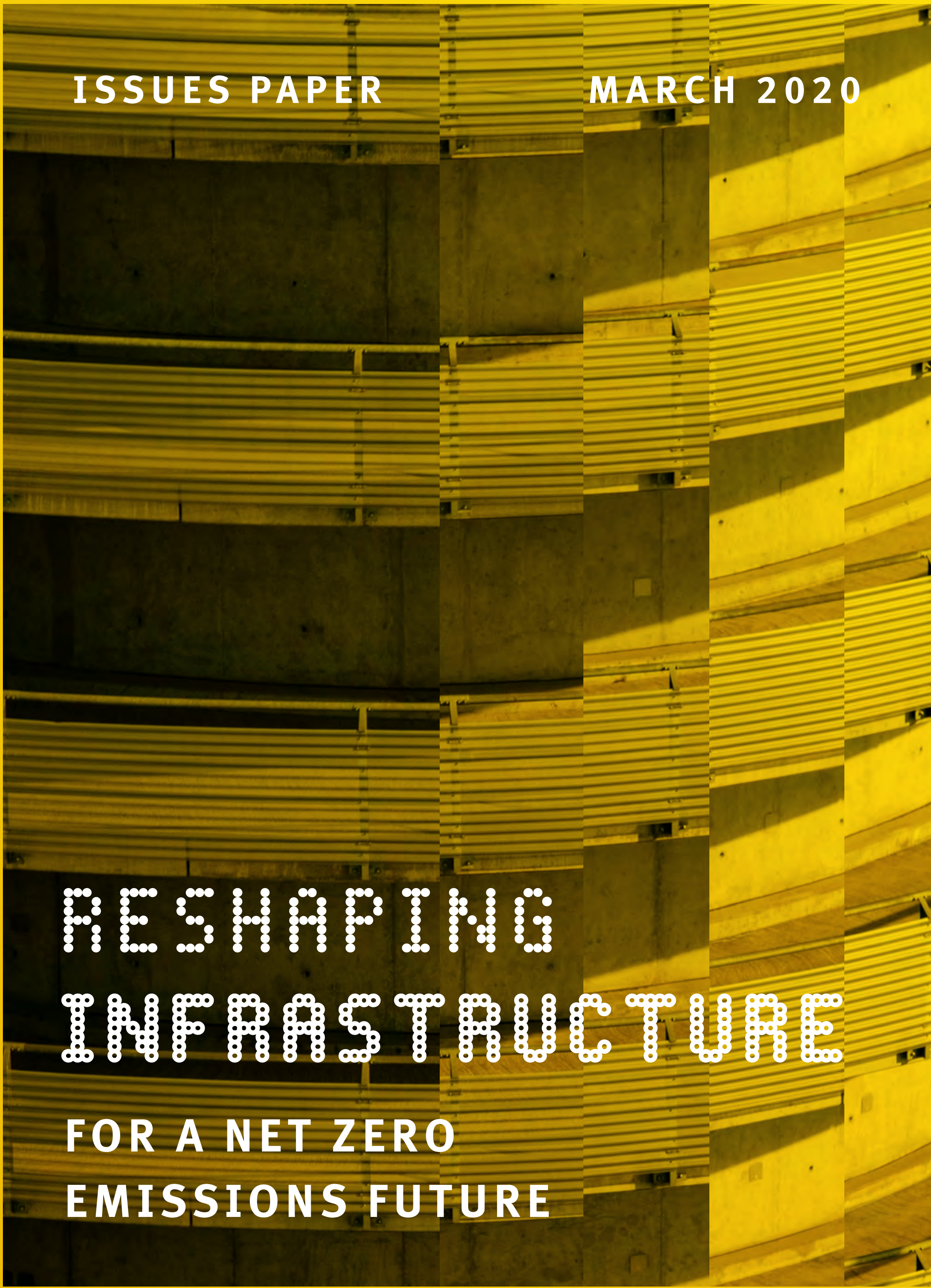

ISSUES PAPER

MARCH 2020

RESHAPING INFRASTRUCTURE

FOR A NET ZERO EMISSIONS FUTURE

ISCA

ClimateWorks AUSTRALIA

asbec AUSTRALIAN SUSTAINABLE BUILT ENVIRONMENT COUNCIL

ABOUT US

Project Partners

This initiative is a partnership between ISCA, ClimateWorks Australia and ASBEC.

The Infrastructure Sustainability Council of Australia (ISCA) is a member-based, not-for-profit peak body operating in Australia and New Zealand with the purpose of enabling and rewarding sustainability best practice in infrastructure. It does this through:

- Operating an industry-led Infrastructure Sustainability (IS) rating scheme for planning, design, construction and operations of infrastructure assets
- Delivering a wide range of training and capacity-building programs specifically to enhance sustainability outcomes in infrastructure
- Connecting infrastructure projects to suppliers of sustainable products and services through its ISupply program
- Bringing together sustainability practitioners and infrastructure professionals to share knowledge and lift the community of practice
- Recognising and rewarding best practice in sustainability and resilience.

ISCA's greatest strength is its community of engaged and knowledgeable stakeholders – ISCA has significant expertise within its network of industry, academic and government members. ISCA is a network for collaboration, discussion and education – holding regular events, conferences and seminars with industry to facilitate knowledge sharing, and to collaboratively develop solutions to sustainability challenges facing the sector.

ClimateWorks Australia develops expert, independent and practical solutions to assist in the transition to net zero emissions for Australia, Southeast Asia and the Pacific. Co-founded by The Myer Foundation and Monash University in 2009, ClimateWorks is a non-profit organisation working within the Monash Sustainable Development Institute. ClimateWorks also benefits from strong relationships with an international network of affiliated organisations that support effective policies, financing and action for emissions reductions.

Acting as a bridge between research and action, the ClimateWorks collaborative end-to-end approach seeks solutions that will deliver real impact. ClimateWorks supports decision-makers with tailored information and tools, working with key stakeholders to remove obstacles and help facilitate conditions that support the transition to a prosperous, net zero emissions future.

The Australian Sustainable Built Environment Council (ASBEC) is the peak body of key organisations committed to a sustainable built environment in Australia. ASBEC members consist of industry and professional associations, non-government organisations and government and academic observers who are involved in the planning, design, delivery and operation of Australia's built environment. ASBEC provides a collaborative forum for organisations which champion a vision of sustainable, productive and resilient buildings, communities and cities in Australia.

Supporters

This Issues Paper was developed with the support of the **Clean Energy Finance Corporation** and the **Queensland Government**. ISCA, ClimateWorks and ASBEC gratefully acknowledge the generous and highly valuable input the Clean Energy Finance Corporation and Queensland Government have provided in the development of this report.

EXECUTIVE SUMMARY

Infrastructure has a significant, lasting influence on Australia's greenhouse gas emissions. Around 70% of Australia's emissions are associated with infrastructure projects. Infrastructure assets built today will still be operating in 2050 when countries like Australia are expected to reach net zero emissions under the Paris Climate Agreement.

Despite this, emissions reductions in line with a net zero emissions future are not effectively prioritised in infrastructure planning, design, procurement and operations across sectors.

The Infrastructure Sustainability Council of Australia (ISCA) is partnering with ClimateWorks Australia and the Australian Sustainable Built Environment Council (ASBEC) to explore and define the role infrastructure can play in achieving a net zero emissions future.

The purpose of this Issues Paper is to progress a new conversation to better understand the challenges and opportunities in reshaping transport, energy, water, communications and waste infrastructure for a net zero emissions world. Infrastructure bodies, governments, professional and industry associations, 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. These stakeholders are the audience for this report and the conversations it engenders.

This conversation is timely. Governments and private investors are spending record amounts of money on new infrastructure. At the same time, infrastructure is facing pressure on two fronts to prepare for net zero emissions:

> All Australian states and territories have set commitments or aspirations to achieve net zero emissions by 2050, or earlier

> Private investors are increasingly aligning investment portfolios with net zero emissions in order to future-proof economic value and investment returns.

Strategic infrastructure choices in both the public and private sector are made with key future trends in mind, such as population growth, urbanisation and new technologies. The global transition to net zero emissions is also a key trend relevant to today's infrastructure choices.

Emissions reduction strategies need to be coordinated with parallel efforts to build infrastructure that is resilient to the impacts of forecast climate change. A comprehensive analysis on the physical impacts of climate change for infrastructure is beyond the scope of this paper, but it is critical to acknowledge the importance of planning, designing and building resilience in infrastructure alongside our transition to a net zero emission future.

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. On the other hand, there are growth opportunities available for infrastructure assets that are prepared for, and enable, the transition to a net zero emissions Australia.

Around 70% of Australia's greenhouse gas emissions are either directly attributable to, or influenced by, infrastructure

ClimateWorks Australia estimates the construction and operation of physical infrastructure assets for transport, energy, water, waste and communications directly contributes to 15% of Australia's annual emissions, while these assets influence an additional 55% of annual emissions through the activities they enable.

The majority of infrastructure-related emissions come from the ongoing use of transport and energy infrastructure. While infrastructure assets do not have direct control over emissions from vehicles or how energy is produced or consumed, there is potential for transport infrastructure to support the uptake of low and zero emissions transport (such as electric vehicles or public transport) and for energy distribution and transmission networks to enable the increased connection of renewable electricity generation and energy storage technologies.

The large scale and scope of many infrastructure projects means the infrastructure sector could be transformative in supporting Australia's transition to net zero emissions.

Different infrastructure projects, sectors, stakeholders, and classes of infrastructure assets face unique challenges in reducing their emissions. Solutions that respond to these unique challenges, appropriate to the context of each project, need to be identified and developed. This Issues Paper intends to start a conversation with infrastructure advisors, funders, designers, builders and operators on the importance of net zero emissions, and to identify where the top priorities and opportunities for action are.

Infrastructure built today can lay the foundations for a net zero emissions future

Strategic planning advice right at the beginning of an infrastructure project can be the most consequential for emissions outcomes. Infrastructure Australia was established by governments to independently advise on infrastructure priorities that adequately meet forecast demand growth, while supporting economic, social and environmental sustainability. Because of their role in providing early strategic planning advice, Infrastructure Australia and the state infrastructure bodies can reshape the infrastructure agenda to support net zero emissions.

While infrastructure bodies set the infrastructure agenda, emissions reduction needs to be prioritised in all stages of infrastructure planning, business case development, delivery and operation. This would support an effective transition to net zero emissions for infrastructure, in line with increasing commitments being made by investors and governments.

The transformation required is enormous; ISCA, ClimateWorks and ASBEC seek your support for the collaboration and conversations we know are essential to progress these critical issues in the months and years ahead.

