Defining Infrastrucutre Net Zero

Setting a net zero definition to enable change

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asbec AUSTRALIAN SUSTAINABLE BUILT ENVIRONMENT COUNCIL

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Contents

Tables

Figures

Executive Summary

We are excited to take the first step on this journey with the launch of a consultation process to establish a clear, industry-wide definition for net zero infrastructure**.**

Infrastructure sector decision makers have a near unanimous intent to meet government net zero targets and transition to a low-carbon sector

The necessity of shifting from intent to action grows more with every passing day. Given the ambition of our net zero commitments, the stakeholders in our nation's infrastructure sector must act now to ensure our net zero commitments are realised.

Our sector's role as the country's largest emissions generator means there is an obligation to act now

About 70% of Australia's greenhouse gas emissions are directly attributable to, or influenced by the infrastructure sector.[1] Significant reductions must be made to emissions from this sector for Australia to have any hope of meeting our national and state commitments. The scale and pace of the low-carbon transition can, in part, be measured by its enormous cost. The global transition to a low-carbon economy, which aligns with Paris Agreement outcomes, is estimated to require developed countries to invest $2.6 trillion each year for the next decade.[2] This investment needs to be deployed for the right assets, networks, systems, and services. Assets built or retrofitted today will be used for decades to come.[3] It is critical their planning and delivery aligns with a trajectory that will achieve long-term net zero emissions targets, while working in the best interests of the users and taxpayers, and the community at large.[4]

Varied demands will be placed on our market capacity and capabilities from different sectors, as our infrastructure needs change. For example, as the energy transition accelerates, energy sector employment is predicted to increase from 1% to 4%.[5] Sustained, cross-sectoral demand as well as regional demand hotspots and labour shortages will prolong the pressure on construction capacity and the ability to prioritise and deliver net zero aligned action.[6]

Infrastructure accounts for 88% of the forecasted global adaptation costs[7]

Infrastructure also plays a key role in safeguarding essential services and ensuring that communities are resilient**.**

Focused action is needed

No one sector can achieve the carbon emission reductions needed to prevent catastrophic climate change. However, the infrastructure sector has the power to make one of the largest contributions to climate action.

While governmental department are at different stages and maturities when it comes to infrastructure decarbonisation, there is considerable active thinking and development in this space. The definitions, strategies, and frameworks in place to systematically and consistently reduce the infrastructure sector's carbon emissions are still mostly developing and yet to be fully implemented.

A definition is a prerequisite to adopting an endorsed, standard approach to help agencies and the private sector identify, measure, and report carbon reduction actions throughout an asset's lifecycle.

The first step on the road to a low carbon future is clearly defining what Net Zero means for the systemic, interconnected, and multifaceted infrastructure sector.

Net Zero for infrastructure definition

This paper makes the case that 'Net Zero' means (in line with international convention):

> *Achieving an overall balance between greenhouse gas emissions produced and greenhouse gas emissions taken out of the atmosphere.*

Further this paper makes the case that 'Net Zero for Infrastructure' should be adopted by Infrastructure Net Zero, with the following definition:

> *Where the sum total of all Scope 1, 2 and 3 related GHG emissions, including operational, embodied, and enabled emissions, over the infrastructure lifecycle, and at each stage, are minimised, meet local carbon targets, and with residual 'offsets', equals zero.*

It is important to consider carbon at each stage of the asset life cycle and strategically prioritise emission reductions to best align with infrastructure type and industry-specific opportunities. Infrastructure-related GHG emissions include operational, embodied, and enabled emissions from:

- The creation of materials, products, and components
- Construction transportation and site activities e.g. transport of materials, plant and equipment operations, transport of plant and equipment, site-based utilities consumption, and removal / treatment of wastes
- Fuel, electricity and water consumption throughout the operating life of the asset
- Maintenance, repair, replacement and refurbishment activities to sustain the operational condition of the asset
- Transport-related and other GHG emitting uses enabled by the piece of infrastructure.

Our proposed definition is broad. This will enable an emissions profile that provides real measurement for infrastructure projects and services across their entire lifecycle, enabling more informed decisions that align with economic, sustainability, and resilience goals and ultimately, climate action.

Benefits of a Net Zero for Infrastructure definition

Our Net Zero for Infrastructure definition works towards the following benefits:

- **Underpinning a consistent measurement and understanding of carbon emissions:** An accurate, uniform, and true portrayal of infrastructure's carbon generation through accepted standards and approaches to measurement.
- **Collective understanding of the net zero task:** Open and consistent carbon reporting will enable building designers, designers, constructors, asset owners, contractors, and users to use a common touchstone to scale to net zero buildings and infrastructure. This will ensure actions taken by different industries, organisations, and individuals are consistent, transparent, and effective in reducing greenhouse gas emissions.
- **The sector's ability to take a systemic approach**: Carbon assessment across the infrastructure lifecycle captures the entirety of carbon emissions associated with infrastructure. Carbon can be managed that is both within the direct control of the infrastructure and within the infrastructure's influence, which will enable place-based carbon assessment. The definition will allow assets and services to be seen in the context of networks, networks in the context of systems and systems in the context of other systems. It enables infrastructure owners, financiers, operators and users to have consistent

conversations with common understanding. Existing carbon management frameworks, such as PAS 2080, instruct organisations to assess the chain reaction effects when planning, designing, specifying, constructing, and operating assets.[8]

- **Better collaboration and innovation:** Consideration of carbon at each lifecycle stage will ensure mutual understanding of net zero goals and enhanced collaboration, maximising opportunities for joint carbon and cost reductions. This is particularly important when trying to reduce carbon in a place or at a cross-sectoral level. Collaboration also fosters innovation, creating opportunities for decarbonisation and additional value generation through shared solutions.
- **Finding the best solutions for users and taxpayers:** Helps the sector to understand and deliver the optimum net zero solution that considers the operational and embodied emissions simultaneously. It also catalyses durable construction and design, ensuring greater longevity and less carbon emissions associated with demolition and new construction.

The proposed Net Zero for Infrastructure definition is the start of a conversation across the sector. This paper welcomes these discussions and feedback (see Chapter 7 for consultation details).

Infrastructure Net Zero joined the Australian Sustainable Built Environment Council network in June 2024 and is thrilled to be working with the Green Building Council of Australia and the Infrastructure Sustainability Council to run an industry engagement process at end of 2024 and early 2025.

Key dates are:

- **Consultation launch**: October 2024 at Infrastructure Sustainability Council conference, with accompanying online webinar. Online consultation launched.
- **Consultation webinar:** 30 October 2024
- **Consultation close**: End November 2024 online consultation closes.
- **Detailed updates**: December 2024 to March 2025 the report will be updated for feedback, and to add detailed policy additional reviews identified through consultation.
- **Final report launch**: March 2025 launch at Australian Sustainable Built Environment Council Adelaide event.

1 The role of Infrastructure Net Zero

1.1 Background to Infrastructure Net Zero

Infrastructure Net Zero brings together key stakeholders across all sectors and asset classes to co-ordinate, collaborate and report on infrastructure's pathway to net zero in a manner that aims to deliver value for community, government, industry, and the environment.

It is a collaborative forum committed to creating an aligned, efficient, and effective use of collective time, resources and expertise to work on the highest priority initiatives and to drive lasting policy change and industry innovation.

Infrastructure Net Zero is premised on the idea that strong leadership and collaboration across the industry is required to achieve net zero quickly, while keeping our sector globally competitive and functioning in the best interests of users, taxpayers, and the community.

Infrastructure Net Zero's primary objective is to decarbonise Australia's infrastructure through collective action to meet or exceed our national targets of 43% by 2030 and Net Zero by 2050.

1.2 The role of Infrastructure Net Zero

The initiative brings together the infrastructure sector's key stakeholders to:

- Agree on common goals and sectoral targets;
- Align on the pathways to achievement;
- Co-ordinate and collaborate on action; and
- Monitor and report on progress.

2 Purpose of this discussion paper

Net zero is the internationally agreed upon goal for mitigating global warming in the second half of the century. The Intergovernmental Panel on Climate Change (IPCC) state that net zero is required by 2050 to limit global warming to 1.5°C. The Australian infrastructure sector, which contributes to or directly influences about 70% of the country's emissions, must play a leading role. While progess has occurred, the scale and pace of the net transition requires a fundamental re-examination of how the sector plans, delivers and operates infrastructure.

This paper discusses the first building block - a net zero definition - required to examine the sector's strategic alignment on priority climate action to achieve national net zero infrastructure. To serve this objective, this report will seek to:

- *Outline a scope for the infrastructure sector and net zero:*
  - Outline the parameters of the infrastructure sector
  - Contextualise the infrastructure sector's current and future carbon contribution
  - Discuss the infrastructure sector's role in achieving net zero.
- *Propose a Net Zero for infrastructure definition:*
  - Discuss the benefits of reaching consensus on a clear and uniform Net Zero for infrastructure definition
  - Outline conceptual foundations for the formulation and assessment of a Net Zero for infrastructure definition
  - Outline current best practice domestic and international Net Zero for infrastructure definitions
  - Make a case that Net Zero for infrastructure is the best definition for ensuring the infrastructure systemically, accurately, productively, and innovatively reduces its emissions, in line with its commitments.

This report and the proposed Net Zero definition contained herein are the outcomes of a collaborative process and significant engagement between key Infrastructure Net Zero stakeholders. To date, this has included:

- Australian Sustainable Built Environment Council (ASBEC)
- Infrastructure Sustainability Council (ISC)
- Green Building Council of Australia (GBCA)
- Australian Government Department of Infrastructure, Transport, Regional Development, Communications and the Arts
- Clean Energy Finance Corporation (CEFC)
- Infrastructure Partnerships Australia
- Australasian Railway Association
- Consult Australia.
- Infrastructure Australia
- Roads Australia
- Engineers Australia

2.1 Infrastructure Net Zero's next steps

This paper also provides context to inform the infrastructure sector and Infrastructure Net Zero's discussions and next steps.

Over the coming months, Infrastructure Net Zero will host a series of discussions to catalyse action in the infrastructure sector. The aim is for Infrastructure Net Zero members to collectively determine a clear understanding of what a low emissions future means for the infrastructure sector, and how to get there.

This discussion paper does not contain all the answers. However, it will inform these discussions across all sectors and asset classes to co-ordinate, collaborate and define our net zero future. It poses questions that need to be answered to inform Infrastructure Net Zero's objective to ensure the infrastructure net zero transition can occur.

2.2 Building on the infrastructure sector's ongoing work

This work does not seek to duplicate the ongoing work of the sector, including but not limited to:

- The Australian Government's sectoral emissions reduction plans[1], including:
  - The transport sector plan (otherwise known as the Transport and Infrastructure's Net Zero Roadmap and Action Plan)
  - The electricity and energy sector plan
  - The industry sector plan
- Infrastructure New South Wales's *Decarbonising Infrastructure Policy* (April 2024)[2]
- *Embodied Carbon Measurement for Infrastructure Technical Guidance* (June 2024), endorsed by Infrastructure and Transport Ministers[3]
- Infrastructure Australia's *Guide to Assessing Greenhouse Gas Emissions* (March 2024)[4]
- Climate Change Authority's *Sectoral Pathway Review* (September 2024)[5].

See Appendix A: Distilling the wealth of infrastructure net zero information, for a review of the 2023 policy landscape.

[1] Net Zero - DCCEEW

[2] Decarbonising Infrastructure Delivery Policy (nsw.gov.au)

[3] Embodied Carbon Measurement for Infrastructure

[4] 24IA_Greenhouse-Gas-Emissions.pdf (infrastructureaustralia.gov.au)

[5] Sector Pathways Review | Climate Change Authority

3 The infrastructure sector's role and remit

3.1 The infrastructure sector has a leading role in mitigating Australia's GHG emissions

About 70% of Australia's greenhouse gas emissions are directly attributable to, or influenced by the infrastructure sector (Figure 3.1). To counter this issue, it must be a leading enabler and adopter of low emissions technology. Significant reductions must be made to emissions from this sector for Australia to have any hope of meeting our national and state commitments.

Figure 3.1: Australia's infrastructure sector emissions[6]

To achieve the Australian Government's net zero aspiration, the sector will have to play a stronger role in meeting Australia's emissions commitments and targets across all levels of government. This is particularly true in the most emissions-intensive infrastructure industries, such as transport and energy.

The gap between intent and action has never been bigger. This discrepancy is fuelled by a lack of a clear vision of what a low emissions future means for the infrastructure sector, and how to get there.[9]

As the gap grows, so does the urgency to act. Assets built or retrofitted today will be used for decades to come.[10] Investment decisions therefore require a thorough understanding of their operational life, benefits and costs. It is critical their planning and delivery aligns with a trajectory that will achieve long-term net zero emissions targets.[11] More information about infrastructure's role and emission sources can be found in Appendix : Distilling the wealth of infrastructure net zero information.

