our research found industry and government stakeholders strongly support a carbon management system in Victoria, such as PAS 2080.[154] The United Kingdom's *PAS 2080 carbon management in buildings and infrastructure* standard is a globally recognised approach. PAS 2080 includes guidance to identify, measure, and report carbon reduction actions throughout an asset's lifecycle.[155] It outlines responsibilities at each step in the supply chain and establishes governance mechanisms to reduce carbon emissions using a common management process.[156]

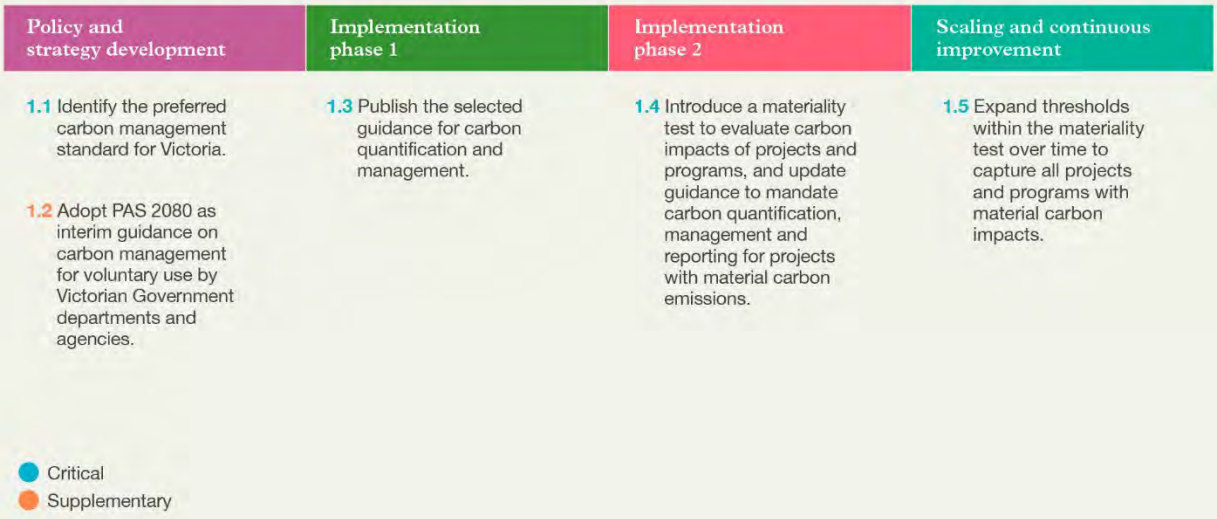
Adopting a carbon management standard such as PAS 2080 will clarify Victoria's direction, including carbon governance and responsibilities, to drive consistent practice in government infrastructure projects. It will also allow tracking of emissions reductions by consistently quantifying and reporting them throughout the infrastructure lifecycle.

Infrastructure development and delivery over its lifecycle involves many participants. If roles and responsibilities are duplicated or not clearly allocated, delivery costs may be higher and decarbonisation efforts may be less effective. The Department of Energy, Environment and Climate Action and Department of Treasury and Finance can lead in setting consistent requirements, guidance and policy for other departments and agencies to follow.

We recommend the Victorian Government adopt a carbon management standard like PAS 2080 to measure and manage carbon emissions and modify as needed to embed it in Victoria. Figure 7 shows the actions required to do this.

Figure 5

Action plan for recommendation 1



The Victorian Government should identify the preferred carbon management standard for Victoria (action 1.1). Our research identified PAS 2080 as a suitable standard to use as a model for Victoria. The United Kingdom's Department of Transport has mandated that PAS 2080 be adopted for all National Highways projects by the end of 2023.[157] The New South Wales Government, Australian Government, and industry bodies (such as the Materials and Embodied Carbon Leaders' Alliance) are currently reviewing carbon quantification and management standards, with PAS 2080 as a leading candidate for adoption.

Initially, the government can adopt PAS 2080 as interim guidance on carbon management for voluntary use by Victorian Government departments and agencies (supplementary action 1.2).

Once the government determines the preferred standard for Victoria, it should openly publish the selected guidance for carbon quantification and management (action 1.3). Updates to existing guidance should reference the new standard. The standard should specify the methods for measuring, managing, and reporting carbon emissions at each stage of the project. It should clearly articulate how any new and existing guidance will reduce carbon emissions.

Requirements for all new public infrastructure projects to measure and report carbon emissions will need additional effort as projects and suppliers develop familiarity with the approach. The Victorian Government should first consider applying the new standard only to projects with large carbon impacts by using an emissions materiality assessment (action 1.4). This materiality test should identify projects that are sufficiently large and have substantial carbon reduction opportunities. The materiality test could apply to a level of carbon emissions or to a financial threshold, of a project or a program of smaller projects as a group. For example, road repairs or upgrades might not meet a materiality threshold individually but could be material as a group. Another approach that could be used is a tiered framework, with projects having to meet a cost and emissions threshold to be considered material. The tiered framework could also set out timeframes within which the emissions thresholds would reduce over time as departments, agencies and industry become more familiar with carbon emissions reduction requirements.

United Kingdom Department for Transport has adopted materiality tests for carbon impacts

The United Kingdom government applies specific thresholds to transport projects in assessing carbon impacts for their business case stages. They monitor these estimates against actual figures during construction and operation. The thresholds include:

- estimated lifecycle carbon impacts of greater than 1 million tonnes of carbon dioxide equivalent
- values exceeding certain thresholds in specific project categories, for example, highway or rail projects of greater than GBP£500 million (approximately AUD$940 million) and maintenance projects of greater than GBP£100 million (approximately AUD$188 million).[158]

The Victorian Government can gradually broaden the scope of the materiality test to apply the standard to more projects, including new build and asset maintenance projects **(action 1.5).**

Recommendation 2: Implement the same carbon measurement approach as New South Wales and deliver training across the Victorian Government.

Assess the suitability of carbon quantification tools and adopt an approach to effectively measure carbon emissions at all stages of infrastructure planning and delivery.

Our research found that where departments and agencies have started to estimate carbon emissions, they use different methods and data sources to do so (see Appendix D, table D-1 and D-2). There is no single source for reliable emissions data in Victoria, so they use data that is inconsistent and sometimes inaccurate, or not sufficiently detailed.[159]

Easy-to-use, non-proprietary tools and standard values for embodied emissions in materials can help government and industry to consistently quantify and report emissions. This promotes better decision-making and enables effective progress tracking.

Our research identifies that leading decarbonisation tools include:[160]

- a comprehensive open-source database of emissions estimates for materials (also known as emissions factors)
- lifecycle assessment software
- carbon footprint calculators
- emissions monitoring and reporting tools.

Tools should rely on standard emissions factors that infrastructure managers can use consistently in different projects. Although the Australian Department of Climate Change, Environment, Energy and Water publish the National Greenhouse Account Factors each year, these do not include emissions factors for construction materials and products or for transport of these materials.[161]

Many different carbon measurement tools are available for use in Victoria, such as Transport for New South Wales' Carbon Emissions Reduction Tool (CERT), the Infrastructure Sustainability Council's IS Rating Scheme[162] and the National Australian Built Environment Rating System (NABERS).[163] Our research has not clearly identified a single tool that is best to adopt in Victoria. Each tool has its own advantages and drawbacks, and many are evolving rapidly to address limitations raised.

But there are many advantages to governments and industry in adopting a consistent approach in using carbon measurement tool across jurisdictions. A consistent approach would allow government decision-makers, project teams, and industry to use any tool and have confidence that the emissions estimates produced will be robust and comparable. A standardised approach to measuring carbon emissions should include:

- consistent inputs, including scopes of emissions considered and emission factors used
- clearly defined data quality expectations throughout the project's lifespan
- defined outputs and reporting mechanisms to promote improved practices and facilitate future benchmarking.

As the level of detail increases during a project's design, the project team can be more accurate about the expected emissions from the project. For example, at the business case stage, the project team are unlikely to know which specific products they will use. However, the early strategic planning and optioneering stage is the best time to make decisions that avoid carbon emissions. Project teams should use the most appropriate emissions calculation approach for the level of design detail available at each stage.

Emission factors can be obtained from a range of specific to general sources, including:[164, 165]

- product-specific emission factors, which apply to specific products used in construction assets (for example, a product-specific environmental product declaration)
- industry-average emission factors, which are relevant for a group of producers working with the same material type or manufacturing region (for example, an industry-average environmental product declaration)
- generic values from life cycle assessment tools (for example, Transport for New South Wales' Carbon Emissions Reduction Tool) or databases (for example, Australian National Life Cycle Inventory Database)[166]
- generic emission factors from global literature sources.

See Appendix D table D-2 for more examples of emissions factor sources.

Infrastructure New South Wales is identifying key areas of alignment and creating measurement guidance as a foundation for a national approach. As there is not a single leading tool, the Victorian Government should adopt the same approach as New South Wales based on the outcome of this assessment. This guidance is expected to be available by the end of 2023.

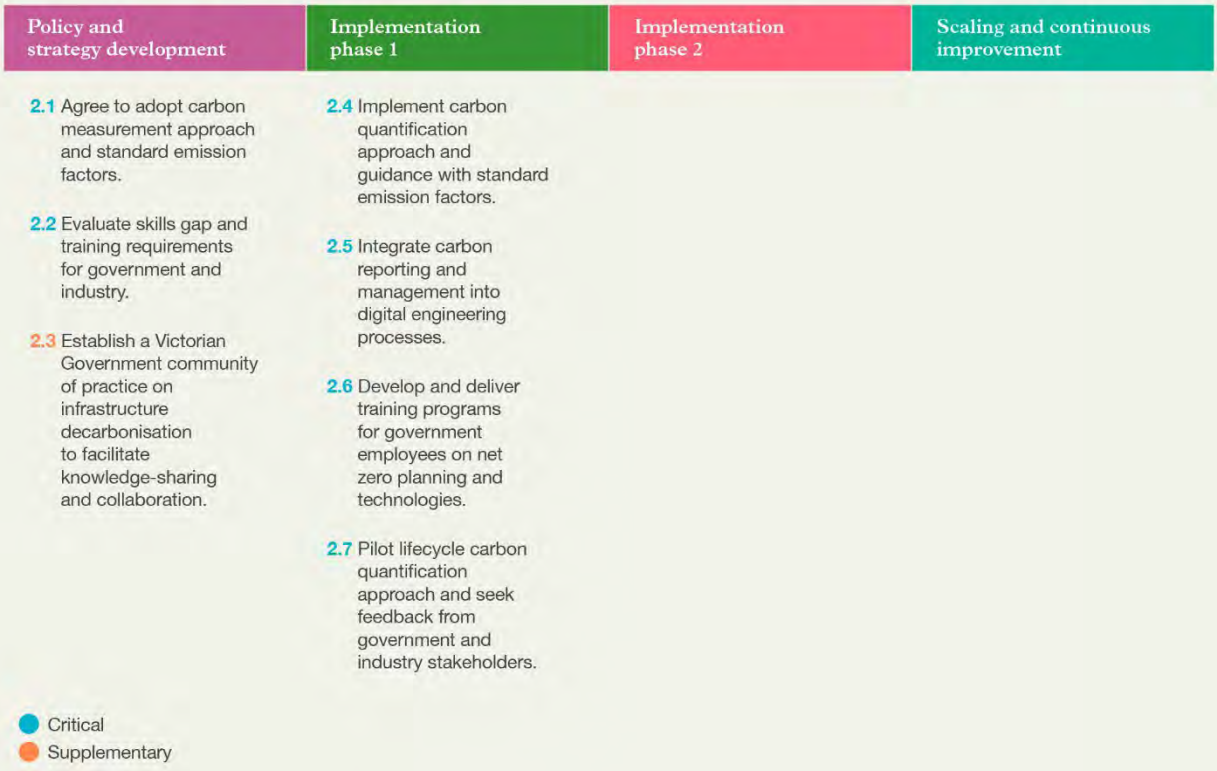
Government and industry staff working on infrastructure projects may not be able to adopt new practices if they do not have training about the new practices, or enough resources to support the staff in using them. Many stakeholders told us that their current awareness of carbon measurement tools is limited.[167]

> "Policy implementation and delivery of projects will be impacted by industry capacity to meet demand. Identifying the skills and knowledge gaps and creating pathways for professional development, training and resources will be critical for ensuring agencies can address gaps in capability, as well as other barriers to decarbonising infrastructure delivery."
>
> Green Building Council Australia, submission to infrastructure Victoria

Government should invest in building the capability of public sector staff and industry partners to use selected tools successfully.

Figure 6 shows the actions required to deliver this recommendation.

Figure 6
Action plan for recommendation 2



The Victorian Government should first agree to adopt the same measurement approach and standard emissions factors as New South Wales (action 2.1). Victorian departments and agencies should use the tool that best meets their needs at the time of assessment, as long as it meets the requirements of the agreed carbon measurement approach.

The Victorian Government should reflect the agreed approach and implement guidance on use of the approach and emission factors (from action 2.1) in the existing processes and systems, including sections of the *Sustainable investment guidelines*, *Investment lifecycle and high value high risk guidelines* and *Victoria's social procurement framework* (action 2.4).

After this, integrating carbon reporting and management into digital engineering tools can rapidly advance their use (action 2.5). The Victorian *Digital asset policy* applies to all projects over $20 million.[168] It defines the required asset and project information needed to support decision-makers during an asset's life. This could be updated to include requirements for carbon emissions data.

Using digital platforms to manage and report carbon emissions will achieve better consistency and lower the costs of carbon emissions reporting. This involves using emissions data and measurement methods in digital platforms. Stakeholders report that visualising carbon 'hot-spots' during the initial design stage allows designers to target the most promising areas for emissions reduction.[169]

Once the carbon measurement approach is adopted by government, each department and agency can assess the current knowledge and skills of their staff to document decarbonisation training priorities (action 2.2). This assessment should focus on improving skills in deploying carbon quantification tools and ensuring staff understand how to use these tools to help contribute broader carbon reduction efforts.

