INFRASTRUCTURE PARTNERSHIPS AUSTRALIA

3 May 2024

Electricity and Energy Sector Plan Taskforce
Office of Energy Economics
Federal Department of Climate Change, Energy, the Environment and Water

Via email: EnergyandElectricitySectorPlan@dcceew.gov.au

SUBMISSION TO THE FEDERAL DEPARTMENT OF CLIMATE CHANGE, ENERGY, THE ENVIRONMENT AND WATER ON THE ELECTRICITY AND ENERGY SECTOR PLAN DISCUSSION PAPER

Infrastructure Partnerships Australia is pleased to provide this submission to the Federal Department of Climate Change, Energy, the Environment and Water in response to its Electricity and Energy Sector Plan Discussion Paper.

Infrastructure Partnerships Australia is an independent think tank and executive member network, providing research focused on excellence in social and economic infrastructure. We exist to shape public debate and drive reform for the national interest. As the national voice for the infrastructure sector in Australia, our membership reflects a diverse range of public and private sector entities, including infrastructure owners, operators, financiers, advisers, technology providers and policy makers.

Infrastructure Partnerships Australia has, and continues to, advocate for sensible, strategic reform that moves the needle on decarbonising infrastructure across all asset classes in Australia, including the electricity and energy sector. Energy emissions contributed 55 per cent of Australia's greenhouse gas emissions in the year to last September. This contribution is higher when accounting for energy emissions across commercial and manufacturing-related activities and fuel combustion in transport.[1]

Successfully transforming Australia's energy industry is fundamental to our decarbonisation transition, not only because of its predominant role in our annual emissions, but it is also a pre-requisite for the majority of decarbonisation efforts in other infrastructure industries. This submission seeks to present data on the forward energy infrastructure pipeline and outline considerations for Government to inform the development of the national Electricity and Energy Sector Plan.

A clear national decarbonisation pathway for all infrastructure asset classes will accelerate innovation and investment, with energy being the first frontier of the decarbonisation journey

Infrastructure Partnerships Australia's major research report *Decarbonising Infrastructure* – released in April 2022 – set out the changes needed and the corresponding actions required to decarbonise Australia's infrastructure sector across its asset classes. The report called for a national decarbonisation plan for infrastructure, with clear and actionable objectives to draw together the separate threads of decarbonisation across the infrastructure

[1] Department of Climate Change, Energy, the Environment and Water (2023), *Quarterly Update of Australia's National Greenhouse Gas Inventory: September 2023*

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sector. Energy – contributing significantly to emissions in its own right and being a major input to all other forms of infrastructure – could act as an accelerator of change across the economy.

The path to decarbonising Australia's energy system has been clear for many years: a renewables-dominated electricity system, backed by a diverse mix of storage technologies, and declining reliance on fossil fuels for energy in other parts of the economy. A low-carbon energy system is vital for a low-carbon Australia, and the sooner energy decarbonises, the easier Australia's transition to net zero will be – but this must happen in an orderly fashion.

Through Infrastructure Partnerships Australia's engagement on *Decarbonising Infrastructure*, another critical issue emerged – the pathway to reduce the carbon embedded in the vast amounts of steel, concrete and other materials required to deliver the infrastructure pipeline is unclear.

In response, we developed *Decarbonising Construction: Putting Carbon in the Business Case*, published in August 2022. That paper set out a proposal that an embedded (or embodied) carbon 'base case' should be included in all business cases for infrastructure projects and programs over $100 million in capital cost. This should be mandatory for all such projects, with government retaining the option to 'compete' a lower carbon outcome through detailed design and procurement – establishing a framework to move infrastructure procurement to a Time, Quality and Cost + Carbon setting. Earlier this year, the NSW Government adopted this solution in its *Decarbonising Infrastructure Delivery Policy* and *Measurement Guidance Policy*.

While this policy solution applies to public infrastructure, it sets a clear framework for the upcoming energy infrastructure pipeline, in order to ensure the transition is built out with a low-carbon profile. There will be significant growth in the number of energy projects under delivery over the coming years to progress Australia's transition efforts. This growth in the pipeline will result in a proportional growth in emissions across the construction, operation and waste of these new projects. Ensuring an appropriate framework is in place to address embedded emissions from the early planning stages right through to the delivery of these projects is crucial for Australia's wider decarbonisation efforts.

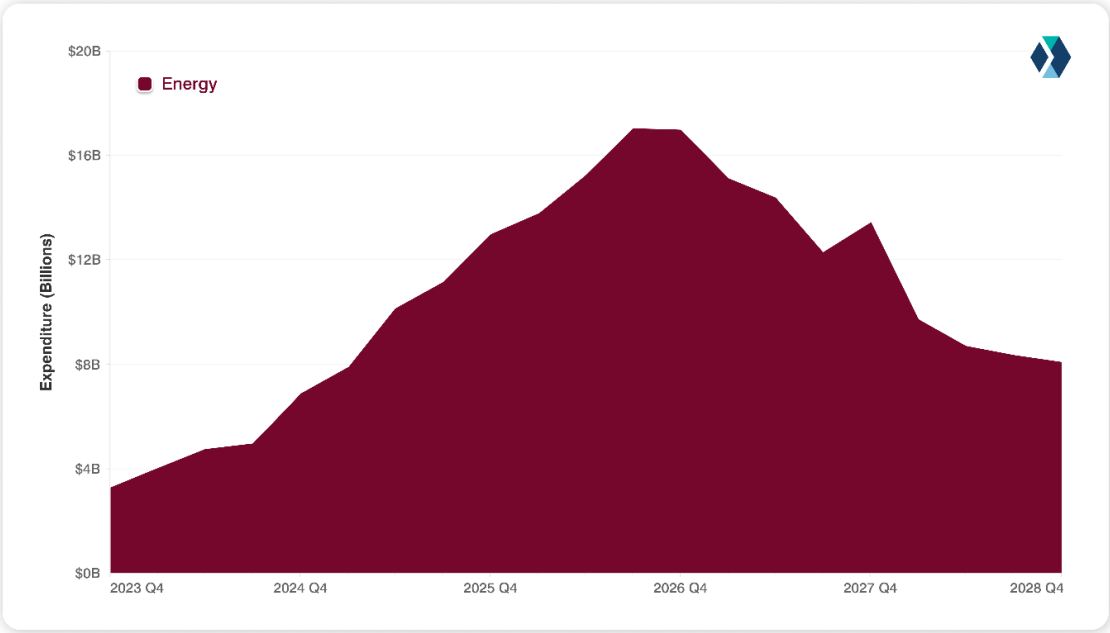
Copies of these two reports are included as attachments for your reference.

There is a growing pipeline of renewable energy infrastructure to be delivered

Infrastructure Partnerships Australia's Australia and New Zealand Infrastructure Pipeline (ANZIP) provides a forward view of major infrastructure projects and contracts across the two countries. ANZIP tracks infrastructure opportunities from announcement to completion, providing updates and analysis as projects develop from conception to operation, recording significant growth in the energy pipeline as Australia mobilises to deliver its nationally-legislated emissions reduction targets. As of February, the combination of private and regulated markets for energy generation, storage and transmission in Australia have been responsible for the addition of a remarkable 99 projects to ANZIP over the previous two years, valued at $121.9 billion. The total energy pipeline on ANZIP stands at 219 projects valued at $426.9 billion.

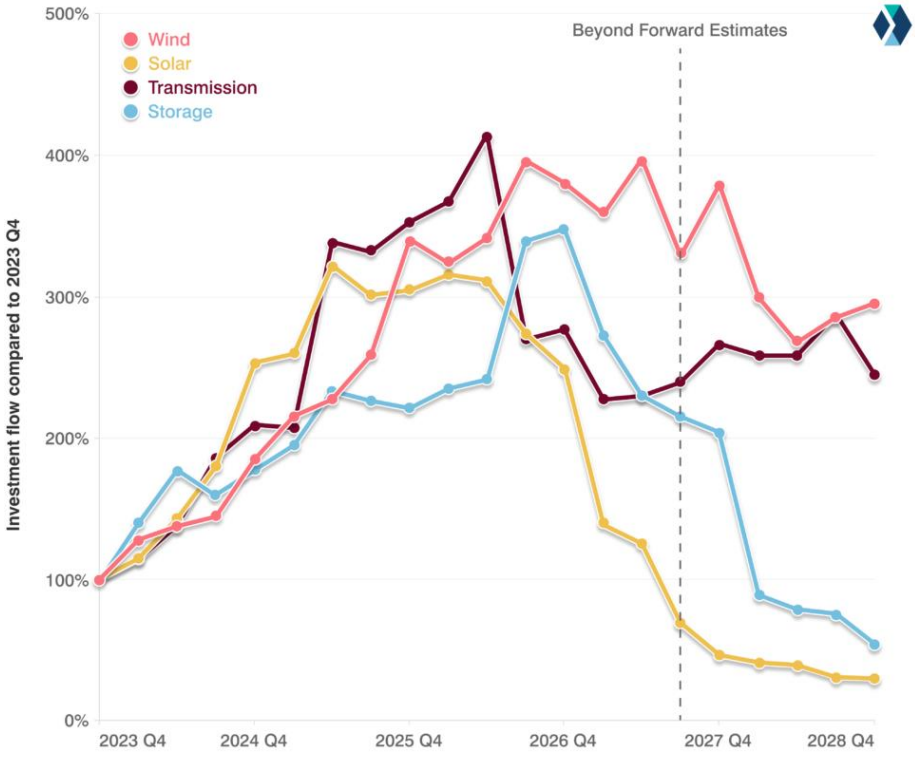
To further illustrate the scale of growth, Figure 1 provides a breakdown of the scheduled quarterly expenditure on energy projects based on publicly-stated construction timelines, Figure 2 provides a forecast of the changes in quarterly expenditure required by the upcoming major renewable energy project pipeline in Australia by asset class, and Figure 3 provides a forecast of the labour demand changes required to deliver the infrastructure pipeline.

Figure 1: Scheduled quarterly expenditure on the energy pipeline



Source: Infrastructure Partnerships Australia

Figure 2: Expenditure demand by energy asset class



Source: Infrastructure Partnerships Australia

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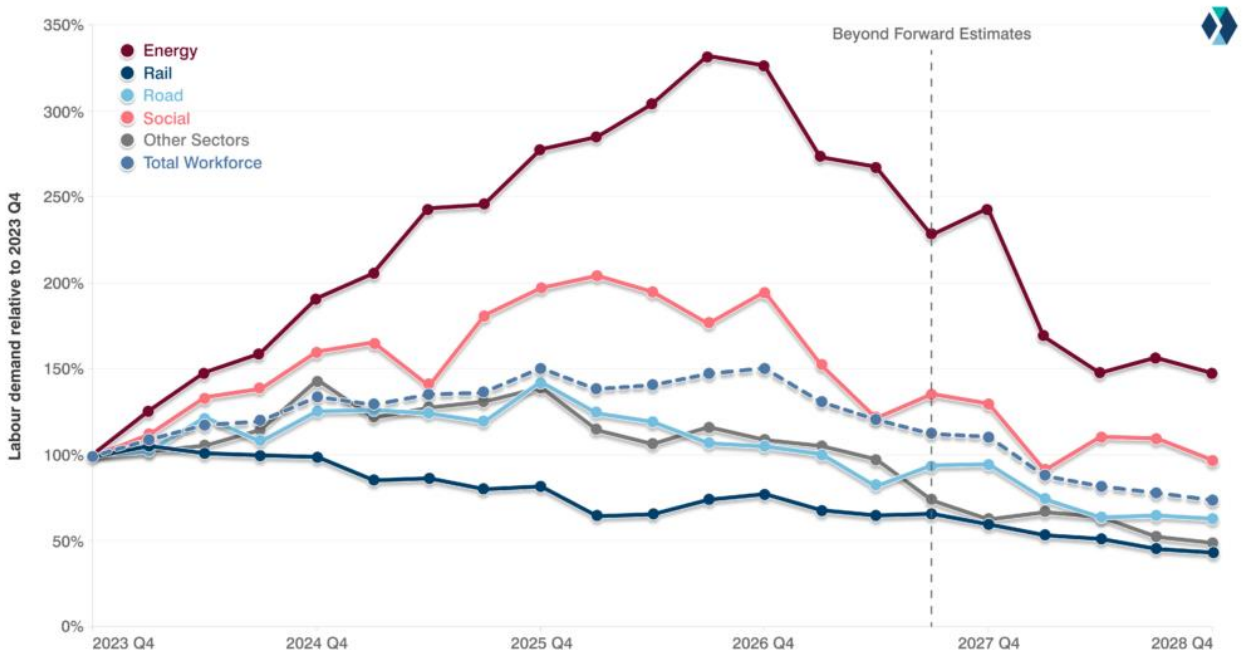
Figure 3: Labour demand by sector



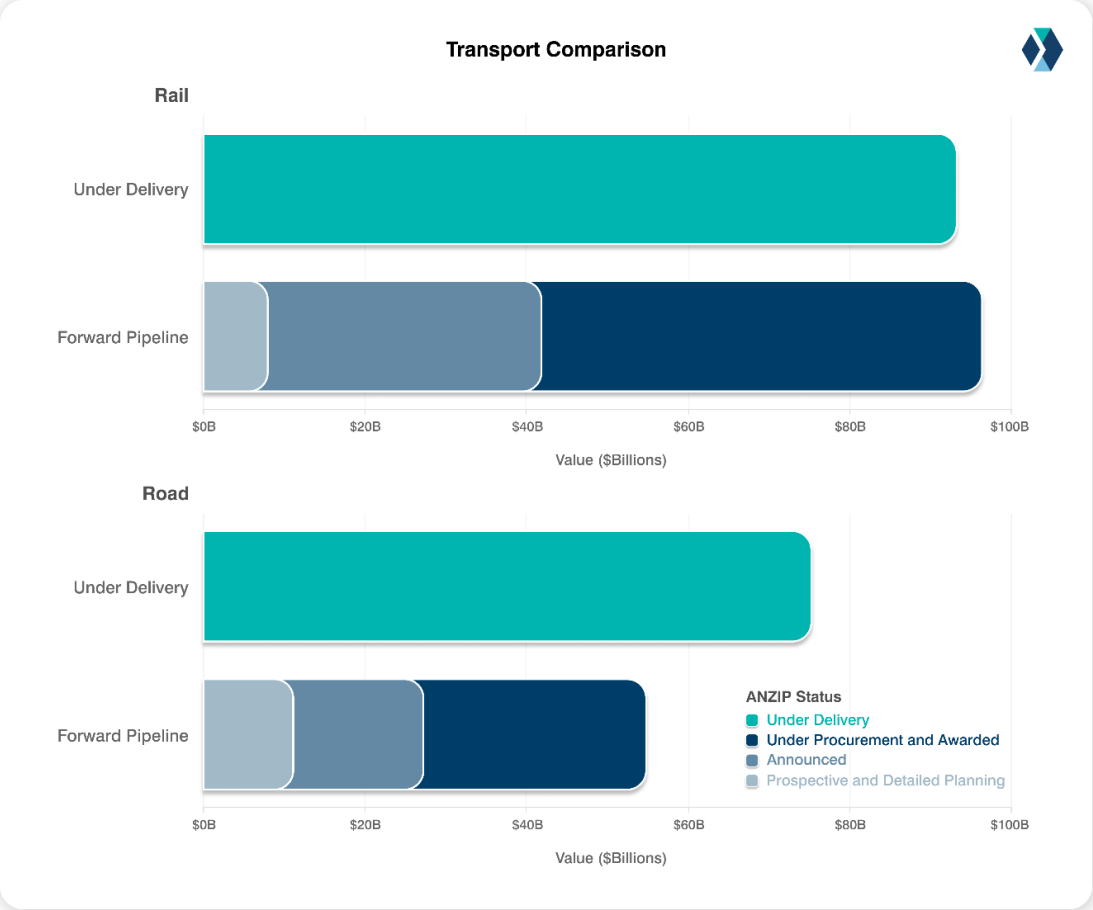
Source: Infrastructure Partnerships Australia

Much of the gain in expenditure and labour demanded for energy projects can be attributed to the rapid expansion in infrastructure required by Australia's ambitious targets for renewable energy generation. Decarbonising the energy sector must happen in an orderly fashion, underpinned by the necessary frameworks to ensure security and reliability of the network, at least cost and with no disruption for consumers.

Energy infrastructure will be required to be delivered concurrently to the wider infrastructure pipeline. This includes Australia's pipeline of transport projects, which has historically underpinned Australia's pipeline of future work. The Australian infrastructure market is currently in the throes of one of the largest waves – in relative terms – of transport infrastructure ever seen in the country. Commencing shortly after the Global Financial Crisis, this wave has seen general government expenditure allocated to infrastructure across all states and territories increase in real terms by 93 per cent since FY2009-10.

Australia is now well and truly riding the delivery of this wave, with the market's ability to rise to the challenge and meet this demand on full display. However, with these historically large programs of work moving through their peak construction phases, the speed and size of transport projects replacing them in the pipeline pale in comparison. Figure 4 presents an overview of transport projects under delivery and in the forward pipeline.

Figure 4: Value of transport projects under delivery and in the forward pipeline

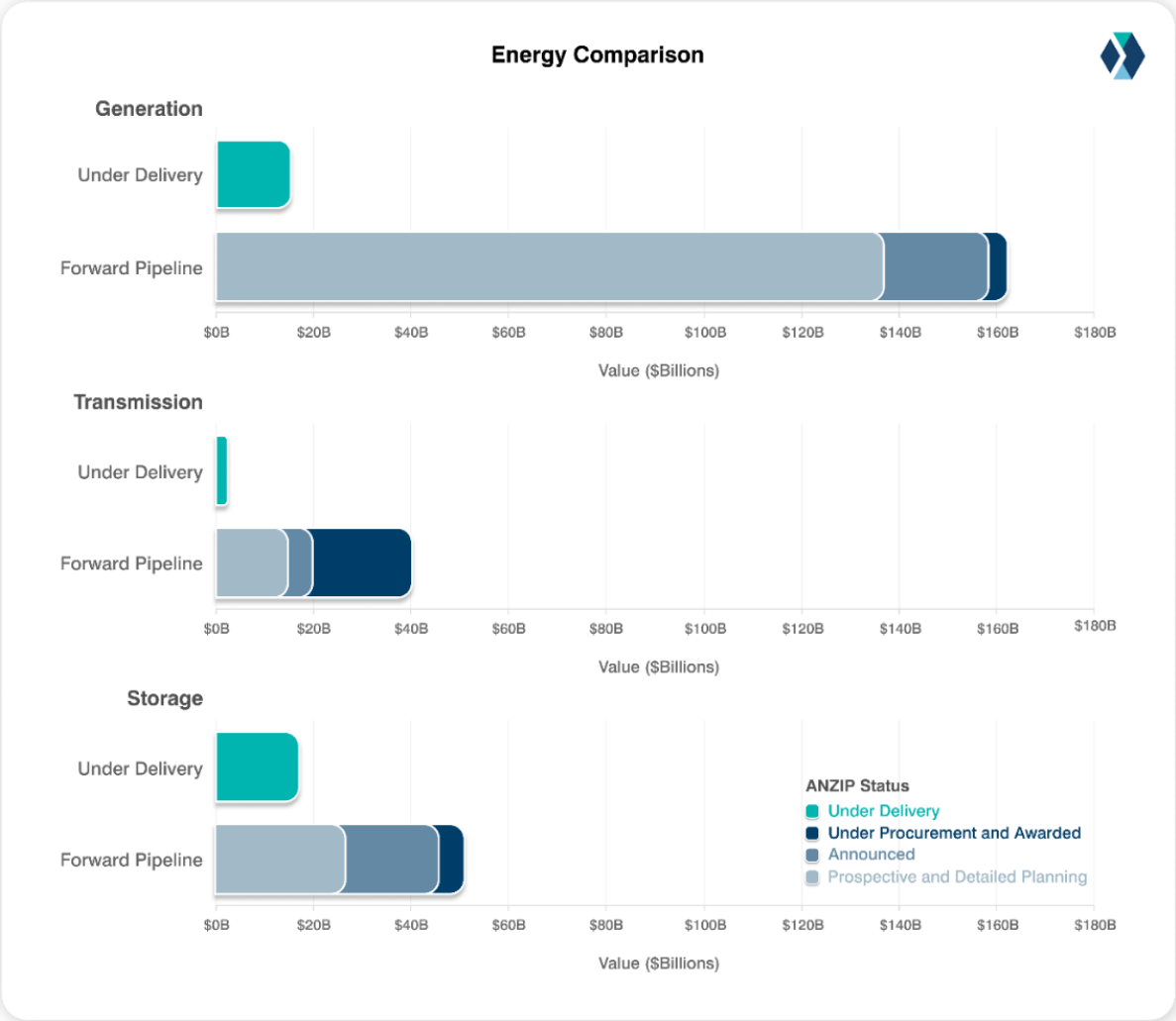


Source: Infrastructure Partnerships Australia

Only 30 transport projects across Australia have entered the pipeline since the beginning of 2022, with six per cent in the early stages of development.