3.2 Outlining the parameters of the infrastructure sector

Infrastructure is the physical bricks and mortar, systems, networks and services that a country, state, organisation or community uses to allow communities, the environment and the economy to function. The following assets, systems, and services form infrastructure sectors that must be considered, assessed, and planned for in the net zero transition:

[6] Portrait report template (roads.org.au)

- **Energy:** this includes the components of generation, transmission and distribution of electricity.
- **Industry:** The industrial sectors include the production of steel and cement, which account for approximately 14% of global greenhouse gas emissions. This also include the mining, manufacture and refinement of aluminium and chemicals.
- **Transport:** this includes assets, systems and services including road transportation and mobility, and transport infrastructure (roads, bridges, airports, ports, aviation, shipping etc..).
- **Telecommunications:** this includes telecommunications equipment, telephone network, broadband network, transmission lines, networks, WiFi services and consumer and industry end use.
- **Water:** Systems of water supply, water resource management, flood management, proper sewage and drainage systems, coastal restoration infrastructure.
- **Social infrastructure**: including school, hospitals, and other built assets used for social and community purposes.
  Note: Social Infrastructure is used to group both building projects and other types of developments such as parks. For purposes of this report, building type projects are excluded as the work in this area by GBCA, ASBEC, and others provide clear guidance, targets, and benchmarks for those assets.[12][13]

Our definition of infrastructure does not encompass, but does influence:

- **Residential and non-residential buildings**: structures designed primarily for people to live in as well as structures used for business purposes, such as offices and retail stores.
- **Agriculture and food:** crop and animal production, engineering and production of agricultural machinery, fertilisers, and products to support farming.
- **Forestry and land-use:** Vegetative cover and the purpose to which the land cover is committed. Carbon emissions in this sector often come from land clearing and deforestation.

Outside of a sectorial context, other terms are often used to define components of the infrastructure sector. For example, the built environment is a term used to refer to man-made structures, features, and facilities viewed collectively as an environment in which people live and work. While useful, the term does not cover the breadth of the infrastructure sector considered in this document.

3.3 There are many roads to net zero

Achieving net zero is not a linear journey, particularly for the infrastructure sector. There are different ways to achieve net zero emissions both in the short, medium, and long term. Figure 3.2, focused on buildings but relatable more broadly, displays the high-level options to reduce emissions.

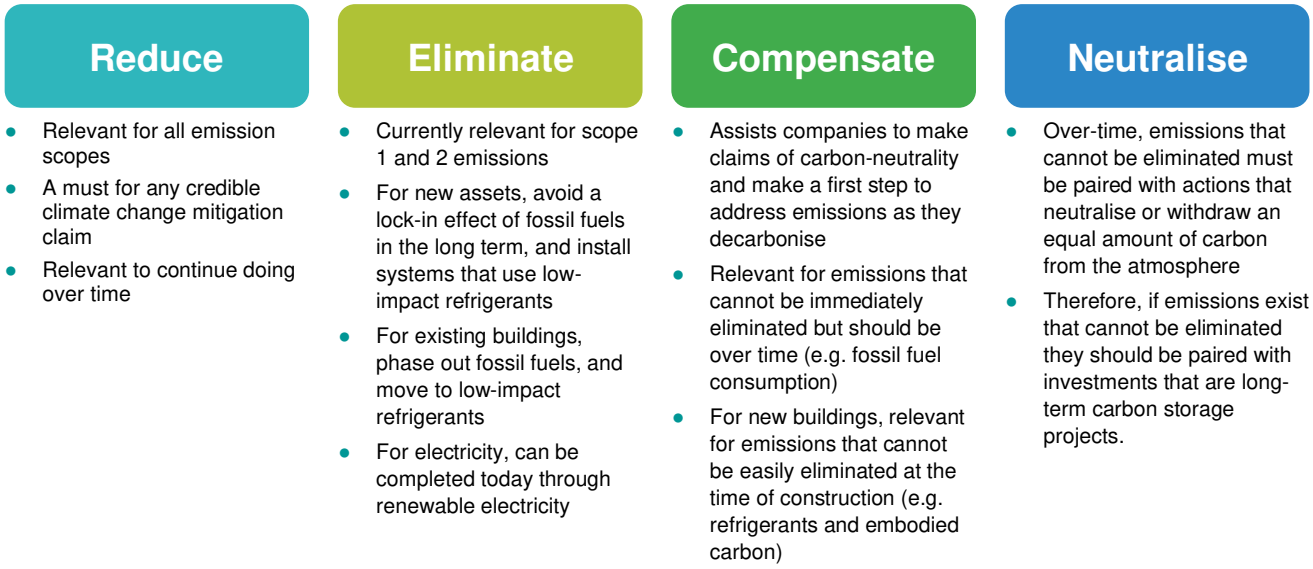


Figure 3.2: There are many roads to reducing emissions

Note: GBCA: Climate Positive Buildings & our Net Zero Ambitions Guidance for Green Star on the use of offsets and renewables 20211126160517_climate_positive_buildings_and_our_net_zero_ambitions_r2.pdf[14]

3.4 Sector's emission intensity varies but all sectors must do their bit

While some sectors have easier emissions pathways, every sector will need to greatly reduce its carbon footprint for Australia to reach net zero. The sectors of electricity (including stationary energy) and transport combined, generate well over 50% of Australia's CO2 emissions, as shown in Table 3.1.

Decision makers in every sector will need to orchestrate significant change to shift from infrastructure representing 70% of Australia's emissions to reaching net zero emissions for the infrastructure sector. This whole of system change will ensure goods, buildings, services and user behaviour associated with infrastructure that underpin are net zero.

Some sectors, such as energy, will not be able to avoid generating emissions due to their intrinsic characteristics. This means they will still produce carbon emissions in 2050. Geothermal generation, gas-fired generation – which is not carbon free – will be required as intermittent power generation to support a vast renewable generation power system[7].

The complexity of the infrastructure net zero challenge is further compounded from assets, networks, and systems that share demand for similar resources, utilise similar supply chains, and/or influence customers carbon related behaviour.

No one sector can achieve the carbon emission reductions needed to reach net zero and prevent catastrophic climate change impacts. However, the infrastructure sector has the power to make one of the largest contributions to climate action.

[7] AEMO's ISP for 2024 estimates the need to have approximately 15GW of flexible gas-fired generation capacity, though it notes that it may only be required for 5% of its annual potential, and could be replaced with green hydrogen if costs come down." 2024-integrated-system-plan-isp.pdf (aemo.com.au) page 69

Table 3.1: Actual annual emissions, by sector, for the year to December 2022 and 2023

Sector	Annual emissions (Mt CO_2-e) year to December 2022	Annual emissions (Mt CO_2-e) year to December 2023	Change (%)
Energy – Electricity	154.9	150.6	-2.8%
Energy – Stationary energy excluding electricity	101.1	100.3	-0.8%
Energy – Transport	94.2	97.6	3.6%
Energy – Fugitive emissions	47.9	46.9	-2.1%
Industrial processes and product use	32.8	32.6	-0.6%
Agriculture	78.9	79.5	0.7%
Waste	13.9	13.9	0.0%
Land Use, Land Use Change and Forestry	-88.4	-88.4	0.0%
National Inventory Total	435.3	432.9	-0.5%

Notes: Mt CO2-e: Million tonnes of carbon dioxide Source: Department of Climate Change, Energy, the Environment and Water[15]

3.5 The infrastructure sector costs of climate change adaptation

As the frequency and severity of climate change-related shocks and stresses increase, more adaptation funding is being allocated to the infrastructure sector. Infrastructure plays a key role in safeguarding essential services and ensuring that communities have the ability to resist, absorb, accommodate, recover, transform and thrive in a timely, effective manner in response to the effects of shocks and stresses to enable positive economic, social, environmental and governance outcomes.[16] Figure 3.3 demonstrates that infrastructure accounts for 88% of the forecasted global adaptation costs. Most of these costs are directed towards the water, buildings and transport sectors.[17]

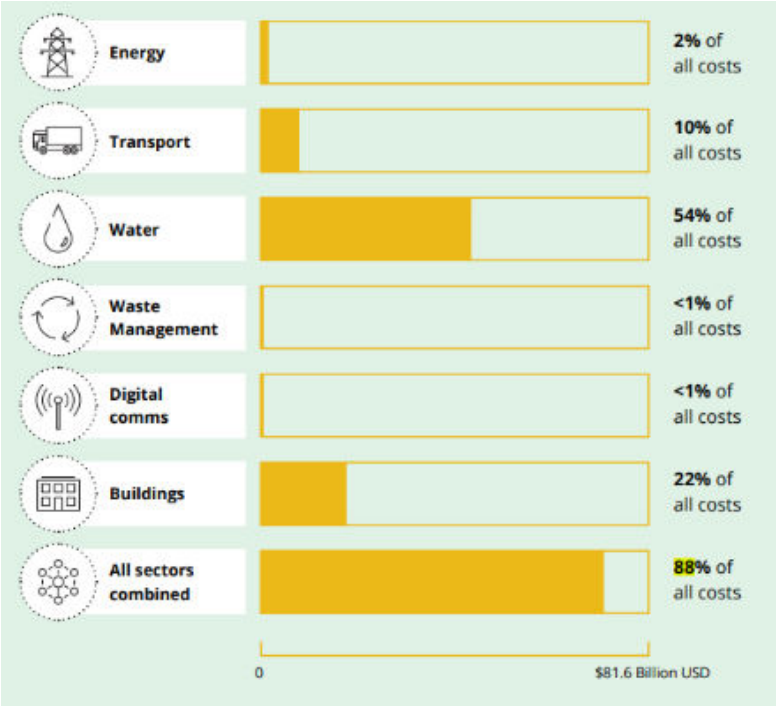


Figure 3.3: Infrastructure sector share of global climate adaptation costs (2010-50 estimates)

3.6 The net zero transition will occur at unprecedented scale and pace

The global transition to a low-carbon economy, which aligns with Paris Agreement outcomes, is estimated to require developed countries to invest $2.6 trillion collectively each year for the next decade.[18]

In Australia, alongside the cost, demands placed on our market capacity and capabilities are expected to increase significantly. Energy sector employment is predicated to increase from 1% to 4%.[19] This substantive increase is not occurring in a vacuum. The forecast for procurement and construction of public infrastructure over the next five years is projected to be in the order of $230 billion. Despite a recent reduction in our 5-year infrastructure investment pipeline over the past 12 months, sustained cross-sectoral demand as well as regional demand hotspots and labour shortages will prolong the pressure on construction capacity.[20]

Different initiatives and strategies support the infrastructure net zero goal, both at the national and international levels. In Australia, Infrastructure Net Zero aims to accelerate the transformation of the infrastructure sector by 2030 through collaboration, innovation, and action.

The Australian Government is developing a Transport and Infrastructure Net Zero Roadmap and Action Plan to reduce emissions across all transport modes and supply chains by 2050. Globally efforts are also underway:

- New Zealand has set into law a target for net zero greenhouse gas (GHG) emissions by 2050 and a number of initiatives to coordinate industry to achieve these goals.
- In the UK, the National Grid Group was established to decarbonise the electricity and gas systems and enable the transition to net zero.
- In Canada, the government has committed to achieving net zero emissions by 2050 and has introduced legislation and policies to support this goal. There are also other examples of public and private sector collaboration to form net zero agencies.[21]

3.7 The net zero transition will be costly and challenging

There is an increasing awareness of the challenge to achieve net zero, and political debate is starting to focus on how mid-term goals can be moved to reduce the short-term financial burden resulting in some scaling back of carbon emission commitments.[22] This departure is partially a consequence of black swan events such as Brexit, the Ukraine War and Covid. However, meaningful carbon reduction also has inherent difficulties. An indicative list of some of the barriers to infrastructure net zero include:

- **Political Will and Leadership:** Net zero requires strong political will, visionary leadership, and long-term commitment.
- **A lack of information about the infrastructure asset base:** Governments have a less than complete view of the assets under their and private sector control, and limited understanding of these asset and services emission's intensity.
- **A lack of optimisation of government bureaucracy and governance to mitigate climate change:** Mitigation falls under the remit of a number of government agencies, each with different levels of appetite and mandate to pursue the necessary actions for change.
- **Technological Innovation:** Developing and deploying new technologies requires substantial investment, research, and development.
- **Infrastructure Sector Change:** Overcoming inertia and persuading infrastructure sector participants to adopt net zero aligned practices.
- **Equity and Justice:** The transition to net zero must be equitable, ensuring that vulnerable communities are not disproportionately affected. Balancing economic growth, social justice, and environmental protection is a delicate task.
- **Cost and Investment:** Transitioning to net zero will involve upfront costs. Changing the mindset from capital cost only to life cycle cost as a measure will be fundamental.
- **Supply Chain Complexity:** Achieving net zero beyond individual organisations, and across sectors and geographies is challenging. Supply chains need to align their practices.
- **Adaptation and Resilience:** Even with net zero efforts, climate change impacts persist. Building resilience and adapting to changing conditions is essential.

The next section outlines:

- the importance of a common understanding and definition of net zero
- how net zero definitions provide a robust foundation supporting the industry in overcoming key emissions reductions challenges.

4 Developing an agreed definition of Net Zero for Infrastructure

Governments, industry, and community are largely united in the need and desire to reach net zero emissions. A foundational element underscoring this transition is a common definition of net zero.

The term 'net zero' is important since it indicates a state at which increases in global warming stop. The Paris Agreement underlines the need for net zero. It requires decision makers to:

> *'Achieve a balance between anthropogenic emissions by sources and removals by sinks of GHGs in the second half of this century'.*[23]

Despite the importance of this term, a consensus around how to interpret or apply the above definition in the multidisciplinary infrastructure sector does not exist. It is interpreted differently by stakeholders, governments, and communities. The issue of a lack of an agreed manner on how to interpret this definition is compounded by the broad and systemic scale of the challenge of reaching net zero, which has a cross-cutting effect across different sectors and communities, and stages of the infrastructure lifecycle.