Stakeholders raised the idea of establishing a community of practice to facilitate knowledge sharing, innovation, and coordination, ultimately promoting best practices, lessons learned, and emerging strategies (supplementary action 2.3).[170] The Victorian Government can build on existing successful examples. For example, EcologiQ promotes awareness of how infrastructure projects can use recycled materials by publishing case studies on its website and hosting annual conferences.[171] The Materials and Embodied Carbon Leaders Alliance is another example of a joint government and industry initiative that helps to share case studies and leading practices through their website and forums. The Victorian Government could consider expanding the role of either of these platforms with associated resourcing.

Stakeholders also suggested improving internal capacity about net zero planning and technologies. Training on these topics can supplement staff knowledge and skills, so they can understand and implement decarbonisation strategies in Victorian public service projects (action 2.6).

Pilot projects can test industry acceptance and understanding of the new requirements, methods and approaches, providing valuable lessons and opportunities for refining them. Using pilot projects to test new requirements, such as carbon measurement approaches, can ensure that they are effective and well understood by industry and government before adopting them widely (action 2.7).

Recommendation 3: Initially adopt a carbon value of *at least* $123 per tonne and then update to reflect values required to achieve Victorian emissions reduction targets.

Incorporate carbon valuation into investment decision-making to reflect the impact of carbon emissions on the community.

Valuing emissions will ensure that infrastructure project decisions account for climate change impacts alongside other costs and benefits. Infrastructure decision-makers and owners have little incentive to reduce carbon emissions that are not costed.

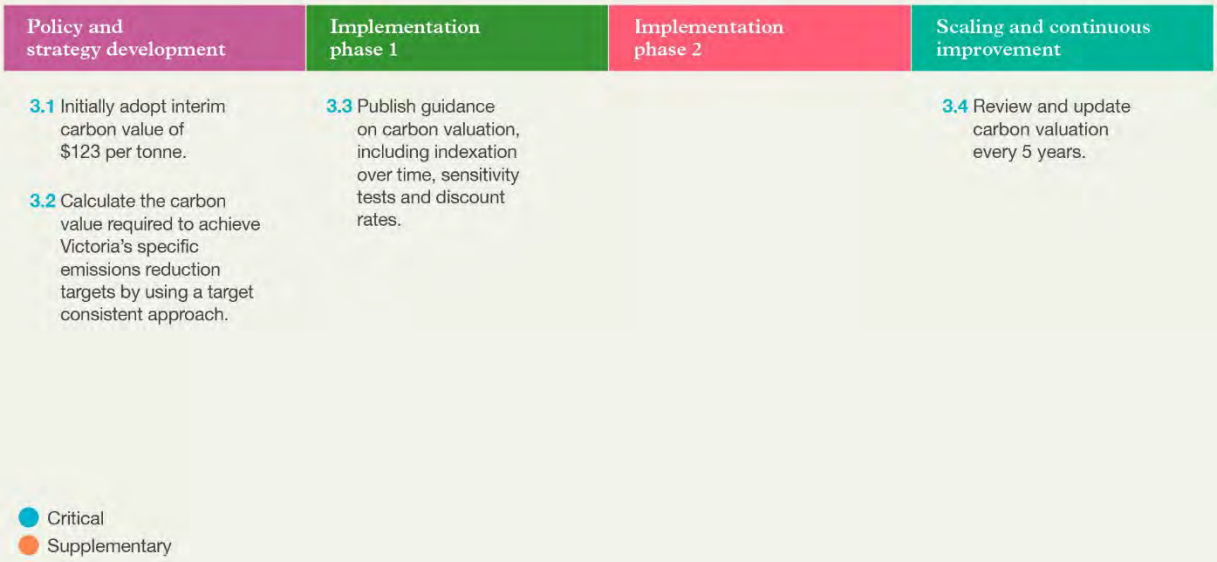
Leading jurisdictions in climate action place a monetary value on carbon emissions so they are measured to inform policy and investment decisions.[172] Victorian Government infrastructure investments either do not measure carbon emissions or use differing values for carbon that are much lower than those of leading jurisdictions.[173]

The Victorian Government should release clear, consistent, and regularly updated guidance on how it will value carbon emissions to measure the impact of its infrastructure investments.

Figure 7 shows the actions required to do this.

Figure 7

Action plan for recommendation 3



As a first step, the government should initially adopt an interim carbon value of $123 per tonne (action 3.1).

Victoria should use a minimum value of $123 per tonne in 2023, which is the European Union Emissions Trading Scheme market spot price converted to Australian dollars. This is the approach that the New South Wales Government has adopted while completing their evaluation of target consistent values[174] (see Table 2).

We recommend the Victorian Government update this carbon value by using a target consistent approach to calculate the carbon values required to achieve Victoria's specific emissions reduction targets (action 3.2). This should be done as soon as practicable.

A target consistent approach uses a policy target, such as net zero by 2045, and determines the scale and cost of emissions abatement required to achieve the target. A carbon value approach consistent with emissions reduction targets is already use in other jurisdictions,[175] such as the United Kingdom and European Union.[176]

A target consistent approach in Victoria would align with other Australian jurisdictions' emerging practices. Infrastructure Australia recommends using a target consistent approach and is engaging with stakeholders on a national carbon value.[177] Transport for New South Wales and New South Wales Treasury are currently collaborating on research to identify carbon values using a target consistent approach, due in September 2023.[178]

Approaches to valuing carbon[179]

There are 3 main approaches to carbon valuation:

- **Damage costs** (social cost): Damage costs are an evaluation of the total costs of climate change under the assumption that no efforts are taken to reduce the pace of climate change. They are estimated as the net present value of climate change impacts of one more tonne of carbon emitted today.

  This approach, in theory, provides a first-best estimate of the economic, social, and environmental impacts of climate change, if underlying data is reliable and accurate. This approach is extremely challenging in practice, such as modelling physical impacts,

securing accurate data in many cost categories, and determining a reliable assessment of a baseline scenario.

- **Target consistent approach** (avoidance cost): The target consistent approach uses a relevant policy target, such as 'net zero by 2050', and determines the scale and cost of emissions abatement required to achieve that target over a given timeframe.

  This approach does not measure and value all impacts of climate change. The outcomes are highly dependent on the adopted policy target, the price of the least-cost options (marginal abatement costs curve), and the chosen baseline scenario.

- **Market prices**: A market price approach bases the carbon values on the observed and expected traded price of carbon in each carbon market. Carbon valuations based on market prices have the advantage that they can represent 'actual' prices of carbon or abatement at a given time. The two most relevant carbon markets are the Australian Emission Reduction Fund and the European Union Emissions Trading System.

  Carbon markets can result in low carbon prices due to market imperfections, including market structure, political influences, and supply and demand factors, leading to disadvantages such as volatility and supply fluctuations.

After identifying carbon values for the Victorian context, the Victorian Government should publish clear guidance on the use of consistent carbon valuation in infrastructure projects including timeframes, sensitivity tests and discount rates (action 3.3). Regularly updating carbon valuations will ensure that they remain relevant, accurate, and aligned with Victoria's emission reduction targets (action 3.4).

Discount rates affect the value of future costs and benefits

What are they?

Analysts use discount rates to compare the value of future costs and benefits relative to current costs and benefits.[180] They use this rate to 'discount' or reduce the value of future costs and benefits. This is based on the observation that people prefer to consume goods and services today rather than in the future.

Why are they important?

Higher discount rates drive decisions that favour benefits to current generations over future generations.

How are discount rates related to climate change?

Carbon abatement benefits accrue far into the future. As climate change intensifies over time, we expect future generations to benefit more from projects that avoid and reduce emissions. This means that lower discount rates can be used to assess projects with carbon reduction potential.

The Organisation for Economic Co-operation and Development (OECD) notes in their 2018 *Cost benefit analysis and the environment report* that in the context of intergenerational issues like climate change, there is strengthening theoretical and empirical support for the use of discount rates that decline with time.[181]

Some governments set tapering discount rates over time for projects with clear emission reductions outcomes. For example, the United Kingdom uses a discount rate of 3.5% for years 0 to 30, 3% for years 31 to 75 and 2.5% for years 76 to 125.[182]

What is the Victorian Government's current approach?

The Victorian Government recommends using a discount rate of 7% when the costs and benefits can be easily translated into monetary terms, such as for public transport, housing and roads. They recommend a rate of 4% when the costs and benefits are more difficult to convert to monetary values, such as in public health, justice and education.[183]

Setting meaningful carbon values and discount rates would support rapid decarbonisation

There are many good reasons for the Victorian Government to review discount rates.[184] The long-term effects of climate change are yet another reason to re-evaluate these arguments.

This advice does not explicitly recommend changing discount rates.

But in our view, further investigation by governments is warranted to understand the implications of discount rates for decarbonisation. In the meantime, business cases should better inform decision-making by undertaking sensitivity tests on the effects of lower discount rates for projects with substantial carbon reduction potential.

Recommendation 4: Update business case guidelines and templates to integrate emissions reduction.

Incorporate lifecycle carbon estimation, assessment and valuation into existing business case guidelines and templates. Define in the guidance how to set an emissions baseline, how to measure carbon, and how to identify carbon reduction strategies.

Infrastructure Victoria reviewed existing business case guidelines for Victorian infrastructure projects. For an overview of guidelines and frameworks see Appendix C, table C-1. Existing guidelines such as the *Investment lifecycle and high value high risk guidelines* and processes such as gateway reviews should verify that infrastructure projects consider greenhouse gas emission reductions in line with the *Climate Change Act 2017*. However, the guidance lists carbon emissions as one consideration in a list of broader sustainability requirements such as reducing water use, energy consumption, and waste.[185] While the Office of Projects Victoria's *Sustainable investment guidelines* provide good suggestions on how to consider sustainability (including scope 3 emissions) in project planning and delivery,[186] the guidelines do not set any emissions reduction requirements or mechanisms to prioritise emissions reduction.

In summary, current business case guidelines and processes:[187]

- have no specific advice on how to estimate, measure and report on carbon emissions in projects
- do not place a financial (monetary) value on carbon to account for emission reductions in decision-making.

This means business case proposals often overlook carbon reduction considerations, and instead favour meeting more tangible cost, quality and time requirements.

We recommend the Victorian Government update business case guidelines, such as *Investment lifecycle and high value high risk guidelines,* and templates to clarify requirements to quantify, value and reduce carbon emissions. Figure 8 shows the actions required to do this.

Figure 8

Action plan for recommendation 4

As an initial step, for the 2024–25 budget process, business cases should include a descriptive estimate of carbon emissions, assess the impact using the interim carbon value and outline emission reduction options in line with the carbon reduction hierarchy (action 4.1).

The description should include a high-level estimate of scope 1 and scope 2 emissions over the project's lifecycle, and scope 3 emissions where feasible, such as for concrete and steel, in line with Infrastructure Australia's interim guidance.[188] Project teams should use the most appropriate emissions calculation approach for the level of detail available (recommendation 2). Project teams should describe the approach used to complete the estimation.

The description should also apply the carbon value of $123 per tonne (action 3.1) to the emissions estimate to inform strategic decisions.

For emissions estimates that are calculated using the Australian Transport Assessment and Planning Guidelines (ATAP), projects should include a sensitivity test using $123 per tonne. This is consistent with the ATAP guideline which 'recommends that practitioners use a range of values for the $ per tonne of CO2-e via sensitivity testing'.[189]

The government can require business cases to describe projects' alignment with state emissions targets. This can include strategies, initiatives, and design choices that align a project with Victoria's emissions reduction targets (action 4.2).

The government can then require all projects and programs to develop descriptive carbon management plans and consider options to avoid, reduce or offset emissions (action 4.3). Including aspects of emissions management in business case development gives the government a view of the project's impacts and encourages the adoption of early strategies to limit carbon emissions.

In implementation phase 2, for projects and programs that meet the emissions materiality threshold (from action 1.4), the government can require quantitative assessment of carbon emissions over

the lifecycle (action 4.4). This action should happen after the government has developed carbon management guidance (action 1.3), adopted a carbon quantification approach (actions 2.4 and 2.6) and piloted the lifecycle quantification approach (action 2.7).

The government can provide guidance and specify these additional requirements in the *Investment lifecycle and high value high risk guidelines* section 2.6.6 'Environmental impacts'. This will allow for more accurate comparison of emissions impacts between projects that have material carbon impacts.

Projects and programs should also be required to set a minimum carbon reduction target against a baseline (action 4.5). Project proponents can then reduce these emissions, for example, through alternative design and the use of low-carbon materials and construction technologies (such as modular construction). Project teams in procurement and delivery stages should be required to monitor and regularly report on progress toward the target (action 6.3).

Building on this, the government can quantitatively assess the impacts of carbon emissions reduction in individual projects on Victoria's emissions reduction targets (action 4.6). Although the Victorian Government has legislated emission reduction targets, individual projects bear no direct responsibility to contribute to the state's emissions reduction targets. The Victorian Government develops sector pledges every 5 years which outline the actions they will take to cut emissions from each sector and from their own operations to achieve these targets.[190] Projects may not see how their actions to reduce carbon emissions can contribute to a broad sector pledge. Connecting their emissions reduction efforts more clearly can help to drive coordinated action.

As familiarity with carbon emissions reductions evolves, government should require all projects and programs with material emissions to develop quantitative carbon management plans, covering all scopes of emissions across the infrastructure's lifecycle (action 4.7).

Introducing carbon management plans

What are they?

A carbon management plan is a roadmap for managing a project's carbon impacts over its lifecycle. It documents:

- the carbon reduction goals over timelines and milestones
- its strategies for avoiding, reducing, mitigating and offsetting emissions
- the mechanisms for identifying, quantifying, monitoring and reporting emissions
- the roles and responsibilities of parties involved in implementing various carbon reduction measures.[191]

When should a carbon management plan be developed?

Developing a carbon management plan in the early stages of a project's development is a critical component in carbon management standards such as PAS2080. It can provide valuable insights into aspects of the project that has material carbon impacts. It can also allow early consideration of strategies to avoid, reduce, minimise and offset carbon emissions. It is critical that early project optioneering can consider carbon impact.

