PAS 2080 – carbon reduction in Queensland infrastructure

Roads Australia Fellowship Group Project 2022

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Executive Summary

The various State groups of the Roads Australia Fellowship program of 2022 were set the task of exploring the topic: *How are transport infrastructure sectors evolving to meet climate change challenges?* During the development of our Project within a broad topic such as this the below points were considered:

- Government commitments (domestic and global, such as the Climate Change Bill 2022 and The Paris Agreement)
- Major publications from industry recognised bodies including Publicly Available Specification (PAS) 2080 Carbon Management in Infrastructure and ISC standards
- Specific procurement methods locally within the Department of Transport and Main Roads and the future pipeline of works leading to the 2032 Brisbane Olympics
- Optimum stages of a project to impose positive, cost effective solutions to meet climate change challenges
- Measurement tools needed to quantify relative carbon reductions

It was identified that potential recommendations could be proposed to the Queensland Department of Transport and Main Roads (TMR) focussing on sub-$100M procurement programs, where Infrastructure Sustainability Council (ISC) policy does not apply. Currently, sub-$100M projects rely mostly upon specification changes and non-price criteria to produce outcomes beneficial to reducing carbon emissions, noting ISC is only now starting to consider a category for projects in the sub-$100M segment. The development of this proposal required consideration of public expectations in regards value for money and align with current procurement practises to be relevant.

Significant change is required to further evolve to higher standards for infrastructure delivery as Carbon dioxide (CO_2) emissions are a major contributor to climate change. Worldwide, some 70% of CO_2 emissions are linked to infrastructure [10]. In Australia, 70% of all greenhouse gas emissions (which includes CO_2) are attributable to or influenced by infrastructure. This is weighted to approximately 15% for the construction of infrastructure and 55% to the operations and activities it enables [11].

In 2020, the transport sector was estimated to be responsible for 18.3% of Australia's emissions. The total volume by weight of CO_2 emissions is expected to continue to increase over the coming years through to 2030 [6].

As a significant contributor to CO_2 emissions, the infrastructure sector holds the promise of major reform to drive decarbonisation and achieve Australia's domestic and international commitments to combat climate change. The removal or significant reduction of carbon from the infrastructure sector requires a whole-of-lifecycle approach, shifting focus to the planning stage to consider how infrastructure is planned, procured**,** delivered and retired.

Team Queensland believes that a key instrument for change lies in supportive procurement methodologies that provide contractors with non-price criteria for measuring and demonstrating the return on investment (ROI) and expenditure required to deliver climate benefits in sub-$100M projects. TMR issued the Proposed Major Works to Competitive Tender Report (1 July 2022 to 30 June 2023) that included 70 projects are under $100M to a value of

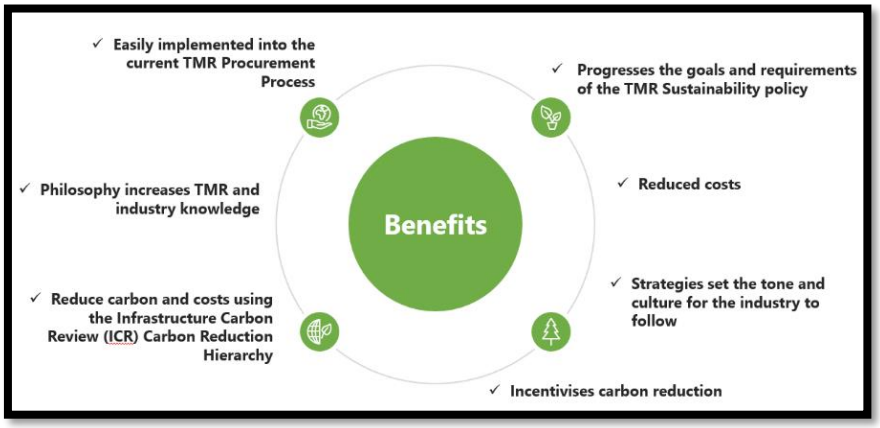
$771.6M. Locally these seemingly small projects add up to a world of difference with sub-$100M projects representing approximately 33% (by value) and 97% by quantum of all infrastructure projects in Queensland by TMR. These projects are undertaken without any consistent direct focus, incentive, or policy in regard to climate change. The large quantum of projects are geographically spread throughout the state which has the potential to positively impact large portions of the population, not just major project proponents.

The greatest opportunity to decarbonise is in the planning phase of an infrastructure project [6]. Meeting our commitments requires a sharp focus on policy, investment, and incentive, driving the planning stage to extract the greatest potential for emission reduction. Innovative thinking, a whole-of-life vision and collaboration are the cornerstones of this approach.

During discussions with Team Queensland's project partner Jacobs Australia, we had the opportunity to discuss the quantification and management of carbon in infrastructure with leading Jacobs experts from the United Kingdom (UK) and United Arab Emirates (UAE). In recent years both these regions have made significant progress, particularly within the public infrastructure sector, in the abatement and reduction of emissions through delivery mechanisms and quantification.

Arising from these discussions and noting that emissions are not adequately considered in Australia when deciding what infrastructure is built [26], we selected the UK and UAE delivery framework, PAS2080, to further examine how carbon can be reduced within the TMR procurement process.

Currently within the UK, UAE and New Zealand, government organisations and infrastructure owners/operators are implementing PAS 2080: Carbon Management in Infrastructure as the best international standard for this purpose. PAS 2080 represents best practice in carbon management in infrastructure and outlines the participants' roles and responsibilities, including leadership for whole-of-life carbon management in infrastructure projects.



Team Queensland recommends augmentation of TMR procurement methods to adopt PAS 2080 within the current TMR Project Assessment Framework, starting with the sub-$100M projects because the aggregated impact of these projects is significant. Feedback from DTMR has been received positively.

Targeting *construct only* provides the opportunity to maximise efficiency and carbon savings operationally through design. PAS 2080 mandates that each phase, from concept through to operations, considers carbon reduction as a key performance indicator (KPI) – no different from cost and program.

Contents

Acronyms

Name	Acronym
Department of Transport and Main Roads	DTMR
Infrastructure Sustainability Council	ISC
Publicly Available Specification 2080	PAS 2080
Environmental, social and governance	ESG
United Kingdom	UK
United Arab Emirates	UAE
Transport Infrastructure Project Delivery System	TIPDS
Queensland Procurement Policy	QPP
Queensland Indigenous (Aboriginal and Tores Strait Islander) Procurement Policy	QIPP
Reclaimed asphalt pavement	RAP
Bill of Quantities	BOQ
Instrumentation Control and Automation	ICA
Key performance indicators	KPI
Greenhouse gases	GHG
Business as usual	BAU
High Speed Rail 2	HS2
Department of Planning, Transport and Infrastructure	DPTI
Marginal Abatement Cost Curves	MACC
Life Cycle Assessment	LCA
Rail Safety and Standards Board	RSSB
Supply Chain. Sustainability Victoria	SV
Major Roads Project Victoria	MRPV
Design and construct	D&C
Major transport Infrastructure Authority	MTIA
Strategic Assessment of Service Requirements	SASR
Project Cost and Estimating Manual	PCEM
Queensland Transport and Roads Investment Program	QTRIP
Infrastructure Carbon Review	ICR

Introduction

Demonstrating a commitment to environmental sustainability is a core aspect of maintaining a company or organisations social licence to operate. As the community becomes more alert to the everyday impacts of climate change, it is imperative that our industry shows how it is delivering transport infrastructure that actively contributes to better environmental outcomes. Aligning businesses and workforces to this objective is fundamental to unlocking the opportunities that will be offered by a decarbonised economy and industry.

The 2022 Roads Australia Fellowship Program was assigned the topic *"How are transport infrastructure sectors evolving to meet climate change challenges?"*. Each of the geographically based teams was able to determine its own approach and work collaboratively with an established business to develop its proposal.

The Team Queensland chose to review the procurement and delivery models used by the public sector to influence positive outcomes in the Transport Infrastructure Lifecycle, and the availability of measurement tools to quantify relative carbon reductions.

A considered design and procurement model can significantly influence a project's ultimate contribution to climate change. The team worked with Jacobs Australia's environmental and sustainability team to understand the current and potential role of industry in influencing these outcomes – particularly in the early phases of project development, from business case studies, concept designs and into detailed design and delivery. A variety of clients and models were evaluated.

It was vital for our team to review traditional contract models and historic projects to identify the roadblocks to achieving better outcomes. The key insight into early project development we have gained has enabled us to observe how the industry as a whole has performed in its climate change obligations and to propose measures that will promote significant industry-wide improvement.

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Team Queensland

Considering this recent research and our Queensland team members' involvement in the local infrastructure market, it was identified that potential recommendations be proposed to the TMR. We believe this to be especially timely, given the Queensland Government's recent announcement of a four-year, $29.7 billion roads and transport investment [16] and the opportunity it presents to significantly change the way in which transport infrastructure meets – and is seen to be meeting – climate change challenges.

Purpose and objectives

The purpose of this paper is to examine a topic that is of high interest to and aligns with Roads Australia's policy priorities. The fellowship program is an opportunity to network, collaborate with peers and work on an industry paper such as this, that has potential to influence industry.

By exploring where the transport infrastructure sector is now and highlighting the challenges and industry best practice both within Australia and Internationally, we aim to identify key recommendations that can assist the industry in overcoming these challenges over the next three decades and helping Australia to reach Net Zero CO_2 emissions and curb climate change.

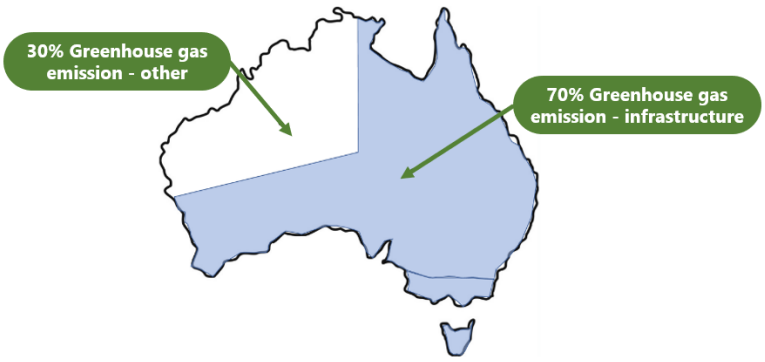
This paper aims to provide recommendations to TMR, acknowledging the transport infrastructure industry's traditionally poor performance in respect to the inclusion of climate change measures in procurement and contract conditions. In particular, the paper focuses on projects valued at below $100M, which has been identified for making a considerable impact.

Our objectives are to:

1. Examine and articulate the current status of the transport infrastructure industry
2. Provide real world examples about innovation and best practice in carbon reduction
3. Provide recommendations to Roads Australia and TMR.

Background

Approximately 70% of carbon dioxide emissions worldwide are linked to infrastructure [10]. In Australia it is estimated that the construction and operation of infrastructure for transport, energy, water, waste and communications directly contributes to 15% of the nation's annual emissions, with these assets influencing a further 55% of annual emissions through the activities they enable (predominantly transport and energy infrastructure [11]).



Australia's National Greenhouse Gas Inventory estimates that the transport sector contributed 18.3% of Australia's emissions in 2020 (94 Mt CO_2e). This is projected to increase to 100 Mt CO_2e by 2030 [4][5][6].

Australia is committed to Net Zero CO_2 emissions by 2050 [7] under The Paris Agreement [9]. Recently the Federal Government introduced the Climate Change Bill 2022, which proposes to legislate a 43% reduction in Greenhouse Gas Emissions between 2005 baseline and 2030, ultimately achieving Net Zero emissions by 2050 [8].

> *"Smart and sustainable procurement choices can enable significant emissions reductions across the transport industry. Planning for lower emissions at the beginning of projects provides the greatest potential for decreasing emissions at every stage of the lifecycle of the asset."*
>
> Journey to Net 0, (PMG, RA, ARA, ARUP, ISC) [6]

As a highly visible contributor to climate change, the infrastructure sector requires wholesale reform to drive decarbonisation and achieve Australia's commitments.

The removal or significant reduction of CO_2 from the infrastructure sector requires a complete lifecycle approach. Focus on emissions reduction needs to commence at the planning stage, with whole-of-life thinking shaping the way infrastructure is planned, procured and delivered. Team Queensland believes that introducing procurement and delivery methodologies that support designer and contractors in delivering climate benefits – a practice currently absent in sub-$100M projects – will yield results that are effective and inspiring to the greater industry.

Combined cement and steel make up 14% of Global Carbon Emissions. A low carbon future depends heavily on how we manage these two critical materials.

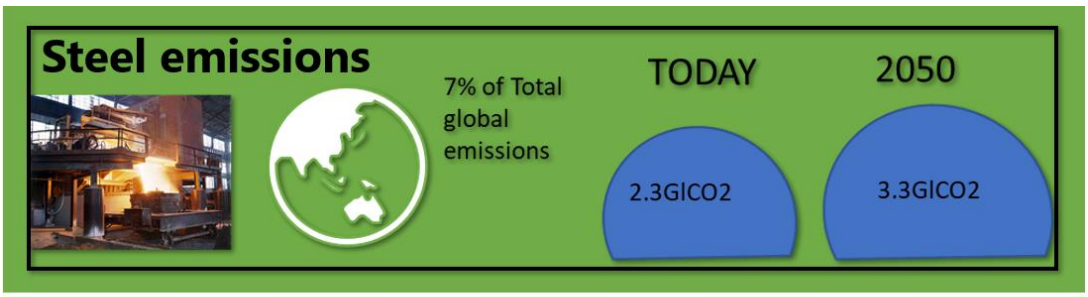
Energy Transitions Commission

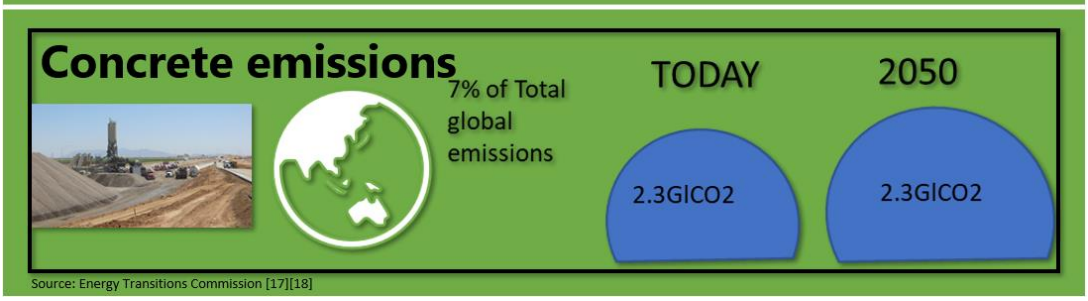
Where to start?

Early planning can maximise the benefits of adopting circular economy and whole-of-life principles. Optimising design and material selections is critical to reducing emissions and this is especially evident in high CO_2-emissions materials such as steel and concrete [6].

These two materials are estimated to contribute respectively 7% and 8% of global emissions [11][17][18] and represent a much higher proportion in the infrastructure sector. Thus, significant reductions in emissions can be attained through the judicious elimination, reduction, reuse, recycling, or substitution of these materials with alternative, lower carbon versions [17][18].