4.1 The benefits of a uniform INZ net zero definition

A commonly agreed definition of net zero is critical to achieving net zero ambitions. The relationships between the net zero definition and the problem statement is presented in Figure 4.1.

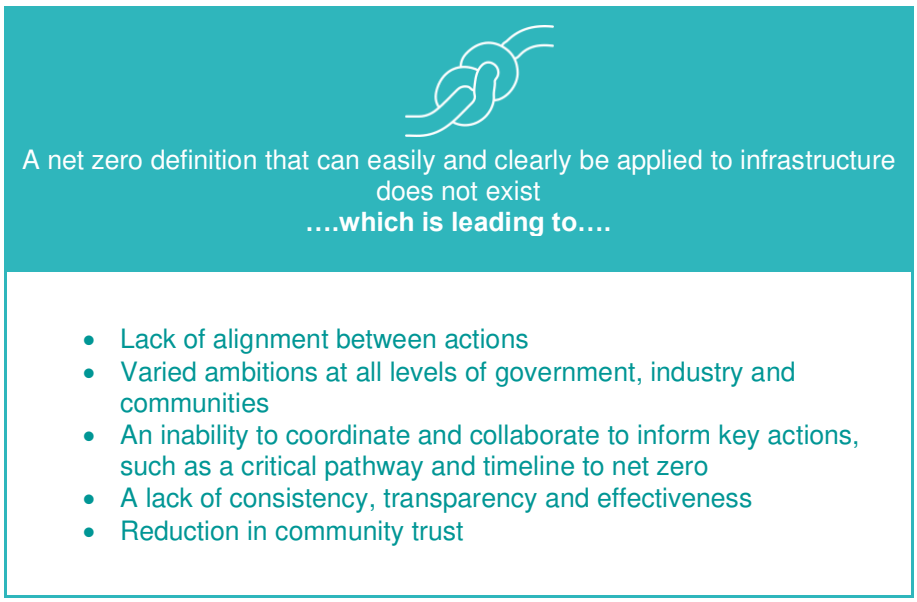


Figure 4.1: The need for a net zero definition for infrastructure

Having an agreed definition of net zero can align actions and ambitions of different actors and initiatives across the infrastructure sector, which are working towards this goal.

An agreed and well-crafted definition of net zero is critical to ensuring actions taken by different industries, countries, organisations, and individuals are consistent, transparent, and effective in reducing GHG emissions. A clear and unified understanding of what net zero means will

facilitate cooperation, accountability, and innovation among various stakeholders and sectors. The way to net zero is not a linear journey. There are different ways to achieve net zero emissions both in the short, medium and long term. Trade-offs are inevitable. Some methods may be more credible and sustainable than others.

The definition of net zero is not an abstract concept. It informs strategies, policies, engagement and forms the basis of accountability, measurement and reporting, and action. A definition will:

- Determine the strategic and operational decisions supporting the net zero transition.
- Act as the first, necessary step towards a framework to provide a nationally applicable and pan-sectoral net zero infrastructure sector transitional plan (Figure 4.2).

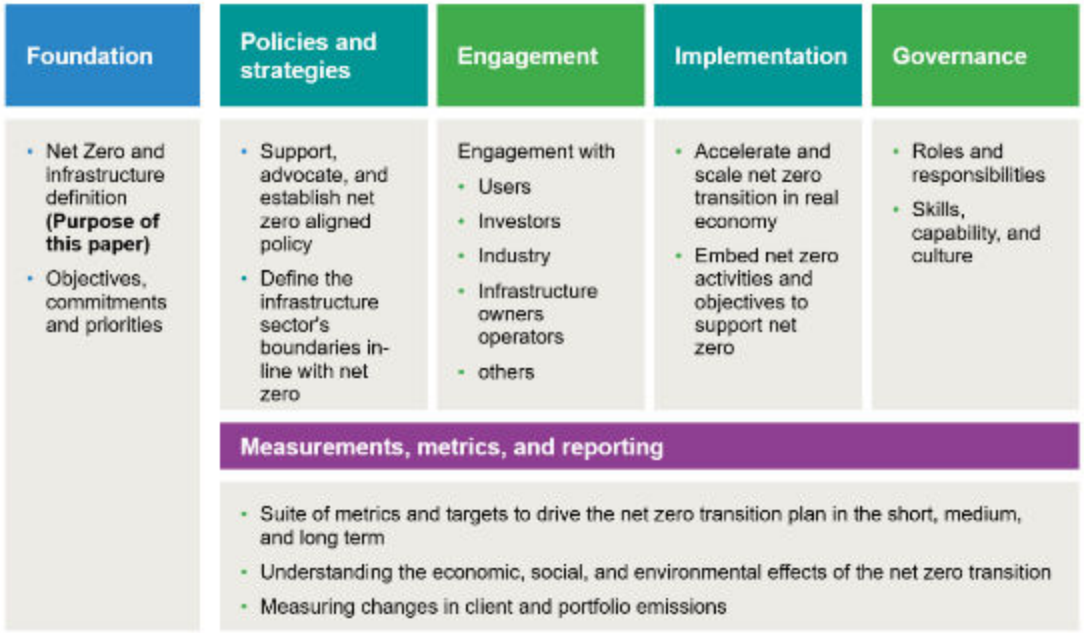


Figure 4.2: A net zero definition acts as the foundation for change

A shared definition of net zero across the whole of the infrastructure sector needs to consider how to cover all GHGs, all infrastructure sectors, and all sources of emissions.

4.2 The base net zero definition

In its most simple terms, net zero suggests the GHG emissions released into the atmosphere should be equal to the amount being removed from it. The term implies that the infrastructure sector either emits no GHG emissions or will offset its emissions through actions such as sequestration (tree planting, soil carbon etc.) or carbon capture and storage. In an infrastructure context, the term refers to the balance between the GHG emissions produced and removed by the infrastructure sectors, such as transport, energy, water, and waste.

The 'net' in net zero is important.[24] It will be very difficult to reduce all emissions to zero on the timescale needed. Cutting emissions and scaling up methods for removal will be required. To be most effective, the methods deployed should involve removing GHGs permanently from the atmosphere.

This broad, understanding of net zero requires translation into a commonly accepted definition, which can be applied by all infrastructure decision makers and practitioners.

4.3 Work to date domestically and globally can assist with the definition of net zero

Understanding the work undertaken to date can help with the formulation of a net zero for infrastructure definition. This discussion paper has reviewed this effort to try and establish the definition of net zero. Table 4.1 identifies existing definitions of net zero.

Table 4.1: Examples of net zero definitions, including for infrastructure

Report	Net Zero definition
World Economic Forum[25]	The term net zero applies to a situation where global greenhouse gas emissions from human activity are in balance with emissions reductions.
IPCC[26]	To 'go net zero' is to reduce GHG emissions and/or to ensure that any ongoing emissions are balanced by removals. Permanent or hard 'net zero' refers to a balance between all GHG sinks and sources that is sustained over matching time scales.
Glasgow Financial Alliance for Net Zero[27]	A state when anthropogenic emissions of GHGs to the atmosphere are balanced by anthropogenic removals.
Climate Council[28]	'Net zero emissions' refers to achieving an overall balance between GHG emissions produced and GHG emissions taken out of the atmosphere.
UK Office for National Statistics[29]	Net zero means that the total GHG emissions would be equal to or less than the emissions removed from the environment. This can be achieved by a combination of emission reduction and emission removal.
UN[30]	Net zero means cutting GHG emissions to as close to zero as possible, with any remaining emissions re-absorbed from the atmosphere, by oceans and forests for instance.
The Net Zero Asset Managers Commitment[31]	Net zero GHG emissions by 2050, in line with global efforts to limit warming to 1.5°C ('net zero emissions by 2050 or sooner').
McKinsey[32]	Net zero is an ideal state where the amount of GHGs released into the earth's atmosphere is balanced by the amount of GHGs removed.
National Grid[33]	Net zero refers to the balance between the amount of GHG that's produced and the amount that's removed from the atmosphere.

4.4 Variety of carbon-related terminology in the infrastructure sector

Net zero is a technical term. To understand its intended meaning, it must be used in conjunction with the intended focus on the emissions and the specific part of the infrastructure lifecycle of the asset in question i.e. net zero for construction, net zero in operations etc.

Locally, organisations have already adopted carbon definitions to inform their projects, services and carbon assessments. For example, the Green Building Council of Australia (GBCA) use actions, scopes, and standards to clarify net zero carbon definitions. In some jurisdictions, a set or family of definitions are adopted. Definitions always aim to align with the Australian government's aim to reach net zero emissions by 2050, and ensure best efforts to limit global

warming to 1.5 degrees Celsius, a trajectory which is supported by the Paris Agreement and the Science Based Targets Initiative (SBTi).

Adopting different or varying terminological definitions can result in large discrepancies in action and outcomes. As a result, well defined carbon-related terminology definitions are a crucial detail in articulating net zero definitions and associated implications by:

- Defining how different terms highlight the various methods for emissions sources and sinks consideration and calculation
- Indicating what is and is not included in the calculation or a target
- Dictating what consistent measurement entails and defining appropriate benchmarking and performance frameworks
- Outlining significant implications for what actions are required to reach net zero.

The list of terminology definitions below provides an overview of some of the most common carbon terms as well as detailed descriptions:

- **Carbon Neutral:** Carbon neutral sectors are those that address all their emissions so that the carbon account is zero. Actions can include energy efficiency, use of renewables, and offsets, and must be considered in that order. The measurement is on a net annual basis. In Australia, the term is defined by the Australian Government through the Climate Active Carbon Neutral program.[34] Carbon neutral usually applies to assets in operation rather than in development stage of the assets' lifecycle.
- **GHG Neutral:** An actor's net contribution to global GHG emissions is zero. Any GHG emissions attributable to an actor's activities are fully compensated by GHG reductions or removals exclusively claimed by the actor — irrespective of the time period or the relative magnitude of emissions and removals involved. Note, this is not a valid end-state target, as it does not require "like for like" balancing, but a possible intermediate step.[35]
- **Climate Positive/net negative:** Climate positive buildings are those that address all relevant emissions, but do so in a manner that drives our built environment to be in line with a 1.5C trajectory in the built environment. These buildings are fossil fuel free, highly efficient, fully powered by renewables, with lower embodied emissions, and with remaining emissions offset with nature – essentially removing carbon from the atmosphere.[34]
- **Carbon negative:** An actor's carbon removals, internal and external, exceed its emissions and any removals are "like for like". Must be specified over a declared time period, and whether removals and emissions are cumulative or represent only the time period specified.
- **Net Zero 1.5C aligned:** Target is aligned with scenarios that yield a long-term warming outcome of below 1.5°C with some probability (e.g. 50%, 66%) and some amount of overshoot (e.g. no, low), both of which should be explicitly specified.[36] Net zero as a term was agreed upon by the IPCC as a method of remaining consistent with 1.5C. For this reason, defining net zero, therefore, means that climate action is net zero aligned in order to advance progress towards this goal.
- **Science based/ Paris aligned** (such as SBTi's Corporate Net-Zero Standard)**:** Target is aligned with what the latest climate science deems necessary to meet the goals of the Paris Agreement — limiting global warming to well-below 2°C above preindustrial levels and pursuing efforts to limit warming to 1.5°C, with no or low overshoot.[37] This standard gives companies a clear blueprint on how to bring their net-zero plans in line with the science, which is non-negotiable and objective. It gives decision makers clarity and confidence that their near- and long-term decarbonization plans are aligned with climate science.[38]
- **Absolute zero:** No GHG emissions are attributable to an actor's activities across all scopes. Under this definition, no offsets or balancing of residual emissions with removals are used.[39]

- **Net Zero Embodied Carbon:** An asset where the sum of GHG emissions and removals over the materials and construction processes of an asset life cycle are minimised, meet local carbon targets and, with additional 'offsets' equals zero.[40]
- **Net Zero Upfront Carbon:** An asset where the sum total of GHG emissions, associated with materials and construction processes up to practical completion, excluding 'carbon sequestration' is minimised, meets local carbon targets and with additional 'offsets' equals zero.[41]

  Net Zero (whole-of-life carbon)**:** An asset where the sum total of all assets related GHG emissions, both operational and embodied, over the asset's lifecycle are minimised, meet local carbon, energy and water targets, and with residual 'offsets' equals zero.[42]

The most common net zero definition used by asset owners and financiers focusses on a state of net zero where GHG emissions align with science-based pathways, with any remaining GHG emissions attributable being fully neutralized, either within the value chain or through purchase of valid offset credits.[43]

5 Our proposed net zero definition for Infrastructure Net Zero

Our proposed net zero definition is intended to apply to infrastructure in a systemic manner. This acknowledges the inherent differences in infrastructure sub-sector's capability to individually reach net zero. There is a need for a systemic, coordinated, effort to reduce emissions considering the need for counterbalancing emissions-heavy subsectors, value chains, and individual assets which include unavoidable residual emissions.

