Australian Government | Infrastructure Australia

Infrastructure Market Capacity 2023 Report

December 2023

Acknowledgement of Country

Infrastructure Australia proudly acknowledges the Traditional Owners and Custodians of Australia, and their continuing connections to the land, waters, and communities. We pay our respects to them and to their Elders past and present. In preparing for the future of our infrastructure, we acknowledge the importance of looking beyond the immediate past to learn from Aboriginal and Torres Strait Islander peoples' unique history of land management and settlement, art, culture, and society that began over 65,000 years ago.

As part of Infrastructure Australia's commitment to reconciliation, we will continue to develop strong, mutually beneficial relationships with Aboriginal and Torres Strait Islander partners who can help us to innovate and deliver better outcomes for Aboriginal and Torres Strait Islander communities, recognising their expertise in improving quality of life in their communities.

A note from the artist:

"Through sharing culture, we can create a sense of belonging, by connecting to the land we stand on. This connection of people and our communities is shown through connecting campfires. These being places we sit, yarn, and share knowledge.

The Infrastructure Australia values - expressed by the colours blue, green, orange, purple and teal - weave through the artwork to represent the opportunities and benefits for our communities.

Under this sits our rivers, lakes, oceans, and waterways. Water being the giver and supporter of life and flows through us all. I see the reconciliation journey as the water along the path to benefiting our people.

Around our waterways I've shown our traditional infrastructure. Our connections and songlines. The systems set up by the First Peoples of this place that we aim to weave into the modern landscape."

Nani, by Kevin Wilson (Maduwongga, Wongutha).

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Chair's Foreword

It is with pleasure that I present this Infrastructure Market Capacity report – an evidence-based analysis of demand against the market's capacity to deliver our country's public infrastructure pipelines.

Since debuting in 2021, our Market Capacity Program of research has proven to be a beneficial resource for governments and industry. As such, we are encouraged by recent government efforts to smooth infrastructure project demand (explored in this report) and the respective pipeline reviews of the Australian Government and NSW Government. These efforts demonstrate positive steps to reduce the gap between supply and demand. In the long run, they will help strengthen the sustainability of the industry.

In this third edition of Infrastructure Market Capacity, we have identified actions that the Australian Government, working with state and territory governments, can take to address the top constraints identified in the report as well opportunities to grow industry capacity through productivity uplift.

We recognise infrastructure delivery cuts across a range of government priorities and policy areas – transport, housing, energy transition, circular economy, workforce, and productivity. We urge governments to continue working collaboratively to actively manage infrastructure demand in the context of the market's capacity to deliver it to maximum effectiveness and efficiency. As governments recognise, they must bring industry along to maximise certainty of the pipeline and ensure a sustainable and healthy ecosystem into the future.

Our Market Capacity program of research is a unique piece of work for Australia, and one that we look forward to evolving in collaboration with the jurisdictions.

Gabrielle Trainor AO

Executive summary

Australia's major public infrastructure pipeline has slightly smoothed over the last 12 months, with projected expenditure more evenly distributed over the forward estimates. This suggests governments have taken positive steps to proactively manage their pipelines and reduce the gap between the supply and demand for resources, as seen in the recent infrastructure pipeline reviews undertaken by some governments.

However, demand still significantly outweighs supply, and productivity growth remains stagnant compared to other industries. Governments will need to remain vigilant and discerning in their infrastructure spend, in the face of budget and inflationary pressures over the short to medium term.

The Australian Government, working alongside the jurisdictions, has outlined a range of key priority reform directions for the nation: productivity, decarbonisation, housing, workforce, education, skills and training. These present opportunities for governments, working together and with industry, to leverage their infrastructure spend to help achieve the vision of a resilient, prosperous, and productive nation.

By acting on the recommendations in this report, Australian governments will spark critical industry change to improve the value of their infrastructure investments and support Australia's social and economic ambitions.

This Infrastructure Market Capacity report identifies key trends in public infrastructure investment, and analyses market capacity constraints that could inhibit delivery of the major public infrastructure pipeline, covering projects valued over $100 million in New South Wales, Victoria, Queensland and Western Australia, and over $50 million in South Australia, the Australian Capital Territory, the Northern Territory and Tasmania.

This report aims to provide an aggregated view of national demand as an evidence base for governments to actively manage their pipelines, with reference to prevailing market conditions. It provides an annual snapshot of the market's capacity to deliver governments' public infrastructure pipelines at a moment in time, analysed as part of the longitudinal dataset managed by Infrastructure Australia's Market Capacity Program.

We note that, since completing our routine annual collection of public and private project data earlier this year, two governments have revised their pipelines following strategic reviews:

- The Australian Government's Independent Strategic Review of the Infrastructure Investment Program (IIP Review).
- The NSW government's Strategic Infrastructure Review.

Infrastructure Australia welcomes these reviews as opportunities to reassess pipelines in the context of recent major and unforeseen economic changes, as well as ongoing market capacity pressures reported in our 2021 and 2022 Infrastructure Market Capacity reports.

Key insights

Overall, public infrastructure demand has flattened compared to the previous year, although growth in key regions and sectors may prolong supply shortages if unaddressed.

Governments have continued to actively manage their infrastructure pipelines. For example, the Australian Government's continued commitment to a sustainable 10-year pipeline and commissioning of the Infrastructure Investment Pipeline Review will assist in ensuring demand is aligned with market conditions. It will also create more certainty for the market and encourage investment to build capacity to meet future demand.

Major public infrastructure spend is now valued at $230 billion over the five years from 2022—23 to 2026—27. While this represents a slight 4% increase from last year, the updated outlook shows a 10% drop in the highest peak of expenditure across those five years as well as a shifting of investments into later years. This indicates that governments have taken positive steps to actively manage the demand-supply gap and create longer term certainty.

Energy sector investment is expected to grow at around four times current activity levels. While most of this growth will be funded by the private sector, it indicates the market is responding to government signals about its energy transition ambitions. It also represents more pressure for materials and labour due to this increased investment.

Regional demand hotspots will create labour gaps. Regions across New South Wales, Queensland, and the Northern Territory will experience extraordinary growth in the three years from 2024—25, with investment up to three times higher than the three years prior in some regions.

Sustained cross-sectoral demand will prolong the pressure on construction capacity. Infrastructure Australia's Market Capacity Program covers transport, buildings, and utilities. We note significant public investment is in planning for defence, energy as described across, mining - especially critical minerals - and housing, which highlights that supply and demand management strategies must be complemented by a nationally coordinated effort to improve construction productivity and innovation.

Key insights

Labour remains the top capacity constraint, indicating longer-term structural barriers, many of which may be addressed through current reforms outlined by the Australian Government in recent months.

A shortage of 229,000 full-time infrastructure workers is predicted as of October 2023, with shortages expected in all occupational groups.

Engineers and scientists will continue to experience the largest of all shortages until mid-2024. Trades and labour shortages are growing at the fastest rate and will remain high until 2025. The tertiary system (higher education and vocational education and training) plays a role in meeting demand in occupation groups in shortage.

Typical infrastructure career pathways have long lead times in and high churn rates out. Governments should consider developing a national infrastructure workforce strategy to grow workforce capacity through long-term workforce planning with industry, to attract, retain and upskill workers, including women, particularly in a tight labour market.

Reforms are underway. Positively, key Australian Government reform directions, namely the Employment White Paper, the Australian Universities Accord, and the recently signed National Skills Agreement, recognise and are looking to address many of the structural barriers outlined in this report. With coordination across the Australian Government, they will provide some key mechanisms for acting to boost workforce supply both in the short and longer term.

Key insights

Industry surveys and interviews indicate concerns with the domestic capacity of materials supply.

Global supply chain pressures have eased, with steady improvements in international production, trade, and transport measures compared with 12 months ago.

Local materials supply - particularly steel and quarry products - cannot meet demand in particular hotspots. Australia is increasingly reliant on steel imports, which over two recent years (2020—21 and 2021—22) are up 20% on the long-run average of the last two decades. Acute quarry shortages loom in several regions nationally, with long lead times from quarry approval to extraction making it difficult to source alternative supplies when and where they are needed, increasing project schedules, costs, and carbon emissions.

Gaps in national market data collection on domestic manufacturing and production hinders government efforts to predict supply and plan in line with anticipated demand.

There is an opportunity to build domestic capacity and markets for new low emissions construction materials - such as green steel and recycled materials - in response to Australia's Net Zero 2050 and 2035 targets. Governments have already taken first steps through national initiatives such as the National Waste Policy Action Plan and the Buy Australia Plan as well as actions at the state and territory levels. National coordination could generate a further step change in increasing adoption of recycled materials.

The Productivity Turnaround

Construction sector productivity has stagnated for over 30 years. Addressing the barriers to growth will take time but there are levers to boost supply over the long-term.

Long entrenched 'wicked problems' have held construction sector productivity back for three decades. It is time for governments and industry to work together to improve long-term sustainability and capacity to deliver current and future infrastructure projects.

This edition of *Infrastructure Market Capacity* highlights key barriers to boosting productivity: lack of diagnostic productivity measures, poor rates of women's workforce participation, inconsistent uptake of new technologies and modern manufacturing methods, and room for improved fair risk allocation between parties in procurement and contracting. Reaching agreement between governments on diagnostic productivity measures and creation of a national productivity baseline would close a critical knowledge gap needed to inform meaningful policy interventions in the future.

We recognise that state and territory governments have already introduced, or are in the process of introducing, reforms to boost industry productivity. Joint effort by all governments will be needed to support work already underway and elevate reform outcomes to the national level.

Infrastructure Australia intends to advance this report's recommendations in 2024 through continued exploration of the evidence base and insights that will inform a turnaround in construction sector productivity. We look forward to the opportunity to work with governments and start meaningful conversations with stakeholders to address barriers and identify policy solutions to improve longer-term productivity outcomes for both industry and governments.

The Federation Funding Agreement on Land Transport Infrastructure (currently under negotiation) will be a key government lever to support overall productivity growth, as well as increasing the adoption of new low carbon methods by a key carbon-emitting sector.

Summary of Findings and Recommendations

We have provided 14 recommendations for the Australian Government to act upon, in partnership with state and territory governments, to improve the demand-supply balance and ultimately the long-term sustainability of the construction sector.

Infrastructure Australia recognises that state and territory governments already have in place a range of initiatives that address various constraint areas outlined in this report. Therefore, the recommendations are aimed at coordinating, uplifting, and identifying national approaches to build on existing work by governments wherever possible.

The recommendations are grouped into four areas:

1. Continued active demand management.
2. Boost materials supply.
3. Boost workforce supply.
4. Improve construction productivity.

Most recommendations include steps for governments to take in the short-term (6—12 months), plus longer term 'future actions' in a handful of cases.

Infrastructure Australia consulted with relevant agencies across the Australian Government and all state and territory governments in the shaping of the recommendations above. We can support implementation and tracking of progress against the recommended actions, as agreed and requested by the Australian Government.

Recommendations to actively managing demand

	Market capacity finding	Opportunities	Recommendations
1	The major public infrastructure project pipeline is slightly smoother compared to last year's projection. Current year investment has decreased for the second year in a row compared to the previous outlook, and forward estimates are spread more evenly across later years. This indicates that governments are responding to current and expected market capacity constraints in its delivery and planning of public infrastructure works.	Ongoing active management will ensure a smoother pipeline, which will provide more certainty and increase industry confidence to deliver. It also supports robust due diligence in project planning by affording more time and resource to the planning phase.	The Australian Government, in partnership with state and territory governments, should continue to actively **manage public infrastructure demand** via the Infrastructure and Transport Senior Officials' Committee by: • working with state and territory governments to regularly, at least annually, review demand and ensure ongoing management of the public infrastructure pipeline • conducting ongoing cross-sector pipeline management, including the use of Infrastructure Australia's analytical pipeline tools developed for governments.
2	Significant levels of public investment in priority growth areas such as energy, housing, heavy industries, and defence, will compete for market capacity. For example, energy infrastructure project investment is projected to increase fourfold over the next four years.	Having a singular, cross-sector view of construction demand would allow governments to prioritise the use of market capacity when considering and implementing projects, to ensure delivery of key public works across all portfolios.	The Australian Government could consider issuing whole-of-government guidance to ensure all relevant portfolios **consider cross-sector market capacity** in the assessment and decision-making processes for new and revised policy proposals with an infrastructure component. ***Future actions*** The Australian Government should develop a **whole of government approach to monitoring and managing construction market capacity**, to facilitate the delivery of committed public works across priority portfolios.