Concrete and steel are said to contribute respectively 7% and 8% of global emissions

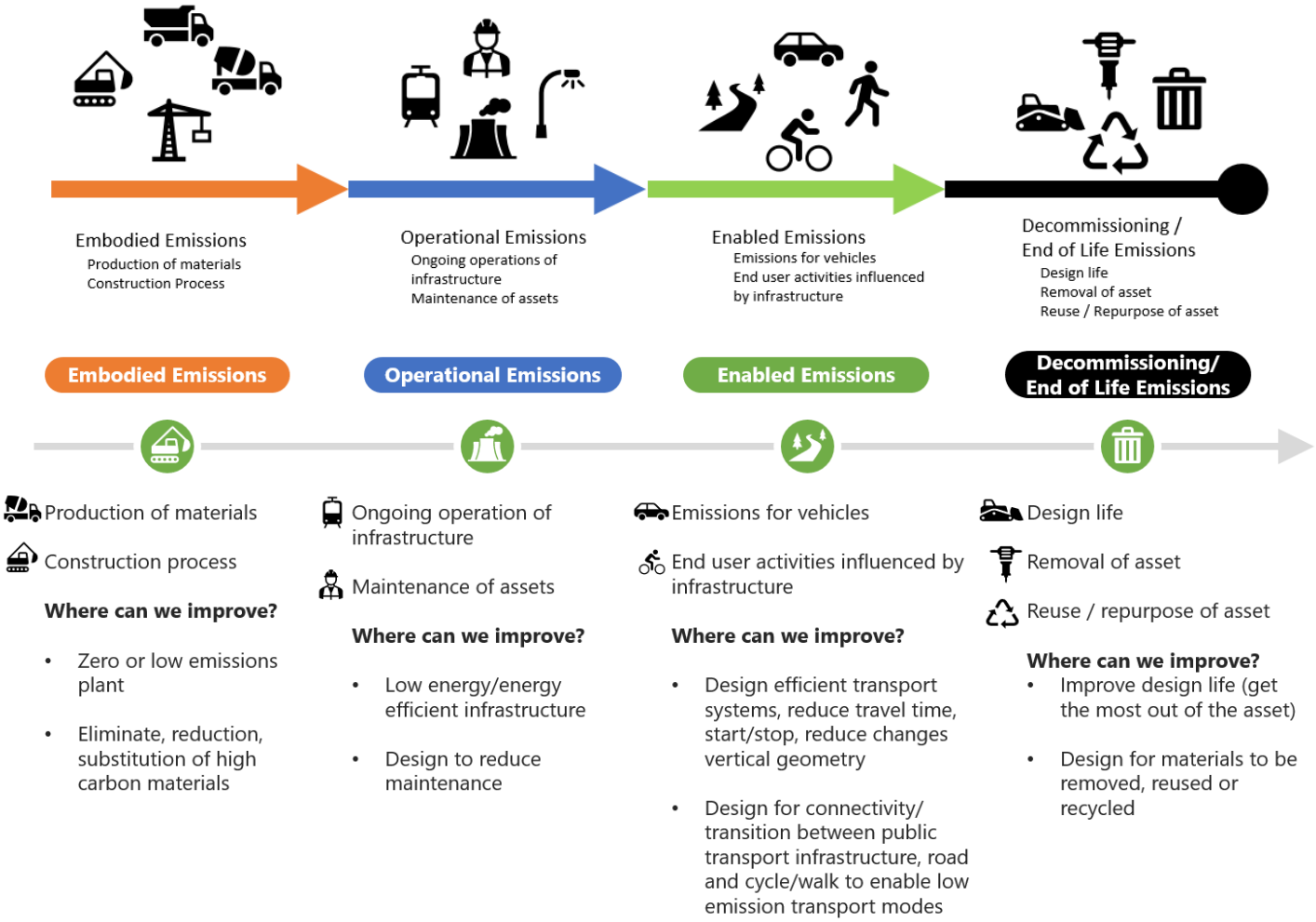




Source: Energy Transitions Commission [17][18]

Sources of emissions in the transport infrastructure sector

Within the transport infrastructure sector, emissions sources can generally be divided into four categories [11], as illustrated below.



The greatest opportunity to decarbonise each of these emission categories is in the planning phase [6] of an infrastructure project. Key focus areas are required to deliver on our government commitments, specifically within policy, investment and incentivisation, optimising the planning stage to extract the greatest potential for emission reduction, circular and whole-of-life thinking and collaboration.

Governments needs to be at the forefront of decarbonisation and driving climate change action, beyond simply committing to Net Zero to date, they have provided minimal direction, leaving industry to drive the change. Globally, the private sectors are starting to shift focus on climate change action which includes:

- Investors are trending towards Environmental, Social and Governance (ESG) credentials and acknowledging the economic value of increasing focus on whole-of-life outcomes [13].
- Designers are driving innovation globally and domestically through internal Net Zero policies, carbon lifecycle considerations, carbon calculators and materials and waste minimisation.

- Contractors are rolling out Net Zero polices, investing in renewable energy and electric vehicle fleets and plant, driving waste reduction and adopting circular economy philosophies.

Leading the way

Infrastructure Partnerships Australia's paper *Decarbonising Construction* identifies the States and Territories are best placed to drive reform though their established strategic planning and procurement agencies, such as the Queensland Governments' Department of Transport and Main Roads. The paper notes the strong case for the Federal Governments to drive change through funding contingent on decarbonisation strategies and delivery models. [13]

Currently within Australia and Queensland, although both government and industry are committing at an increasing rate to Net Zero by 2050, there are no clear mechanisms to take the next step and convert all the good intent, ideas and innovation into real action. The current policy lacks certainty on who is accountable and when, and there is an absence of a framework for how to collaborate.

Australia is behind the global curve of significant reform, innovation and positive carbon outcomes being delivered through collaboration between governments and industry. However, across the industry the argument is growing for the introduction or reform of policy, strategic investment and incentivisation, along with clear governance structures, process and collaboration [6].

Fortunately we are not starting from a blank slate: best practice and innovations in pursuit of Net Zero are already underway, with the following case studies identifying positive steps being taken by industry and governments globally. One such process is PAS 2080, the international best practice for carbon management in infrastructure, is examined in depth in this paper.

To manage the climate change impact of infrastructure projects and meet or exceed targets, governments will need to adapt full-lifecycle carbon management. Team Queensland has focused on procurement processes and worked with Jacobs Australia based on their global experience in design and delivery. Jacobs currently works international in influencing procurement frameworks to determine how to effectively design, specify, assess and measure full-lifecycle carbon emissions, to make better choices for climate change outcomes.

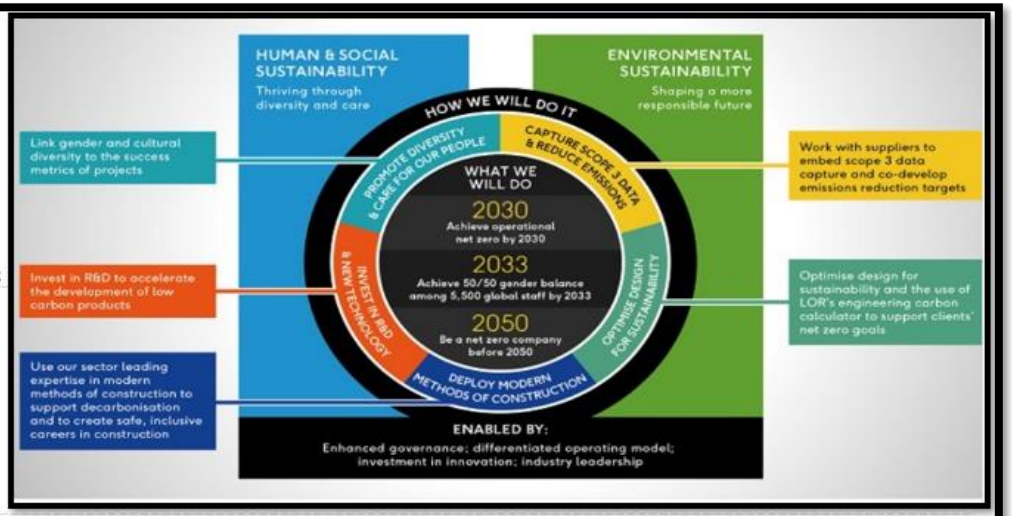
"Governments have a critical role to play as the planners, funders, procures, regulators, owners, and operators of a significant portion of Australia's infrastructure."

Decarbonising Infrastructure, Infrastructure Partnerships Australia

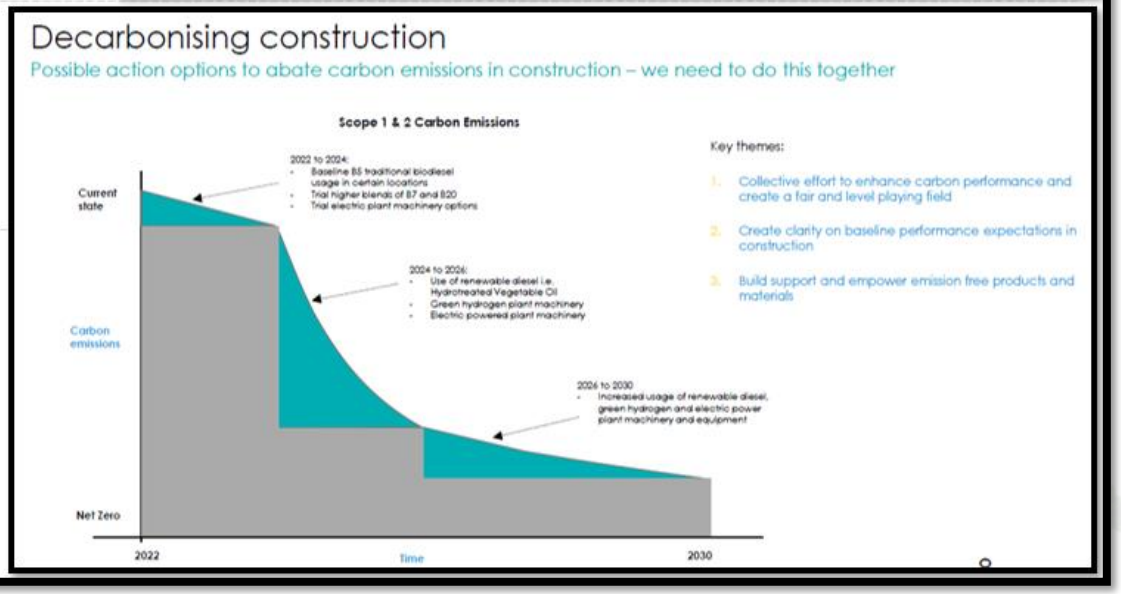
Below are three case studies showing examples of what industry is doing to align with current federal Net Zero targets.

Case Study 1: Laing O'Rourke's Sustainability Targets

An example of the private sector led transformation addressing climate change challenges is the investment in strategy and procurement of carbon reducing methods of construction. The targets set below highlights the industry's willingness to change the way things are done and invest without the certainty of client directions. The Sustainability target focuses key components on climate change along with social and economic benefits.



This plan was set off research of what is possible, not comfortable and provides a target for the team to deliver on. The decarbonisation process needed to align with the available technologies, hence a considered path has been mapped as below. Note this is an interpretation of potential scope targets from internal Subject Matter Experts.



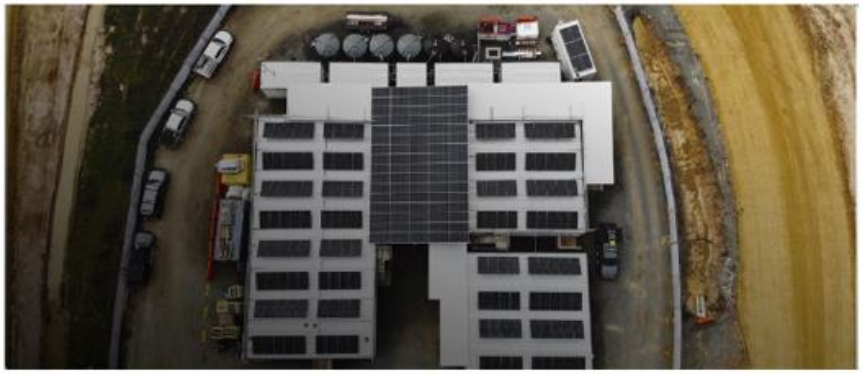
Case Study 1: Laing O'Rourke's Sustainability Targets

Laing O'Rourke has a clear purpose and targets around decarbonisation with a potential forward focus with the targets being embedded into our internal procurement process along with the selection of clients they wish to work with.

Within Scope 1 and 2, a focus on plant and fuel for direct construction work along with how we power our offices and material reuse is currently underway. The business has invested significantly in electric and hybrid items with the below an indication across Australia and the UK.

Australia		UK
• 1no. electric light vehicle • 24no. hybrid light vehicles • 1 no. electric heavy vehicle [+3 on order due March 2023] • 110no. non-diesel lighting solutions - solar and/or battery powered • 28no. solar powered w/ battery VMS boards • 2no. hybrid excavators • 2no. battery energy storage systems to suit site compound (currently on hire to Melconnx Whiteman Park & MRPV Kilmany) • 1no. modular solar array (currently on hire to Melconnx Whiteman Park) • 1no. solar pergola (currently on hire to MRPV Kilmany)	• 16no. solar powered modular complexed site offices (currently on hire to MRPV Kilmany) • 2no. 250T electric crawler cranes [due May 2023] • 10no. 2.5T electric telehandlers [due early 2023] • 10no. solar powered self-contained site offices [in negotiation with preferred supplier] • 10no. battery energy storage systems to suit site compound [under consideration] • Approved compatibility of diesel powered assets with B5 biodiesel blend and up to B20 on request	• 1no. electric piling rig • 16no. 1.8T electric pallet trucks • 30no. crawler cranes Stage 5 engine 60T – 220T • 4no. electric crawler cranes 160T – 250T • 20no. Punch Flybrid – power efficiency accessory for tower cranes • 6no. battery energy storage systems to suit tower cranes and hoists [scheduled for evaluation November 2022] • 119no. electric scissor and vertical mast lifts • 22no. electric tower crane hoist lift • 188no. electric tower cranes

Case Study 2: 100% renewable energy off-grid site compound



SUSTAINABILITY

Friday 22 April was Earth Day, a day that has been honoured annually since 1970 with the aim of educating and activating the worlds populations to drive positive actions for our planet. This year's theme is to Invest in Our Planet. All in - as time is short.

Change is required on both an individual level and a collective front from business and governments. The IPCC has also released its most recent climate change mitigation report, which clearly states we are not on track to limit global warming to the 1.5 or 2 degrees Paris Agreement targets. This means that reduction of carbon and other emissions needs to occur more urgently than ever before to prevent irreparable damage to our planet.

Laing O'Rourke's Global Sustainability targets align with the Paris Agreement targets and this latest IPCC Report as we commit to achieving net zero scope 1 and 2 operational emissions by no later than 2030, and achieving net zero scope 3 operational emissions by no later than 2050. A snapshot of our sustainability achievements across our projects to date can be seen here.

A great example of a project pushing the low carbon pathway and bringing our sustainability strategy to life is MRPV Princess Highway East – Kilmany where the Select team has installed a 100% renewable energy off-grid site compound. This renewable power solution - the first of its kind in Australia - was energised in mid-March to power the off-grid compound and avoid the emissions from a diesel fuel generator. Over the final three weeks of March, Select estimates that the renewable power solution reduced CO_2 emissions by 13,000 kg when compared to a diesel-powered generation or 6,300 kg compared with the main grid connection.

The team has also implemented a number of sustainable measures including:
Energy and water-efficient products across the offices, crib rooms and ablution blocks

- Rainwater harvesting
- Recycled furniture; and
- Sensors and energy metering for continuous refinement of the project's energy requirements.

Select continues to heavily invest in their capability to deliver environmentally sustainable solutions across their plant and equipment, fleet and site solutions portfolios, so reach out to the team to see how your project can implement some of these smart and sustainable solutions.

Case Study 3: Pacific Motorway M1 Varsity Lakes to Tugun upgrade

Queensland Department of Transport and Main Roads (TMR), QLD
Certified IS Design Rating – Leading, Registered As Built

The Pacific Motorway (M1) is a vital transport link between Queensland and the southern states, carrying interstate freight, tourist, and commuter traffic.

The section of motorway between Varsity Lakes (Exit 85) and Tugun (Exit 95) currently sees around 90,000 vehicles per day and is frequently congested during both weekday and weekend peak periods. Traffic demand for this section of the M1 is growing and by 2026 is expected to exceed 100,000 vehicles each day.

Now in construction, the Varsity Lakes to Tugun (VL2T) upgrade is a City-shaping project for the southern Gold Coast and forms part of the wider Pacific Motorway M1 upgrade program aimed at improving safety and reducing congestion along one of Australia's busiest highways.

