WWF

REPORT

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THE TIME IS NOW:
TACKLING EMBODIED CARBON IN THE BUILDING AND CONSTRUCTION SECTOR

This work is proudly funded by the NSW Government

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WWF-Australia acknowledges the Traditional Custodians of Country throughout Australia and their continuing connection to land, water and culture. We pay our respects to their Elders - past, present and emerging.

WWF is one of the world's largest and most experienced independent conservation organisations, with over five million supporters and a global network active in more than 100 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

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Foreword

Wherever they operate, businesses have an impact on the environment. As our natural resources continue to diminish and our carbon emissions climb, we are learning that many traditional production practices are not sustainable, and often contribute to global environmental challenges. For over 40 years, the World Wide Fund for Nature (WWF) in Australia has worked in partnership with businesses and industry organisations to reach solutions that work for business, the environment and the community. As with any relationship, we do not always agree with our partners. However, working with openness, using evidence to inform decisions, and by sharing a sense of mutual purpose, we are able to achieve great things for the future. Since 2018 , WWF-Australia has worked successfully to support business and organisations through the purchase of large-scale off-site renewable energy through our Business Renewables Centre-Australia (BRC Australia). And we are also instrumental in helping companies set science-based emission reduction targets for direct business emissions (Scope 1 and 2) and value chain (Scope 3) emissions.

2020 is a different year. The world is facing a once-in-a-lifetime challenge as we start to rebuild the economy from COVID-19. It could also be Australia's once-in-a-lifetime opportunity to bring manufacturing back to our shores, grow existing industries, unlock new industries and boost global exports as we also move towards a zero carbon future. We could emerge from this crisis as a renewable energy powerhouse in a post-COVID world including reimagining how we manufacture low and zero carbon products. Recognising the growing demand for lower-carbon materials worldwide, WWF-Australia is keen to explore the intervention points to drive the transformation of the building and construction materials industry in NSW, to move Australia towards a zero-carbon economy and position Australia in the top five zero-carbon materials suppliers.

The built environment sector is responsible for one quarter of Australia's emissions. The steel and cement industries each represent about 7% of global emissions. Reducing the emissions intensity of those sectors will be fundamental to achieving a zero carbon economy. Bringing different sectors together and gaining a better understanding of barriers to uptake will be vital to moving ahead. Supported by the NSW Government, WWF-Australia is bringing together various conversations across the building and construction sector to help accelerate this shift.

We have undertaken desktop research, including interviews with key players. This report will go towards shaping our first high-level industry event with participants across the supply chains, which will then develop into a plan of action that defines roles for government, industry and consumers to play.

Fundamentally, there is no single solution or intervention point. This requires a systemic view of the barriers, and therefore the opportunities for intervention. Transformational change is needed, with leadership at all levels, and decisions driven by the need to decarbonise at a rapid rate to keep warming at 1.5°C and ensure the achievement of the Sustainable Development Goals. In particular, SDG number 17, which seeks to strengthen global partnerships and bring together national governments, the international community, civil society, the private sector and other actors, will be fundamental to this being successful.

Executive Summary And Recommendations

The NSW Government has aligned itself to the Paris Agreement to deliver a net zero carbon society by 2050. They have released their Net Zero Plan Stage 1 2020-2030 program earlier in the year as an early step towards supporting the reduction of embodied carbon in the building and construction sector. This plan does come with both opportunities and challenges, and will require collaboration across all parts of industry and government. Taking a science and research-based approach, WWF interviewed over 30 professionals across different parts of the industry supply chain. These are our insights from the interviews.

There is a clear role that **governments at all levels can play to create critical demand for low- and zero-carbon construction materials.** As the largest procurer of building and construction projects in the state, the NSW Government has sufficient buying power to strongly influence the direction of the market to purchase more low-emissions building materials. In particular, the industry leaders we interviewed encouraged the government to send the right signals to the market by committing to specific targets for net zero materials as an explicit subset of the Net Zero Plan, starting with identifying the priority materials and a trajectory to net zero for each material, while still allowing for necessary competition between materials.

The **four roles for government action** are: a) procurement, b) policy and regulation, c) planning, and d) whole-of-government coordination.

We heard from our interviewees that there are multiple levers that need to be moved at once, that state governments are well-positioned to lead a broad transition, and that "both positive regulation and government procurement signals are needed".

An **"Impact Procurement"** approach - where anchor customers buy strategically and at scale as a precursor to switching to low-carbon materials in the near future - was welcomed by many of our interviewees as a way of transforming local supply chains. An Impact Procurement approach would also be a significant change to current procurement practices, which are reportedly based almost entirely on price (time-cost-quality is the current paradigm) with innovation not rewarded and actively discouraged. A concept that was supported by many interviewees was an alliance of buyers, an impartial body that can support, advise, and connect aligned parties on the path to decarbonisation. To this end, we propose the establishment of a ***Buyers Alliance for Reducing Embodied Carbon in Construction***. The scope of such an Alliance would be in three key areas: a) aggregation of demand and supply; b) knowledge sharing; and c) pre-competitive collaboration across industries.

Design optimisation was raised by the interviewees in the developer, contractor and customer parts of the sector ecosystem as having significant potential to reduce embodied emissions by designing-out unnecessary materials, operational emissions and unnecessary energy load. **Making every decision count towards a zero-carbon future** using thoughtful design processes could yield considerable benefits.

Interviewees emphasised the importance of **not locking ourselves into incumbent materials in the design process.** Rather, we should first consider the functions of materials required in construction projects, and then think afresh about the best materials to achieve those functions. Such an approach to buildings might look at, for example: structure, envelope, building operating systems (heating, cooling, lighting, lifts, fire systems), and finishes rather than starting with the materials (such as steel, concrete and aluminium).

Nonetheless, some interviewees were concerned that leaving it to customers alone to request these lower/zero carbon materials would not drive sufficient change. They indicated that we need both customer pressure and industry

transition plans for each material. Customer pressure can be effective where industry action does not keep pace with the urgency of the challenge, and a **Buyers Alliance** could assist in giving voice to this urgency.

Manufacturing solutions exist, to varying degrees, for steel, concrete, and aluminium. The report goes into greater detail on **concrete, steel, aluminium and substitute materials such as cross-laminated timber.**

However, **innovation** also has a major role to play, especially as we move from low-carbon to zero-carbon materials. There are many opportunities to reduce the embodied carbon incrementally, but for some materials, once early gains have been made, innovation is needed to either find alternative processes to cut emissions further, or to find zero-carbon alternatives to replace the conventional materials. From this perspective, there is a need to leapfrog pilot trials to "deep demonstrations".

While Australian innovation in low-carbon materials is strong, this innovation is not translating into large-scale use in construction projects due to the barriers identified. However, with the right kind of partnership and support, we could leverage this opportunity to build a low-carbon materials industry in Australia. Thoughtful procurement can drive the process and build resilient, local supply chains that add value to Australian primary resources and lessen our dependence on imported materials.

Green hydrogen has been spoken about as a solution to decarbonise manufacturing, such as in the case of steel. However, hydrogen electrolysis at the required scale is still some years away. Rather, an opportunity that exists now, that can be realised with government leadership, is to work towards an industrial cluster, say in the Hunter region, that could provide multiple options for transitioning local manufacturers towards a **zero-carbon industry precinct.** An ARENA-funded or similar feasibility study was suggested as a reasonable next step.

Private capital is one of the drivers for decarbonisation in the construction sector ecosystem. Parts of the finance sector are actively seeking investments that reduce their climate risk exposure in line with the Paris Agreement commitments. This includes physical, transition, and liability climate change risks. As developers start to understand the benefit of attracting carbon-conscious capital, they will in turn seek suppliers that can offer lower- or zero-carbon materials. To appeal to private sector investors, these projects need lower risk profiles through reduced interest rates and longer loan terms, perhaps underwritten by governments, for example through state treasuries or the Clean Energy Finance Corporation. **A Facility for Reducing Embodied Carbon** could finance projects across a number of industry sectors including industrial decarbonisation while at the same time stimulating local job creation.

Recommendations:

1. There is no one single intervention. The most significant shift will require addressing a number of the barriers and collaborating to achieve real and lasting change - a systems-led approach across the entire building and construction sector *ecosystem* will provide the best chance of success. Government and industry leadership will both play a fundamental role in setting expectations that every decision should count towards achieving a zero-carbon future, and this needs to be encouraged and rewarded.
2. The strongest theme in our research was that government procurement is a key lever for change, particularly in infrastructure projects. NSW Government leadership on procurement for contracts that goes beyond traditional time, cost, and quality is needed.

3. Private sector developers and constructors are willing to step up and deliver low-emissions building materials but need collaboration to drive the change all across the supply chain. Collaboration between and across industry sectors and government will be the key to success through an alliance or partnership approach. A **Buyers Alliance for Reducing Embodied Carbon in Construction** would have three key roles, namely: a) aggregation of demand and supply through 'anchor customers'; b) knowledge sharing across industry sectors; and c) collaboration between industry sectors.
4. Construction contracts that require and specify lower- and zero-carbon products with voluntary targets are considered global best practice and should be actively encouraged and duly rewarded by the Infrastructure Sustainability Council of Australia (ISCA), Green Building Council of Australia(GBCA)'s Green Star rating system and other mechanisms.
5. There is a need to actively embed low- and zero-emissions material building standards into the National Construction Code, as well as existing and new rating systems.
6. Innovation across materials and industries can drive change, including systems thinking from the design and conception stage, and building resilient and local supply chains to reduce our dependence on imported materials. A Hunter Valley industrial precinct cluster with "deep demonstration" projects could provide multiple opportunities for local manufacturing of zero carbon building materials. A feasibility study could be investigated with support from industry and government.
7. Investors are increasingly concerned about their climate risk exposure in line with the Paris Agreement's commitments to net zero by 2050. Consideration could be given to a Facility for Reducing Embodied Carbon underwritten by governments either through state treasury and/or the Clean Energy Finance Corporation to help finance decarbonisation projects across a number of industry sectors.