Recommendations to expand non-labour supply

	Market capacity finding	Opportunities	Recommendations
3	**Acute quarry shortages** loom in a few hotspots across the country. Shortages in local quarry supply threatens the deliverability of major public infrastructure works, increases project costs and schedule delays, and contributes greater emissions by bringing heavy materials to site from further afield via truck or train. Data availability of raw quarry products varies by state and territory, while long quarry approval times (5—10 years) impede efforts to plan supply for demand. While quarries are monitored and managed by state and territory governments predominantly, national regulation and policies across biodiversity and environment, cultural heritage, and net zero requirements, may also contribute to delays in quarry approvals.	Reducing quarry approval times would allow for increases in output in response to projected demand, with the additional benefit of reducing costs and carbon emissions.	The Australian Government, working with state and territory governments, should **investigate ways to boost quarry output to meet local demand** by identifying barriers and considering any national solutions to ensure adequate supply of quarry materials for infrastructure projects, via the Infrastructure and Transport Senior Officials' Committee. ***Future actions*** The Australian Government should: • encourage jurisdictions experiencing quarry shortages to consider developing a program similar to Victoria's successful Quarry Approvals Coordinator model, to support applications to increase quarry supplies for priority infrastructure projects • explore options to improve data collection and transparency of national quarry supplies to support longer term planning.

	Market capacity finding	Opportunities	Recommendations
4	Steel imports are 20% higher in 2020—21 and 2021—22 compared to the average of the previous two decades and will likely grow in line with sustained construction demand over forward estimates and beyond. Overreliance on global supply chains for steel, a key construction material, potentially creates uncertainty in pricing, quality, and carbon emissions. Adoption of low emissions steel making methods, such as green steel, provides an opportunity to grow domestic industry and local supply capacity. However, take up of green steel production and construction methods remains relatively low. Governments have clearly signalled support for helping industry achieve the ambition of becoming a renewable superpower. Relevant investments at the national level include the National Reconstruction Fund, Powering the Regions Fund - Safeguard Transformation Stream, and the Buy Australia Plan. State and territory governments have set various local content requirements on the use of green materials in major construction projects.	Increasing Australia's steel production and fabrication capacity could potentially help improve the price certainty, availability, and quality of steel. It could also help lower the uncertainty of the potential carbon impact of steel imports, and prepare the domestic industry to maximise future opportunities.	The Australian Government, in partnership with state and territory governments, should **undertake analysis of domestic steel production and fabrication capacity** as part of broader Australian Government policy initiatives to strengthen and support sovereign supply chain capability and grow new capacity for future industries.
5	There is no current method for collecting or analysing market data on local manufacturing and production outputs nationally. This hinders governments' capacity to predict supply and mitigate if/when shortfalls occur. It forces reactivity when shortages transpire, which increases the risk of cost escalations and delivery delays.	A national collection of local manufacturing and production outputs would enable governments to better track and mitigate future supply shortages for materials. It could also enable a more coordinated approach to stage demand in line with project need and market capacity.	The Australian Government should **track and analyse local manufacturing and production output** by working with the Australia Bureau of Statistics to develop options for collecting data needed. This could include reinstating funding for national longitudinal data collection of domestic manufacturing materials used in construction, per the now-discontinued Australian Bureau of Statistics Manufacturing Industry Collection Australia (Catalogue Number 8221.0).

	Market capacity finding	Opportunities	Recommendations
6	43% of conventional material tonnage used in road construction could be replaced by a range of recycled materials. Cost savings from the application of recycled alternatives in roads infrastructure range from 2% to 83% depending on geography, availability, time, and other measures. Uptake of recycled materials has been slow and inconsistent. The distance between project site and materials processing facility significantly influences the availability of certain recycled materials, which particularly disadvantages regional and remote areas. Potential customers of recycled materials are not fully aware of the availability of supply stocks.	Supporting the increased uptake of recycled materials in construction can help to lower project costs, and support Australia's Net Zero 2050 decarbonisation efforts.	The Australian Government, in partnership with state and territory governments, should continue to build capacity for increased uptake of recycled material products in infrastructure by **adopting a national recycled first policy.** This would capture information to: • build a baseline for use of recycled content, which has a current target 4.01, under the National Waste Policy Action Plan (2022) • help better understand why recycled materials were not adopted on projects to identify supply gaps, under-served areas and other barriers for potential government intervention.

Recommendations to expand labour supply

	Market capacity finding	Opportunities	Recommendations
7	As of October 2023, there will be a projected shortfall of 229,000 full-time infrastructure workers. Industry action and longer term workforce planning is required to address the range of barriers to growing workforce supply. These include long lead times into an infrastructure role, high attrition rates, and a need to upskill the current workforce in emerging skills. Various sectors compete for the same labour pool (transport, buildings, defence, energy), with distinct skills required at different project stages. There may be opportunities to better coordinate and stagger demand in line with capacity. Jobs and Skills Councils are industry-led organisations responsible for workforce planning and addressing skills and workforce challenges for their industry. There is no dedicated Jobs and Skills Council for infrastructure. Instead, infrastructure overlaps Building, Construction, Property and Water (BuildSkills), Gas and Renewables (Power Skills), and Mining and Automotive (Mining and Automotive Skills).	A coherent, long term national workforce strategy could help to boost infrastructure workforce supply and enable a more coordinated approach for staging demand in line with project need and market capacity.	The Australian Government, in partnership with state and territory governments, should **explore development of a national infrastructure workforce strategy** that outlines how governments should work with industry to improve infrastructure worker attraction and retention, including women, and ensure growth of the workforce pipeline to meet demand. The strategy should also consider how to improve workforce mobility for transferring skills and workers across sectors and locations in line with market demand. To support this work: • Jobs and Skills Australia should consider a national infrastructure workforce study in the context of its 2024—25 work plan and in consultation with relevant Jobs and Skills Councils • relevant Jobs and Skills Councils should be encouraged to consider infrastructure demand in industry specific workforce plans and consider strategies to address workforce challenges and skills gaps, including greater support for upskilling workers through micro-credentialing and workplace training and supporting greater collaboration between higher education and VET to create new types of qualifications.

	Market capacity finding	Opportunities	Recommendations
8	Higher education is a supply source for engineers, scientists, and architects. This occupation group is predicted to experience the largest shortages of all until mid-2024. Different fields of education have varying potential to contribute to the infrastructure workforce. Strategies to grow the pipeline of graduates should be targeted by field of education. The Australian Universities Accord has set a positive reform direction to ensure government investment in higher education meets priorities in key areas, including infrastructure.	Boosting the pipeline of higher education candidates would ensure the infrastructure workforce in the long term, and reduce shortages in engineer and scientist occupations most in need.	The Australian Government, in partnership with state and territory governments, should **grow the pipeline of higher education candidates** for the infrastructure sector by: • targeting government investment to reduce shortages in the occupations that underlie the occupation groups most in need – currently, engineers and scientists - including addressing barriers limiting women's participation in these occupations • exploring new credit recognition pathways to boost the higher education pipeline of engineers and scientists, which should include consideration of recognition of prior learning pathways from on the job learning and Vocational Education and Training.
9	Engineers continue to suffer the largest of all occupational shortages, yet in 2021, 47% of qualified migrant engineers were actively seeking an engineering job. Likely barriers to employment include a lack of local experience and professional network, as well as reluctance by business to employ skilled migrant workers. Several government initiatives are underway to identify solutions to maximise workforce participation for onshore skilled migrants who have unrecognised or under-recognised skills to participate in the Australian workforce, including engineers.	Offering employment to migrant engineers with recognised overseas qualifications will rapidly assist in addressing the shortage of engineering professionals.	The Australian Government, in partnership with state and territory governments, should **place more qualified migrant engineers in engineering jobs,** by working with industry and employers to identify actions to overcome barriers preventing businesses from employing onshore skilled migrants, including women migrants. ***Future actions*** The Australian Government should: • consider developing a national program of wraparound services to increase employability of overseas qualified migrant engineers, which considers existing programs such as Victoria's Overseas Qualified Professionals and Engineers Australia's Global Engineering Talent Program to help migrant engineers secure work • in relation to the above actions, build on the lessons learned and evidence base gathered from relevant initiatives already underway to maximise workforce participation for onshore skilled migrants.

	Market capacity finding	Opportunities	Recommendations
10	Shortages in trades and labour are growing and are predicted to peak at 131,000 full time workers by 2024 (based on the current pipeline). Around 50% of infrastructure-related apprenticeships and traineeships are completed, slightly lower than completion rates across all trades (53).[1] The most effective interventions to boost completions would be targeted at the first two years of commencement, and students recommencing a course. The Australian Government, though the Universities Accord and the Employment White Paper, have committed to exploring options to support innovative, flexible pathways to infrastructure careers. [2] [3]	Increasing the pipeline of apprentices and trainees, in particular trades in shortage, would increase the capacity of the infrastructure workforce to deliver public works.	The Australian Government, in partnership with state and territory governments, should **increase supply of apprentices and trainees** in infrastructure occupations by: • encouraging the relevant Jobs and Skills Councils to include identification of barriers and opportunities to **increase completions** in their 2024 workplans. Interventions should be targeted at pathways most likely to lead to employment in the intended occupations • working with states and territories to continue developing equitable **innovative, flexible pathways** for entering, remaining, and progressing in infrastructure careers. Options for exploration include new micro-credentials, higher apprenticeships[1], and strategies that address skills gaps and improve foundation skills to reduce lead times into jobs.

Recommendations to prioritise productivity

	Market capacity finding	Opportunities	Recommendations
11	Construction sector productivity has remained stagnant, lagging comparable sectors over the last 30 years. There is currently no agreed set of productivity measures at the project level for the construction industry. This makes it difficult to meaningfully design, implement and measure policy interventions to boost industry productivity.	Leveraging existing project data collection processes of governments will support the development of baseline construction productivity measures. These baseline measures would provide a launchpad for policies designed to increase productivity over time.	The Australian Government, in partnership with state and territory governments, should **enable measures to uplift construction industry productivity** by: • commissioning a productivity study to better understand the drivers and barriers • working with states and territories, to agree on: – productivity metrics and indicators to measure infrastructure productivity diagnostics – a national collection and baseline, and regular reporting of productivity metrics for the public infrastructure pipeline to Infrastructure and Transport Senior Officials.