This project utilised a concrete fracturing technique, known as 'rubblisation' – a process that involves cracking the existing concrete road pavement in-situ and using the material as subgrade under the new motorway. This technique removes the need for off-site disposal and recycling and allows the new pavement to be constructed on the newly rubblised layers. Sustainability benefits include reduction in waste, materials, transport, energy (less construction time) and water with lower overall carbon impacts.

This project also features the first Australian use of French manufactured EME (Enrobés à Module Elevé) – a high modulus asphalt that was developed in France in the mid-seventies. EME is predominantly used for the structural layers in asphalt. The distinctive component of EME mixes is a very hard paving grade bitumen applied at a high binder content and lower air voids content.

The main benefit of EME2 (as opposed to traditional AC20 asphalt) is that it can potentially reduce the layer thickness of the base course for heavily trafficked pavements by up to 30%, depending on climatic and traffic conditions. Therefore, a reduction could be seen in the use of virgin materials, haulage distances and associated carbon emissions. (Roads and Infrastructure Australia 2017). Furthermore, EME2 provides the opportunity for improved structural life, this means that less structural maintenance is required during the design life of the pavement.

An average of a 24% reduction in embodied carbon and greenhouse gas emissions has been achieved on the M1, and this project showcases the potential to reduce embodied carbon through multiple different methods.[177]

TMR procurement framework

As an industry working together, we are making progress, but we lack a unified and collaborative front to prioritise decarbonisation. To enact real, meaningful change, Governments need to play a more significant role, however we first we need to understand where Governments are currently positioned. The Queensland Government, through TMR, delivers key transport infrastructure and plays a major role in setting the framework and standards for the industry.

How is Queensland tackling emissions reduction?

An in-depth look at the current state government policies and strategies to tackle climate change through infrastructure show that the Queensland Government is still at a low level of maturity, having yet to take meaningful steps toward Net Zero by 2050. This is, however, definitely improving.

While TMR and the Queensland Government are tackling this complex issue with dedication, effort and commitment, the status quo has a long way to go. The commitment to the task can be shown in the *Queensland Government Zero Emission Vehicle Strategy 2022–2032* which also complements the following work in this space:

- Queensland Transport Strategy provides a 30-year strategic direction for transport to achieve on the TMR Strategic Plan.
- Queensland Climate Action Plan outlines how the state will achieve a Net Zero emissions future, describing the need to develop a Net Zero Emissions Infrastructure Plan and a Net Zero Emissions 2050 Buildings Plan.
- Queensland Hydrogen Industry Strategy will ensure that government and industry work towards a common vision for Queensland's future hydrogen industry, with specific actions in five focus areas:
    1. supporting innovation
    2. facilitating private sector investment
    3. ensuring an effective policy framework
    4. building community awareness and confidence
    5. facilitating skills development for new technology.
- Queensland Procurement Policy is the government's overarching policy for the procurement of goods and services. Procurement needs to deliver with probity and value for money to advance our economic, environmental and social objectives for the community over the long term.
- Queensland Indigenous Procurement Policy provides a whole-of-government framework to increase

Objectives

The objectives of the policy are to:

- Engage with TMR staff and stakeholders on the potential environmental impacts, opportunities and management requirements of the department's plans and activities.
- Adopt a best practice, cost-effective approach of 'avoid, minimise, mitigate and offset' to manage environmental impacts associated with all aspects of TMR's activities to achieve the benefits of this policy and comply with legislative and policy requirements.
- Monitor, review and implement TMR's environmental management system to ensure alignment with AS/NZS ISO14001 and to improve environmental performance in all of the department's plans and activities.
- Protect the environment by moving beyond compliance in encouraging innovative solutions to minimise TMR's environmental footprint and embed environmentally sustainable practices in the ways we work by:
  - maximising energy efficiency and reducing greenhouse gas emissions to work towards net zero carbon emissions
  - promoting research and adoption of innovative practices and construction methodologies to facilitate reducing, reusing and recycling resources as part of the circular economy
  - reducing the impacts of our transport operations, both directly and indirectly, on the environment
  - identifying and developing opportunities for restoration and conservation of areas of significant environmental value within the transport network
  - adopting and integrating climate change risk management and adaptation measures to ensure network resilience and sustainable business operations
  - reducing pollution in our activities
  - dealing with ship-sourced pollutant discharge in our coastal waters.
- Foster a culture of environmental sustainability and leadership within TMR by providing training and support to our people to take a whole of life, balanced and holistic perspective to drive the best money outcomes balanced with protecting the environment.
- Develop effective policy that incorporates environmentally sustainable practices.
- Collaborate with and lead our stakeholders and delivery partners, including local governments and transport operators, to:
  - improve the environmental sustainability of their organisations, products and services
  - improve the environmental sustainability of the transport network.

NScales.

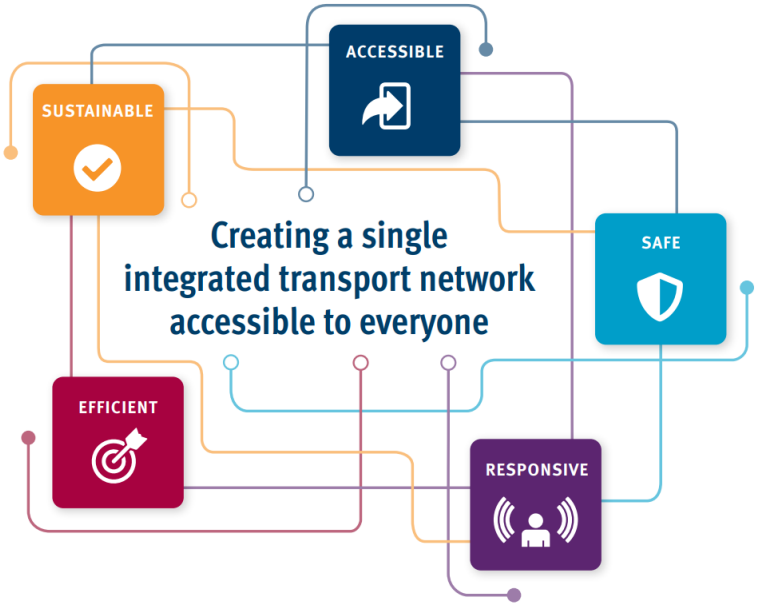
Neil Scales
Director-General
Department of Transport and Main Roads

procurement with Indigenous businesses (noting the success of this non-mandatory framework on increasing indigenous participation, especially across TMR infrastructure portfolio).

One of the core sustainability objectives within the Strategic Plan 2019-2023 [12] is to create an environmentally, economically and socially sustainable transport system that supports liveable and prosperous communities. The ways in which TMR will achieve this sustainability objective will be to support low and zero emission vehicles, prioritise sustainability suppliers and make innovative, sustainable solutions an integral part of doing business.

However, there are challenges within the current framework that make this shift difficult. The Transport Infrastructure Project Delivery System (TIPDS) aims to provide guidance for the procurement of works to those who have the responsibility for obtaining value for money in the delivery of a project. TIPDS relates to the delivery areas which are responsible for delivering a program of works and sequencing projects to achieve their efficient and effective delivery.

Volume 1 of TIPDS assists in developing project delivery strategies during the concept phase for consideration during business case development. It also mandates certain delivery strategy options for projects of various sizes. Volume 2 of TIPDS is focused on tendering for infrastructure works and contains the concepts, policies and procedures for material supply contracts within TMR. Volume 2 Appendix L outlines all the policies for TMRs infrastructure contract.



There are currently no policies specifically related to supporting the movement towards Net Zero, aside from ISC for projects greater than $100M. For State funded projects, as per Volume 2 of TIPDS the current policies are:

- Tenderers will need to comply with the Queensland Code of Practice for the Building and Construction Industry.
- Above $3M in civil construction (including GST) and $500,000 in building work (including GST), tenderers will need to comply with the Queensland Government Building and Construction Training Policy.
- Tenderers must comply with the Ethical Supplier Threshold and Ethical Supplier Mandate (refer to the Queensland Procurement Policy [QPP]). If any Tenderer is sanctioned under the Ethical Supplier Mandate, they are not eligible to tender for the projects.
- At least one regional and one Queensland supplier, where possible, who participate in the tender to comply with the QPP.
- Include local benefits test and/or best practice principles (refer to the QPP) non-price criteria where applicable.

- Where the total Queensland Government contribution is above $5.5M (including GST) for south-east Queensland or $2.75M (including GST) for regional Queensland, tenderers will need to comply with the Queensland Charter for Local Content. This contribution applies at the project level.

For major projects over $100M, ISC is already embedded, driving innovation and change through industry leaders which filters down through the supply chain and onto smaller projects.

A clear precedent

In reviewing Queensland Government policies, one success story of innovative policy changes kept coming to the forefront: the growth in Indigenous participation across all procurement category expenditure (including infrastructure). Like the journey to Net Zero, the quest for increased Indigenous participation was multi layered, complex and difficult to measure in a repeatable way. The effective implementation of the 2017 Queensland Indigenous (Aboriginal and Torres Strait Islander) Procurement Policy (QIPP) [28] relied on commitment from all Queensland Government agencies and strong governance and reporting mechanisms.

The QIPP objective in 2017 was to increase the value of Queensland Government procurement spent awarded to Indigenous businesses, to 3% of addressable spend by 2022. QIPP is making clear to the market the value of this work, and government's commitment to create employment opportunities for Aboriginal and Torres Strait Islander Queenslanders.

The QIPP supports Queensland Government agencies to better target their procurement activities to ensure Indigenous businesses can equitably access the procurement spend. The QIPP is a procurement-related policy within the broader framework provided by the QPP and is consistent with its principles, including its focus on value for money along with the achievement of environmental and social objectives. An agency-led procurement operating model ensures agencies are accountable for their own procurement activities, within a whole-of-Government framework.

One success story of innovative policy changes kept coming to the forefront: the growth in Indigenous participation across all procurement category expenditure (including infrastructure).

For TMR, this included *The Aboriginal and Torres Strait Islander Engagement in Transport and Roads Infrastructure Delivery and Maintenance Strategy*, supporting TMR to further embed Aboriginal and Torres Strait Islander engagement into transport infrastructure and maintenance programs.

The framework that is used to increase Indigenous participation in government procurement could be replicated to support Queensland's delivering on Australia's commitment to Net Zero carbon emission.

The model included having a suitably appropriate department as lead for the policy. Centrally led, locally delivered policy implementation ensures that government as a whole is aligned in the outcome (meeting Net Zero, in this case), but each agency is empowered to deliver it in a way that is appropriate for them.

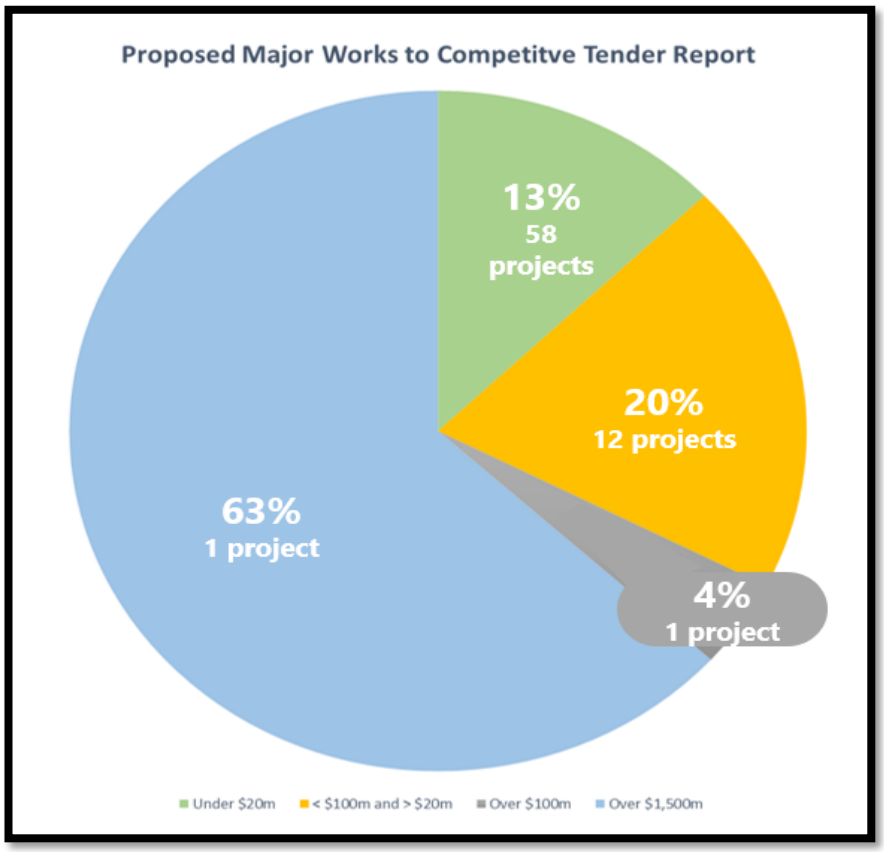
TMR Director (Pre-qualification and Contracts) Graham Hobbs confirmed that the smaller projects are generally cost driven and have no mandatory sustainability key result area (KRA) in their contracts, due to their complexity. The smaller projects are usually outside the remit of the Tier 1 and Tier 2 companies that have their own sustainability initiatives. The lower tiered companies do not currently have the ability (based on feedback from industry to TMR), nor do the existing practices of smaller firms support reducing whole of life carbon emissions.

Therefore, it is Team Queensland's view that the whole of life carbon reduction agenda should be driven and supported directly by government, through TMR's procurement strategies. Mandating targets has forced the industry to react and push beyond the policy targets, with all contractors providing robust and progressive RAPs.

Current project landscape

TMR has recently issued the *Proposed Major Works to Competitive Tender Report* (1 July 2022 to 30 June 2023). The graph below outlines a total of 72 projects worth $2.371 billion:

- 70 projects are under $100M, to a value of $771.6M (orange)
- 1 project @ $100M (grey)
- 1 project @ $1,500M (blue)
- 58 projects under $20M to a value of $304.8M (green).



Projects under $100M represents approximately 33% of value – but about 97% of total projects, which are being delivered without a focus, incentive or any targeted policy to actively drive climate change reduction.

There is nil consideration for ISC among these projects (due to its typical defining lower limit being $100M) and nil policy or incentive around climate change for the infrastructure industry (especially under the $100M limit).

Procurement Policy states that projects under $20M do not warrant or consider non-price criteria. This equates to 13% by value and more than 80% by quantum of the planned infrastructure projects between 1 July 2022 to 30 June 2023.

For the current 2022-23 to 2025-26 there is a total of 112 projects listed within the current that are over $20M and under $100M. These projects have a total value of more than $4.5 billion [30].

A global perspective where best practice in carbon management is making a real difference

During discussions with Team Queensland's project partner Jacobs Australia, we had the opportunity to discuss the quantification and management of carbon in infrastructure with leading Jacobs experts from the United Kingdom (UK) and United Arab Emirates (UAE). In recent years both these regions have made significant progress, particularly within the public infrastructure sector, in the abatement and reduction of emissions through delivery mechanisms and quantification.

In these two nations and in New Zealand, government organisations and infrastructure owner/operators are implementing PAS 2080 as the best practice international standard for carbon management in infrastructure. PAS 2080 outlines the participants' roles, responsibilities and leadership for whole-of-life carbon management.

PAS 2080 makes use of the ICR's Carbon Reduction Hierarchy throughout the delivery process to guide Owners, Designer and Contractor's through a strategic culturally led carbon reduction process.

PAS 2080: 2016 – Standard for international best practice for carbon management in infrastructure

In 2013, the UK Government's Infrastructure Carbon Review identified that more than 50% of the UK's emissions were attributable to infrastructure. As a result, PAS 2080 was developed to address carbon management specifically within infrastructure. The PAS 2080 standard was developed by a steering committee comprised of many industry participants including Mott Macdonald and ARUP and was facilitated by BSI Group (the British Standards Institution). Projects and asset owners in the UK and UAE are currently implementing the PAS 2080 standard in infrastructure. The basis for the standard – which was fast-tracked into publication in 2016 – was to achieve a 75% whole-of-life carbon reduction in projects, to meet the targets stipulated in the 2008 Climate Change Act [25].