1. INTRODUCTION - CHALLENGE, OPPORTUNITY, BARRIERS AND DRIVERS

1. Introduction - Challenge, Opportunity, Barriers And Drivers

While the Covid-19 pandemic is the immediate challenge facing governments, businesses and communities globally and locally, countries that have applied a science-based approach have demonstrated the most success in tackling the pandemic. Collaborative problem solving and systems thinking are proving that we can successfully tackle a massive global challenge.

Likewise, climate change poses a threat on a global and local scale, and the Paris Agreement sets out a science-based pathway for global cooperation towards achieving net zero by 2050 and halving emissions by 2030. Having learnt from the Covid-19 response, we know that taking a science-based approach to collaborative problem-solving can guide governments, businesses and communities as we tackle climate change. Throughout the research for this report, we applied a systems approach towards reducing the embodied carbon of the building and construction sector. No one silver bullet will achieve the large-scale changes needed.

The Challenges

GLOBALLY, CONSTRUCTION IS A HUGE CONTRIBUTOR TO GREENHOUSE GAS EMISSIONS WITH PRODUCTION OF CONCRETE AND CEMENT MAKING UP 8% OF TOTAL GLOBAL EMISSIONS.

Transitioning to low- and zero-carbon building and construction materials is complex. Not only because of the size and significance of the building and construction sector ecosystem in our economy, but because of the size of its carbon emissions footprint and value to the Australian economy. Construction represents between 10% and 15% of Australian GDP, with roughly a third of this value is attributable to construction materials. Globally, construction is a huge contributor to greenhouse gas emissions with production of concrete and cement making up 8% of total global emissions. That's more than the operating emissions from all the cars in the world. And steel is another 7%. The challenge is compounded by the complexity of the *ecosystem*, the number of moving parts, decision points and the cultural aversion to risk in the sector.

However, the transition to a zero-carbon economy has begun, and each of the industry participants interviewed recognised that change *has* started, and have sought to further accelerate the changes.

Recognising the complexity of the sector *ecosystem* is central to the call for a systems approach to the solution. Action and intervention is needed at each point of the value chain: customers, engineers, contractors, sub-contractors, material providers. Put another way, there are no silver bullets. But with 100 per cent renewable energy inputs including electricity and industrial processes, waste as a material input, using less material through better design, and embracing circular economy principles, collaborative procurement and a clear direction set by government projects, the market can and will respond.

For major property companies, the Scope 3 embodied emissions might be ten times those of scopes 1 and 2. As one of the developers said, embodied carbon is "our biggest challenge and the one we don't have good answers to. We rely on the supply chain to come to the party. It is much less in our direct control. We can't lead without progress on this".

That same developer commented that "there'll be a tipping point when a chunk of the market has carbon targets". We know that already some in the industry have set net zero targets for 2050, not least the NSW Government.

The Opportunity

"We are holding the pen that is writing our history," Christiana Figueres [1] said to an audience at UNSW in April 2020, and this sums up the opportunity we have to create a zero-carbon future. The post-Covid recovery provides an ideal time to reset key economic indicators to include Scopes 1, 2 and 3 carbon emissions as important

[1] Christiana Figueres in conversation with Professor Emma Johnston, the UNSW Dean of Science at UNSW on 9 April 2020

performance metrics. Directing recovery efforts into economic activities that head NSW along the zero-carbon pathway will help ensure long-term viability of the state's economy and is perfectly aligned with the NSW Net Zero Plan Stage 1: 2020-2030.

Like Covid-19, we must take decisive action. We don't have time for incremental change. A step change is needed. The scale of emissions from current practices is so large that rapid decarbonisation is required across all parts of industry. Fortunately there is much that can be done quickly through coordinated action by government and major industry participants on a pathway to decarbonisation.

Barriers

We know that in addition to there being no single solution, there are multiple substantial barriers to be overcome if the building and construction industry is to dramatically cut its embedded emissions. Developing a very clear picture of those barriers and how they can be overcome is therefore part of this research.

THERE IS ENOUGH INFORMATION AND ENOUGH AVAILABLE MATERIALS, THE MAIN BARRIER IS **RESISTANCE TO CHANGE.**

Changing the material inputs, design and procurement processes and building techniques will be difficult. Furthermore, it is widely recognised that the building and construction sector is conservative and tends to resist change. We recognise that many existing practices are entrenched, often for sound reasons of structural integrity, keeping costs down, continuity of supply and managing risks. Decisions are made on cost, quality and time. Currently, little attention is given to embodied carbon and with limited or no pressure to innovate or collaborate. In an economic environment where there is no price signal on emissions or incentive to reduce embedded emissions, there is little commercial reason for the sector to change.

One of the interviewees commented that "there is enough information and enough available materials, the main barrier is resistance to change".

Drivers

Despite the barriers, change is underway. We sought to understand what is driving the early movers. When asked about the primary drivers for embarking on the transition to low- and zero-carbon construction materials and developments, the interviewees uniformly indicated that it was their investors who were expecting this. One industry participant summed it up: *"this is being driven first by investors, second by the market."*

Capital markets are already beginning to recognise the risks posed by climate change and are seeking low carbon investments. Armed with the Taskforce for Climate-related Financial Disclosure (TCFD) framework, and with a clear understanding of the Paris Agreement, the investment community looks to be the leading player in this area: *"It's all about finance; this is a CFO conversation."*

With private capital taking the lead, it is clear that there is an opportunity to harness the sector's expertise and to increase the access to capital for suppliers and developers alike.

In some sectors of the market, there is an emerging customer demand for reduced embedded carbon in construction projects, namely the infrastructure sector. The market take-up of the Infrastructure Sustainability Council of Australia (ISCA) IS Tool demonstrates this, particularly for large projects worth over $50m. We also learnt that the residential building sector, responsible for 12% of Australia's emissions, is only just beginning to address operational energy efficiency and emissions, putting them way behind in mainstreaming demand for low or zero embodied emissions.

Investors are starting to understand the downside risks, developers are starting to understand the upside market advantages. The NSW Government's Net Zero Plan of action will help drive the changes and address the barriers.

THE RESEARCH APPROACH - SECTORS AND INDUSTRIES COVERED

WWF-Australia, with consultants from Presync, interviewed 32 participants across different parts of the building and construction industry supply chain, or the *ecosystem* as we came to define it. The insights from these conversations are the basis of the findings in this report.

PART OF THE ECOSYSTEM	NO. OF INTERVIEWS
Building and construction contractors	8
Material suppliers	6
Policy experts/advocates	6
Government infrastructure "clients"	2
University researchers	3
Government entities	4
Rating scheme bodies	3
Total	**32**

The interviews sought to understand the various perspectives of the key players of the ecosystem, to learn about the opportunities, barriers, and levers for change in producing and using zero-carbon construction materials.

The key materials addressed in the interviews were:

- Steel
- Cement and concrete
- Aluminium
- Copper
- Bricks, tiles and masonry
- Glass
- Asphalt
- Timber

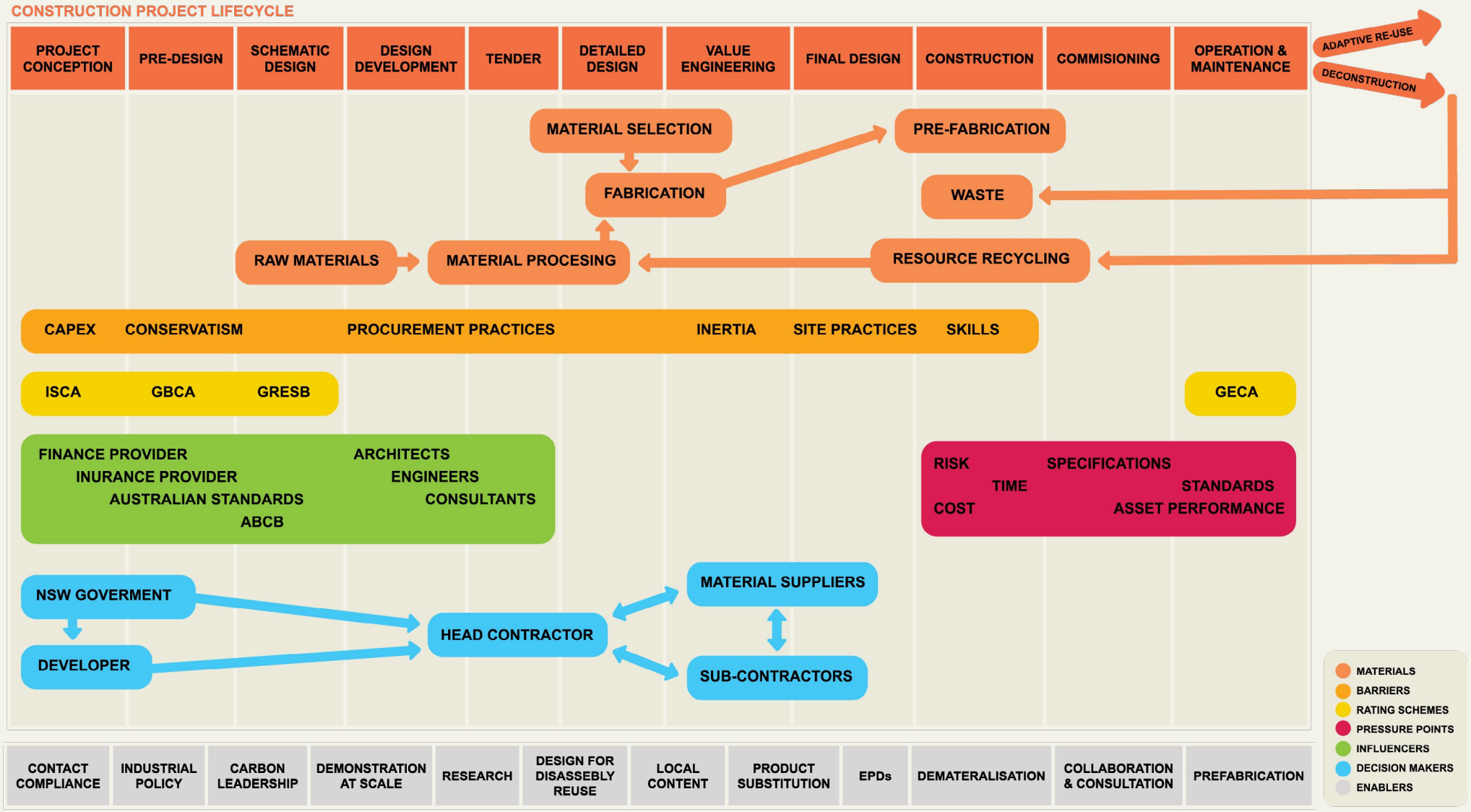
2. Main Finding: Multiple Intervention Points Necessary

A system-wide approach is needed with multiple intervention points to affect change. A central insight from the research is that the building and construction industry is made up of a complex ecosystem with many participants and sub-systems, both local and international. To successfully change the carbon performance of the system requires an appreciation of the complexity of the ecosystem, but also an understanding of the points of greatest influence.