	Market capacity finding	Opportunities	Recommendations
12	The 2021 Census reports that women represent 14% of the construction workforce - a marginal increase on 12% reported in the 2016 Census. State and territory governments have differing requirements and targets for increasing women's participation through procurement processes. A range of cultural problems are reported to hinder women's participation in the sector and increasingly, that of young men. Aspects of poor culture contribute nearly $8 billion in annual economic losses. The Australian Government, the Victorian Government, NSW Government, and the Government of South Australia have joined the Construction Industry Culture Taskforce, which seeks to directly address recognised cultural problems in construction.	Increasing participation in construction and improving workplace culture in construction overall will unlock productivity benefits.	The Australian Government, in partnership with state and territory governments, should **increase participation and improve workplace culture for all in construction** by: • establishing national monitoring of key measures to increase women's participation, for example through Federal Funding Agreements such as the Land and Transport Infrastructure Agreement • identifying national approaches to increase participation in construction, including considering evidence from the Construction Industry Culture Taskforce pilots' application of the Culture Standard in procurement across jurisdictions • encouraging broader participation by jurisdictions in the Construction Industry Culture Taskforce • including increasing women's participation and addressing culture issues in the National Construction Industry Forum's 2024 work plan.
13	Construction is one of the least innovated sectors in Australia. Nationally, Australia lags other economies in the uptake of new techniques. Industry surveys and interviews indicate the reasons for this include: • low awareness and/or understanding of the advantages of new and different techniques • outdated procurement processes and attitudes • manufacturing capacity limitations • low pipeline visibility that suppresses industry's appetite for capability investment.	Productivity uplift from take up and trialing of new technologies and methods.	The Australian Government, in partnership with state and territory governments, should **encourage increased uptake of new technologies and modern methods of construction** by**:** • prioritising projects that adopt productivity enhancing technologies and/or methods to progress national priority objectives, such as emissions reduction, boosting domestic workforce capability, boosting sovereign capability, and/or strengthening local supply chain resilience for funding. (A potential mechanism includes as part of the project selection process under the Land and Transport Infrastructure Federal Funding Agreement). • investigating ways to promote best practice and facilitating sharing of emerging best practice.

	Market capacity finding	Opportunities	Recommendations
14	For the third consecutive year, *Infrastructure Market Capacity* industry survey respondents rank risk identification and allocation as the greatest threats to market capacity. Fixed-priced contracts, poor risk methods, and higher input costs are still forcing historically high rates of construction insolvencies. Companies that regularly collaborate with their suppliers can achieve higher growth, lower operating costs, and greater profitability than industry peers. [4] Collaboration across the value chain means risks are easier to identify, manage, and allocate. Collaborative models have delivered some positive outcomes in Australia, but adoption rates of new approaches appear to be inconsistent.	Introducing more efficient risk allocation practices can improve the sustainability and innovation of the construction sector. Better understanding and management of risk among governments can help stakeholders discern how to engage smaller members of the supply chain without undue risk to projects or suppliers.	The Australian Government, in partnership with state and territory governments, should **develop national guidance on best practice risk identification, management and allocation between parties during procurement and contracting processes,** including: • mitigation strategies for common risks by project type • guidance for making procurement decisions • guidance on standard contracting solutions that efficiently identify and allocate risk among parties.

Suggested timeframe to commence recommendations

Area		Recommendation	Commence < 6 months	Commence within 6-12 months
Proactive demand management	1	Proactive pipeline management	●	
	2	Cross sector whole of market capacity	●	
Boost materials supply	3	Quarry supply	●	
	4	Steel supply		●
	5	Local materials production data		●
	6	Recycled materials		●
Boost workforce supply	7	National Infrastructure Workforce Strategy	●	
	8	Higher education pipeline		●
	9	Onshore migrant engineers		●
	10	Supply of apprentices and trainees		●
Improve construction productivity	11	A productivity study and national baseline	●	
	12	Participation and workplace culture		●
	13	New technologies and modern methods of manufacturing		●
	14	Risk allocation between parties	●	

1. Introduction

The annual Infrastructure Market Capacity reports have become the flagship output of Infrastructure Australia's Market Capacity Program, which responds to a request made by the Prime Minister and First Ministers in 2020: that Infrastructure Australia work with jurisdictions and industry bodies to monitor the infrastructure sector.

> *"Leaders considered analysis on the market's capacity to deliver Australia's record pipeline of infrastructure investment to support the country's growing population. This analysis highlighted the importance of monitoring infrastructure market conditions and capacity at regular intervals to inform government policies and project pipeline development.*
>
> *Leaders agreed that Infrastructure Australia will work with jurisdictions and relevant industry peak bodies to monitor this sector."*

Source: Council of Australian Government Communiqué, 20 March 2020

The third publication on infrastructure demand and supply from Infrastructure Australia

Like the previous two editions of Infrastructure Market Capacity, this report examines public infrastructure demand and market supply capacity over five years - in this case, 2022—23 to 2026—27. This report includes the following updates:

Demand: a quantification of infrastructure demand across five years by sector, project type, and labour and non-labour inputs.

Supply: an appraisal of the main supply-side risks to market capacity today, including industry views gleaned from interviews and surveys conducted for this report.

Labour and skills: a summary of labour shortage projections by jurisdiction, capital cities and key regions, and occupation groups. Plus, a review of the factors surrounding key occupations in shortage.

New for 2023: refined energy methodology, regional analysis, career insights, and productivity trends

This edition of *Infrastructure Market Capacity* includes advanced analysis on current and emerging influences on market capacity, including:

Energy demand methodology: we have refined our approach for sourcing and analysing energy project demand in the last 12 months. Previous editions of *Infrastructure Market Capacity* relied on Australian Energy Market Operator projections of the installed generation capacity of its Integrated System Plan, because in the absence of announced projects to meet this demand, it represented the most likely future scenario outlook for resource demands. Now that many new projects have been announced in the past 12 months, the 2023 edition of this report draws on actual private *and* public energy project data as more realistic and contemporary representations of demand.

Regional analysis: using analytical tools we have built in partnership with governments, we have identified regional 'hotspots' that face labour gaps due to exceptional investment growth.

Availability of construction materials: our reporting on construction inputs has expanded this year to include a supply-side analysis of seven construction materials, plant, and equipment.

Key productivity roadblocks: this concise review looks at the key obstructions to construction industry productivity growth, which signal the need for a long-term government intervention strategy.

Career pathways: this edition of *Infrastructure Market Capacity* is supported by career pathways analysis of key infrastructure occupations, which was undertaken to better understand workforce dynamics, particularly in key areas of shortage.

Greater emphasis on policy implications and recommendations

This edition of *Infrastructure Market Capacity* includes a suite of practical and implementable recommendations for the Australian Government, working with states and territories, to manage infrastructure market capacity constraints. These were developed in consultation with relevant government stakeholders and are reinforced with the latest evidence.

A brief outline of the Market Capacity Program

The Market Capacity Program is an assumptions-based methodology for identifying market capacity risks. It was developed in collaboration with state and territory governments, industry, advisory bodies, and other subject matter experts. These partnerships are integral to the ongoing evolution of the Market Capacity Program.

The Market Capacity Program is underpinned by two system components:

National Infrastructure Project Database

The National Infrastructure Project Database ingests, aggregates, and organises infrastructure project data supplied by the Australian Governments and state and territory governments (public investments), and GlobalData (private investments).

The following infrastructure sectors are included in the Market Capacity Program:

- **Buildings:** non-residential buildings for health, education, sport, justice, transport buildings (e.g., parking facility and warehouse), other buildings (art facilities, civic/convention centres, and offices), limited coverage of detached and semi-detached residential buildings.
- **Transport:** roads, railways, level crossings and other transport projects such as airport runways.
- **Utilities:** water and sewerage, energy and fuels, gas and water pipelines, and telecommunications.

Market Capacity Intelligence System

The Market Capacity Intelligence System is a set of analytical tools that interrogates and visualises project demand sector, project type and resource inputs, for the following infrastructure pipelines:

Major Public Infrastructure Pipeline: Publicly funded infrastructure projects valued over $100 million in New South Wales, Victoria, Queensland and Western Australia, and over $50 million in South Australia, the Australian Capital Territory, the Northern Territory and Tasmania.

Small Capital Public Infrastructure Pipeline: Publicly funded infrastructure projects valued $100 million and under in New South Wales, Victoria, Queensland and Western Australia, and $50 million and under in South Australia, the Australian Capital Territory, the Northern Territory and Tasmania.

Private Infrastructure Pipeline: Privately funded public infrastructure such as a wind farm that is funded, delivered, and operated by the private sector.

Private construction: Residential and non-residential buildings projects.

Road maintenance: Resource demands for road maintenance projects.

2. Understanding demand

Apparent efforts to align government pipelines with market capacity should be maintained through ongoing coordination of infrastructure demand in the context of real-world supply.

A national pipeline that is commensurate with market capacity takes the heat out of delivery, lessens the risk and impact of cost escalations and schedule delays, and gives industry confidence to invest in capacity growth.

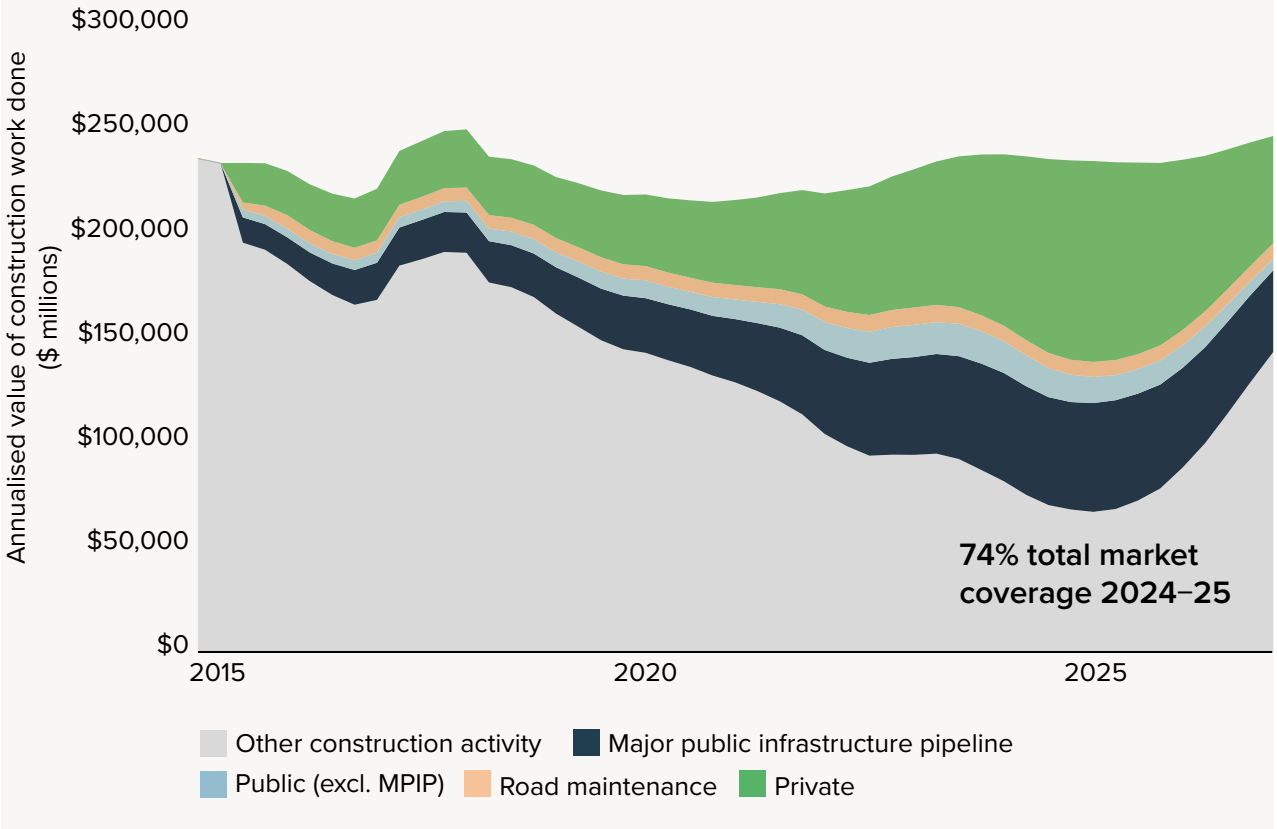
Recommendations for ongoing pipeline management are included in this section.

The market capacity database now reflects 74% of national construction demand

Our view of infrastructure demand has widened by 7% in 12 months - mostly due to enhancements in our methodology for analysing energy demand (see Section 1: Introduction*)* – to represent 74% of all construction activity (see **Figure 1**), valued at $691 billion over 5 years from 2022–23 to 2026–27.