Carbon management plans may form part of environmental and sustainability management plans.[192]

Over time, the level of detail and comprehensiveness of a project's carbon management plan should be expected to improve as project proponents obtain more information on the project design.

An example of a comprehensive carbon management plan

The United Kingdom's National Highways agency developed an advanced carbon management plan for their A57 Link Roads project in line with the PAS2080.[193] The plan:

- considers the carbon reduction hierarchy and management processes at the preliminary design stage. For example, the plan uses value engineering to explore options to build minimum (the 'build less' principle); the plan then integrates 'build cleverly' and 'build efficiently' principles into the design as the detailed carbon management plan is developed.
- engages all parties involved in the value chain to consider low carbon ideas, including the principal designer and contractor, subcontractors, subconsultants, material suppliers, and National Highways management.
- integrates carbon into cost estimates, and monitors carbon as part of regular cost and performance reporting.

Recommendation 5: Measure carbon in infrastructure cost benefit analysis and make decisions that reduce emissions.

Integrate the measurement and value of carbon emissions into decision-making processes. This means the impacts of carbon are considered alongside other monetised components of a cost benefit analysis.

In Victoria, cost benefit analyses do not consistently or adequately consider carbon emissions.[194] This means infrastructure project business cases do not adequately consider the impacts of carbon emissions on society, the economy and the environment. Projects have little incentive to reduce emissions. Consequently, project teams tend to emphasise reducing financial costs instead of integrating emissions reductions in business cases.

We recommend the Victorian Government measure carbon emissions in infrastructure cost benefit analysis and make decisions that reduce emissions. Figure 9 shows the action required to do this.

Figure 9
Action plan for recommendation 5

This recommendation integrates the carbon management standard (recommendation 1), carbon measurement approach (recommendation 2), and carbon value in business cases (recommendations 3 and 4). Once these practices are established, the Victorian Government should require infrastructure projects and programs with material emission impacts (action 4.3) to value the lifecycle carbon emissions in their cost benefit analyses (action 5.1). This will help to align investment decisions with Victoria's climate change objectives and emissions reduction targets.

At this point of implementation, the projects and programs are required to apply the emissions materiality test established under recommendation 1 (action 1.4), and if they meet the materiality threshold, to measure lifecycle emissions (from action 4.3).

Evaluation guidelines should be incorporated into the *Investment lifecycle and high value high risk guidelines*' *Economic evaluation for business cases.* Projects can initially use interim values to account for carbon emissions in their cost benefit analysis (action 3.2) until the Victorian Government adopts a consistent carbon value for infrastructure projects (action 3.3).

This will help to align investment decisions with Victoria's environmental objectives.

Recommendation 6: Update procurement frameworks and guidance to embed carbon reduction in tenders.

Update Department of Treasury and Finance's *Investment lifecycle and high value high risk guidelines: Procurement* and associated procurement templates to clearly specify the requirements for decarbonisation. Require projects to integrate minimum decarbonisation requirements, communicate carbon reduction expectations and request alternative carbon reduction offers in tender documents.

The Victorian Government has the opportunity to use its purchasing power to set clear signals for industry and business on how it will reduce carbon emissions of the infrastructure it commissions. It can do so by providing clear and consistent guidance on how to reduce emissions through government procurement policy.[195]

Guidance for major infrastructure projects in the Department of Treasury and Finance's *Investment lifecycle and high value high risk guidelines* has no detail about reducing emissions. Instead, emissions reduction is listed with other sustainability and social procurement guidance, diluting the focus on reducing carbon emissions. *Victoria's social procurement framework* mentions climate change policy objectives to minimise greenhouse gas emissions.[196] Evaluation criteria direction and instruction 3.7 advises how to evaluate a tender for government construction projects. It includes 'value for money' and 'occupational health and safety' as mandatory evaluation criteria but does not name climate change or carbon emissions reduction as mandatory.[197]

Stakeholders advise that multiple guidance documents on carbon emissions create increased administrative burden in the public and private sectors. Adopting a carbon management standard like PAS 2080 will clarify the role of individual guidance documents. But most government staff are uncertain about the most effective way to promote carbon reduction through procurement. Even when project teams understand and incorporate these approaches in procurement processes, tender evaluation teams are unsure about how to evaluate proposals that include measures for carbon reduction.[198]

We recommend the Victorian Government update procurement frameworks and guidance to embed carbon reduction in tenders. The government procurement policy should support the industry to make the decarbonisation transition as efficiently as possible. Figure 10 shows the actions required to do this.

Figure 10

Action plan for recommendation 6

The government should immediately review major procurement frameworks and decide how to integrate decarbonisation actions (action 6.1). We recommend updating Department of Treasury and Finance's *Investment lifecycle and high value high risk guidelines: Procurement* guidelines section 3.8. 'Climate Change Act 2017 and related climate change initiatives' and associated procurement templates to clearly specify the decarbonisation requirements.[199] An updated framework used by all government agencies will provide more precise and streamlined guidance compared to a new separate guideline.

We do not recommend updating the *Social Procurement Framework* to include this guidance. This framework is an important component of Victoria's approach to sustainability and fairness in procurement. But including carbon emissions in this framework dilutes other social opportunities while at the same time failing to effectively incorporate emissions reduction in decision-making.

Updating *Investment lifecycle and high value high risk guidelines* should consider (actions 6.2):

- specifying a minimum carbon emission reduction as a tender requirement in procurement
- communicating carbon reduction expectations in tender document templates provided for Victorian Government infrastructure projects
- including carbon emissions in tender evaluation criteria, for example by assessing the relative size of embodied carbon estimates or emissions reduction commitments
- seeking alternative carbon reduction mechanisms in procurement, enabling tenderers to suggest other carbon reduction actions in their tender response (this is also known as a bid-back process)
- offering guidance on how emissions reduction can be achieved in different procurement models.

The example of the 'CO_2 performance ladder' approach in the Netherlands demonstrates how suppliers can be incentivised to reduce emissions.[200]

Netherlands government procurement rewards industry innovation

The Dutch Government requires organisations to reduce their carbon emissions using its procurement policy.

It has introduced a 'CO_2 performance ladder' in its procurement processes. The ladder has 5 levels, each representing a different commitment to reducing carbon. Organisations that achieve a certification at level 1 to 3 commit to reducing emissions in all of their projects. Those certified at level 4 or 5 also strive to reduce emissions in the sector and supply chain.[201]

During the tender process, organisations submit proposals and their current CO_2 performance ladder certification. Organisations with a ladder certification receive a hypothetical discount on their tender price, with higher discounts given to those at higher ladder levels.[202]

The CO_2 performance ladder creates a competitive advantage, incentivising organisations to actively reduce their carbon emissions. If an organisation has both the highest tender price and the highest level on the CO_2 performance ladder, they can still win the contract due to the significant discount offered.

Table 3: fictitious example of contract award with CO_2 ladder

Company	Entry price	Level on CO_2 ladder	Fictitious discount/ award advantage	Fictious rate	Award the contract
A	€ 9.7 million	none	0%	€ 9.7 million	NO
B	€ 10 million	3	4%	€ 9.6 million	NO
C	€ 10.3 million	4	7%	€ 9.58 million	YES: € 10.3 million

The procurement framework should include mandatory carbon reductions from a set baseline (action 6.3). These can then be relied upon in evaluating tender responses and can be incorporated into contracts. Project teams can set the initial carbon baseline using simple metrics like cement and steel volumes that are ordinarily estimated in development of the reference design at business case stage. These estimates can use carbon measurement tools and emissions factors introduced by responding to recommendation 2. The project team should periodically refine reduction targets as the project progresses and more data is available.

Procurement processes can use the published carbon valuation guidance (from action 3.3) to assess and compare the economic return on possible emission reduction actions (action 6.4). This will allow decision-makers to decide whether carbon reduction actions generate a positive economic return. This is particularly relevant when low carbon solutions cost more to the project upfront but may reduce financial costs and risks in the longer term. Decision-makers can use this information to maximise benefits throughout the life of the asset.

Recommendation 7: Update standard form contracts to include carbon reporting, abatement requirements and further reduction opportunities.

Integrate minimum requirements into contracts to set clear expectations for suppliers, ensuring their practices deliver emissions reductions consistent with government decarbonisation commitments. Establish carbon reporting requirements and include

mechanisms for carbon abatement and reduction opportunities within standard form contracts.

Procurement and contracting practices that encourage, enable and require emissions reduction should be complementary and mutually reinforcing. The right contractual terms help ensure the emission reductions agreed to in the procurement process (Recommendation 6) will actually be implemented during delivery of the project and throughout the infrastructure's operating life.

The Victorian Government can provide certainty and set clear expectations for suppliers by including emissions reduction requirements in standard form contracts. Binding contractual mechanisms that mandate emissions reduction across standard form contracts will incentivise suppliers to seek out and implement low carbon methods, materials, and practices. It will stimulate innovation as industry gains clarity on government expectations and commitments.

> "Supporting industry and sending the right signals to support low embodied carbon solutions is an important role for government."
>
> Materials and Embodied Carbon Leaders' Alliance, submission to Infrastructure Victoria

We recommend the Victorian Government update contracts to include minimum carbon reporting and reduction requirements, and incentives for carbon abatement. Figure 11 shows the actions required to do this.

Figure 11
Action plan for recommendation 7

The government can start by designing mechanisms to include carbon abatement in the approved standard form contracts within the Department of Treasury and Finance's suite of commercial deeds, contracts and schedules, such as the *Practitioner's Toolkit*[203], *Ministerial Directions and Instructions for Public Construction Procurement*[204] or other department based approved standard forms (action 7.1).

Standard form contracts should include mechanisms for additional carbon abatement (action 7.1) and minimum carbon reduction requirements (action 7.5). By updating government standard contracts to integrate minimum carbon reduction requirements, the Victorian Government can set

clear expectations for suppliers to reduce carbon emissions. This will drive investment in upskilling and innovation across the sector as participants are clear about the government's expectations. This is consistent with Infrastructure NSW's recommendation in its recent Government discussion paper to update standard contracts to enforce carbon reductions.[205]

Different mechanisms for carbon abatement and reduction can be applied, depending on the capacity and maturity of industry in carbon management and low carbon technologies. Standard form contracts can initially include 'soft' mechanisms to encourage industry to provide their best offers to achieve carbon reduction requirements set by government. Over time, as carbon management and low carbon technologies become widely established across industry, standard form contracts can include 'hard' obligations. The 'hard obligations' will be applicable when there is an established practice in using a consistent carbon quantification approach, and performance in carbon reductions can be reliably monitored.

Mechanism	Early stage application	Mature stage application
A carbon baseline or carbon reduction target set by government	Initially as a part of 'continuous improvement' requirement, to encourage best effort.	'Hard' emission reduction obligations as part of contractor's performance.
Contract variations initiated by suppliers	Not applicable	Suppliers can propose variations to facilitate further emission reductions as new innovations and technologies become available (similar to the 'value engineering variations' mechanism).
Contract variations initiated by government	Not applicable	The supplier is required to comply with increases in emission reduction, in line with government policy objectives, over the life of the project, with relief available via the variation mechanism for time and cost impacts (similar to the 'change in law' mechanism).

Over time as 'hard' obligations on carbon abatement are included in standard form contracts, incentives for contractors who exceed baseline performance should also be included (supplementary action 7.2). For example, this can be done with a gain-share regime where performance is monitored against key performance indicators. Adopting 'hard' obligations will require first adopting a standardised carbon emission approach, so that the carbon calculation in a project's proposal is transparent to both project proponents and the bidders. This can minimise risks of creating inflated baseline estimates in the tender process.

As a more progressive step, suppliers can also be contractually incentivised to monitor carbon emissions throughout a project, based on performance benchmarks as compared to the market. If the contractor generates excess emissions compared to the benchmark in the market, it will trigger the benchmarking mechanism under which the contractor could be required to engage with experts to accelerate emissions reduction measures on the project.[206]

Examples of carbon reductions requirements in contracts

The Chancery Lane Project is a global legal initiative which produces precedent clauses to assist organisations in delivering net zero through contracts. This can serve as a peer-reviewed resource that informs updates to standard Victorian Government contracts. The Chancery Lane Project[207] suggests the following clauses to integrate minimum carbon reduction requirements into standard form contracts:

- The contractor is required to carry out the works so that the carbon budget is not exceeded.
- The contractor is required to provide monthly management information on its ongoing compliance to enable the employer to assess the progress of the works towards meeting the carbon budget and provide input to the contractor on further progress.
- If the carbon budget of the works (excluding changes issued in accordance with clause x) is exceeded due to a breach by the contractor of its obligations under this clause, then liquidated damages at the rate of $[X] per tonne of carbon dioxide equivalent of greenhouse gas over and above the carbon budget, shall be due and payable from the contractor to the employer. To avoid doubt, liquidated damages payable under this clause represent the reasonable commercial concerns of the employer and its costs of offsetting the excess greenhouse gas emissions.

The standard form contract should also require suppliers to develop carbon management plans, which specify how they will manage, measure and deliver on emission reduction requirements under the contract. These requirements will vary depending on the type of project and opportunities for emissions reduction. The contract can initially require suppliers to develop descriptive carbon management plans first, with some measurement and reporting (action 7.3), and then quantitative carbon management plans later for projects and programs with material carbon impacts (action 7.6). While actions 4.3 and 4.7 describe guidance and requirement for carbon management plans, in practice, the parties may be required to meet periodically to discuss carbon reduction measures and opportunities for further abatement.

An important step in driving emissions reduction through contracting is mandating carbon reporting requirements in the approved standard form contracts within the Department of Treasury and Finance's suite of commercial contracts, such as *Practitioner's Toolkit* or other department based approved standard forms (action 7.4). Reporting requirements should embed measures such as:

- embodied and operational carbon throughout the performance of the contract (at intervals as appropriate for the size and duration of the project)
- measures taken to reduce carbon throughout the performance of the contracts (at appropriate intervals)
- performance of the supplier against any carbon reduction targets for the project, summarised within a compliance table showing the status of compliance with the requirements and specified targets
- data to support reporting on carbon and performance against targets
- analysis of trends including actions to be undertaken to improve carbon reduction performance.