This diagram captures the main components of the ecosystem that surround the construction project lifecycle.

FIGURE 1

ECOSYSTEM OF CONSTRUCTION AND PROJECT DECISIONS



Enablers

There are many factors that can be considered as enablers of change towards low- and net zero carbon construction materials. These include:

a. strong carbon leadership by government and companies;

b. ensuring contract compliance to lock-in low- and zero-carbon outcomes;

c. sharing of research and case studies where low- and zero-carbon have been used;

d. product substitution that sees a carbon-intensive material replaced by a low- or zero-carbon alternative;

e. avoiding and recycling demolition waste;

f. designing for disassembly and re-use;

g. collaboration and co-design between engineers, contractors, sub-contractors and clients; and

h. dematerialisation and environmental product declarations (EPDs).

GOAL TO REACH
NET-ZERO
EMISSIONS BY
2050

Decision-Makers

There are many decision-makers throughout the building and construction ecosystem with the capacity to influence the carbon performance of a given project. The NSW Government is the largest procurer of building and infrastructure projects in the state. Their tremendous buying power and the facility to influence projects will lay the foundation for NSW's action on climate change and the goal to reach net zero emissions by 2050. Developers are clearly key decision-makers in the development lifecycle as are contractors. Conventionally, competition for contracts is based on time, cost and quality, but if carbon emissions become an evaluation criterion, then it will be in their interest to reduce the carbon intensity of the materials used. Material suppliers obviously respond to market demands, but can also play a role in developing low- and zero-carbon materials.

Influencers

There are many parties that influence a project, whether implicitly or explicitly. Understanding the roles and point of influence of each party will be important in achieving systemic change. Government infrastructure bodies that tender projects can bring huge influence to bear on all their projects. Finance providers are sending strong signals to industry investment decisions, and therefore the flow of capital is becoming increasingly aligned with the Paris Agreement and actively seeking low- and zero-carbon assets. Similarly, insurance providers recognise the huge exposure of many asset classes to the physical, transition, and liability risks posed by climate change. They are seeking to de-risk their exposure, thereby making low- and zero-carbon assets more attractive. Australian Standards, the Australian Building Codes Board (ABCB), and rating tools can play a role via standards and codes that recognise the benefits of low- and zero-carbon materials. In the design process, architects and engineers have significant influence over the selection of low- and zero-carbon materials, including considerations for dematerialisation, disassembly and re-use. Consultants, including urban planners, energy, approvals, communications, all influence elements of construction and infrastructure projects. Their advice can foster or hinder decarbonisation.

Barriers To Change

There are many barriers to changing the way designs are prepared, materials are specified, and projects are procured. Capital expenditure (CAPEX) is often the top priority when major projects are being designed and bought, especially when the public purse is involved. As low-carbon practices become business-as-usual, costs will come down with economies of scale, so fostering change at scale will be needed

to achieve longer-term savings. Conservatism and sticking to what is known is a well-recognised barrier to change. For good and obvious reasons, engineers and construction managers can be risk-averse which can lead to a reluctance to consider alternative materials and methods. This, coupled with the pressure to keep costs low, stifles innovation. The site practices and skill levels of building and construction teams can prevent change due to a preference for what is known and can be done easily. Dealing with new materials,changing practices and up-skilling takes time and money. There is considerable inertia and path dependency in project delivery that helps maintain the known and safe way of doing things. This can make a lot of sense from a quality perspective, but if business-as-usual is high-carbon, then the inertia must be recognised and overcome.

Procurement policies and practices that have been designed to prevent collusion can inadvertently prevent collaboration between suppliers, designers and clients during the pre-design and design development stages of a project.

Pressure Points

Project pressure points can also act as barriers to change at the project delivery stages, and then feed into the design stage. These pressure points include risk aversion in project delivery, which is understandable but not insurmountable. Avoiding the unknown is a known way to reduce risks, but will also hinder innovation. Controlling the cost and time of project delivery are central to successful project management and so changes that put either at risk are generally avoided. Meeting the project specifications is contractually non-negotiable. Once the specifications have been established, it is highly unlikely that a contractor can make changes, even if they represent an improvement in carbon or any other dimension of performance. At times, adhering to standards will result in a "lowest common denominator" outcome without any impetus to consider alternative, new, or better approaches. Ensuring good asset performance over its lifetime should be the objective of the construction process and can, therefore, be used to influence design decisions. Locking in a metric of embedded carbon, intensity and the amount of carbon saved or avoided in absolute terms, could become a foundational performance criterion against which the construction project lifecycle is measured.

MATERIAL SELECTION HAS A **MAJOR** INFLUENCE ON THE TOTAL LEVEL OF EMBEDDED CARBON

Rating Mechanisms

Rating mechanisms can have a positive influence on project design, construction and performance and can be a major lever in the shift to environmentally sustainable development (ESD). The Infrastructure Sustainability Council of Australia (ISCA) has developed the IS Rating Scheme (IS), which is Australia and New Zealand's only comprehensive rating system for evaluating sustainability across the planning, design, construction and operational phases of infrastructure programs, projects, networks and assets. The Green Building Council of Australia (GBCA) is a leading industry body that has developed and administered the Green Star tool to assess the sustainable design, construction and operation of buildings, fitouts and communities. Other mechanisms include the Global Real Estate Sustainability Benchmark (GRESB), an international benchmarking scheme focused on the environmental, social and governance (ESG) performance of real estate assets and Good Environmental Choice Australia (GECA), an eco-labelling service aimed at architects, builders, designers and consumers to provide confidence in the sustainability performance of a range of products such as furniture, furnishings, appliances, and office equipment.

Materials

Material selection has a major influence on the total level of embedded carbon of a project and should be considered in terms of carbon performance in addition to the usual considerations such as fit for purpose, structural integrity, cost and availability. There are many factors that influence the embedded carbon in building

and construction materials. These include the process of mining or harvesting raw materials, leading to varying levels of carbon emissions. Some material processing can be significantly more carbon intensive than others, such as cement-making for instance, due to the chemical reaction in the processing of the limestone to make Portland cement. Other process emissions depend largely on the source of electricity used, such as aluminium smelting and fabrication. Many materials from construction and demolition waste can be reused or recycled, preventing the need for additional virgin materials being harvested. Waste can be reduced by many upstream decisions and should be the last resort in the materials management hierarchy. There are cost savings and business opportunities from post-construction recycling and the circular economy that are yet to be fully realised.

Environmental Product Declarations (EPD) can play an important role in understanding the lifecycle environmental impact of a product, including embodied carbon, and can contribute to making informed design and procurement decisions. By providing an independently verified and transparent set of data, EPDs allow comparison between alternative products and are recognised under the Green Building Council Australia's (GBCA) Green Star rating scheme and the Infrastructure Sustainability Council Australia (ISCA) IS tool.

As described by EPD Australasia "Multiple datasets are included in an EPD: resource consumption of energy, water and renewable resources, and emissions to air, water and soil. This data is aggregated using multiple environmental impacts including contributions to climate change (carbon footprint), air, water and soil pollution and resource depletion. Other relevant impacts and environmental information may also be included. This may include data on product performance, the company's environmental management system or other environmental certifications."

It is clear to see the value in the growing use of EPDs, however our research suggests that much more could be achieved if there was greater uptake of and requirements for EPDs. As one interviewee put it "some EPDs just don't exist. Governments could start saying we want an EPD product spec' for everything we build. That would change the market instantly because it is so transparent."

The ecosystem is complex but must be understood. Collaboration across multiple components of the system will be essential to drive low-carbon outcomes. It can be done!

3. LEADERSHIP OPPORTUNITIES FOR THE NSW GOVERNMENT

3.Leadership Opportunities For The NSW Government

STATE GOVERNMENTS ARE WELL POSITIONED TO LEAD A BROAD TRANSITION

Government Role

There is a clear role that governments at all levels can play to create critical demand for low- and zero-carbon construction materials. As the largest building and construction 'customer' in the state, the NSW Government has sufficient buying power to strongly influence the direction of the market to purchase more low-emissions building materials. By requiring and demonstrating that buildings and infrastructure projects minimise embedded carbon content, the government can influence the sector without having to directly regulate. We heard from a number of interviewees that "there is plenty to do and the state [governments] are well-placed to lead".

The NSW Government has a history of world-leading environmental programs such as GGAS, BASIX, NABERS and SEDA. [2] Now is the time to lead the world again, as set out in the NSW Net Zero Plan Stage 1: 2020-2030, Priority 4 - Ensure the NSW Government leads by example. The Plan was warmly received by all our interviewees. We heard that attitudes have been shifting within government and industry on the need for urgent action to reduce emissions including in embedded carbon, and this was the time for NSW to "seize its opportunity".

In particular, we heard encouragement for the government to send the right signals to the market by committing to specific targets for net-zero materials as an explicit subset of the Net Zero Plan, to identify the priority materials and as well as a trajectory to net zero for each material, while still allowing necessary competition between materials. This commitment would show a top-down commitment, a fair approach to individual sectors, and demonstrate that the government is willing to move away from the status quo.

The four roles for government action identified were procurement, policy and regulation, planning and whole-of-government coordination. We heard there are multiple levers that need to be moved at once, that state governments are well-positioned to lead a broad transition, and that "both positive regulation and government procurement signals are needed". Otherwise, as one interviewee said, "we are pushing it uphill without either regulation or end-user pull".