As Figure 1 demonstrates, there are plentiful energy projects seeking to play a part in Australia's transformation. However, in a direct comparison to transport, under delivery energy projects comprise just 13 per cent of the pipeline, the remaining 87 per cent of projects are at the pre-delivery stage, with the vast majority of these – 61 per cent – being prospective or in planning. Figure 5 presents an overview of energy projects under delivery and in the forward pipeline, organised by asset class.

Figure 5: Value of energy projects under delivery and in the forward pipeline



Source: Infrastructure Partnerships Australia

Some of this distribution differential can be attributed to the fact that the delivery of renewable energy infrastructure at scale is relatively new. Public and private stakeholders are still coming to grips with the design, supply, and construction of some very complex projects.

The trend of energy projects entering the pipeline and progressing slowly to delivery is becoming increasingly concerning

With such a large proportion of energy projects in the early stages of the pipeline, a much less certain view on their delivery begins to emerge. The most obvious issue arising is Australia's preparedness to close non-renewable generation facilities and the rapidly approaching 2030 date for emissions reduction targets.

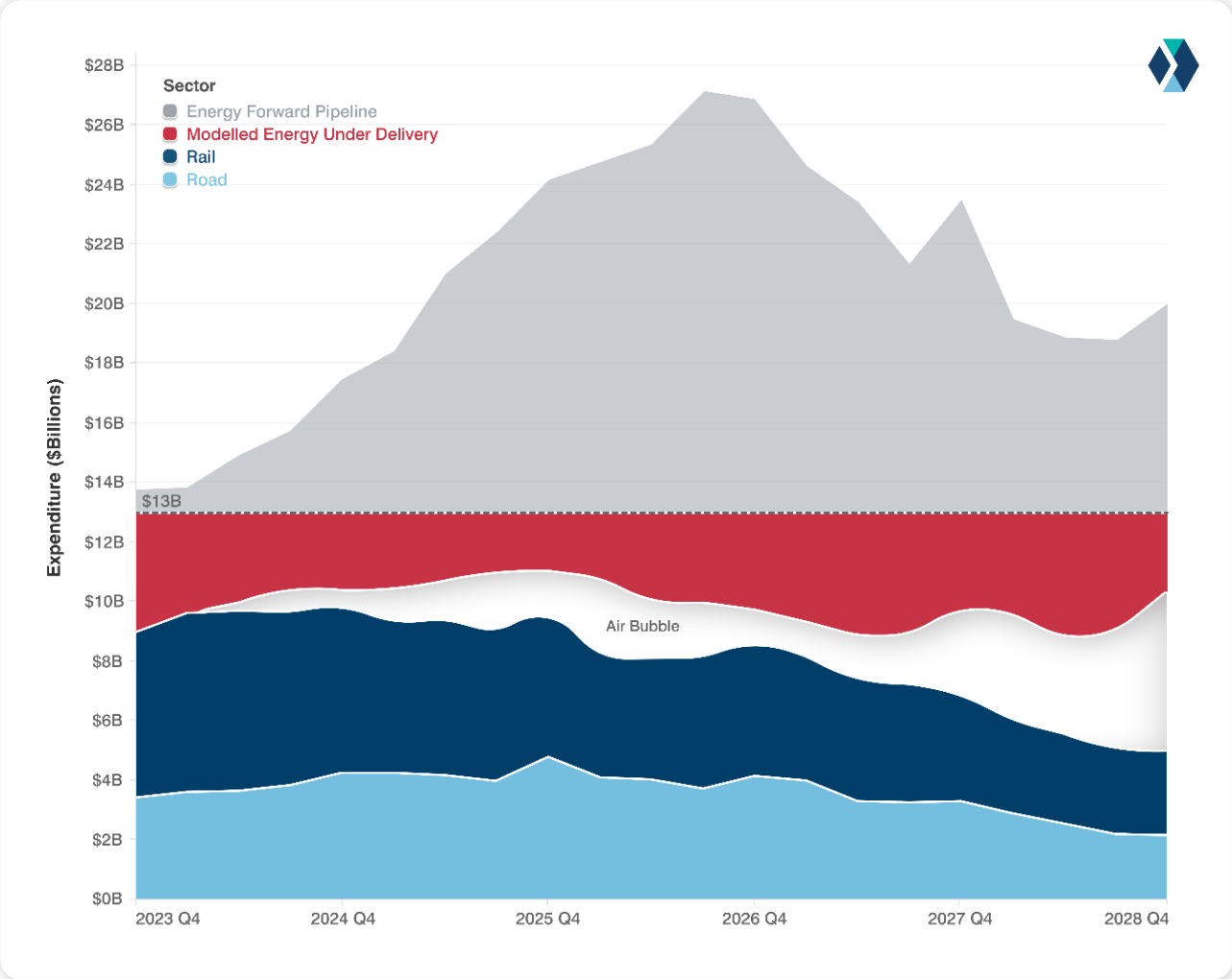
Another consequence of the pipeline moving slowly to delivery is the impact that a delayed energy transition build-out will have on the smooth operation of Australia's infrastructure market as the delivery phase of the current transport boom draws to a close. The prevailing wisdom has been that as the tide of transport capital receded it would be replaced by an incoming tide of energy expenditure. The high-level market conditions for this transfer exist but, owing to a combination of factors, a delay in the planning and pre-contracts phase has occurred,

dragging the energy pipeline to the right. The result of this delay is the emergence of a potentially damaging 'air bubble' in the pipeline.

Despite an unquestionable willingness from all sides of the market, the rate of delivery for energy projects is only marginally increasing year on year, and by some metrics, stagnating. Over the last three years, the value of projects entering main works delivery has averaged $12 billion per year, much lower than the average $23.5 billion in projects entering main works in the declining transport pipeline.

Infrastructure Partnerships Australia has conducted scenario modelling to understand the market-level impact of this air bubble.

Figure 6: Modelled expenditure on transport and energy using lower energy growth scenario



Source: Infrastructure Partnerships Australia

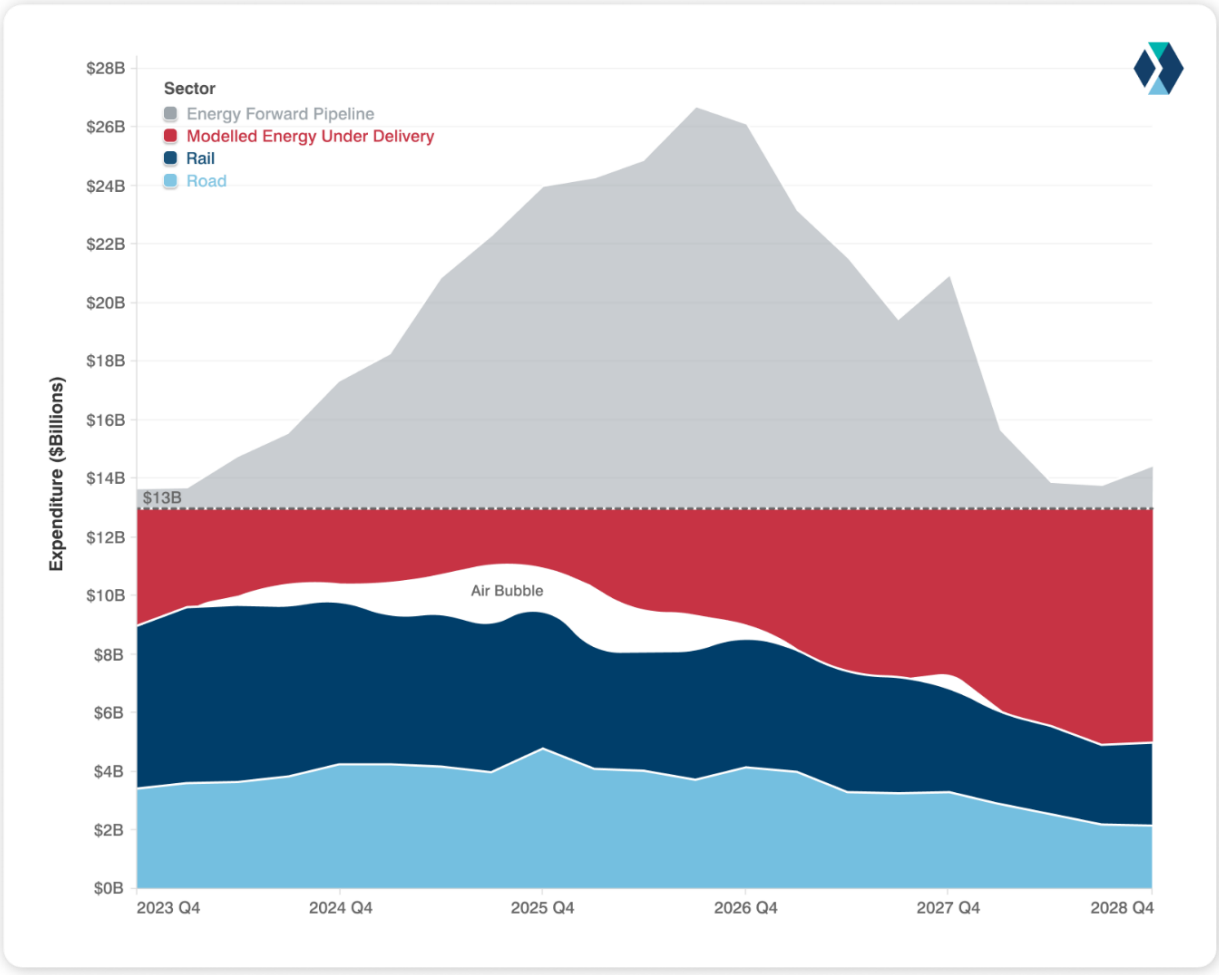
Figure 6 models a scenario where the quantum of on-the-ground expenditure for transport and energy infrastructure from the final quarter of 2024 remains steady at $13 billion a quarter over the next five years. The scenario utilises the forecast expenditure of the more certain transport pipeline. For the less certain energy pipeline, the scenario models the expenditure of projects already under delivery, plus an assumed conversion rate of $3 billion a quarter, plus an annual compound growth rate of 20 per cent, for projects moving from the

forward pipeline to main works construction. In this scenario, an air bubble of latent capacity develops this quarter and grows to $5 billion a quarter by the end of 2028.

The acceleration of energy projects out of the planning and regulatory phase is the key to bleeding the air bubble, and meeting nationally legislated emissions reduction targets

The emergence of an expanding air bubble in the transport and energy pipelines under prevailing conditions is of course a concern, however it is not a fait accompli. Despite a conversion growth rate of 20 per cent a year in the previous scenario, there remains a very large number of credible projects in the forward pipeline. If the planning and pre-contracts problems were gradually resolved, and some of these projects entered their construction phase, they would bleed much of the air bubble over the next five years.

Figure 7: Modelled expenditure on transport and energy using higher energy growth scenario



Source: Infrastructure Partnerships Australia

Figure 7 retains the same market conditions as Figure 6, except that it increases the assumed growth rate of conversion from the forward pipeline to under delivery from 20 per cent to 50 per cent. This still results in an air bubble between this year and 2026, however with energy projects modelled to enter construction faster than transport projects are completed, the majority of the air bubble is bled out of the system.

Next steps

The simple solution to the air bubble, and to achieving mandated net zero targets, is an acceleration of energy projects out of the planning and regulatory phase and into the shovels-in-paddocks phase.

Resolving this issue will require a sustained effort from all stakeholders involved. Governments need to ensure they are setting defined boundaries and market rules, while not crowding out private investment with well-meaning but misplaced direct interventions into markets. On the other side of the equation, developers and delivery partners need to up the ante on making sure they are proposing and delivering high-quality projects that account for supply chain, regulatory and social licence considerations.

Infrastructure Partnerships Australia looks forward to further assisting DCCEEW on the Sector Plan. If you require additional detail or information please do not hesitate to contact Mollie Matich, Head of Policy and Research, on (02) 9152 6000 or mollie.matich@infrastructure.org.au.

Yours Sincerely,

ADRIAN DWYER
Chief Executive Officer

Attachment A: Infrastructure Partnerships Australia's *Decarbonising Infrastructure*

Attachment B: Infrastructure Partnerships Australia's *Decarbonising Construction: Putting carbon in the business case*

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Attachment A

DECARBONISING INFRASTRUCTURE

INFRASTRUCTURE PARTNERSHIPS AUSTRALIA

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CONTENTS

EXECUTIVE SUMMARY

Australia needs to decarbonise, and infrastructure has a major role to play in driving us towards a zero-emission future.

Energy contributes over half of Australia's greenhouse gas emissions annually. Electricity generation accounts for a third of our emissions, and energy use from construction and other manufacturing industries make up another 20 per cent. Transport contributes a further 18 per cent, and even more emissions are generated through the construction and operation of community infrastructure like schools, hospitals, and waste facilities.[1]

Decarbonisation of infrastructure has progressed over the past decade, largely driven by the uptake of renewable energy. But in transport, emissions have been rising, with improvements in fuel efficiency and electrification of the vehicle fleet outweighed by rising demand. Similarly, progress in project-level construction and waste management methods have been lost in record levels of investment and growth.

Australia prides itself on being a global leader in many areas, but with other parts of the world pushing forward in their transition strategies, national leadership in our decarbonisation journey has slipped to laggard status. To date, individual state and territory governments have been driving the nation's decarbonisation agenda with commitments focused on differing state-level priorities, leading to piecemeal outcomes at the national level. There have been pockets of great progress in our transition, but other areas where we trail significantly.

The sooner we fully commit to the challenge, the better.

The environmental risks of inaction are immense. The risks of climate change, mounting for decades, were laid bare during the Black Summer bushfires in the summer of 2019-2020, and again in this year's floods in South-East Queensland and New South Wales, with the health, safety and livelihoods of millions of Australians seriously exposed. Severe weather events are becoming more intense and frequent, while Australia's ecosystems – from the Great Barrier Reef to the Murray-Darling Basin – are rapidly deteriorating in the changing climate.

So too are the risks to Australia's economy. Reduced access to – or higher cost of – increasingly competitive, climate (or carbon) risk-averse global capital, the potential for carbon border levies and weaker demand for our exports would cost Australian jobs and filter through to increased costs of living. Failing to act decisively will shift an ever-greater burden to future generations, and increase the costs of action.

But these risks and costs should not be our focus, as they have been over many years of futile political debate in Australia. Instead, our focus should be on the rewards and opportunities from this change, which are enormous. The time for political debate is behind us. It is time to get on with the job.

No country in the world has more sun and wind than Australia, while our technology, finance and professional services expertise is globally sought after. In the energy-hungry, rapidly growing region of the Asia-Pacific, Australia can transform this comparative advantage into an engine for growth, domestically and abroad. We have the chance to become the literal powerhouse of the Asia-Pacific. But this window of opportunity is closing. For the benefit of current and future generations of Australians, we need to act now to ensure this opportunity to build a lasting comparative advantage in energy does not pass us by.

Of course, change is already underway in the sector. Infrastructure operators and owners have been taking steps to address climate risk and decarbonise their assets. The rise of Environmental, Social and Governance (ESG) factors has seen Australian infrastructure investors seek

out opportunities for accelerating change across asset classes. Transport operators and constructors have been making incremental changes to reduce emissions and prepare for a low-carbon future. Electricity providers and grid operators have been seeking to support a rapid transition to renewables. Many companies have committed to reach net zero emissions in their own right by 2050 or earlier.

However, change is piecemeal, and there remains a gap between intent and action. This owes in a large part to a lack of national leadership, with no clear vision of a low-emissions future, including the role infrastructure will play in achieving this – or the actions, incentives and regulations required to accelerate positive change. Australia's leaders need to stop tinkering with the past and set about transforming the economy – and infrastructure's place within it – in line with a vision of the future we want to create.

Adequately responding to this challenge requires deeper levels of government involvement to set the terms for decarbonising each asset class, then step away to allow the market to respond to those settings.

This paper considers a range of different policy mechanisms to transition the infrastructure sector to a zero-emission future rapidly, efficiently and affordably, laying out potential actions by the public and private sectors against some of the biggest emitting forms of infrastructure. However, with the increasingly convergent and dynamic relationships between historically separate infrastructure asset classes, overcoming challenges and unlocking progress towards decarbonisation will require collaboration across the sector.

Energy and Electricity

- Successfully transitioning Australia's energy is fundamental to our decarbonisation transition, not only because of its predominant role in our annual emissions, but it is also a pre-requisite for the majority of decarbonisation efforts in other infrastructure industries.
- This transition is two-fold, where first, Australia's electricity production needs to shift to clean, renewable energy sources, and second, Australia's remaining energy demand need to be electrified.
- Solar and wind energy-based production will be the backbone of our future energy mix, with a diverse firming base to aid the transition, and fast-paced roll out of large-scale transmission upgrades across the country.
- The Federal Government must lead in this space through creating a clear, national energy transition plan in consultation with state and territory governments, relevant agencies and key industry stakeholders. It should set the rules of the game, not take to the field itself.

Transport

- Transport emissions continue to increase in Australia, which is a fraught challenge to tackle given that the industry's performance is often tied to economic activity.
- The technology required to drive zero-emission transport either already exists or is under development across the transport of both people and goods, albeit at starkly different rates of change. Decarbonising these asset classes efficiently and rapidly will require close collaboration between the transport and energy industries.
- Better planning of transport networks to incentivise people and goods to move in the most efficient way, and remove points of friction, is the other major policy lever state and territory governments should be prioritised.
- As transport electrifies, decarbonising the movement of goods and people becomes an energy industry challenge.

Construction

- Construction is complex and requires the integration of many disparate components and techniques, so no single breakthrough is likely to unlock major benefits. Sustained effort over a multitude of fronts is required.
- Procuring agencies must look beyond lowest price for best value and set ambitious lower-carbon outcome requirements for contractors to respond to.
- Continued innovation will be required through construction and design methods, as well as production of construction materials and waste management.
- Data on carbon emissions from infrastructure assets lacks granularity, regularity, and reliability – especially given that Scope Three emissions are missing from some industry reporting standards. Urgent reform on calculating and reporting emissions from infrastructure construction, operation and waste activities is needed to improve visibility of the sector's embedded emissions.