Of the remaining 26% of total construction demand not currently covered by the market capacity database, significant public investment is in planning for defence, mining (especially critical minerals) and residential buildings. Infrastructure Australia is working with the Australian Government to expand the scope of our market capacity database, with ambitions to provide the full national infrastructure demand in the future.

Figure 1: Infrastructure spend – in the context of full construction activity



Source: Oxford Economics commissioned by Infrastructure Australia (2023).

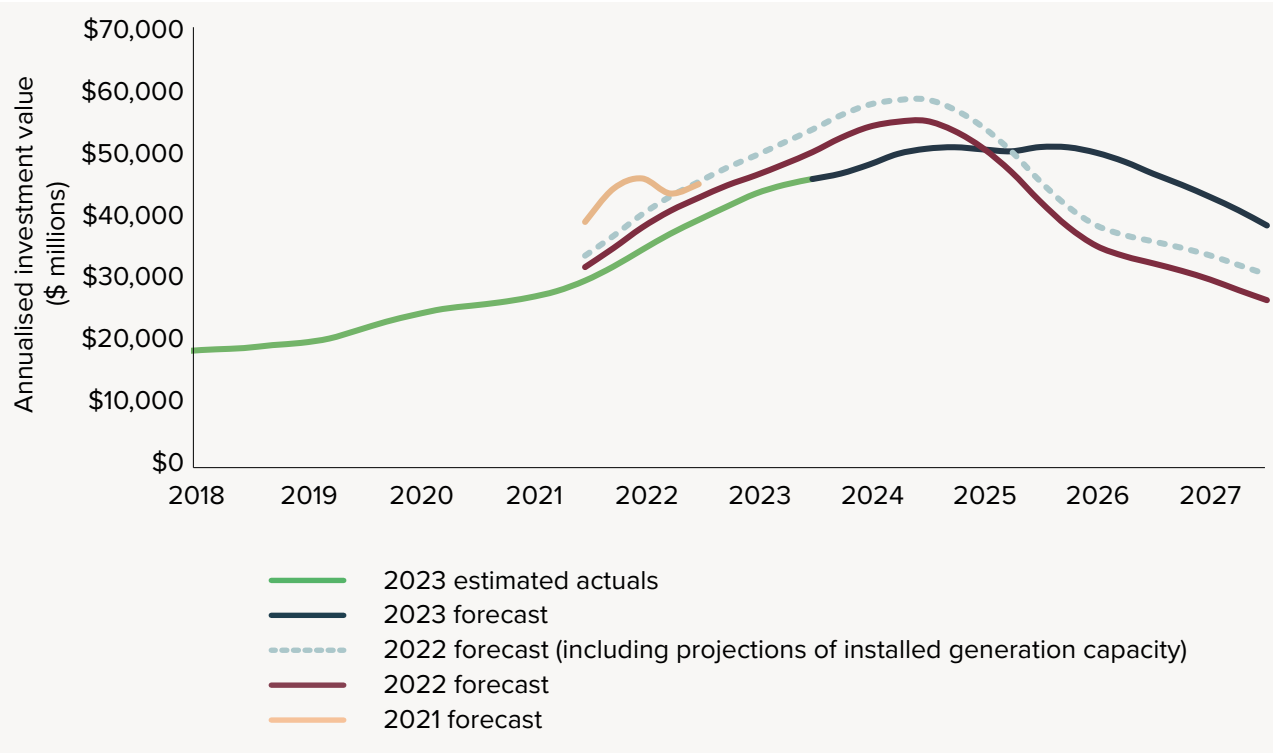
The market capacity database no longer relies on projections of installed generation capacity

This report marks a key refinement from previous editions of *Infrastructure Market Capacity*. While previous versions relied on the Australian Energy Market Operator projections of installed generation capacity in its Integrated System Plan, this updated report draws on a combination of project-specific private and public energy data. This shift in methodology is timely, driven by the Australian Government's strong commitment to decarbonisation. The increased pace of investment in the energy sector is expected to surpass the projections outlined in the Australian Energy Market Operator's 2022 Integrated System Plan. This surge in expected investment reflects a more dynamic market, demanding a finer degree of coverage. Therefore, transitioning to a projects-based perspective now offers a more realistic representation of demand within the energy sector.

The major rolling public infrastructure pipeline is smoothing out to later years, suggesting governments are continuing to align ambitions with market capacity

Based on this year's forecast, the forward project re-estimates are more evenly distributed across later years compared to the 2022 forecast, which projected a 10% higher peak with a sharper drop off (**Figure 2**).

Figure 2: Change in five-year major public infrastructure investment forecasts from 2021 to 2023



Source: Infrastructure Australia (2023).

Despite the smoother shape of the rolling pipeline, total cost of the five-year major public infrastructure pipeline has grown by $9 billion to $230 billion, representing 4% growth (as a rolling pipeline comparison between 2021—22 to 2025—26 and 2022—23 to 2026—27).

ANALYSIS

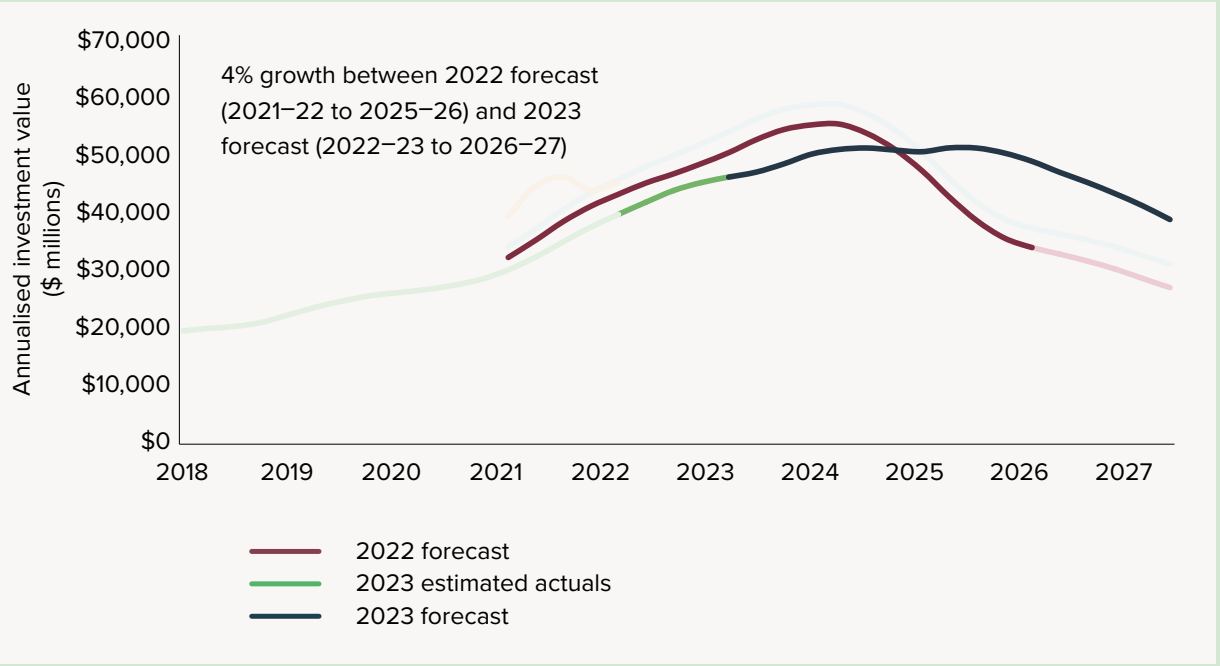
Infrastructure Australia's analysis of the rolling pipeline

Each year, governments across Australia introduce new budgets, and with each budget, the forecasting horizon rolls forward by a year. Infrastructure Australia compares the current forecast of major public infrastructure pipeline activity to previous years over 'rolling periods', which refers to a continuous time frame that shifts each year, to track changes in forecasts.

This allows us to assess how projections from the previous year's report compare to the current projections, noting the shift in the five-year horizon. It provides a view of committed budgets each year and the changes from year to year.

Figure 3 illustrates this change, with highlighted chart lines from both 2022 and 2023 clearly demonstrating the shift in the five-year horizon.

Figure 3: Major Public Infrastructure Pipeline – rolling comparison



Source: Infrastructure Australia (2023).

The growth of the major public infrastructure pipeline is primarily driven by the addition of new projects and the impact of cost escalation in near equal proportion

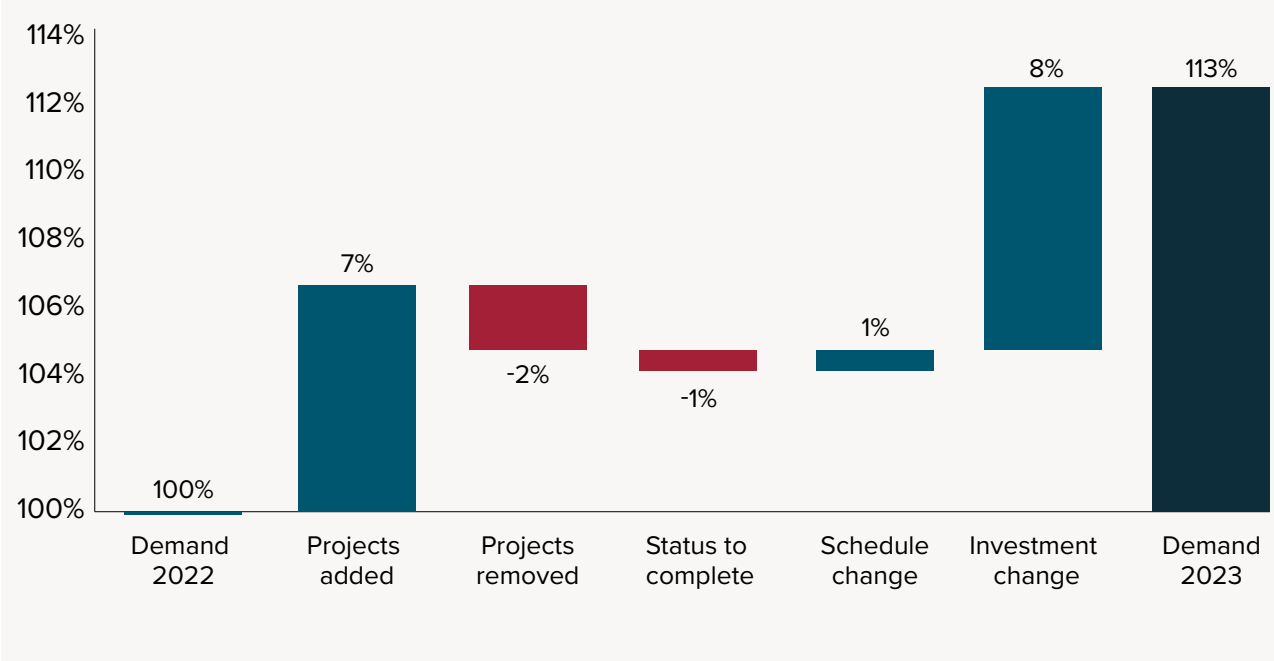
To better understand the drivers of change to arrive at a 4% growth in the rolling pipeline, Infrastructure Australia for the first time conducted an in-depth year-on-year analysis of the pipeline, comparing project cost changes as observed between 2022 estimates and 2023 estimates.

By studying a sample of 258 ongoing projects, year-on-year analysis of the change in estimates reveals that in 12 months there was an increase of 13% in the estimated investment required for those projects overall.

Figure 4 breaks down the total demand growth in 2023 by different categories of change:

- New projects added: +7%
- Cancelled / postponed projects removed: -2%
- Completed projects: -1%
- Schedule changes to ongoing projects: +1%
- Overall investment change: +8%

Figure 4: 2022—23 to 2026—27 major public infrastructure pipeline spend comparison from 2022 to 2023



Source: Infrastructure Australia (2022 and 2023), using like for like MPIP project types only.