This Issues Paper is the first step in a broader effort to reshape Australia's infrastructure agenda for a net zero emissions future

In the coming months, ISCA, ClimateWorks and ASBEC will begin engagement with infrastructure bodies, governments and agencies, investors, construction companies and other stakeholders, from the project level all the way through to government frameworks and policies. The project partners will facilitate roundtables and other forums to uncover infrastructure sector views on the opportunities, challenges and priorities for action. The outcomes of these conversations will be brought together in a synthesis report that recommends next steps.

If you would like to engage further in ISCA, ClimateWorks and ASBEC's effort to deliver infrastructure for a net zero emissions future, including participation in stakeholder workshops and forums, please contact:

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INTRODUCTION

Australian governments from federal to local level are spending record amounts on new infrastructure projects. Total government infrastructure funding for the four years from 2018-19 to 2021-22 is estimated to be $152.2 billion[1]. These multi-billion-dollar government expenditures on infrastructure aim to unlock economic opportunities, create jobs and meet the needs of growing populations. Meanwhile, in the private sector, capital flowing to Australian infrastructure projects continues to rise, as Australia remains a destination of choice for global investors seeking reliable, long-term returns[2].

Strategic infrastructure choices in both the public and private sector are made with key future trends in mind, such as population growth, urbanisation, new technologies and projected physical impacts of climate change. The global transition to net zero emissions is also a key trend relevant to today's infrastructure choices[3]. Net zero emissions refers to reducing greenhouse gas emissions to zero, or as close to zero as possible and offsetting any remaining emissions (e.g. through forestry).

Infrastructure assets – in transport, energy, water, waste and communications – are by their very nature, long term investments, lasting decades into the future. 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.

Decisions made about Australia's infrastructure need to be responsive to broader policy and economic trends. The infrastructure assets that are built today will still be operating in 2050, by which time all Australian states and territories have committed or aspire to reach net zero emissions. Private investors are also increasingly demanding infrastructure investments with future-proofed economic value, in preparation for a net zero emissions world. 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.

The Infrastructure Sustainability Council of Australia (ISCA) is partnering with ClimateWorks Australia and the Australian Sustainable Built Environment Council (ASBEC) to explore and define infrastructure's role in enabling a net zero emissions future. This Issues Paper illustrates the influence infrastructure assets have on Australia's greenhouse gas emissions and sets out opportunities to prioritise emissions reductions towards achieving net zero emissions in the planning, designing, building and operation of infrastructure. It is intended to start a conversation with infrastructure advisors, governments, funders, designers, builders and operators on top priorities, challenges and opportunities.

Section one defines the infrastructure sectors on which this paper is focusing, while acknowledging the breadth and complexity of infrastructure as a whole. Section two examines the relationship between infrastructure and climate change, both in terms of infrastructure's influence on Australia's greenhouse gas emissions and its role in enabling net zero emissions, as well as the resilience of infrastructure assets to climate change impacts. Section three explores how net zero emissions can be prioritised in strategic advice, funding decisions and the delivery of infrastructure assets.

SECTION 01

INFRASTRUCTURE SHAPES OUR FUTURE

Infrastructure provides the basic structures that enable economic and social opportunities, create jobs and meet the needs of growing populations

Infrastructure is a key enabler of economic and social growth[4]. It provides the essential services society relies on, and connects communities to their jobs, education and other opportunities[5]. To do this, infrastructure responds to broader trends such as economic development, population growth and increased urbanisation, and is designed to unlock the opportunities presented by these trends. For example, investment in public transport infrastructure and efficient use of road infrastructure are critical for addressing congestion issues in growing cities[6]. Taking an international perspective, Infrastructure Australia has noted the potential for Australian exporters to capitalise on growing Asian markets 'is only as good as our freight and supply chain networks'[7].

Infrastructure assets can be funded, built and operated by governments or the private sector, or a combination of both. For all funding models, investors generally require infrastructure projects to demonstrate a shared, public benefit for the community, as well as an economic return on investment[8].

> This paper focuses on physical infrastructure for transport, energy, water, waste and communications.

There is no definitive list of assets that are considered infrastructure. Infrastructure Australia advises on nationally significant assets in the transport, energy, water, communications and social infrastructure sectors[9]. The term 'infrastructure', however, has been used for a wider array of assets than these, and has been applied to assets held by the defence force and mining operations through to non-tangible but fundamental foundations of society, like our legal frameworks.

For this Issues Paper, infrastructure has been broadly defined as[10]:

The basic physical systems on which a business, city or country is built. These systems, which have a long lifespan and require significant investment, are vital to a country's productive activity and liveability for its people.

This Issues Paper focuses on physical infrastructure for transport, energy, communications, water and waste. These infrastructure classes fall under 'economic infrastructure' as defined by Infrastructure Australia[11]. Currently, the largest proportion of government and private infrastructure spending in Australia is on transport (see Figure 1).

Social infrastructure (such as schools and healthcare) is excluded from the scope of this Issues Paper.

Social infrastructure is covered by buildings sustainability rating tools and Environmentally Sustainable Design (ESD) principles and policies. These asset classes are the focus of parallel efforts by organisations including ASBEC and the Green Building Council of Australia, which may inform future infrastructure sector work by ISCA, ClimateWorks and ASBEC.

Similarly, green infrastructure assets – such as parks, waterways and road verges – are not included in the scope of this Issues Paper. Green infrastructure does have a role to play in Australia's response to climate change, offsetting and sequestering emissions from other infrastructure assets, and increasing our resilience to the physical impacts of climate change.

Table 1 provides examples of some of the key infrastructure asset types in each of these sectors. This is not an exhaustive list, as categorisation of infrastructure assets can vary and new technologies can create new infrastructure needs. Infrastructure assets face unique challenges that vary between sectors and asset classes, including increased urbanisation, population growth, affordability and climate change[13]. This diversity creates further challenges in developing solutions that work across all infrastructure sectors.

FIGURE 1: Construction value added in 2018 from infrastructure construction in the communications, energy, transport and water sectors[12].

SHARE OF INFRASTRUCTURE CONSTRUCTION VALUE ADDED (%), AUSTRALIA, 2018

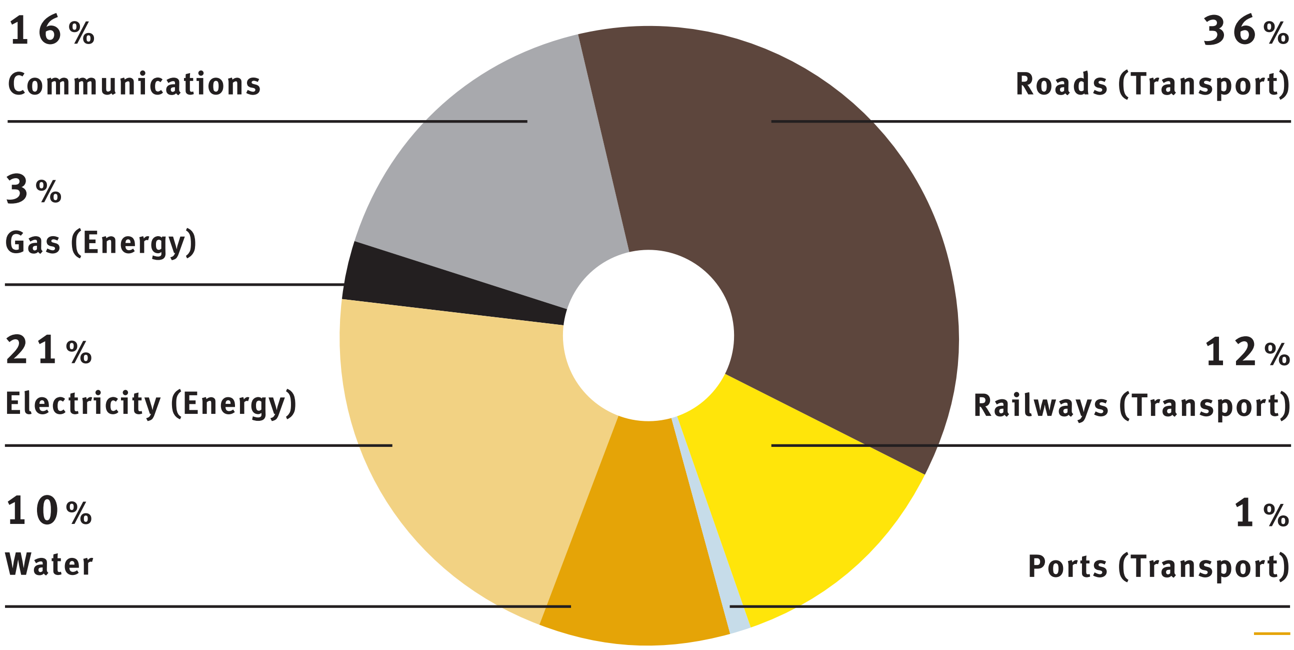


TABLE 1: Examples of infrastructure asset types covered in this Issues Paper

Transport	Energy	Communications	Water	Waste
Railways Roads Airports Bridges Ports	Transmission and distribution lines Gas pipelines Large-scale energy storage Substations	Mobile transmission towers Internet and telephone lines Data centres	Dams Water pipelines, pumps and treatment plants Wastewater pipelines, pumps and treatment plants Stormwater drains	Landfills Solid waste pipelines Recovery centres Waste to energy facilities

Infrastructure will shape economic activity for decades to come

Infrastructure assets are long-term investments, lasting decades into the future. Historically, infrastructure has shaped the long-term physical, social and economic development of Australia's cities, towns and regional areas.

While infrastructure can be broadly categorised into asset types as listed in Table 1, in reality, these assets often have a much broader influence beyond an individual sector. This is due to complex interdependencies between different sectors of the economy. For example, electric vehicle charging infrastructure impacts both the transport and energy sectors. The *Australian Infrastructure Audit 2019* notes the role of electric vehicles, along with on-site solar and batteries, in supporting increasing appetite amongst households and businesses to take control of their energy use[14].

Availability of public transport infrastructure and services also influences how, and to what degree, different areas of a city develop and grow. In the absence of bus and rail infrastructure and services, people living in the outer suburbs of Australian cities rely more on their cars, and face spending a larger share of their income on transport[15].

Given these factors, decisions being made about infrastructure today – strategic and land use planning, what infrastructure is needed, which projects to prioritise, and how to build and operate these assets – are decisions that will shape Australia's future.

A number of reports provide advice and guidance on issues for and priorities for infrastructure, including the Productivity Commission's *Inquiry Report into Public Infrastructure* (2014), the Clean Energy Finance Corporation's *Investing in Australia's Infrastructure Sector* report (2018) and Infrastructure Australia's *Australian Infrastructure Audit* (2019). Steps to prioritise emissions reductions in line with a net zero emissions future in infrastructure planning, design, procurement and operations can be undertaken alongside these and other reforms.