Many other forms of infrastructure generate emissions through construction, and then through electricity use, so are dependent on progress in those parts of the sector. Governments, regulators and operators of these assets should focus on levers to incentivise innovation and accelerate decarbonisation up their respective supply chains. Other forms of infrastructure like waste would benefit from utilising the circular economy model as an organising principle to help re-prioritise government agendas on how to best decarbonise these asset classes.

The changes needed to the sector will not be delivered overnight and will be easier in some asset classes than others. The energy transformation will play a foundational role during this decade to support the transition of transport, construction, and other carbon-embedded industries.

While land use-based carbon offsets may provide an interim measure in getting the sector to zero, they will become scarce and expensive over the coming decades as competition for credits heats up, particularly for hard-to-abate industries. As such, they cannot be seen as a lasting solution to decarbonise infrastructure when we can do better long-term.

It is important to note that a market-based mechanism for pricing carbon could provide a highly effective and efficient way to drive rapid decarbonisation in Australia, including for the infrastructure sector. There is clear evidence to support this from Australia's own experience of carbon pricing, as well as from similar, more comprehensive mechanisms internationally. While Infrastructure Partnerships Australia would support the development of a new carbon pricing mechanism in Australia, change can equally be driven by a myriad of policy, regulatory, commercial and technology solutions across the economy – and these are the focus of this paper.

Of course, there is no shortage of words published on Australia's decarbonisation challenge and how to address it. However, there are few sources of succinct, direct and actionable advice on the role infrastructure needs to play, and the steps required to transform our nation from laggard to leader in the global green economy.

This paper aims to lay out advice in a simple, pragmatic way. While many of the changes required will be complex, the policy direction and vision required to make them happen are not, and they can build on commitments and actions already taken by industry and governments. With a change in mindset, a little imagination and a lot of leadership, Australia will be well on its way to a zero-emission future, propelled by action in the infrastructure sector. The case studies in this paper are illustrative of the types of innovation that can be actioned to decarbonise infrastructure but are not policy recommendations in themselves.

Infrastructure Partnerships Australia will drive change through making decarbonisation of the sector a major priority, galvanising industry efforts, and pushing on many reforms outlined in this paper.

The most common readiness barriers in our decarbonisation challenge are in the technology, commercial, policy, and regulatory spaces. Technology, being where the technology needed for a zero-emission future needs further development before implementation; **commercial**, being where the private sector faces substantive challenges to take up the transition, such as uneconomic costs of production; **policy**, being when a challenge could be readily solvable with adequate policy direction; and **regulatory**, being where substantive gaps in regulatory frameworks exist.

The following chapters contain a series of tables that describe the changes needed to decarbonise infrastructure asset classes in Australia, and the types of barriers that each change faces, and actions required to tackle them.

AUSTRALIA NEEDS A NATIONAL DECARBONISATION PLAN FOR INFRASTRUCTURE

The need for Australia to decarbonise rapidly is clear. While there is considerable progress underway, change will come faster, cheaper and with less disruption if it is guided by a national plan that places infrastructure at its core. This should draw from the range of existing policies, strategies and regulations to provide a single, clear and actionable agenda for decarbonisation to accelerate innovation and investment.

A national plan is required to draw together the separate threads of decarbonisation across the infrastructure sector. Assets and networks across transport, energy, construction and other assets have converged over recent years, creating new opportunities for reducing emissions efficiently. Energy – comprising over half of our emissions in its own right and being a major input to all other forms of infrastructure – could act as an accelerator of change across the economy. But this will only happen if actions in each form of infrastructure, which have previously been governed and operated as almost wholly separate systems, are coordinated and guided by common objectives.

All Australian states and territories have committed to net zero by 2050, with the Federal Government making the plunge shortly before COP26. Committing to net zero is a start, but it is not an achievement in its own right, and is worth little if it is not backed by an actionable plan. The Federal Government's *Australia's Long-Term Emissions Reduction Plan*[2] provides no additional policy commitments to articulate a pathway to net zero.

State and territory governments have been shouldering much of the burden, with a range of commitments and strategies. This has created a complex, overlapping patchwork of actions and reforms across nine separate jurisdictions. Many of these could bring about some positive change on their own, but rapid, efficient change is only possible if they are brought together under a cohesive national plan.

Corporates are signalling their own drive to decarbonise their assets and adopting net-zero targets themselves. Many are driving real change, supported by shareholders that are increasingly focused on decarbonisation and climate risk. But for much of the private sector, there remains a distance between intention and action, and governments can help to bridge this gap.

There is a mass of private capital looking for opportunities to drive decarbonisation in Australia, but it is being held back by regulatory and policy uncertainty. Without a clear national plan, Australia risks being left behind, with capital flowing to other nations with compelling, long-term mandates for green investment.

The benefits of decarbonisation clearly outweigh the costs and embracing this challenge could hold enormous opportunities for a major boost in Australia's productivity and export potential, economic strength, and financial prosperity. But the window of opportunity is closing.

Infrastructure Partnerships Australia calls on the incoming Federal Government to commit to the development of a national plan to guide Australia's decarbonisation. This paper provides a menu of options to drive change across each form of infrastructure, building on the existing array of commitments and strategies across the country. Bringing these together in a national plan can provide a platform for rapid decarbonisation.

OUR INFRASTRUCTURE CARBON FOOTPRINT

In Australia's National Greenhouse Gas Inventory, carbon emissions in construction are spread across several broader categories, including in **stationary energy,** with emissions occurring from the direct combustion of fuels to use energy to manufacture materials like steel, as well as **industrial processes and product use,** with emissions for material production like cement clinker and steel.

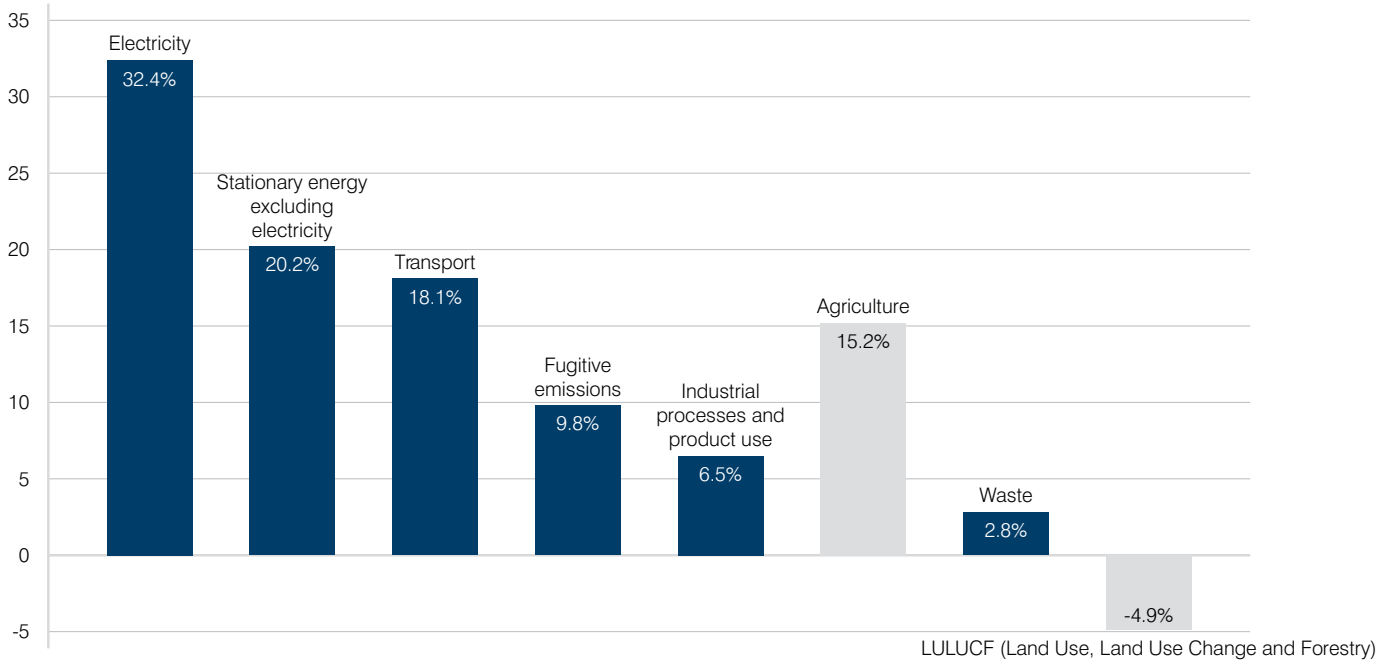
"**Fugitive emissions** occur during the production, processing, transport, storage, transmission and distribution of fossil fuels. These include coal, crude oil and natural gas."

- Australian Department of Industry, Science, Energy and Resources, *Quarterly Update of Australia's National Greenhouse Gas Inventory: September 2021*

"**Stationary energy excluding electricity** includes emissions from direct combustion of fuels, predominantly from the manufacturing, mining, residential and commercial sub-sectors."

- Australian Department of Industry, Science, Energy and Resources, *Quarterly Update of Australia's National Greenhouse Gas Inventory: September 2021*

Australia's share of total emissions, by sector, for the year to September 2021

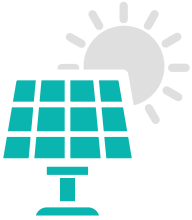


Source: Australian Government Department of Industry, Science, Energy and Resources, 2022, *Quarterly Update of Australia's National Greenhouse Gas Inventory: September 2021*

Energy

Coal's share of total energy consumption declined from **42%** in 2005 to **29%** in 2021,
Oil's share rose **1%** from **35%** in 2005 to **36%** in 2021,
Gas' share has increased from **18%** in 2005 to 27% in 2021.
Renewable Energy's share increased from **5%** in 2005 to **8%** in 2021[3]

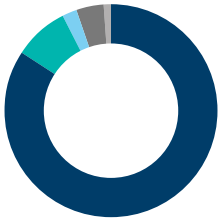
Investment in **solar energy** has been the **top infrastructure investment priority** for Australians for the past three years[4]



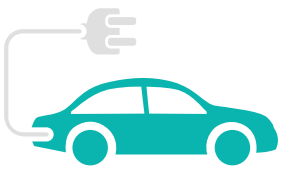
The largest source of renewable generation in 2020 was **solar (9.0%)**, followed by **wind (8.5%)** and **hydro (5.6%)**[5]

Transport

In 2019, emissions from transport modes were broken down as follows:[6]



- Road transport (passenger and freight) **84.2%**
- Domestic aviation **8.4%**
- Domestic navigation **2.3%**
- Rail **4.1%**
- Pipeline transport **0.9%**



In 2021, **electric vehicles** made up ~2% of new vehicle sales[7]

Asset lifecycle

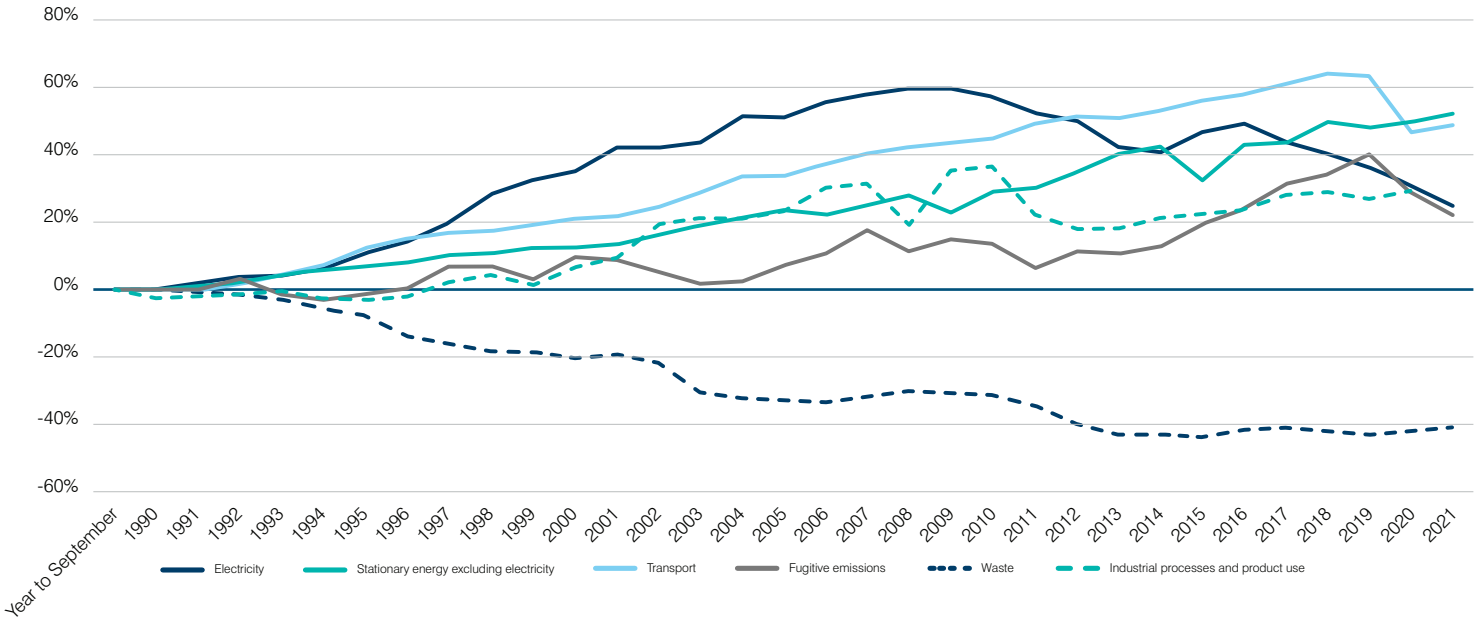
It is estimated that Australia's construction industry generates **30 to 50 million tonnes** of carbon emissions every year[8]

27 million tonnes of construction and demolition waste was produced in the FY2018-19.[9]

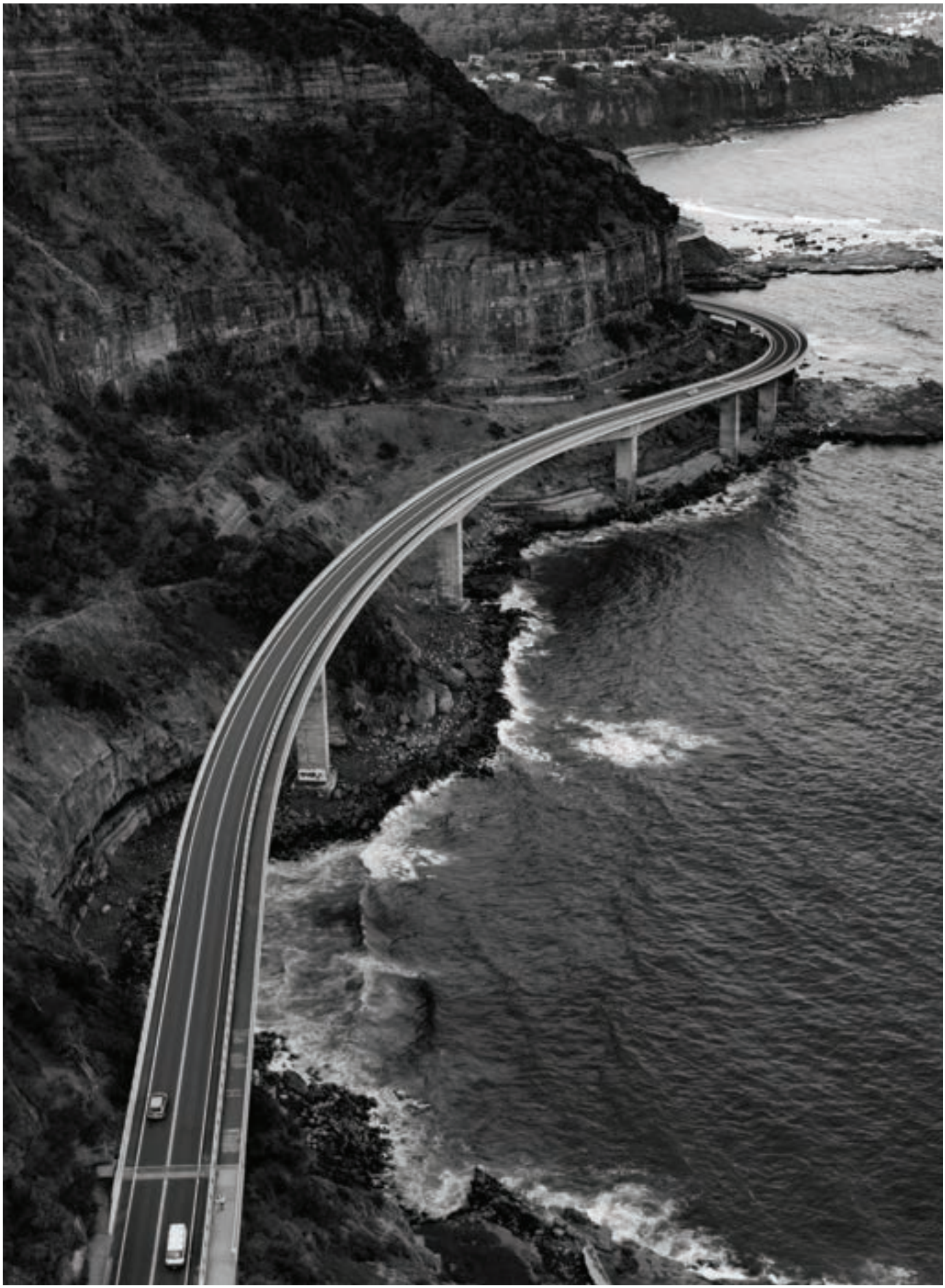
Masonry materials **(81%)** and metals **(76%)** are the two types of waste with the highest recovery rates in the country[10]

The largest contributors to embedded emissions in construction are **electricity, gas and water utilities**, and the **materials** used to build assets[11]

Percentage change in emissions, by sector, since the year to September 2021 (excluding Agriculture and LULUCF)



Source: Australian Government Department of Industry, Science, Energy and Resources, 2022, *Quarterly Update of Australia's National Greenhouse Gas Inventory: September 2021*



ENERGY IS THE FIRST FRONTIER OF AUSTRALIA'S DECARBONISATION JOURNEY

The path to decarbonising Australia's energy system has been clear for many years: a renewables-dominated electricity system, backed by a diverse mix of storage technologies, and declining reliance on fossil fuels for energy in other parts of the economy. A low-carbon energy system is vital for a low-carbon Australia, and the sooner energy decarbonises, the easier Australia's transition to net zero will be – but this must happen in an orderly fashion.

The good news is that we have the tools for the job and we know how to do it. Industry has been driving the transition at pace over recent years, and Australia has been installing wind and solar resources at a per capita rate ten times quicker than the world average.[12] This has been driven by rapidly changing economics, with wind and solar having clearly surpassed fossil fuel-fired generators as the least-cost sources of new supply. Energy projects have been added to the Australia New Zealand Infrastructure Pipeline (ANZIP) at record pace over recent years,[13] with 100 renewable energy projects with an estimated total cost of $254 billion now under development or construction across Australia. The recent announcements of early coal plant closures for Liddell in 2023, Eraring in 2025, and Yallourn in 2028, are real-time examples of new low-cost renewables forcing out higher cost legacy fossil fuel generation.

The major challenge is completing this transition at least-cost and with no disruption for energy consumers. This is where governments can do more. While state and territory governments are pushing forward with their own energy transition priorities and projects, and institutions, including the Energy Security Board and the Australian Energy Market Operator, are providing guidance, the absence of Federal coordination and leadership is the equivalent of boxing with one arm tied behind our back.

A national transition strategy that is focused on the future end state of the nation's energy networks at a whole-of-system level, not broken by jurisdictional boundaries, is the missing piece of the puzzle.