This paper makes the case that 'Net Zero' for the sector (in line with international convention) means:

> *Achieving an overall balance between GHG emissions produced and GHG emissions taken out of the atmosphere.*

Further this paper makes the case that 'Net Zero for Infrastructure' should be adopted by Infrastructure Net Zero, with the following definition:

> *Where the sum total of all Scope 1, 2 and 3 related GHG emissions, including operational, embodied, and enabled emissions, over the infrastructure lifecycle, and at each stage, are minimised, meet local carbon targets, and with residual 'offsets,' equals zero.*

It is important to consider carbon at each stage of the asset life cycle and strategically prioritise emission reductions to best align with infrastructure type and industry-specific opportunities.

The Net Zero for Infrastructure definition considers existing and new infrastructure across the infrastructure sector and includes carbon emissions over the expected life of infrastructure. It is globally applicable, systemic, and pan-sectorial. The definition is intended to cover projects / assets, sub-sectors e.g. water, energy, rail, and the interconnected infrastructure sector. Organisational carbon accounting is covered elsewhere. Infrastructure-related GHG emissions include operational, embodied, and enabled emissions (Table 5.1) from:

- The creation of materials, products, and components
- Construction transportation and site activities e.g. transport of materials, plant and equipment operations, transport of plant and equipment, site-based utilities consumption, and removal / treatment of wastes
- Fuel, electricity and water consumption throughout the operating life of the asset
- Maintenance, repair, replacement and refurbishment activities to sustain the operational condition of the asset
- Transport-related and other GHG emitting uses enabled by the piece of infrastructure.

Table 5.1: Understanding operational, embodied and enabled emissions

Operational emissions[44] **Result from the ongoing operations of infrastructure assets.**	Embodied emissions[45] **Result from the production of materials used in the construction of infrastructure, as well as those from the construction process itself.**	Enabled emissions **Emissions are generated from third parties or ends users using infrastructure**
• Associated with the energy required to run the infrastructure. • Produced by the infrastructure's day to day occupancy and use. • Whether carbon is created by people managing the infrastructure or those who are occupying it.	• Associated with all the non-operational aspects of a building or infrastructure asset. • Generated as part of the manufacture of materials used in infrastructure as well as emissions created during the transportation of materials and the construction and demolition of building or infrastructure assets.	• Emissions are generated from third parties or end users using infrastructure. • Can generate more demand orientated solutions, such as prioritisation of infrastructure that reduces the amount of travel people require, such as public transport. • Accounted for 55% of Australia's emissions in 2018.46. • Enables a wider array of decarbonisation and demand-led actions to considered. Inclusion of this element will push decision makers to explore how they can incentivise people to engage with infrastructure in a way that reduces the project's whole-of-life carbon footprint.
Examples: • Energy used to provide lighting, power, heating, cooling, ventilation, and water services. • Vehicle emissions released by cars, trucks, buses, and other vehicles during operation. • Carbon emissions from waste incinerations, landfills, and sewage treatment plants. • Energy used by data centres, servers, cooling systems and infrastructure, for example, the Beryl Solar Farm in NSW supplying electricity for the Sydney Metro NorthWest project. • Installing LED lights rather than high pressure sodium bulbs in road street lights).	Examples: • Extraction, manufacture and assembly of a building's materials and components, its repair, maintenance and refurbishment, and end of life activities. • Transportation of material from their source to the construction site. • Energy required for the installation and demolition of infrastructure, and disposal of waste from demolished buildings.	Examples: • Energy and fuel use by user vehicles (road, aviation, water and rail). • Emissions associated with the use of energy at the point of energy consumption.

6 Considerations when reviewing the net zero for infrastructure definition

6.1 The benefits of assessing net zero and associated emissions across the infrastructure lifecycle

It is critical to provide a meaningful measurement for infrastructure projects and services, enabling more informed decisions that align with economic, sustainability, resilience goals, and climate action.

While a lifecycle perspective is essential in the context of defining and achieving net zero, it is important to consider carbon at each stage of the life cycle and strategically prioritise emission reductions to best align with infrastructure type and industry-specific opportunities.

A full lifecycle carbon assessment has the following benefits:

- **Collective understanding of the net zero task:**
  - *Aligned Net Zero Goals:* To reach net zero, an open and consistent carbon reporting will be necessary. Building designers, designers, constructors, asset owners, contractors and users can use full lifecycle carbon assessments as a common touchstone to scale to net zero buildings infrastructure.
  - *Understand the true carbon footprint***:** Lifecycle carbon assessments provide an accurate and true portrayal of infrastructure's carbon generation.
  - *Understand opportunities for reducing carbon emissions:* Assessing the entire lifecycle of infrastructure projects, including design, construction, operation, and end-of-life phases facilitates a more rigorous examination of how to reduce carbon through the infrastructure's existence.
- **Ability to take a systemic approach:**
  - *Ability to take a holistic, systems approach:* Carbon can be managed that is both within the direct control of the infrastructure and within the infrastructure's influence, which will enable place-based carbon assessment and action.
  - *Analysing at a system's scale:* Assets and services are capable of being seen in the context of networks, networks in the context of systems and systems in the context of other systems. Infrastructure carbon management frameworks, such as PAS 2080, instruct organisations to assess, as best they can, the chain reaction effects when planning, designing, specifying, constructing and operating assets.[47]
  - *Embedding net zero into assessment and appraisal:* At concept and/or business case stage of a transport asset understanding the full lifecycle carbon impacts between options can provide clarity on whether the project will enable significantly more carbon emissions from the fleets and vehicles operating on the asset or an overall low carbon solution is selected.
- **Better collaboration and innovation:**
  - *Greater collaboration:* lifecycle carbon assessment maximizes opportunities for joint carbon and cost reductions. This is particularly important when trying to reduce carbon in a place or at a cross-sectoral level.
  - *Enhanced innovation:* Collaboration can create opportunities for decarbonisation and, additional value generation, through shared solutions.
- **Finding the best solutions for users and taxpayers:**

- *Resource efficiency and cost savings*: encouragement of re-use of existing materials instead of new materials and the retrofit and retention of existing structures and fabric over new construction.
- *Discovery of optimum net zero solutions:* consideration of operational and embodied emissions simultaneously over the infrastructure's lifecycle.
- *Encouraging durable construction and flexible design:* greater longevity and less carbon emissions associated with demolition and new construction.

Figure 6.1 shows the modules used in a whole life carbon assessment over an infrastructure asset's entire lifecycle and the various terms that are used.

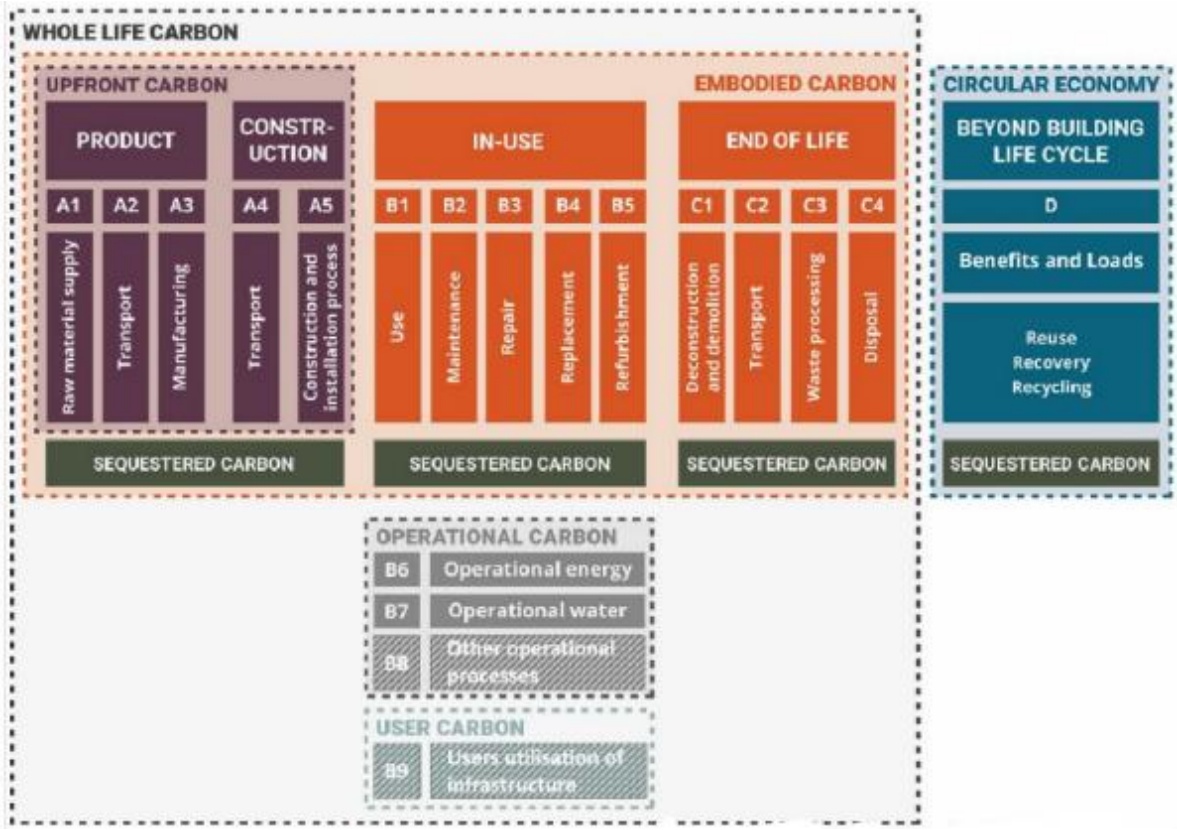


Figure 6.1: Modules used in assessing lifecycle carbon emissions

6.2 Avoided emissions

Avoided emissions (sometimes referred to as Scope 4 emissions), are not called out separately in the 'Net Zero for Infrastructure' definition. Avoided emissions recognise innovative solutions to lower emissions infrastructure, and supporting long-term and decision-making aligned with a net-zero world.[48] Avoided emissions represent the GHG emissions that are prevented from being released into the atmosphere due to the adoption of infrastructure or services that are more efficient or less carbon-intensive than conventional alternatives. This is particularly relevant for infrastructure which, through its design, can have an important emission's impacts through transport modal shifts and altering the proportion of renewable energy included in the grid.

Mandatory requirements to report avoided emissions do not exist in Australia and methods to measure and report are unstandardised.

6.3 This technical guidance is aligned with PAS 2080. A definition can catalyse immediate action

Sitting in isolation, a definition and carbon measurement system will not drive the required transition to a net zero future. However, a definition can act as the foundation for future actions. Below is an indicative list of actions that will benefit from the adoption of Net Zero infrastructure definition.

- **Define a systems map:** A systems map framework is a way of visualising and analysing the interrelationships between different elements of a system, such as activities, resources, stakeholders, and outcomes. It can help identify a critical path by showing the sequence of activities that determine the minimum completion time, as well as the dependencies and constraints. As reflected by the policy scan, a need exists for decision makers to understand what they are responsible for and in what period. This will break down the siloed approach and encourage an understanding of interdependencies and connections.
- **Define measurement standards:** Use whole-of-life carbon assessment to define metrics, targets and credible carbon accounting. These are used to assess and manage relevant emissions. These tools can be used to create infrastructure carbon reports, which detail whether the public and private sector are making informed decisions with respect to carbon and achieving sufficient progress.
- **Adopt a whole system approach:** No one organisation has direct control over all carbon sources or solutions. Decarbonisation calls for systems awareness, coordination and collaboration – vertically from top to bottom of the value chain, and horizontally within and between sectors. This can be accomplished using a whole of system approach. This approach accounts for a broader spectrum of outcomes, which better align with community needs and preferences, such as economic, social, environmental and governance/cultural outcomes.
- **Create a roadmap for carbon reduction:** The roadmap should detail the necessary settings to ensure whole-of-life costs form the basis of reporting and goal setting, and are systemically embedded into all infrastructure governance, strategy and risk management.

7 Consultation process and questions

7.1 Consultation process through Infrastructure Net Zero within ASBEC

Infrastructure Net Zero as an enabler for consultation

Infrastructure Net Zero (INZ) brings together key stakeholders across all sectors and asset classes to co-ordinate, collaborate and report on infrastructure's pathway to net zero in a manner that aims to deliver value for community, government, industry, and the environment. It is a collaborative forum committed to creating an aligned, efficient, and effective use of collective time, resources and expertise to work on the highest priority initiatives and to drive lasting policy change and industry innovation.

Infrastructure Net Zero is premised on the idea that strong leadership and collaboration across the industry is required to achieve net zero quickly, while keeping our sector globally competitive and functioning in the best interests of users, taxpayers, and the community. Infrastructure Net Zero's primary objective is to decarbonise Australia's infrastructure through collective action to meet or exceed our national targets of 43% by 2030 and Net Zero by 2050.

Context to engagement

To accelerate effectiveness of these efforts in promoting system-wide decarbonisation and reaching net zero objectives, an infrastructure net zero definition can assist by providing clarity and applicability for industry sectors seeking compliance with legislation, as well as support and uplift leaders in their efforts in aspirational / beyond compliance responses. The following questions are proposed to ensure that the infrastructure net zero definition assists with these objectives.