SECTION 02

INFRASTRUCTURE AND CLIMATE CHANGE

Infrastructure built today needs to be resilient to climate change and designed to support the transition to net zero emissions

Climate change is becoming a central consideration for infrastructure advice and decisions. Infrastructure both shapes and responds to Australia's economy, which will be challenged and restructured by climate change[16]. Infrastructure Australia has identified climate change, and the related need for mitigation (reducing emissions) and adaptation, as a key future trend for Australia that will have implications for our infrastructure over the coming 15 years and beyond[17]. The *Australian Infrastructure Audit 2019* observes that Australian governments often do not incorporate sustainability or resilience into infrastructure projects, and warns that without taking action to reduce emissions, Australia is risks failing to meet its international climate change commitments.

Two ways in which climate change can affect infrastructure are[18]:

> **PHYSICAL IMPACTS**, which refer to resilience in a changing climate.
This includes:

  – Direct impacts which alter the asset's ability to perform its intended role. For example, if storm intensity increases and causes greater damage than is anticipated to electricity transmission lines

  – Indirect impacts which alter the demand for the asset. For example, if rising sea levels degrade the liveability of a geographical area, in turn affecting the value of roads connecting that area.

> **TRANSITION IMPACTS** from policy, technology or societal action on climate change, which consider how infrastructure projects are fit for purpose in a net zero emissions future. This includes:

  – Reduced demand for emissions-intensive goods and services. For example, the demand for natural gas will likely decrease as buildings are increasingly electrified to reduce their emissions profiles, potentially reducing the value of gas networks that are not adapted to supply zero-emissions gas

  – Indirect impacts on the broader economy. For example, transport behaviour changes, such as increased availability and use of public transport and ride-sharing applications, may reduce the revenue of car parking.

This Issues Paper focuses on transition impacts, but recognises the importance of both impacts being integrated into infrastructure decision making frameworks.

ROLE OF INFRASTRUCTURE IN PREPARING FOR NET ZERO EMISSIONS

Infrastructure influences the majority of Australia's emissions

ClimateWorks Australia analysed the historical breakdown of emissions sources from different economic sectors to estimate that around 70% of Australia's annual emissions are either directly attributable to, or influenced by, infrastructure assets.

> Around 70% of Australia's greenhouse gas emissions in 2018 was either directly attributed to or influenced by infrastructure, according to ClimateWorks Australia analysis.

These emissions resulted from the construction, operation or other activities enabled by infrastructure assets (Box 1). The first two of these emissions sources – the construction and operation of infrastructure – are considered to be under the control of infrastructure decision-makers. The third source of emissions – activities enabled by infrastructure – are outside the direct control of infrastructure decision-makers but can still be influenced by infrastructure decisions.

> The scale and scope of infrastructure's influence on emissions means a small number of projects could play a significant role in enabling net zero emissions. Emissions and activities by suppliers, manufacturers, construction companies and end-users are all affected by infrastructure decisions.

BOX 1: Three types of infrastructure-related emissions

Embodied, operating and enabled emissions of a railway.

Embodied emissions

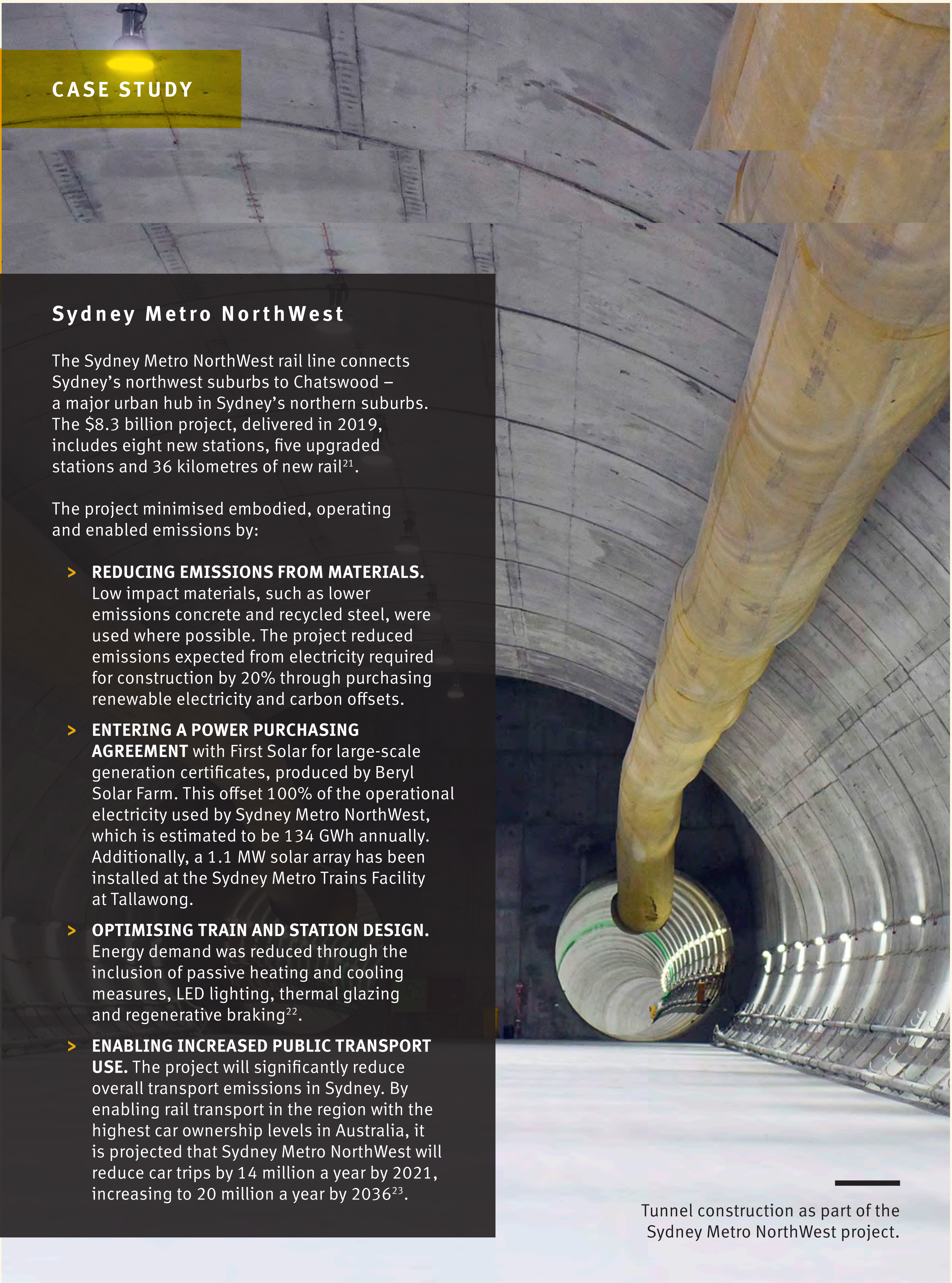
Result from the production of materials used in the construction of infrastructure, as well as those from the construction process itself. Infrastructure decision-makers have control over these emissions through choices made in the planning, siting, designing and procurement stages of a project (for example, sourcing less emissions-intensive steel for the construction of a bridge). Control over these emissions may be limited by the cost and availability of technology and the constraints of their supply chain. However, the magnitude of infrastructure expenditure can be large enough that procurement preferences (for example, for recycled materials or low-carbon construction practices) can transform the activities of their supply chain.

Operating emissions

Result from the ongoing operations of infrastructure assets. Infrastructure decision-makers and operators have direct control over these emissions through choices made in the planning, design and operating stages of the project (for example, installing LED lights rather than high pressure sodium bulbs in road street lights). As is the case for embodied emissions, control over these emissions may be limited by a project's supply chain, but infrastructure project preferences may transform markets for low-emissions technologies and energy generation (for example, the Beryl Solar Farm in NSW was established to supply electricity for the Sydney Metro NorthWest project[19]).

Enabled emissions

Result from the activities of infrastructure's end-users. Infrastructure decision-makers have influence (but limited control) over these emissions. Choices about what infrastructure to build enables or restricts low-emission activity. For example, by offering port charge rebates for low-emitting ships, NSW Ports can influence the emissions of the marine transport sector[20]. Decisions regarding where infrastructure is built can also influence emissions (for example, the proximity of rail and public transport infrastructure to population centres will influence local road transport emissions).



CASE STUDY

Sydney Metro NorthWest

The Sydney Metro NorthWest rail line connects Sydney's northwest suburbs to Chatswood – a major urban hub in Sydney's northern suburbs. The $8.3 billion project, delivered in 2019, includes eight new stations, five upgraded stations and 36 kilometres of new rail[21].

The project minimised embodied, operating and enabled emissions by:

- **REDUCING EMISSIONS FROM MATERIALS.** Low impact materials, such as lower emissions concrete and recycled steel, were used where possible. The project reduced emissions expected from electricity required for construction by 20% through purchasing renewable electricity and carbon offsets.
- **ENTERING A POWER PURCHASING AGREEMENT** with First Solar for large-scale generation certificates, produced by Beryl Solar Farm. This offset 100% of the operational electricity used by Sydney Metro NorthWest, which is estimated to be 134 GWh annually. Additionally, a 1.1 MW solar array has been installed at the Sydney Metro Trains Facility at Tallawong.
- **OPTIMISING TRAIN AND STATION DESIGN.** Energy demand was reduced through the inclusion of passive heating and cooling measures, LED lighting, thermal glazing and regenerative braking[22].
- **ENABLING INCREASED PUBLIC TRANSPORT USE.** The project will significantly reduce overall transport emissions in Sydney. By enabling rail transport in the region with the highest car ownership levels in Australia, it is projected that Sydney Metro NorthWest will reduce car trips by 14 million a year by 2021, increasing to 20 million a year by 2036[23].

Tunnel construction as part of the Sydney Metro NorthWest project.

Table 2 breaks down the emissions that are influenced by Australia's infrastructure. Enabled emissions by end-users make up the largest share. Most of this is from the use of transport and energy infrastructure. Appendix A provides a more detailed breakdown by emissions source and sector.

Transport emissions result from fuel combustion and electricity use by cars, trains, trams, buses, trucks, ships and aeroplanes. In 2018, road transport contributed the majority of Australia's transport emissions (71%), followed by aviation (20%), rail (6%) and shipping (3%)[24].

Emissions from energy transmission and distribution infrastructure include operational losses (electricity power losses, gas leaks and fugitive emissions) and enabled emissions (production and consumption of electricity gas to service a broad range of sectors, including the built environment and heavy industry). Decision-makers in energy transmission and distribution infrastructure may not have direct control over how energy is generated or consumed, but transmission infrastructure can enable the increased connection of zero emission renewable electricity generation (such as solar, wind, and hydro power) and storage technologies (such as battery and pumped hydro storage) to the electricity grid.