This approach is twofold – covering what Australia can do with existing renewable energy technology today, and how emerging renewable energy technology can support the transition in the near-term. To build a low-carbon, low-cost energy system fit for the twenty-first century, Australia must do more than tinker with historical market settings. Australia needs a whole new approach to delivering energy, backed by governments with a clear and unified vision.

But instead of a national transition plan that unites state priorities and gives space for the market to run its course, a broader trend of government intervention in large energy projects is emerging, as seen in projects Snowy 2.0, the Kurri Kurri gas plant, and the recent Waratah Big Battery announcement. Some degree of government intervention may be justifiable, where a genuine market failure exists. But when a broader pattern of intervention in the project pipeline is established, particularly with a preference for certain generation or storage technologies, this risks distorting the market and undermining the confidence of investors who have no shortage of capital to finance an efficient energy transition.

The Energy Security Board's *Post-2025 Market Design* agenda and goal of ensuring the electricity grid is affordable, reliable and secure has gone a long way to bringing the sector on a whole-of-system journey. Building on this as the sector's transition starting point, we need to think longer term to decarbonise in a proactive manner. Energy's transition to renewably generated electricity is happening one way or another, but it would be smoother, less expensive, and much quicker, if there was a national plan in place to coordinate an orderly transition. Pursuit of a net zero emissions by 2050 target will be enhanced by interim targets along the way – including, in the first instance, a reduced emissions by 2030 target. There are three key components that need to be considered in this plan: where energy comes from, how energy will be firmed, and how will that energy be moved to where it is needed.

Sun and wind will overwhelmingly power Australia's future

Australia has world-class solar and wind energy resources. With continued investment over the coming decades, these resources can easily meet Australia's energy needs, while providing almost limitless potential for energy exports. Investor appetite for renewable energy asset projects has never been stronger and opportunities for solar, offshore wind and onshore wind emerge on an almost weekly basis.

Wind and solar energy generation technology have become growing forces of supply in Australia's energy mix. In the last three months of 2021, renewable energy made up 27.8 per cent of the National Electricity Market's (NEM) energy supply[14] and nearly 40 per cent of Western Australia's Wholesale Electricity Market's energy supply.[15] By 2030, this figure could reach 61 per cent of the nation's total energy supply.[16]

Much has been made of the cost, pain and disruption of the transition to a renewables-dominated energy system, but less has been made of the incredible opportunities this could bring for Australians. While change will be hard, particularly for communities that have been heavily reliant on coal extraction or coal-fired generation, a low-carbon energy system provides far greater opportunities than one stubbornly hanging on to the past. And there are far greater opportunities for productivity growth and job creation across an economy powered by low-cost, low-carbon energy.

Case studies 1 and 2: Design and implementation considerations for Contracts for Difference

Contracts for Difference (CfDs) are often proposed as a tool to accelerate investment in emerging renewable energy technologies where policy or markets do not provide sufficient incentives. Project developers pursuing energy generation projects with emerging technologies often face additional risks on top of energy generation's usual high capital costs, long payback periods, and volatile wholesale electricity markets.

This additional risk makes it more difficult for the private sector to invest in emerging technologies, but CfDs can reduce this risk, by providing a mechanism for a public sector entity to guarantee the offtake price for a new generation investment. To guarantee the offtake price, the public sector entity signs a contract with an energy generator, whereby the public sector entity will pay a subsidy equal to the difference between the market price and the agreed strike price (which is the price required by the generator to make the project investable).

CfDs differ from typical subsidy schemes in several ways:

- The subsidy amount paid is not fixed, if the market price is high then the subsidy will be small, but if the market price is low, then the public sector entity must subsidise a large amount.
- If the market price is higher than the strike price, the generator will pay back the subsidy to the public entity.
- The strike price can be determined administratively or through reverse auctions where bidders submit the price needed to make their project investable, with the lowest bids awarded contracts.
- CfDs have fixed time limits (the contract) which avoids the common problem of removing subsidies once they have served their purpose.

These two case studies illustrate potential positive and negative outcomes of CfD programs. These experiences highlight that CfD programs must be fit for purpose and designed appropriately for the specific market and technologies that are targeted.

Driving down offshore wind costs in the United Kingdom using CfDs[17]

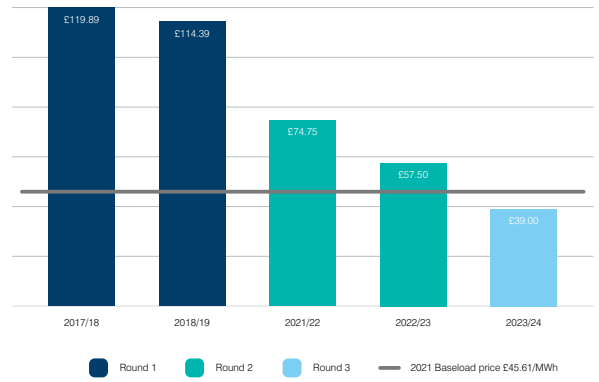
The United Kingdom (UK) was experiencing an increase in electricity demand at the same time many older emissions-intensive power plants were closing. In response, the UK Government announced a CfD program as part of its 2013 Electricity Market Reforms to incentivise investment in emerging renewable energy technologies including offshore wind.

At the time, offshore wind was still an emerging technology in the UK, so the Government sought to kickstart private investment by using 15-year CfDs to guarantee the offtake price needed to make these projects investable. The CfD program operated as a series of competitive reverse auctions. The UK Government would then establish a threshold strike price and all bidders below this price would be offered a contract.

Over the course of three rounds of CfDs, the strike price for offshore wind was lowered from almost £120/MWh to £39/MWh (see Figure 1 below). Alongside offshore wind technology improvements in the global industry, the UK's CfD program helped to incentivise investment, which accelerated learning rates and technology improvements – in turn driving down project costs.

The three rounds of CfDs for emerging technologies cost the UK Government £260 million (Round One), £296 million (Round Two), and £65 million (Round Three).[18] In December 2021, the UK launched a fourth round of the CfD program. Significantly, the last quarter of 2021 also saw generators across the UK's CfD portfolio for renewable energy, including offshore wind generators, pay back £39,222,407 since the strike prices are now below the market reference price.[19]

Figure 1: Reductions in UK Offshore Wind Strike Prices



Source: University of Oxford Smith School for Enterprise and the Environment, 2021, *Zero-Emissions Shipping: Contracts-for-difference as incentives for the decarbonisation of international shipping*

Bill shock for Australian Capital Territory energy customers due to CfDs

To support an ambitious target of sourcing 100 per cent of electricity from renewable energy by 2020, the ACT Government implemented a CfD program to incentivise the development of new renewable energy generation. The program was administered by Evoenergy, the ACT's distribution network service provider, with any subsidy costs incurred due to CfDs to flow through to customer network charges.

Five reverse auctions were run between 2012 and 2020, with contracts awarded for 840 MW of renewable energy generation over durations of between 10 and 20 years. The ACT used its large-scale feed-in tariff scheme to guarantee offtake prices, with many contracts locking in strike prices of $90/MWh.

The ACT Government's CfD program had been performing as expected for several years, with some generators even paying back subsidies because wholesale prices were higher than the strike price. However, in 2021 the wholesale electricity price decreased significantly to an average of $35-40/MWh,[20] which left a significant gap to be covered under the CfD program. Evoenergy's payments to generators rose from $42 million in FY2020-21 to $127 million in FY2021-22, with these additional funds flowing through to customer bills, which saw average network charges increase by 41 per cent.[21]

Designing CfDs

The UK's experience with CfDs shows that they can be a useful tool to incentivise investment in emerging technologies, whereas the ACT's CfD program has recently led to unintended consequences for customers. Although many factors contributed to these divergent outcomes, the design and context of each CfD program played an important role.

For example, Australia has an energy-only electricity market, whereas the UK has an energy capacity market, which typically has lower wholesale price volatility and therefore provides a more predictable environment for CfDs. Moreover, the UK's CfD program was implemented at the national level, rather than the sub-national level as with the ACT, which made it easier to consider and control for interactions with other policy measures.

In the context of Australia's complex and changing policy environment for electricity markets, CfDs may have a more appropriate role in incentivising zero-emission fuels for harder-to-abate sectors such as heavy transport.

Firming will be an essential component of a low-carbon electricity system

For all the advantages of renewables, the reality is the sun does not always shine and the wind does not always blow. But this is not a critical flaw in a renewables-dominated grid – it is an eminently solvable challenge.

Firming of intermittent renewable supply is possible by storing energy when renewable supply is abundant, and then providing power to the grid during times when demand outstrips supply. These services can be provided by a growing array of storage and backup technologies, including large-scale battery storage, pumped hydro and peaking gas plants.

The NEM relies on price signals to ensure reliable supply. Firming providers look for moments where demand outstrips supply when wholesale prices peak to provide energy, while taking energy to recharge their assets when supply is abundant and prices are low. This is backed by measures such as the Retailer Reliability Obligation, which was introduced in 2019, and the Reliability and Emergency Reserve Trader mechanism, which each provide additional safeguards to ensure supply is available when required. The economics of energy storage can also be bolstered by acting as an insurance product even while not in use.

An alternative model could see a capacity market established within the NEM. Capacity markets are quantity- rather than price-driven, and can provide greater certainty over long-term supply, and also bring lower price volatility, though also bring challenges in ensuring price efficiency over a much longer horizon than the wholesale spot market. This approach is used in the UK, European Union (EU), some parts of the United States of America (US) and in Western Australia via its Reserve Capacity Mechanism.

Firming should form an important part of a national plan for decarbonisation, as should a clear determination on the optimal market mechanisms to ensure reliable supply over the long-term. The present ad hoc system of project development and approvals is likely to grow increasingly problematic over the coming years as demand for storage and backup services increases in line with renewable penetration.

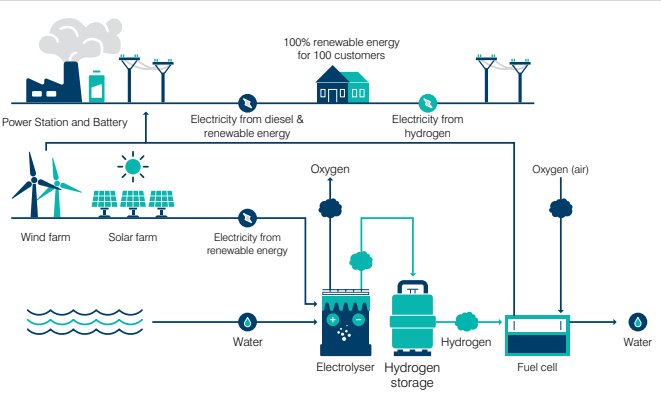
Case study 3: QIC and Pacific Energy Hydrogen Demonstration Plant

QIC Global Infrastructure Fund's portfolio company, Pacific Energy, provides power to its client, Horizon Power, who provides power to the remote town of Denham, in Western Australia. Horizon Power has a goal of no new installations of diesel generation from 2025 and is exploring offsetting diesel generation requirements with viable renewable alternatives. Pacific Energy is delivering a demonstration plant as a pilot project to investigate the feasibility of hydrogen filling this gap. The Plant will test the:

- integration and deployment of the technology into remote diesel microgrids, and
- reliability of hydrogen to produce dispatchable power for towns dependent on diesel fuel power systems.

The Plant will use solar renewable energy to power an electrolyser that produces hydrogen, which is stored for later use in a fuel cell to deliver electricity. It will also provide base load green hydrogen power into a microgrid.

The total project cost is $8.9 million, with the Federal Government's Australian Renewable Energy Agency providing $2.6 million in funding, and the Government of Western Australia providing $5.7 million in funding as part of its Recovery Plan, including $1 million from the Western Australian Renewable Hydrogen Fund.



Horizon Power Denham Hydrogen Demonstration

Sources of firming to support a low-carbon electricity system

Batteries

Batteries contribute to firming both as grid support services during unexpected disruptions to the supply network, and as energy storage to supplement supply when demand becomes higher than usual.[22] Batteries lose little energy in their round-trip efficiency[23] and can operate independent of transmission grid infrastructure. However, with current technology the best rechargeable batteries can store up to four hours' capacity and most big battery proposals in Australia are below this capacity,[24] while the manufacturing of grid-scale batteries requires large volumes of rare earth minerals and other resources. As of April 2022, there are 13 big battery projects equating to a total 7.45-gigawatt capacity on ANZIP, along with another 22 energy projects that include battery storage. While this technology has taken substantive steps forward in recent years and will likely continue to do so, it is insufficient to rely on alone – particularly where firming may be required for more than a few hours.

Hydrogen

When feasible and commercialised, the ability to create green hydrogen using only renewable electricity and water will be game changing, and the opportunities are immense for Australia with its abundant solar and wind resources. Hydrogen is volatile in liquid form, but converting hydrogen to ammonia – a technology pioneered by the CSIRO[27] – could enable the transport of energy in a relatively stable form to global markets.

Despite a number of studies and research projects pushing towards this outcome, the development pathway of hydrogen to a commercially-viable form of energy storage in Australia's domestic system or export markets remains uncertain. The most feasible form of hydrogen long-term will be fully renewable, but this will only be viable with an abundant supply of cheap renewable energy powering its production. The economics of hydrogen are advancing rapidly, with a range of hydrogen production facilities underway across Australia – including some backed by institutional investors as highlighted in Case Study 3.

Pumped Hydro

Given its renewable nature, pumped hydro will play a foundational role in Australia's long-term firming mix. Despite pumped hydro assets losing more energy with a lower round-trip efficiency than batteries, they last longer than batteries. Special Adviser to the Australian Government on Low Emissions Technology, Dr Alan Finkel, supports growth in the technology, acknowledging that while for most of the year pumped hydro facilities may not be used, their multi-day storage capability will be a lifeline for consecutive calm days and overcast skies.[25] A research team at the Australian National University led by Professor Andrew Blakers has identified up to 22,000 potential sites for projects across the country, which could be developed to support a fully renewable grid.[26] In planning new pumped hydro assets, where they are located must be weighed against the cost of production, the environmental impact of their development, the capacity they can generate, and their proximity to sections of the grid with latent or expandable transmission capacity.

Natural Gas

Gas-powered generators are a proven firming option to bridge the energy output gap when required. While these plants are exposed to price volatility and supply constraints in global gas markets, and are the most carbon-intensive form of firming, peaking plants are likely to provide a key interim technology to ensure reliability while more sustainable sources of firming capacity are developed. A number of gas plants developed in recent years have the capacity to switch to hydrogen as a fuel source. While the economics of this switch remain unclear, the creation of an efficient green hydrogen market could help to prolong the useful lives of these assets while supporting broader decarbonisation of the energy system.

Transmission and distribution network upgrades will be required to support a transformed energy system

Just as Australia's electricity supply and storage require an overhaul to deliver a low-carbon system, so too do the poles and wires moving electricity where it is required. Australia's electricity grids were built and developed to support a system with relatively few centralised sources of power – mostly coal generators. The dramatic shift in where and how energy enters the grid and changing patterns of demand means much of Australia's grid must be upgraded or expanded to meet consumers' needs in the twenty-first century.

Recent decades have seen rapid growth in intermittent renewable generation, rising from 0.6 per cent of supply in the NEM in 2006 to 19.4 per cent in 2020.[28] The proliferation of rooftop solar – backed by government subsidies and generous feed-in tariffs – has created a two-way electricity relationship, increasingly feeding energy back into the grid through low voltage electricity lines. Rooftop solar accounts for 8.3 per cent of total annual supply across the country.[29]

These distributed energy resources have exposed the limitations of existing grid infrastructure, and technical challenges have been compounded by a lack of coordination. Energy market operators have struggled to understand how and when distributed sources of supply will come online, while many solar and wind projects have been developed in rural corners of the grid with limited capacity. This has caused bottlenecks and frustration for energy providers, while rule changes to protect system stability and encourage supply in more efficient parts of the grid have undermined the commercial outcomes of recent renewable projects. Policies to encourage generators in efficient parts of the grid can help to coordinate distributed supply more efficiently, but these types of reforms have proven difficult to land.

Many of these issues have been ironed out over time, with work by AEMO through its Integrated Systems Plan (ISP) and the introduction of future Renewable Energy Zones (REZs) by a number of state governments having helped to better coordinate supply, prioritise grid upgrades and provide greater certainty for energy providers, customers and investors. However, limitations persist across whole regions such as the West Murray Zone.[30] Greater coordination between energy market bodies, federal and state governments could utilise REZs as a more effective tool for managing demand and supply across the whole of the NEM. Similarly, reforms to simplify and accelerate planning and approvals of new transmission capacity could provide greater ability to address grid constraints *before* they emerge. Regulatory reform is also required to ensure investment made by regulated networks in the required transmission infrastructure is commercially-viable and can proceed with certainty.

For now at least, the top priority for Australia's energy bodies and market participants must be getting on with the energy transition. The focus of energy bodies and governments must be on the creation of an efficient, low-emission, affordable and reliable energy system, connected by a grid fit for our twenty-first century needs. Beyond efforts to support efficient investment in this system, introducing further major reforms now – when the market has already adapted to the vision laid out in the previous ISP and numerous other major plans and strategies by the energy market bodies – risks further delays and disruption at a time when Australia can least afford it. National leadership needs to empower energy market bodies to take accountability for the delivery of a decentralised, low-emission grid, ensuring market participants are able to attract the necessary capital and resources to make the transition.

Case study 4: Developing transmission infrastructure through renewable energy zones[31]

Renewable energy development, such as wind and solar, often face the impediment of a lack of transmission capacity. Wind and solar resources are often strongest in regional and remote locations, where there has not been a historically large demand for electricity and therefore there is not a great deal of transmission capacity.

In Texas in 2005, the State Government began developing a strategy to address the mismatch between traditional transmission planning and the project development requirements of renewable energy. This led to legislation to designate Competitive Renewable Energy Zones (CREZs). The Texas public utilities commission identified demand for circa 20 gigawatts (GW) of wind energy across five renewable energy zones.

By 2013, US$7 billion was invested to construct new transmission lines, enabling wind generation capacity to grow from one GW to 20 GW while maintaining low electricity prices.

In July 2020, the Australian Energy Market Operator identified potential renewable energy zones across the NEM as part of the Integrated System Plan.[32] Since then, several state governments have already committed to develop renewable energy zones, with six zones in Victoria, five zones in NSW and three zones in Queensland.

Renewable energy as a future export economy

There has been a lot of hype about Australia's potential role as a renewable energy export powerhouse. This hype is not unjustified. Australia's geographic comparative advantage puts us in good stead to create an ultra-cheap renewable energy market to sell to the rest of the world. The potential rewards of a future export economy are significant – increased jobs, higher wages, and a higher standard of living to name a few – but the nation's leaders need to get on with laying the foundations of this economy. Balanced against this is the need to retain sufficient domestic energy supplies for our domestic market, and ensure Australians are not short-changed of affordable and reliable electricity.

Our country is uniquely positioned with access to sun and wind resources that many of our energy-intensive trading partners, including Japan, Korea, Singapore and others, do not have. That presents an opportunity for Australia to be the literal powerhouse of the Asia-Pacific. But realising this opportunity requires development, planning and negotiation in the short-term to unlock benefits in the long-term. A clear and strategic national policy framework and energy transition plan will pave the way for the next steps required to shape this future economy.

It is not just renewable energy that Australia has the future opportunity to export either. Potential future production of green hydrogen also presents us with opportunities to create and export zero-emission steel and aluminium overseas – and concurrently decarbonise the domestic construction industry.