The overall 8% absolute investment change in the portfolio averages out to a 7% per project cost increase across ongoing projects from the sample analysed. This is consistent with the estimated 7—10% construction cost escalation reported in relevant Australian Bureau of Statistics Producer Price indices (specifically, Heavy and Civil, and Road and Bridge). Across the sample projects, a range of 7% decrease to 20% increase in cost changes was observed, indicating that changes are not exclusively due to the escalation of inputs.

Beyond input cost escalations, a deeper analysis of the 20 projects with the highest cost increases indicates that cost changes are caused by a range of factors:

- Geotechnical issues discovered during construction (accounting for +$2 billion average cost change).
- Revised cost estimates (accounting for +$960 million average cost change).
- Project scope change (accounting for +$320 million average cost change).
- Program scope expansion (accounting for +$170 million average cost change).

ANALYSIS

Infrastructure Australia's project level analysis of the year-on-year pipeline

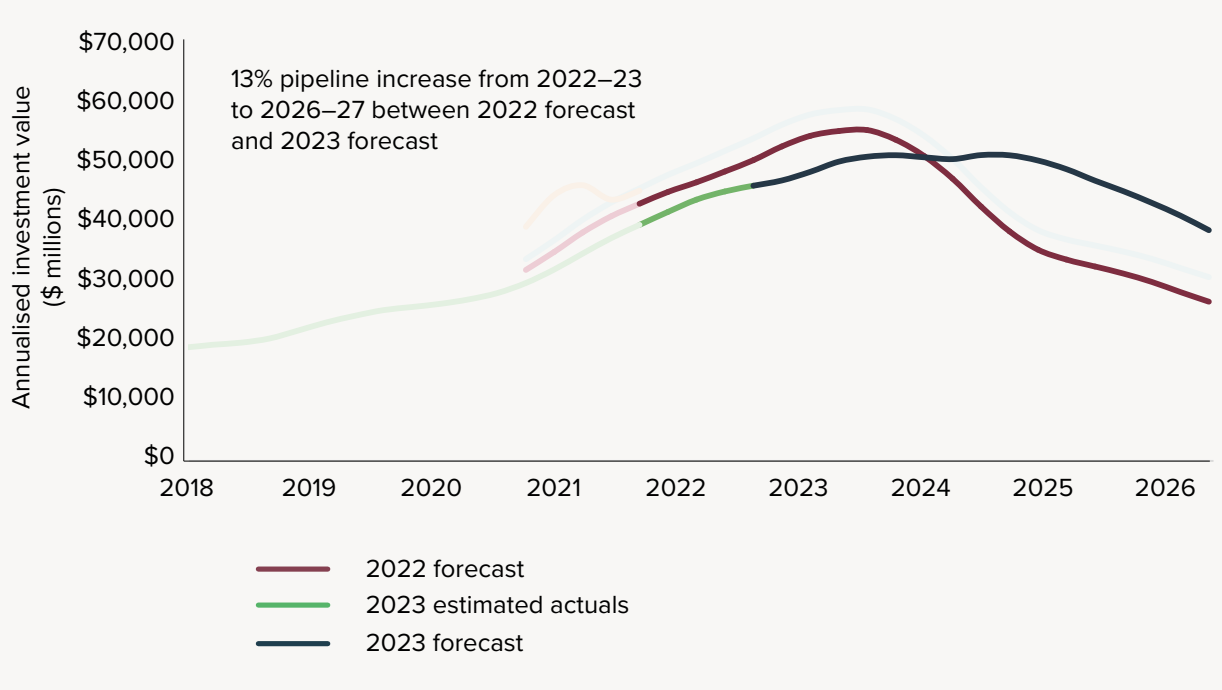
Whereas the rolling analysis allows us to compare how the five-year horizon evolves from year to year, a project level year-on-year analysis directly compares forecast major public infrastructure pipeline activity over an equivalent time period, enabling isolation of drivers for cost movement.

In this approach, Infrastructure Australia examines data for the same five-year period from both 2022 and 2023 project cost estimates. This allows us to understand how the composition of the pipeline has been impacted by inflow; the proportion of new projects, by outflow; the proportion of completed or cancelled projects, and by movement within the base of in-flight projects; the proportion of change attributable to cost escalation, for instance.

Due to data availability, it is important to note this analysis is done on a sample of projects sufficiently sized to represent the major public infrastructure pipeline.

Figure 5 visualises this parallel comparison, showing how forecasts differ in 2022 and 2023 for the same five-year period, in which the 2023 projections are 13% higher than projected in 2022.

Figure 5: Comparison of the 2022 and 2023 forecasts of major public infrastructure pipeline activity in 2022—23 to 2026—27



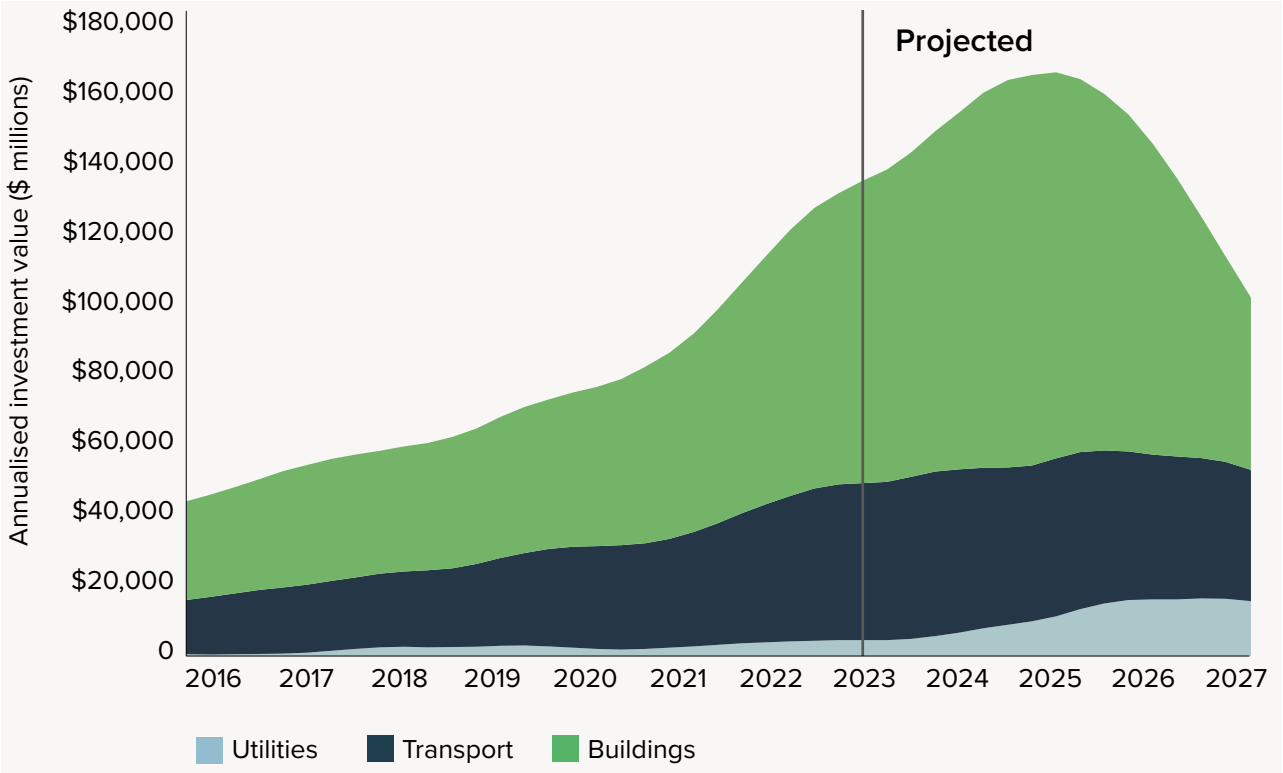
Source: Infrastructure Australia (2023).

Considering private investment in infrastructure, energy investments will increase four-fold in the next five years, and will compete for scarce resources

Industry has responded to government signals and announced a wave of energy projects. Combined with public works, the utilities pipeline will rise in total value to reach over $53 billion between 2022—23 to 2026—27 – four times higher than $13 billion invested between 2017—18 to 2021—22.

The $53 billion utilities pipeline (including energy projects) over five years and will compete for resources despite being overshadowed by building and transport investments of $427 billion and $210 billion respectively - see **Figure 6**.

Figure 6: Combined Infrastructure (public and private sector) - annualised investments by sector

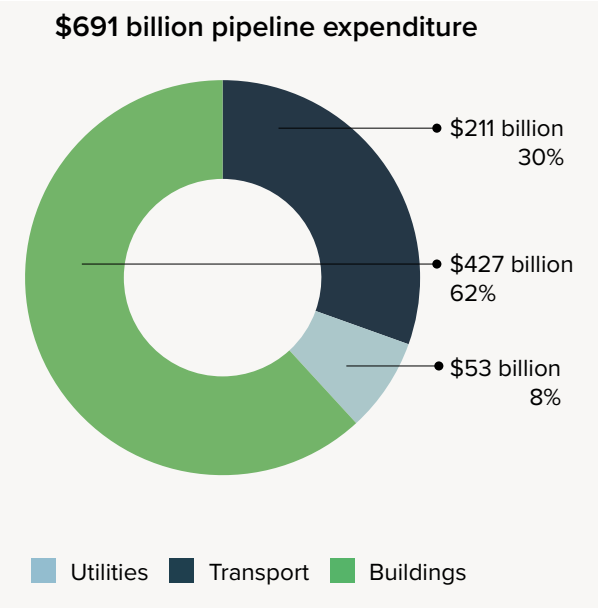


Source: Infrastructure Australia (2023).

The building sector represents the greatest investment share, representing 62% of total combined infrastructure expenditure

Building investments retain most the majority of total expenditure ($427 billion, representing 62% of total market demand), followed by transport ($211 billion, representing 30% of total market demand), and utilities 8% ($53 billion). See **Figure 7**.

Figure 7: Combined infrastructure pipeline (2022–23 to 2026–27) – split by sector



Source: Infrastructure Australia (2023).

Residential represents the largest share of buildings expenditure having experienced the highest investment growth

Residential investment has increased by $13 billion in the last year, the highest increase of the building subsectors. Its estimated value is now $225 billion over the next five years, representing 53% of building expenditure.

A singular cross-sector view of construction demand would allow governments to better ensure delivery of key public works across all portfolios

We note that substantial infrastructure investment by the defence and mining sectors over the forward years will also compete for market capacity. [5] [6]

Government decision makers should consider total construction demand when assessing proposals for new investments within their respective sectors across transport, buildings, utilities, mining, and heavy industry.

Infrastructure resource demands

Labour, materials, plant, and equipment are all constrained by unique factors

Table 1 breaks down major public spend over the next five years by four construction input categories: labour, materials, plant, and equipment. Aside from labour availability, which industry ranks as the primary supply-side risk for the third consecutive year, each category faces unique constraints, risks, and implications: these are briefly summarised here and analysed elsewhere in this report, as indicated below.

Key challenges by construction input category

Labour: shortages have reached 229,000 full time workers as of October 2023. The key occupational groups in shortage are engineers, architects, and scientists, and trades and labours. Opportunities exist to attract, retain, and upskill these workforces to meet current and future demand. See *Section 4: Workforce and skills* for workforce analysis and recommendations.

Materials: quarry shortages threaten projects in Melbourne, Mid North Coast New South Wales, and South East Queensland, highlighting a need for a national view of quarry supply. Steel imports are increasing, exposing investments to global supply chain risks. See *Section 3: Understanding non-labour supply* for construction materials analysis and recommendations.

Plant and equipment: long wait times remain for inputs in high demand – for example, trucks and site equipment - which increases the risk of schedule delays. Imported machinery requires local configuration by specialist engineers in shortage. See *Section 4: Workplace and skills* for labour and skills analysis and recommendations.