Consistent reporting requirements in standard form contracts will necessitate accelerated upskilling across the sector, which is integral to delivering recommendation 2. This is an important incremental step in implementing more ambitious carbon reduction measures as sector capability improves.

We have summarised these proposed contractual reporting and governance measures in Table E-1 of Appendix E. Key considerations for implementing this recommendation 7 are set out in Table E-1 of Appendix E and further detail on suggested contractual mechanisms to deliver emissions reduction is set out in Table E-2 of Appendix E.

Contractual incentives for innovation in carbon reduction

The Chancery Lane Project suggests a specific 'Net zero aligned construction modifications' clause that could provide incentives for contractors to propose innovative approaches that reduce carbon in projects.[208] The contractor will have access to a shared 'gain share' arising from cost savings or other financial incentive from introducing the modification. Such a clause provides that:

- The contractor may propose a net zero modification to the works, by giving a written notice (the net zero modification proposal) to the principal and superintendent, setting out:

  (a) the proposed net zero modification

  (b) the reason for the proposed net zero modification, including how the net zero modification will assist in delivering the net zero objectives or, alternatively, how the net zero modification will improve the [carbon footprint/ carbon intensity] of the [project/ asset]

  (c) the time within, and the manner in which, the contractor proposes to implement the proposed net zero modification

  (d) the effect the proposed net zero modification will have on the construction program (including any extension of time required to the date for practical completion

  (e) any approvals required to implement the proposed net zero modification, and the effect of the proposed net zero modification on any existing approvals

  (f) the effect the proposed net zero modification will have on the contractor's ability to satisfy its obligations under the contract

  (g) the financial impact on the employer arising from the net zero modification, including but not limited to: cost savings or increases to the [contract sum]; costs savings to the ongoing operation and maintenance of the completed [project/ asset] (including reduced energy costs arising from the net zero modification); reduced [costs of GHG Emissions obligations/ offsets and carbon price etc]; reduced financing costs of the project, and

  (h) any other relevant information reasonably required by the employer to assess the proposed net zero modification.

Recommendation 8: Establish carbon management prequalification requirements for government contracts.

Establish requirements ensuring that contractors possess the necessary experience, knowledge, and commitment to decarbonisation.

The Victorian Government already has prequalification requirements for suppliers involved in construction works. It is a key mechanism designed to streamline public construction procurement.[209] These requirements mean suppliers must adhere to the Victorian Government supplier code of conduct. This code focuses on ethical standards, including for health and safety, and labour rights. It includes general expectations for suppliers to minimise their environmental

impact, such as by maintaining policies and practices that reduce carbon emissions and the risk of pollution, and for the efficient use of energy and natural resources.[210]

Setting pre-qualification requirements for government contracts for decarbonisation requires careful design, including developing supporting technical standards and specifications, training for contractors, processes to assess supplier capacity, capacity, and contractor behaviour. Setting clear prequalification requirements is an effective way to streamline government procurement processes and help the market consistently work towards lowering carbon emissions in Victorian Government infrastructure projects.

The government can determine the suitability of suppliers based on specific criteria related to decarbonisation. Suitable contractors would possess sufficient experience, knowledge and commitment to decarbonise infrastructure projects.[211] It can set prequalification requirements in contracts based on this suitability, before engaging a supplier in a project.

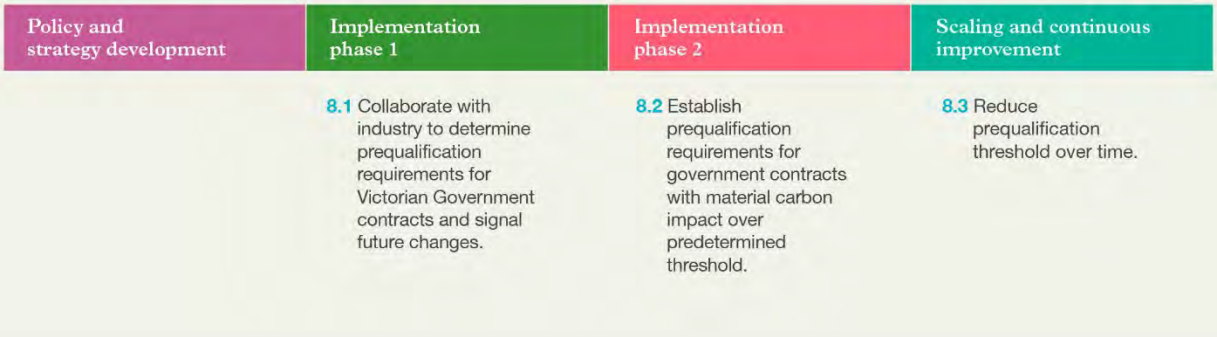
For example, the United Kingdom Government only accepts bids from suppliers who commit to achieving net zero by 2050, for government contracts worth over £5 million a year (around AUD$9 million).[212] Successful businesses detail their emissions in a carbon reduction plan, which lists their emissions sources and their current or planned environmental management measures.[213]

Prequalification requirements for Victorian suppliers could include:[214]

- demonstrating a commitment to reducing carbon emissions on infrastructure projects in line with Victoria's emissions targets
- possessing relevant experience in implementing low-carbon technologies and practices
- submitting a carbon reduction plan outlining the supplier's approach to decarbonisation and their emissions reduction targets (which should align with standard form contract requirements as outlined in recommendation 7)
- employing a dedicated sustainability or carbon reduction team or expert
- setting an organisational emission reduction target and creating a credible climate transition plan.

We recommend the Victorian Government establish carbon prequalification requirements for government contracts. Figure 12 shows the actions required to do this.

Figure 12
Action plan for recommendation 8



The Victorian Government should consult with industry to inform proposed decarbonisation prequalification requirements for government projects (action 8.1). This will create a shared expectation of the experience, knowledge and commitment to decarbonisation required for government contracts. Signalling future changes gives suppliers time to adapt and prepare for any new requirements.

The United Kingdom' prequalification requirement applies to government contracts exceeding GBP£5 million annually. In Victoria, prequalification requirements could apply only to projects of significant carbon impact such as high value high risk projects with capital investments over $10 million initially (action 8.2). Over time, prequalification can be extended to projects of all sizes as systems and processes are established (action 8.3).

Recommendation 9: Support industry to develop zero or low emissions solutions by testing alternative materials and adopting performance-based standards.

Drive demand by using infrastructure projects to motivate industry stakeholders to invest in producing and improving use of sustainable materials and practices. The Victorian Government can help to lower the barriers to adoption of alternative materials by testing and piloting materials. Collaborate with industry to update standards and specifications in support of low carbon materials across infrastructure projects.

Some materials, like cement and steel, create a high level of emissions that are hard to reduce. Before low carbon options for these materials become commercially viable, using alternative materials can be more expensive.[215] Developing a new product requires significant investment from industry, which is where government can support the industry's innovation and market transition. Government support will also help with rigorous testing and widespread acceptance of the new materials.

The Australian construction material industry is worth over $65 billion per year.[216] More infrastructure projects in other states are demanding low carbon and recycled materials.[217] For example, WestConnex is a 33 km motorway network that focused on reducing the embodied carbon in materials. The project team replaced 32% of the Portland cement they needed with cementitious alternatives, such as waste fly ash from power generation, to reduce the concrete's embodied carbon emissions. This approach reduced carbon emissions during construction and operation of the tunnels by around 400,000 tonnes or 28% of forecast emissions throughout the project lifecycle.[218]

Industry stakeholders told us that current government procurement practices tend to lock out innovative low carbon approaches. Projects prescribe materials and design specifications, rather than performance outcomes.[219] Prescriptive government specifications and standards can unnecessarily prohibit the use of low carbon materials and practices.

The Victorian Government is currently reviewing the approach to standards in Victoria. Acciona, a global engineering and construction firm, report in their submission to this review that many projects are using the Australian standard for bridge structures (AS5100) to construct underground structures, tunnels and rail viaducts. Using this standard rather than other standards for specific elements like concrete structures (AS3600) requires designers to interpret how to apply the standard in this context, and can lead to conservative design choices. Acciona estimates that materials and costs could be reduced by 10% to 20% if suppliers could nominate suitable standards.[220] Less material usually equals lower carbon emissions.

Industry stakeholders we spoke to also expressed their preference for performance-based standards. They told us that projects often include their preferred standards and specific materials requirements in tender documentation. This constrains the ability of suppliers to suggest alternative standards or materials and risk their bid being non-compliant. Acciona estimates that a performance-based procurement approach could lead to a 10% to 25% reduction in materials for temporary structures and a 5% to 15% reduction in materials for permanent structures. It could also create cost and time savings.[221]

Another challenge is that new materials and practices have a brief performance history, meaning they face challenges in demonstrating long-term performance or may not have been considered when writing specifications and standards.[222]

Projects with short timelines can find it challenging to test and pilot new materials. Stakeholders report that approving new materials for infrastructure projects takes a long time. When suppliers bid on projects, they may propose innovations in low carbon materials. But securing necessary approvals for these materials may take longer than the time available for a supplier to begin construction. It can also be time-consuming to achieve consensus on using new materials among different infrastructure project professionals such as designers, engineers, contractors, and asset owners. Project teams can engage in early and structured collaboration with industry to identify opportunities to use low carbon materials initiate requests for approvals to use these to eliminate schedule risks.[223]

Industry must navigate the profusion of different regulations and requirements in different jurisdictions to secure approval to use new low carbon materials and practices. This adds complexity and increases compliance costs for industry.[224]

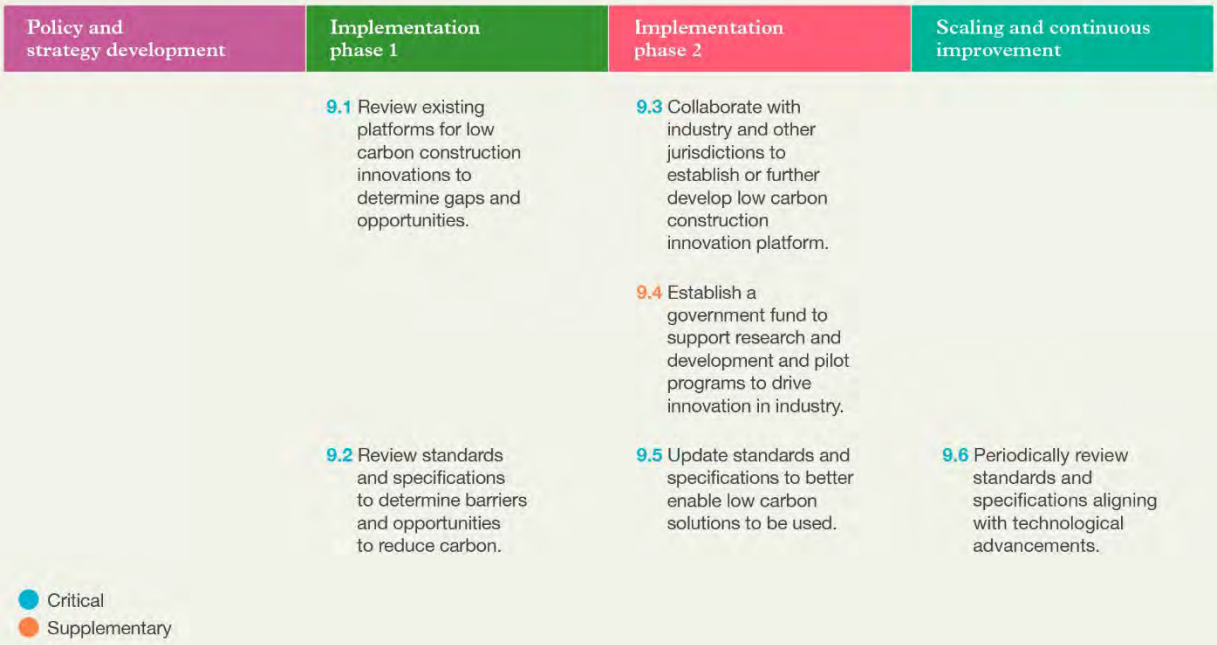
The Victorian Government can stimulate demand for sustainable materials and practices by using the purchasing power of its large infrastructure pipeline. This can motivate industry stakeholders to invest in producing, using and devising better sustainable materials. Building demand for low carbon materials can generate economies of scale, which drive down their cost and make contractors more familiar with using alternative materials and construction techniques.

Emerging materials with lower carbon profiles can be more expensive than conventional materials. However, projects that use a carbon value in cost benefit analysis and use performance-based standards may use less materials and therefore low carbon materials can still be cheaper overall for the project. The Victorian Government can also encourage the use of lower carbon materials by supporting further research and development, which helps make them more affordable, accessible and financially feasible. This will further boost their market demand.

We recommend the Victorian Government support decarbonisation innovation across industry by testing new materials and adopting performance-based standards. Figure 13 shows the actions required to do this.

Figure 13

Action plan for recommendation 9



The government can begin implementing this recommendation by reviewing existing sharing platforms for low carbon construction innovations (action 9.1). It can also establish or further develop a low carbon materials register in collaboration with industry and other governments (action 9.3).

Creating a sharing platform for low carbon solutions encourages the transfer of knowledge between different firms in the supply chain. Both EcologiQ and the Materials and Embodied Carbon Leaders' Alliance platforms have strengths and limitations. The EcologiQ platform is currently focused on the building industry's practices in recycled materials. It is limited to users within Victoria. The Materials and Embodied Carbon Leaders' Alliance is an industry-led platform driving knowledge sharing of low-carbon materials Australia-wide. With appropriate funding, governance and reporting arrangements, the Victorian Government could leverage either of these platforms to help facilitate knowledge sharing and speed up dissemination of low carbon construction practices.

The Materials and Embodied Carbon Leaders' Alliance (MECLA)

As a not-for-profit organisation funded by the New South Wales Government and Government of South Australia, MECLA provides resources and case studies for industry stakeholders looking to adopt sustainable practices in their projects. Their website provides:[225]

- information on sustainable materials and their specifications
- industry-led research for materials, such as steel, cement and aluminium
- case studies demonstrating the implementation of low-emission construction practices across different sectors and project types.