The findings of the UK's Infrastructure Carbon Review make clear that reducing carbon is synonymous with reducing costs. Therefore, reducing the carbon footprint of an infrastructure project brings material, energy and labour efficiencies that reduce capital and operational costs, resulting in savings from design to decommissioning. PAS 2080 outlines a staged process of project delivery, with a targeted approach to carbon management whereby each stage builds on the one prior, taking on the global target strategy and goal set by the project/portfolio at its inception. The major outcomes of the PAS 2080 are:

- Reduced carbon, equating to reduced infrastructure costs
- Promotion of innovation through collaboration, delivering benefits to society and communities serviced by economic infrastructure
- Effective carbon management in infrastructure, making an important contribution to tackling climate change and leaving a positive legacy for future generations

- Delivering more sustainable solutions, at a lower cost, enhancing the reputation of the infrastructure industry, attracting new people and skills and generating pride for those who work in it.

In outlining the roles and responsibilities for managing the whole-of-lifecycle approach on projects, PAS 2080 allows for the cross-over of roles (i.e. the owner or the contractor being responsible for design) and identifies the key stages of project delivery and when to quantify carbon. PAS 2080 is a process and leadership driven standard, compared to the ISC model which focuses more on intervention points along delivery process. Unlike ISC, PAS 2080 is specifically focused on carbon and greenhouse gas emissions, rather than wider environmental or sustainability issues.

Where the ICR established the case for reducing carbon and reducing cost in infrastructure, PAS 2080 provides the practical guidance to make it a reality.

Mark Enzer, Water sector lead, Mott Macdonald and member of Green Construction Board, Infrastructure Working Group, UK, PAS 2080 Guidance document.

As part of the carbon management process, PAS 2080 clearly outlines different requirements and responsibilities for each of the delivery proponents (owner, designer, contractor and product/material supplier) in the following principles:

- Leadership and governance
- Requirements of all value chain members
- Carbon emissions reduction hierarchy
- Quantification of greenhouse gas (GHG) emissions
- Target setting, baselines and monitoring
- Reporting
- Continual improvement.

Given that PAS 2080 is a strategically and culturally led approach to carbon reduction, these principles can be applied frequently and at all stages of the infrastructure delivery process, as shown in Figure 1. The principles are championed by each or multiple proponents within the supply chain.

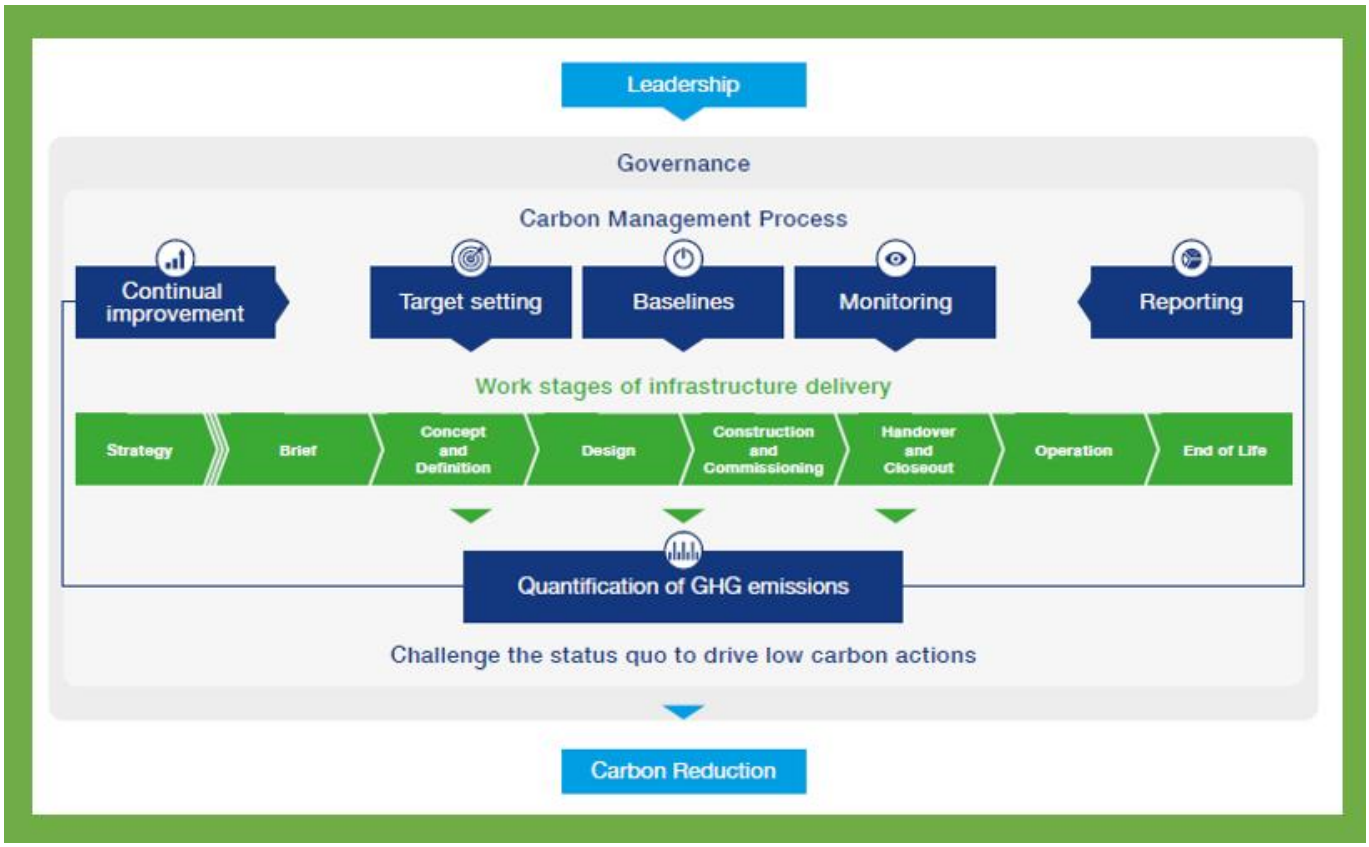


Figure 1 – The Interaction of the PAS 2080 carbon management process and infrastructure delivery

Guidance on the Carbon Management Process requirements described in PAS 2080 is laid out for each work stage, to help practitioners understand when such requirements need to be addressed and which organisation from the value chain is best placed to address them.

Stage 1 – Carbon and greenhouse gas strategy setting

Stage 1 identifies the strategy for the overall carbon reduction policy for infrastructure, ultimately setting the culture for the project or portfolio delivery. PAS 2080 encourages bold strategies to be set, which will challenge business as usual delivery practices to create a step change through the entire supply chain from owner through to contractor and product supplier. Measurable targets should be set at this stage, which can be considered for a portfolio of projects or for individual projects.

It is important for the asset owner to consider the whole of life carbon emissions as part of the strategy for the portfolio or project. Targets should be set relative to baselines, where the baseline is the “no intervention on carbon delivery model.” In setting the target/s, individual projects can be aggregated together, or a global strategy target should be set for the organisation. The target strategy can be separated into capital, operational, user carbon or a single life carbon target.

Stage 2 – The Brief

The Brief stage is where actual projects or work programs are scoped and key actions to maximise carbon reduction opportunities are established. In this stage, consideration is given to the Carbon Reduction Hierarchy, particularly around the first two options, *Build Nothing and Build Less* (see Figure 2).

In this stage, baselines for infrastructure are developed for the project, based on historical and benchmarked industry data and the quantification methodology, scope and rules are determined. The baseline is "(the) scenario for what carbon emissions would have been in the absence of planned measures aiming to reduced emissions" [21].

Baselines are developed as early as possible. For smaller assets/projects this is relatively simple and can be derived by concept drawings, bill of quantities (BOQ), specifications and construction methodologies. Even if data is limited in this stage of delivery, baselines should be set and refined through continual improvement as the procurement of the infrastructure progresses.

Setting the baseline and project brief early in the procurement phase allows for the carbon reduction culture to be included within scoping documents and sets the tone through the design and construction phases. How the project fits into the overall portfolio strategy should be well established by this stage; that is, a stand-alone project or project that fits into a broader carbon neutral solution, which ultimately impacts the project abatement strategy.

Stage 3 – Concept and definition

The concept stage still contains large opportunity for achieving significant carbon reduction, which includes the *Build Nothing* option, as the owner and/or designer considers the Carbon Reduction Hierarchy (see Figure 2). In this stage the Carbon Management Process considers several options for delivery, which tie back to the overall strategy based on the whole of life emissions considerations and baselines that were previously set.

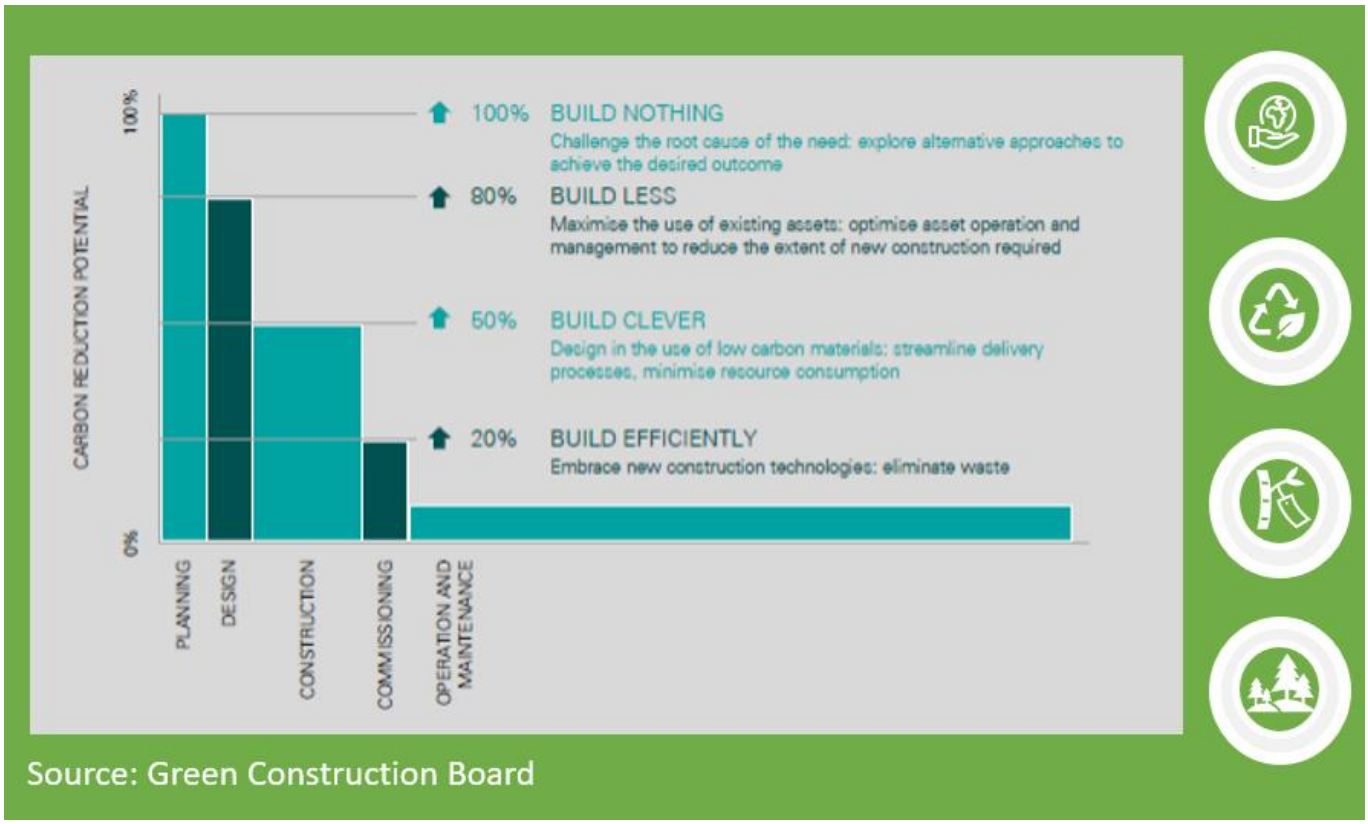


Figure 2: Infrastructure Carbon Review (ICR) Carbon Reduction Hierarchy

The concept should consider optimum balance between capital carbon and operational carbon and explore the use of "hotspot tools" to identify key carbon contributors. As the project definition matures, the baseline can be updated to consider the ultimate asset to be delivered. In this stage, project documentation can include material use, key construction techniques/methodologies and end-of-lifecycle strategies. Operational carbon should be a focus where changes to designs and concepts, such as grade lines and network routes, can have a significant impact on overall whole of life carbon, as shown below.

If multiple options exist, these can all be compared against the baseline at this stage to inform decision-making. Here, one can separate the carbon quantification into capital, operational and user carbon emissions. GHG quantification should be broken down into key components in this stage to ensure that target areas or hotspots can be understood and reduction strategies investigated or considered during option selections. The ability to maximise carbon reduction occurs in these early stages of procurement, where it is most cost effective (see Figure 3).

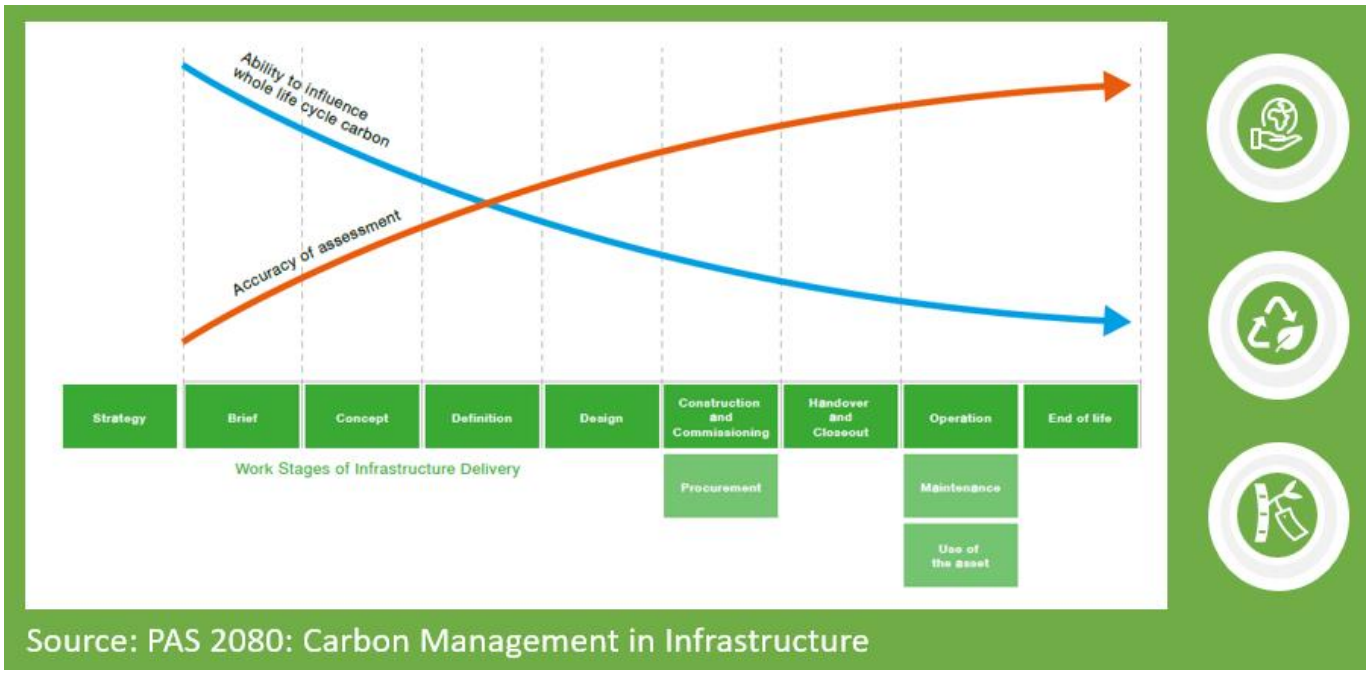


Figure 3: Influence of Carbon reduction across delivery phases: PAS 2080

Stage 4 – Design/detailed design

During Stage 4, the need for a project has been determined and the designer is tasked with the *Build Clever* opportunity in the Carbon Reduction Hierarchy. Optimisation of carbon is progressed through resource use and energy efficiency of the preferred design option through low carbon materials, leaner design methods, efficient construction methodologies operational efficiency.