Changes needed to decarbonise Australia's energy

What needs to change	Change barrier	Actions required
A consistent lack of national leadership and coordination on the energy transition has resulted in a patchwork of overlapping and competing strategies and policies across the country, causing substantial policy and investor uncertainty.		The Federal Government should coordinate with state and territory governments to create a clear, national energy transition plan with solar and wind as the backbone of energy supply, an appropriate mix of firming technologies, and adequate transmission network capability. This plan should empower industry to act within a clear framework and an ambitious timeline for action.
		Pursuit of a net zero emissions by 2050 target will be enhanced by interim targets along the way – including, in the first instance, a reduced emissions by 2030 target.
		Industry and government stakeholders should improve coordination and engagement to augment the role of existing mechanisms, like REZs, in the energy transition.
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 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.
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.
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. Clear retirement timeframes within a national agenda will allow industry to plan for the future of their assets.

EMISSIONS FROM THE MOVEMENT OF PEOPLE AND GOODS HAVE BEEN RISING, BUT TRANSFORMATION IS AROUND THE CORNER

Despite improvements in vehicle efficiency over recent decades, Australia's transport emissions have risen by 48.8 per cent against 1990 levels.[33] But change is on the horizon, with the commercialisation of technologies that will underpin decarbonisation of public transport and light vehicles – of which the latter is consumer-led. Freight decarbonisation is on a slower trajectory, but there are clear steps governments and industry can take now to accelerate the change required.

In contrast to the gains made in energy, pre-pandemic transport emissions rose steadily from 9.7 per cent in 1990 to 19 per cent of Australia's national total in 2019. There was a brief dip during 2020, but transport emissions have bounced back to make up 18.1 per cent of the national total last year.[34] Actual emissions are likely much higher as well, given emissions from international aviation and shipping are excluded from these totals.

This upward trend reflects some of the challenges we face as a nation – vast distances between cities, production regions and markets, as well as a growing population with changing needs. But emerging technologies will turn this trend on its head. This is particularly true for light vehicles, which are on the cusp of a major transformation. Uptake of hybrid- and battery-electric vehicles is growing rapidly as their prices fall relative to internal combustion engine vehicles. The trajectory towards a low- to zero-emission light vehicle fleet is now all but certain.

With zero-emission bus commitments and renewable energy-powered metro and train networks, the future of public transport is also clear. Most state and territory governments have set strong directives for change. These have been driven through procurement and contractual arrangements, and supported by a range of private sector operators and technology providers.

But much more could be done through policy reform to accelerate the transition to net zero emissions mobility. The uptake of electric vehicles (EVs) remains slower than in other parts of the world. Our petrol and diesel vehicles remain among the dirtiest in the OECD, due to the absence of vehicle emissions standards and our use of poor-quality fuel. The country's EV charging infrastructure is also incomplete, and energy network upgrades will be required to enable the delivery of charging hubs and zero-emission bus depots.

Inadequate planning has acted as another barrier to decarbonisation initiatives too. Poor town planning – particularly in the growth areas on the outskirts of major cities – has left many residents without adequate access to transport, increasing their reliance on private vehicles. But a more holistic approach to transport and land use planning, focused on creating liveable, accessible cities with a variety of zero-emission mobility solutions, will unlock the most effective long-term solutions.

In the absence of commercially-viable and scalable decarbonised technologies, reducing the emissions produced by moving goods is proving more difficult. Future modal choices will be driven by the need to save time and money in an industry that typically operates on slim margins. Major technological breakthroughs – akin to the shift from steam to diesel locomotives in the mid-twentieth century – may take years but will likely bring about rapid transformation when they arrive.

In the interim, there is a lot to do in the way of meaningful incremental freight reform. Better planned freight networks would alleviate last mile access and efficiency issues, encourage modal shift through intermodal facilities, and improve connections to existing infrastructure. Moving to outcome-based regulation would provide a clearer pathway for zero-emission technologies to be piloted and implemented in Australia. Enabling the electrification of local freight would also aid in reducing emissions in a rapidly expanding part of the market.

As with energy, stronger national leadership is required to coordinate and capitalise on the transition efforts already underway. The Federal Government, in partnership with states and territories, should work with industry to identify zero-emission solutions, support their development, and accelerate their implementation. These solutions will need to meet the needs of Australia's freight networks while minimising the costs of this transition.

Zero-emission fuels that fill the gaps

Uptake of zero-emission fuels would see the use of fossil fuels in combustion engines replaced by a range of possible alternatives. Zero-emission fuels fall into three main categories:

- biofuels (bio-methane, bio-ethanol, bio-methanol)
- electricity derived fuels (ammonia, hydrogen, e-methanol), and
- synthetic carbon-based fuels (synthetic methanol and synthetic methaneproduced by combining green or blue hydrogen with carbon retrieved from the atmosphere).

Each fuel has its advantages and disadvantages. Just as a range of fossil fuels are currently used for different applications, a range of zero-emission fuels will be used based on the needs of the particular transport mode and journey.

Transition strategies to decarbonise the movement of people

Electrify the light vehicle fleet

The market has already signalled that the future of light vehicles is unquestionably electric – positive news for decarbonisation given that light vehicles represent 10 per cent of Australia's total emissions.[35] To have the intended result, however, the electricity powering these vehicles must be generated from renewable zero-carbon sources, the pathway for which is outlined in Chapter 1 on energy.

EV uptake will result in a range of positive benefits for individual users and the community. In addition to reducing greenhouse gas emissions, EV uptake will reduce noxious tailpipe emissions from internal combustion engines. This will improve air quality, particularly in dense urban areas, and bring significant health benefits. The move to EVs will also reduce Australia's reliance on imported fuels, improving fuel security and reducing exposure to oil price volatility.

Yet Australia's transition is slower than other countries. In 2021, EVs made up two per cent of new vehicle sales,[36] being a major jump in its market share from previous years. But the global average for EV sales is much higher, at 4.6 per cent in 2020, and 10 per cent in the EU.[37] With only 20,095 EVs registered out of a total Australian passenger vehicle fleet of 14.9 million at the beginning of 2021[38] (and 2022 figures anticipated shortly), dramatic growth in EV sales is required to bring down light transport emissions.

Overcoming challenges to accelerating EV uptake

Making EVs more affordable

EVs are likely to become the main vehicle of choice once cost parity with petrol and diesel vehicles has been reached. But relying on natural replacement of the fleet will see only gradual change over the next decade, with the average age of the passenger vehicle fleet being 10.6 years,[39] and the EV sticker price remaining higher than its fuel equivalents in the near term. While heavy taxes on petrol and diesel vehicles have been used overseas in the EU and elsewhere to reduce the cost gap between these technologies, this approach is unlikely to be politically viable in Australia.

A number of state and territory governments have recognised this challenge and are responding with different mechanisms – including feeding growth in the second-hand market in the medium-term by incentivising EVs for commercial fleets and purchasing EVs for government fleets.

Governments in Victoria, South Australia, New South Wales and Tasmania have also introduced or committed to introduce a distance-based road user charge on electric vehicles through a model proposed by Infrastructure Partnerships Australia.[40] Together with the subsidies to the sticker price and investments in charging networks announced alongside this reform, road user charges can catalyse rapid electrification of light vehicles. This can occur by providing prospective EV buyers with greater certainty about future costs of using their vehicles, while providing sustainable funding to maintain and upgrade the roads their EVs will rely on.

Improving integration with energy systems

As the EV fleet grows, the load requirement for electricity infrastructure in residential areas will too. The average Australian EV consumes around 2,220 kilowatt-hours of electricity each year,[41] which, if charged solely at home, would represent around a 41 per cent increase in demand for the average household.[42]

This is an entirely new source of demand that will be placed on distribution grids, potentially exacerbated by EVs being plugged in to charge during the evening when commuters return home. If left uncoordinated, rapid EV uptake could result in rising costs for energy users as well as declining reliability of local grids.

Looming over the challenge of integrating EV infrastructure with the electricity system is another related issue – how to successfully integrate distributed energy resources into the grid. There are many potential solutions for EV charging that would benefit not only the EV motorists plugging in, but other energy users too. Providing incentives or greater discounts for off-peak demand could help to spread demand. Developing bidirectional charging could reward users for enabling their vehicles to supply spare capacity to their home or the grid when it is needed. Network operators coordinating a neighbourhood network of public or home chargers, could then utilise connected EVs to both absorb demand when there is excess renewable supply, and draw energy during peak periods to reduce local grid demands.

Overcoming range anxiety

Range anxiety is often considered a barrier to EV uptake in Australia, with the country's size often cited as a major challenge. The natural policy response would be to develop a network of destination and en-route chargers. However, the average Australian commute is just 16 kilometres,[43] and only 7.2 per cent of travel by Australian EVs is outside urban areas.[44] Additionally, there is evidence that supply of charging infrastructure is already strongly leading demand. In 2020, there were approximately 2,400 charging stations across Australia, making the ratio of chargers to vehicles 1:9.[45]

Data also shows most users charge at home. In Norway, 90 per cent of charging is done at home,[46] and in California this figure is 86 per cent.[47] For those who lack access to a garage or driveway, changes to planning regulations can ensure chargers are installed in new apartment and commercial buildings. On-street charging can help to address remaining access gaps for many motorists in dense urban areas.

Governments should be careful not to invest in charging infrastructure where no market failure exists, or take on technology risks they are not well-placed to manage. Growing demand will be met with a growing commercial supply of chargers.

Identifying the appropriate locations for charging infrastructure requires complex analysis and long-term forecasts of user behaviour and commercial factors, which governments are not best-placed to undertake. A range of existing market players – service station owners, shopping centres, and tourism operators – are well-placed to deploy charging infrastructure on their sites in line with demand without additional government assistance.

Protecting against dumping of inefficient vehicles

Australia is the only OECD nation without light vehicle emissions standards. So long as there are no standards in place, mobility transport will remain exposed to the risk that any influx of high-emitting, low-cost internal combustion vehicles will undermine the uptake of EVs over the medium-term. With looming bans on petrol and diesel vehicle sales in other global regions, Australia's market is at risk of becoming a future dumping ground for inefficient vehicles.

The policy solution is simple – the Federal Government should legislate a light vehicle emissions standard and tie its level of implementation over time to standards in the EU or the US.

Case study 5: NSW EV fleet incentive[48]

In November 2021, the NSW Government announced the EV Fleets Incentive to help drive the uptake of battery-electric and fuel cell EVs. The initiative includes a funding pool of $105 million, which will be used to bridge the cost to businesses of transitioning their vehicle fleets to EVs. The initiative targets corporate and government vehicle fleets as they account for half of new vehicle sales in Australia and often have high fuel and maintenance costs.

It is hoped the incentive scheme will drive demand for EVs, which in turn will increase supply of new and used EVs.

The incentive functions like a Contract for Difference system. Businesses looking to procure vehicle fleets submit a bid to the NSW Government detailing two key figures:

1. the difference in total cost of ownership (TCO) between the EVs the business is looking to procure and the vehicles that would have otherwise been purchased or leased, and
2. the amount of emissions saved (CO_2 equivalent) if the business were to procure EVs.

The total cost of ownership figure is then converted into a request for funding per vehicle and bids are then ranked based on $/tonnes of CO_2 equivalent saved. The initiative also considers whether businesses intend to use renewable energy to charge their EVs.

The initiative is designed to hold multiple funding rounds until 2024. Businesses must buy at least 10 vehicles at a time.

Eliminate public transport emissions

Historically, buses and trains have been among the heaviest emitting transport vehicles. But recent public transport transformation has been rapid, with zero-emission technologies becoming commercially-viable, reliable and energy efficient over recent years across almost all modes. The question for governments and transport operators of *how* to decarbonise public transport has moved to *how quickly* it can be achieved. And elimination – not just reduction – of emissions from public transport operations has become an achievable goal.

Technology has been a major driver of change. For buses, advances in battery-electric and hydrogen fuel cell vehicles have provided options and flexibility for fleet operators to progressively shift routes and depot infrastructure to renewable energy-powered technologies. For trains and light rail, energy efficiency improvements have been made with advances in control systems and route optimisation, while installation of renewable energy generation across networks has enabled decarbonisation of energy sources.

Simple policy levers used to decarbonise fleets have also found great success. Train networks – even those as large as Sydney Trains – have moved to 100 per cent renewable energy by purchasing renewable energy certificates or signing power purchase agreements with renewable suppliers. Governments have set ambitious targets for the transition of bus fleets, then put this out to market through fleet and service contract procurements, with scope for innovation in how manufacturers and service providers

deliver on governments' objectives. There are numerous targets and commitments across states and territories but the NSW Government leads other jurisdictions in this regard. It has committed to transitioning its fleet of 8,000 buses to zero-emission vehicles by 2030,[49] and driven positive change through its ongoing bus service contract procurements.

Despite the positive outlook, a number of challenges will need to be resolved through this transition:

- For **buses**, battery capacity, geography and infrastructure may limit running of zero-emission vehicles on some routes, while upgrades to electricity distribution networks are likely to be required to handle the demand loads at depots.
- For **trains and light rail**, further improvements in energy efficiency and installation of distributed energy resources across networks can reduce their substantial call on grid capacity, while renewable energy agreements should be structured to ensure they support development of new renewable capacity.
- Further advances are required to reduce the embedded carbon in the manufacturing of zero-emission vehicles, including through lower-carbon materials and methods.
- For **hydrogen buses and ferries**, availability of commercially-viable fuels may restrict uptake in the near to medium-term. The hydrogen powering these vehicles will need to be green, meaning these vehicles will not be viable without an abundant supply of cheap renewable energy to create the hydrogen fuel.

Taking a smarter approach to transport planning

Decarbonising the transport sector will require a holistic lens that considers more than just how our vehicles are powered. How our mobility choices are influenced, and what incentives and options are required to shift user behaviour, are key considerations in our transition to reduce emissions. Moving people closer to jobs, education and services – or vice versa – reduces demands on transport networks and gives people back their most precious commodity: time.

But this is easier said than done. With over 86 per cent of the Australian population living in urban areas,[50] and many suburbs already laid out over vast areas, retrofitting solutions to improve transport connectivity often comes at great cost. Transport access is often worst in low-density outer suburbs of major cities, where a lack of public transport means more cars and more congestion, which compounds disadvantage.[51] Planning concepts like '30-minute cities' have proven easy to propose but tough to implement.

Alongside private vehicle transport, public transport also plays an important part of Australia's mobility mix, and will play a key part in reducing mobility transport emissions too. The COVID-19 pandemic saw a sharp decline in travel overall, followed by a return to private vehicles for many commuters. At the same time, public transport patronage, which has grown markedly over recent years in line with improvements in service quality, has fallen. This is likely to be a transient phenomenon, as user behaviours revert to the long-term trend in the coming years – further encouraged by the delivery of metro networks and other substantive public transport investments in major cities.

Moving to a more efficient, lower-emission transport system also requires a focus on making mobility transport modes easier, simpler and safer to use:

- **Walking and cycling** – active transport modes spiked in popularity during the pandemic in urban areas. These are travel habits that can be locked in and further incentivised by improving access and safety on footpaths and bike paths.
- **Mobility as a Service** – the integration of transport modes, including on-demand services, and payment platforms can provide seamless connections for users while enabling network operators to use the most effective and efficient means of getting customers where they need to go.
- **Access to transport data** – moving to digital payment platforms, alongside a range of technologies for monitoring vehicle passenger movements, has enabled transport providers to put more information in the hands of users to choose the most efficient trip.
- **Spreading transport peaks** – using pricing to encourage off-peak transport trips or staggering school and work start times can help to spread peaks in transport demand. While these measures will not reduce emissions in their own right, they can help to better utilise road networks and public transport capacity.

Case Study 6: Creating seamless zero-emission public transport journeys

Transport for NSW (TfNSW) has implemented a range of technologies and transport network planning strategies to make public transport easier to use and more attractive for customers. An example is the introduction of the B-Line bus services from the Northern Beaches Sydney to Sydney CBD, which opened in November 2017.

When launching this new mass transit link, TfNSW also planned for first- and last-mile transport to get customers from their homes to a major transport hub (and back again) without having to use private vehicles. In partnership with transport operator, Keolis Downer, TfNSW launched the Keoride On Demand bus service on the Northern Beaches to bring customers to and from key B-Line bus transport hubs. A 2020 survey of passengers showed 42 per cent of respondents would get rid of their car to use the Keoride On Demand service.[52] Keolis Downer reports that the service has also achieved 98 per cent customer satisfaction since the start of the service in 2017.[53]

To make end to end public transport journeys even more seamless, TfNSW created an online platform called Transport Connect (previously Opal Connect) to be used on On Demand bus services such as Keoride. Transport Connect provides travel credits to passengers making multi-modal journeys, so that passengers don't have to pay full price for each leg of their public transport journey. Customers can earn up to $2 On Demand travel credit (or $1 for child/concession) every time they transfer between participating On Demand services to or from another mode on the Opal network, if they transfer within 60 minutes. On Demand travel credit are added to the customer's Transport Connect account balance to be used for future On Demand bookings.

The next step for TfNSW is to transition its fleet of over 8,000 buses to zero-emission buses. TfNSW expects to have nearly 200 battery-electric buses by the end of 2022, with 76 of these buses already in service. TfNSW is also supporting the development of depot infrastructure such as charging points and hydrogen storage.

Similarly, TfNSW added zero-emission buses to the tender criteria for recent bus region contracts in Sydney. Keolis Downer was awarded an eight-year contract to run bus services on Sydney's Lower North Shore, including the Keoride On Demand bus service. Keolis Downer has ordered over 100 new zero-emission buses to replace older diesel buses as they are retired from the fleet.[54] Selected depots will also be converted to allow the implementation of the necessary infrastructure to re-charge the electric buses.

Changes needed to decarbonise Australia's mobility fleet

What needs to change	Change barrier	Actions required
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 interventions – beyond those already announced by state and territory governments – to expedite the uptake of new low- or zero-emission light vehicles. This includes introducing national standards on vehicle emissions, bringing Australia into line with other countries, while also working with commercial providers to address gaps in urban and regional charging networks.
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.
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 – if they have not already – 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-emission bus depots.
		Passenger train and metro operators should sign Power Purchase Agreements to support uptake of renewable electricity generation and certify their services as zero-emissions.
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 users to take the most efficient mode of transport.		State and territory governments should look to build on the positives to emerge during the COVID-19 pandemic, including growth in the popularity of walking and cycling and implementing measures to encourage peak spreading, while continuing to enhance transport users' experience to encourage efficient, lower-emission trips.
		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, particularly in outer urban areas, to ensure residents have access to alternatives to private vehicles.

 Regulatory  Policy  Commercial  Technology

Transition strategies to decarbonise the movement of goods

Compared to the outlook on light vehicles, the pathway to decarbonising freight in Australia is less clear. The vehicle-powered technologies needed to enable change are further away from commercial viability. Coupled with this, the scale of investment required to decarbonise freight networks is likely to be greater. Freight transport cannot be electrified in the same way as light vehicles, with long distances and heavy loads requiring a solution beyond the existing, commercially available, capabilities of battery-electric technology.

Despite this, decarbonisation is imminent in the industry. Once the economics fall into place, market dynamics are likely to bring about rapid transformation to zero-emission freight networks.

Decarbonising freight transport requires medium-term and long-term goals, based on the availability of *low-* and *zero*-emission technologies as they come to market. In the medium-term, there will likely be a role for technologies enabling low-emission freight in order to decrease Australia's greenhouse gas emissions while zero-emission technologies are not feasible. In the long-term however, the goal must be to move freight within Australia and overseas using zero-emission technologies.

Preparing for this change requires action and reform across three fronts:

1. prioritising freight network planning and regulatory reforms to pave the way for decarbonisation
2. capitalising on potential improvements through the electrification of local freight, and
3. supporting the commercialisation of zero-emission fuels and technologies to drive the transformation of Australia's freight networks.