7.2 Consultation questions

The key consultation questions are:

1. Do you agree with the definition?
2. Does the definition provide a clear point of reference and boundary for infrastructure net zero – to be used within procurement and for operational implementation?
3. Does the definition include sufficient flexibility and applicability to account for changing and evolving areas of focus (upfront carbon, whole life carbon, avoided, etc.)?
4. Do you suggest any additions or changes to the definition?
   a. What and why?
5. What is the value to you of a commonly understood and applied definition?
6. Avoided emissions (sometimes referred to as Scope 4) has been an emerging area that is not covered by the definition. Do you agree?
   a. Why?
7. INZ completed a 2023 policy review (within the document) and are currently updating this for 2024 (prior to 2025 report launch). Currently the Infrastructure Australia Embodied Carbon report, INSW net zero launch, DITRDCA and CCA sectorial plans are due to be added.
8. What else has changed and progressed over the last 12 months in the net zero and decarbonisation policy landscape?
9. INZ is undertaking a skills review, what other critical areas should INZ focus on in the future?

7.3 Consultation next steps

Infrastructure Net Zero joined the Australian Sustainable Built Environment Council network in June 2024 and is thrilled to be working with the Green Building Council of Australia and the Infrastructure Sustainability Council to run an industry engagement process at end of 2024 and early 2025.

Key dates are:

- **Consultation launch**: October 2024 at Infrastructure Sustainability Council conference, with accompanying online webinar. Online consultation launched.
- **Consultation webinar:** 30 October 2024
- **Consultation close**: End November 2024 online consultation closes.
- **Detailed updates**: December 2024 to March 2025 the report will be updated for feedback, and to add detailed policy additional reviews identified through consultation.
- **Final report launch**: March 2025 launch at Australian Sustainable Built Environment Council Adelaide event.

Appendix A: Distilling the wealth of infrastructure net zero information

Understanding the work to date to advance infrastructure net zero

Infrastructure Net Zero members have identified five common priority areas of work required to ensure the infrastructure sector can most effectively contribute to the net zero journey:

- **A National Plan & Pathway:** Support the development of a national plan to decarbonise infrastructure, creating pathways for critical assets that optimise wider socio-economic benefits.
- **Policy:** Encourage policy, investment, and incentives at state and federal level to assist with the transition to renewable energy, sustainable materials and advanced manufacturing.
- **Procurement:** Co-create governance structures, processes and approaches for reducing emissions with transparency and through sound decision-making.
- **Capability Building:** Identify the core skills gaps, create access to knowledge and build capability.
- **Technology:** Trial, adopt and promote technology solutions that optimise a holistic approach to an asset's lifecycle from design through to end of life

A wealth of infrastructure sector, net zero related reports already exist. They provide a vast array of information on each of the priority areas. However, how these reports interlink and what gaps exist is often misunderstood. This section articulates the key findings and actions associated with these reports, and orders them in accordance with the Infrastructure Net Zero common priority categories (see Table A.1). By doing so, we aim to:

- Understand the strengths, weaknesses and gaps in our current approach
- Seek out any information or consensus that would assist with the formulation of a net zero definition
- Understand the alignment of current infrastructure reports with Infrastructure Net Zero identified measures
- Help prioritise and focus effort on the right areas, to establish a robust performance measurement framework
- Understand the inputs that would inform an infrastructure orientated system's map
- Get a better understanding of who is accountable for action and in what timeframe.
- Assist with the understanding of currently implementation, barriers, challenges and successes, with a view to assisting with measurement and reporting.

It is acknowledged that several new policies and reports have been published since the material below was collated. 2024 policy release documents will be added in the final report.

Table A.1: 2023 infrastructure net zero policy landscape

Report name, authors, release date and summary	Actions and findings					Implications for INZ and net zero definition
	A National Plan & Pathway Support the development of a national plan to decarbonise infrastructure, creating pathways for critical assets that optimise wider socio-economic benefits.	**Policy** Encourage policy, investment, and incentives at state and federal level to assist with the transition to renewable energy, sustainable materials and advanced manufacturing.	**Procurement** Co-create governance structures, processes and approaches for reducing emissions with transparency and through sound decision-making.	**Capability Building** Identify the core skills gaps, create access to knowledge and build capability.	**Technology** Trial, adopt and promote technology solutions that optimise a holistic approach to an asset's lifecycle from design through to end of life.	
The Journey to Net Zero – Inspiring Action in the Australian Transport Sector **KPMG, Roads Australia, Australasian Railway Association, Infrastructure Sustainability Council, Arup** **2022** 	**Finding:** It is critical for the industry to work together and act in unison to create change and help build a sustainable future. Governments, businesses and transport users can achieve rapid decarbonisation at scale, provided they work together. There is a need for the power of collective industry action to drive these actions. **Finding:** An integrated, connected and responsive transport network that aligns with how we work, live, and connect is essential to meeting the needs of generations to come. **Finding:** To arrive at a low carbon future with zero emissions, transport and connected and fluid active transport systems, we will need significant political will, bipartisan support, collaboration at all levels of government and community engagement. **Action 1: Create a national, strategic approach to the transport sector and its infrastructure revolving surrounding placemaking.** • Advocate for a national measurement framework • Advocate for a national and coordinated approach to regulations • Implement an integrated design approach • Advocate for a coordinated approach to place making • Ensure systems thinking, circular economy and whole-of-life choices are utilised • Advocate for a coordinate planning approach by governments	**Action 2: Policy, investment and incentives for efficient, sustainable and resilient transport systems should be introduced.** Federal and state policy change will be necessary to attract investment in technology and solutions for renewable energy, sustainable material and manufacturing. Regional areas will require investment in infrastructure alongside incentives to transition away from internal combustion engines. **Action 3: Introduce policy, investment, and incentives for an efficient, sustainable and resilient transport system both at a state and federal level.** • Advocate for the Australian Government to increase investment and incentives in the technology that is requited to support transport decarbonisation. • Support discussion with industry and government on pathways to transition to renewable sources of energy generation • Advocate for investment in cross industry working groups to create a comprehensive blueprint for our communities • Advocate for greater investment in financial vehicles that benefit the community, environment and social needs • Advocate for all new infrastructure projects to incorporate net zero emissions targets • Advocate for all new and existing infrastructure projects to consider climate resilient and climate impacts in their design and operations • Advocate for investment in new zero emissions hydrogen energy sector • Advocate for the development of government policies and incentives that will attract investment • Implement requirements in the draft National Construction Code of Australia (NCC) • Advocate for a national policy and incentives to assist in driving the uptake of Electric Vehicles (EVs) and Fuel Cell Electric Vehicles (FCEVs) • Build on the Modern Manufacturing Strategy • Introduce fuel efficiency standards • Advocate for enhanced carbon sequestration and biodiversity outcomes.	**Action 3: Place making is required for a sustainable transport network. A national approach to placemaking is required** and is best planned and implemented at a local level. The general aims should be for private vehicle use to reduce. **Action 4: Government and industry should work together from the outset of projects, at the business case and investment decision phase**, to recognise carbon as a material issue to be addressed, create significant carbon reduction targets, include a shadow carbon price, and optimise the solutions to address social, environmental, governance and cultural needs and issues. **Finding:** Greater governance, accountability and transparency is needed for decisions relating to our transport infrastructure. Decisions should be clear and supported by a strong community consultation process. **Finding:** Circular and whole-of-life thinking should inform decision making and materials selection. **Action 5: Implement exemplar governance structures, process and approaches to drive transparency and enable sound decision making.** • Advocate for the adoption of sustainability performance standards • Facilitate industry wide collaboration • Advocate for a new ownership and delivery mode for government infrastructure • Advocate for the adoption of sustainable procurement practices • Advocate for Life Cycle Analysis • Incorporate transparent processes in decision making at all gates of the project lifecycle • Advocate, as a key part of the sustainable procurement, for governments to ensure policy incorporates whole-of-life assessments into early decision making • Advocate for business cases to include the environmental, social and cultural benefits • Engage with industry, government and regulators to create a nationally approved supported approach to the measurement, identification and selection of low carton materials, products and services • Advocate for collaborative contracting models such as alliance contracting to impose upon social, sustainable and cultural outcomes.	**Finding:** Collaboration and capacity building and education should be enabled at all stages of an asset's lifecycle. **Action 6: Enable collaboration, capacity building and education at all stages of the process.** • Build upon this report by seeking further input from industry. • Educate key stakeholders on systems thinking, circularity and whole-of-life principles. • Encourage collaboration to facilitate the multi-pronged approach necessary to overcome barriers and increase uptake of low embedded carbon construction strategies. • Advocate for early engagement and collocative approach with industry • Coordinate activities across industry/government to develop better and more coherent policies and drive innovation in industry to transition to a low carbon economy • Advocate for a change in culture to allow sustainability to be integrated into the design and planning of infrastructure • Engage with all construction partners on upcoming governments driven projects • Build capacity across all stakeholders • Foster a culture of sharing to ensure lessons are learnt • Establish integrated project teams • Utilise key infrastructure projects with innovative solution or high social, environmental or cultural benefits to build capacity within the industry	**Finding:** Innovation and technology needs to be adopted and promoted to optimise both asset design, construction, operation and enabled solutions. **Action 7: Adopt and promote technology solutions that optimise asset design, construction operation and road and rail fleets.** • Advocate for a national and coordinate effort to attract investment in renewable energy solutions • Adopt technology solutions that incorporate transparency and accountability • Increase the use of active monitoring of infrastructure assets and incorporate predictive maintenance regimes. • Engage with industry to ensure all infrastructure projects are created using BIM and internationally recognised open-sourced protocols and standards. • Phase out diesel trains.	The report is focused on land- based transport and associate infrastructure which includes road, rail, buses, intermodal and active transport solutions such as pedestrian and bicycle paths, and other related infrastructure. The key drivers for change are: • The electrification of our fleets • Investment in sustainably produce biofuels. • The development of a zero-emissions hydrogen industry The paper proposes a vision for a future where people and communities are connected through safe, accessible, resilient and efficient transport systems. There is no discussion about the definition of net zero in this paper.

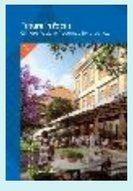
Place-based Approaches to NetZero **Infrastructure Sustainability Council and Mott MacDonald** 		**Action 1: Reconnect and realign with purpose.** Advocating for sustainability and climate action to be a core objective of the infrastructure reform agenda. Creating opportunities for the sector to collaborate and develop ways of working that embed quadruple bottom line outcomes in infrastructure planning from earliest possible opportunity. **Finding:** A systems approach, that looks at the interconnectedness of infrastructure rather than at the sector and sub-sectors in isolation, is required for place-based approaches. **Finding:** It is only by understanding the unique context of a city or region and its systems that we can truly conceptualise the net zero solutions, opportunities and barriers. Treating the city and regions as a system-of-systems can help governments understand where potential vulnerabilities exist, and highlight the best places to instil new resilience, resulting in lower long-term costs for the city and regions. **Finding:** Digitalisation is key to better identifying and understanding city and regional systems, system efficiencies and their solutions.	**Finding:** A place-based approach, the principles of how we conceive of, plan for, implement and operate our city and regional systems must change to embrace a different cross-sectoral governance structure. This involves co-design, a systems approach and innovation. **Finding:** Collaboration and new innovative models of governance and partnerships should be introduced to overcome barriers and enable transition at pace. **Finding:** The benefits of a localised and place based energy transformation with appropriate governance could be substantial. **Finding:** Looking at land use and urban planning through a place based net zero lens and creating analogous governance structures is likely to stimulate an appreciation of wider benefits.	**Action 2: Bring people around the table. The Infrastructure Sustainability Council will:** • Convene an ISC Member Coalition of committed infrastructure leaders to drive this approach forward by piloting placed-based practices across Australia and New Zealand. • Being an active, inclusive community member and collaborator who partners across industry to help every person and organisation find their voice and role in delivering positive climate action and net zero places. • Join the ISC Member Coalition, or in an act of collaborative leadership, start your own conversation. **Action 3: Rapidly invest to build our capability. We need a bigger, better, more accessible toolbox.** Climate action needs to be embedded in our systems, policies and culture so people are empowered to act. The Infrastructure Sustainability Council will do its part by: • Supporting the rapid rise of capability across our multi-disciplinary sector so that we have many hands lightening the load. • Collaborating with members to develop common sector-wide tools, resources and systems that will support collective climate action for all. • Making the IS Rating Scheme more accessible and scalable and through partnerships that embed sustainability in the digital-by-default agenda. • Make sustainability and climate change the core objective of your digital agenda. • Invest in your people by building their skills and capability, but more importantly empower them to challenge norms, think creatively and experiment with new ideas that have the potential to create positive change. • Collaborate to develop common industry-wide tools, knowledge and systems that reduce the learning curve and normalise climate action.		The paper provides a call to action for the infrastructure sector, and outlines a leading role for the sector in delivering climate action. The report does not provide information relating to a net zero definition.
A net zero future - delivered through our infrastructure pipeline **Autodesk, Consult Australia, Infrastructure Sustainability Council of Australia, Australian Constructors Association** 		**Finding**: Delivering a net zero future will require a systems-based approach which will also need to undertake at times complex and multifactorial analysis. The pathway to achieving net zero requires consideration of the integrated nature of infrastructure. **Finding:** Considerable carbon reductions may be achieved within existing budgets, and in most cases will even reduce cost. Practical activities are being deployed as business-as-usual on major infrastructure projects to reduce carbon at the planning and design, and construction phases. **Finding:** Embodied Emissions from Materials Studies indicate emissions from materials and construction (embodied emissions) could be nearly halved by using current best-available technologies and methods. **Action 1: Harmonised decarbonisation policy for public infrastructure;** Align investment decision-making with stakeholder expectations; Embed sustainability and	**Finding:** Focusing procurement reform on productivity, maximises long-term social, economic and environmental value. **Action 2:** Rapidly innovate and adopt substitute or alternative low emission products particularly with high materiality (e.g. steel, concrete and asphalt). Maximise resources by adopting circular economy practices. **Action 3:** Build capability, embed responsibility, incentivise innovation and fairly allocated risk. Encourage and reward collaboration and sustainable outcomes.	**Finding**: The following principles are required to achieve a net zero future: • Rethink and redefine: Ask if new infrastructure is always the answer during problem identification and optioneering. • Repurpose, recover and recycle: Monitor and optimise performance of existing assets. • Reduce: During the construction phase, reduce emissions using low-carbon materials, streamlining delivery approaches and minimising the consumption of resources. • Regenerate: Leave a net positive environmental legacy. **Finding:** Our industry is strongly placed to help enable this transition over the next decade because of its role in shaping societies and economies and through its unique position to influence emissions reductions, leverage investment, and respond to policy incentives from government, proponents, and asset owners.	**Finding: Advancements in digital design methods, standards and technologies provide platforms for practically implementing a net zero vision.** This range from asset introduction, engineering, procurement and construction, operations and maintenance to demolition and decommissioning. **Action 6: Accelerate investment and uptake of new technology with incentives to catalyse innovation, productivity and holistic value delivery.** This can include improved; data and insights, automation, efficiencies across the value chain, design and modelling outcomes, resilience and futureproofing of assets. **Action 7: Adopt consistent sustainability and emissions targets,** metrics and indicators across the asset lifecycle. Leverage technology for transparent monitoring and reporting across the quadruple bottom line.	There is no discussion about the definition of net zero in this paper.