Once the design is complete or progressed to completion, emission potential is quantified with a more robust methodology, being the most detailed quantification to date. The quantifier should be seeking the most accurate and detailed information from the supply chain based on the materials, products and construction methods used.

The quantification in this stage can be used to check against the baseline and set the target for construction. This information should be included within the tender pack, to ensure that contractors are aware of any GHG reduction targets, reporting requirements and KPIs as further reducing GHG emissions are part of the construction stage. Mandatory innovative carbon reducing techniques can be included within project annexures to ensure that competitive tendering is still possible.

Stage 5 – Construction and commissioning, handover and closeout

At the end of this stage, capital GHG emissions will no longer be estimated as it will be measured and recorded as part of the PAS 2080 requirements. Industry has undertaken significant work to include carbon reduction strategies as part of their competitive advantage/offering, as shown in Case Study 1 by Laing O'Rourke. However, as part of the PAS 2080 implementation, the reduction in carbon becomes a driver and major KPI as part of the construction process. This occurs through innovative construction techniques to minimise waste and plant fuel use and optimisation of construction energy use to reduce capital carbon from construction/commissioning activities.

In this stage, the contractor will quantify actual GHG emissions or as-built carbon, using the quantification methods set in previous stages. This data is then used by the owner as part of updating their quantification databases, baselines assessments and forming major parts of the continual improvement principle.

Stage 6 – Operation

This stage is focused on optimising performance to further reduce carbon emissions. The reduction in carbon in this stage applies to the Owner activities, such as maintenance and operational optimisation, rather than the user-carbon as determined in the cut off rules and boundaries within quantification. Where possible, the owner/operator of the infrastructure asset must be committed to efficient operation, where technology such as Intelligent Transport Systems (ITS) could be used to further reduce carbon through operational efficiency.

The significant monitoring focus in the operational phase should be based on actual measurements, with ongoing periodic reporting matching those determined as part of the strategy phase. Reporting and monitoring should be frequent enough to intervene should the asset not achieve its expected performance levels. Data collected in this phase is encouraged to be fed back into estimate and modelling databases for ongoing carbon and future assessments.

Stage 7 – End of life

PAS 2080 asks practitioners to consider the maximisation of carbon reduction during the end of serviceable life or design life of the infrastructure. This stage ties in with stages 2 and 3 as part of the continual improvement process. The feedback loop is closed when opportunities at the end of an asset life are considered as part of new projects/programs, where carbon reduction is optimised through the *Build Nothing* solution, recycling of the asset, recovering materials or repurposing the asset.

The PAS 2080 table below provides a summary of the roles and responsibilities of all parties through the delivery and procurement of infrastructure and how the carbon management process is implemented (see Table 1).

Table 1: The carbon management process

	Strategy	Brief	Concept	Definition	Design	Construction | Commissioning	Handover | Closeout	Operation | Use	End of life
Leadership and Governance	Set objectives for carbon management (in organization and/or asset or programme of work), aligned with business goals. Define roles and responsibilities. Establish robust governance framework for infrastructure delivery	Communicate governance framework throughout value chain. Communicate objectives and carbon reduction targets, internally and externally. Set incentives, where appropriate, to encourage desired behaviours. Assign staff to roles. Delegate internally/externally to deliver carbon management process requirements, as appropriate.		Ensure sufficient (and trained) resources to deliver the carbon management process requirements. Apply governance framework to ensure challenge at each work stage and throughout value chain, to achieve or exceed carbon reduction targets and to promote sharing of current good practice. Recognise and reward innovative behaviours.			Review carbon reduction performance, act on feedback and drive continuous improvement through better data collection, capturing current good practice in carbon reduction, etc.		
Target setting | Baselines | Monitoring	Set measurable targets to achieve objectives. Determine responsibility for carbon baselines.	Challenge carbon targets where there is potential for improvement Develop appropriate and realistic baselines				Capture construction data and feedback to help improve baselines		Capture operational data and feedback to improve baselines.	
Carbon reduction hierarchy	**Build nothing:** Challenge the need for an asset and explore alternative approaches to achieve outcomes that minimise whole life carbon.		**Build less:** Maximise use of existing assets. Optimise operational efficiency to reduce construction and whole life carbon		**Build clever:** Use low carbon materials/ products to minimise resource use and select technologies for efficient operation	**Build efficiently:** Embrace construction techniques that reduce resource consumption.		Operate, maintain (and decommission) efficiently.	
	Identify carbon hotspots in existing asset operation and opportunities for reduction.	Identify carbon hotspots in proposed solutions and opportunities/approaches for reduction. Assess opportunity to reduce capital, operational and user carbon.		Ensure impacts of design on the carbon emissions of construction, future operation and use are minimised.		Minimise material use, transport to site, construction waste and maximise opportunities for reuse/recycling/ recovery.		Minimise operational use of energy, transport, chemicals and other consumables in new or existing assets.	
		Share/develop/deploy low carbon solutions technologies, materials, products or methods to be incorporated into solutions							
Quantification	Set and communicate functional unit(s) for measuring performance. Define and communicate quantification requirements. Identify appropriate data sources. Review suitability of existing tools.	Develop and apply appropriate tools to aid quantification (asset owner/manager could delegate this responsibility).							
		Define goal, scope and assumptions. Establish scope & boundaries of GHG assessment. Select calculation methodology.	Collect and assess data. Calculate GHG emissions. Ensure options are assessed within consistent boundaries. Take account of forecast emissions in operation and use.		Undertake more detailed quantification of forecast GHG emissions, as required.	Assess actual GHG emissions from construction up to handover		Assess actual GHG emissions of operation (from actual activity data).	
		Share existing information on GHG emissions quantification of technologies, products and materials considered or used.			Quantify GHG emissions of materials/products supplied, as required				
Reporting	Define reporting requirements and communicate throughout value chain.		Capture data on innovative approaches, technologies, materials and products to be used. Report forecast emissions and performance against targets, in accordance with general principles and reporting requirements.			Capture data on innovative construction techniques, materials and products used. Report actual emissions and performance against targets, in accordance with general principles and reporting requirements.		Report actual emissions and performance against targets, in accordance with general principles.	
		Provide reporting on the performance of technologies, materials and products (to be) used.							
Opportunity to reduce carbon	Highest						Lowest		

Key to table	Asset owner/manager	Designer	Constructor	Supplier	All parties

To date, several projects located in the UK, UAE and NZ have been successfully implementing the carbon management and reduction process outlined by PAS 2080. These projects are summarised in the table below, including the strategies implemented and the outcomes experienced, (note that some of these projects/portfolios are ongoing as part of their overall delivery).

Case studies – PAS 2080 Lifecycle Carbon Assessment

Project/Region		Drivers/Strategies	Outcomes
Anglian Water – UK	Early adopter of PAS 2080	Demonstrated the causal link between carbon and cost by analysing its data for 8 years and establishing correlation between reduced carbon and reduced cost Anglian Water is the first water company to set a target of becoming carbon neural by 2050.	Anglian Water's annual integrated report for 2019 states that they are on track to achieve this and demonstrates the reduction in capital carbon from their 2010 levels by 58% and operational carbon emission by 29%. The company is achieving a capital cost saving of more than 20%, measured against a 2010 baseline. [22]
Thameslink Rail Program	Development of a baseline – through a BAU delivery carbon to influence the design and delivery program	The Rail Carbon Tool was mainly used, based on total materials used in work packages – this allowed transparency and traceability. Used early in the design process.	Setting the baseline early and spending time developing the most efficient method of calculating the baseline increased efficiency in measuring and reporting carbon for the whole project. Allowed for key stakeholders to be aware and raised awareness which influenced the priority of whole of life carbon management process. [5]
Thameslink Signal Structures – Balfour Beatty Rail UK		Reduction of GHG emissions during operational phase – including maintenance and upgrades of infrastructure. Application of PAS 2080 to rail operations and maintenance.	Carbon footprint was 60% less than baseline. Installation works were less intrusive with a saving in time and cost of approximately 60%. A reduced scope lessened the risk through avoidance of demolition works. Specifically, signal structure modifications were undertaken through assessment of existing infrastructure and modifications rather than full replacement. [5]
Watercare – NZ	Full adoption of PAS2080 to all capital works	Full application, but particularly - Setting of goals and leadership - Setting a baseline for the program for next 10 years of delivery	Watercare is at the beginning of its low carbon infrastructure journey and has strongly embraced the 40:20:20 vision as a way to get better value from infrastructure delivery, through both reduced emissions and reduced costs

		- Applying the ICR Hierarchy throughout each delivery stage - Involving the supply chain at the right stages to maximise carbon reductions creating innovative culture.	TARGET - 40% reduction in carbon emissions from construction by 2024; 20% reduction in cost of construction by 2024; 20% year-on-year improvement in health, safety and wellbeing [24]. Watercare is achieving these targets through the use of carbon tool to identify carbon hotspots – concrete, concrete lined steel pipe, fuel consumption in construction and excavation and aggregates.
Abu Dhabi Sewerage Services Company (ADSSC)		- Embedment of PAS 2080 into all operations. - Implementation of baseline, measurement and monitoring tools - Carbon leadership - Carbon reduction culture.	The 2030 roadmap set out the potential for a 35% cut in annual carbon emissions – equal to reducing emissions by 1tCO_2e per person in Abu Dhabi – and a more than AED300M saving on operational costs by 2030. Pilot projects confirmed significant opportunities for carbon reductions through more efficient operations. Modifying pump control could provide a 70% reduction in energy and carbon emissions, optimising chemical dosing control can cut chemical use by 14% and save up to AED268,000 a year, and diverting sludge from landfill would save 120,000tCO_2e/year. [29]
Rail Safety and Standard Board (RSSB) (UK)		RSSB developed the Rail Carbon Tool for use by the entire industry to measure and reduce its carbon footprint that meets PAS 2080 requirements. An industry-based approach meets the overall objective of measuring carbon to reduce emission and help improve sustainability.	RSSB uses a central database for the whole rail industry to use that allows for the calculation of carbon footprints for projects and activities. By using a centrally maintained database, carbon reduction quantification can be consistent within the industry and the most up to date data is being considered. As projects progress, data can be easily updated to meet continual improvement requirements. A central system informs the development of a low carbon strategy. [5]

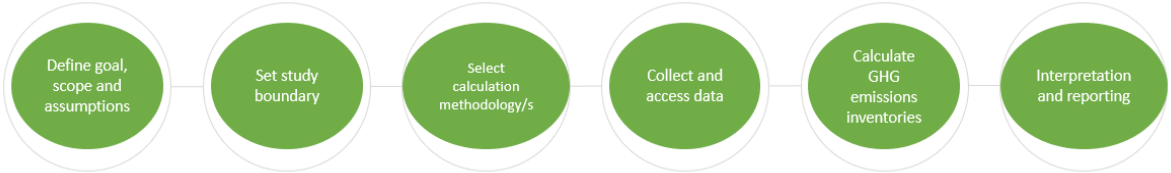
Quantification of carbon and greenhouse gas emissions

All major stages of infrastructure delivery require emissions quantification as part of the Carbon Management Process outlined by PAS 2080. These are particularly prominent in:

- Baseline setting
- Design
- Construction
- Operations.

Depending on project definition levels, the amount of effort put into the quantification process must be consistent with the level definition and cost outlay. Therefore, as the project progresses through the delivery stages, the increased assessment detail of carbon will increase up until the construction stage, where actual carbon will be reported and monitored.

The industry is currently working on several different tools and mechanisms to understand the carbon emission implications of design decisions with cost and program commensurate to project definition levels. PAS 2080 outlines the steps in quantification of carbon as follows:



PAS 2080 outlines a modular approach to emissions lifecycle study boundaries and cut-off rules for the quantification of carbon. Study boundaries define the scope of carbon quantification and with this, the processes and physical aspects included or not included. Only activities that do not significantly change the result of the assessment can be excluded from the assessment. PAS 2080 separates these modules into the following stages, to ensure the full lifecycle is considered within the quantification (see Figure 4).

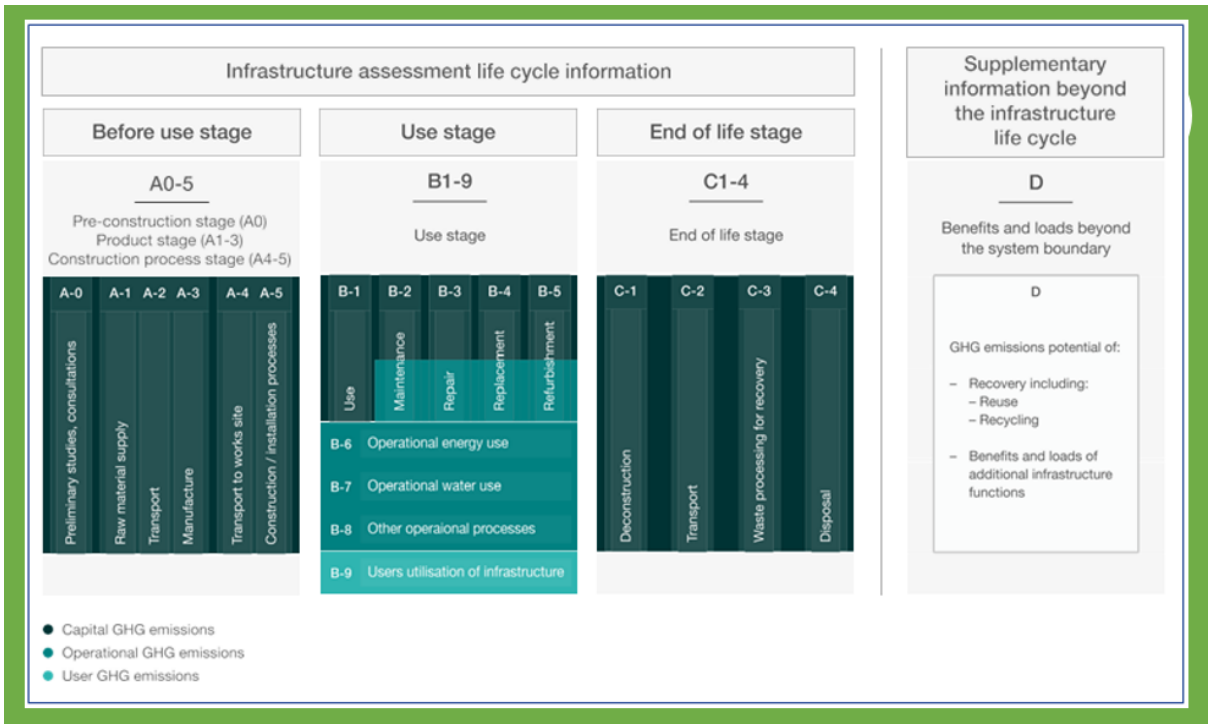


Figure 4 – Framework for module quantification of carbon emissions

During the assessment of emissions, PAS 2080 considers different emissions categories as *controlled* or *influenced*. Typically, the *influenced* category considers user carbon which can be controlled by aspects of the design but cannot be directly controlled by the infrastructure owner. C*ontrolled* examines direct control through design decisions and construction techniques, all of which can be actively managed by proponents of the infrastructure delivery process. This is typically operational and capital carbon.

There are three major types of carbon calculations acceptable as part of the carbon management process outlined by PAS 2080:

- Top down/input-output analysis – uses industry average data to estimate carbon emissions. Best for high level estimates and only limited data is available. Will not necessarily help identify where emissions are concentrated and where reduction efforts should be focused.
- Bottom up/lifecycle assessment – collates and analyses all materials and activities to be completed to deliver the infrastructure. Provides opportunities to conduct more in-depth analysis to determine where emissions are concentrated and where reduction efforts should be focused.
- A combination of the two methods – this uses a combination of detailed data and general industry assumptions when data is lacking and time constraints exist.