The government should then extend the Office of Project Victoria's review of current standards and specifications to identify any barriers and opportunities they impose on using low carbon materials (action 9.2). Using this review's findings, the government can change the standards and specifications, or the approach to defining or making exceptions to standards, to allow more low carbon solutions to comply (action 9.5). The Victorian Government can test and pilot low carbon materials in infrastructure projects to lower the barriers to their uptake. This can take time. Project teams often cannot test these new materials in the required decision timeframes. Even if they do, they may not make their insights available to other projects, which a sharing platform can support. Government should periodically review standards and specification to align with technological advancements (action 9.6).

The Victorian Government can also engage with industry and other governments to improve and align standards and specifications for low carbon solutions with current best practices. For example, Transport for New South Wales is set to develop a *Zero carbon materials innovation program* in 2024, which aims to fast-track research, develop updates to standards and specifications and broaden uptake of low carbon materials in procurement.[226]

Austroads provides a national example of aligning standards. Austroads develops and updates technical guides and tools to promote a consistent approach to the design, maintenance and operation of road networks in Australia and New Zealand. Austroads' technical specifications are a comprehensive set of best-practice construction guidelines for roads and bridges.[227] The specifications aim to consider reusing materials, reducing emissions and mitigating the impacts of climate change.[228] For example, Austroads technical specification ATS 3050 sets out the minimum requirements for manufacturing and supplying recycled crushed glass for pavements.[229]

The Victorian Government can leverage current resources with EcologiQ's work for recycled materials. EcologiQ collaborates with the industry to develop reference guides that show designers, contractors, and infrastructure asset owners how to use recycled materials in line with existing design and construction standards.[230]

The Victorian Government can invest in research and development to support introducing new materials into the construction sector. The government could consider a dedicated fund to support research, development, and pilot programs for low carbon construction materials and techniques (supplementary action 9.4). For example, it could build on the existing $7 million *Low carbon manufacturing grant* program. However, this funding is relatively small when compared to other jurisdictions like New South Wales, which has a $300 million fund for developing and manufacturing low carbon products and materials.[231]

Recommendation 10: Update assurance processes to include carbon emissions.

Update project assurance checks in Department of Treasury and Finance's *High value high risk framework* to incorporate the changes introduced in recommendations 1 to 9 to require carbon emissions to be reported and managed in benefit management plans. Assurance checks are carried out by experts external to the project to review plans and progress at important decision points.

Governments use established processes and systems to ensure that solutions achieve their intended purpose. A good project assurance process, aligned with common project management principles, involves clear objectives, detailed planning, efficient execution, ongoing monitoring and successful closing. It integrates effective management of scope, time, cost, quality, resources, risk, and communication, ensuring stakeholder alignment and project success.[232]

Experts outside government carry out assurance checks to review complex projects at important decision points.[233] Including carbon emissions in assurance processes makes infrastructure

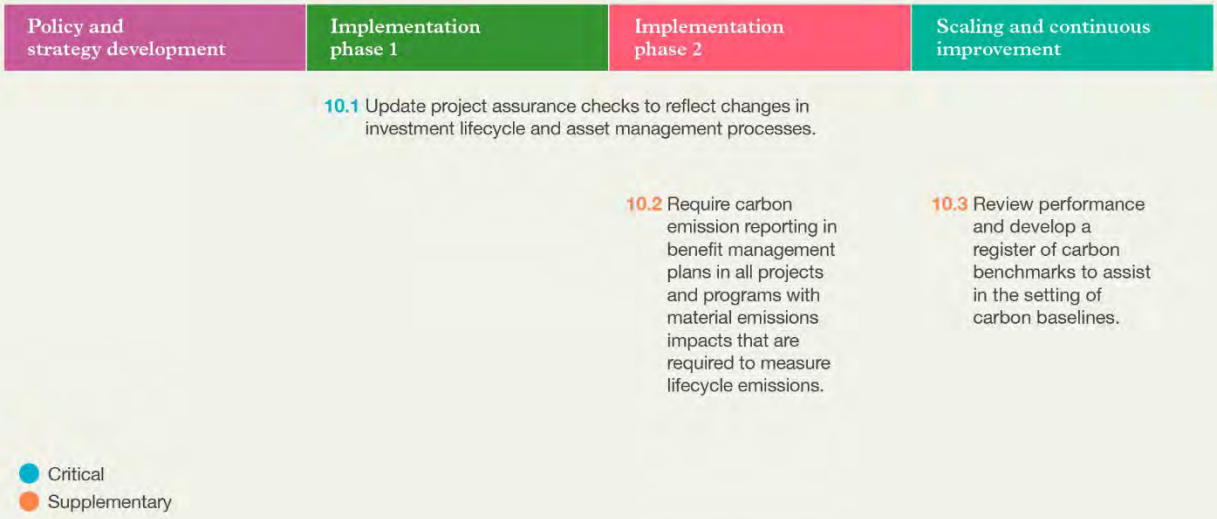
investment decisions more transparent and accountable. A model for good benefit management includes:[234]

- clearly defining objectives, outcomes, benefits and measures
- assessing the quality and consistency of a benefit management process to understand, plan, manage and report and evaluate benefits throughout a project's lifecycle.

By improving assurance processes, the government can effectively monitor their carbon emissions reduction actions, evaluate the benefits of emissions reduction and enhance overall accountability and transparency in reducing carbon emissions.[235]

We recommend the Victorian Government update assurance processes to consider carbon emission reductions. Figure 14 shows the actions required to do this.

Figure 14
Action plan for recommendation 10



To ensure carbon impacts are identified, quantified, managed and reported in infrastructure's lifecycle, carbon emission requirements should be clearly delineated from other sustainability requirements. The Victorian Government should update project assurance checks in existing business case and procurement frameworks, guides and templates to reflect the changes in recommendations 1 to 9. This should include updating asset management processes such as the *Gateway review* process and asset management responsibilities such as the *Asset management accountability framework* and individual project assurance review guidance (action 10.1).

Strengthening assurance processes should also require benefit management plans to report on and track carbon emissions (supplementary action 10.2). The Victorian Government should update the *Investment management standard to* require that carbon emission reduction be considered as part of benefit management plans.

Similar to developing carbon management plans (actions 4.3 and 4.7), the level of details and completeness of the assurance process is expected to mature over time, commensurate with project's materiality and with the public sector's capability in carbon quantification. The supplementary action 10.2 should also leverage the digital data collection as part of action 2.5.

Reviewing completed projects and gathering feedback on contractor performance can produce valuable information for future projects (supplementary action 10.3). It can improve estimates of embodied emissions and support the creation of consistent carbon footprint models. The government can use historical data to make informed decisions and establish reliable benchmarks for carbon emissions reductions.

Timing and implementation considerations

The Victorian Government must decide on the preferred timing to decarbonise infrastructure

Confirming its commitment and establishing clear timelines will be important as the Victorian Government works to decarbonise its infrastructure. By setting priorities and expectations, all stakeholders can focus their efforts on the most impactful measures and ensure that progress is made at an appropriate pace.

We identified 3 potential pathways to support decarbonisation of public infrastructure – leading, measured and lagging – each with varying timeframes for implementation and delivery.[236] The sequencing of recommendations and actions identified earlier in this advice is consistent across all 3 pathways.

While the Victorian Government needs to consider the recommendations in this advice from Infrastructure Victoria, other jurisdictions are already progressing quickly. Infrastructure New South Wales has already released guiding principles and timelines for action on decarbonisation, as well as a policy roadmap setting out detailed actions the government will complete by 2026.[237] New guidance has been issued by the New South Wales Department of Finance, and efforts are underway to adopt new carbon management guidance soon. Commonwealth Government agencies are also undertaking similar work. Australian Transport and Infrastructure Ministers have agreed that progressing decarbonisation is a priority.

Infrastructure Victoria recommends government adopt timing that is aligned with other jurisdictions

Aligning the timing of Victoria's approach with other jurisdictions offers the greatest potential to proactively reduce emissions. The proposed timing will allow Victoria to catch up with, and then progress at the same pace as, other jurisdictions.

This approach proposes that key decisions in the policy and strategy development phase to be completed within 6 to 12 months of receipt of this advice. Implementation stage 1 would follow within 18 months, with a stage 2 of up to 24 months before moving to a steady state within 4 years of this advice.

This approach allows Victoria to align its efforts with other leading jurisdictions and best responds to current and pressing issues identified by both government and industry stakeholders. However, it requires strong commitment and swift decision-making by government.

The timing and phases for implementing our recommendations aim to achieve the best long-term outcomes while minimising transitional costs for the government, industry, and the community.

The scale of decarbonising Victoria's economy, including in the infrastructure sector, requires immediate and sustained action to be able to meet Victoria's net zero emission targets by 2045.

Our research demonstrates that reducing carbon emissions from infrastructure can expedite infrastructure delivery and save cost through design and material innovation. Victoria can benefit from the increased demand for low carbon materials and technologies, which would stimulate the development of new markets, foster the growth of new skills and capabilities, and create job opportunities.

However, if the Victorian Government fails to take swift action, it may fall behind in reducing emissions, resulting in infrastructure that is more expensive and less productive as well as missed chances to have a dynamic low carbon economy.

Work is already underway in other Australian jurisdictions, such as:

- the South Australian Government released the *Sustainable procurement policy* incorporating an embodied carbon target as a minimum tender requirement for government work in August 2023.[238]
- the Queensland Government is developing a carbon budget and refining strategies for a climate positive and sustainable Olympic and Paralympic Games in 2032.[239]
- Infrastructure Australia's final guidance on decarbonising infrastructure is anticipated in 2024.
- Infrastructure New South Wales and Transport for New South Wales are addressing key activities and milestones from the decarbonising infrastructure delivery roadmap for 2023 to 2026.[240]
- The New South Wales Government, Australian Government, and industry bodies such as the Materials and Embodied Carbon Leaders' Alliance are currently reviewing carbon quantification and management standards, with PAS 2080 as a leading candidate for adoption.
- state and national infrastructure ministers initiated a Decarbonisation of Transport Working Group in June 2023, with the next meeting scheduled for December 2023.[241]
- the Australian Accounting Standards Board plans to hold a consultation on climate disclosure standards by the end of 2023.[242]

We recommend the Victorian Government initiate clear and quick actions to catch up to and align better practices with other jurisdictions.

Victoria can learn from New South Wales' decarbonising infrastructure roadmap

The New South Wales *Decarbonising infrastructure delivery roadmap* sets out the key initiatives from 2023 to 2026 to decarbonising infrastructure delivery.[243] It follows the discussion paper *Decarbonising infrastructure delivery*.[244]

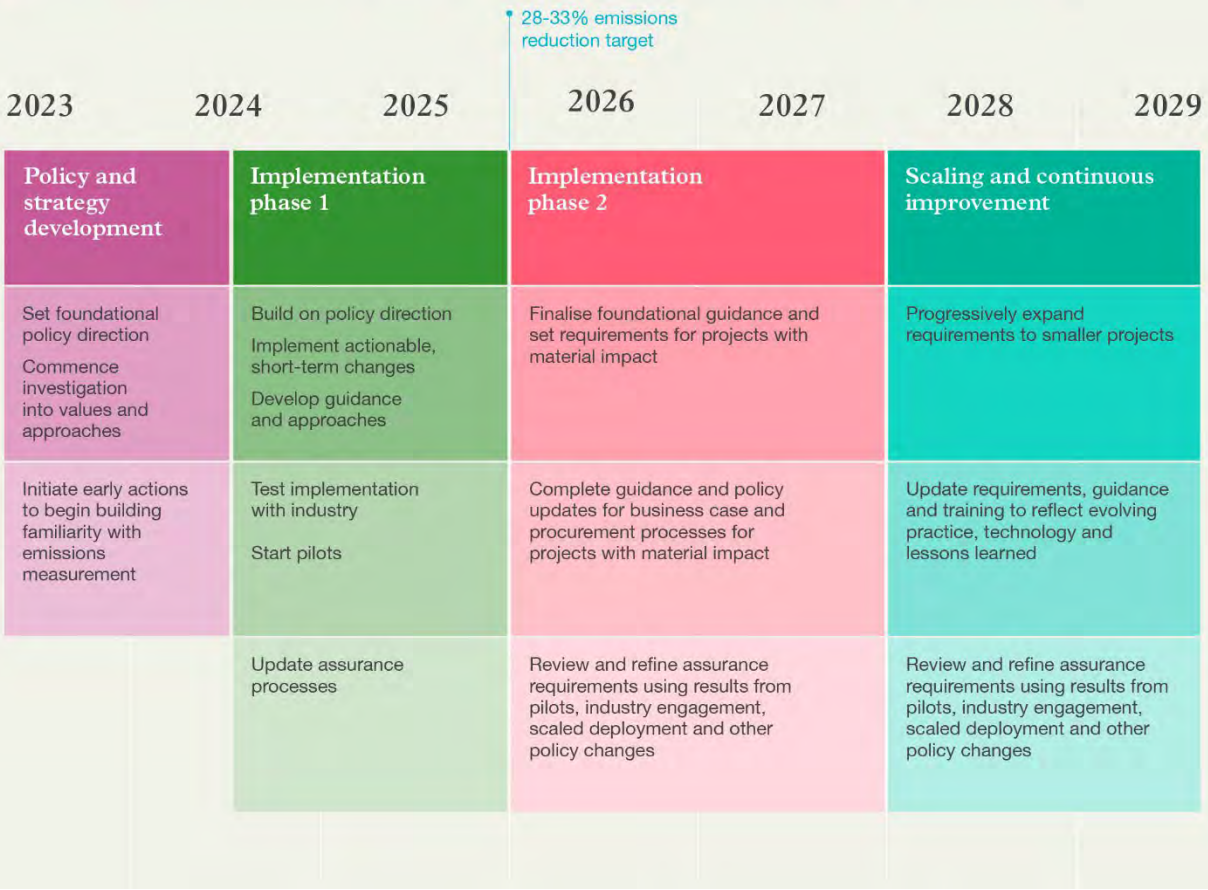
Prepared by Transport for New South Wales (TfNSW) and Infrastructure New South Wales it contains the activities and milestones for reducing embodied emissions in New South Wales.[245]

Examples of key activities and milestones include:[246]

- implement a sustainable procurement framework including minimum emissions reduction target incorporating embodied emissions across TfNSW major projects in 2023
- establish carbon measurement guidance for all government infrastructure in 2023
- introduce whole-of-life carbon estimates into TfNSW strategic decision-making and optioneering phases in 2024
- develop consistent carbon footprint models by asset type that use historical data to inform early decision-making in 2024
- implement a certified carbon management system by TfNSW in 2025
- introduce incentives for low carbon TfNSW projects in 2025
- establish a certified carbon management system in 2026.