		emissions-reduction in business-case development.		**Action 4: Improve industries culture, capability and capacity to lead the step change.** This can include training and upskilling, implementing the culture standard, adopting principles-based engineering, valuing collaboration over competition, and measuring and rewarding delivery of sustainable outcomes. **Action 5: Identify and implement low emission methodologies for key processes** (e.g. heavy transport, excavation etc.); Harmonise national standards and guidelines for low emission methodologies across design, construction, and maintenance.		

Reshaping Infrastructure for a Net Zero Future
 	
Infrastructure Sustainability Council, Climate Works Australia, ASBEC, CEFC, the Queensland Government
 	
 
 	
	Finding: Emissions reduction strategies need to be coordinated with parallel efforts to build infrastructure that is resilient to the impacts of forecast climate change.
	
	Finding: Identifying the need to transition to a net zero emissions economy as a high priority strategic objective for infrastructure, should be undertaken.
	
	Finding: Planning for sector transitions to net zero emissions (e.g. in electricity and transport), and identifying strategic infrastructure needs and priorities to enable these transitions, should be undertaken.
	
	Finding: A comprehensive analysis on the physical impacts of climate change for infrastructure is critical to acknowledge the importance of planning, designing and building resilience in infrastructure alongside our transition to a net zero emission future.
	
	Finding: The global transition to net zero emissions is also a key trend relevant to today's infrastructure choices.
	
	Finding: Decisions made about infrastructure today – what infrastructure is needed and where, which projects to prioritise, and how to build and operate these projects – are decisions that will shape Australia's future
		Finding: No better understand the challenges and opportunities in reshaping transport, energy, water, communications and waste infrastructure for a net zero emissions world.
		
		Finding: Infrastructure unprepared for a net zero emissions future risks becoming 'stranded' due to significant and unanticipated losses of value and faces restricted pools of financing.
		
		Finding: Decisions made about Australia's infrastructure need to be responsive to broader policy and economic trends.
		
		Finding: Infrastructure is facing increasing pressure on two fronts to prepare for the net zero emissions economy: Government policies targeting net zero emissions, in line with the Paris Climate Agreement, and demands from private investors and insurers to future-proof the economic value and returns of infrastructure assets, in preparation for a net zero emissions world.
		
		Finding: Infrastructure that is prepared for a net zero emissions future and is resilient to climate change impacts offers investors the opportunity to continue receiving the long term, reliable returns of traditional infrastructure investments, with reduced transition and physical risks associated with climate change.
		
		Finding: Strategic planning advice right at the beginning of an infrastructure project can be the most consequential for emissions outcomes
		
		Finding: There is an urgent need to prioritise emissions reductions in line with net zero emissions in the assessment, planning and decision making processes for infrastructure today
			Finding: To successfully prepare for a net zero emissions future, emissions reductions need to be prioritised at all stages of infrastructure planning, business case development, delivery and operation
			
			Finding: Infrastructure bodies, governments, investors, designers, builders and operators have a shared responsibility to support the transition to net zero emissions within their own scope of influence, and collaborate with the broader sector to deliver solutions
			Finding: Interdependencies between sectors need to be explored to leverage potential opportunities
			
			Findings: The report provides potential opportunities to prioritise emissions reductions in each phase of an infrastructure project. These include opportunities at the following stages:
			• Strategic planning
			• Project initiation, development and procurement
			  ○ Prioritising emissions reductions and setting an overarching goal of net zero emissions as part of assessment frameworks for infrastructure
			  ○ Pricing the estimated enabled, operational and embodied emissions by valuing emissions in cost-benefit analysis, in line with a transition to net zero emissions by 2050 Design and construction
			• Design and construct
			  ○ Undertaking real options analysis conducted to explore how to stage design and construction processes to adapt to new information
			  ○ Showing evidence that options to reduce construction emissions were explored and taken where financially feasible
			• Operations and maintenance
			  ○ Seeking opportunities to reduce operating emissions
			  ○ Reviewing projects post-completion
			• Decommissioning.
						This Issues Paper makes the case for why emissions reductions should be prioritised in infrastructure advice and decisions today.
						
						It provides context to inform how to define net zero.

Decarbonising Infrastructure **Infrastructure Partnerships Australia**	**Energy actions:** Support the development of a national plan to decarbonise infrastructure, creating pathways for critical assets that optimise wider socio-economic benefits. • A lack of national leadership and coordination on the energy transition has	**Energy actions:** The transmission grid was built for a different type of energy production in another era, and has become constrained with what low- to zero-emission sources can contribute to its electricity supply. • National leadership needs to empower Australia's energy market bodies to take	**Construction, operation and waste actions:** Procurement is underutilised as a tool for incentivising innovation in design and construction to drive decarbonisation across asset lifecycles. • Governments need to determine the assets they want to buy, in line with their		**Freight fleet action: The vast majority of freight haulage relies on fossil fuel-powered vehicles, but the timeline for a commercially-viable transition to zero-emission heavy vehicle technology is uncertain.**	This report sets out a high-level assessment of the policy action required to decarbonise Australia's infrastructure sector, across its asset classes. It covers energy, transport, and asset management during construction, operation and waste.

	resulted in a patchwork of overlapping and competing strategies and policies. • The Federal Government should coordinate with state and territory governments to create a clear, national energy transition plan with solar and wind, an appropriate mix of firming technologies, and transmission network capability. • Pursuit of a net zero emissions by 2050 target will be enhanced by interim targets along the way. • Industry and government stakeholders should improve coordination and engagement to augment the role of existing mechanisms, in the energy transition. **Energy action:** The precise mix of generation sources, firming and storage technologies in a low-emission energy system is unclear. • A national transition plan should capitalise on commercially-viable solutions in the near term, while supporting studies and pilots to accelerate development of currently sub-commercial solutions, including green hydrogen, over the medium- to long-term. Planning should not wait for these technologies to emerge, but plan for their integration within an already rapidly decarbonising energy system. **Freight fleet actions:** There is no national transition plan for heavy vehicles and the role of Australia's transport networks in a decarbonised future. • Federal and state bodies through National Cabinet should develop, consult with industry on, and implement a cohesive national plan for the decarbonisation of freight transport. • Governments should build on the work in the National Freight and Supply Chain Strategy to identify and address gaps and deficiencies in nationally significant freight corridors and locations.	accountability for the delivery of a grid that supports a decentralised, low-emission electricity system, and ensure market participants are able to attract the necessary capital and resources to make the transition. • Regulators and policy makers should seek to accelerate and simplify planning and regulatory approvals for transmission upgrades required to support the energy transition. They should also undertake reform to ensure that regulated transmission network projects needed for the transition are commercially-viable so they can proceed with certainty. **Energy action:** The absence of a plan for existing fossil fuel assets that may be stranded in the wake of the energy transition. • Governments should adopt a hold-and-transition-fossil-fuel-assets approach for responsible owners to follow, requiring the orderly withdrawal of coal and fossil fuel-based energy production, followed by the transition of sites to renewable generation or storage facilities. **Mobility fleet action: Australia's light vehicle transition is slower than other countries, despite availability of low- to zero-emission vehicle technology in the market.** - The Federal Government should explore the economic benefits and costs of policy or regulatory to expedite the uptake of new low- or zero-emission light vehicles. This includes national standards on vehicle emissions, addressing gaps in urban and regional charging networks. **Mobility fleet action: Left unchecked, rapid uptake of EVs could place local electricity systems under strain.** • State and territory governments should work with distribution network providers to identify potential shortcomings in infrastructure, regulations and planning to cater to increased demand from EV uptake. • All governments should continue to support trials and pilots of distributed energy technologies and pricing arrangements to optimise integration of EVs within local grids. **Mobility fleet action:** The majority of public transport buses are diesel-powered and emission-intensive. Many heavy passenger rail services draw large volumes of electricity from the grid, much of which remains non-renewable. • State and territory governments should commit to transition their bus fleets to zero emissions and set a target for full transition. • Bus operators should work with energy distribution companies to ensure adequate, reliable supply of electricity to zero emissions bus depots. • Passenger train and metro operators should sign Power Purchase Agreements to support uptake of renewable electricity	net zero commitments, and set these as clear outcomes sought in procurement processes, letting the private sector compete for this lower-carbon work. • Public procurement agencies should seek and support bids which use of digital design and planning tools to test new methods, optimise the efficiency of construction and the whole-of-life emissions of assets, as well as bids which incorporate lower-carbon materials and products in construction. • Public sector institutions should adopt new risk appetites, agreeing to innovative solutions that will reduce emissions embedded in the projects they sign off on. **Construction, operation and waste actions:** Regulation of existing assets may inhibit owners and operators from implementing improvements to reduce emissions through technology, construction, or pricing solutions. • Regulators should provide an avenue for asset owners and operators to propose measures that would reduce emissions, provide pricing incentivises for more efficient customers, or prepare for use of networks by lower-emission customers. • Asset regulation should focus on outcomes in relation to emissions and energy use, rather than restrictive measures. **Construction, operation and waste actions:** Emissions data for construction, operation and waste lacks detail, clarity, and reliability, including assessment of supply chain and material-related emissions. • Governments should work with industry to develop agreed reporting guidelines for calculating emissions from infrastructure construction, operation and waste activities, and report, tracking progress against long-term targets. • The Federal Government should introduce reporting requirements on Scope Three emissions under the NGER Scheme to increase visibility of emissions generated through the operation and use of infrastructure and track performance over time. **Construction, operation and waste actions:** Australia's construction standards do not sufficiently integrate or promote sustainability and decreased emissions – or address embedded emissions across the construction supply chain. • Governments should undertake a review of construction standards to ensure they reflect global best practice and promote the use of more sustainable, lower-emission methods and materials. These reforms should allow for innovation and piloting new techniques and materials. • Governments must ensure transformation in risk-adverse practices within public sector institutions, who need to adopt risk-friendly appetites towards projects proposing innovative low-carbon solutions. **Construction, operation and waste actions:** Australia's regulations provide		• Governments should bring forward the development curve for a range of potential solutions by supporting real world deployment. These could be better coordinated among academic, public and private sector stakeholders by tying research to common national objectives. • As technologies approach commercial viability, governments should enable pilots and trials within flexible regulatory arrangements, and look to accelerate the transition of fleets to lower-emission solutions. This may include applying incentives for the adoption of low- or zero-emission technologies, or through phasing out schemes that support fossil fuel powered heavy vehicles. • Regulators should work with industry to identify potential barriers to implementation of zero-emission freight in future, and ensure these are addressed before enabling technologies become commercially available.	There is no discussion about the definition of net zero in this paper.