Carbon measurement and reporting – Initial phases

Since the reduction in carbon is most cost effective and has the most impact in the first stages of infrastructure delivery, it is important to assess the carbon impacts quickly in proportion to the level

of project definition and budget. In these early phases of project scoping, a fast identification of "carbon hotspots" allows designers and owners to understand emissions implications and major contributors to explore as the design progresses and project matures.

Consequently, Jacobs has developed the Carbon First Assessment Tool, which aims to make carbon visible even from limited project scope and design. Jacobs is a global leader in the implementation in portfolio carbon management, working on projects such as High Speed Rail 2 (HS2), National Grid (UK) and Transport Scotland Portfolio. During the development of these projects, Jacobs has developed tools for implementation in carbon reduction and management.

Carbon First assesses project attributes such as materials, routes and major/key activities, and creates project carbon and cost curves. These curves help to identify hotspots and make suggestions for investigation of carbon reduction opportunities which can be balanced with cost. These outputs inform designers and owners to drill down into the opportunities for carbon abatement as the project progresses through design. Carbon First uses real data, from real projects. Jacobs has made considerable investment into the development of the carbon database that drives the tool.

The use of the hotspot identification tools during the concept and development phases of the project ensures that time and resources are not spent unnecessarily (thus reducing the cost to the client) and ensures that the impact in the reduction and management of carbon is progressed as the project matures. Ultimately, Carbon First is a benchmarking tool that identifies embodied carbon hotspots within the design where further investigation is required or interrogation of the design can potentially reduce emissions.

In 2019, the South Australian Government's Department for Infrastructure and Transport (DIT) commissioned Edge Environmental to undertake a hotspot analysis of three major assets – Road, Rail and Tunnel – adjusting the review in relation to current DIT policy. The study examined potential areas of carbon reduction and compared them to carbon baselines developed for each infrastructure type. The study then examined the cost-effectiveness of carbon reduction, by developing Marginal Abatement Cost Curves (MACC) as shown for the Road findings in Figure 5.

The MACC allows for an easy comparison between carbon reduction initiatives. The carbon abatement potential of an action is represented on the x-axis, where the width of each column represents tCO_2e abated per year. The cost of carbon abatement is represented by the y-axis per tCO_2e abated. Negative costs represent a profitable investment over the life of the investment.

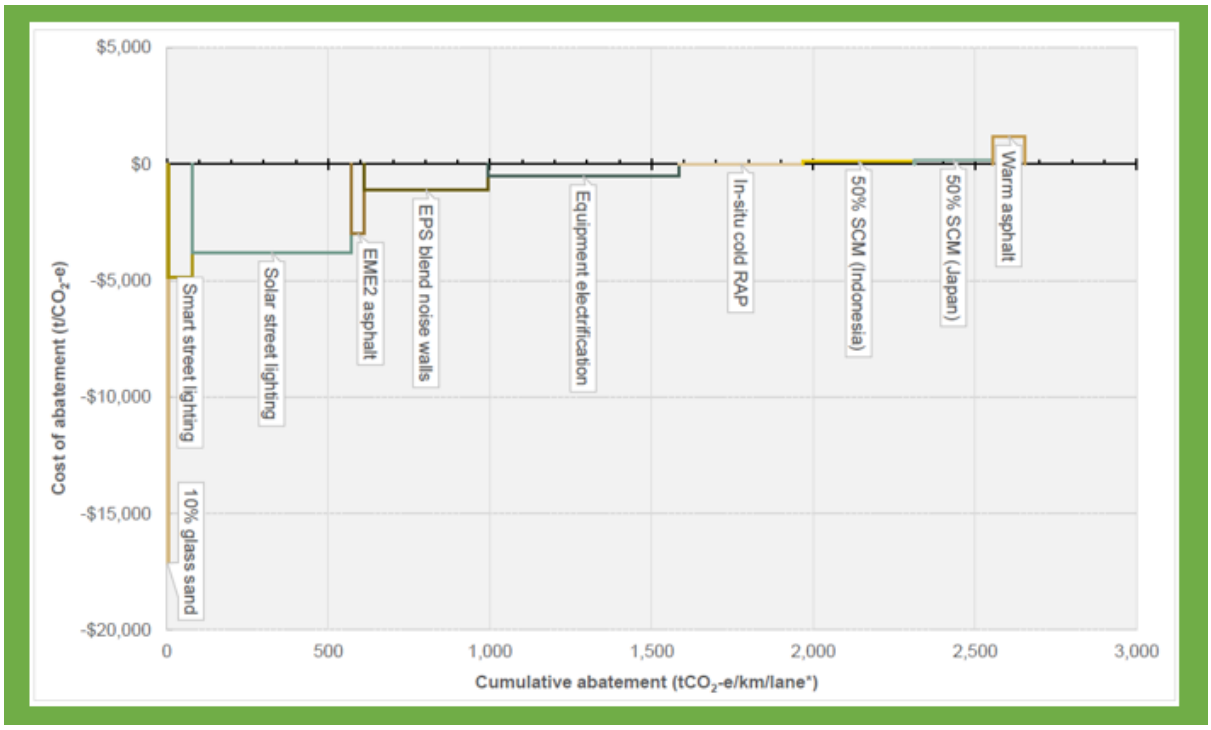


Figure 5 – Marginal Abatement Cost Curve – Road. Source: SA DPTI [19].

The study resulted in the identification of 34 potential profitable investment (cost reduction) and reduction in carbon emissions [19]. These hotspots act as a starting point to be drilled down further by the DIT to identify changes to specifications and procurement documentation in order to introduce carbon saving initiatives as projects continue through the delivery stages.

Carbon measurement and reporting – as procurement progresses – Carbon Software Tools

As the project matures and progresses through to design, the definition of the project sharpens and a more accurate carbon quantification tool is required. Entering the detailed design phase, the Carbon Reduction Hierarchy will have already been considered by the designer and owners and the project will be reaching the stage of *building clever and efficient*. Therefore, as the project custodian shifts from designer to contractor, the quantification of the carbon must be robust, detailed and accurate in order for the contractor to monitor and report against.

A standardised system or tool is important to ensure that the owner's set target and strategy is achieved and can be managed at both the project and portfolio level. Table 2 outlines some of the available software that meets the PAS 2080 requirements and is suitable to road construction projects in Queensland. As an aside, there is a vast array of software options available throughout the industry which are specific to building, rail and general civil.

Table 2 – Carbon Quantification Tools

Tool		Country of origin	Purpose	Benefits	PAS 2080 compliant
One Click Life Cycle Assessment (LCA)		Finland	Helps calculate and reduce the environmental impacts of building and infrastructure projects, products and portfolio.	Quickly generates a ready-to-use LCA report in three stages: 1. Import design data from BIM, energy models (gbXML), or Excel 2. Data is automatically transformed to LCA results in compliance with chosen certification scheme 3. Analyse results to identify the most meaningful improvement opportunities. LCA report can immediately identify hotspots in carbon footprint and intervene to fix those issues Track the progress of building and immediately check which design options would help to reduce its environmental impact.	Yes
eTool		Australia	Targeted at large construction projects and asset portfolios, it is a secure, collaborative, holistic, high value carbon management platform Reports on CO_2e, cost, energy, water, land use, ozone depletion, human toxicity and more.	The goals of an eTool LCA are to: • Quantify the environmental impacts of the design (normal eTool assessments pay particular attention to CO_2 equivalent emissions, CO_2e) • Compare these impacts against a typical 'business as usual' benchmark • Provide recommendations that will ideally reduce the total impacts of the building	Yes eTool LCA meets the requirements of PAS 2050 and is able to support a PAS 2080 process pending further

				• Conduct this in a cost effective, auditable and repeatable manner. A typical eTool assessment allows reporting of numerous impacts: • Global warming potential • Primary energy • Water use • Land use • Costs	scrutiny of their standards.
Rail Safety and Standards Board (RSSB) Rail Carbon Tool		UK	The Rail Carbon Tool is an online carbon reduction tool for the UK rail organisations to: • calculate and analyse the carbon footprints of UK rail projects and activities • identify and assess alternative low carbon options • select low carbon solutions.	• Helps reduce the industry's carbon footprint • Specifically designed to enable lower carbon solutions to be identified with maximum effectiveness and the least administration • Carry out carbon footprint calculations • Analyse resulting carbon models • Identify, assess and select low carbon options and solutions—collectively referred to as 'options evaluation and selection'.	Yes

Examples of best practice procurement used in the industry by clients

Through research and industry engagement there have been various examples of client-driven initiatives to aid in reducing the transport infrastructure sector's impact on climate change. Figure 6 below depicts the target commitments from each State or Territory government, with some being further progressed than others in achieving these targets.

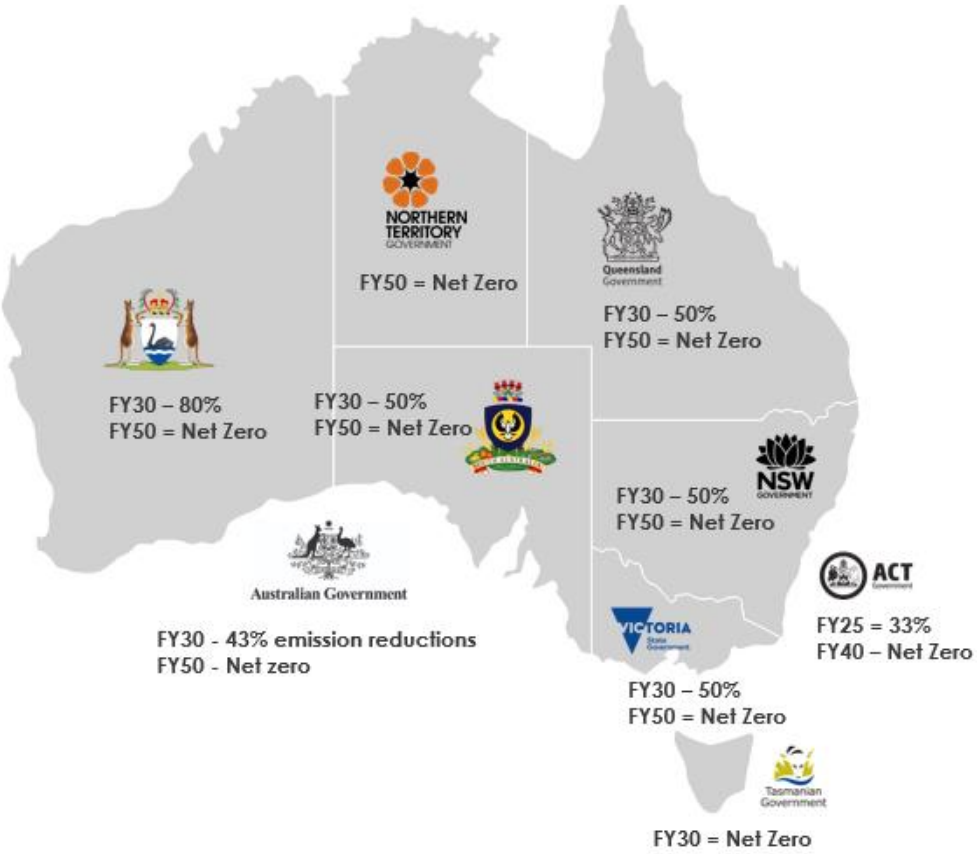


Figure 6 – State and territory commitments

The Victorian Government has shown strong progress, ensuring that its policies are in place and procurement models create a consistent message to the Supply Chain. Sustainability Victoria (SV) is a delivery agency for the Victorian Government which helps Victoria move towards a circular, climate-resilient clean economy to meet set targets. This agency is not a regulator – they are a statutory authority established in 2005, reporting to the Minister for Energy, Environment and Climate Change. The focus areas for the next 10 years are:

- Investment and innovation
- Behavioural change and education
- Community action.

The significance of setting up SV is that a consolidated strategy has provided the Victorian Government with guidance on how best to achieve its goals within its forward infrastructure plan. In addition to this strategy, the Recycled First Policy has provided a mechanism in the procurement process since March 2020 whereby all tenders on Victorian major transport projects have had to demonstrate commitments to this policy.

The Major Roads Project Victoria (MRPV) has developed a way to procure works in a systematic and collaborative way. MRPV has preselected contractors based on skill and capability, and assigned them to a panel pending project value and complexity. Each panel will have a procurement process to ensure the contractor who wins the work does so from a fair tender that aligns with the Government's strategy for infrastructure delivery. The panel criteria are identified in Table 3.

Panel	Panel definitions
Panel 1	For works which MRPV anticipates will have an approximate capital cost of great than $300 million and/or which are considered to be of high complexity
Panel 2	For works which MRPV anticipates will have an approximate capital cost greater than $100 million, but less than $400 million, and/or which are considered to be of moderate to high complexity
Panel 3	For works which MRPV anticipates will have an approximate capital cost great than $25 million, but less than $150 million, and/or which are considered to be of moderate complexity.
Panel 4	For works which MRPV anticipates will have an approximate capital cost of less than $50 million, and/or which are considered to be low complexity.
Panel 5	For specialist works and services, such as utilities works.

Table 3 – MRPV Contractor panel criteria

When projects are tendered to the market, early contractor involvement is encouraged by way of how the panels are engaged. The request for proposal (RFP) phase allows MRPV to select the suitable contractor to continue onto the development phase. This early contractor involvement allows the true drivers for the specific project to be collaboratively identified and worked through with the client. The development phase enables the team to establish targets for the project in an open book environment, to provide value for money and best for community outcomes in all aspects, especially towards climate change challenges (see Figure 7).

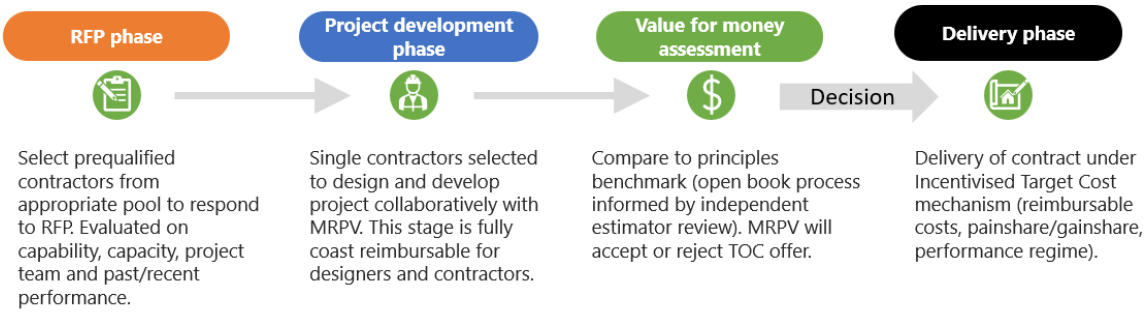


Figure 7 - Procurement Flow

Once an assessment of value for money is completed against benchmarked estimates, the work completed in the development phase informs the contract and KPIs to promote positive outcomes. Figure 8 indicates a potential commercial model of how the performance regime rewards outcomes that exceed the set criteria.