Construction of transport infrastructure including roads and rail contributed around half of the emissions embodied in new infrastructure.

TABLE 2: Emissions influenced by Australian infrastructure, by emissions type, and share of Australia's total emissions, 2018

Emissions type	Estimated emissions (Mt CO_2e)	Estimated share of Australia's total emissions (%)
Embodied	**34.3**	**5.9%**
Operations	**53.0**	**9.1%**
Total Enabled	**320.7**	**55.0%**
> Transport	121.1	20.8%
> Electricity	125.3	21.5%
> Gas	74.2	12.7%
TOTAL EMISSIONS INFLUENCED BY INFRASTRUCTURE	**407.9**	**69.9%**

See Appendix A for full list of sources. Note: to avoid double counting, the enabled (influence) emissions total in this table does not include the emissions from activities enabled by infrastructure that are simultaneously activities involved in the construction or operations of other infrastructure (e.g. electricity used in operating infrastructure assets). Similarly, the operations (control) figure does not include emissions from the waste and water sectors attributable to waste generated and water used in the construction of infrastructure assets. These are included in the embodied total.

CASE STUDY

Reducing emissions from cement and steel

Central to the embodied emissions of infrastructure projects are emissions-intensive materials like steel and concrete. Cement production accounts for 8% of global emissions[25], while energy use in the steel and iron industries accounts for almost 8% of total global energy demand[26]. Achieving net zero emissions in concrete and steel presents considerable technology and supply change challenges that are not easily overcome. Nonetheless early movers are signalling their ambition to transform their business and gain a first-mover advantage. Heidelberg, the fourth largest global cement producer, has pledged to be net zero by 2050[27], as has Thyssenkrupp, the second largest steel manufacturer in Europe[28].

Traditional Portland cement can be replaced with lower emissions alternatives made from the by-products of steel production. It can also be blended with materials such as fly ash, which have a much lower emissions intensity[29]. Boral Limited has invented one such blend, ENVISIA®, which has a 30% reduction in emissions compared to traditional Portland cement and no associated performance compromises[30]. Wagners has developed an 'Earth Friendly Concrete' product that replaces all Portland cement with industrial waste by-products. This product saved 8,800 tonnes carbon dioxide equivalent (tCO_2e) of emissions from the Toowoomba Wellcamp Airport redevelopment[31].

Holcim has become the first Australian company to publish an Environmental Product Declaration for its ready-mix concrete products, ViroDecs™[32]. Transparency like this will be crucial for infrastructure material procurers reducing the embodied emissions of projects.

In the steel industry, options exist throughout the production process to reduce emissions. Green hydrogen can replace coking coal, and Electric Arc Furnace production methods combined with renewable electricity and increased recycling can bring total steelmaking emissions to 0.1 tCO_2e per tonne of steel produced[33] (instead of the current 1.8tCO_2e per tonne global average[34]). Upgrades to the Whyalla Steelworks in South Australia are scheduled to include a solar farm, a pumped-hydro project, and energy co-generation from the steel production itself. The combined renewable energy generated on site is expected to power the steelworks, as well as provide electricity back to the South Australian grid.

Industry-recognised standards can support broader uptake of zero emissions steel production practices; for example, the ResponsibleSteel Standard requires certified facilities to meet emissions reduction targets consistent with the Paris Climate Agreement[35].

CASE STUDY

Bayswater Level Crossing Removal Project

The Victorian Government's Level Crossing Removal Project involves the removal of 75 level crossing in Melbourne by 2025, one of which is the Bayswater Level Crossing Removal[36].

The Bayswater Level Crossing Removal project's planning and delivery addressed embodied, operational and enabled emissions by reducing:

- The emissions intensity of materials used in construction by 30% through smart design, minimising materials used, and switching to sustainable alternative materials, like recycled asphalt products and blended materials such as fly ash, where possible[37]
- Operating emissions by 43% from a baseline emissions profile through design inclusions like project-wide LED lighting, and altered rail track alignment[38]
- Enabled emissions by decreasing traffic congestion over its life cycle due to smoother traffic flow from cars no longer being required to wait at the level crossing. The project also included 52 new bicycle spaces at the Bayswater rail station, providing new active transport infrastructure to enable emissions-free bicycle travel.

The measures introduced to decrease emissions on the project also resulted in whole-of-life cost reductions. LED lights used in one part of the project are estimated to achieve a 70% reduction in energy costs over their operation, and are associated with reduced maintenance costs compared to traditional bulbs.

Bayswater rail station

Australia's transition to net zero emissions will affect the future value of infrastructure assets

It is generally accepted that the Paris Climate Agreement requires developed countries, including Australia, to reach net zero emissions by 2050[39]. The transition to net zero emissions is expected to present growth opportunities and risks in different parts of the economy[40].

Most infrastructure projects are physical assets with decades-long lifetimes and multi-year project development timeframes. Infrastructure assets that are built today will still be operating in 2050. As such, identifying infrastructure's critical role in Australia reaching net zero emissions is a question that should not be left to the future. Today's strategies, policies and investments will underpin Australia's potential to transition to a thriving net zero emissions economy.

Infrastructure assets that rely on emissions intensive activities, or produce high emissions during operation, risk becoming 'stranded' in a net zero emissions future due to significant and unanticipated losses of value[41]. Examples of stranded assets include fossil fuel power plants that close before the end of their planned technical lifespans, a risk that could extend to electricity network infrastructure that services those plants[42]. Asset owners, investors and operators, in both the private sector and government, will face transition risks and opportunities such as this.

The global Task Force on Climate-Related Financial Disclosures (TCFD) recommends the use of scenario analysis to examine the potential risks and opportunities of climate change[43]. Scenarios that draw on recognised frameworks, such as those presented in the Centre for Policy Development's Climate Horizons report[44], can support robust decision-making about managing risks and capturing opportunities[45].

Due to the high capital intensity and long-lived nature of infrastructure assets, a broad range of scenarios specific to each asset should be explored. Through this exploration process, strategies can be developed that do not attempt to predict the future, but are adaptive to a range of possibilities.

Both government policy and private investors are driving infrastructure to prepare for net zero emissions

Infrastructure is facing increasing pressure on two fronts to prepare for a net zero emissions economy:

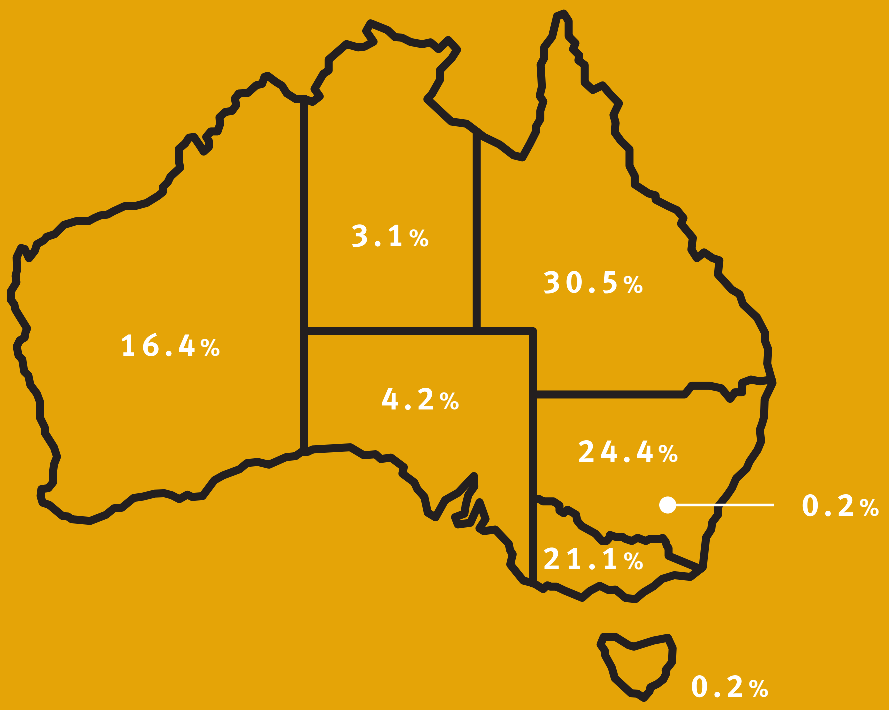
- Government policies targeting net zero emissions, in line with the Paris Climate Agreement
- Demands from private investors and insurers to future-proof the economic value and returns of infrastructure assets, in preparation for a net zero emissions world.

Infrastructure will play a central role in supporting governments to meet their emissions reduction targets. Australia has signed and ratified the Paris Climate Agreement, committing along with 185 other parties to keep global temperature rise to 'well below 2 degrees Celsius', and 'to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius'[46]. As part of this agreement, the Australian Government has committed to reducing economy-wide greenhouse gas emissions by 26% to 28% below 2005 levels by 2030.

In addition, all Australian states and territories have set commitments or aspirations to achieve net zero emissions by 2050 or earlier (see Figure 2).

> All Australian states and territories have set commitments or aspirations to achieve net zero emissions by 2050, or earlier. Infrastructure built today will need to be compatible with this future.

FIGURE 2: State and territory 2017 share of national emissions[47]



Australia

Emissions: 530.8 Mt CO_2e

Emissions per capita: 21.4 t CO_2e

Targets: 26-28% below 2005 levels by 2030

Signed and ratified Paris Climate Agreement

Queensland // 30.5%

Emissions: 161.5 Mt CO_2e

Emissions per capita: 32.5 t CO_2e

Targets: 30% below 2005 levels in 2030

Net zero emissions by 2050

New South Wales // 24.4%

Emissions: 131.5 Mt CO_2e

Emissions per capita: 16.6 t CO_2e

Targets: Net zero emissions by 2050

Australian Capital Territory // 0.2%

Emissions: 1.3 Mt CO_2e

Emissions per capita: 3.1 t CO_2e

Targets: 40% below 1990 levels by 2020 (legislated)

65-75% below 1990 levels by 2030

Net zero by 2045 (legislated)

Victoria // 21.1%

Emissions: 110.3 Mt CO_2e

Emissions per capita: 17.3 t CO_2e

Targets: 15-20% below 2005 levels by 2020

Net zero emissions by 2050 (legislated)

Tasmania // 0.2%

Emissions: 0.9 Mt

Emissions per capita: 1.7 t CO_2e

Targets: 60% below 1990 levels by 2050 (legislated)

Net zero by 2050

South Australia // 4.2%

Emissions: 22.1 Mt CO_2e

Emissions per capita: 12.8 t CO_2e

Targets: 60% below 1990 levels by 2050 (legislated)

Net zero emissions by 2050

Western Australia // 16.4%

Emissions: 88.5 Mt CO_2e

Emissions per capita: 34.2 t CO_2e

Targets: Aspiration of net zero emissions by 2050

Northern Territory // 3.1%

Emissions: 16.6 Mt CO_2e

Emissions per capita: 67.4 t CO_2e

Targets: Aspiration of net zero emissions by 2050

Alongside government emissions targets and policy, pressure from asset managers and investors has mounted in recent years. The private sector is becoming increasingly aware of climate change risks and is seeking better risk disclosures and strategies from those in whom they invest. According to global investment managers BlackRock: 'Investors can no longer ignore climate change'[48].