		generation and certify their services as zero emissions. **Mobility fleet action:** Transport and land use planning in many parts of the country remains highly disconnected and fails to efficiently connect people to services and jobs, or encourage efficient transport modes. • State and territory governments should implement measures to encourage peak spreading, while continuing to enhance transport users' experience. • State and territory governments should work closely with local governments to address gaps in transport provisions and ensure the provision of new housing supply is coordinated with adequate transport capacity. **Freight fleet action:** The local and last-mile freight task is growing rapidly in line with the popularity of e-commerce, bringing increased emissions, pollution and noise in urban areas. - Governments should support and accelerate electrification of the local freight fleet. For instance, authorities should allow electric trucks to make deliveries outside of regular hours. State and territory governments should consider providing special access to designated low-emission zones in urban areas.	barriers to the development of infrastructure technologies and facilities that have proven successful in reducing emissions in other parts of the world. • State and territory governments should review and update regulatory and planning frameworks to remove barriers to the development of technologies and facilities that can reduce emissions, are supported by strong evidence, and provide clear guidance to their respective planning and environmental protection agencies. • Where new technologies and facilities are introduced in Australia and best practice standards for the operation exist, these should be adopted and applied through nationally consistent regulation. • State, territory, and local governments should support the development of energy-from-waste facilities by providing nationally consistent regulations for feedstock, and supporting the development of a market for by-products. **Construction, operation and waste actions:** Private investment in infrastructure is under utilised as a driver of decarbonisation, and Australia risks missing out on access to ESG-focused global capital unless it sharpens its focus on providing a solid, politically-neutral commitment to achieving net zero-emission infrastructure. • Governments should provide greater confidence to investors about Australia's long-term commitments and transition strategies. Public procurement agencies should routinely considering whether there is a role for private finance to accelerate investment in zero-emission initiatives, unlock innovation and support a greater focus on whole-of-life outcomes. • Infrastructure investors should integrate ESG factors within their investment and asset management frameworks. • Federal and state governments need to actively work with the private sector to encourage and incentivise investors to define a transition pathway for existing assets.			
Future in focus - climate positive roadmap for precincts **GBCA** **2022**  **The roadmap sets the trajectory and actions that need to happen to decarbonise precincts. As such, the roadmap:** **Sets out the principles and outcomes to delivering climate positive precincts**	**Action: Government should set zero carbon targets for all government delivered and operated social and transport infrastructure**	**Action: Commit to fossil-fuel-free precincts and ensure policy and planning processes:** • Developers need to commit to gas free, all electric developments and facilitate renewable energy use. • Governments need to ensure policy and planning processes recognise gas as a harmful fossil fuel and ensure local development requirements do not mandate gas connection. • Peak bodies, governments and education institutions must work together to ensure ongoing education of industry and the community about the benefits of a gas free future and how to deliver all electric buildings and precincts. **Action: Remove the barriers to low carbon precinct energy solutions.** • Energy market operators and regulators need to establish clear, efficient, and	**Action: Embed climate positive pathways into all stages of planning:** • Planners and policy makers must integrate a climate positive approach across key policies and frameworks. • City and regional planning policies need to acknowledge the urgent need for decarbonisation and provide clear pathways for development that align with the climate positive principles and goals. • Precinct scale planning and urban design needs to align with the goals for climate positive precincts, and the climate positive principles. • Early strategic and infrastructure planning needs to evaluate and drive decisions that lead to low carbon outcomes . • Knowledge and capacity need to be built amongst planners and urban designers on their role in driving climate positive precincts, and the use of modelling tools and processes that can support them in doing so.	**Action: Government should:** • Understand the cumulative carbon impacts of sustainable precinct development and develop frameworks for tracking their contribution to city and state carbon reduction targets • Position government land organisations (GLOs) as leaders on climate positive precincts; trialling new innovations and partnerships • Ensure all lessons are captured from government projects, and shared with industry stakeholders. • Ensure conversations with utility network planners addresses the need to support for innovative precinct energy solutions	-	The report also outlines what we need to do to try and limit climate change to 1.5ºC: Strong, rapid, and sustained emissions reductions to net zero, with a focus on methane from agriculture and energy. Emissions must be net zero by 2050 at the latest. This can only be done with drastic cuts, and by stopping the use of fossil fuels in buildings and precincts as quickly as possible. We need to compensate for existing and unabated emissions by focusing on carbon removal activities, preferably of the natural kind. The report has the following climate positive principles for precincts: Reduce: • Built with lower upfront emissions • Highly efficient

Defines the key actions that will facilitate a scaling up of climate positive precincts **Details the stakeholders and the goals needed to make this roadmap a success** **Sets a pathway for carbon reduction expectations within the Green Star Communities rating tool.**		nationally consistent approvals processes for connection of distributed energy systems to the grid. • Energy market operators and regulators need to make it easier for developers and third-party operators to play an active role in precinct scale energy solutions and energy market reforms. • Governments should provide financial support for feasibility studies for precinct energy system demonstration projects in precinct development. • Peak bodies and governments should develop a set of precinct energy guidelines for planners, precinct developers and third parties, on the range of energy solutions available at precinct scale, with supporting innovations in governance and business model. **Action: Commit to delivering low carbon buildings in all precincts:** • Precinct developers can commit to requiring low carbon buildings in their precincts, and work with building developers to deliver this. • Developers, industry groups and governments must promote the benefits of sustainable, low carbon buildings **Action: Government should:** • Plan and deliver sustainable forms of transport earlier in development areas, and prioritise the adoption of electric vehicles and supporting charging infrastructure • Develop residential and business grant schemes to support the transition to all electric existing buildings. • Develop plans to transition all infrastructure in the public domain to efficient, all electric and powered by renewables • Integrate climate positive principles into priority neighbourhood renewal strategies and explore how this can be delivered through statutory planning, education and behaviour change, and the upgrade of public spaces.	**Action: Drive lower upfront carbon in materials and construction activity.** • A precinct development low carbon materials supply chain roadmap needs to be developed, mapping all major supply chains, and how to overcome the barriers to a market transition to low carbon, durable and appropriate alternatives. • Governments need to update and harmonise their materials standards with lower carbon choices. • Developers, peak bodies, and industry researchers need to embrace decision making frameworks to test and procure low carbon materials in precinct development **Action: Government should:** • On high priority precincts, provide the vision, clear governance frameworks for the design, approvals, and curation of the development following climate positive principles.			• Walkable and liveable Eliminate • Fossil free • Powered by renewables Compensate • Offset with nature There is no discussion about the definition of net zero in this paper.
2022 Integrated Systems Plan **AEMO**  **The document outlines a 30-year roadmap of investments for the National Electricity Market (NEM).** **The ISP and its optimal development path support Australia's complex and rapid energy transformation towards net zero emissions, enabling low-cost firmed renewable energy and essential**	**Action: Continue with the significant, concurrent and accelerated collaboration between the energy sector and its regulators, governments and communities.** **Action: Sequence projects.** The ISP has commenced that work by giving participants more certainty on the timing of the large-scale transmission builds, which should assist in negotiating better contract outcomes, and securing long-lead and specialist equipment well in advance and at lower cost. However, project timings in the ISP deliberately allow time for stakeholder engagement and more precise scheduling by relevant parties. Collaboration will be required.	**Action: Immediate action is required to progress actionable projects.** Government support through finance, underwriting or other measures, fast-tracked licencing and environmental assessments, and streamlining of the regulatory framework governing critical transmission projects identified in the ISP, would assist in accelerating their delivery to realise these potential benefits. **Action: Secure social licence for generation and transmission investments.** Substantially expand community engagement programs that help to improve the recognition of these additional benefits to assist project proponents with securing appropriate social licence. **Action: Secure social licence for greater DER coordination.** Strong coordination of DER with system requirements as signalled by the market, including through some active management for efficient operation and export, is required to realise the optimal	**Action: Manage the complex and growing supply chain risks** that are inherent for investments of this scale that face prior competing claims on plant, skills and resources. The delivery timetable of the ODP also partially depends on carefully managing the risk to supply chains of increasing coincident global demand for the same infrastructure expertise, materials and equipment. The level of VRE, dispatchable supply and transmission projects is unprecedented for the NEM, and the NEM is not alone in this transition. **Action: Coordinate to improve supply chain efficiency and alleviate potential constraints.** The change required will need to draw on local and international markets for funding, steel, concrete, engineering equipment and labour, and technical and project management skill, which need to be coordinated. **Finding:** the NEM is not insulated from global markets, nor is Australia alone in its	**Action: Engage with landholders and regional communities to co-design solutions that will earn a lasting social licence.** **Action: Preparatory Activities and REZ Design Reports to progress the design of future ISP projects.** This may require supporting government policies or other investment. **Action: Urgent action is required through AEMO's Engineering Framework to prepare the NEM for its future demands.** The Engineering Framework and its work program define the priorities to realise the transition, and AEMO's annual system security and reliability reports focus on immediate performance. **Action: Secure the needed workforce.** Demand for skilled labour in large-scale renewable energy is forecast to double from approximately 12,500 in 2022 to 25,000 in 2027. The growth in the renewables workforce will outpace the decline in the		This plan is for a true transformation of the NEM, from fossil fuels to firmed renewables. It calls for levels of investment in generation, storage, transmission and system services that exceed all previous efforts combined. It offers a clear and transparent roadmap through to 2030, and then to 2040 and 2050. Not only is the NEM expected to significantly reduce its carbon emissions, but it is a critical enabler for the industrial, transport and other domestic sectors to reach their net zero emissions objectives through electrification As a result, the ISP must help guide the NEM through: - the inherent complexities in its physical system, - the challenge of switching to renewables while increasing electricity demand from newly electrified consumers, - the uncertainties of the global energy market and supply chain constraints.

transmission to provide consumers in the NEM with reliable, secure and affordable power. **The National Electricity Market (NEM) is supporting a once-in-a-century transformation in the way electricity is generated and consumed in eastern and south-eastern Australia. It will replace legacy assets with low-cost renewables, add energy storage and other new forms of firming capacity, and reconfigure the grid to support two-way energy flow. Consumers will be able to draw on low-emission electricity for their transport, industry, office and homes, replacing oil, gas and other fuels. Technical innovation, ageing generation plants, economics, government policies, energy security and consumer choice are all driving this transformation, and driving it faster than many anticipated.**		development path projections and optimise the NEM's net benefits, security and reliability. That in turn will rely on a step change in engagement between consumers, retailers, VPP operators, networks and other market participants to orchestrate their resources. **Action: Undertake market reform to unlock Distributed Energy Resources. (DER)** Full integration requires a step change in engagement to ensure consumers, retailers, networks and other market participants increase the orchestration of new technologies and resources, to increase benefits to consumers and enable the grid to maintain security and reliability at lower cost.	race to decarbonise. The already heavy investment in global power systems is expected to surge in the wake of both European conflict and COP2622 . **Action: Understand the infrastructure pipeline:** A pipeline of infrastructure initiatives to support economic recovery in the aftermath of COVID-19, and to accelerate the energy transition, have added to short-term demand. While many countries have committed to net zero targets by 2050, there may be a short-term opportunity to advance projects before the global competition for materials increases. **Action: Secure essential materials.** Renewable energy projects will significantly increase the demand for steel and concrete through the mid 2020s. To meet the needs of the 2020 ISP, the Market Capacity for Electricity Infrastructure analysis projected both steel and concrete demand to nearly double by 2028, to 0.62 million tonnes and 1.3 million cubic metres respectively83	traditional generation workforce, which is forecast to drop by 6,000 or over 50% over the next decade. Stakeholders and governments will need to collaborate on ways to develop and secure a long-term, reliable supply of workers at every needed level of qualifications and skills. **Action: Expand the role of distribute networks to unlock DER.** AEMO is seeking to strengthen the links between the ISP and distribution network planning processes, establishing a working group with Distribution Network Service Providers (DNSPs) and Energy Networks Australia (ENA).		The inherent complexities in operating the NEM's physical system include: • increasing levels of consumer-driven DER, • uncertainties in the timing of and market response to the retirement of coal-fired generators, • satisfying the critical operational needs for the power system as system services from fossil-fuelled generators decline, • uncertain yet intensifying climate change impacts. Reducing emissions while increasing supply adds to the complexity The NEM's operating environment is always subject to an array of economic, trade, security, policy (including on-land gas extraction) and technology environments, as set out in the 2020 ISP. The speed and scale of the transformation to a low-emission NEM poses a unique set of challenges. There is no discussion about the definition of net zero in this paper.

Renewable energy industrial precincts: Scaling up industrial decarbonisation through a coordinated approach
 	
Climateworks
 	
2023
 	
 
 	
Renewable energy industrial precincts (REIPs) are a practical solution to scale up and accelerate climate solutions in carbon intensive industries. REIPs offer industry the chance to capitalise on Australia's abundant clean energy sources as global markets shift towards decarbonisation.
 	
This brief for policy-makers outlines what a REIP is and identifies four pillars that support the effective development and operation of a REIP.
	Action 1: Australian governments should establish Renewable Energy Industrial Precincts (REIPs) through a national place-based industrial decarbonisation program (Program), planned and delivered by the Australian Government in partnership with state and territory governments. This will ensure the transition of industrial regions occurs in a coordinated and collaborative way.	**Action 2:** Australian governments should co-design a 'co-investment partnership' through which Program funding will be administered, to send a clear signal to invest in industrial decarbonisation. The Australian Government should scale up ambition and:
		
		• Provide co-investment in line with all pillars, for example, through funding for:
		  ○ planning processes (including roadmaps)
		  ○ developing and upgrading transmission infrastructure needed to provide firmed, lower-cost renewable energy into REIP locations
		  ○ decarbonising existing industries (such as through research and development and capital outlays); and
		  ○ attracting new industries.
		• Explore existing initiatives relevant to REIPs to identify how they can be coordinated and scaled to achieve greater impact.
		• Provide advice to states and territories on potential infrastructure reforms required to enable REIPs.
		• Provide support to businesses in REIP locations to access global markets through international linkages.
		