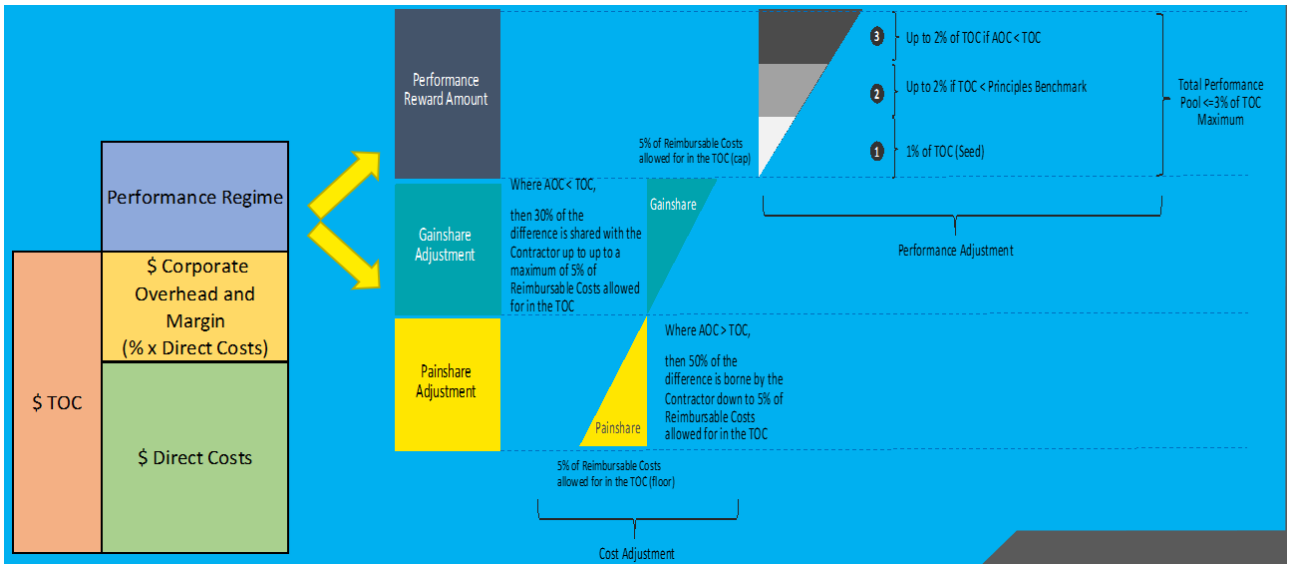


Figure 8 – An example of a commercial model

It is noted that lump sum *Design and Construct* contracts have traditionally been preferred by clients, as these are risk-averse. In the absence of client driven KPIs or mandatory directives, the supply chain will typically focus on reducing time and cost, as value-add items outside of these metrics are not measured and put the tendering investment at risk of not winning the work.

The above example from MRPV provides an alternative path for procurement that enables the project team of client, designer and contractor to flexibly link key project-specific outcomes to the contract. An example would be assigning mandatory ISC ratings or targeted outcomes for the project based on in-depth knowledge of what is possible, along with metrics against the consistent Recycled First Policy applied to all infrastructure projects.

For projects below the value of $100M that do not currently have the ability to comply with ISC requirements and reporting, individual KPI targets provide an avenue for the Recycled First Policy to promote positive outcomes. Consistency across the delivery of these projects allows contractors the confidence to invest further in technologies that will benefit the client and climate change challenges, creating a catalyst for the infrastructure industry to accelerate carbon reducing practices.

It is evident from the action of the Victorian Government through MRPV that they are attempting to achieve balance between incentivising climate change impact, without putting all the risk on the contractor and broader industry on bearing the brunt.

Recommendation for future evolution of Queensland infrastructure

Taking into consideration Queensland's current position, local and national progress, impact to designers, contractors, the broader supply chain and best practice locally and globally, Team Queensland has developed a key recommendation for procurement and delivery of infrastructure by TMR.

Our recommendation considers return on investment (or effort), practical internationally proven strategies, integration into the current industry and viability to be rolled out in the short term.

Key Recommendation: Reform of TMR procurement models to adopt PAS 2080 into TMR Project Assessment Framework

Based on current international best practice, we recommend the adoption of the PAS 2080 Carbon Management in Infrastructure standard within the current TMR Project Assessment Framework (PAF), starting with sub-$100M projects. This section of the report will outline the proposed structure, timing and the benefits of implementing PAS 2080 portfolio wide.

Targeting *construct only* provides the opportunity to maximise efficiency and carbon savings operationally through design (grades, route, material selection). It also allows the contractor to add further carbon savings, if they are able, and does not exclude businesses from tendering, which helps enable the supply chain to catch up with emerging technologies.

Each phase, from concept through to delivery, considers carbon and more broadly the environment as a key performance indicator (KPI) – no different from cost and program. Indeed, they should be set just as high as other KPIs by TMR.

Implementation

By reviewing the PAS 2080 standard and its guidance documents and given the staged approach of PAS 2080 to infrastructure delivery, its implementation into the current TMR procurement process is a matter of augmentation rather than having to develop an entirely new system, which would need to be managed by TMR and the broader industry. Therefore, the implementation can be in effect in the short term with minimal industry disruption, but maximum impact to climate change reduction.

Table 4 outlines how the stages of PAS 2080 delivery phases and carbon management processes interact with the TMR gated procurement process.

TMR Procurement Gate	PAS 2080 Delivery Phase	Carbon Management Process
	Set the Strategy	Target Setting
Strategic Assessment of Service Requirements (SASR)	The Brief	Setting Baselines Continual Improvement Quantification of Emissions
PE	Setting Baseline	Setting Baselines
Business Case	Design	Quantification of Emissions
Detailed Design	Design	Quantification of Emissions Monitoring and Reporting Continual Improvement
Construction	Construction	Quantification of Emissions
Finalisation	Operation	Monitoring and Report
	End Of Life	

Table 4 – PAS 2080 Delivery Phases

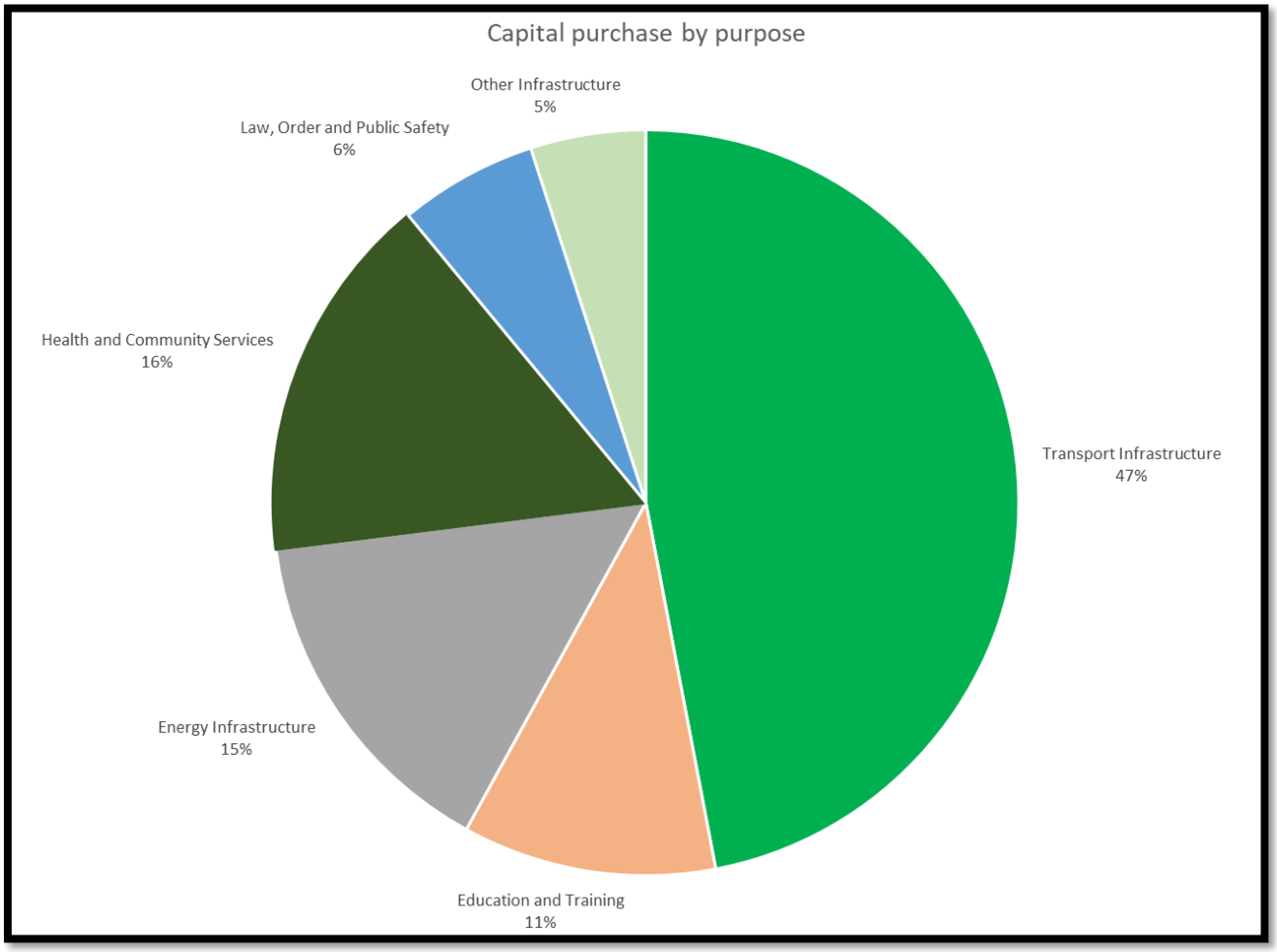
Most importantly, the implementation of the Carbon Reduction Hierarchy must be introduced to all stages in the procurement of infrastructure. As demonstrated in the case studies presented in this report, applying this thinking throughout the entire delivery process will result in reduced carbon and reduced costs.

The following major steps are required to be implemented into the procurement process of infrastructure by TMR as shown in the delivery phase of Table 4.

Setting the target

In the 2022-23 State budget, the Queensland Government has allocated a total of $15.510 billion to provide productivity-enhancing economic infrastructure, essential social infrastructure and a broad range of capital works projects and programs across the state. Of this, $9.824 billion (63.3 per cent) of the capital program in 2022–23 is to be spent outside of the Greater Brisbane region (Brisbane and Redlands, Logan and Ipswich), supporting an estimated 31,100 jobs across those regions.

Significantly, transport (47%) continues to account for the largest share of purchases, followed by health, housing and community services, energy infrastructure and education and training as shown below.



Source: Capital Statement, Budget Paper #3, budget.qld.gov.au

PAS 2080 is a standard based on leadership and culture, which drives innovation and change. The Target Setting Phase is where TMR and the Queensland State Government will be able to show clear leadership to the industry and the greater community.

Based on the recommendation of this report, the suggested target would be a consideration of the significant carbon reduction target (from the baseline) to be separated into Capital, Operational and User Carbon, or a single Life Carbon target, for the sub-$100M project portfolio.

By setting a bold target to achieve, TMR will be signalling to the industry and greater community that there is a serious commitment to the reduction of emissions within infrastructure delivery. This stage is extremely important as it will serve to set the culture and leadership driver for carbon management in infrastructure procurement and delivery.

Setting the baseline

Baselines for infrastructure can be set early using standardised measures such as tCo_2/km, similar to those produced by Jacobs Australia and South Australia's DIT and reviewed in this report. Incorporating work undertaken in the UAE [20] and in the UK and through discussions with Jacobs Australia, the carbon assessment of current infrastructure assets can be used in setting baselines. As work progresses in this area, data can become more refined and the baselines continually improved. These baselines can be developed by TMR as part of Preliminary Evaluation Stage, or earlier in SASR phase.

Quantification of carbon

A range of tools are already available for the quantification of carbon, with many major design firms having developed in-house tools for both early identification of hotspots and carbon quantification and reporting. Of the software tools available globally, it is clear that large differences exist among them. Therefore we advocate that instead of selecting one single tool for use, the development of a quantification process will be easier and faster for industry proponents to adopt. Similar to the TMR Project Cost and Estimating Manual [31], the quantification of carbon and more generally emissions data would be process-oriented, where the designer and/or contractor could select their own tool, provided it met with the mandated requirements.

In terms of baseline data and data collection and monitoring, it is recommended that TMR select one system to be maintained by TMR for managing this information – similar to the 3PCM portfolio management software TMR currently uses to manage the QTRIP project costs and time. Lessons learned from the UK implementation of PAS 2080 quantification suggest that a single (or minimal) data source better ensures that the most up to date and efficient data is available for all industry proponents, which in turns feeds back into continual improvement and better outcomes for all.

The PAS 2080 standard does not prescribe a single quantification method for emissions accounting. It does, however, provide requirements for the key components that are to feature within the methodology, boundary guidance and cut-off rules. We recommend that TMR develops and implements a standardised methodology of carbon quantification in projects. TMR should set these requirements and boundaries early in the project phase and continually update these within baselines as the data matures and develops.

A manual for quantification of carbon, data requirements and assumptions should be developed to inform industry on how to progress projects through PAS 2080 in a way that is optimal for TMR in terms of management, monitoring and reporting.

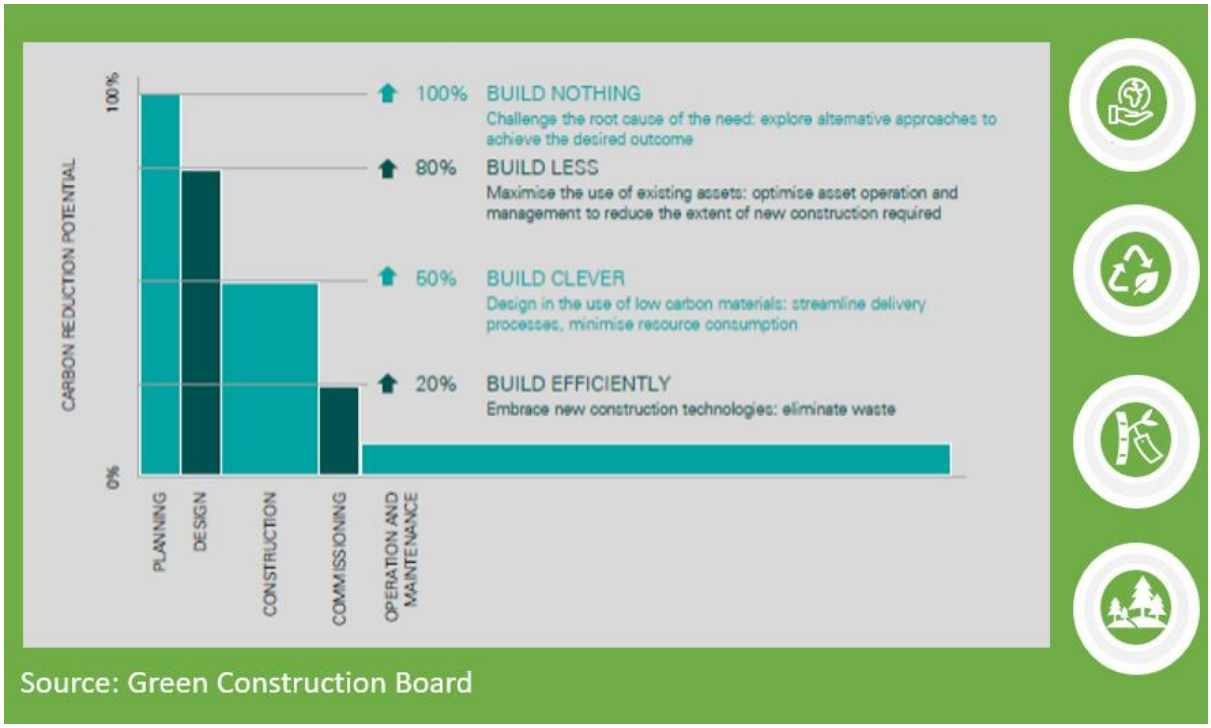
At each investment gating phase of the PAF, similar to cost, a carbon estimate should be included to ensure that carbon reduction is actually being achieved, or at least considered.

To reach the best outcome – being the reduction of carbon within the TMR infrastructure portfolio – it is recommended that TMR hold major datasets, or develop datasets that can be shared with consultants and contractors as required, to ensure the most recent carbon quantification data is used and that it is being continually updated and improved.

Jacobs' international observation is that the PAS 2080 process is rarely implemented in a unified manner, thus there are multiple datasets being managed by multiple organisations. Effort is better focused here with a unified approach to develop the most accurate, up-to-date data which is continually updated as design and construction progresses, to benefit the greater community through efficiency and accuracy.

Design

PAS 2080 is a culturally and strategically led process of infrastructure delivery, where the project requirements are set very early and emissions impact is considered at every step. This process is led primarily by the owner and designer, which is why it has been considered an appropriate mechanism for *Construct Only* TMR projects. The implementation of a mandatory requirement to include a robust assessment of the project using the ICR Carbon Reduction Hierarchy is recommended.