The leading pathway entails an implementation plan from 2023 to 2027. Figure 15 illustrates the timeline for implementing our recommendations for infrastructure decarbonisation.

Figure 15
Proposed implementation timeframe towards infrastructure decarbonisation



Guidance for projects already underway

This advice focuses largely on projects that are in early decision-making stages. But it is not too late for the Victorian Government to apply some of these recommendations to projects already in delivery.

Significant amounts of materials, valued at $75 billion,[247] will be consumed in the existing five-year infrastructure pipeline, offering ample opportunities to consider carbon reductions in procurement and construction phases. Of these materials, steel and concrete account for 34% and 33%, respectively,[248] and their production accounts for over 50% of all industrial emissions globally.[249] Seeking to identify opportunities in construction and operation stages of these infrastructure projects would help reduce the risks of 'locking in' significant emissions for infrastructure built in the coming decade.

Project teams should use the emissions materiality test (action 1.4) to evaluate their carbon emissions reduction potential. Where possible, they can use digital engineering tools to identify opportunities to reduce carbon in their designs (action 2.5).

The government can also require projects to identify opportunities to introduce alternative materials by using set carbon values (action 3.1) in their evaluation of materials choices at key decision points. Testing and piloting materials and reforming standards review processes (recommendation 9) can benefit existing projects. In some cases, introducing incentives for decarbonisation innovations within existing contracts may be suitable (recommendation 7).

But more than any specific recommendation, the Victorian Government's clear and firm commitment to decarbonising infrastructure will set an example for projects to follow. Projects can work with existing contractors to identify opportunities to decarbonise proactively if they understand that this is the government's direction.

Decarbonisation creates costs and benefits for stakeholders across the supply chain

Industry stakeholders told us they are ready to increase their efforts to reduce carbon emissions in government infrastructure projects.

Reducing carbon emissions can reduce costs and improve productivity, especially if a lifecycle carbon management approach, such as PAS 2080, is used. There may be a tipping point between cost reduction and carbon reduction when the supply and demand for low carbon materials are out of balance. If the supply of low carbon or 'green' materials are not available at the scale required, decarbonisation efforts may come with rising costs. This further points to the need to act across the supply chain.

Meeting new carbon management requirements is likely to add costs for government and industry before systems and processes are embedded.

Costs may be incurred as part of:

- developing standards and carbon management plans, which involves setting up datasets and tools and ongoing maintenance
- any incentives that the government makes to promote low carbon materials and construction methods
- identifying, developing and conducting new training needed to upskill both government and industry, and knowledge sharing through open and accessible platforms.

The actual cost impact is likely to vary across the supply chain, with government and large industry players absorbing the upfront investments in establishing datasets tools, guidelines, and capability building, but also sharing in the benefits of early gains in driving decarbonisation outcomes.

A key consideration is how to reduce the cost impact on infrastructure delivery associated with low carbon materials and construction methods. Industry stakeholders note that low carbon materials:

- may not be available at competitive prices while quantities are low
- require trials and testing before they can be accepted as business-as-usual, which typically needs approvals at various governance levels and can be time-consuming
- may behave differently than high carbon alternatives which means training and upskilling is required to facilitate their wider use.

These cost factors are similar to the use of recycled materials in Victorian major projects. The Victorian Government has achieved substantial progress in this area by setting clear policy direction and developing a responsive procurement approach. EcologiQ facilitates testing of new recycled materials in major projects and builds capacity through conferences, case studies and an open-sourced supplier register.

Several actions can help reduce the cost impacts of decarbonisation:

- establish a Victorian Government community of practice on decarbonisation of infrastructure to facilitate knowledge-sharing and collaboration (supplementary action 2.3)
- identify areas for improvement and collaboration (action 9.1)

- apply a materiality threshold to focus on projects with the greatest carbon reduction impacts. Early decarbonisation requirements will initially affect larger firms, reducing unnecessary compliance costs on both the government and smaller businesses (actions 1.4, 1.5, 4.4, 4.7).

Achieving equitable distribution of costs and benefits across the infrastructure supply chain

Industry stakeholders indicated that larger suppliers are likely to lead the supply chain in innovations in low carbon solutions. With more resources and capability to invest in research and development, they tend to be better positioned to respond to government's decarbonisation requirements.

Industry stakeholders expressed concern that smaller players will likely miss out on the opportunity from government projects in the transition to decarbonisation. This may be problematic for small suppliers in rural and regional areas, particularly when low carbon materials may be difficult to source at affordable costs.

There is a broader economic interest for the Victorian Government to enable suppliers of all sizes and capabilities to compete freely in the market. The government should aim to remove market entry barriers to get the best outcomes from genuine competition.

To minimise the likely adverse effect on smaller players or players in remote areas, we recommend the Victorian Government consider capability building, gradual and specific requirements targeting smaller players and provide additional incentives to support smaller players.

Our recommendations are structured so that certain actions first apply to larger projects and programs through a materiality test to focus on projects of high impact (action 1.4). As both government and industry improve capability to embed emissions reduction, we recommend progressively lower thresholds to apply to smaller projects and programs (actions 1.5 and 8.3).

When determining how and when to lower thresholds, we recommend government agencies collaborate closely with industry to:

- avoid imposing unnecessary administrative burdens on smaller projects
- build capacity together to help smaller players compete in the low carbon economy
- provide time and financial incentives to support smaller players.

We recommend the government consider a range of incentives, such as monetary rewards, funding of innovation or research and development initiatives, contract extensions, or preferential treatment in future procurement processes (supplementary action 7.2). These incentives should encourage suppliers to continuously enhance their whole-of-life sustainability performance.

Continue measuring progress to decarbonise infrastructure

This advice offers principles, recommendations and actions the Victorian Government can adopt to step up the transition to net zero across the lifecycle of new infrastructure projects.

More work is needed to quantify the potential costs and benefits of reducing the greenhouse gas emissions of future public infrastructure investments.

As of August 2023, Infrastructure Australia is developing research to estimate the embodied carbon intensity of Australia's buildings and infrastructure pipelines from 2022–23 to 2026–27. It will assess the potential emissions savings from substituting low emissions building materials into these projects, including from Victoria. The work may help quantify the amount of embodied carbon in Victoria's infrastructure pipeline and identify opportunities for reducing emissions under different scenarios. The work is expected to be published late 2023.

Determining the amount of carbon emissions embodied within the existing infrastructure pipeline is important for tracking emissions in Victoria and assessing progress. Adopting a similar standardised framework or tool as undertaken by Infrastructure Australia can help to consistently measure emissions. This approach can help identify hard-to-abate sectors and projects that may have limited emissions reduction capacity, as well as sectors and projects that are comparatively easier to address. By gaining a better understanding of the infrastructure sector's emissions, focused efforts can be directed towards low carbon, recycled and re-used construction materials.

Appendices

Appendix A: Stakeholder engagement summary

Our stakeholder engagement helped us develop our advice and refine our recommendations. We would like to thank all organisations that engaged with us during the development of this advice.

We had discussions with stakeholders throughout the formulation of our advice and held an open submissions process. We also held 6 interviews with Victorian Government stakeholders and 4 workshops with government and industry stakeholders.

Discussions

During the development of our advice, we had discussions with:

- BIS Oxford Economics
- Department of Energy, Environment and Climate Action (DEECA)
- Department of Treasury and Finance
- Climateworks Centre
- Infrastructure Australia
- Infrastructure Sustainability Council
- Melbourne Water
- Nation Partners
- Office of Projects Victoria
- Rail Projects Victoria
- Sustainability Victoria
- Transport for New South Wales
- Yarra Valley Water.

Interviews and workshops

We consulted with Victorian Government and industry stakeholders through 6 interviews and 4 workshops. These stakeholders are listed below.

Table A-1: Overview of Victorian Government and industry stakeholders

Victorian Government	
Department of Education	Department of Treasury and Finance
Department of Energy, Environment and Climate Action	Development Victoria
Department of Health	EcologiQ
Department of Justice and Community Safety	Major Transport Infrastructure Authority
Department of Premier and Cabinet	Office of Projects Victoria
	Victorian Health Building Authority

Department of Transport and Planning	Victorian School Building Authority

Industry

Acciona	Engineers Australia
Australasian Procurement and Construction Council	Green Building Council of Australia
Arcadis	Infrastructure Partnerships Australia
Arup	Infrastructure Sustainability Council
Aurecon	Jacobs
Australian Constructors Association	John Holland
Australian Flexible Pavement Association	KPMG
Australian Steel Institute	Laing O'Rourke
Business Council of Australia	Lendlease
Civil Contractors Federation Victoria	Materials and Embodied Carbon L'aders' Alliance
Cement Concrete and Aggregates Australia	Mott MacDonald
Climateworks Centre	Royal Institution of Chartered Surveyors
Consult Australia	Slattery
CPB Contractors	Transurban
Deloitte	Victorian Chamber of Commerce and Industry

Public submissions

We held a public submission process to help inform our advice. Submissions were open from 14 April 2023 to 14 May 2023.

Those who consented to their submission being published are listed below:

- Australian Steel Institute, in conjunction with BlueScope Steel and InfraBuild Steel
- Cement, Concrete and Aggregates Australia
- Cement Industry Federation
- Engineers Australia
- Green Building Council Australia
- Materials and Embodied Carbon Leaders' Alliance.

A summary of the submissions we received can be found in Appendix B. If we were given permission to do so, the submissions we received have also been published and can be found at our website.

Appendix B: Submissions summary

Infrastructure Victoria received 14 public submissions in relation to the Victorian Government's opportunities to reduce the greenhouse gas emissions of future public infrastructure investments. Of these 14 submissions 8 came from peak bodies and industry groups in fields such as construction and transport. A further 3 were from private companies involved in infrastructure development, the remaining three submissions were from a government organisation, an advocacy group, and a private individual. We would like to thank all organisations that engaged with us and provide submissions during the development of this advice.

Table B-1: Summary of submissions

Theme	Summary
Leadership	The Victorian Government has a leadership role in commissioning large-scale construction projects. Supporting industry and sending the right signals to support low embodied carbon solutions is an important role for government. The lack of whole-of-government action is a barrier to meeting its own stated policy goals. Government engagement with industry is an opportunity to develop and communicate policy intent, collaboratively design technical guidance, and apply carbon targets in early project phases. Public procurement can play a key leadership role here given public investment provides a major part of infrastructure spending.
Confirm commitment	The Victorian Government should align decarbonisation commitments with the existing Climate Change Pledge and Adaptation Plan. A new infrastructure emission reductions pledge could set targets, timelines and specify when net zero carbon will become mandatory in infrastructure. The government could also encourage industry pledges and self-monitored targets to create industry-wide commitment to decarbonisation.
Aligning practices	Most submissions from national and international organisations' recommend that policies and regulations align with national and global standards to reduce the cost burden of compliance across multiple contexts. However, some noted harmonised standards risk failing to account for Victoria's unique needs and context.
Circular economy (Whole-of-life)	The Victorian Government can reward and incentivise circular economy principles. Circular economy practices are the most effective pathway to reduce material-related emissions. Circular economy policies should include goals and incentives for reduced consumption of materials. These could be achieved with a 'Reduce First Policy' rather than the 'Recycle First Policy'. The government can prioritise non-build options and give greater consideration…to opportunities that reuse and repurpose existing infrastructure…Mitigating the need for new infrastructure builds is paramount. Victorian Government procurement and cost benefit analysis needs to consider the whole-of-life cost of decarbonisation. Procurements systems could accept higher upfront costs to achieve long term reduced emissions.

	The government can consider increasing project budgets to factor in the costs of innovative decarbonisation solutions. But accounting for lower carbon materials at the procurement stage can also reduce contractors' expenses. The government can build on the Australian Government's circular economy incentives such as the Recycling Modernisation Fund. It can also draw on interstate frameworks such as the South Australian Government's current circular economy work.
Pre-planning and whole of project planning	The Victorian Government can begin pre-planning for carbon risks and opportunities at the strategic planning stage of projects. Pre-planning and design phases can consider sustainable materials and techniques, providing sufficient lead time for delivery. This is an effective and cost-effective opportunity. The absence of sustainability considerations in current planning for road contracts is a barrier "preventing the realisation of sustainability initiatives across many forms of procurement and transport modes". Successful delivery is also more likely if the private sector is engaged in early project conception and pre-design. A lack of industry engagement in pre-planning and restrictive government standards or building specifications can constrain innovation. Interactive sessions during tender processes can help government and industry to work through sustainable and innovative modifications.
Clarity and consistency	Clear and consistent frameworks to quantify and monitor decarbonisation are important: "Provision of frameworks, tools and training could empower or incentivise planners to consider carbon in the early stage". Well-defined frameworks, tools, and training can incentivise private organisations and help them demonstrate they are meeting policy objectives. Consistent reporting standards can include shared data collection and auditing requirements, defined metrics and centralised data. Government tenders could include a pre-requisite for contractors to have their own decarbonisation pledge with published targets: "By being in the public realm…the head contractor is motivated to provide a credible and robust target and verifiable progress against it". Improved measurement and low carbon infrastructure key performance indicators could show the potential cost effectiveness of sustainable materials and encourage their adoption in private development.
Standards and specifications	The Victorian Government could publish low carbon emission project approvals and materials. This public knowledge sharing could encourage private industry to replicate innovative solutions and reduce the effort required to access information. Regulation and government procurement policies can "hinder the optimal use" of sustainable alternatives and make Victoria a more challenging development context. Overly restrictive targets can have unintended consequences such as an increased demand for imported rather than locally produced recycled steel. In high-cost contexts, the government could require contractors to identify their own alternative lower carbon materials. This may be more effective than targets. Performance-based specifications are another option.
Training and capacity building	Higher demand for decarbonisation will impact costs and industry capacity. The lack of industry capability, available information, skills and resources could be a

	barrier to wide-scale decarbonisation. The Victorian Government can support and drive market readiness through professional development and training.
Cost of decarbonisation	Cost effective solutions for reduced embodied carbon in infrastructure already exist. The Victorian Government can support research and awareness to improve quality and access to existing reduced carbon products. However, “the availability of low carbon products and services is limited in the Victorian region and the majority of low carbon products and services available comes at an extra CapEx cost." The government can consider ways to support the “supply-side issue of these products and services” in anticipation of increased demand and to reduce costs.
Incentives	Financial incentives such as tax relief and rebates are potential tools for collaboration and innovation. The Victorian Government can encourage best practice examples through awards. The government can use its purchasing power as an incentive for locally produced sustainable products.