Enable efficiency improvements through long-term freight network planning

Freight decisions are based on two key factors: efficiency and cost. Australia's competitiveness and cost of living depend on goods moving where they are needed as cheaply and efficiently as possible. This means that rapid decarbonisation of freight only becomes commercially and economically viable when low- or zero-emission solutions become cost-competitive. Despite the technological challenges of decarbonising freight vehicles, emissions reductions are also possible through measures to improve the efficiency of freight *networks.*

Dominating past policy efforts to improve freight network efficiency has been a focus on shifting freight from roads to rail and sea. These modes are typically much less energy- and emissions-intensive on a per-tonne kilometre basis. However, modal shift has been hard to come by. While goods moved by rail have grown exponentially in Australia, this has been driven by growth in bulk commodities. For non-bulk, containerised freight, roads still dominate, carrying four times the tonne-kilometres of rail and sea – much the same as in the early 1980s – as shown in Figure 2.[55]

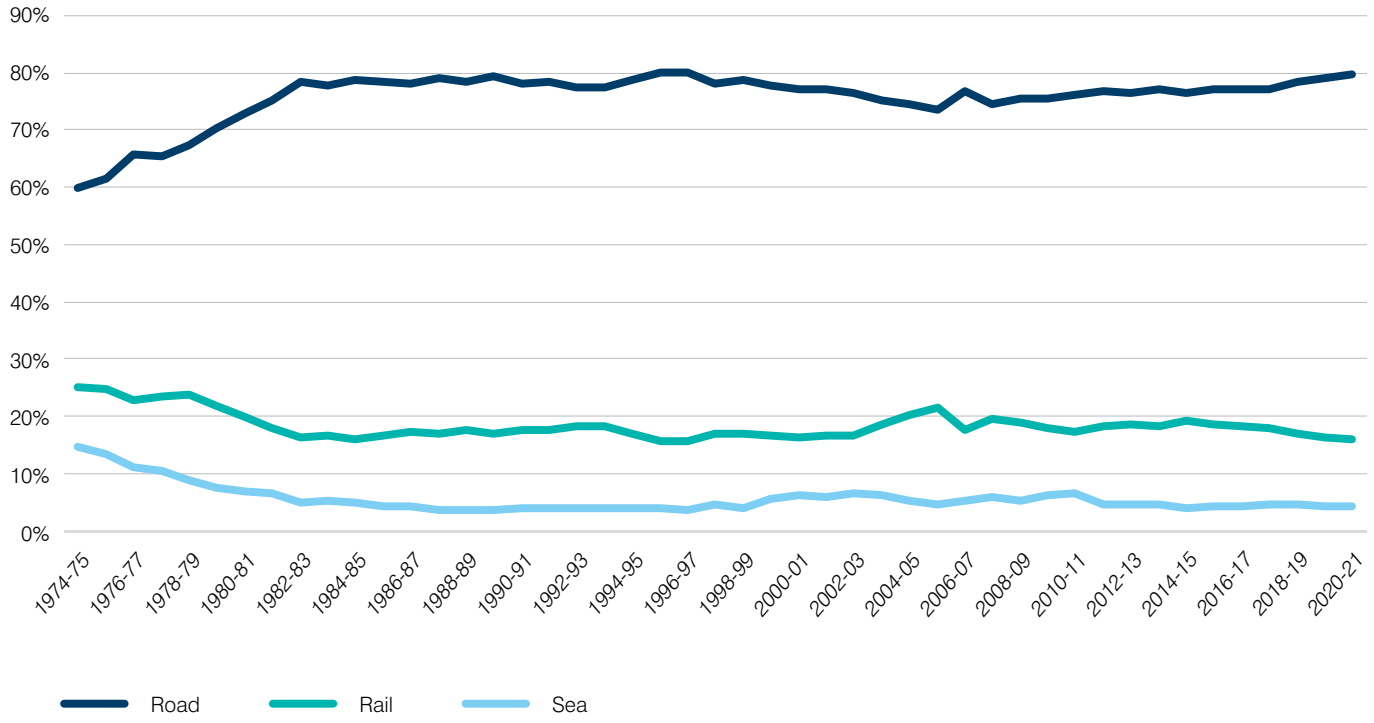
Shifting freight from road to rail is an important aspiration, but is challenging in practice. While rail can provide efficiency gains over long distances, many types of typically short-distance freight – including materials and components for construction sites – can only be carried by road due to their start or end point. This phenomenon is not exclusive to Australia. The International Transport Forum found modal share of road freight has increased over the past four decades in 44 out of 51 countries studied.[56]

Despite these challenges, incremental improvements in the emissions intensity of freight are possible by taking a smarter approach to network planning. This includes:

- Identifying gaps and deficiencies in nationally significant freight corridors and locations.
- Resolving planning and investment issues to provide efficient connections to Inland Rail in line with its completion.
- Supporting the development of new hubs and intermodal terminals to provide opportunities for freight operators to move goods to more efficient modes where possible.
- Addressing last mile and urban encroachment issues – including reserving strategic corridors and lands around key transport hubs – to enable long-term efficiency gains as Australia's freight task grows over the coming decades.

The *National Freight and Supply Chain Strategy* provides a good starting point, but the reality is Australia has no plan for decarbonising freight. A national plan should focus on locking in measures to improve efficiency in the short-term. This plan should also pave the way for the technologies that will more rapidly decarbonise freight when they become available. This includes taking an outcome-based approach to regulation where possible and providing simple avenues to unlock carve-outs for new technology pilots and trials. With the lack of first mover advantage in the shift to low- or zero-emission freight solutions, time-limited government grants or subsidies could help accelerate change and make Australia a world-leader in this field.

Figure 2: Share of Australia's total non-bulk domestic freight task by mode



Source: Infrastructure Partnerships Australia analysis of BITRE 2021[57]

Case Study 7: Long-term integrated freight planning at Moorebank

The Moorebank Logistics Park in south-west Sydney provides an example of how emissions can be reduced across the freight value chain with effective long-term planning to shift containerised freight distribution to and from Port Botany from emissions-intensive trucks to rail networks.

The initial project and business case were developed by the Australian Government enterprise, the National Intermodal Corporation, then Moorebank Intermodal Company, from 2010. Sydney Intermodal Terminal Alliance (a wholly-owned subsidiary of Qube Holdings) was then appointed to develop and operate the project in 2015.[58]

The Moorebank Logistics Park will remove the need for 3,000 truck journeys each day and reduce emissions by 110,000 tonnes of CO_2-e annually. The Park will supply a minimum of 12 megawatts of solar generation capacity. The PV installed onsite will feed into an embedded power network, the network will enable business within the site to access renewable energy onsite. As part of this, the project also includes a 40,000 square metre warehouse with three megawatts of rooftop solar capacity.[59]

Moorebank Logistics Park also includes a range of innovative technology solutions to reduce embedded and operational emissions:

- Automation at the site will include automated stacking cranes, rail mounted gantry cranes, a fleet of low-emission hybrid auto-shuttles and computer software to handle all containerised freight on the site. Using automation in operations reduces energy use and emissions, enhances safety, minimises environmental impacts and improves productivity.
- The project design has incorporated features to help reduce urban heat island effect through features including landscaping, green space, lighter coloured building façade, large awnings and bioretention structures such as rain gardens.
- An online sustainability performance tool has been implemented to measure and monitor electricity use and fuel consumption.

The project is the first clean energy transport infrastructure project to have received financing from the Clean Energy Finance Corporation (CEFC), with the CEFC providing a $150 million loan. Arcadis advised Qube and the CEFC on a range of emissions reduction strategies across the project, including site operations and avoidance of embodied carbon in construction materials.

Capitalise on the potential for electrification of local freight

The local freight sector has grown exponentially in recent years, super-charged by the explosion in home shopping during the COVID-19 pandemic. From 2014 to 2019, e-commerce sales ratios nearly tripled globally.[60] In 2020, online purchases in Australia grew by 57 per cent, while 1.4 million Australians made an online purchase for the first time.[61] This growth has resulted in a sharp rise in the greenhouse gas emissions from local freight, as well as exhaust and noise pollution in urban areas.

Despite this growth, local freight is likely to prove easier to decarbonise than long-haul freight. Urban freight and last-mile deliveries are typically carried out in smaller vehicles to which battery-electric technology is better suited. This solution effectively aligns their potential decarbonisation pathway more closely with light vehicles and means zero-emission local freight is on a nearby horizon.

Local freight operators have already started to enact change. Australia Post operates the nation's largest fleet of electric vehicles, with 3,500 electric delivery vehicles and bikes and 20 electric trucks.[62] However, this represents only 23 per cent of the total Australia Post last mile delivery fleet,[63] leaving substantial latent capacity for further decarbonisation to the rest of the fleet. Continued improvements in battery capacities, fast-charging technology, and model availability over the coming years will likely make zero-emission local freight vehicles the commercially superior choice for many freight operators – and underpin a rapid fleet transition.

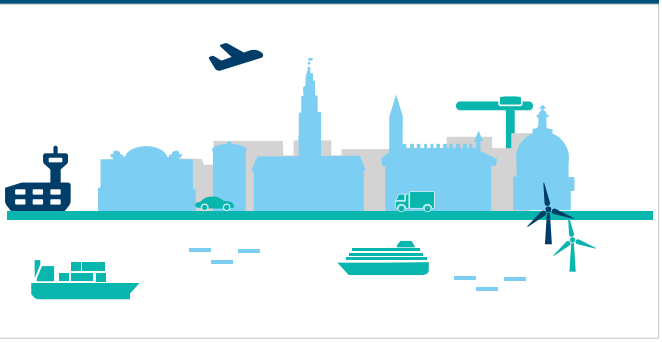
Governments can support and accelerate this transition through nips and tucks to regulatory measures. At the local level, quieter electric vehicles are less likely to disturb residents in local areas, so could be allowed to make deliveries outside of regular hours. At the state and territory level, electric vehicles could be given special access to designated low-emission zones in urban areas. This would remove emissions and noise pollution from dense commercial and residential zones, while enhancing the logistics value of zero-emission vehicles to freight operators.

Case Study 8: Multi-sector decarbonisation in the 'Green Fuels for Denmark' project

The Green Fuels for Denmark project seeks to bring together the supply and demand sides of zero-emission fuels by forming a partnership across the full energy and transport value chain. The project aims to produce zero-emission fuels derived from renewable electricity, with production scaling up over three phases until 2030. The end goal is to have electrolyser capacity of 1.3 GW coupled with offshore wind, carbon capture and usage and chemical synthesis for fuel production.

Green hydrogen will be produced for use in hydrogen fuel cell powered trucks and buses, with e-methanol produced for the maritime sector and e-kerosene produced for aviation. At full scale the project expects to supply 30 per cent of total fuel consumption at Copenhagen Airport. This combined with renewable fuels supplied to maritime and road transport operators is expected to reduce annual CO_2 emissions by 850,000 tonnes.[64]

The partnership includes Ørsted (renewable energy), Copenhagen Airports, SAS (aviation), A. P. Moller-Mærsk (shipping), DFDS (passenger ferries and shipping), DSV Panalpina (road, air, and sea freight). The project is also supported by government bodies such as the City of Copenhagen and the Capital Region of Denmark, as well as renewable fuel technology providers.



Support advances in zero-emission fuels

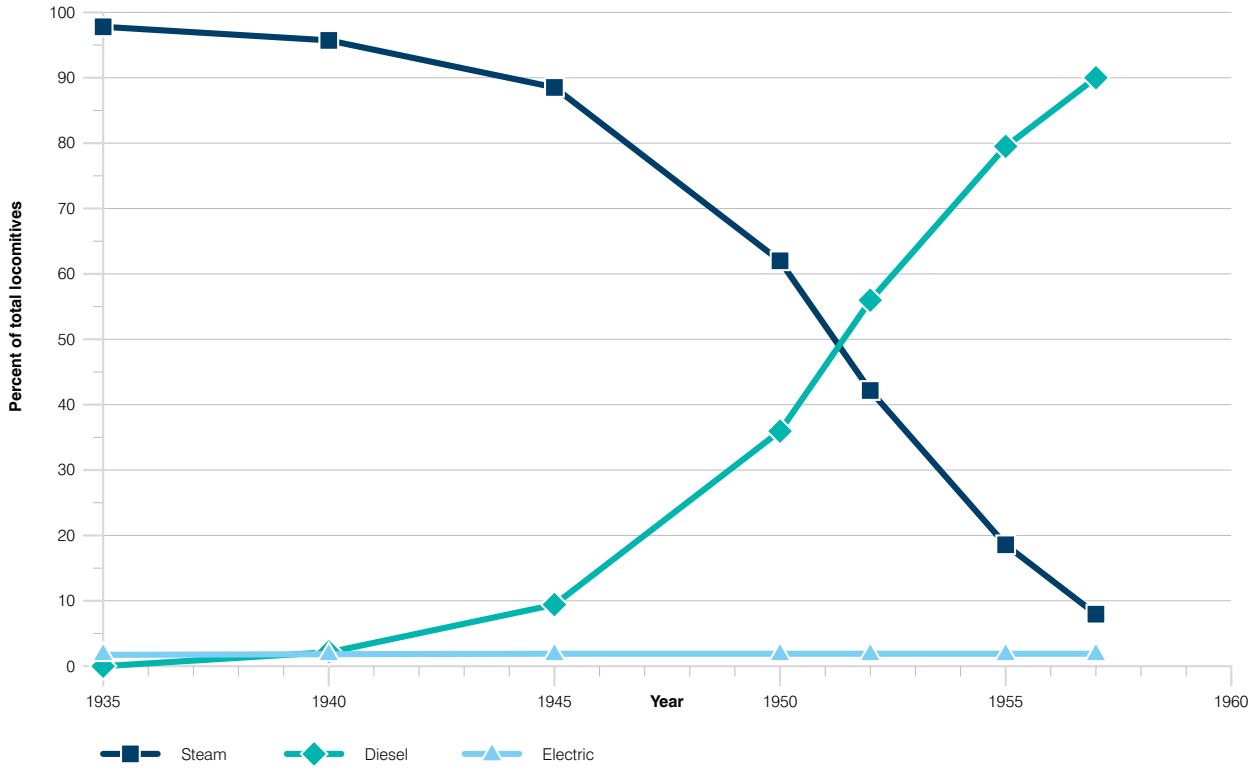
The commercial realities of long-haul freight are tight margins and large overheads. For truck, train and most shipping operators looking to renew their fleet – even those committed to decarbonisation – diesel-powered vehicles and ships remain the only option for the vast majority of freight applications. Considering freight vehicles and ships are typically owned and maintained for decades to deliver a return on investment, the natural replacement for assets purchased today may be sometime around 2050.

Change is likely to happen slowly while zero-emission options remain more expensive, then very rapidly once the costs stack up. This has occurred before, with the transition from steam to diesel locomotives a clear example. As Figure 3 shows, 'dieselification' of the US railroads occurred during a brief window, when the superior efficiency of diesel locomotives displaced steam trains' dominance following World War II. Diesel locomotives took a decade to reach 10 per cent market share, before reaching 90 per cent in the following twelve years.[65]

A similar trajectory for the transition to zero-emission freight technologies over the coming years is plausible. As the costs of these technologies fall, there will be greater focus on the operation and maintenance costs of freight assets. The same tight margins that have hindered investment in costlier, more sustainable technologies are likely to underpin rapid transformation when lower-emission fleets become cost effective.

There are a range of emerging technologies with the potential to dramatically reduce emissions from freight vehicles. Some of these, such as biofuels, could be introduced with relative ease once commercially-viable. Others, like hydrogen-powered long-haul shipping and aviation, may require more work. This will likely include transforming existing supporting infrastructure, restructuring supply chains, and substantial investment in new vehicles. Many of these technologies are both competing and complementary, and it is likely that the answer to decarbonising freight will require a diverse set of technologies to enable change.

Figure 3: Technological change on the US railways, 1935 to 1960



Source: Ayres, R.A. et al, 2002. Exergy, Power and Work in the US Economy, 1900-1998

Decarbonising ports and shipping

The shipping industry will play a key role in the future of the Australian economy, with 99 per cent of exports relying on sea trade. Ports themselves are large energy users and many are in the process of transitioning to renewable energy supplies. Significantly, ports will also play a role in the supply chains of zero-emission fuels, not just for ships, but also for trains, trucks and industrial applications.

Australia's maritime sector faces additional challenges to decarbonisation given Australia's distance from many of our trading partners and position at the end of global shipping lines. While electric ships may prove commercially-viable in the near term for relatively short-distance shipping,[66] long distances and heavy loads are not suitable transport characteristics for this technology. The size of batteries required to power long trips would mean there is little room left for the freight itself. This lack of energy density means Australia will need to wait for further breakthroughs in alternate fuel sources to move away from a reliance on fossil fuels.

Federal Government policy that supports the decarbonisation of the maritime sector primarily focuses on the production of low- and zero-emission fuels. The *Future Fuels and Vehicles Strategy* and the *National Hydrogen Strategy* both discuss options to support the development of biofuels and hydrogen. However, the maritime industry would benefit from a more comprehensive action plan for decarbonisation, covering port infrastructure as well as fuel development.

A comprehensive plan for decarbonising maritime transport would support the acceleration of numerous industry actions already underway. These include feasibility studies into creating hydrogen hubs at Port Kembla and the Port of Newcastle,[67] other potential hydrogen projects in Bell Bay, Tasmania[68] and Port Pirie,[69] Geelong Port's achievement of carbon neutral status,[70] and NSW Ports introduction of an Environmental Incentive[71] providing rebates on port charges for vessels that have reduced emissions beyond regulatory requirements.

Case Study 9: Clydebank Declaration for green shipping corridors[72]

International shipping is not included in national carbon accounts, yet it contributes around three per cent of all global emissions – having a large impact on achievement of global decarbonisation goals. But the shipping sector is also one of the harder-to-abate transport industries due to the long-distances travelled, heavy loads carried, as well as its truly international nature and low-margin economics. The decarbonisation of harder-to-abate industries can benefit from the implementation of early demonstration projects, which create learnings that can be applied for broader adoption.

In November 2021, at the COP26 meeting in Glasgow, 22 countries, including Australia, committed to support zero-emission shipping demonstration projects by signing the Clydebank Declaration. Signatories to the Declaration have committed to support the establishment of at least six zero-emission maritime routes between two (or more) ports by the mid 2020s. These routes are referred to as green shipping corridors and will require access to zero-emission fuels, land side infrastructure and new vessels capable of running on new fuels.

Signatories to the Declaration will support green corridors by facilitating partnerships between ports, shipping operators, fuel producers and other parts of the value chain. Signatory countries must also consider how to include green shipping corridors in relevant national action plans and address project barriers through revising regulatory frameworks, using incentives and providing supporting infrastructure.

The degree of uncertainty around freight's future presents challenges. There is little to be gained and much to lose from governments or industry 'picking winners' when technologies remain in their infancy. But there is plenty to do in the near-term to prepare for a zero-emission freight system, irrespective of which technologies emerge over the medium- to long-term. The challenge for regulators and policy makers is to ensure Australia is well-placed to capitalise on the benefits of change when it arrives.

For governments, the overarching decarbonisation goal should be to bring forward the development curve of low- and zero-emission propulsion for long-haul freight. With a number of existing decarbonisation initiatives already in place, there is a lot of potential for greater national coordination of academic, public and private sector efforts. 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 phasing out schemes that support traditionally-powered heavy vehicles.