Source: Green Construction Board

The strategies, culture and quantification requirements during the design phase, as a maturity of reduction from baselines within the SASR and Business Case Phases, will ultimately lead to reduced carbon and reduced cost outcomes as the design progresses.

Emissions hotspots are one of the most cost-effective design tools to be implemented at the early stages of the design. They allow focus to be given to areas of potential reduction in both cost and carbon, ensuring the overarching carbon strategies are being implemented. As a minimum, the following design tools should be considered for implementation:

- Hotspot tools in early design phases (PE, BC) – similar to Jacobs' Carbon First Tool
- Quantification tools, such as OneClickLCA and etoolLCA.

As noted above, a single software should not be selected by TMR, but rather the methodologies and outputs of quantifications outlined in manuals by TMR should be shared with and adopted by organisations as the project progresses.

Opportunities for carbon reduction will be further considered as project definition matures and progresses to IFC. At the point of IFC, documents and ultimately the development of tender documentation, the carbon quantification will be at a point where a carbon budget can be included with the tender for contractors to achieve.

Construction

A carbon estimate or budget for the construction should be mandatory and supplied by as part of the tender documentation to be realised or adjusted by the contractor (similar to the construction program). This can be compared against the baseline GHG quantification that has occurred during the detailed design phase and will help TMR in decision-making for tender award.

It is recommended that TMR develop a checklist against their standardised quantification method to ensure that tenders provide accurate carbon targets commensurate with the goal and scope of the whole-of-life carbon management. Setting a carbon budget for the project creates the ability to incentivise further reductions to the emissions targets, through KPIs. This is where industry collaboration is nurtured through incentivisation of investments, rather than punishment or precluding parts of the supply chain for being less advanced than others.

As construction progresses, TMR should mandate a requirement for monthly updates on carbon quantification, similar to the program update requirements of the contract. As variations and extensions of time are awarded, considerations to the impacts to carbon emissions and their quantification should be provided and reported. Quantification during construction is to be used for monitoring and reporting purposes, comparing actuals with estimates and the baseline.

Monitoring, reporting and continual improvement

Implementation of the PAS 2080 process can be successfully achieved by augmenting the current procurement and contract management processes with the PAS 2080 requirements as shown in Table 4. Continual improvement runs through each stage, reviewing the quantification and baselines along the way, creating a feedback loop back to the overarching strategy and targets. The monitoring and reporting of carbon throughout the project lifecycle continually reinforces this culture throughout the stages. It also enables TMR to intervene when baseline assumptions are incorrect and update the baselines, providing lessons learned for other projects for continual improvement.

PAS 2080 provides requirements for all members of infrastructure delivery to contribute and develop data that continually improves the process. TMR in this instance would be the champions to continually seek feedback to improve processes, from whole-of-life emissions quantifications, to design efficiencies, to operational excellence. This all assists in building specifications and standards for the entire industry that progress the reduction of carbon within infrastructure.

TMR already includes lessons learned within their procurement and delivery frameworks. Augmenting this with the PAS 2080 requirements would be of minimal effort, for substantial effect.

Contract implementation and incentivisation

The implementation of PAS 2080 allows for an industry cultural change that is driven by incentivisation rather than intervention, all while keeping the tendering process fair and competitive. The baselines set during the Preliminary Evaluation to Detailed Design phases can act as carbon targets or budgets, to be monitored and reported by the contractor during construction.

Using these carbon budgets during construction allows competitive tendering, where contractors are fairly assessed on the mandated tender criteria. There is an opportunity for the contractor to introduce carbon saving processes and technologies during the construction process and be paid an incentivisation bonus as part of a provisional item.

Each infrastructure project is unique and will require a bespoke approach to suit factors such as contract type, project value, project location, local resource availability and capacity. The flexibility and cultural approach of PAS 2080 allows the consideration of all these factors, delivering the most carbon and cost-efficient solution possible. Figure 9 details the potential incentivisation mechanisms.

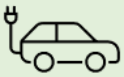
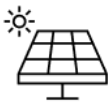
	**Carbon Target with KRAs measured against the baseline with financial incentivisation**
	**Carbon actual used and measured during construction stage against target set during design quantification and baseline setting**
	**Bio-diesel use for plant and equipment**
	**% of LV fleet electric and/or hybrid**
	**Site power 100% renewable (renewable from the grid or solar & battery onsite)**

Figure 9: Potential Incentivisation Models During Contract Delivery Phase

Benefits

The sub-$100M project category has specifically been targeted for the implementation of PAS 2080 as the catalyst for change. As detailed earlier, these projects currently have no stipulated non-price criteria assessment within the TMR Procurement policy. For major projects that are greater than $100M, the current ISC target within TMR is to achieve a Design and As-built ratings of "Excellent". However, major projects currently only account for 67% of the TMR budget.

Unlike the ISC rating scheme, where there are intervention points along the infrastructure delivery process, PAS 2080 takes a cultural approach, which is driven by the strategy and targets set early within the TMR portfolio. This strategy creates the overarching driver of change where innovation is considered a part of the process, not just at stipulated intervention points or hindsight reviews.

The major benefits of implementing PAS 2080 across this portfolio are as follows:

- TMR Procurement Process can be easily augmented to adopt the PAS2080 requirements.
- Meets, facilitates and progresses the goals and requirements of the TMR Sustainability policy with measurable results.
- Bold owner-led strategies set the tone and culture for the industry to follow, creating the step change required for supply chain thinking change and technology development.
- Fosters a culture of environmental sustainability and leadership – this is at the forefront of the PAS 2080 process.
- Design driven to reduce carbon and costs using the Carbon Reduction Hierarchy.
- Each stage builds on the next in reducing carbon.
- Reduced carbon means reduced costs.
- Continual improvement requirements and philosophy increases TMR and industry knowledge, which creates feedback loop for future projects and operations.
- Incentivises carbon reduction without precluding supply chain proponents, allowing fair tendering, value for money and meeting Queensland Procurement Policy Requirements.

By augmenting the current TMR infrastructure delivery process with PAS 2080, international best practice standard for carbon management in infrastructure, and a standardised carbon quantification process the goal of Net Zero can be achieved sooner. Since the PAS 2080 carbon management process is heavily focused on the upfront design phases, TMR has full responsibility for the cost and outputs generated from this process. Although the implementation of PAS 2080 will initially increase the design costs, it will ultimately lead to reduced total costs of infrastructure as carbon is reduced and the process is refined through continual improvement and building less.

PAS 2080 is cost effective, demonstrated on projects such as HS2 and Watercare that with the reduction in carbon comes a reduction in cost – aside from the environmental considerations. It has been reported by numerous bodies such as Mott Macdonald and the Green Infrastructure Board that since the majority of the carbon emissions are from the construction, operation and maintenance of the asset, focusing on these key areas enables considerable carbon and cost reduction to be achieved [8][23][27].

The PAS 2080 standard allows for changing technologies to be implemented and retired as the supply chain evolves. Owners, designers, contractors and suppliers

are always able to consider the best carbon reduction outcomes and balance these with cost and local market conditions, pushing boundaries for innovation and efficiency. The strategic and cultural drivers that are developed and shaped by the implementation of PAS 2080 across a portfolio will challenge current practices, making carbon reduction an expected outcome of the procurement delivery process.

The PAS 2080 process gives the framework to drive carbon reduction as a BAU process. Projects commence with a set outcome, wherein carbon reduction and management is implemented through the design process. It empowers the project to review, manage and reduce as part of the project delivery process, as opposed to set intervention points, such as those which apply to the ISC process.

PAS 2080 has an opportunity to unite the industry and enhance outcomes by being flexible with emerging technologies, producing measurable results and making a real difference on climate change impact in infrastructure procurement, delivery and operation.

Therefore, the implementation of PAS 2080 through augmentation of the current TMR PAF and delivery frameworks can only provide positive outcomes through carbon and cost reductions. Meeting all the requirements of the TMR sustainability policy and with many organisations already focusing on their own internal Net Zero journey, PAS 2080 has an opportunity to unite the industry and enhance outcomes by being culturally led, flexible with emerging technologies, producing measurable results and making a real difference on climate change impact in infrastructure procurement, delivery and operation.

Industry Feedback

The Queensland Team engaged different areas across TMR from strategic policy through to the collaborative procurement project team for feedback on the benefits of PAS 2080 and how it could be adapted to existing TMR procurement processes, especially focused on the sub- $100M transport infrastructure contracts – construct only, noting that the greatest opportunity to decarbonise is in the planning phase of an infrastructure project.

TMR's Manager (Sustainability) Claire Thorstensen, identified that there is growing evidence to support the value that other countries (like UK and NZ) are accruing from the application of PAS 2080, and a need to undertake a pilot to assess the best way to compliment the existing processes and understand the value that can be achieved.

Additionally, Adam Williams, Director (Strategic Procurement) has acknowledged that the effort of the Queensland Team in outlining PAS 2080 and a potential alignment to current TMR processes and was extremely positive about how it could be utilised within the new collaborative infrastructure procurement framework that TMR has been consulting industry on to help achieve better industry engagement across a multitude of factors including sustainability.

Conclusion

Globally, concern continues to grow around the impact of climate change on standards of living and economic activity, with much focus placed on the reduction of carbon emissions. As infrastructure is both a large direct and indirect contributor to carbon emissions, solutions lie within its delivery in management for climate change action. The State of Queensland has an unprecedented infrastructure investment portfolio to be delivered and managed over the next decade, which provides significant opportunity in the management and reduction of carbon within its transport infrastructure projects. International best practise and current project delivery evidence from regions of the United Kingdom, United Arab Emirates and New Zealand, show that the reduction of carbon emissions is not only possible, but also results in a reduction in total infrastructure cost. This was achieved through the use of the PAS2080 process and the ICR Carbon Reduction Hierarchy implemented at the initial stages of the project delivery process. By targeting sub-$100M projects within Queensland, motivation is aimed to create a step change in the procurement and operation of infrastructure, which will serve as an example for larger infrastructure projects to follow. The PAS2080 process works as a whole of project lifecycle process driven by culturally led goals where the status quo is challenged. Its flexibility allows for introduction of emerging materials and technologies while catering for the local nuances ensuring minimal impact to delivery and maximum impact to carbon reduction, of which may be neglected by current industry environmental and sustainability initiatives. TMR has indicated the desire to undertake a pilot program using the PAS20280 delivery framework, indicating the framework's real potential for carbon reduction in infrastructure projects. It is anticipated the State of Queensland will experience the benefits through the reduction in infrastructure emissions, similar to those demonstrated by International projects delivered under PAS2080, and the continual improvement to the delivery process, further reducing emissions as investment in infrastructure progresses toward net zero by 2050.

References

References in this document are notated by inline numbering. E.g. [1]

[1] Roads Australia Fellowship Program – 2022 https://roads.org.au/diversity/fellowship-program/

[2] RA 2022 Fellowship Project (E-mail) | Group Research Project, Michael Kilgarif, RA CEO, 23 May 2022

[3] Industrial Decarbonisation Strategy – March 2021 - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/970229/Industrial_Decarbonisation_Strategy_March_2021.pdf

[4] Publicly Available Specification (PAS) 2080:2016 (PAS 2080), https://knowledge.bsigroup.com/products/carbon-management-in-infrastructure/standard

[5] Guidance Document for PAS 2080 – Construction Leadership Council – Various Authors, https://www.constructionleadershipcouncil.co.uk/wp-content/uploads/2019/06/Guidance-Document-for-PAS 2080_vFinal.pdf

[6] Journey to Net 0 – Infrastructure Sustainability Council, Various Authors (KPMG, RA, ARA, ARUP), 2022 - https://www.iscouncil.org/journey-to-net-zero/

[7] Affirming Australia's Net Zero emissions by 2050 target, Australian Government, Dept. Climate change, Energy the Environment and Water, 29 July 2022 - https://www.dcceew.gov.au/about/news/affirming-australias-net-zero-emissions-by-2050-target

[8] Climate Change Bill 2022, Parliament of Australia, House of Representatives, 13th Sept 2022 - https://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22legislation%2Fbillhome%2Fr6885%22

[9] The Paris Agreement, United Nations Climate Change, 29/09/2022, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

[10] Meaningful measurement for whole-life carbon in infrastructure, Institution of Civil Engineers (UK), 2022-04-13-meaningful-measurement-for-whole-life-carbon-in-infrastructure.pdf (ice.org.uk)

[11] Reshaping Infrastructure for a Net Zero emissions future, various authors, March 2020, https://www.iscouncil.org/reshaping-infrastructure-for-a-net-zero-emissions-future/

[12] Department of Transport and Main Roads Strategic Plan - https://www.tmr.qld.gov.au/About-us/Corporate-information/Publications/Strategic-plan

[13] Decarbonising Infrastructure, Infrastructure Partnerships Australia, 21 April 2022, https://infrastructure.org.au/decarbonising-infrastructure/

[14] Decarbonising Construction: Putting Carbon in the Business Case, Infrastructure Partnerships Australia, 29 August 2022, https://infrastructure.org.au/decarbonising-construction-base-case/

[15] Energy Transitions Commission. 2022. Industry, https://www.energy-transitions.org/sector/industry/

[16] Record investment in Queensland's transport infrastructure, Qld Government, 21 June 2022 - https://statements.qld.gov.au/statements/95471

[17] Cement – Energy Transitions commission, 2022 - https://www.energy-transitions.org/sector/industry/cement/

[18] Steel – Energy Transitions Commission - https://www.energy-transitions.org/sector/industry/steel/

[19] Review of Emissions Reduction Opportunities, Report for Department of Planning, Transport and Infrastructure. January 2019, South Australian Government Department of Planning, Transport and Infrastructure & Edge Environment, accessed online - https://www.dit.sa.gov.au/__data/assets/pdf_file/0005/528728/DOCS_AND_FILES-13564957-v1-INF065_FinalReport_rev2.pdf

[20] H. Alzard, Mohammed H., "Assessment of Carbon Emissions of Road Projects and Development of a Framework for Carbon Footprint Calculation of Roads in the City Of Abu Dhabi" (2018). Civil and Environmental Theses. 14. https://scholarworks.uaeu.ac.ae/civil_enviro_theses/14

[21] PAS 2080: 2016 *Carbon Management in Infrastructure,* Green Construction Board, The British Standards Institution, 2016.

[22] Davide Stronati (2019). Why carbon is key to success. [Online] from https://www.mottmac.com/views/why-carbon-is-key-to-success.

[23] Global Railway Review (2020) HS2 becomes second global client to achieve PAS 2080 accreditation. [Online] https://www.globalrailwayreview.com/news/113475/hs2-achieves-pas-2080-accreditation/

[24] Construction Sector Accord (2020). Watercare – partnering for carbon reduction. [Online] https://www.constructionaccord.nz/assets/Construction-Accord/files/watercare-beacon-case-study.pdf

[25] BSI group. How a fast-track standard helps reduce infrastructure carbon emissions. [Online] https://www.bsigroup.com/globalassets/documents/energy/pas-2080_bsi.pdf)

[26] Rachel Lynskey, C. C. (2021). *Australia's transport emissions: the role of infrastructure in reaching zero emissions*. Retrieved from Climatework Centre: https://www.climateworksaustralia.org/news/australias-transport-emissions-the-role-of-infrastructure-in-reaching-zero-emissions/

[27] Suryan, L. Daoutis, G. & Girrbach, L. (2020) *Cut Carbon, Cut Cost – Feasibility of Applying PAS 2080* [Online] https://core.ac.uk/download/pdf/322372476.pdf

[28] Queensland Indigenous (Aboriginal and Torres Strait Islander) Procurement Policy (QIPP), Department of Aboriginal and Torres Strait Islander Partnership

[29] Mott Macdonald (2022). *Cutting Carbon, saving money.* [Online] https://www.mottmac.com/goal-13-cutting-carbon-saving-money

[30] QTRIP 2022-23 to 2025-26: Queensland Transport and Roads Investment Program 2022–23 to 2025–26 (Queensland Transport and Roads Investment Program 2022-23 to 2025-26) (tmr.qld.gov.au)

[31] Project Cost Estimating Manual: https://www.tmr.qld.gov.au/business-industry/Technical-standards-publications/Project-cost-estimating-manual