Procurement

The strongest theme in our research was that government procurement is a key lever for change, particularly in infrastructure projects. Leadership examples can also be found in the building sector. There are already examples of this, such as Sydney Metro's progress on sustainability - including on lower-carbon cement - which were part of its planning approvals. However we heard that other states are leading the way on coordinated government procurement aimed at transitioning local supply chains towards net zero materials. Often, the opportunity to make progress comes at no or low cost to the projects, and higher performance requirements would be welcomed by industry. This approach of "Impact Procurement" - where anchor customers buy strategically and at scale as a precursor to switching to low-carbon materials in the near future - was welcomed by many of our interviewees as a way of transforming local supply chains. Such impact procurement would include specific requirements to use lower-carbon materials and goes beyond a requirement for a certain sustainability rating. Absolute carbon targets rather than percentage reductions were recommended, to avoid the use of inflated baselines. The UK GBC approach to benchmarking and performance assessment was welcomed. Interviewees suggested targets should be "open-ended, technology-agnostic and supplier-agnostic", and we heard that "until [targets are embedded] in tenders it's just talk". Governments need to take a position then 'walk the talk'; some have

[2] GGAS (Greenhouse Gas Reduction Scheme); BASIX (Building Sustainability Index); NABER (National Australian Built Environment System); SEDA (Sustainable Energy Development Authority)

mentioned that the Queensland Government is becoming a leader in this respect.

Interviewees noted this Impact Procurement approach would be a significant change to current procurements, which are reportedly based almost entirely on price (time-cost-quality is the current paradigm) with innovation actively discouraged. Part of the problem is a reticence towards early engagement with industry. The understandable desire to avoid collusion can have the disadvantage of dampening collaboration and sustainability aspirations. Open pre-procurement collaboration can assist to "reduce material quantities by using better design, better quality materials and design-out excess materials at no overall cost increase". An example of progress on this approach is the North East Link project in Melbourne, where all shortlisted bidders engaged with the Victorian State Government as an industry, ahead of the tender.

THE PROCUREMENT APPROACH NEEDS TO BE **INTEGRATED** WITH SUSTAINABILITY STRATEGY, CONTRACT MANAGEMENT AND PROJECT DELIVERY. CONTRACT FLEXIBILITY **ENCOURAGES CONTRACTORS** TO FIND OPPORTUNITIES TO IMPROVE EMBODIED CARBON OUTCOMES WITH A REASONABLE APPROACH TO SHARING COST SAVINGS.

Rather than treating each project as separate, an iterative approach was recommended, with mandatory improvements to environmental outcomes over the previous project to "continue to raise the bar". One government source noted that "we got 80% of what we asked for over the last decade and moved the market, so maybe we should be asking for more". Interviewees challenged the assumption that ambition on low-carbon materials would add to project cost: "If you know how to ask the question you can get 10-20% reduction at zero cost". Proven methods, such as use of renewable energy for manufacturing of products - which offers long-term price stability and often savings, should now be required without exception in the same way that compliance with modern slavery laws is no longer a 'nice to have' but a 'ticket to entry'.

Importantly, the procurement activity discussed here should not be about trials or small-scale pilots. Quick action at scale is needed, and possible. Our interviewees saw a role for government to "find what works, test and bring to market safely at scale, then tell the market they are good to go". This should generate excitement, appetite for technological and commercial innovation, and encourage new contractors to enter the market, thereby broadening competition.

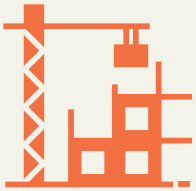
This approach needs to be coupled with a deep understanding, gained through market engagement, of the current state and trajectory to zero carbon for each major material. Proven improvements should be scaled up and projects used to test the next generation of improvements at scale. The ARENA model was mentioned favourably. In particular, the government's ability to look carefully at the potential of the technology to come down the cost curve, prospects for widespread demand, and supporting that process with funding, policy and procurement. This process will not be free from mistakes but those lessons need to be learned quickly. State governments also need to recognise lessons already learned elsewhere, even if these were interstate or overseas. Government could "bring forward 'no-regrets' opportunities and avoid locking in continued use of high-carbon materials".

The procurement approach needs to be integrated with sustainability strategy, contract management and project delivery. Contract flexibility encourages contractors to find opportunities to improve embodied carbon outcomes with a reasonable approach to sharing cost savings. The current process is reportedly "a nightmare, not structured for efficiencies, with minimal incentive to drive material change, so contractors try to hide the savings so as not to share them". To have impact, policy must be embedded into contracts.

Much of the construction material bought by the government today is imported, and Australian demand has limited influence on the direction of industries overseas. There is the opportunity to instead work with local manufacturers to help them along a pathway to leadership even if their products are higher-carbon than imported choices today. NSW's upcoming transport projects and the Western

Sydney Airport are prime opportunities to implement the change described in this section. Anecdotal wisdom from overseas also supports the notion that government procurement can help drive the required change. Lord Adair Turner, from the UK's Energy Transition Commission, said recently on a local webinar that "public procurement has a role to play in the transition (though shouldn't replace strong public policy)".

Role of Policy and Regulation



MANY IN INDUSTRY WOULD **WELCOME** REGULATORY INTERVENTION

As one of the interviewees noted, "these are not political issues, but about our survival as a species". Another said, "this is not just a supply/demand problem but an industrial policy problem".

While the single biggest driver of change to low-carbon materials would be a national carbon price, without exemptions for emissions-intensive industries, there are sectoral measures which could also be effective. Local manufacturers have an interest in low-carbon production, lest their exports become the subject of border tax adjustments. We heard that "demand is moving, the technology portfolio is starting to become clearer; politics may clarify and allow pragmatic progress on policy".

Many in industry would welcome regulatory intervention and this "can be a good thing for business if done well, as it is in Europe. Europeans don't even know that they can't buy non-FSC timber, because the regulations mean it is not allowed". Smart regulations can deliver, as NSW has proved in the past. Big property players are willing to invest and lead but "want to see movement from the government in raising the bar for all in the absence of a carbon price". Residential housing regulations were singled out as an area of weakness: "BASIX hasn't been significantly improved for 20 years, a national rating scheme will be a step forward".

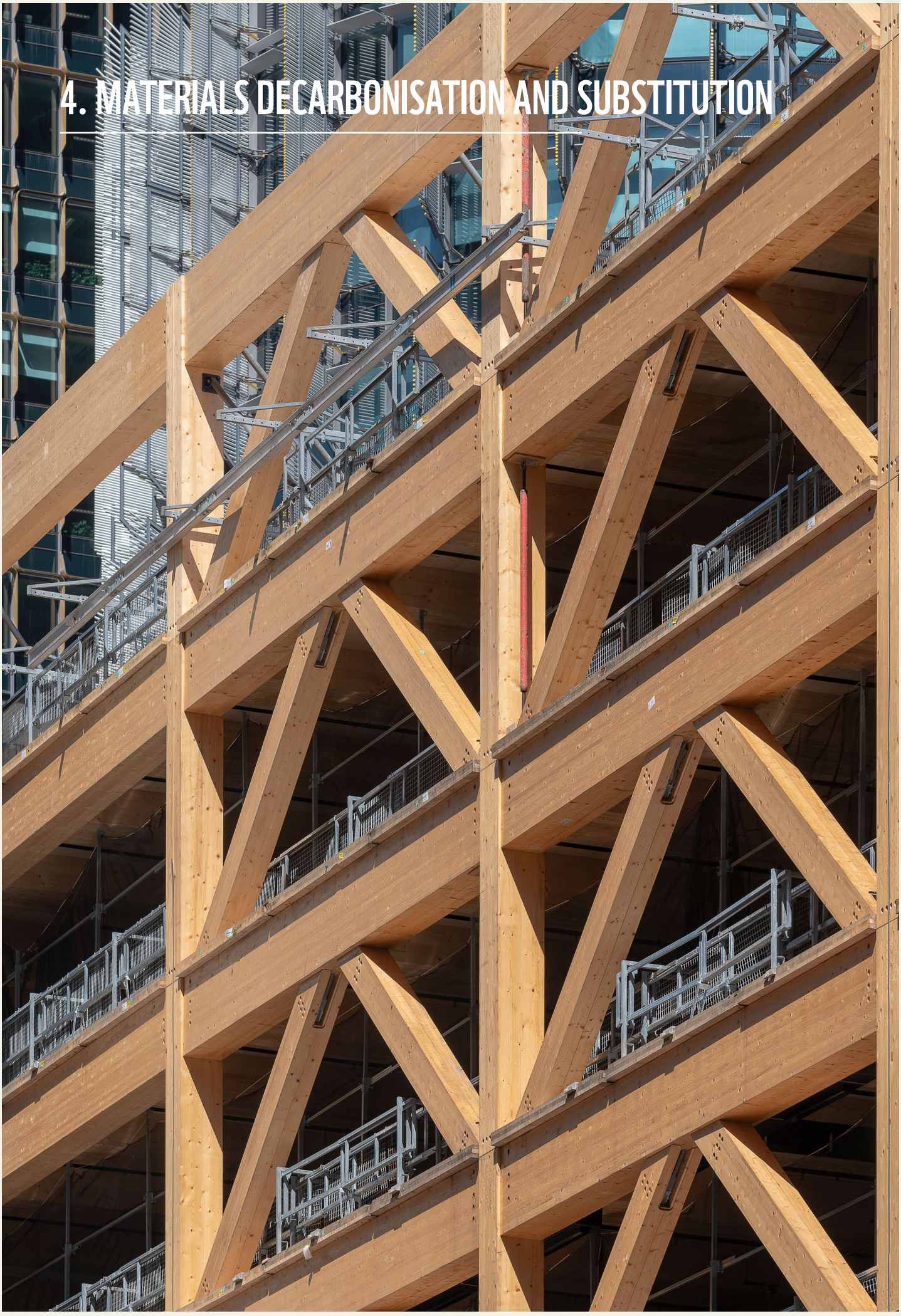
Planning

Planning approvals are a strong tool if aligned with procurement and regulatory action. Incorporating sustainability requirements into state and local government planning approvals is one way to match rhetoric with action, and the public commitments assist with compliance during delivery. The Sydney Metro project has demonstrated the benefits of this approach, which could be used more widely going forward.