Changes needed to decarbonise Australia's freight fleet

What needs to change	Change barrier	Actions required
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. This should provide a pathway to reduce end-to-end emissions across supply chains, with short-, medium- and long-term actions to support change, and the role of intermodal networks will be fundamental to this work.
		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. This includes resolving planning and investment issues to provide efficient connections to Inland Rail in line with its completion, as well as support for the development of new hubs and intermodal terminals, and addressing last mile and urban encroachment issues.
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 can support and accelerate electrification of the local freight fleet. For instance, where appropriate, 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.
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.		While governments should avoid 'picking winners' among zero-emission technologies for long-haul freight, they 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.


MAERSK

DECARBONISING ASSETS THROUGH CONSTRUCTION, OPERATION AND WASTE REQUIRES SUSTAINED INNOVATION AND REFORM

The final frontier of decarbonising the infrastructure sector requires a reduction in the emissions across asset stages – emissions embedded through construction, generated by asset operations, and left behind through waste. Compared to energy and transport, the technologies and methods required to overcome this challenge are the least developed. But with sustained commitment to innovation and reform, and by aligning incentives and investment opportunities with industry appetite for change, decarbonisation of the full infrastructure sector is possible.

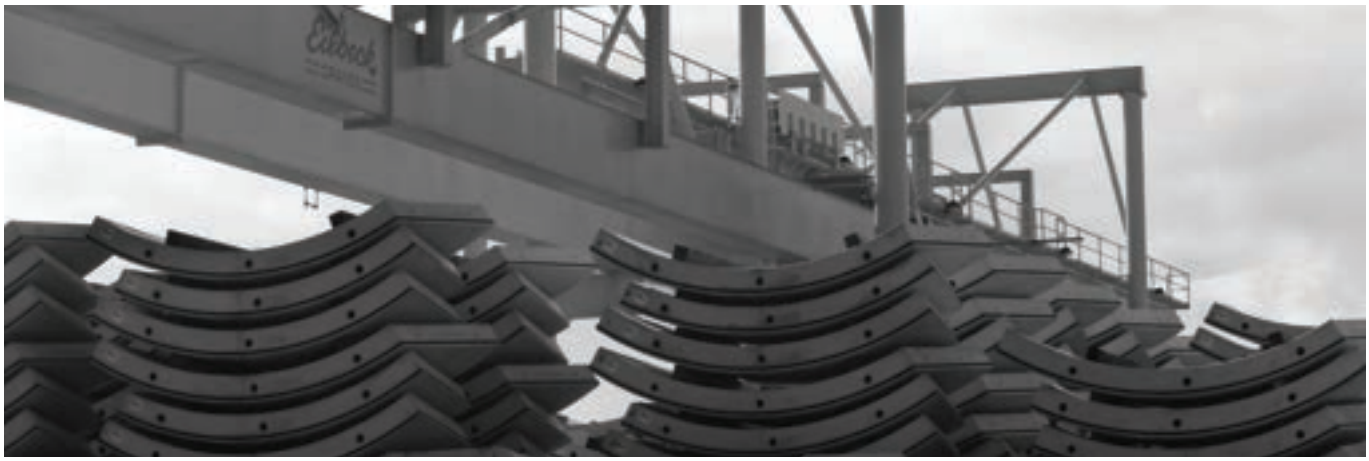
The scope of emissions-related challenges in infrastructure has expanded rapidly over recent years, to a moment now where the carbon embedded within assets is in stark focus as an area for action. There has been some progress – largely industry-driven – through developments such as green concrete, recycled waste in construction materials, and pre-fabricated construction. But, up until now, embedded emissions across construction, operation, and waste have generally been a second order issue in dialogue on decarbonising the sector.

While Australia's official carbon emission reporting does not account for construction emissions in its own standalone category, it is estimated that Australia's construction industry generates 30 to 50 million tonnes of carbon every year.[73]

Asset operation emissions are typically accounted for under transport and energy, without considering how infrastructure assets are designed – or the potential Scope Three emissions generated during an asset's life. Changes to how existing assets are operated or priced to account for this can bring significant reductions in emissions.

Waste management remains an underutilised method of decarbonisation – with 27 million tonnes of construction and demolition waste produced across Australia in the financial year 2018-19.[74] Assets are rarely planned to ensure their components can be reused or recycled once parts are renewed or assets are retired and replaced. Too many useful materials end up in fast-growing landfills, adding to waste emissions. As highlighted in Infrastructure Partnerships Australia's report *Putting waste to work: Developing a role for Energy from Waste,* Australia is yet to fully embrace the potential of technologies such as energy-from-waste to extract value from refuse before it reaches landfill.

With a record project pipeline underway, and a range of pressures across the industry, it would be easy to suggest Australia lacks the time and capacity to plan and design lower-carbon infrastructure. But the scale of upcoming sector investment provides a once-in-a-lifetime opportunity to transform infrastructure asset lifecycles and drive change on a grand scale.



Governments have a critical role to play as the planners, funders, procurers, regulators, owners, and operators of a significant proportion of Australia's infrastructure. This requires leadership on reforms, updates to codes and standards, and a future-focused approach to planning and procurement. The latter should be guided by broader strategies, targets and circular economy thinking. This goes beyond simply updating policy and regulatory frameworks, it requires public sector institutions to adopt a new risk appetite, agreeing to innovative solutions reducing emissions embedded in the projects they sign off on. Governments must be prepared to purchase the outcome they want – low-carbon infrastructure – from the private sector if serious about their commitments to net zero emissions by 2050.

In industry, many major constructors and technical advisors are regularly exposed to global markets and overseas practices. This provides opportunities for innovation at scale through identifying, advocating for, and implementing lower-carbon initiatives in Australia that have proven successful in other parts of the world.

Transparency will also be critical to enabling and tracking decarbonisation. Australia's data on the emissions generated by infrastructure assets lacks granularity, regularity and reliability. Governments should work with industry to develop agreed reporting guidelines for calculating emissions from construction, operation and waste, tracking progress against long-term targets and commitments. Scope Three emissions – being the indirect emissions that occur in an organisation's value chain (outside of purchased electricity, heat, and steam) – remain a major blindspot for the end users of infrastructure. These should be incorporated under the *National Greenhouse and Energy Reporting Scheme* to increase visibility and track performance over time.

Incorporating a reduce, reuse and recycle ethic into Australia's asset mix

For the infrastructure sector, the circular economy framework can be used to drive sustainability. Incentivising reuse and recycling, and minimising waste and production of new manufactured goods, will reduce supply chain emissions. This framework also places a higher value on shorter supply chains (use of goods produced locally where possible), or closed resource loops (where renewable energy powers resource extraction, manufacturing, use and reuse), which can dramatically reduce the environmental footprint of traditionally heavy-polluting industrial processes.

Australia has historically performed poorly in comparison to its peers in terms of the proportion of resources we reuse, recycle or recover within the economy. In a large part this is due to the higher proportion of our economic activity and exports derived from resource extraction. But with dramatically lower costs of distributed energy, and the prospects of green hydrogen production, Australia has a chance to overhaul its heavy industry and become a world leader in sustainable resource extraction and production.

Climate-aligned contracting in infrastructure projects – from sleeper issue to key lever in the transition to net zero

Contributed by Sarah Barker and Phoebe Roberts, MinterEllison

Setting a 2050 net zero target is quickly becoming a base expectation and 'ticket to play' across infrastructure procurement – with the expectation also now shifting to interim emissions reduction targets to 2030. In 2022, that focus is now on the *'how'* of getting to net zero – with contracts as a key lever in implementing organisations' emissions reduction plans.

However, traditional approaches to contractual risk allocation and project procurement do not typically address climate change risks, or provide optionality to capture value and commercial opportunities in the net zero transition. Every aspect of a project – concept, design, engineering, materials selection, construction, operation and decommission – has to account for extreme weather and shifting economic conditions for which past experience is an imperfect (and often inadequate) proxy.

Robustly addressing climate change risks and opportunities in contractual frameworks goes far beyond including obligations to meet 'green' technical criteria for the design/as-built standards at completion of a project. Emissions reduction is an entire value chain proposition – and for infrastructure, a significant portion of those emissions are Scope Three emissions and fall outside business fence lines. Contracting is one of the few mechanisms within a party's sphere of influence in managing their Scope Three emissions and protecting their organisation from the risks of climate change – in a demonstrable and forward-looking way.

Organisations around the world are embedding climate solutions into their commercial arrangements. The Chancery Lane Project (TCLP) is a global legal initiative designed to assist organisations to use climate-aligned contractual clauses – including their Net Zero Toolkit – which provides free and open-source tools to deliver their net zero commitments through contracts. TCLP's model clause for GHG Emissions Management Plans in Infrastructure and Construction Project Finance, for example, makes public or private finance conditional upon the borrower developing and adopting a whole life decarbonisation management plan.

Case study 10: Unprecedented weather events are not analogous with historical force majeure events

The importance of a bespoke and forward-looking approach to account for climate-related risks in drafting force majeure clauses was recently considered by the New York Supreme Court in *Stephens Ranch Wind Energy LLC v Citigroup Energy at al.* In February 2021, a 'polar vortex' storm occurred in Texas, leading to a widespread power system failure, which caused 70 per cent of the state to be without power in freezing temperatures for an extended period, and contributed to a tragic loss of life. During the blizzard, energy generation was halted at Stephens Ranch's 210 turbine 376-megawatt wind farm due to the turbines freezing over. Stephens Ranch was unable to meet supply obligations under two fixed-price power purchase agreements with Citigroup – leading to Citigroup seeking compensation for the outage costs. Stephens Ranch sought to rely on the outage being an 'extreme unanticipated event' covered under their contract's force majeure clause.

The court found in favour of Citigroup finding that while the storm was unprecedented in force and effect, such weather would not likely excuse non-performance under the contract. Justice Reed made specific reference to Federal Energy Regulatory Commission reports, which concluded that such winter storms were likely to take place in Texas going forward – and recommended wind farm operators take preventative measures to 'winterise' their turbines.

Source: PHOTO: GEORGE STEINMETZ FOR THE WALL STREET JOURNAL

Unlocking a zero-carbon future for infrastructure construction

For Australia to reach net zero-emission and beyond, we must transform how we build. With more than $759 billion of projects listed on Infrastructure Partnerships Australia's ANZIP, there is no shortage of opportunities to drive this transformation. This includes the $248 billion in taxpayer-funded infrastructure over the next four years, allocated by governments in last year's Budgets.[75]

To date, much of the policy and regulatory focus for reducing construction emissions has centred on improving the energy efficiency of buildings and other built assets.[76] This has relied on the mandatory minimal obligatory requirements for energy efficiency set out in the National Construction Code, alongside voluntary measures such as the National Australian Built Environment Rating System (NABERS) and Green Star. While these requirements are a good start to reducing emissions, more can be done to advance policy and regulatory frameworks to address embedded emissions from construction materials and supply chains.

A number of barriers have stymied progress on low- to zero-carbon innovation in construction. Cost has been a primary concern, with a focus on price efficiency often leaving little room for innovative solutions. This has been underpinned by a historical stigma surrounding recycled materials, often seen to bear poorer engineering characteristics and higher costs. However, this concern is diminishing as new products emerge that are both cheaper and more efficient than conventional materials. Reduce, reuse, and recycle principles should guide governments and the private sector to foster innovation across the construction value chain.

Decarbonising cement and steel

Decarbonising construction materials will be a challenging but critical hurdle on the path to net zero. Building Australia's infrastructure pipeline will require vast amounts of both materials, particularly as part of the growing metro and road tunnel networks in major cities. But this is not only an Australian issue. Cement and steel are two of the highest emitting materials used in construction, both contributing around eight and seven per cent respectively[77] of global carbon emissions. Cement would be the third-largest emitter in the world if it were a country.[78]

Some progress has been made with lower-carbon 'green cement' products being used to replace or be mixed with conventional cement in Australia. Green cement can drive incremental improvements in emissions intensity, particularly if reinforced with other reused and recycled components or decarbonised steel. However, a proportion of the emissions from clinker production are unavoidable – with CO_2 a by-product of the chemical process. This means the development of reliable and efficient industrial-scale carbon capture and storage at cement manufacturing facilities is likely to play a key role in the shift towards zero-carbon cement. The world's first large-scale carbon capture and storage cement production facility is under development in Brevik, Norway, and is scheduled to commence operations in 2024.[79]

Similarly, progress is possible in decarbonising steel through three main strategies. By 2050, Bloomberg New Energy Finance estimates the steel market could use green hydrogen instead of coal-fired blast furnaces for 31 per cent of steel production. Recycling of steel could contribute another 45 per cent of production, with the remaining 24 per cent of steel produced with coal-fired furnaces combined with carbon capture and storage.[80]

Government procurement policies can be a key driver of the shift to decarbonised steel production. One example is the Industrial Deep Decarbonization Initiative, which was announced at the November 2021 COP26 meeting. The initiative is led by the UK and India, with support from Germany, the United Arab Emirates and Canada. These countries have committed to purchasing low-carbon steel and concrete, with another key goal of the initiative being to convince a minimum of ten countries to sign up to green public procurement commitments within three years.[81]

Governments should set a vision for lower-carbon infrastructure construction

Governments at all levels in Australia have a fundamental part to play in decarbonising infrastructure across four key stages: planning, procurement, regulation and operation. Across all these spheres, there is a crucial opportunity for governments to implement their collective strategic objective of decarbonising the sector. Simply put, governments need to determine the assets they want to buy (being lower-carbon infrastructure) in line with their macro commitments (net zero emissions by 2050), and let the private sector compete to deliver and operate this lower-carbon work.

Actions taken by governments must be matched with a willingness within public institutions to adopt and approve innovative, low-carbon solutions proposed for assets by bidders and governments. While institutional risk aversion seeking to avoid potential perverse outcomes is understandable, decarbonisation cannot be held back by a conservative risk appetite to change. Governments must go beyond simply putting standards in place, and ensure a transformational attitude is adopted institutionally.

Planning

The continued construction of a major pipeline of new, heavy infrastructure assets will be needed to cater to the evolving needs of Australians in the coming decades. Governments should prioritise planning the delivery of the most appropriate pieces of infrastructure that will effectively and adequately respond to these evolving needs.

Procurement

Public agencies should stipulate clear outcomes sought from bidders in procurement, including requirements for lower-carbon methods, materials or whole-of-life efficiency. Bidders should be provided sufficient scope and time to propose innovative solutions to tender requests, responding to the thresholds set by procurers. Whether private capital investment or Public Private Partnerships could help to facilitate these outcomes should be a routine consideration on major projects. It is critical that procuring agencies look beyond lowest cost to select the bidder proposing the highest value – with sustainability and decarbonisation attributes forming a key part of that value.

Operation

Governments are by far the largest collective category of infrastructure owners and operators in Australia. Despite a mix of targets across states and territories, the majority of hospitals, schools, roads, railways and other public assets operate as they have for decades, with little progress on decarbonisation. Governments can lead from the front by setting clear and ambitious targets in the near-term to decarbonise the operation of their vast portfolios of assets over the medium-term.

Regulation

It is governments' role to set the standards for industry to follow, and then make room for the private sector to create lower-carbon solutions. Reforming standards in line with global best practice and with regard to embedded emission issues will deliver substantial benefits. A key area of reform will be to improve visibility of the sector's embedded emissions through supply chains in where, and how, the construction industry sources materials.[82]

Case Study 11: Clarence Correctional Centre in Grafton NSW

The largest correctional facility in Australia, Clarence Correctional Centre (CCC), is a Public Private Partnership correctional complex located in Grafton NSW. CCC was delivered by the NorthernPathways consortium – comprising of John Laing, John Holland, and Serco. NorthernPathways are tasked with maintaining and operating the facility on behalf of the NSW Government for 20 years. The capital value of the project was $706 million, and the total contract value over 20 years is $4.2 billion.

Project construction was completed in April 2020, and operations commenced on time in July 2020. The design of the project focused on 'pathway from reception to the gate', a socially conscious campus design that removed the institutional feel as part of designing for best correctional outcomes, including reduced recidivism.

Innovative design and construction of the project saw prefabrication methods of construction used to install over 5,000 precast concrete panels and more than 600 prefabricated cells in the facility. The modularised pre-cast volumetric cells were fabricated at the on-site concrete batch plant.

This allowed for higher quality control, reduced logistics and improved programming activities with the works occurring on site. The overall cell design, in conjunction with flat panel precast methodology, led to increased construction efficiency and build quality, overall satisfying the design life requirements. These benefits enabled the buildings to be assembled concurrently, and as a result, the cell installation was completed five weeks earlier than planned.

Drone aerial mapping was also used to plan delivery routes and facilitate the movement of trailers, further fast-tracking the project, and providing a safe work environment.

Decarbonisation of infrastructure operations can be accelerated

Many assets require huge amounts of energy to operate. While the exact proportion of Australia's infrastructure-created emissions are often hidden within the energy columns of reporting datasets, there is clear scope to materially improve emissions through a focus on decarbonising operations.

Renewable energy will be pivotal to decarbonising infrastructure operation. Many assets – railways, hospitals, stadiums, tunnelled roads, desalination plants, water and wastewater treatment facilities, among others – consume vast amounts of electricity from the grid. A lot of these same assets occupy large sites that present a range of possible locations for installing distributed energy resources, particularly solar panels. These spaces can, and should, be utilised to reduce the demand these assets place on energy grids.

Additionally, aligning the timeframe of when assets draw power with periods of high renewable generation can reduce peak loads and minimise the need for additional grid capacity. For many assets, the best hours for solar generation will also typically overlap with their standard operating hours. Excess energy could be fed back into the grid, while onsite storage could help to spread peak demand and reserve power. For other assets, on-site storage through batteries may provide greater control over when and how grid power is deployed.

Power Purchase Agreements can provide an efficient mechanism for both sourcing renewable energy, and supporting the development of renewable generation infrastructure for assets without the capacity to generate enough energy onsite.

How Australia *uses* infrastructure also needs to be smarter. Despite the importance of reducing emissions in construction, most of the infrastructure that will be operating in 2050 has actually already been built. It is crucial for the sector to find ways to use existing assets more efficiently and extract more value from them – including retrofitting and repurposing existing assets. Employing methods like selective demolition will be key to recovering and re-using materials on site prior to demolition.

Finally, governments need to re-evaluate existing regulations on infrastructure operation – some put in place many years ago – to ensure they provide sufficient scope and incentive for achieving emissions reductions. Looking to best practice overseas for guidance will be helpful, such as the EU's Industrial Emissions Directive, established over a decade ago to regulate pollutant emissions from industrial assets in Europe.

Case Study 12: Powering roads with renewable energy and optimising tunnel ventilation

Electricity usage represents 93 per cent of Transurban's total energy consumption from its operations. Most of this electricity is used to ventilate tunnels, power lighting and roadside equipment, and to operate traffic management centres.

As part of Transurban's commitment to achieve net zero emissions by 2050, and halve its direct emissions by 2030, the company has signed power purchase agreements with several wind generators to provide renewable energy to roads across Sydney, Brisbane and Melbourne. For example, from May 2021 the Sapphire Wind Farm in regional NSW began providing renewable energy for the Eastern Distributor, Cross City Tunnel, M2, Lane Cove Tunnel, WestConnex M4, M5 East Motorway, and WestConnex M8. Across these three cities, the switch to 80 to 100 per cent renewable energy is estimated to save up to 150,000 tonnes of greenhouse gas emissions each year.[83]

As well as switching to renewable energy, Transurban is trialling ways to minimise energy consumption to further reduce emissions. Ventilation systems account for 70 per cent of operational energy use on road tunnels. The ventilation systems run constantly, even during low traffic periods, to ensure there are zero portal emissions of air pollutants from the tunnels.