Appendix C: Victorian policy and guidelines on carbon emissions

Key policies and guidelines

Multiple guidelines, policies and processes concerning investment decision-making, procurement and sustainability exist, see Table C-1. Our advice looks to expand and improve on these where appropriate.

Table C-1: Existing investment guidelines, policies and processes

Organisation	Policy	Rationale
Department of Treasury and Finance	*Investment Lifecycle and High Value High Risk Guidelines* (ILHVHR) [250]	The guidelines are applicable to any investment proposal (asset or output) and mandate the development of business cases for capital investments over $10 million. They apply to all government departments, corporations, authorities, and other bodies falling under the Financial Management Act 1994.
Department of Treasury and Finance	*Gateway Review Process* [251]	The assurance process examines projects and programs at 6 key decision points in their lifecycle. This process is mandatory for all projects deemed to be high value and high risk. The gateway review process involves: Gate 1: concept and feasibility Gate 2: business case Gate 3: readiness for market Gate 4: tender decision Gate 5: readiness for service Gate 6: benefit analysis.
Department of Treasury and Finance	*Economic Evaluation for Business Cases. Technical Guidelines* [252]	The guidelines supplement the ILHVHR guidelines and provide high level guidance for incorporating general environmental impacts. The guidelines state that a cost benefit analysis, where possible, should capture all welfare costs and benefits to society, including changes in carbon dioxide emissions generated by an activity or investment. The guidelines also provide recommendations on the specific discount rates that correspond with the category of investment.
Department of Treasury and Finance	*FRD24. Reporting of environmental data by government entities* (June 2022) [253]	The guidance requires reporting of scope 1 and scope 2 emissions for office-based government activities. It does not require mandatory reporting for scope 3 emissions.
Office of Project Victoria	*Sustainable Investment Guidelines* [254]	The guideline provides 'good practice' advice on how to incorporate sustainable investment considerations into project planning and delivery throughout the investment

		lifecycle.
Department of Treasury and Finance	*Investment Management Standard*[255]	The investment management standard is a comprehensive approach to investment decision-making. It involves a structured process of workshops that support organisations to identify evidence-based problems, evaluate the potential benefits of addressing those problems, establish meaningful key performance indicators, assess the feasibility of proposed solutions, and ensure adaptability to changing conditions. By following the standard, organisations can make sound investment decisions that align with their strategic goals and deliver valuable outcomes.
Department of Treasury and Finance	*Asset Management Accountability Framework*[256]	The framework outlines asset management requirements and responsibilities across the entire asset lifecycle. It includes mandatory requirements such as developing strategies, governance frameworks, and performance standards. It provides general guidance for agencies managing assets, including maintenance systems, performance monitoring, and addressing failures. The soon to be updated *Impact of Climate Change Guidance Note* will detail climate change considerations in line with the Victorian climate change related policy.
Department of Treasury and Finance	*Victoria's Social Procurement Framework*[257]	The framework aims to ensure that Victorian Government procurement considers social and sustainable outcomes that benefit the Victorian community. In the framework, the Victorian Government commits to achieving positive environmental outcomes through sustainable procurement. This helps to achieve value for money while minimising the impact on the environment.
Department of Treasury and Finance	*Evaluation Criteria* (Direction and Instruction 3.7)[258]	The guidance explains the requirement to prepare a tender evaluation plan and how to determine the tender evaluation criteria for public construction.
Victorian Government	*Recycle First Policy*[259]	The policy requires all tenderers on Victorian major transport projects to demonstrate how they will optimise the use of recycled and reused materials at the levels allowed under current standards and specifications.

Appendix D: Standards, rating schemes, tools and carbon values

Carbon emissions standards

Our research identified multiple standards that are adopted in Victoria, see Table D-1.

Organisational standards generally focus on emissions that organisations can directly control (scope 1 and 2). Project or asset level standards provide clear guidance on defining and measuring carbon emissions associated with infrastructure delivery. Product level standards quantify and measure carbon for materials in infrastructure projects.

Table D-1: Examples of carbon standards adopted in Victoria[260]

Type	Standards adopted in Victoria
Organisational standards	• The GHG Protocol Corporate Standard • ISO 14064-1 GHG Assessment Part 1 (Organisational level quantification) • The Climate Active Carbon Neutral Standard for Organisations
Project or asset level standards	• 14064-1 GHG Assessment Standard Part 2 (Project level quantification) • Climate Active Carbon Neutral Standard for Buildings • EN 15978 Sustainability in Construction Works (adopted for Green Star Lifecycle Assessments)
Product level standards and environmental labels	• The Climate Active Carbon Neutral Standard for Products • EN 15804 Sustainability of Construction Works

Carbon measurement and assessment tools

Our research identified various tools that are used in Victoria, see Table D-2.

Table D-2: Examples of lifecycle emission assessment tools adopted in Victoria[261]

Type	Tools commonly adopted in Victoria	Tools from other jurisdictions
GHG conversion / emissions factors	• DCCEEW National Greenhouse Account Factors • Australasian EPD Programme (product specific) • EPiC Database – Melbourne University	• UK GHG Conversion Factors • UK Transport Appraisal • Intergovernmental Panel on Climate Change Emission Factor Database

Guidance	• Transport Authorities Greenhouse Group (TAGG) GHG Assessment Workbook for Road Projects (2013)	• UK Department for Transport Quantifiable Carbon Reduction Guidance
Building and infrastructure specific tools	• Transport Authorities Greenhouse Group (TAGG) Carbon Gauge (2013) • IS Materials Calculator • Green Building Council of Australia Upfront Carbon Calculator	• Transport for NSW Carbon Estimate and Reporting Tool (CERT) • Waka Kotahi (NZ) Project Emissions Estimation Tool (PEET) • National Highways Carbon Tool (UK) • Klimatkalkyl “carbon calculation” (Sweden) • InfraLCA (Denmark)
Lifecycle assessment tools and databases	• Tool LCD* • OneClick LCA* • Tally* • Sima Pro Ecoinvent databases* **Offer BIM integration*	• OpenLCA • NorEnviro (database) • ICE database • CO2data.fi (database)

Table D-3: Sustainability rating tools used in Victorian infrastructure projects[262]

Sustainability rating tool / guidelines	**Adoption in Victorian public sector**
Infrastructure Sustainability Rating	• North East Link Project (NELP) • West Gate Tunnel Project • Suburban Rail Loop (SRL) • Projects CAPEX > $100million • Preliminary review for adoption by Victorian Water Corporations • LXRP, MRPV and Metro Tunnel projects
Green Star (Design and As Built, Building and Communities)	• Railway stations (LXRP and Metro Tunnel) • NELP and SRL operational control centres • Development Victoria • Office accommodation, social housing and used to benchmark institutional buildings (courts, police stations)
NABERS	• Office accommodation, hospitals

Carbon values and discount rates

Our research identified that Victorian delivery agencies use different carbon values and discount rates, see Table D-4.

Table D-4: Carbon values and discount rates used in Victorian infrastructure projects[263]

Project	Carbon value and discount rate	Source
Suburban Rail Loop, 2021	• $46/t CO2-e • 4% discount rate	• Austroads, Updating environmental externalities unit values, 2014
Evaluation of the Victorian 6-star housing standard, 2019 (DELWP)	• 2020: $28/t CO2-e • 2030: $71/t CO2-e • 2050: $213/t CO2-e • 7% discount rate	• The World Bank Carbon Pricing Dashboard • IPCC Fifth Assessment Report
North East Link, 2018	• $52.40/t CO2-e • 7% discount rate	• Austroads, Guide to Project Evaluation Part 4: Project Evaluation Data, 2012

Note: Values listed are in terms of the year of publication of the source document and are not adjusted to 2023 values

Appendix E: Contractual mechanisms to reduce carbon

In Recommendation 7, we recommend that government update standard form contracts to include minimum carbon reduction requirements for infrastructure projects. Table E-1 sets out key matters which government must consider when implementing carbon reduction mechanisms in contracts. Table E-2 sets out suggested contractual mechanisms to deliver emissions reduction.

Table E-1: Key considerations for inclusion of carbon reduction mechanisms in standard form contracts

Key consideration	Carbon reduction mechanism in standard form contracts
Alignment with business case, procurement frameworks and tender documentation	Contractual mechanisms included in standard form contracts must align with each of the recommendations in this report as implemented, most specifically recommendations 1, 2, 4, 6 and 8. For example, government must update pre-contract documents to align with decarbonisation objectives of the project so that bidders can accurately assess these matters from both a commercial and technical standpoint, for these matters to successfully flow through to the contract.
Alignment with technical and commercial requirements	Technical and commercial teams must be aware of, and collaborate with the legal team on, the proposed carbon reduction requirements for the project. Guidance of this nature should be included in the draft contract documents. For example, the commercial framework should embed carbon reduction matters in the pre-contract stage so that any financial incentives or Key Performance Indicators (KPIs) can appropriately be tied to performance. This is particularly important as enforcement of carbon related obligations may be difficult in practice.
Incremental steps and nuance for different project types	Some of the proposed carbon reduction contractual mechanisms may require significant upskilling and costs to comply (for example, for investment in new reporting systems and technology). It is therefore important that government takes appropriately incremental steps to assist suppliers to meet these new requirements. This does not mean that government should delay implementation of these updates to contracts, but rather should adapt the clauses as appropriate for the ambition of the project and current market capability.
Increased emissions data collection, reporting & project governance	Increasing data collection and more robust project reporting and governance structures relating to emissions reduction is often a first step in increasing decarbonisation ambition in infrastructure projects and to allow government to collect accurate and consistent emission data across projects. It is important to align these requirements with recommendations 1 and 2 in relation to carbon measurement. This will assist with upskilling the sector and allow organisations to invest in upgrading their reporting systems to meet this elevated expectation. It is important that these matters are included in contracts, even where

	there may not be a 'hard' emissions reduction obligation.
Mechanisms for further abatement as technology and practices evolve	The speed at which decarbonisation commitments and solutions are accelerating means that the decarbonisation ambitions of a project and technical solutions, when it is first being procured, may have significantly shifted by the time the project is under construction or being operated. As such government should ensure that contracts include mechanisms to rachet up ambition (without commercial disadvantage to the supplier, for example, through modifications to the project works) which prevent government from being locked into long term high-emitting contracts which may be inconsistent with updated commitments or elevated climate-related risks.
Risk allocation and enforcement mechanisms	The infrastructure sector has entrenched risk allocation practices, especially in respect of design and performance warranties that may extend for decades. Decarbonisation requires suppliers to innovate and so government must be prepared to adopt more collaborative testing and acceptance process, in addition to amended warranties for these innovations in the short term. Government should consider a range of appropriate enforcement and incentive mechanisms for carbon reduction in contractual obligations including liquidated damages, additional conditions to practical completion, enhanced defects regimes – and bonus, abatement and pain/gain share regimes.