		State and territory governments should:
		
		- Set net zero goals for REIP locations.
		- Co-design decarbonisation roadmaps with key stakeholders, such as industry and local communities, for REIP locations.
		- Identify skills gaps and establish training programs targeting the skills needed within REIPs.
		- Undertake strategic land use and infrastructure planning and analysis to identify priority infrastructure needed in REIP locations. REIP locations. Set up for success
		- Co-design decarbonisation roadmaps with key stakeholders, such as industry and local communities, for REIP locations.
			Action: The Australian Government should:
			
			• Establish governance mechanisms
			• Establish a national coordinating body to coordinate Program design, administered by an Australian Government secretariat with an advisory group comprising state and territory departmental officials.
			• Develop Program guidelines and objectives, including setting long-term goals and vision for REIPs.
			• Support state and territory governments in determining priority REIP locations to unlock regional economic opportunities (e.g. identified hydrogen hub locations).
			
			Action: State and territory governments should:
			
			• Establish governance mechanisms
			• Administer the deployment and ongoing activities of each REIP through a regional coordinating body, leveraging existing programs where possible.
					Action: The Australian Government should:
					
					• Coordinate workforce development in REIPs by monitoring and reporting on skills gaps relevant to REIPs (such as through Jobs and Skills Australia).
					
					Action: State and territory governments should:
					
					• Identify skills gaps and establish training programs targeting the skills needed within REIPs.
						There is no discussion about the definition of net zero in this paper.

		• Undertake strategic land use and infrastructure planning and analysis to identify priority infrastructure needed in REIP locations. Incentivise demand for new zero carbon technology and accelerate deployment of commercial technologies needed for the development of REIPs, with Australian Government co-investment.				
Climate positive buildings and our net zero ambitions **GBCA** **2021**  **The paper builds on our roadmap to articulate a clear strategy that all buildings should follow. It also sets global and leadership targets that should be adopted and exceeded by every stakeholder in the built environment.**	**Action:** Seek the support of government to make the necessary changes to policy and codes to drive climate positive buildings.	**Finding:** Measure and disclose the performance of building and fitouts **Finding:** Measure and disclose the performance of building and fitouts **Finding:** Reduce the building's upfront carbon emissions **Finding:** Reduce building and fitout energy demand Stimulate markets for carbon-neutral products and services **Finding:** Switch away from fossil fuel use Increase access to active transport facilities and public transport **Finding:** Phase down refrigerants with a high global warming potential **Finding:** Support the adoption of electric vehicles			**Finding:** Use 100% renewable energy Support high-quality offsets for remaining emissions as a transition strategy **Action:** Partner with GBCA to deliver skills, services, and mechanisms to drive change in industry.	**Net Zero is defined as:** The balance between the amount of GHG produced and the amount removed from the atmosphere on a net annual basis. It is a technical, though open-ended term. Its use must be accompanied by the focus on emissions, e.g. net zero in operations, net zero for construction, etc. **Carbon Neutral is defined as:** Carbon neutral buildings are those that address all their emissions so that the carbon account is zero. Actions can include energy efficiency, use of renewables, and offsets, and must be considered in that order. The measurement is on a net annual basis. In Australia, the term is defined by the Federal Government through the Climate Active Carbon Neutral program. **Climate Positive is defined as:** Climate positive buildings are those that address all relevant emissions, but do so in a manner that drives our built environment to be in line with a 1.5C trajectory in the built environment. These buildings are fossil fuel free, highly efficient, fully powered by renewables, with lower embodied emissions, and with remaining emissions offset with nature – essentially removing carbon from the atmosphere.

	A National Plan & Pathway Support the development of a national plan to decarbonise infrastructure, creating pathways for critical assets that optimise wider socio-economic benefits.	**Policy** Encourage policy, investment, and incentives at state and federal level to assist with the transition to renewable energy, sustainable materials and advanced manufacturing.	**Procurement** Co-create governance structures, processes and approaches for reducing emissions with transparency and through sound decision-making.	**Capability Building** Identify the core skills gaps, create access to knowledge and build capability.	**Technology** Trial, adopt and promote technology solutions that optimise a holistic approach to an asset's lifecycle from design through to end of life.	There is no discussion about the definition of net zero in this paper.
Climateworks Centre decarbonisation scenarios **Climateworks** **2023**  **The paper uses a tool called AusTIMES, which was developed by CSIRO, to model two possible emissions pathways.**	**Finding:** The modelling in this paper should be a starting point for developing sectoral pathways, which align with the Federal Government's 2023 announcement of the development of net zero pathways for six sectors: electricity and energy, industry, built environment, agriculture and land, transport and resources. **Finding:** A decarbonised electricity system is crucial for Australia to deliver on its commitments under the Paris Agreement. **Finding:** The modelling suggests it's cost effective for Australia to rapidly replace fossil fuel generated electricity with renewable sources and go beyond its current target of generating 82 per cent of its electricity from renewables by 2030. **Finding:** an unprecedented scale of effort to absorb carbon dioxide is needed to stay within the Paris Agreement temperature limits.				**Finding:** Hydrogen can play a role in industry, long-haul freight and maritime shipping if it becomes commercially viable for these sectors.	There is no discussion about the definition of net zero in this paper.

Appendix B: Emerging opportunities and gaps identified by the infrastructure net zero policy scan

The following gaps and opportunities were highlighted by our assessment (Table B.1).

Table B.1: Understanding embodied and operational emissions

Finding	Description and implication for INZ
There is no consensus or discussion about a net zero definition and little discussion regarding carbon definition in an infrastructure context	Few reports make mention of a net zero definition or carbon definitions or the challenges they present.
Increasing the shared understanding of what Net Zero is	There is an opportunity to increase the shared understanding of what is Net Zero Infrastructure is and to develop the appropriate practical tools to equip industry accordingly, as well as the policy platform and coordination that will unlock the potential of the sector to accelerate the transition to net zero. Many reports called for a sustainable approach but did not reference or consider the trade-offs of their actions on broader sustainability outcomes, such as economic, social, environmental or governance.
The need for coordination and collaboration	A chorus of support exists for expediating emission reductions through strong coordination and collaboration. Infrastructure Net Zero is well placed to pool and coordinate the resources of infrastructure stakeholders to deliver on a common ambitious agenda.
Change is required across all of Infrastructure Net Zero's strategic pillars	All strategic pillars attract a significant number of actions and findings. However, most actions fall into either the policy or procurement pillars.
Tackling emissions early in the lifecycle	While most of the work reviewed currently focused on embodied and operational emissions at procurement, design and delivery stages, there is an opportunity for thought leadership on how to tackle emissions from the earliest stages of the lifecycle, and with a whole-of-life approach that includes enabled emissions. The more upfront emissions are being addressed, the higher is the potential to reduce embodied, operational and enabled emissions across the whole life cycle.
There is lack of mechanisms for monitoring and reporting	An overarching framework does not exist to monitor and report on the status of carbon emissions. Additionally, whole-of-life carbon costs are addressed differently across sectors.
Bigger pieces of the emissions pie are getting most of the attention	Larger emissions sources Scope 1 and 2 are attracting the most action, reform and investment from government and industry. Other scopes are often not being considered, planned for, delivered, and measured and reported on.
Systems thinking is called for but not articulated	Several the papers specifically call for a system's thinking or holistic approach to net zero without outlining how this approach would work.

Appendix C: Implementation considerations and carbon related standards

Consistent measurement and understanding of carbon emissions

Different tools and definitions can be used to measure carbon emissions across the infrastructure lifecycle. For example, PAS 2080 describes and quantifies carbon emissions for assets and infrastructure and promotes the principle of whole life carbon, or whole life-cycle carbon emissions.

At the asset level, Table C.1 sets out how to achieve net zero carbon at each project stage using a lifecycle carbon assessment. It also illustrates the requirements across project life cycle modules through to the circular economy stage, and the relationship to achieving net zero through residual carbon offsets.

Table C.1: Summary measuring and achieving Infrastructure Net Zero49

	Whole-of-life carbon				**Circular Economy** (Assess separately)
Project Stage	**Upfront Carbon (A1-A5)**	**In-Use Embodied Carbon (B1-B5)**	**In-Use Operational Carbon - Energy and Water. (B6-B7)**	**End of Life (C1-C4) End of Life (C1-C4)**	
Concept Design	Prediction based on generic values	Prediction based on generic values	Prediction based on generic values	Prediction based on generic values	Prediction based on generic values
Detailed Design	Prediction based on specific values	Prediction based on specific values	Prediction based on specific values	Prediction based on specific values	Prediction based on specific values
Practical Completion	Calculated on actual values	Prediction updated using as built values	Prediction updated using as built values	Prediction updated using as built values	Prediction updated using as built values
Use Stage		Calculated on actual usage	Based on actual metered consumption	Prediction updated using as built values from B3-B5	Prediction updated using as built values from B3-B5
End of life				Calculated on actual values	Prediction updated using as deconstructed values
Future Projects' (A1-A3)					Calculated on actual values
Residual Offsets to achieve 'Net Zero	At Practical Completion based on third party verified assessment	Annually in use based on third party verified assessment	Renewable energy with annual offsets for residual indirect emissions from energy and water	End of Life based on third party verified assessment	N/A

Note: text in green indicates that at this stage, the project will be verified as having achieved net zero carbon, using actual measured data and a third party verified assessment.

Tools to aid the transition to system scale net zero

GHG Protocol

The GHG Protocol establishes comprehensive global standardised frameworks to measure and manage GHG emissions from a variety of sectors including private and public sector operations, across value chains, and defined appropriate mitigation actions.[50]

The GHG Protocol provide valuable guidance on emission types and scopes (Scope 1, Scope 2, and Scope 3) and is a widely used framework for emissions tracking and reporting.[51] These are described as follows:

- Scope 1: Direct emissions from owned or controlled sources
- Scope 2: Indirect emissions from the generation of purchased electricity, steam, heating, and cooling
- Scope 3: All other indirect emissions that occur in the value chain.

The GHG Protocol and associated guidelines support the standardisation of emissions measurement and reporting across infrastructure systems. By following the GHG Protocol, science-based targets, aligned with global climate goals, can be set and used to track progress towards net zero.

Finally, adhering to the GHG Protocol helps with compliance with national and international climate policies and regulations, which are increasingly requiring robust emissions reporting and reduction plans.

PAS 2080

PAS 2080 is an updated specification for managing carbon across the built environment. It is a practical 'how to' guide for decarbonising infrastructure and buildings, over their whole lifecycle. In March 2024, Infrastructure Victoria recommended the adoption 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.[52]

PAS 2080 encourages carbon emissions to be considered at a system scale. Assets need to be seen in the context of networks; networks in the context of systems; systems in the context of other systems. Organisations are instructed to assess, as best they can, the chain reaction effects when planning, designing, specifying, constructing, and operating assets. PAS 2080 provides a framework for doing so.

PAS 2080 requires the asset owner to set a carbon reduction target and communicate it to all members of the value chain. Those organisations must then work together to meet or beat the target. Within the value chain, it calls for mutual trust and respect, supported by commercial arrangements. Doing so ensures risks are shared proportionately and fairly, intellectual property arising from innovation is correctly assigned, and the benefits shared.

Between organisations within and across sectors, it calls for mutual understanding of carbon reduction possibilities and challenges. Within sectors, organisations can leapfrog forward by sharing knowledge about technical, process and commercial innovations.

Collaboration can create opportunities for decarbonisation and, additional value generation, through shared solutions.

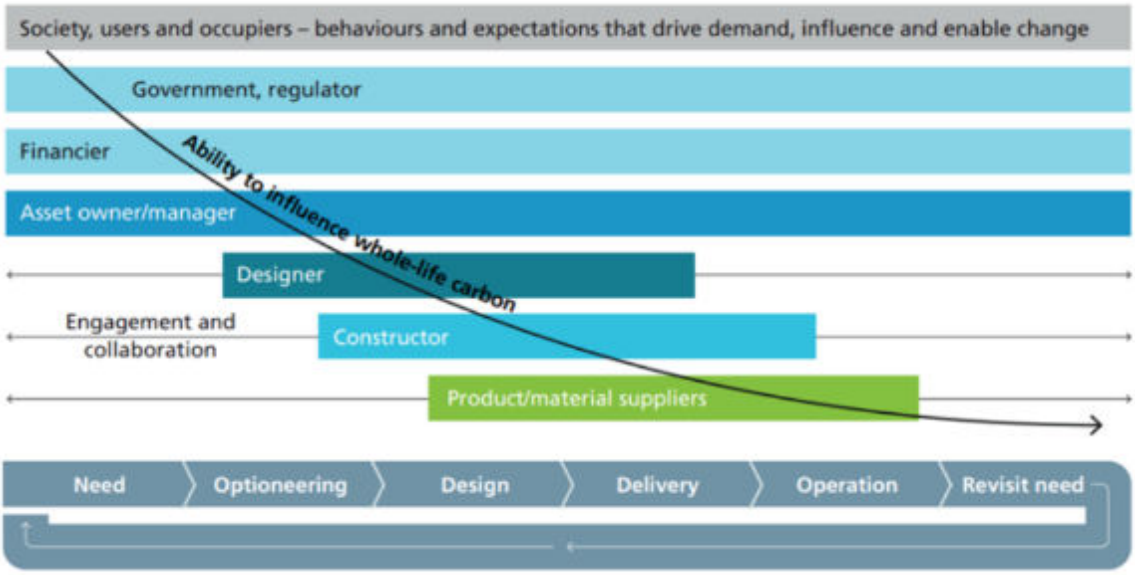


Figure C.1 Visual overview of PAS 2080

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