Whole-of-Government Coordination

While differences between states are not unexpected, we heard about inconsistencies and poor communication between, and even within, NSW Government agencies: "there is no consistent policy or anything that would make it easier for a project director". A lack of ambition on this important issue can encourage uneven progress and internal tension; there are examples of parts of government which have adopted a welcome leadership position then being criticised for "going it alone". While an overarching vision and leadership commitment is clearly needed, progress doesn't have to be uniform. One interviewee suggested finding an agency that is keen on a particular opportunity, and with a director willing to be the champion, and let them demonstrate what is possible to the rest of government. Best practice would include engaging with industry stakeholders and other organisations already working in the area. It was suggested that the Department of Premier and Cabinet could play a role in coordination and that there are lessons to be learned from the Victorian Government's approach, which could help facilitate a "race to the top".

4. MATERIALS DECARBONISATION AND SUBSTITUTION



4. Materials Decarbonisation And Substitution

TRANSITION PLANS ARE NEEDED FOR EACH MATERIAL AND **CUSTOMER PRESSURE** CAN BE EFFECTIVE WHERE INDUSTRY ACTION DOESN'T **KEEP PACE** WITH THE URGENCY OF THE CHALLENGE.

It is important not to lock ourselves into incumbent materials without question, but to first consider the functions of materials required in construction projects, then reconsider the best materials to achieve those functions. We heard such an approach to buildings might look at, for example, structure, envelope, building operating systems (heating, cooling, lighting, lifts, fire systems), and finishes rather than starting with materials such as steel, concrete or aluminium. Competition between materials should be encouraged, and substitute materials actively considered. A price on carbon naturally favours low-carbon materials; in the absence of such a price, purchasers and industry need to factor in carbon content on all project decisions.

Timber can replace steel in buildings and is already doing so in residential construction, composites have replaced aluminium in aviation, and geopolymer concretes have been deployed at scale replacing Portland cement-based concrete. There is excitement about advanced manufacturing, including 3D printing, in construction and we heard this is coming "faster than we think" and has already been used for a concrete bridge in the Netherlands. This may enable the use of much less material in "skinny" structures as well as the use of alternative materials.

These three industries are complex with significant capital invested in manufacturing equipment, and we heard that this means it is "hard to turn these ships quickly". However solutions exist, to varying degrees, for each of these three materials, though some are concerned that it is not enough to leave it to customers to request these low/zero carbon materials. Rather, industries should lead, transition plans are needed for each material, and customer pressure can be effective where industry action doesn't keep pace with the urgency of the challenge.

While we consulted on a larger list of materials, we will concentrate here on concrete, steel, and aluminium, plus timber, which is a promising replacement material that also has potential for an extensive local supply chain.

Concrete

The concrete industry is dominated by global players and all the main manufacturers have a lower-carbon product ready when requested. Barangaroo was repeatedly raised as a project that demonstrated good carbon reductions in concrete. There are some "carbon-neutral concrete" claims around, but these rely on offsetting, seen as an easy way out that should not replace efforts in actual emissions reduction and technological innovation in its production.

Concrete consists of aggregate (often gravel or sand) and a binder (cement), often reinforced with a structural material. Emissions from concrete are mostly derived from the process of producing Portland cement from limestone. We heard there is also an opportunity to use recycled materials to replace aggregate, particularly substituting crushed glass for virgin sand. For example, an infrastructure player in Australia already requires 15% recycled glass sand, while an American firm uses limestone created from a carbon capture process to replace larger aggregates. On reinforcing, we heard that fibre can be a good alternative to steel, resulting in a lighter product so less structure is needed to support it.

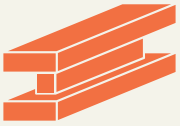
The emissions from creating Portland (limestone-based) cement derive from the chemical process of calcination of limestone to form lime, the active ingredient in cement. Much of our cement is currently imported and its sourcing can cause environmental degradation through limestone mining. One approach to reduce emissions in cement is carbon capture during this process, and the NSW company, Calix, has developed a promising capture technology which has received support from the EU as a Horizon 2020 project.

However, most of the progress on lower-carbon cement is from the displacement of some Portland cement with supplementary cementitious materials (SCMs), which

can include waste products from steel manufacturing and coal combustion: fly ash and blast furnace slag. We heard reports of SCM levels as high as 60% in a building 20 years ago and 70% on a recent roads project. Sydney Metro requires 40-50% SCMs as a minimum in contracts and one infrastructure company is aiming for up to a 90% reduction by 2040. [3] Barriers to high levels of SCMs appear to be less about technical issues but more resistance to change. Cure times can be longer but if understood up front, there can be no additional cost and no commercial or practical problems. Use of high levels of SCMs appears to be a "low-hanging fruit" measure ready for wide-scale deployment as an initial approach to substantially reduce the embodied carbon of concrete.

A more fundamental approach replaces Portland cement with geopolymer binders. Geopolymer concrete has around one-third the embodied carbon of conventional concrete and is one-fifth the weight, resulting in a substantial flow-on emissions reduction in transport. Geopolymer concrete is highly resistant to fire and many common concrete durability issues. Geopolymers require inputs with silicon and aluminium content like slag or fly ash, for which stockpiles remain for at least the next 20 years. Beyond that, clay-like materials can be substituted. Geopolymer plants, which do not require kilns, are cheaper to construct than Portland cement plants, and could be located near coal plants due to be decommissioned, creating new employment and business opportunities in regional communities. No new skills are required at construction sites. Geopolymer concrete has been used on projects including Toowoomba airport's runway, Sydney streets, a Sydney Metro viaduct, and Sydney Water tanks. We heard that geopolymers are a "game changer" as a lower-carbon, lower-cost, superior outcome; that Australian research and industry deployment over 20 years have evolved the technology massively, removed limits on its use and that "there is no reason why it shouldn't be our primary cement".

For geopolymer concrete's full potential to be unleashed, certainty of supply at scale needs to be improved. While available in Queensland and Victoria, we heard it is hard to get in NSW. This appears to be a state development opportunity and we heard the situation would change fast if Transport for NSW required use of geopolymers on its projects: "The suppliers are ready to go, there are loads of opportunities to start using geopolymers and enormous frustration on how difficult it is to get buy-in from government customers".



THE AUSTRALIAN STEEL SECTOR IS REPORTEDLY IN THE **TOP HALF** OF GLOBAL PRODUCTION FOR EMBODIED CARBON

Steel

The steel industry is global, though Australia maintains a substantial manufacturing capability. China and Europe dominate global production and progress is being made on decarbonising steel. We heard that it will be Europe, not Australia, that drives "green" steel production but we were encouraged by the opportunities for local industry to make progress. The Australian Steel Stewardship Forum initiative helped found the Responsible Steel Forum, now a global entity, which is working to develop further requirements for the responsible sourcing of input materials and for greenhouse gas (GHG) emissions. Meeting these requirements in addition to the already approved standard will allow steel sites to not only make claims about the way their site is operated, but also about the steel products they offer. The Australian steel sector is reportedly in the top half of global production for embodied carbon. While lower-carbon steel is likely available for import, this appears to be a case where it may be preferable to work with local industry on a low-carbon pathway to build local capability. A green steel industry was identified as Australia's best low-carbon transition opportunity by the Grattan Institute [4] based on its likely low-cost premium: Australia has all the necessary ingredients: the ore, low-cost renewable electricity enabling competitive hydrogen production, and the workforce.

[3] https://bze.org.au/research/manufacturing-industrial-processes/rethinking-cement/
[4] "Start with steel: A practical plan to support carbon workers and cut emissions" https://grattan.edu.au/report/start-with-steel/

Production of steel involves significant emissions, not just from the energy used, but from the chemical process (reduction) of iron ore to produce metallic iron. Carbon is the main reductant, resulting in direct carbon dioxide emissions. There are multiple technologies being progressed to reduce steel's carbon impact, including the use of waste or biomass to replace fossil fuels in the reduction process, carbon capture and the replacement of the carbon reductant with hydrogen. Another approach is the use of an electric arc furnace to reprocess used steel. Finally, an electrolysis process similar to that used for aluminum production and which promises much lower carbon steel is being developed in the US and Europe. Most in the industry see hydrogen direct reduction as the most promising path. However, it needs significant work and cost reduction for large scale deployment. Others believe the electrolysis path has potential to revolutionise rather than tweak the industry, as it is able to be deployed in small, modular facilities powered by renewable electricity, although this technology is likely to be decades away from commercialisation.

We talked to local manufacturers Infrabuild and Bluescope, both of which report progress on lower-carbon steel. Infrabuild has local manufacturing which is part of their global group's "Greensteel" journey towards net zero by 2030 (including some level of offsets). They report their use of renewable power purchase agreements, have electric arc furnaces in Sydney and Melbourne which use recycled steel as inputs, and other process improvements. The emissions intensity of their locally-produced steel is improving in a range of between 6 and 20% compared to a 2017 baseline and the business works with clients to customise products to reduce waste. Bluescope also has electric arc furnace production and a roadmap to a 12% carbon reduction at its Port Kembla blast furnace facility, through a series of process improvements (around 1% each year). It has investigated use of biochar as a coal replacement, carbon capture, and has, for example, worked with roofing material customers to improve product coating so steel thickness could be reduced. We heard that further gains are possible if customers engage with manufacturers early in the design process, for example by using reduced quantities of higher-grade steels. We have good visibility of the embodied emissions for local products due to the vertical integration and increasing transparency in the industry, whereas the full impact of imported products may not be known; plus there is anecdotal evidence that customers attribute value to the known sustainability credentials of Australian steel.