Responding to climate change risks is becoming critical for accessing capital markets. For investors, the transition risks of climate change have flow-on effects for insurance premiums, credit risks and portfolio value-at-risk (a measure of an investment portfolio's exposure to risk over a given timeframe). As investors increasingly align their portfolios to net zero emissions in order to hedge these risks, infrastructure projects that are incompatible with net zero emissions in 2050 will face a restricted pool of financing and insurance. For example, in July 2019 QBE Insurance Group Limited stopped underwriting thermal coal projects. This includes coal mines and power plants, but also the transport network infrastructures that support them[49].

> As investors increasingly align their portfolios to net zero emissions, incompatible infrastructure projects will face restricted pools of financing and insurance.

On the other hand, infrastructure assets aligned to net zero emissions and sustainable development outcomes are becoming increasingly attractive to investors. In their *Investing in a Time of Climate Change* report, Mercer predicts that sustainable infrastructure will provide the second highest return of all asset classes (behind renewable energy) between today and 2030 in a world transitioning to net zero emissions[50].

There is also an increasing pool of green finance allocated exclusively to sustainable projects[51]. Green finance can take the form of green bonds, loans linked to emissions performance, or finance allocated exclusively to climate change solutions.

For example:

- The National Australia Bank has committed $55 billion of lending over ten years to 2025 for projects that support the transition to a low-carbon economy[52].
- The Queensland Treasury Corporation has issued $2 billion in green bonds to fund green projects and assets that will support Queensland's transition to a low-carbon and climate-resilient economy[53].
- The Commonwealth Bank of Australia and Westpac have loaned Queensland Airports Limited $100 million to redevelop the Gold Coast Airport. The loan comes with the opportunity for a reduced interest rate if the airport meets sustainability targets, including reducing greenhouse gas emissions and achieving carbon accreditation through the Airports Council International.
- The CEFC is a significant investor in emissions reduction projects across Australian infrastructure, including in the MIRA Australian infrastructure platform, targeting lower carbon emissions and improved energy efficiency in airports, electricity, port, rail and water. Together with the IFM Australia Infrastructure Fund, CEFC finance is supporting emissions reduction in key assets operated by Ausgrid, the Melbourne, Brisbane and Northern Territory airports, NSW and Queensland ports and Melbourne's Southern Cross railway station. Further CEFC investments in the Morrison & Co Growth Infrastructure Fund target diverse assets in health care and data centres. Additionally, CEFC finance is supporting the Qube Holdings transformation of Sydney's Moorebank Logistics Park, switching from road to rail for the distribution of containerised freight[54].

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.

> Infrastructure compatible with net zero emissions offers the opportunity for long-term, reliable returns for investors.

BOX 2: Benchmarks and standards can improve sustainability

Infrastructure Australia's *Australian Infrastructure Audit 2019* notes that widely-adopted standards and rating tools have improved sustainability outcomes for passenger transport infrastructure[55]. Example standards currently applied to infrastructure assets and portfolios include ISCA's Infrastructure Sustainability rating, the Green Building Council of Australia's Green Star rating, and the Global Real Estate Sustainability Benchmark (GRESB) Infrastructure Fund Assessment.

These standards offer guidance and benchmarks for reducing emissions from infrastructure assets across all sectors, including transport, water and waste. They provide a common language to consider sustainability throughout a project lifecycle, which helps manage delivery risks and assures government, communities and the market of project outcomes. When applied as part of a broad suite of strategies (see Section three for examples), the standards are a useful tool for investors, designers, builders and operators to prioritise emissions reductions at relatively low cost to users.

Infrastructure built today can lay the foundations for a net zero emissions future

ClimateWorks Australia's forthcoming *Decarbonisation Futures* research identifies several ways in which Australia can achieve a thriving, net zero emissions economy by 2050[56]. For all of these scenarios, infrastructure plays a critical role.

In the transport sector, new charging and refuelling infrastructure can support increased uptake of renewable energy-powered electric and hydrogen vehicles. Similarly, investment in public transport, cycling and pedestrian infrastructure can reduce emissions by supporting a switch to these lower and zero emissions transport modes[57].

In the energy sector, Australia can capitalise on its abundant solar and wind energy resources to become a 'renewable energy superpower'[58]. This will rely on investment in transmission networks (such as power lines and substations) and energy storage infrastructure.

Infrastructure that aligns with sustainability outcomes, such as net zero emissions, can sometimes involve higher upfront capital costs than traditional infrastructure.

In many cases, capital costs are declining, and increases in upfront costs are often more than compensated for by savings in operational costs, such as those from energy use and maintenance[59].

Investment in sustainable infrastructure today can unlock long term social, environmental and economic objectives[60]:

- Enabling society to flourish as our population grows and urbanises
- Enabling Australia's progress towards a net zero emissions future, which will include new industries, sectors and export opportunities
- Opening employment opportunities in new industries and markets
- Providing financial returns to infrastructure investors that outperform returns from other asset classes[61].

> Investment in infrastructure today can enable a long-term transition to net zero emissions.

CASE STUDY

Western Australia's Electric Highway

Western Australia's Electric Highway is a project by the Royal Automotive Club of Western Australia (WA) and the Australian Electric Vehicle Association. The 'highway' consists of 11 electric vehicle charging stations on local council land along along a 520km route between Perth and Augusta[62].

This initiative spurred on what has become Australia's national electric vehicle infrastructure network. The Australian Electric Vehicle Association, and WA's largest energy provider Synergy, extended the original network from Perth to Broome, and across to Adelaide. In 2018, there were 783 charging locations in Australia[63], and the average distance between stations nationwide is 200km[64]. Chargefox and its partners, including RAC, will be installing a further 21 electric vehicle chargers across Australia, including in WA.

It is expected that electric vehicles will reach price parity with internal combustion engine vehicles by 2030[65]. Electric vehicle uptake will not rely solely on cost, but also the availability and convenience of charging infrastructure[66]. Energeia predicts that for infrastructure to keep pace with consumer demand, there will need to be close to 30,000 public charging points deployed in Australia by 2040[67].

RESILIENCE OF INFRASTRUCTURE TO EXTREME WEATHER AND A CHANGING CLIMATE

Warmer temperatures, higher sea levels and more frequent and intense extreme weather events all put stress on infrastructure assets

Modelling by Australia's Bureau of Meteorology and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) indicates consistent, ongoing and long term climate change in Australia as a result of emissions from human activity[68]. Average temperatures and sea levels are rising, while the frequency and intensity of extreme weather, such as heatwaves, bushfires and severe storms, is increasing.

It is well documented that climate change is impacting Australia's infrastructure, through extreme weather events and long-term stress. The 2011 Brisbane floods cost Optus $1 million due to damage to the city's telecommunications infrastructure, and cost Brisbane telecommunications users $1 million a day in lost services. The loss of electricity services during the 2007 Eastern Victoria Great Divide bushfires cost the economy $234 million[69]. At the time of printing, communities and government are still counting the costs, including cost to rebuild infrastructure, of the ongoing 2019-20 bushfire season in southern and eastern Australia.

Increasing temperature trends have led Melbourne's Metro Trains to develop hot weather speed restrictions[70]. In the water sector, increased droughts and flooding are challenging the ability of water authorities to provide reliable water supply, given existing infrastructure was designed for historic rainfall patterns. In recent years, over $10 billion has been spent on desalination plants across Australia to improve water security and climate resilience[71].

If greenhouse gas emissions continue at current high levels, over $226 billion in Australian infrastructure assets will be at risk by 2100 due to sea level rise alone[72]. The flow-on financial effects are expected to land much sooner – one in every 19 property owners face the prospect of unaffordable insurance premiums by 2030[73].

Decision-makers are already considering resilience in financing, designing, building and operating infrastructure assets

In recent years, federal and state infrastructure bodies have increasingly highlighted the importance of climate change resilient infrastructure. Objective 9 of Infrastructure Victoria's *30 Year Infrastructure Strategy* is to 'advance climate change mitigation and adaptation'[74]. Meanwhile, the Queensland Department of Environment and Science has called on state agencies to ensure climate risks are considered when building and assessing new infrastructure assets[75]. Private investors are also embedding resilience. For example, Macquarie Group invests in improved climate change adaptation for energy and transport infrastructure assets across its global portfolio, including assets in the Philippines, New York, Finland and Western Australia[76].

Standards and frameworks provide recognised, simplified guidance on project design to deliver resilience benefits at relatively low cost (see Box 2 on page 23). ISCA's Infrastructure Sustainability Rating tool supports planning for climate change hazards such as heatwaves, flooding and sea level rise in all stages of an infrastructure asset's life cycle, from planning and design, through to construction and operation[77]. Investors around the world are also increasingly using the Global Real Estate Sustainability Benchmark (GRESB) Infrastructure Fund Assessment to assess and manage resilience of infrastructure fund portfolios and individual assets, with the number of assessments in 2019 more than double that of 2018[78]. Planning for these risks may mean building infrastructure to different standards, or considering different options for the nature, operations or location of an asset.

According to Infrastructure Australia, embedding resilience to climate change into infrastructure can deliver broader benefits to the community, including improved health and economic productivity[79]. Addressing physical risks in the business case for new infrastructure projects is already embedded in section D4.6 of Infrastructure Australia's *Assessment Framework*, which is supported by resilience planning and risk management guidance in the IS Rating tool[80].

Increasing an infrastructure asset's resilience to climate change may result in trade-offs or co-benefits with measures to reduce emissions[81]. For example, barriers for coastal roads that protect against rising sea levels and erosion will involve additional construction and therefore an increase in embodied emissions.

Scenario analysis to explore potential climate change risks and opportunities can simultaneously include physical and transition impacts.

The case studies presented in this Issues Paper show there are existing solutions for delivering infrastructure that is resilient to climate change and supports the transition to net zero emissions. Opportunities exist to formally prioritise emissions reductions in all infrastructure projects throughout the whole life cycle, from inception to operation.

CASE STUDY

Australian Energy Market Operator's *Integrated System Plan*

The Australian Energy Market Operator has developed a strategic infrastructure plan for the National Electricity Market called the *Integrated System Plan*[82]. The National Electricity Market connects regional markets in Queensland, New South Wales, the Australian Capital Territory, Victoria, Tasmania and South Australia, and supplies electricity to around nine million customers[83].