Table 1: Major public infrastructure resource demands, 2022—23 to 2026—27

Key facts	Labour	Materials	Plant	Equipment
Five-year spend ($)	$133.5 billion	$68.0 billion	$17.2 billion	$11.9 billion
Share of total resource demand	51%	34%	8%	7%

Regional demand hotspots

Exceptionally high demand in some regional areas will likely create resource gaps

Infrastructure Australia has pinpointed regional areas where extraordinary levels of public and private investment are expected to create labour gaps in the coming years.

The basis for measuring, comparing, and identifying demand hotspots is average annual growth rate over three years, from 2022—23 to 2024—25 (the peak in pipeline expenditure).

Top five regional hotspots, nationally:

- Murray - New South Wales
- Mid North Coast - New South Wales
- The Northern Territory Outback – The Northern Territory
- Central Queensland - Queensland
- Riverina – New South Wales

Top regional hotspot for jurisdictions not featured in top five:

- Barossa, Yorke, Mid North – South Australia
- Warrnambool and South West - Victoria
- West and North West – Tasmania
- Wheatbelt – Western Australia

The regional analysis was produced using analytical tools built by Infrastructure Australia in partnership with governments across the country. These analytical tools are designed to help government decision makers diagnose supply bottlenecks, spot growth opportunities, and build strong evidence bases for investment decisions.

Two analytical tools developed this year analyse investment demand, material demand, and labour demand and supply. See below *Example of market capacity regional analysis* for Mid North Coast, New South Wales using these tools.

The regional analysis does not include material supply because the availability of materials supply data is variable and inconsistent among jurisdictions. Further analysis and recommendations for a national collection of material outputs is provided in *Section 3. Understanding non-labour supply.*

In the meantime, Infrastructure Australia hopes to continue working with industry to produce supply forecasts that contextualise materials demand that help governments identify and plan for local constraints ahead of time and build industry confidence to invest in capacity growth.

ANALYSIS

Example of market capacity regional analysis

Mid North Coast, New South Wales

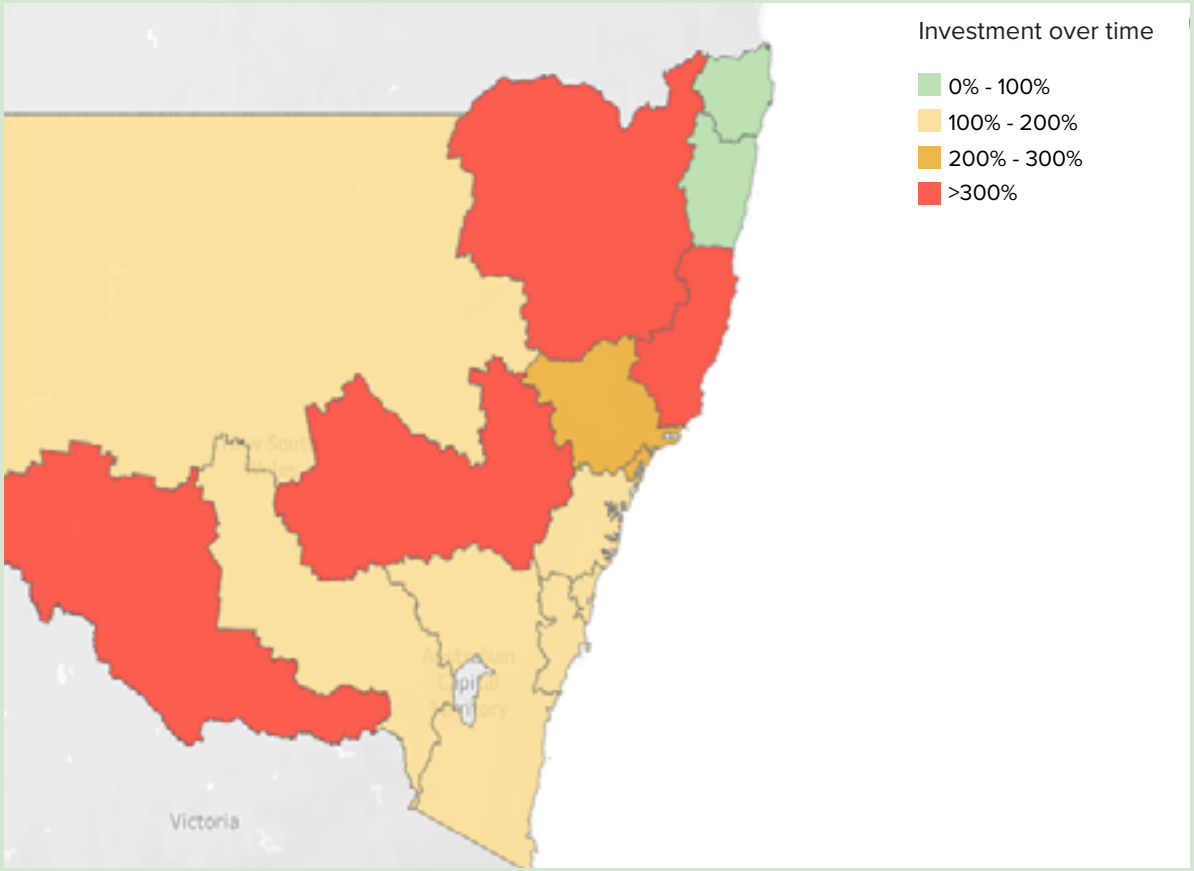
Figure 8 shows four regions in New South Wales with extraordinary demand growth predicted between 2022—23 and 2024—25. Growth will be highest in the Mid North Coast region, increasing at an average rate of 98% each year.

Expenditure: At its current peak in 2024—25, total expenditure in Mid North Coast will be more than 3 times higher than actual work done in 2022—23 ($89 million versus $323 million), averaging 98% growth a year.

Labour demand: 1,600 full-time equivalent employees are required to meet peak demand in 2024—25, compared to 600 in 2022—23.

Materials supply: Industry has indicated that local quarry supplies are low and may be insufficient to meet demand.

Figure 8: Average annual growth, 2022—23 to 2024—25, by SA4 region, New South Wales



Source: Infrastructure Australia map dashboard (2023).

Recommendations to actively managing demand

RECOMMENDATION

Recommendation 1: Active pipeline management

The Australian Government, in partnership with state and territory governments, continue to actively manage public infrastructure demand via the Infrastructure and Transport Senior Officials' Committee by:

- working with state and territory governments to regularly, at least annually, review demand and ensure ongoing management of the public infrastructure pipeline
- conducting ongoing cross-sector pipeline management, including the use of Infrastructure Australia's analytical pipeline tools developed for governments.

RECOMMENDATION

Recommendation 2: Cross-sector whole of market capacity

The Australian Government could consider issuing whole of government guidance to ensure all relevant portfolios consider cross-sector market capacity in the assessment and decision-making processes for new and revised policy proposals with an infrastructure component.

Future actions

The Australian Government should develop a whole of government approach to monitoring and managing construction market capacity, to facilitate the delivery of committed public works across priority portfolios.

3. Understanding non-labour supply

Steps must be taken to address knowledge gaps and supply capacity limits that prevent limit industry efficiency and self-sufficiency.

Project uncertainties and risks decrease when domestic supply can meet domestic demand: this maximises investment value, ensures smoother project delivery, bypasses global supply chain issues, and increases industry confidence to invest in its productive capacity.

This section offers analysis and recommendations for building supply-side knowledge and capacity.

Key findings: supply-side risks

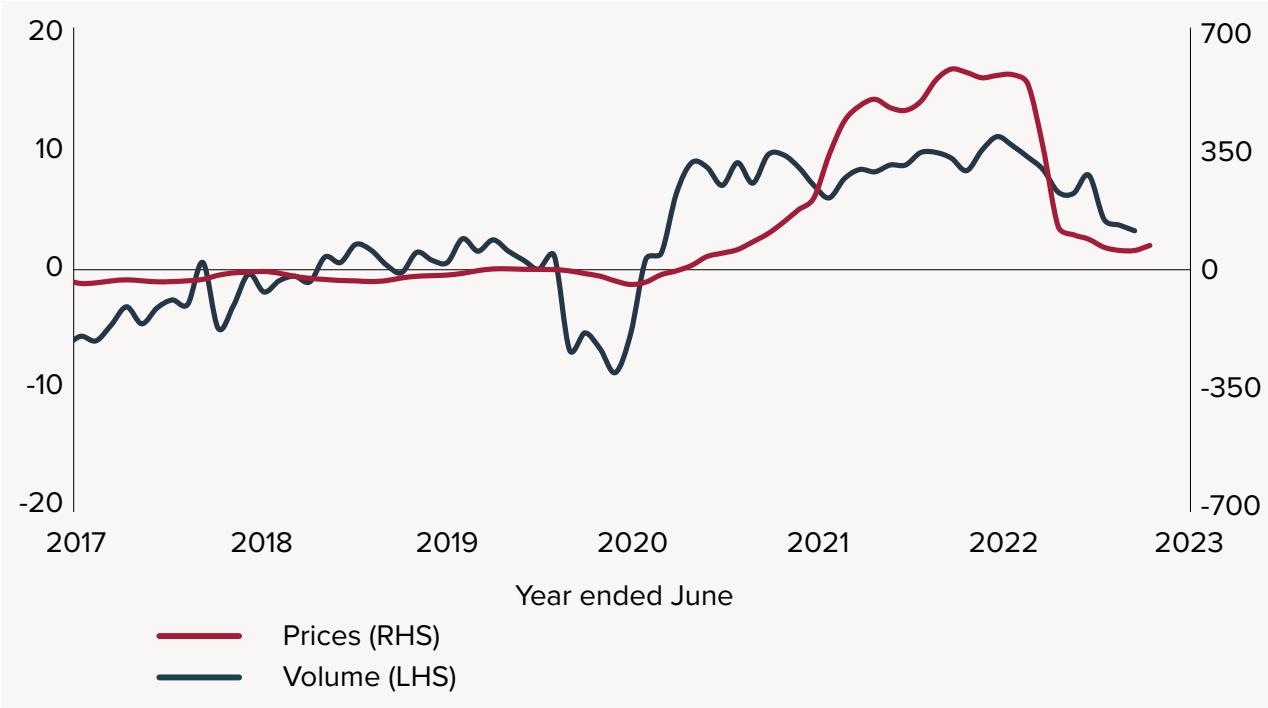
International pressures have eased in the last 12 months

In the last year, global growth has slowed due to high inflation and rising capital costs, and the production output of China (and other major economies) has increased following a relaxing of COVID-19 restrictions.

With greater balance in global supply and demand, pressures that existed in global supply chains 12 months ago have eased, and steady improvements in international production, trade and transport measures have been observed.

For example, **Figure 9** shows that global shipping volumes and prices are re-normalising following a surge over 2021 and 2022.