Steel is already heavily recycled and recycled steel avoids two-thirds of the carbon embodied in virgin steel, but we heard that "recycled content is not a proxy for low carbon steel". Industry argues that increasing demand outstrips the availability of recycled scrap, so requiring recycled content creates no difference at the system level as steel is already "as recycled as it can get". Others say there is an abundance of scrap but no easy way to salvage it, even before landfill mining which promises an incredibly rich future material resource. One possible area for progress is the designing of structures for disassembly and future re-use.

Aluminium

Aluminium production is a high-carbon activity, but one which has potential to decarbonise more easily than some materials. It is another global industry which is aware of the need for a net zero pathway, though the supply chain is complex with many "moving parts". Strategically, aluminium has not been an attractive sector for investors over the last decade but its longer-term future appears more attractive, as a low-weight, broadly applicable material, important for electrified transport and in buildings, with decent long-term industrial demand.

Australia has natural advantages for vertically-integrated aluminium production. The supply chain consists of 3 parts, of increasing economic value:

- Bauxite mining, which is not carbon intense. Australia has the second

largest reserves globally and is the leading producer.

- Alumina (aluminium oxide) production, which is energy intensive andrequires heat rather than electricity. To reduce emissions, hydrogen could replace the fossil fuels currently used, or carbon capture and storage employed. Australia is the second largest producer globally after China.
- Aluminium smelting by electrolysis, which produces carbon dioxide as part of the process, adding to any emissions attributable to the electricity consumed. Australia produces a little over 3% of global supply, while China is the largest producer at over 60%. For most Australian smelters, the electricity emissions far outweigh the process emissions. The scale of the electricity demand is such that the Tomago smelter uses around 10% of NSW's power supply and Bell Bay around 30% of Tasmania's.

Unlike other materials, no fundamental process change is required for a significant decarbonisation of aluminium, a sufficient supply of low-carbon electricity can get us there. To fully decarbonise smelting, a replacement for the carbon anode technology which leads to the process requirements would be required. An inert anode technology, in development for 20 years, is now being tested in Canada. This would be a good complement to a process with zero-carbon electricity but until then, this technology remains a relatively "small lever". Australian smelters have made process improvements which reduce emissions from other parts of the process, so electricity becomes an even larger part of the solution and is also around 40% of the total smelting cost.

The progressive decarbonisation of Australia's electricity supply will make a big difference to local aluminium's footprint. Aluminium is already made from renewables in many places globally and in Tasmania. Alcoa has 70% of its global production sourced from renewables and is aiming for 85%. Rio Tinto has a 2050 net-zero-carbon goal and has factored in an internal carbon price to its decisions for over 15 years. Conversely, over 90% of China's production is coal-powered, most of it from on-site power stations, so Chinese imports would struggle on emissions intensity in all scenarios.

Being such a large part of electricity demand, aluminium smelting has the potential to underpin the transition to a renewable grid, but only if a firm, constant electricity supply is available to the smelters.

For example, others have calculated that as much as 3 GW of new renewable capacity in NSW would be needed to reliably power Tomago, which today requires a constant supply of around 1 GW. If it were possible to modulate smelter electricity demand up and down at short notice, this task would become easier. Some progress on improving the ability to handle supply interruptions and provide demand-response services is being made by local smelters. A technology promising this capability being developed in New Zealand and trialled in Germany, based on the capture and use of waste process heat, and has shown it can enable a 25 to 30% increase or decrease in smelter load. It is not clear whether this technology is anywhere near ready for commercial or local deployment, but the prospect is tantalising. Until then, NSW has baseload power stations available to bolster an increasingly renewable grid.

However, local smelters are not currently adequately rewarded for their potential demand-response role. They are under long-term electricity contracts which do not include exposure to the dynamic price of electricity or particularly incentivise demand response, and the National Electricity Market is unusual compared to other grids in its lack of reward for demand-side services. If this was addressed, it would benefit both the grid as it transitions to renewables, and the smelter, by providing an additional income stream. Aluminium smelting has the potential to be part of the solution, underpin new renewables, and enable a switch from a supply-centric to a demand-responsive grid, while maintaining capability in an industry where Australia has natural advantages.

MATERIALS TYPICALLY GO TO LANDFILL SO THERE IS **SIGNIFICANT** ROOM FOR IMPROVEMENT IN CLOSING THIS LOOP.

Today, however, the industry reports little customer pull for lower-carbon aluminium. There are reports that customer demand in Europe is driving uptake there, so this is possible. An Aluminium Stewardship Initiative already exists, and most of Australia's alumina production is certified. Of the smelters, only Bell Bay is certified. The industry says they see few drivers for certification as there is no price premium associated with it, but that in some niche markets this is a ticket to entry. Demonstrations of demand from local customers will be key in driving the transition of the local industry.

Aluminium is highly recycled. The industry claims that 70% of the aluminium ever produced is still in circulation globally, however global growth means much virgin production is required. Post-consumer recycling does not occur in Australia and international best practice is 75% post-consumer, so by global standards, we are not performing well. Aluminium construction materials typically go to landfill so there is significant room for improvement by closing this loop. Smelters only process virgin alumina, while different facilities are involved in recycling aluminium. Like in steel, recycled content is not a proxy for decarbonising the production process.

Other Materials

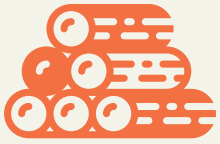
While not investigated in depth, we note the following developments on other building materials that came up in our interviews:

- **Asphalt** incorporating end-of-life plastics is now in common use, though there is plenty of room to raise content levels. In particular, Downer has created a business unit focusing on this technology and notes the end product has durability and smoothness advantages meaning less vehicle rolling resistance, enabling further emissions reduction. It reportedly also improves performance at high ambient temperatures and so has climate adaptation advantages as well. One interviewee said the asphalt demand of a single large infrastructure project, Snowy Hydro 2, could consume all our waste plastic stocks.
- **Bricks** require high-temperature firing so a substitute energy source is required. This has been achieved by Brickworks in Tasmania using forestry wood waste.

- **Glass** is no longer made in Australia, and most comments were around collection of waste glass for use in other processes, particularly cement, though waste glass could be re-melted and used in residential constructions replacing tiles and bench products.
- **Copper** is less carbon-intensive than other metals but efforts are being made by one manufacturer to decarbonise it completely and use the product in the construction of renewable energy equipment.

Substitute materials - Timber

Many interviewees saw timber as an excellent replacement for structural materials in many applications, but lacking a driver for its broad uptake. Depending on the supply chain, timber can be carbon negative (i.e. removing more carbon out of the atmosphere than it puts in), though it is important to also consider environmental and social sustainability attributes beyond carbon, such as the impact on biodiversity.



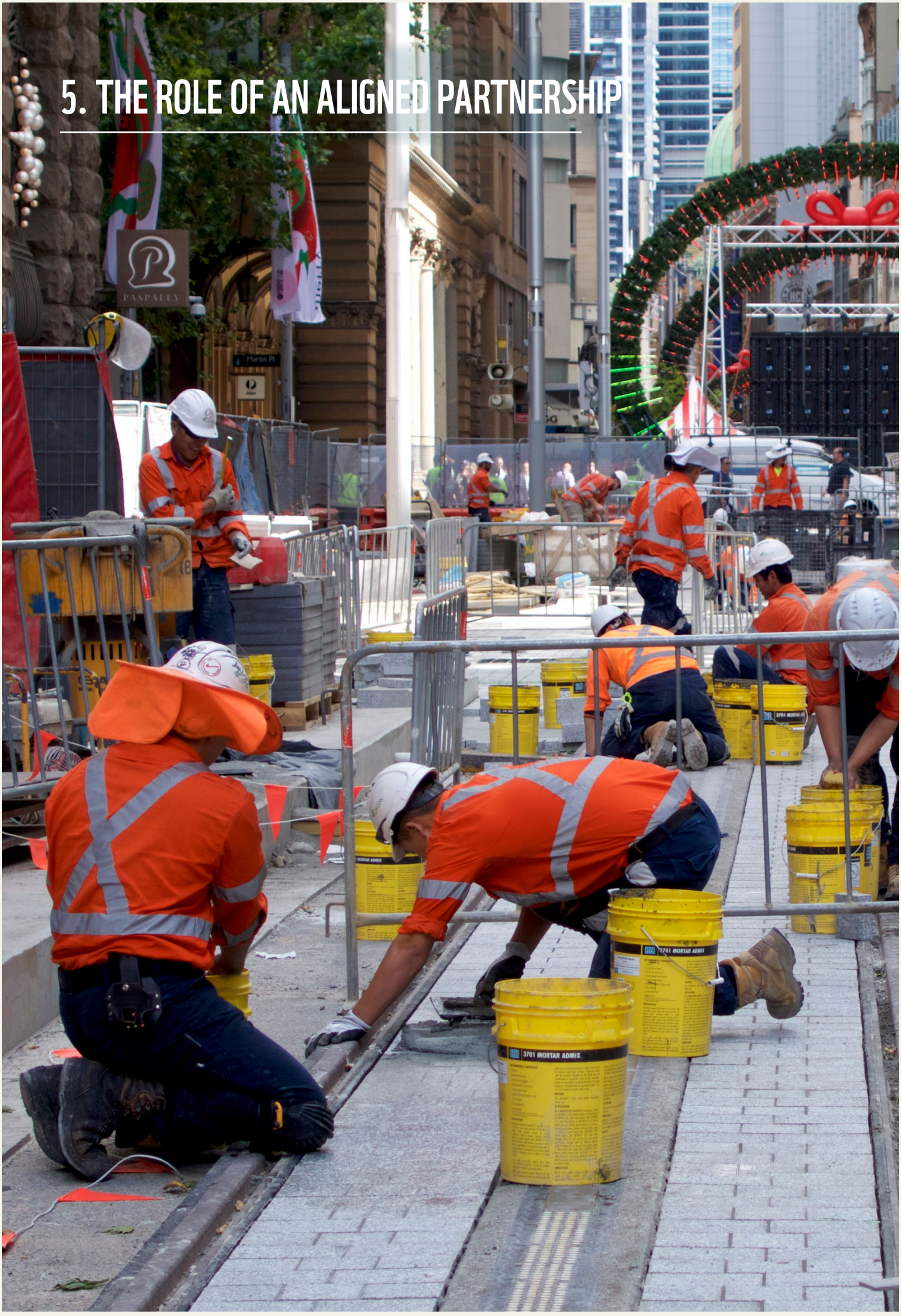
WOOD STRUCTURES CAN BE BUILT TIGHTER, OFFERING THERMAL PERFORMANCE AND ACOUSTIC BENEFITS.