The *Integrated System Plan* identifies strategic infrastructure needs (such as transmission lines) to respond to a range of emerging changes in the electricity system including digitisation, ageing coal fired power stations, changing electricity demand, rapidly declining renewable power and energy storage costs, cyber security concerns, as well as climate change impacts and emissions reduction policies. It considers both the resilience of electricity infrastructure under climate change impacts (over a 40 to 80 year timeframe) as well as the transition to a lower emissions electricity system. According to the Australian Energy Market Operator: 'Extreme weather events can have a significant influence on the reliability of the power system, if not taken into account when designing infrastructure and planning the power system'[84].

Climate risks are embedded in the *Integrated System Plan* in a variety of ways. The plan identifies investing in transmission lines as a way of managing the risk of bushfires, droughts and heatwaves. For example, resilience is a factor in the route planning for new transmission lines; previous transmission plans have often focused on multiple power lines running side-by-side through wide easements to deliver the lowest-cost option under normal conditions. However the risks and impacts on supply reliability from more extreme weather events need to be factored into future planning.

The *Integrated System Plan* also considers the importance of diversity in generation assets, both with regard to the geographic location of the asset and the nature of generation. For example:

- In high temperatures between 35°C and 45°C, the power rating of gas turbines can decrease, wind farms can shut down, and the capacity of major transmission lines can be reduced by as much as 14%
- Drought conditions can restrict the capacity of hydroelectric, coal and gas power generation
- Bushfires can affect the operation of transmission lines.

SECTION 03

PRIORITISING EMISSIONS REDUCTIONS IN INFRASTRUCTURE ADVICE AND DECISIONS

Advice and decisions at all stages of an infrastructure asset's life can lay the foundations for a net zero emissions future

Several project phases are common across infrastructure assets: strategic planning; project initiation, development and procurement; design and construction; operations and maintenance; and decommissioning. There are opportunities to prioritise emissions reductions at each project phase. This also presents challenges, as no single stakeholder, or group of stakeholders, can control advisory or decisions made across all of these phases. Therefore, a collaborative approach is needed.

Strategic planning advice right at the beginning of an infrastructure project can be the most consequential for emissions outcomes (see Box 3). Infrastructure Australia was established by governments to independently advise on infrastructure priorities that adequately meet forecast demand growth, while supporting economic, social and environmental sustainability[85]. Because of their role in providing early strategic planning advice, Infrastructure Australia and the state infrastructure bodies can reshape the infrastructure agenda to support net zero emissions.

While infrastructure bodies set the agenda, all infrastructure stakeholders have a responsibility to engage in conversation about their role in effectively prioritising emissions reduction across the project lifecycle. See Table 3 for a starting point to inform further conversations on opportunities.

Reshaping infrastructure for a net zero emissions future is an enormous challenge that will require support and engagement of all stakeholders. To support these conversations, ISCA, ClimateWorks and ASBEC acknowledge the following high-level principles (which are reflected in Table 3) as we move towards practical action:

- 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
- 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
- Different infrastructure projects, and classes of infrastructure assets, face unique challenges. Solutions need to be developed that respond to these unique challenges, appropriate to the context of each project
- Interdependencies between sectors need to be explored to leverage potential opportunities (for example, for infrastructure projects to enable transformations in the materials supply chain) and manage risks (for example, by testing transition risks against different scenarios).

TABLE 3: Potential opportunities to prioritise emissions reductions in each phase of an infrastructure project

The potential opportunities listed here are intended as a starting point for further conversations on implementation options, challenges and priorities for action.

Infrastructure project phase	Description of key decisions in each phase	Potential opportunities to prioritise emissions reductions towards a goal of net zero emissions
1 **Strategic planning**	> Identifying strategic infrastructure needs, issues or opportunities, including decisions whether or not to invest in infrastructure (see Box 3) > Strategic land use planning > Strategic infrastructure or sector (e.g. transport, energy) planning	> Identifying the need to transition to a net zero emissions economy as a high priority strategic objective for infrastructure > 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 > Examining proposed needs, issues and opportunities for compatibility with a broad set of scenarios achieving net zero emissions by 2050 > Designing adaptive strategies, where required, to ensure solutions are resilient to future changes > Drawing on existing standards to guide design and lifecycle decisions, such as Green Building Council of Australia's Green Star tool, and ISCA's Infrastructure Sustainability Planning Rating Tool. Upgrading or developing new tools where relevant.
2 **Project initiation, development and procurement**	> Establishing or refining assessment frameworks or requirements for infrastructure > Assessing options or projects against these frameworks > Analysing costs and benefits of proposed infrastructure projects > Selecting and prioritising infrastructure projects or initiatives > Deciding which projects to fund or invest in, and timeframes for delivery	> Prioritising emissions reductions and setting an overarching goal of net zero emissions as part of assessment frameworks for infrastructure > Prioritising and investing in infrastructure projects critical to enabling a net zero emissions future > Testing the performance of project options against a broad set of scenarios achieving net zero emissions by 2050, with only those that perform well in such scenarios progressing to business case development > 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 > Drawing on existing standards to guide investment decisions at the portfolio and asset level, such as GRESB's Infrastructure Assessment tool. Upgrading or developing new tools where relevant.

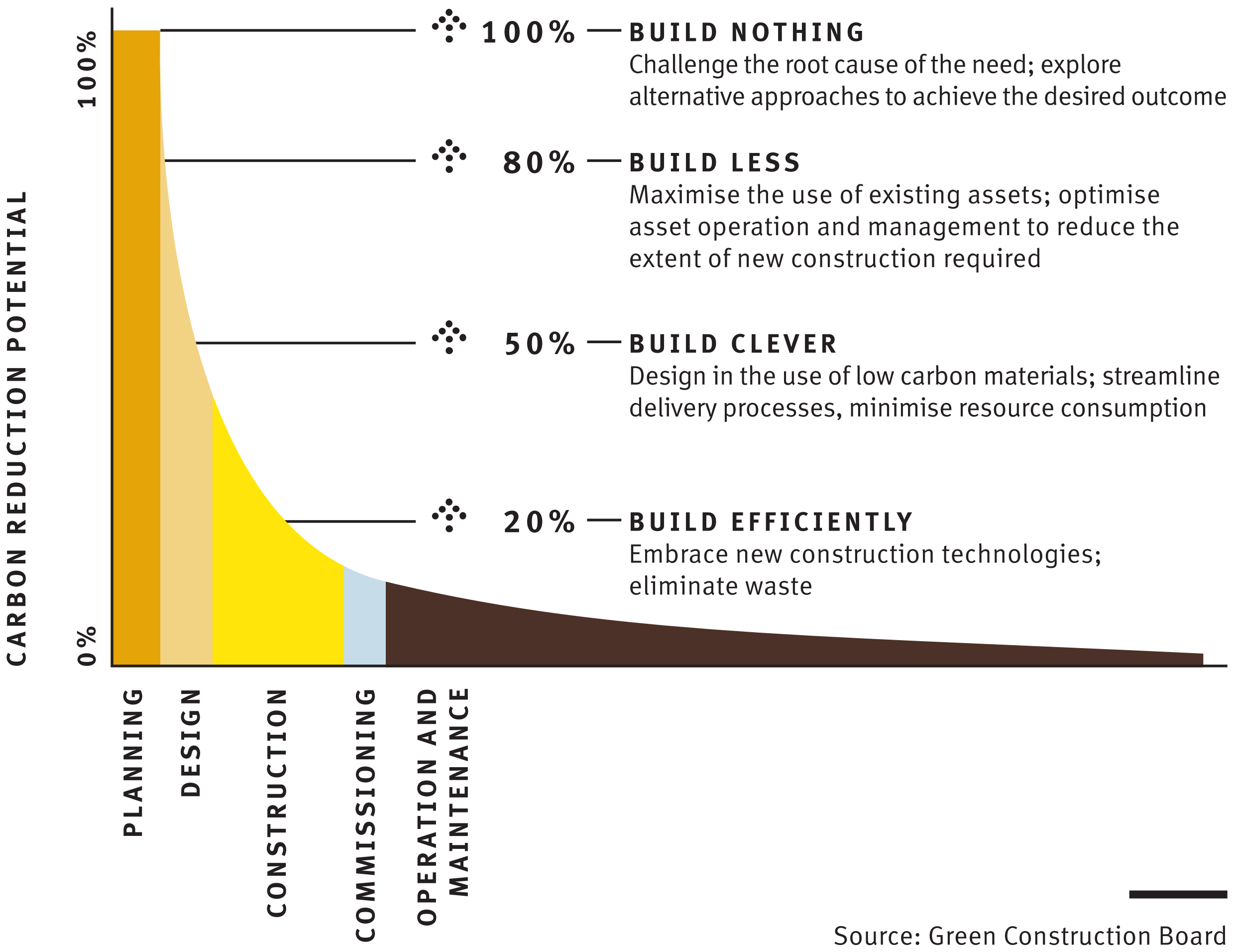
Infrastructure project phase	Description of key decisions in each phase	Potential opportunities to prioritise emissions reductions towards a goal of net zero emissions
3 **Design and construction**	> Determining how a project will be built, its final form, what materials will be used, construction methods and operating conditions (e.g. noise and lighting) > Determining performance standards for infrastructure > Deciding when and how infrastructure assets will be disposed of or retrofitted at the end of their operational life	> Undertaking detailed cost-benefit analysis (and sensitivity tests of demand and cost modelling) of chosen project design, testing for robustness across a variety of future climate change scenarios, including multiple net zero emissions by 2050 scenarios > Undertaking real options analysis conducted to explore how to stage design and construction processes to adapt to new information > Developing and defining plausible least, middle and greatest risk climate change scenarios in terms of the specific risks of the short-listed, or final selected, project design. Disclosing to the public transparent and detailed explanations of the climate change analysis completed > Showing evidence that options to reduce construction emissions were explored and taken where financially feasible > Setting emissions performance standards for infrastructure, including caps for emissions embodied in construction materials, produced during construction and operation
4 **Operations and maintenance**	> Determining the ongoing operating conditions and providers (e.g. hours of operation, electricity providers, fuel or vehicle use, and materials suppliers)	> Updating cost-benefit analysis and sensitivity modelling as time progresses and climate change policies and targets are updated > Seeking opportunities to reduce operating emissions (e.g. through retrofitting infrastructure, or through renewable power, energy efficiency, electrification, and offsets) > Reviewing projects post-completion to evaluate whether a project achieved its emissions performance objectives, along with its strategic objectives and economic performance
5 **Decommissioning**	> Deciding when and how infrastructure assets will be disposed of at the end of their operational life (this can also be considered in the design and construction phase)	> Showing evidence that options to reduce emissions in decommissioning practices were explored and taken, where financially feasible, as well as recycling materials where feasible (decisions made in design and construction phase can also impact feasibility of recycling in the decommissioning phase)

BOX 3: Planning for lower emissions at the beginning of an infrastructure project

As shown in Figure 3, the greatest potential for decreasing emissions happens at the stage of deciding whether or not to build a new asset. For example, the Queensland Government State Infrastructure Plan highlights that building new capital infrastructure is the least preferred option for improving service delivery. Reform of institutions and laws, and better use of existing infrastructure, are preferred from both economic and emissions standpoints[86].