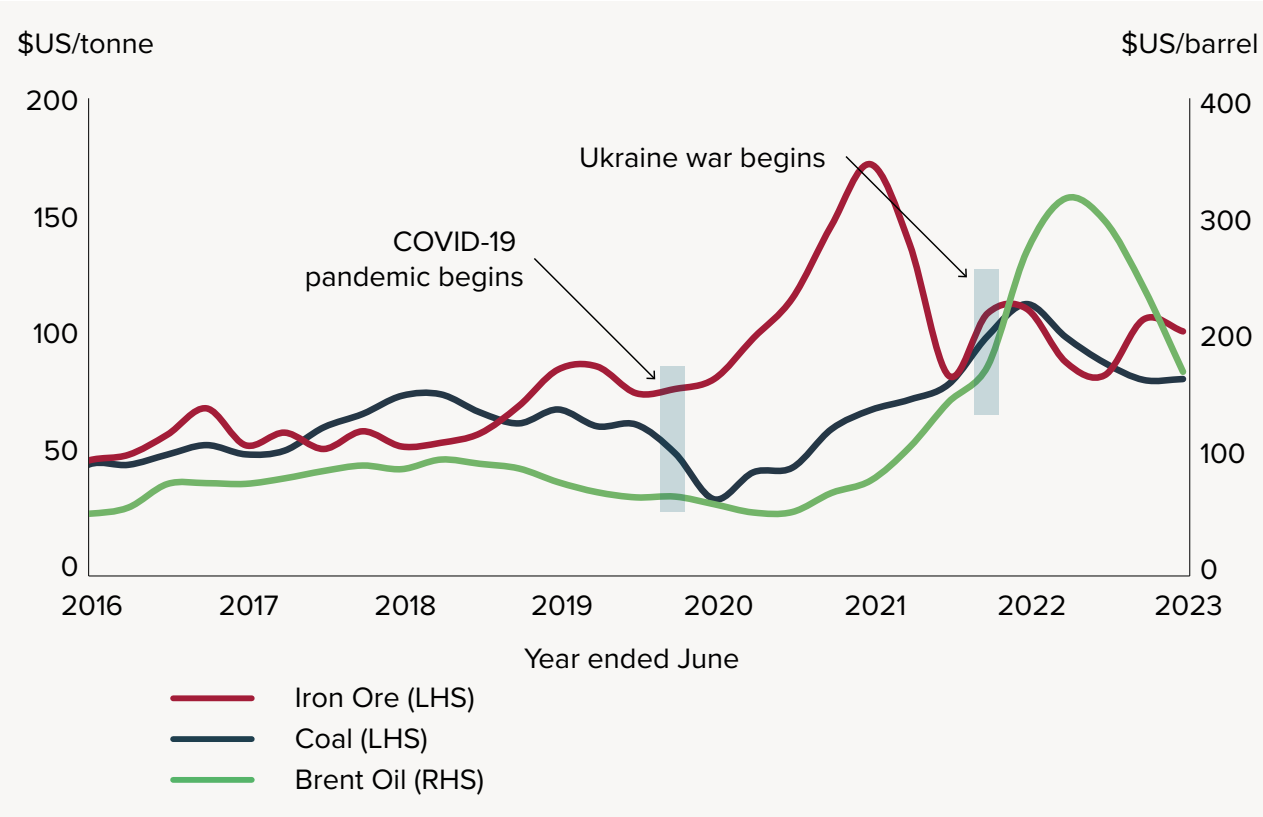
Figure 9: Changes in global shipping volumes and prices from 2017 to June 2023



Source: Haver Analytics (2023).

Greater supply and demand balance is also helping lower prices of globally sourced infrastructure inputs, which boomed in 2021 and 2022 after briefly dipping in 2020 with the onset of the COVID-19 pandemic. Despite falling over the last 12 months however, **Figure 10** shows that commodity prices remain well above pre-pandemic lows.

Figure 10: Changes in oil, coal, and iron ore prices ($USD), 2016 to June 2023



Source: Australian Bureau of Statistics data (2023).

ANALYSIS

Views from industry: methodology in brief

This section includes industry views on the availability of construction materials, and ideas for securing those most at risk.

To gather insights, we interviewed 19 industry suppliers over the phone, between March and May 2023. Representations covered steel production and fabrication, quarry, cement, concrete, plant and equipment, and plasterboard.

Each interview followed a similar agenda:

- Involvement in infrastructure activity and segments.
- Specific challenges regarding own ability to meet industry demands.
- Perceived broader capacity and capability challenges in the infrastructure industry.
- Perceived causes of capacity and capability risks.
- Potential solutions to mitigate risks to industry capacity and capability.

To supplement our analysis, we used publicly available data to report on the production and import of key materials and form our views on timber and bitumen.

See *Appendix* for full methodology.

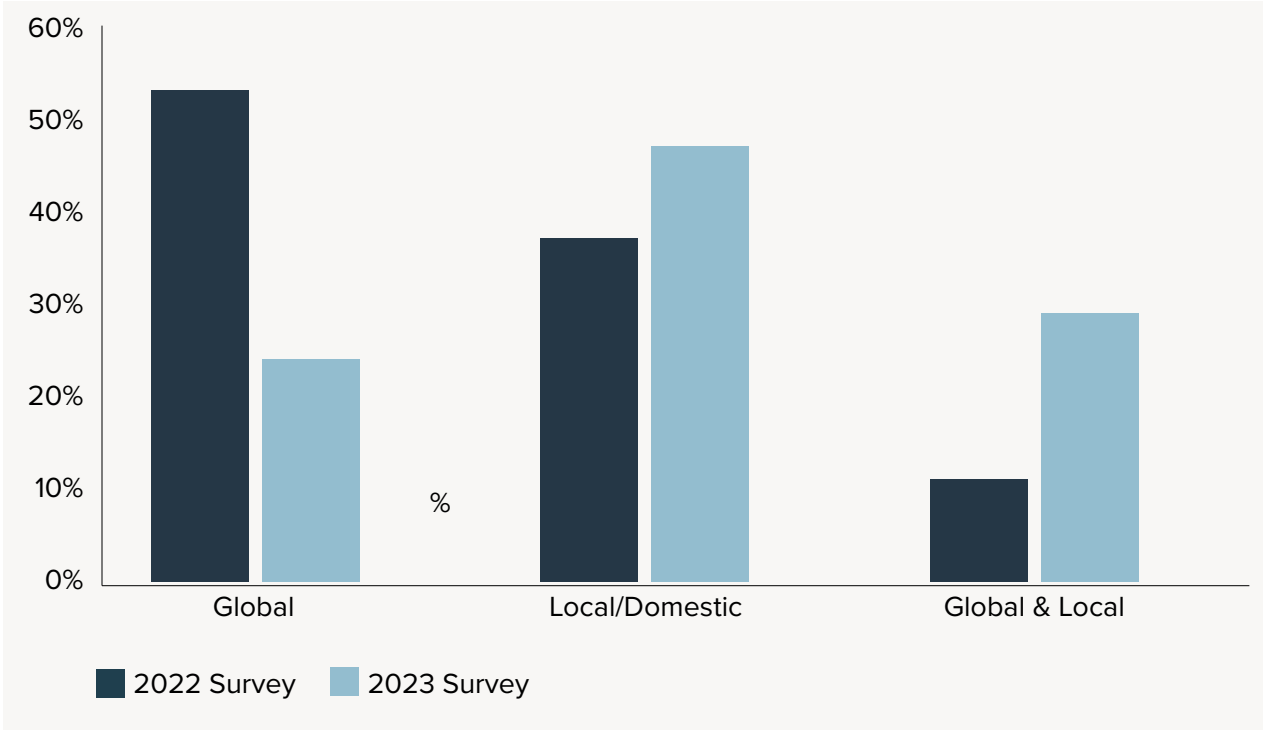
Domestic factors are driving most supply-side risk

As shown in **Figure 11**, industry's opinion on the source of supply-side risk has changed in the last year, shifting from global factors in 2022, to domestic factors in 2023.

Industry and suppliers generally agree that the following domestic supply-side risks are the greatest threat to market capacity:

- Availability of labour
- Access to key materials
- Cost escalation
- Risk management practices
- Low pipeline visibility

Figure 11: Source of supply-side risks, 2022 and 2023 industry survey



Source: Oxford Economics commissioned by Infrastructure Australia (2022 and 2023).

Industry ranks availability of labour as the primary supply-side risk for the third consecutive year

Once again, the construction industry has ranked labour availability as the biggest threat to market capacity. In fact, the risk rating attached to all broad labour categories has risen significantly in the last 12 months. This is especially pronounced in heavy industries and trades that are viewed as 'old fashioned' (e.g., boiler-making).

There is greater risk in sourcing key materials than 12 months ago

Risk scores for locally sourced materials such as concrete, cement, sand and quarry products have all increased in the last 12 months. In contrast, risk ratings for often-imported materials such as steel, timber, and oil products have decreased, the exception being construction equipment, where risk scores have risen marginally.

Table 2 provides a summary of key risks and implications in the supply of construction materials.

Table 2: Risks and implications of the supply of construction materials

Construction materials	Key risks	Implications	Capacity risk
Quarry products	Quarries that serve Melbourne, Mid North Coast New South Wales, and Southeast Queensland are identified by industry as being low on supply. It takes 5—10 years between quarry application approval and extraction.	Without a view of national quarry supply there is no basis for predicting current capacity or planning future capacity. Inefficient planning, development, and re-approval processes prevent timely responses to emerging supply constraints. Projects carry the risk of higher transportation costs and schedule delays if forced to source quarry materials from further afield.	High
Steel and steel fabrication	Steel imports are 20% higher in 2020—21 and 2021—22 than the average of the previous two decades, and will likely grow in line with sustained construction demand over the forward estimates and beyond. Boom/bust investment cycles are a disincentive for industry investment in capacity.	Investments relying on imported steel carry global supply chain risks such as: • Fluctuating prices • Transport costs • Complex logistics • Product quality	Medium
Concrete	Concrete production relies on adequate quarry supply. Precast concrete lead times are still very long.	See *Quarry products*.	Medium
Plant and equipment	Demand is still very high for many plant and equipment inputs. Australia relies heavily on overseas markets to meet demand.	Long wait times for inputs in high demand – such as trucks and site equipment - increase the risk of schedule delays. Imported machinery often requires local configuration by specialist engineers that are currently in short supply. *Section 4: Workplace and skills* for workforce analysis and recommendations.	Medium

Construction materials	Key risks	Implications	Capacity risk
Timber	Local softwood timber supply is forecast to remain relatively constant for 25—30 years. [7] Collectively, legal logging areas in native forests – the source of local hardwood timber - have almost halved in 20 years and will shrink again when Victoria and Western Australia introduce native forest logging bans in 2024. Local timber supply carries ongoing environmental risks, such as flooding and bushfires (the latter affected 10% of local softwood plantations in 2019—20).[8]	Investments that rely on imported timber carry risks common to global supply chains – for example: • Price variability • Increased competition • Local / global inflation • Product availability • Transportation costs • Product quality	Medium
Cement	Imports of clinker, and other ingredients for cement production, are increasing because local demand exceeds the capacity of Australia's five remaining cement kilns. More kilns are likely to close due to rising energy costs and carbon emissions targets, which will increase Australia's reliance on imported materials.	Investments that rely on imported clinker and other materials required for cement production risks common to global supply chains – for example: • Price variability • Increased competition • Local / global inflation • Product availability • Transportation costs • Product quality	Low
Plasterboard	Industry reports no current supply issues. The plasterboard industry is a major consumer of gas, directly (product) and indirectly (transportation).	Rising energy costs could increase the price of plasterboard within infrastructure projects.	Low
Bitumen	Australia imports most of its bitumen. Industry reports no supply issues.	Investments that rely on imported bitumen carry risks common to global supply chains – for example: • Price variability • Increased competition • Local / global inflation • Product availability • Transportation costs • Product quality	Low