Lendlease has used cross-laminated timber (CLT) on commercial and residential buildings, and says it is suitable for buildings between 10 and 12 storeys - though this could mean only the top 10 to 12 storeys of every building - and in much higher buildings, cross-laminated timber could be used as part of a hybrid structure used with steel or concrete. As a lighter material, the use of timber reduces the foundation structure required. Use of timber may mean standard designs need to be reconsidered, such as the number of columns needed in car parks. But starting with a blank sheet rather than relying on old template designs may be exactly what is needed to make broader improvements. Use of wood tends to multiply the dematerialisation benefit, in that wood surfaces will be left exposed for aesthetics, removing the need for cladding, plasterboard and hanging ceilings. Wood structures can be built tighter, offering thermal performance and acoustic benefits, and tenant feedback has been consistently “excellent”. Designs should take into account the lower thermal mass of timber buildings. Fire engineering is a barrier and needs specific demonstration tests on each wood type. Timber chars slowly in a fire so some oversizing can ensure there is no or low risk of structural failure in a fire. Firefighters report predictable behaviour in a fire and the dematerialisation discussed above can reduce toxic fumes from associated materials.

Interviewees reported that local manufacturing capacity is not currently at sufficient scale to satisfy widespread demand, but that can change quickly when it becomes a focus of procurement. The raw material is usually imported today, but in some cases finished at a local factory. The low-carbon nature of the material means even significant transport does not erode the embodied carbon advantage. The Australian plantation forestry industry is significant and this could be a new source of high-value demand. “Timber is better than steel in a lot of ways, there’s just no price signal driving uptake”. Demand at scale is needed to drive the investment in local capacity, and there have been local company failures in its absence; the scale involved is larger than any one building developer. Pooled demand by the government or a Buyers Alliance as discussed above would be one route to greater impact.

In addition to supply, more skills and training are needed. Lendlease used its European team to transfer skills and learnings and found most of its local team welcomed the opportunity to develop different skills.

5. THE ROLE OF AN ALIGNED PARTNERSHIP



5. The Role Of An Aligned Partnership

An impartial body that can support, advise and connect willing and aligned parties on the path to decarbonisation will play a valuable role. This concept was confirmed by many of the interviewees and it is apparent that there are sufficient interested parties to build such a partnership. Such an approach is aligned with the United Nations Sustainable Development Goal 17 on creating partnerships to achieve the goals.

Bringing parts of the industry sector together, linking supply-sides and customer-sides of the supply chain, is known to overcome the barriers to change and will help unlock opportunities. Just as the Business Renewables Centre Australia (BRC-A) is playing a catalytic role in the take-up of corporate renewable power purchasing agreements, an equivalent body could bring together suppliers, builders, developers, contractors, procurement professionals, engineers and architects, researchers and policy makers to accelerate the adoption of low- and zero-carbon construction materials. Other examples of pre-competition collaboration include the Better Buildings Partnership and the CitySwitch program, both of which feature members coming together to improve their sustainability performance in the built environment.

To this end, we propose the establishment of a ***Buyers Alliance for Reducing Embodied Carbon in Construction.*** The role of the Alliance will be in three key areas:

1. Aggregation of demand and supply

- Convene the anchor customers, which will provide bankable contracts to give suppliers the confidence to scale up supply manufacturing and invest in required plants, R&D and skills.
- Providing an enabling environment for investment:
  - Attract more capital, and therefore competition, into the market.
  - Leading property players expect their supply chains to come on board. How can we help to achieve price parity and improve uptake?
  - But private sector demand will pale in comparison to the change that governmental 'impact procurement' can achieve.
- Aggregate demand for low- and zero-carbon materials to reach critical mass needed for the particular material. This will also overcome the misconception of "there's no call for it". As one interviewee put it; "We need innovation and coordination between all parts of the [value] chain. Sometimes the problem is the customer not asking, sometimes the supplier is resisting change, sometimes the contractor in between is not across the latest opportunities to reduce embodied carbon. Sometimes construction is engaged late and there's limited ability to affect the design."

WE NEED
INNOVATION
AND COORDINATION
BETWEEN ALL PARTS
OF THE CHAIN

2. Knowledge sharing

- Become an industry capability network that can:
  - Demonstrate what is possible to contractors, engineers, architects, procurement specialists
  - Provide a *ready reckoner* with capacity, volumes specification capabilities
  - Demystifying requirements and providing quality checklists for contractors
  - Accelerate efforts already undertaken in the local supply chain
  - Act as a repository of case studies, material data, performance specifications, and standards
  - Provide insights into system and technological advancements on the horizon

- Share knowledge with builders and developers on substitution options, including a matrix of current materials and replacements.
- Develop proper traceability processes to ensure claims are real and prevent potential for 'green washing'.

3. Collaboration across industry sectors

- Build a partnership of aligned parties.
- Create a cross-collaboration, open-source tool to share lessons between buyers and sellers.

EXPECT MORE COLLABORATION, BETTER ADVOCACY TO THE SUPPLY CHAIN

We heard several examples of where collaboration is already underway and getting positive results. One infrastructure company has engaged with all its major suppliers on decarbonisation, who are all agreeable with having targets but do not want the routes to be prescribed. Another says it is working with its supply chain on their journey to reducing materials volumes. Frasers and Lend Lease are both collaborating with their suppliers on low carbon materials and told us to "expect more collaboration with, and better advocacy to the supply chain".

One interviewee advocated for a more centralised supply chain, suggesting there is a lot of wasted time tendering everything every time. They suggested a less transactional model with a panel of pre-approved suppliers that gets reviewed every few years. Furthermore, "the steel and concrete industries are already collaborating to reduce the amount of high-carbon materials".

6. FOSTERING INNOVATION

6. Fostering Innovation

Innovation has a major role to play, especially as we move from low-carbon to zero-carbon materials. There are many opportunities to reduce the embodied carbon incrementally, but for some materials, once early gains have been made, innovation is needed to either find alternative processes to cut emissions further, or to find zero-carbon alternatives to replace the conventional materials. But innovation can be hard, expensive and risky. However, there is a bigger risk from doing nothing, especially fiduciary risks. So how can we foster innovation to gain benefits for local economies and communities in NSW?

THERE IS A
BIGGER RISK
FROM DOING NOTHING

From a startup viewpoint, this industry is conservative, set in its ways and fragmented with multiple layers of decision-making. It's often difficult for start-ups to get supported or even piloted. Furthermore, design engineers can be reluctant to substitute materials and diverge from their own experience.

However, there is a cohort of innovators already challenging business as usual practices. In some large companies, there are examples where a segment of the business is given a licence to experiment as a lean startup, where the leader gets promoted and the company learns. We also heard that lots of SMEs view innovation as simply sound business sense: "Why throw money away on high carbon products that will be with us for a long time?"

The innovation process is complex and often fraught. We heard that many organisations talk about innovation but "vested interests squash the innovation". Challenging the conservatism of the building and construction industry is hard work. The materials produced must be fit for purpose, affordable, and above all, proven. But the process from invention to commercialisation can take multiple decades. So how can this be accelerated?

Pilot projects received mixed views during our research. There is concern that pilots do not scale fast enough to address the decarbonisation challenge. Considering the rapid changes needed, this is a valid concern. A further problem is that pilot projects do not prove the commercial viability of an innovation because they invariably overestimate the cost due to lack of scale.

However, others felt that pilots can still help to get new products into the scale demonstrations, while full-scale exemplar projects show a real alternative and help normalise a new approach, material or process. This came with the caveat and reminder that "zero-carbon homes didn't sell". The inherent risk of innovation is that it will not always work.

From this perspective, there is a need to leapfrog pilots to "deep demonstrations". A pathway to deep demonstration with trusted third-party verification is offered by Climate Knowledge and Innovation Community (Climate-KIC). Set up to tackle systemic solutions to climate change, Climate-KIC operates across the innovation ecosystem and could play a valuable role in bringing innovative low- and zero-carbon materials and processes from concept to market. WWF is an NGO partner to ClimateKIC both in Australia and in Europe.

7. INDUSTRY TRANSFORMATION, JOBS AND ON-SHORING MANUFACTURING

7. Industry Transformation, Jobs And On-shoring Manufacturing

AUSTRALIA WAS SEEN BY MANY TO HAVE **NATURAL ADVANTAGES** AS A FUTURE LOW-CARBON MANUFACTURING HUB DUE TO ITS NATURAL RESOURCES

Almost without exception, our interviewees saw positive opportunities for employment growth in the low-carbon materials industry over the coming decade, with the most pessimistic view being that there would be no new jobs created. The conversion of existing industry to low-carbon production offers a degree of future-proofing as we expect these industries globally to transition in that direction. In some cases, where material manufacturing has already been lost overseas, there is an opportunity to win it back with innovative low-carbon local manufacturing and a net addition of jobs. In others, there is the prospect of innovation creating export opportunities. Some interviewees raised the concept of a critical mass of manufacturing needed for long-term sustainability; for example, by maintaining capacity in steel and aluminium, and increasing capacity in for example, geopolymers and timber. A critical mass also implies multiple players competing which would tend to reduce procurement costs.

Australia was seen by many to have natural advantages as a future low-carbon manufacturing hub due to its natural resources, innovative tertiary sector and abundant, cheap, and clean energy. Solar PV technology from Australian universities leads the world, and helped build an industry in China. While Australian innovation in low-carbon materials is strong, it is not translating into large demand in construction projects due to the barriers identified above. However with the right kind of partnership and support, we could build a world-leading low-carbon materials industry in Australia.