In 2018, for example, the Queensland Government amended *Electricity Regulation* (2005) to allow electricity provided to operate at lower voltages due to the effect of increased power flows from rooftop solar to the grid. Previously, distributors needed to make significant capital investments to the network in order to manage these power flows[87].

FIGURE 3: Carbon reduction potential of strategic infrastructure choices[88]



Source: Green Construction Board

Despite commitments being made by investors and governments, emissions reduction in line with a net zero emissions future is not effectively prioritised in infrastructure planning, design, procurement and operation across sectors.

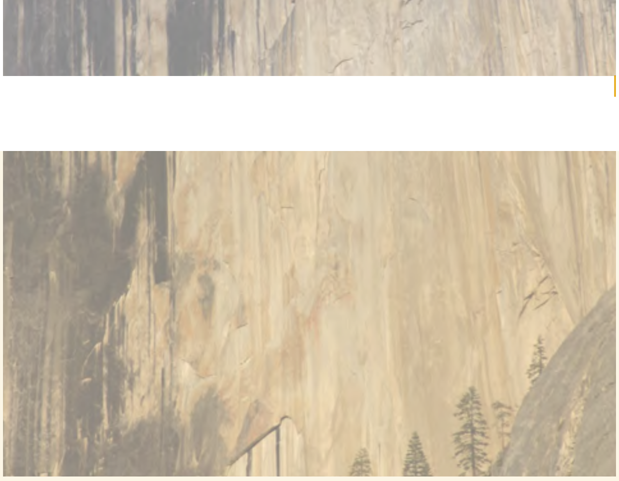
Sustainability considerations are already embedded in some Australian infrastructure policies; for example, Sydney Metro and Melbourne Metro require all project packages to achieve an IS and/or Green Star rating, while roads authorities in Queensland and Western Australia require an IS rating on all projects over $100 million[89]. However, there is currently no consistent, formalised process for prioritising emissions reductions in infrastructure advice, decisions or projects across Australia.

Infrastructure Australia notes that governments often have the ambition to incorporate climate change considerations into their infrastructure projects, but that final outcomes can fail to reflect these intentions due to the lack of a consistent approach in translating goals into action[90].

Government can play a central role in standardising infrastructure advisory and decision-making to support a net zero emissions future

In 2018, approximately 57% of infrastructure built was completed for the public sector[91]. Australian governments from federal to local level make the majority of infrastructure decisions, determining which infrastructure projects proceed, the timeframes for delivery, and the project requirements and conditions (for example, in assessment and approval processes, and contract tender documents). Infrastructure Australia and the state infrastructure bodies play a central role in advising on the infrastructure priorities, planning and funding agenda for governments, through documents such as the *Infrastructure Priority List*[92] and *Australian Infrastructure Plan*[93].

State and territory governments are also committed to achieving net zero emissions by 2050 or earlier. Prioritising emissions reductions in government infrastructure decisions will be critical in meeting these commitments. A formalised process for defining net zero emissions scenarios and their applications, assessing transition risks and prioritising emissions reductions can enable a consistent and efficient approach across the sector. This does not necessarily mean starting afresh; there is the opportunity to build on existing government infrastructure assessment frameworks, investment decision-making tools, and rating tools such as ISCA's IS Rating Tool and GRESB's Infrastructure Assessment.



CASE STUDY

California's 'Buy Clean' Act

Signed in 2017, California's Buy Clean California Act targets the embodied carbon emissions of materials used in construction of state infrastructure projects. Beginning in 2020, manufacturers of four key building materials – carbon steel rebar, structural steel, flat glass and mineral wood insulation board – will be required to submit Environmental Product Declarations as part of their bids to supply materials for infrastructure projects.

In 2021, California's Department of General Services will publish maximum acceptable Global Warming Potentials – a measure of emissions intensity – for the production of the four materials. Government authorities will gauge compliance against these limits through the required Environmental Product Declarations[94].

CASE STUDY

Melbourne's metropolitan water corporations are targeting net zero emissions by 2030

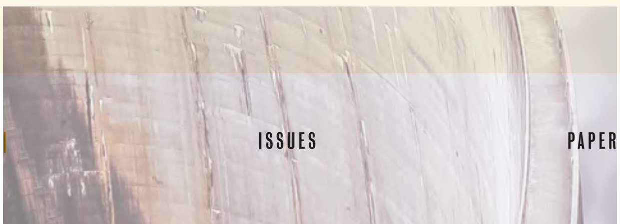
Victoria's water sector has adopted a target of net zero emissions by 2050 in its key strategic plan, Water for Victoria. This is consistent with the state-wide target set out in the Victoria's *Climate Change Act 2017*.

The water sector is responsible for the largest proportion (24%) of emissions from Victorian state government activities – bigger than rail and healthcare[95]. These emissions result from the energy used to pump and treat water to safe standards, and emissions resulting from wastewater treatment.

In addition, Victoria's four metropolitan water corporations have committed to achieving net zero emissions by 2030.

For example, Melbourne Water has committed to reducing its operational emissions to net zero by 2030, and has set an interim target to reduce its emissions by half (from current levels) by 2025[96]. Melbourne Water's emissions relate primarily to the transfer and treatment of wastewater (84%) and water supply (15%). Practices that Melbourne Water is undertaking to achieve its net zero emissions goal include:

- Moving to a zero emissions vehicle fleet
- Capturing renewable biogas at the Western Treatment Plant to provide energy for the operation of the treatment plant
- Generating hydro electricity through the water transfer system.



CONCLUSION

Infrastructure assets can lay the foundations for Australia's net zero emissions future. This Issues Paper makes the case for why emissions reductions should be prioritised in infrastructure advice and decisions today.

Infrastructure bodies, governments, investors and industry all have a role to play in making this happen. There is also the need to build on existing tools and frameworks, and to create new tools underpinned by rigorous technical analysis, where required, to support advisors and decision-makers in prioritising emissions reductions in infrastructure planning and delivery.

Prioritising emissions reductions infrastructure advice and decisions includes formalising emissions requirements in the assessment frameworks and plans of federal, state and territory infrastructure bodies, such as Infrastructure Australia. It also includes embedding net zero emissions scenarios into individual projects and investment portfolios, in a way that suits the specific context of each project proponent or investor.

This Issues Paper is an invitation to engage all stakeholders in a conversation about the challenges, opportunities and priorities in reshaping infrastructure for a net zero emissions future. In the coming months, ISCA, ClimateWorks and ASBEC will begin engaging with infrastructure advisors, governments, investors, construction companies and other key stakeholders and decision-makers, from infrastructure advice and government frameworks and policies through to individual projects. The outcomes of these conversations will be brought together in a synthesis report that recommends next steps.

If you would like to engage further in ISCA, ClimateWorks and ASBEC's effort to deliver infrastructure for a net zero emissions future, including participation in stakeholder workshops and forums, please contact:

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APPENDIX:

Infrastructure's influence on emissions – methodology and results

This appendix outlines the methodology used in this Issues Paper to estimate the share of Australia's emissions that is influenced by infrastructure.

A summary of emissions, by type and sector, is provided in Table A.1.

Infrastructure's embodied emissions

The emissions embodied in the construction of Australian infrastructure for 2018 were estimated using three data sources: Australian Bureau of Statistics (ABS) construction activity data, Department of the Environment and Energy emissions data, and Yu et al.'s analysis in *The Carbon Footprint of Australia's Construction Sector* (2017)[97].

TABLE A.1: Australia's annual infrastructure-related emissions, by emissions type, and infrastructure sector (Mt CO_2e)

Infrastructure type	Estimated embodied emissions	Estimated operations emissions	Estimated enabled emissions
Energy	**8.3**	**25.2**	**237.2**
> Electricity networks	7.3	21.0	162.2
> Gas networks	1.0	4.3	75.0
Transport	**17.0**	**4.2**	**121.1**
> Roads[i]	12.4		86.2
> Railways	4.2		24.5
> Airports	0.6		6.7
> Ports	0.5		3.8
Communications	**5.5**	**9.1**	**N/A**
Water	**3.5**	**6.9**	**N/A**
Waste	**N/A**	**9.2**	**N/A**

[i] Roads includes roads, bridges and tunnels. It may also include some bridges and tunnels built for rail, though this is assumed to be a small portion of the overall figure. Total emissions for each sector are not provided in this table due to some emissions being counted in multiple cells of the table. For example, electricity used in the construction of roads is counted in both the embodied emissions of roads and the enabled emissions of electricity networks. Please see Table 2 for an estimate of infrastructure's total emissions, taking into consideration this double counting.

Yu et al. (2017) finds that, in 2013, 10.6% of Australia's carbon footprint was attributable to engineering construction[98]. Engineering construction includes the emissions embodied in the processes and materials used in construction of infrastructure, as well as the construction of other heavy and civil works such as mine sites.

ABS Engineering Construction Activity, Australia (2019) reports that 66.2% of Australian engineering construction value added[99] is infrastructure that is within the scope of this Issues Paper. This data was used to estimate the share of engineering construction emissions - as calculated by Yu et al. (2017) - that is attributable to infrastructure construction, broken down by different asset types (see Table A.2).

The exception to the methodology was airport construction. Estimated construction value added in the airport sector for 2018 was taken from Deloitte's *Connecting Australia: The Economic and Social Contribution of Australia's Airports* (2018).

The estimate of infrastructure embodied emissions is subject to the following limitations:

- The engineering construction share of Australia's emissions from Yu et al (2017) is based on 2013 data. The analysis assumes that this proportion was the same for 2018
- The breakdown of infrastructure construction emissions by infrastructure type uses construction value added as a proxy for emissions. This assumes that the emissions intensity of construction for different infrastructure types is the same
- ABS *Engineering Construction Activity, Australia* does not include waste infrastructure, and for this reason emissions embodied in the construction of waste infrastructure are not included
- The methodology does not allow for the embodied emissions of infrastructure projects to be apportioned across the life cycle of the assets. Infrastructure embodied emissions are counted solely in the year of construction.