Table E-2: Table of suggested contractual mechanisms

Contractual mechanism	Description	Recommendation for government
Reporting & governance measures		
Periodic emissions reporting (Delivery & Operations Phase)	This clause requires the supplier to provide periodic information on carbon emissions and emissions reduction matters during project delivery and operations. This clause should be included in all contracts – including where there are no specific emission reduction measures. Government should consider proactively setting a standard reporting format across projects so that data is gathered in consistent format and comparable across projects. This is a critical baseline requirement to enable government to track real emissions across infrastructure projects and assist with benchmarking projects across the sector. Additionally, this will enable suppliers to upskill in measurement and management of emissions. For example, see the Chancery Lane Project's *Olivia's Clause (Net Zero Obligations in FIDIC Engineering, Procurement and Construction (EPC) Contracts* (drafted for England & Wales law)*):*[264] The drafting mechanism in Olivia's Clause imposes obligations on	Mandatory – recommended for all projects

Contractual mechanism	Description	Recommendation for government
	contractors to, among other things, measure and calculate projected and total emissions in respect of the project, provide emissions reports to the principal annually and to engage an independent consultant to provide climate impact assessments and emissions reporting services to verify the contractor's measurements. Infrastructure NSW has also recommended in its NSW government discussion paper *Decarbonising Infrastructure Delivery* that embodied emissions reduction form part of contractor performance reporting to inform future target setting (see action 5.2).[265] See also the UK government's 2022 guidance note on *Promoting Net Zero Carbon and Sustainability in Construction*, which outlines mechanisms for carbon monitoring and reporting as part of broader emissions reductions strategies (in particular, see chapter 3.7).[266]	
Decarbonisation Management Plans (Delivery & Operations Phase)	This clause requires the supplier to prepare and submit a 'Carbon Management Plan' to government which sets out their proposed plan to manage and measure carbon during the project delivery / operations phase (depending on the type of supplier). This is an important governance mechanism to ensure that the supplier has an appropriately detailed plan to manage and abate carbon during the project. For example, see The Chancery Lane Project's *Rose's Clause (GHG Emissions Management Plans in Infrastructure and Construction Project Finance)* (drafted for England & Wales law):[267] The drafting mechanism in Rose's Clause makes the infrastructure or project finance conditional upon the principal or borrower developing and implementing a whole-of-life decarbonisation plan (which covers both the construction and operational phases). Infrastructure NSW has also recommended that, as part of the updates to standard contracts, contractors should be required to prepare carbon management plans to demonstrate how carbon reduction targets will be achieved (as a Key Performance Indicator with associated financial incentives) (action 4.2).[268]	**Mandatory** – recommended for all projects
Decarbonisation working group (Delivery & Operations Phase)	This clause requires the government and suppliers to establish a working group to meet to evaluate carbon reduction performance and to discuss opportunities for further carbon abatement on the project. This is an important mechanism to promote collaboration between the parties on carbon matters, as well as to provide a forum to discuss the performance against targets or	**Mandatory** – recommended for all projects

Contractual mechanism	Description	Recommendation for government
	other obligations (that is, with a view to manage and assess before significant issues arise). For example, see The Chancery Lane Project's *Zoe and Bea's Clause (Green Supplier Agreement Terms)* (drafted for England & Wales law)*:*[269] This clause provides that the principal will establish a 'Greenhouse Gas and Carbon Emissions Group', being a forum for discussions between the parties in relation to emissions, reduction targets and other strategies for the achievement of carbon emissions reduction. While not a specific contractual mechanism, in the HS2 (High Speed 2 railway), a 'carbon collaboration group' has been established and is chaired by HS2 and attended by supply chain partners (chapter 6.3.20).[270] The carbon collaboration group is a forum for civil engineering and construction supply chain partners to discuss carbon reduction strategies and to drive continuous improvement for project outcomes.	
Emissions reduction measures		
Acknowledgement of government's emission reduction target & project emission reduction objectives (Delivery & Operations Phase)	This obligation may be included as an operative clause or as a recital to the contract to signal the importance of the government's decarbonisation objectives for the project and broader policy commitments. This clause does not necessarily impact on risk allocation under the contract, but assists in steering performance under the contract is a manner which is aligned with those emission reduction goals. For example, see The Chancery Lane Project's *Eddie's Recitals (Climate Recitals)* (drafted for England & Wales law):[271] This clause sets out relevant climate change-related and net zero recitals. While non-binding, the recitals elevate climate change-related issues as a key consideration and signifies the parties' overarching intentions for the performance of their contractual obligations.	**Mandatory** – recommended for all projects
Broad obligation to assist progress toward the government's emission reduction targets (Delivery & Operations Phase)	This clause requires the supplier to perform its obligations under the contract in a manner that assists the government to meet its broad emission reduction objectives. This clause can either be a broad obligation from the supplier to perform activities under the contract in a manner which promotes emissions reduction or can include a specific list of carbon reduction measures the supplier will employ to assist with meeting such targets. For example, see The Chancery Lane Project's *Owen's Clause (Net Zero Target Supply Chain Cascade)* (drafted for England & Wales law)*:*[272] Whilst the clause	Mandatory – recommended for all projects

Contractual mechanism	Description	Recommendation for government
	is directed to passing through the principal's net zero targets and obligations to their supply chain and contractors which contribute to the principal's own carbon emissions (e.g. such as the materials procured for a construction project which would be considered scope 3 emissions), the clause also sets out a number of reduction measures which the supplier must take to achieve its net zero target date (being tied to the principal's own net zero target). Additionally, the UK Environment Agency's (EA) Thames Estuary Asset Management Programme (TEAM2100), an integrated delivery team focussing on flood management, has implemented contractual mechanisms (inspired by The Chancery Lane Project clauses) to require contractors to deliver against sustainability objectives, including carbon reduction and the use of circular economy materials.[273]	
Carbon baseline (budget) (Delivery phase)	This clause requires the supplier to carry out the project (applicable to design, construction and operations, as appropriate) so that the specified 'Carbon Budget' is not exceeded. For example, for the construction phase, this clause would require the parties to establish a genuinely ambitious baseline for carbon across the delivery phase which covers embodied carbon up to completion (which can be on an absolute or intensity basis depending on the type of services). It is important include appropriate incentivisation mechanisms in the contract to motivate the suppliers to meet the baseline. This can be achieved through pain/gain share mechanisms, linking the performance against the budget to the KPI framework or the financing arrangements (for example, through a green loan with a margin adjustment trigger for performance against the baseline). For example, see the Chancery Lane Project's *Tristan's Clause (Construction Materials: Procurement)* (drafted for England & Wales law):[274] Tristan's Clause sets a 'carbon' budget for the materials procured for a construction project. Tristan's Clause can be used alongside the financial 'budget' for the project to incentivise contractors to reduce the embodied carbon emissions across the project lifecycle.	Optional to begin then mandatory across all projects over time as capacity and capability increases
Modifications and enforcement matters		
Modifications for Emissions Reduction (Delivery &	This clause would introduce a positive obligation on the supplier to propose variations where new innovations and technologies facilitate further emissions reductions	Mandatory – recommended for all projects

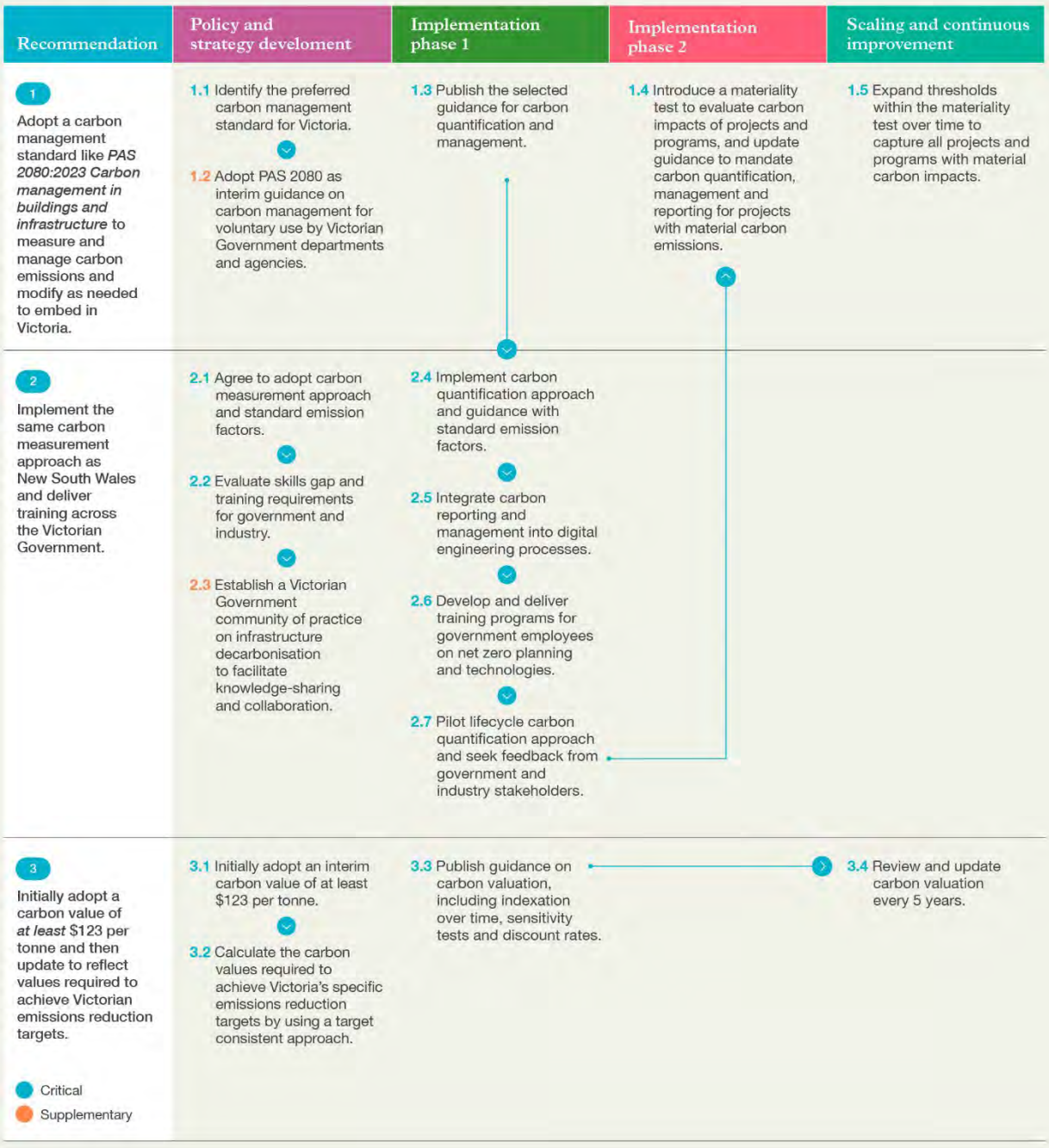
Contractual mechanism	Description	Recommendation for government
Operations Phase)	(similar to the 'value engineering variations' mechanism). This would follow the typical process under the contract for a variation which would allow the supplier to price the variation and propose an adjustment to the time for completion accordingly for the government's approval). A regime should also be included that requires the supplier to comply with any increases to government ambition on emissions reduction, in line with elevated policy measures, over the life of the project with relief available via the variation mechanism for time and cost impacts (similar to the 'change in law' mechanism). For example, see The Chancery Lane *Project's Luna's Clause (Net Zero Aligned Construction Modifications)* (drafted for England & Wales law):[275] The drafting mechanism in Luna's Clause provides a specific framework for contractors to propose sustainable net zero aligned modifications to the project works. Luna's Clause can be used to encourage contractors to propose and implement sustainable construction solutions during the delivery phase. UK law firm Foot Anstey has introduced Luna's Clause for its clients to incentivise 'Net Zero Modifications' to project works, particularly those with a longer delivery schedule.[276]	

Appendix F: Complete action plan

Figure F-1 shows the actions and interdependencies for all 10 recommendations across the four implementation stages: foundational, business case, procurement, assurance.[277]

Figure F-1
Complete action plan

Foundational



Business cases

Recommendation	Policy and strategy development	Implementation phase 1	Implementation phase 2	Scaling and continuous improvement
4 Update business case guidelines and templates to integrate emissions reduction.	4.1 Require business cases to include a descriptive estimate of carbon emissions, assess the impact using the interim carbon value and outline emission reduction options in line with the carbon reduction hierarchy.	4.2 Require all projects and programs to describe alignment with state or sector emissions targets. 4.3 Require all projects and programs to develop descriptive carbon management plans, detailing considerations of emissions avoidance, reduction, mitigation or offset.	4.4 Require quantitative assessment of carbon emissions over the lifecycle for projects and programs that meet the emissions materiality threshold. 4.5 Require carbon reduction targets set against a given baseline. 4.6 Require quantitative assessment of impacts on sector and state emissions targets. 4.7 Require all projects and programs with material emissions impacts to develop quantitative carbon management plans.	
5 Measure carbon in infrastructure cost benefit analysis and make decisions that reduce emissions.			5.1 Require projects and programs with material emissions impacts to value lifecycle carbon emissions in the cost benefit analyses.	

Critical
Supplementary

Procurement and delivery

Recommendation	Policy and strategy development	Implementation phase 1	Implementation phase 2	Scaling and continuous improvement
6 Update procurement frameworks and guidance to embed carbon reduction in tenders.	6.1 Determine how to change the current public infrastructure procurement frameworks to effectively consider carbon emissions.	6.2 Update the procurement frameworks, guides and templates to include more detailed guidance and requirements for decarbonisation, including: – Minimum carbon reduction as a tender requirement. – Tender document templates and evaluation criteria that clearly communicate carbon reduction outcomes. – Methods to promote alternative carbon reduction mechanisms during procurement.	6.3 Update procurement templates to include mandatory carbon reduction targets from a set baseline. 6.4 Incorporate carbon valuation into procurement processes to assess the value for money of decarbonisation measures.	
7 Update standard form contracts to include carbon reporting, abatement requirements and further reduction opportunities.		7.1 Include mechanisms for additional carbon abatement in standard form contracts. 7.2 Add incentives within standard form contracts for suppliers to further reduce emissions. 7.3 Develop requirement for descriptive carbon management plans within standard form contracts, with some measurement and reporting.	7.4 Establish carbon reporting requirements within standard form contracts for projects and programs with material carbon impacts. 7.5 Update government standard form contracts to include minimum carbon reduction requirements. 7.6 Develop requirement for quantitative carbon management plans within standard form contracts for projects and programs with material carbon impacts.	
8 Establish carbon management prequalification requirements for government contracts.		8.1 Collaborate with industry to determine prequalification requirements for Victorian Government contracts and signal future changes.	8.2 Establish prequalification requirements for government contracts with material carbon impact over predetermined threshold.	8.3 Reduce prequalification threshold over time.
9 Support industry to develop zero or low emissions solutions by testing alternative materials and adopting performance-based standards.		9.1 Review existing platforms for low carbon construction innovations to determine gaps and opportunities. 9.2 Review standards and specifications to determine barriers and opportunities to reduce carbon.	9.3 Collaborate with industry and other jurisdictions to establish or further develop low carbon construction innovation platform. 9.4 Establish a government fund to support research and development and pilot programs to drive innovation in industry. 9.5 Update standards and specifications to better enable low carbon solutions to be used.	9.6 Periodically review standards and specifications aligning with technological advancements.

Critical
Supplementary

Assurance

Recommendation	Policy and strategy develoment	Implementation phase 1	Implementation phase 2	Scaling and continuous improvement
10 Update assurance processes to include carbon emissions.		10.1 Update project assurance checks to reflect changes in investment lifecycle and asset management processes.	10.2 Require carbon emission reporting in benefit management plans in all projects and programs with material emissions impacts that are required to measure lifecycle emissions.	10.3 Review performance and develop a register of carbon benchmarks to assist in the setting of carbon baselines.

Critical
Supplementary

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Published by Infrastructure Victoria
September 2023

This document is also available in PDF and accessible HTML or Word format at www.infrastructurevictoria.com.au

ISBN 978-1-925632-92-7 (PDF/online/MS word)