As the vehicle fleet electrifies, tailpipe emissions will decline and air quality in tunnels will improve. This could enable reduced demands on ventilation systems without compromising air quality. However, the regulatory conditions governing toll road use do not account for electrification of the fleet. Reviewing these arrangements and shifting to an approach based on maintaining air quality outcomes could enable significant reductions in the demands of road tunnels on the energy grid as the uptake of low- and zero-emission vehicles increases.[84]

Improving waste management can unlock hidden avenues for decarbonisation

Waste is frequently discussed with respect to its sustainability outcomes, but less so in relation to decarbonisation. Thinking more critically about how Australia manages its waste across asset procurement, construction, operation, and decommission can unlock multiple avenues for zero-emission solutions. Reducing the country's waste output will lead to a long-term reduction in carbon emissions – an enormous decarbonisation opportunity considering construction alone contributes nearly a third of Australia's total 67 million tonnes of waste each year.[85]

Decades of inconsistent and fragmented waste policy have enabled complacency across Australian industries and extended reliance on landfill. Previously, we shipped much of our waste to our Asian neighbours. China's 2018 National Sword Policy and clampdowns from India, Indonesia and Malaysia made these arrangements untenable, bringing a clear impetus for change in how we manage and extract value from waste.

While policy progress has been made since then, Australia's piecemeal approach to reform and investment is missing an opportunity to reimagine the nation's approach to waste. A linear model of waste, where the majority of goods are overproduced, underutilised and ultimately destined for landfill is inefficient, unproductive and emissions-intensive. Governments waste management policies should squarely fit within reduce, reuse and recycle principles. Where waste generation cannot be avoided, separating out materials for reuse and recycling should be prioritised, and residual refuse treated through energy recovery processes. Energy-from-waste facilities are currently the least-used waste generation and management method in Australia – processing only plastics, organics, textiles, leather and rubber[86] – but should be playing a greater role in managing the nation's refuse.

While major construction is, and is likely to remain, a messy exercise, governments can incentivise low-waste construction techniques in their procurement processes to minimise its generation, support integration of reused and recycled content, and allow excess material to be repurpose elsewhere on-site.

Harnessing ESG investment as a driver of change

> **"We all know the end game here and whether or not governments are laggards is irrelevant. People want to invest in assets that reflect a decarbonised future and that's where they will land."**
>
> – Institutional investor, 2021 Australian Infrastructure Investment Report

The emissions generated by existing infrastructure have come under increasing scrutiny over recent years. Investors are increasingly looking beyond financial and economic value in assets to understand their ESG credentials, with carbon profiles and scope for decarbonisation as key considerations.

This forms part of a broader, rapid shift towards ESG as a core driver of investment decisions across greenfield and brownfield assets. This is happening at pace, with 93 per cent of investors surveyed by Infrastructure Partnerships Australia indicating ESG has grown in importance in the sector over the past two years.[87] Investors have sharpened their focus on the underlying credentials of assets and increased their focus on whole-of-life outcomes, including end-to-end decarbonisation.

As projects are developed, aligning private capital with long-term project outcomes can bring a greater focus on whole-of-life emissions and resilience to climate risk – with an incentive to innovate through project design. For existing assets, ESG-focused investors can give asset operators licence to invest in measures to minimise Scope One, Two and Three emissions. And as assets reach the end of their useful lives, there remains an incentive for investors to look for ways to renew, reuse or recycle components and materials.

A burgeoning pool of capital is available for projects with strong ESG credentials as investors look to adjust their portfolios in response to net zero policies and mitigate their climate risk profile. Australia is well-placed to tap into this finance in order to drive investment in projects and technologies that will move the needle in decarbonising the sector.

However, almost three-quarters of investors surveyed have said uncertainty in Australia's policy and regulatory settings limits their willingness to invest.[88] This is particularly evident in decarbonisation, where political disunity and a lack of national coordination has been noted by many investors. Australian governments need to do more to pave the way for investments in zero-emission infrastructure initiatives and provide greater certainty to investors of a politically neutral, solid commitment to decarbonisation.

The final, essential step in decarbonising Australia's infrastructure is to ensure that responsible asset ownership is encouraged in both private and public realms. Responsible owners who manage fossil fuel-emitting assets that are focused on a transition pathway should be encouraged, not demonised. If the imperative is to get to net zero by 2050, a truly poor outcome would be a responsible asset owner divesting a carbon-intensive asset to an irresponsible one. Simply divesting high-emitting assets to investors with weaker ESG targets will not move Australia closer to net zero. 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, instead of selling them off.

Changes needed to decarbonise infrastructure construction, operation, and waste

What needs to change	Change barrier	Actions required
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 (being lower-carbon infrastructure), in line with their macro commitments (net zero emissions by 2050), 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 need to adopt new risk appetites, agreeing to innovative solutions that will reduce emissions embedded in the projects they sign off on.
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 that are prone to being made obsolete through technological change or may create perverse incentives for inaction.
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 quarterly or biannually, tracking progress against long-term targets and commitments.
		The Federal Government should introduce reporting requirements on Scope Three emissions under the National Greenhouse and Energy Reporting Scheme to increase visibility of emissions generated through the operation and use of infrastructure and track performance over time.

What needs to change	Change barrier	Actions required
Australia's construction standards do not sufficiently integrate or promote sustainability and decreased emissions – or address embedded emissions across the construction supply chain.		Governments, through National Cabinet, 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, with a focus on the integration of reused or recycled materials.
		Governments must ensure that policy and regulatory reform is accompanied by a transformation in risk-averse practices within public sector institutions, who need to adopt risk-friendly appetites towards projects proposing innovative low-carbon solutions.
Australia's regulations provide 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. This includes providing clear guidance and planning arrangements in relation to how and where these facilities can be developed.
		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, unless there is legitimate cause for variation.
		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.
Private investment in infrastructure is underutilised 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 look to tap into the global capital available to finance decarbonisation by providing greater confidence to investors about Australia's long-term commitments and transition strategies. Public procurement agencies should support this by 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, instead of selling them off.

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Attachment B

INFRASTRUCTURE PARTNERSHIPS AUSTRALIA

DECARBONISING CONSTRUCTION: PUTTING CARBON IN THE BUSINESS CASE

INFRASTRUCTURE PARTNERSHIPS AUSTRALIA

Infrastructure Partnerships Australia is an industry think tank and an executive member network, providing research focused on excellence in social and economic infrastructure. We exist to shape public debate and drive reform for the national interest.

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SUMMARY

An embedded (or embodied) carbon 'base case' should be included in all business cases for infrastructure projects and programs over $100 million in capital cost. This should be mandatory for all such projects, with government retaining the option to 'compete' a lower carbon outcome through detailed design and procurement. This would establish a framework to move infrastructure procurement to a Time, Quality and Cost + Carbon setting.

This proposal has been developed as a discrete policy solution to address the lack of clarity on how the Australian infrastructure sector will reduce the carbon embedded in the vast amounts of steel, concrete and other materials required to deliver the upcoming project pipeline. This proposed reform is targeted specifically at the pre- and early-stages of a project to consider its carbon footprint in construction, rather than an asset's operational emissions, which are well established through tools like the Design/ As-Built IS Rating Scheme.

This proposal arises out of the rigorous analysis undertaken in Infrastructure Partnerships Australia's report, *Decarbonising Infrastructure*, and is intended to be read in conjunction with that wider body of work.

BACKGROUND

> Governments need to determine the assets they want to buy (being lower-carbon infrastructure), in line with their macro commitments (net zero emissions by 2050), and set these as clear outcomes sought in procurement processes, letting the private sector compete for this lower-carbon work.
>
> – Infrastructure Partnerships Australia, *Decarbonising Infrastructure*

In April 2022, Infrastructure Partnerships Australia released *Decarbonising Infrastructure,* a report setting out a pragmatic agenda for Australia's governments and industry to drive emissions reductions across all forms of infrastructure, including a set of recommended actions. All Australian states and territories have already committed to net zero carbon emissions by 2050. Most recently, the Federal Government introduced a Bill into Parliament proposing to legislate a 43 per cent reduction in net greenhouse gas emissions from 2005 levels by 2030, and net zero emissions by 2050.[1]

While many of the changes required to decarbonise will be complex, the policy direction and vision required to make them happen are not, and they can build on commitments and actions already taken by industry and governments.

Investors are increasingly looking beyond financial and economic value in assets to understand their ESG credentials, with carbon profiles and scope for decarbonisation as key considerations. This includes a sharpened focus on the underlying credentials of assets and an increased focus on whole-of-life outcomes, including end-to-end decarbonisation. A burgeoning pool of capital is available for projects with strong ESG credentials as investors look to adjust their portfolios in response to net zero policies and mitigate their climate risk profile. Nevertheless, investors still face challenges in this space – by the time a brownfield asset is transacted, the opportunity to account for the carbon embedded during its construction has usually long disappeared.

Through Infrastructure Partnerships Australia's engagement on this report, a critical issue emerged. The pathway to reduce the carbon embedded in the vast amounts of steel, concrete and other materials required to deliver the infrastructure pipeline is unclear. Both the scale of this issue and who bears accountability are also remarkably unclear. Without reform, the benefits of the coming wave of infrastructure construction could be undermined by the significant economic and environmental costs of unnecessary embedded carbon.

[1] *Climate Change Bill 2022* (Cth).

POSITION STATEMENT ON EMBEDDED CARBON

The scope of emissions-related challenges in infrastructure has expanded rapidly over recent years, to a moment now where the carbon embedded within assets is in stark focus as an area for action. There has been some progress – largely industry-driven – through developments such as green concrete, recycled waste in construction materials, and pre-fabricated construction. But, up until now, embedded emissions across construction, operation, and waste have generally been a second order issue in dialogue on decarbonising the sector. As Australia's energy and transport decarbonise, embedded carbon in construction will become a proportionally larger contributor to our overall emissions, bringing the need to act early into plain view.

While Australia's official carbon emission reporting does not account for construction emissions in its own standalone category, it is estimated that Australia's construction industry generates 30 to 50 million tonnes of carbon every year.[2] Asset operation emissions are typically accounted for under transport and energy, without considering how infrastructure assets are designed – or the potential Scope Three emissions generated during an asset's life. Changes to how existing assets are operated or priced to account for this can bring significant reductions in emissions.

Governments have a critical role to play as the planners, funders, procurers, regulators, owners, and operators of a significant proportion of Australia's infrastructure. For procurement, public agencies should stipulate clear outcomes sought from bidders in procurement, including requirements for lower-carbon methods, materials or whole-of-life efficiency. It is critical that strategic planning and procuring agencies look beyond lowest cost to select the bidder proposing the highest value – with sustainability and decarbonisation attributes forming a key part of that value.

In industry, many major constructors and technical advisors are regularly exposed to global markets and overseas practices, providing opportunities for innovation at scale through identifying, advocating for, and implementing lower-carbon initiatives in Australia that have proven successful in other parts of the world.

Overseas development of an Infrastructure Carbon Management Standard

The challenge of managing carbon in infrastructure has been in focus in the United Kingdom for over a decade. Following the publication of the Government of the United Kingdom's *Infrastructure Carbon Review* in 2013, *Publicly Available Specification (PAS) 2080: Carbon Management in Infrastructure* was developed by industry experts engaged by the British Standards Institute.

PAS 2080:2016 was released in 2016, and among other things, covers carbon management and consistency in the use of data, quantification, benchmarking, and target-setting, as well as value chain carbon, and whole life cost reductions through whole life carbon reduction.

To date, much of the policy and regulatory focus for reducing construction emissions has centred on improving the energy efficiency of buildings and other built assets. This has relied on the mandatory minimal obligatory requirements for energy efficiency set out in the National Construction Code, alongside voluntary measures such as the National Australian Built Environment Rating System (NABERS) and Green Star. While these requirements are a good start to reducing emissions, more can be done to advance policy and regulatory frameworks to address embedded emissions from construction materials and supply chains.

A number of barriers have stymied progress on low- to zero-carbon innovation in construction. Cost has been a primary concern, with a focus on price efficiency often leaving little room for innovative solutions. However, this concern is diminishing as new products emerge that are both cheaper and more efficient than conventional materials.

Additionally, data on carbon emissions from infrastructure assets lacks granularity, regularity, and reliability – especially given that Scope Three emissions are missing from some industry reporting standards.

[2] Property Council of Australia, 2021, *Why embodied carbon is the next frontier.*

PROPOSED REFORM

Infrastructure Partnerships Australia proposes the introduction of a carbon base case for infrastructure projects and programs over $100 million in capital cost. In the initial planning phase of a proposed infrastructure asset, strategic planning and procuring agencies would be required to develop a carbon base case in the project's business case. This carbon base case would be an estimate of the carbon that would be embedded in the infrastructure asset during its construction, based on data from previous projects of a similar type and scale, and knowledge from the business case about the project's build characteristics.

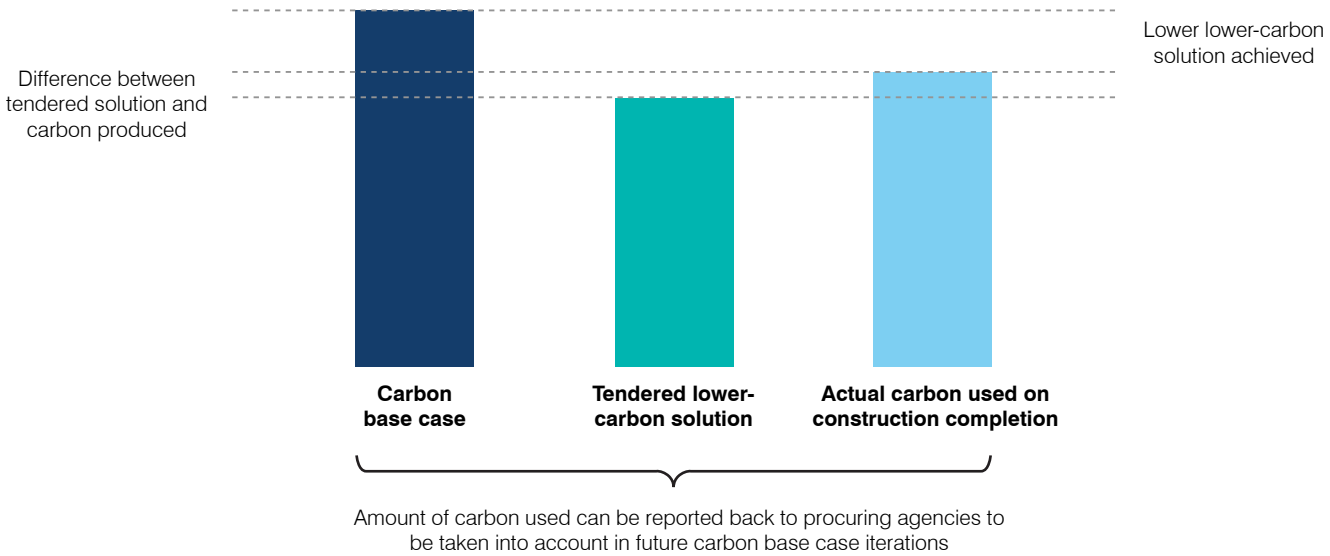
This proposed reform is targeted specifically at the pre- and early-stages of a project to consider its carbon footprint in construction, rather than an asset's operational emissions. A key issue identified in the development of Infrastructure Partnerships Australia's *Decarbonising Infrastructure* report was that for the most part, the majority of the carbon embedded into a project during its construction, has been determined during the early planning and design phases of the project – before it becomes shovel ready.

In a Minimum Viable Product (MVP) form, a carbon base case could be built through simple metrics like estimated volume of concrete, aggregate and steel – and thus carbon – to be used in construction, based on other asset characteristics and parameters set out in the business case. Once tested and implemented, the carbon base case could be periodically refined over time, as assessing embedded carbon on major infrastructure projects becomes more sophisticated. Simply put, government agencies will be able to utilise the carbon 'base case' dataset built up over time to inform future work.

As a prospective project reaches procurement, tenderers could – at governments discretion – be asked to bid a lower carbon option than the carbon base case put forward in the business case. Procuring agencies could then take embedded carbon into account in the assessment of bids, alongside the traditional metrics of time, quality and cost. Project planning and procurement stages will, of course, introduce further complexities as a project progresses through detailed design, or becomes subject to a significant variation. However, this is not a reason for inaction – in the same way that variations for cost and scope are treated, the carbon base case should be too.

Following construction completion, the amount of carbon used, measured by the same metrics used to calculate the base case, is reported back to the strategic planning and procuring agencies, as well as other embedded carbon factors accounted for in the project. This reporting should then feed into strategic planning agencies carbon base case iterations, targeting a reduction in the carbon base case on similar projects over time. See Figure 1 for illustrative purposes for the possible lower-carbon solution that could be achieved in a procurement scenario.

Figure 1: Illustrative scenario of a carbon base case being used in the procurement and construction of a project



Case Study:
Swedish Transport Administration Carbon Requirements[3]

The Swedish Transport Authority (STA) is a Swedish government agency, responsible for planning, building and operating state roads and railways. In 2016, the STA introduced a similar policy reform to the one proposed by Infrastructure Partnerships Australia, utilising carbon reduction requirements in the procurement of STA's infrastructure projects. STA requires consultants and contractors working on projects with a budget of five million Euro or more, to use an official carbon calculation tool, Klimatkalkyl, which can be used to calculate the 'carbon baseline' in the planning or design phase of a project.

The carbon reduction requirements apply to design and build contracts with a value of five million Euro or more, and the reduction is based on the estimated operational start date as follows:

- projects with an estimated operation start date between 2020 and 2024 must achieve a 15 per cent carbon reduction compared to baseline,
- projects with an estimated operation start date between 2025 and 2029 must achieve a 30 per cent carbon reduction compared to baseline, and
- the baseline must be verified by a carbon declaration based on Klimatkalkyl by end of the project, and certified Environmental Product Declarations (based on applicable standards) required for cement/concrete, reinforcement steel and construction steel.

[3] Anna Kadefors, Stefan Uppenberg, Johanna Alkan Olsson, Daniel Balian and Sofia Lingegård, 2019, *Procurement Requirements for Carbon Reduction in Infrastructure Construction Projects - An International Case Study.*

PROPOSED MECHANISM FOR REFORM

States and territories – through their strategic planning and procuring agencies – are best placed to drive this reform, and be responsible for tracking and reporting on data. However, there is a strong case for the Federal Government to make infrastructure funding contingent on adherence to this model – being the inclusion of a carbon base case in project business cases. This goes beyond governments procuring lower-carbon infrastructure, it is also an opportunity for governments to use this policy reform as a lever to 'buy innovation' in design and construction processes and materials. It also provides an imperative for design efficiency – a significant benefit in the face of growing supply constraints and substantive cost escalations.

Common standards and guidelines for calculating a carbon base case will make this reform a long-term success. Whether in an MVP project drawing on simple concrete and steel metrics, or a more sophisticated base case, there are already many operational tools and technology solutions developed by industry experts – both in Australia and overseas – that define, measure, and estimate carbon inclusion. Governments can, and should, take a coordinated approach to investigating and agreeing consistent standards and tools for implementing the carbon base case methodology – as seen with the STA's Klimatkalkyl carbon calculation tool – and can build on existing work such as the standards set out in PAS 2080 or the IS Rating Scheme. However, establishing a common standard should not delay implementing carbon base cases in project planning.

Infrastructure Partnerships Australia would be happy to leverage the dataset held through the Australia and New Zealand Infrastructure Pipeline (ANZIP) to develop some initial expectations around the potential for decarbonisation across the breadth of the pipeline and contribute to sector-wide analysis of infrastructure's carbon footprint.

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