Australian manufacturing was built on abundant, cheap, coal-fired electricity. It has declined in recent years due to coal becoming much more expensive. But it can return and thrive with the prospect of abundant, cheap, and clean energy. This transition will not happen by itself. We need to make deliberate decisions to create local supply chains and local employment. Thoughtful procurement can drive the process and build resilient, local supply chains that add value to Australian primary resources and lessen our dependence on imported materials.

Construction materials may not be seen as an attractive sector by the next generation of workers, but a climate-positive, innovation-based approach could change that. There are early signs of this already; we heard examples of innovative local companies showing growth throughout market cycles.

Opportunities for Regional NSW

NSW has regional manufacturing centres, particularly in the Hunter, Illawarra and Lithgow regions. We heard suggestions to retain and build upon all of these regions, but the opportunities in the Hunter drew most attention.

The Hunter region has existing capacity in multiple relevant industries, particularly steel and aluminium, as well as Orica's ammonia/ammonium nitrate chemical plant. Traditionally, it is also the electricity generation and transmission hub for the state. If we take a big-picture view, we could consider the Tomago aluminium smelter, Infrabuild's steel plant and the chemical facility, each of which has a need to decarbonise and replace fossil fuel inputs. The chemical facility, facing higher prices for its fossil methane feedstock, and the nearby steel operations could in future both use hydrogen to progressively replace gas and coal respectively if it were available at scale. A Hunter-based hydrogen facility would be well located in terms of electrical grid infrastructure and supply hydrogen to two large local industrial operations.

Meanwhile, the massive renewables build-out needed to provide near-firm electricity supply to Tomago, and potentially to the steel electric arc furnace operations as well, would often produce more energy than required. This could be converted to hydrogen for later use in steel and chemical manufacture. Excess generation could also be used by Tomago to increase production if it were able to introduce process and technology changes allowing some load flexibility, as discussed earlier (Section 4). When the renewable generation level is low, Tomago

could shed its load by between 25 and 30%. At all times, Tomago could act as a provider of grid stability services. While hydrogen electrolysis at the required scale is some years away, it appears that with government leadership, there is an opportunity to work towards, for example, a Hunter industrial cluster. This could provide multiple options for transitioning local manufacturers towards a zero-carbon industry precinct. An ARENA-funded or similar feasibility study was suggested as a reasonable next step.

Beyond particular regions, the emerging decentralisation opportunities offered with technologies including 3D printing could enable a much broader base of small-scale manufacturers. The possibilities are expanded by adopting circular economy approaches emphasising the opportunities to live within our local means by repurposing resources which would otherwise be wasted. If, for example, a small town had a 3D printer and access to recycled waste plastic, it could make products enabling local resilience, or grow its capacity to become a local exporter.

8. LEVERAGING PRIVATE SECTOR FINANCE

8. Leveraging Private Sector Finance

Private capital is one of the drivers for decarbonisation in the construction sector ecosystem, as noted in the introduction. Parts of the investment sector are actively seeking investments that reduce their climate risk exposure in line with the Paris Agreement commitments. This includes physical, transition and liability climate change risks. Investing in asset classes with low embodied carbon will become increasingly attractive as liability risks become more apparent, which will increase the pressure on developers and governments to disclose their climate exposures and carbon liabilities.

The demand for more risk-related information is a key driver. In response to the increasing fiduciary responsibilities of directors for listed entities, investors and asset portfolio owners are seeking more information on their carbon and climate risk exposure. The Task Force on Climate-related Financial Disclosures (TCFD) and the Principles for Responsible Investment (PRI) are two of the leading international frameworks to assist the sector in understanding its risks. The requests for asset performance data increasingly includes scope 3 carbon emissions. The Science Based Targets Initiative is also becoming more mainstream for companies and financial institutions setting medium to long term targets for Scopes 1, 2, and 3 which are aligned with the Paris Agreement and will help drive embodied carbon targets.

SUSTAINABILITY BONDS, GREEN MORTGAGES, THERE'S NO REASON WHY THESE CAN'T BE **USED TO DRIVE** DECARBONISATION

A major developer commented during our interview that "super funds, investment managers, Blackrock etc, they want to know exactly what we're doing. This has become a major force we have noticed in the last couple years. The breadth of TCFD is causing cut-through." Another interviewee added that, "the REITs [Real Estate Investment Trusts] are now catching on! Some property sector players looking at acquisitions are already considering the carbon liability of the asset".

The pressure from investors is also being felt in the materials supply chain. One of the steel makers we spoke with commented that "shareholder pressure has only been felt in the last couple years, but it's been evolving, getting stronger."

If disclosure is the stick, then investment opportunities offer the carrot. As one of our interviewees put it: "sustainability bonds, green mortgages, there's no reason why these can't be used to drive decarbonisation. It is happening overseas." As developers start to understand the benefit of attracting carbon-conscious capital, they will in turn seek suppliers that can offer lower carbon materials. A strong position on carbon translates into all relevant metrics: Greenstar, GRESB, ISCA, sustainability-linked loans, green bonds. Lenders will become more perceptive, and carbon reduction will be the chosen paradigm. For the volume residential market, this could take the form of discounted or interest-free loans for a package of better materials and products. Investors are starting to understand the downside risks. Developers are starting to understand the upside market advantages.

New and cutting-edge clean technologies and processes often have trouble attracting finance because they require non-traditional financing structures. To appeal to private sector investors, these projects need lower risk profiles through reduced interest rates and longer loan terms, perhaps underwritten by governments, either through for example the state treasury and/or the Clean Energy Finance Corporation. A Facility for Reducing Embodied Carbon could finance projects across a number of industry sectors including industrial decarbonisation while at the same time stimulating local job creation.

9. DESIGN AND THE CONSTRUCTION PROCESS

9. Design And The Construction Process

Design optimisation was raised by the interviewees in the developer, contractor, and customer parts of the sector ecosystem as having significant potential to reduce embodied emissions by designing-out unnecessary materials, operational emissions and unnecessary energy load. Thoughtful design can yield both these benefits as well as lower costs.

For example, we heard from a steel manufacturer that when their company is involved in some key structural design decisions, higher quality steel components, although more expensive per piece, can replace a larger volume of cheaper steel, resulting in net cost and carbon savings.

SMART NOT LAZY ENGINEERING - **FEWER MATERIALS** REDUCES COSTS AS WELL AS EMBODIED CARBON

Inherent conservatism and risk aversion, albeit derived from concerns for safety, can result in over-design, which we learnt is prevalent. One of our interviewees estimated that "most buildings are 30% over-designed beyond accepted safety factors", which leaves a huge margin for design optimisation.

The risk aversion of engineers and architects often stems from a desire to avoid jeopardising professional indemnity policies. However, we heard from one interviewee that we need "smart, not lazy engineering - fewer materials reduces costs as well as embodied carbon". This win-win should resonate with quantity surveyors and developers alike. We also learn that "building faults occur more in construction than design", meaning that over-design does not necessarily reduce faults. One of the developers commented that "our smart engineers are trying to push the boundaries on reducing material inputs, but it's mostly the next generation and a few older renegades."

There are ongoing commercial benefits to be realised. A refined design will reduce inputs. An example provided by one of the developer interviewees: "typically in a tall building, we can reduce embodied carbon by about 30% through optimised design, we improve value if it's smartly done because slimmer columns will increase gross leasable area (GLA) as will stronger, lighter, bigger spans that require fewer columns".

Targeting the twin benefits of reduced embodied carbon and improved yield could certainly turn the value engineering process into a positive outcome. The Co-operative Research Centre of Low Carbon Living tested this approach with Multiplex to use less concrete.

The design optimisation and value engineering processes require a multidisciplinary approach that sees collaboration between design specifiers, structural engineers, architects, procurement and asset management professionals that goes beyond business as usual.

10. CONCLUSION

10. Conclusion

It is heartening to see that industry and government are willing to come to the table and act on this important issue and address the many challenges of reducing the embodied carbon in the building and construction sectors. Recognising the complexity of the sector ecosystem is central to the call for a systems approach to the solution. Action and intervention is needed in each point of the value chain: designers, customers, engineers, contractors, sub-contractors, and material providers. There are no silver bullets. But with measures such as 100 per cent and more renewable energy inputs including in electricity and industrial processes, considering waste as a material input, better design to use less material, embracing circular economy principles, collaborative procurement and a clear direction set by government projects, the market can and will respond. Making every decision count towards zero carbon from design through to execution and delivery of all projects should be seen as a priority.

There is a clear role that governments at all levels can play to create critical demand for low- and zero-carbon construction materials. The establishment of a Buyers Alliance for Reducing Embodied Carbon in Construction will play a critical first step to help drive the building and construction industries and their supply chain towards a zero-carbon future and WWF is willing to help accelerate this transition by collaborating with industry and government to make it happen. The key recommendations are listed in the Executive Summary of this report.

The solutions are available, the challenges can be tackled, and our planet cannot wait any longer. The time is now.

During the time of researching and writing this report, parallel and relevant research reports have been launched into the public domain. This is a small sample:

- ClimateWorks Decarbonisation Futures
- Institute for Energy Economics and Financial Analysis Why Aluminium Smelters are a critical component in Australian Decarbonisation
- Grattan Institute Start with Steel Report
- World Green Building Council Bringing Embodied Carbon Upfront
- Mission Possible work by ETC
- Ross Garnuat Superpower - Australia's Low Carbon Opportunity
- Recommendations-for-a-zero-carbon-economic-recovery
- Zero-Emissions-Copper-Mine-of-the-Future-Report.pdf

A RENEWABLE FUTURE

CLIMATE CHANGE

As the world moves to act on climate change and fulfil the promise of the Paris Climate Agreement, places that have the best renewable resources in the world have a significant opportunity.

CLEAN ENERGY

Renewable energy such as solar and wind is critical to decarbonising more than two thirds of global emissions, in the electricity, transport, building and industrial sectors.

POPULAR CHOICE

With over 2.1million rooftop solar systems, you just have to walk down the street to see how Australians have embraced renewable energy.

A JUST TRANSITION

WWF-Australia supports a climate action plan that ensures nobody is left behind.

RENEWABLE LEADER

Our goal is for Australia to be a leading exporter and investor in renewable energy with a zero-carbon economy achieved well before 2050.

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Why we are here

To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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