TABLE A.2: Australia's infrastructure construction by value added ($000's), share of construction, and estimated embodied emissions, 2018

Infrastructure type	Value added ($m)	Value added share of total infrastructure construction (%)	Estimated embodied emissions (Mt CO_2e)
Transport	**32,055.8**	**49.6%**	**17.0**
> Roads	21,091.8	32.7%	11.8
> Airports	1,080.0	1.7%	0.6
> Bridges	1,088.4	1.7%	0.6
> Railways	7,916.8	12.3%	4.2
> Ports	878.8	1.4%	0.5
Water	**6,584.9**	**10.2%**	**3.5**
> Water storage + supply	4,027.5	6.2%	2.1
> Sewerage and drainage	2,557.5	4.0%	1.4
Energy	**15,537.6**	**24.1%**	**8.3**
> Electricity	13,666.8	21.2%	7.3
> Gas	1,870.8	2.9%	1.0
Communications	**10,408.8**	**16.1%**	**5.5**
TOTAL INFRASTRUCTURE	**64,587.2**	**100.0%**	**34.3**

The embodied and operational emissions across an infrastructure asset's life cycle varies by project. For example, data from a small selection of road projects with an Infrastructure Sustainability (IS) rating[100] suggests embodied emissions for roads without tunnels were, on average, two and a half times larger than operation emissions. In contrast, operational emissions were more than double the embodied emissions for road projects that included tunnels. This is because the majority of operating emissions from tunnels come from electricity used in ventilation, while the majority of embodied emissions are attributable to asphalt, concrete, aggregate and metals used in construction.

Infrastructure operating emissions

The emissions associated with the operation of infrastructure in Australia for 2018 were estimated using two primary data sources: Department of the Environment and Energy emissions data, and Australian Bureau of Statistics (ABS) energy use by ANZSIC sector[101] data. Where these sources were not sufficient, other datasets have been used. These are detailed in the relevant explanations below.

Where necessary, conversions from energy use to emissions were completed using emissions factors from the Department of the Environment and Energy's *National Greenhouse Accounts Factors July 2018 (2018)*.

Transport

An estimate of the emissions from operating transport infrastructure was derived from energy use in the *Transport Support Services* ANZSIC sector, and the energy used to power street lights.

The *Transport Support Services* sector includes airport operations, rail station operations, toll road operations, stevedoring services and other transport infrastructure operations. Energy use in this sector is detailed in the ABS' *Energy Use, Electricity Generation and Environmental Management, Australia*, 2014-15 (2016).

Emissions associated with street lights was estimated based on figures in the Institute of Public Works Engineering Australasia's *SLSC Roadmap: Street Lighting and Smart Controls Programme* (2016). This methodology is subject to the following limitations:

- The *Transport Support Services* sector energy data used is from 2015. It is assumed that the energy use in 2018 would be the same
- The *Transport Support Services* sector includes some activities that are not involved in the operations of infrastructure, such as freight forwarding services and customs agency services. As such, the emissions figure used may be an overestimate
- Some infrastructure operating emissions, such as those from the energy used to ventilate road tunnels, were not included in the analysis due to data limitations
- Total operating emissions for transport infrastructure could not be apportioned by infrastructure type due to data limitations.

Energy

Emissions from the operating of energy infrastructure were estimated based on energy use in the Electricity Supply and Gas Supply sectors, as well as the electricity and gas lost during transmission, storage and distribution.

Electricity use and losses in the *Electricity Supply* sector are derived from the Department of the Environment and Energy's *National Inventory by Economic Sector* (2018) and *Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2018* (2019). Fugitive emissions from transmission, storage and distribution in the *Gas Supply* sector are also derived from the *National Inventory by Economic Sector* (2018) and *Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2018* (2019).

Fuel use and electricity use emissions in the *Gas Supply* sector were derived from the Australian Energy Statistics' *Australian Energy Update* (2018) and the ABS' *Energy Use and Electricity Generation, Australia, 2017-18* (2019).

Water

Emissions from the operating of water infrastructure were estimated based on energy use in the *Water Supply, Sewerage and Drainage Services* sector, as well as the non-energy emissions resulting from wastewater treatment and discharge.

The *Water Supply, Sewerage and Drainage Services* sector includes activities such as water distribution, water reservoir operation, desalination plant operation, stormwater drainage system operation and sewage treatment plant operation. Electricity use in this sector is detailed in the ABS' *Energy Use and Electricity Generation, Australia, 2017-18* (2019).

Direct emissions from fuel use in the water sector, and from wastewater treatment and discharge, are derived from Department of the Environment and Energy's *National Inventory by Economic Sector* (2018) and *Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2018* (2019).

Waste

The operating emissions of waste infrastructure were estimated based on energy use in the *Waste Collection, Treatment and Disposal Services* sector, as well as the non-energy emissions from the disposal, incineration and biological treatment of solid waste.

The *Waste Collection, Treatment and Disposal Services* sector includes activities such as hazardous waste treatment, the operation of landfills, and the operation of other waste treatment facilities. Electricity use in this sector is detailed in the ABS *Energy Use and Electricity Generation, Australia, 2017-18* (2019).

Direct emissions from fuel use in the waste sector, and from the disposal, incineration and biological treatment of solid waste, are derived from Department of the Environment and Energy's *National Inventory by Economic Sector* (2018) and *Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2018* (2019). This methodology is subject to the following limitation:

> The *Waste Collection, Treatment and Disposal Services* sector includes some activities that are not involved in the operations of infrastructure, such as the remediation and collection of hazardous materials. As such, the emissions figure used may be an overestimate.

Communications

The operating emissions of communications infrastructure were estimated based on energy use and activity data for the *Information, Media and Telecommunications* sector, and the energy used to power Australia's data centres.

Energy use in the *Information, Media and Telecommunications* sector is detailed in the ABS' *Energy Use, Electricity Generation and Environmental Management, Australia, 2014-15* (2016).

Emissions associated with data centre energy use were estimated based on projections in E3's *Energy Efficiency Policy Options for Australian and New Zealand Data Centres* (2014).

This methodology is subject to the following limitations:

> The *Information, Media and Telecommunications* sector energy data used is from 2015. It is assumed that the energy use in 2018 would be the same

> Capital expenditure data is used as a proxy for telecommunications' share of the *Information, Media and Telecommunications* sector's energy use. Furthermore, the *Information, Media and Telecommunications* sector capital expenditure data used is from 2014. It is assumed that telecommunications' share of capital expenditure in 2018 would be the same.

The results of this analysis are summarised in Table A.3.

TABLE A.3: Australia's infrastructure operating emissions, by infrastructure type, 2018

Infrastructure type	Estimated operating emissions (Mt CO_2e)	Share of total infrastructure operating emissions (%)
Transport	**4.2**	**7.7%**
Energy	**25.2**	**46.2%**
> Electricity	21.0	38.3%
> Gas	4.3	7.8%
Communications	**9.1**	**16.7%**
Water	**6.9**	**12.5%**
Waste	**9.2**	**16.9%**
TOTAL INFRASTRUCTURE	**54.7**	**100.0%**

Infrastructure-enabled emissions

Emissions enabled by Australian infrastructure in 2018 were estimated using: Department of the Environment and Energy emissions data, Australian Energy Statistics energy use data, and ClimateWorks Australia's *Decarbonisation Futures* analysis.

Where necessary, conversions from energy use to emissions were completed using emissions factors from the Department of the Environment and Energy's *National Greenhouse Accounts Factors July 2018* (2018).

Transport

For transport infrastructure, estimates of the emissions produced by domestic vehicle fuel combustion were taken from the Department of the Environment and Energy's *National Greenhouse Gas Inventory Report* (2018) and *Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2018* (2019). This includes emissions from domestic road, rail, aviation and water transport.

Emissions associated with electric rail transport, as well as international aviation and water transport, were derived using the Australian Energy Statistics' *Australian Energy Update* (2018). As a proxy for Australia's share of international aviation and water transport, the *Australian Energy Update* estimates the energy use of flights and vessels leaving Australian shores.

Energy

In the energy sector, emissions enabled by electricity infrastructure were estimated based on the Department of the Environment and Energy's *National Greenhouse Gas Inventory Report* (2018) and *Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2018* (2019). The figure reported in Table A.4 is Australia's total electricity-related emissions, less those associated with electricity used by the electricity providers themselves and the electricity lost in the distribution and transmission process. These excluded emissions are considered the operational emissions of electricity infrastructure.

Emissions enabled by the gas sector were derived using the Australian Energy Statistics' *Australian Energy Update* (2018). The figure reported in Table A.4 is Australia's total gas use emissions less those associated with gas used by the gas providers themselves and the gas lost in the distribution and transmission process. These excluded emissions are considered to be the operational emissions of gas infrastructure. Also subtracted from Australia's total gas use emissions are those associated with the gas mining process, the estimate for which is taken from ClimateWorks Australia's *Decarbonisation Futures* (2019).

The results of this analysis are presented in Table A.4. They are subject to the following limitations:

- Only emissions enabled by transport and energy infrastructure were considered in the analysis completed for this Issues Paper
- No emissions were identified to be enabled by waste infrastructure
- The emissions enabled by communications and water infrastructure were not quantified due to data limitations. Emissions from the energy used to power communication devices, such as phones and computers, are an example of emissions enabled by communications infrastructure. Emissions from energy used by consumers for water heating is an example of emissions enabled by water infrastructure.

TABLE A.4: Emissions enabled by Australia's infrastructure, by infrastructure type, 2018

Infrastructure type	Estimated enabled emissions (Mt CO_2e)
Transport	**121.1**
> Roads and bridges	86.2
> Airports	24.5
> Railways	6.7
> Ports	3.8
Energy	**237.2**
> Electricity	162.2
> Gas	75.0
TOTAL INFRASTRUCTURE	**355.6***

* Note: Some emissions are enabled by both transport infrastructure and energy infrastructure (e.g. those from electric rail). The total emissions enabled by infrastructure figure reported in the table addresses this, and, as such, the total figure is different to the sum of the figures above it. The figures in this table however do not address double counting between enabled emissions and operating or embodied emissions (e.g. electricity used in the construction of infrastructure assets). For this reason, the total emissions enabled by infrastructure reported here is different to the figure presented in Section 2 of this discussion paper.

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99 Construction value added is the total value of the asset constructed, after deducting the cost of intermediate goods and services used in construction.

100 ISCA's IS Rating Scheme (IS) evaluates sustainability across the planning, design, construction and operational phases of infrastructure projects. For more information, see: https://www.isca.org.au/is_ratings.

101 The Australian and New Zealand Standard Industrial Classification (ANZSIC) is an industry classification system developed by the Australian Bureau of Statistics and the New Zealand Department of Statistics.

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Published by ClimateWorks Australia
Melbourne, Victoria, March 2020

This publication may be downloaded at:
www.climateworksaustralia.org

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