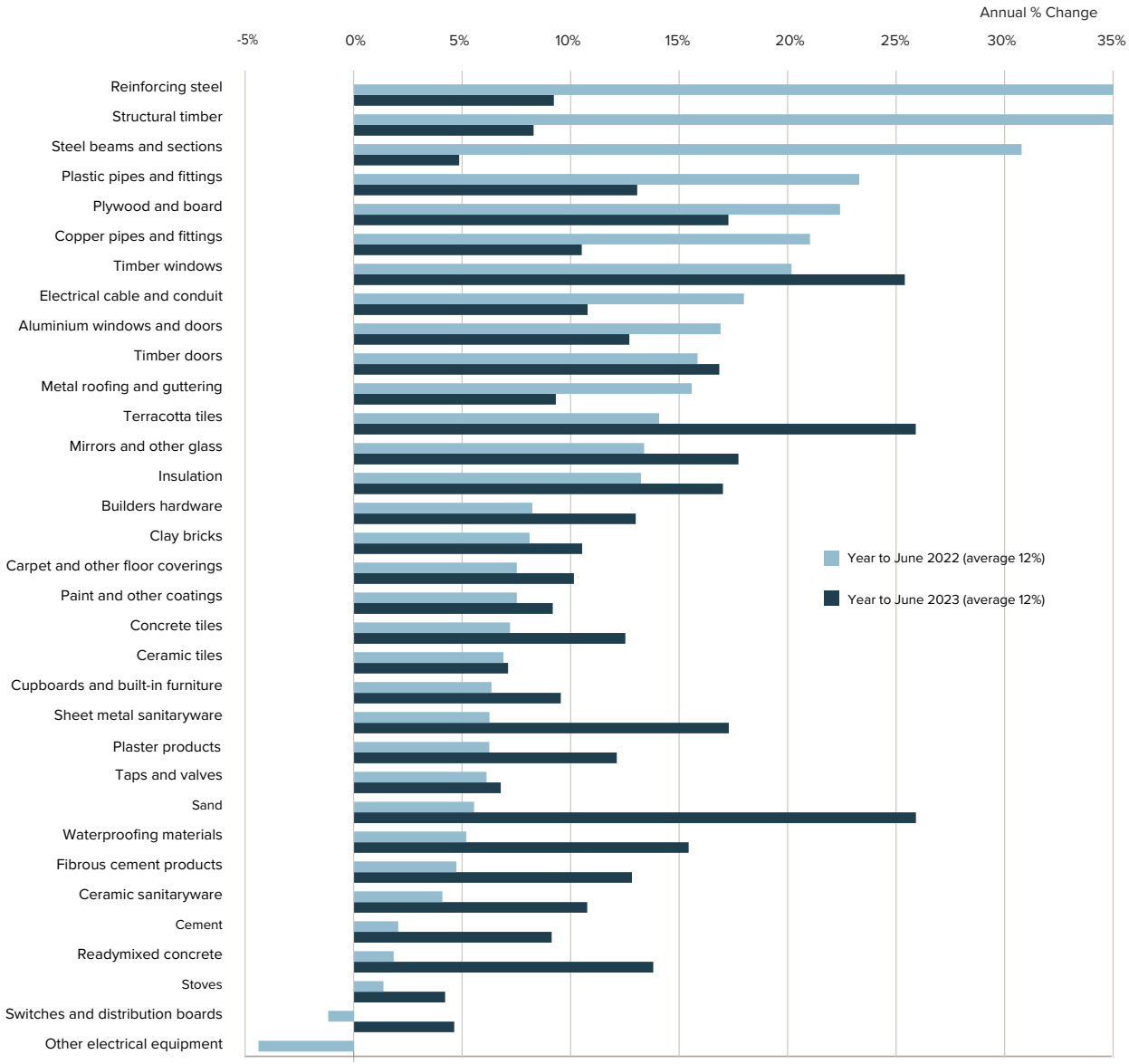
Price growth has increased for infrastructure inputs specifically

While the rate of construction input price increases have eased over the last 12 months, total escalation is still elevated at 7–10 % (see **Figure 12**), reaching growth 20–30% for individual inputs such as sand, glass, reinforcing steel, aluminium products, insulation, and tiles.

Survey responses indicate the following construction cost escalations in the last 12 months:

- 71% of Tier 1 constructors indicate a cost escalation rate that is either the same or higher than 2022.
- 46% of Tier 2 and 3, report a cost escalation rate of at least 25%.
- 88% of construction companies attribute cost escalations of the last 12 months to variations in contracts.
- 82% of construction companies believe that price growth is at or past its peak.
- 60% of Tier 1 constructors expect supply chain challenges to persist for more than 2 years, compared to 26% in 2022.

Figure 12: Annual % change in price from 2022 to 2023 by construction material



Source: Australian Bureau of Statistics data, Producer Price Index, June Quarter, 2022 and 2023.

Risk practices are still the biggest impediment to alleviating market capacity

Industry continues to flag the damaging effects of poor risk allocation and risk identification on capacity, signalling that project failures and rework continue to disrupt schedules, divert resources, escalate costs, and stymie productivity growth. See *Section 5: Productivity* for detailed analysis and recommendations for improving risk practices.

Pipeline uncertainty is a growing concern for some suppliers

Large construction companies agree that pipeline uncertainty is a bigger threat to capacity than 12 months ago, while smaller constructors still rank the lack of funding certainty third out of ten capacity risk factors.

At the same time, the confidence among larger construction companies to increase operations by 25% or more has dipped drastically. This may be due to pipeline uncertainty and ongoing domestic supply chain issues.

It is worth noting that in the last year, the Australian Government commissioned a review of its Infrastructure Investment Pipeline. Among other objectives, the review aims to ensure a sustainable pipeline of nationally significant projects that is both commensurate to market capacity and upholds $120 billion over 10 years to ensure market certainty.

Similarly, NSW Government's Strategic Infrastructure Review assessed its forward capital program to ensure it was adequately balancing fiscal, service delivery, and market capacity pressures. It identified projects and programs that can proceed to investment and delivery, and those that can be delayed, re-sequenced, re-scoped or re-prioritised.

These strategic reviews demonstrate governments' ongoing commitment to proactive pipeline management to ensure the deliverability of Australia's public infrastructure works. In the long run, they will contribute to more stable and sustainable public infrastructure pipelines that will provide industry certainty on the longer-term demand profile.

Smaller suppliers are still more confident in scaling up compared to larger firms

Confidence to deliver near-term projects has increased among large construction firms, while smaller firms are still highly assured in their ability to scale up operations, should it be required, within six months, including in regional areas.

SPOTLIGHT

In the spotlight: Quarry products

Capacity risk: High

Key insights

- Due to high transportation costs relative to materials value, quarry products must be sourced locally.
- Planning processes are the biggest constraint to quarry expansion and capacity. It takes 5—10 years from quarry application approval to extraction, during which time the built environment may take over a prospective quarry site.
- Melbourne has been projected to experience acute quarry shortage as several quarry consents are due to expire before new greenfield quarries can be established. If consents are not renewed, local construction costs will increase significantly. The VIC Government has sought to address this issue by establishing a 'Quarry Approvals Coordination Unit' which has delivered promising results during the pilot phase. See the case study below.
- In South East Queensland, increased infrastructure demand fueled by population growth and the Brisbane 2032 Olympics will exert pressure on local quarry reserves for the next decade.
- Elsewhere, quarry capacity in Mid North Coast NSW is a growing risk to Coffs Harbour Bypass investments, as are quarries that serve regional and remote areas due to a lack of logistics and capacity approvals.
- Labour access remains the biggest issue for the quarry industry: truck drivers and quarry operators are in particularly short supply.
- It is difficult to predict the availability of raw quarry products without data. Victoria and Queensland publish quarry production statistics, but no jurisdiction publishes supply data or latent capacity analysis.
- Geoscience Australia's Mineral Potential Mapper[9] is a computer-based system designed to map the nation's inventory of known mineral resources and advise industry and governments on the potential for as-yet undiscovered resources. The Mapper might also help to improve transparency of national supplies and support long term planning for quarry materials in line with demand.

SPOTLIGHT

Supplier soundbites:

> *Generally, across the country...road access networks for our trucks are fairly prohibitive. And assets and reserves are moving further and further away from metropolitan areas, which means they're getting more and more expensive.*

> *Developing quarries is a 5–10-year process. And a lot of people are just giving up, saying it's just too hard and too costly. And there's no guarantee of a return.*

> *Clearly, we use more truck drivers than anything else. So, that's where we're feeling the labour shortage the most. But quarry operators are very hard to find at the moment. Even admin staff in offices are very difficult to come by.*

CASE STUDY

Case study: Victorian Government Quarry Approvals Coordinator (QAC)[10,11]

A successful pilot that delivered immediate results

In 2022, a Victorian Government study on quarry material demand and supply indicated the construction industries were facing pressure from unprecedented supply chain challenges .

The Quarry Approvals Coordinator pilot program was launched to directly respond to these challenges. It was tasked to engage with the quarry industry to secure the supply of quarry-based construction materials.

The Quarry Approvals Coordinator was a dedicated resource within the Victorian Government for industry, to make regulatory pathways and processes more accessible. The Quarry Approvals Coordinator case managed opportunities within its scope to ensure applications met the necessary requirements, and applications were prepared and submitted without unnecessary delay.

Short term interventions

The primary goal of the QAC was to unlock, in the short term, additional supplies of hard rock and sand resources for development across Victoria. To do so, it worked with quarry operators to identify opportunities to expand existing operations via a change process known as an administrative update.

Alongside its core functions, the QAC also played a critical role in developing the government's emergency flood response for quarry materials, including facilitating Victorian planning provision amendment VC228. This amendment will enable quarries supplying materials for road construction and maintenance apply for a temporary extension of operating hours to assist in the state's flood recovery efforts. In the first instance, this material will assist deliver the government's $165 million road repair blitz.

Pilot outcomes

During its eight-month pilot phase, the Quarry Approvals Coordinator helped targeted quarries unlock more than 40 million tonnes of additional resources, including sand for concrete production and hard rock for road construction and maintenance. This additional resource would have otherwise not been realised.

Medium term solutions

Following the success of the Quarry Approvals Coordinator, a further two years of funding was provided under the 2023-2024 Victorian State Budget to establish Resources Victoria Approvals Coordination. The funded initiative continues the work of the Quarry Approvals Coordinator with an expanded remit, including minerals development projects.

SPOTLIGHT

In the spotlight: Steel and steel fabrication

Capacity risk: Medium

Key insights

- Australia has a shortage of fabrication capacity and plate to meet strong increases in demand, which may impact the construction of wind and telecoms towers if not well managed.
- Uneven annual spend produces ‘end of year’ bottlenecks: these boom/bust cycles of income disincentivise capacity investment from industry.
- Inconsistent local content planning and energy policies distort investment decisions and capacity.
- Access to skills is a problem in general, and truck drivers remain a particular concern.
- Long lead times for labour-saving equipment from overseas further exacerbate capacity constraints.
- Steel plate transportation is logistically challenging and therefore expensive.

SPOTLIGHT

Steel Products

Production

> *Local content policies to attract domestic fabricators are still a bit loose. There's no definitive focus on the content and what [it] means. It's about having that consistent pipeline of work…rather than going from feast to famine. Once [fabricators] understand there is a pipeline and [are] confident of where it is and how it's going to be managed, [they] will invest and set up.*

> *Certainly, what has become very apparent is…every jurisdiction that puts significant investment into fabrication has generally quite high levels of local content mandated, particularly in Europe and elsewhere. That's the sort of policy certainty we need to invest in fabrication capacity and capability here.*

Regional activity

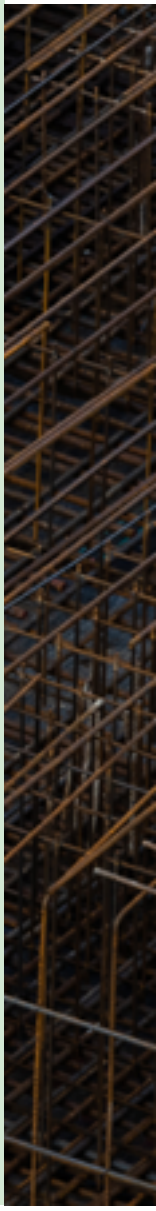
> *Queensland [has] so much work coming through with the Olympic infrastructure and their roads and everything else that's going with it, if it's not well planned, everything's going to hit at the same time and everyone's just going to be running around trying to find the next best alternative to get something in and get something done. So that planning phase and that early communication is critical...*

> *Western Australia might be the trickiest from a supply standpoint. Like, the rail line was washed out three times last year... logistically Western Australia's hard because we're East Coast manufacturing-based. But I think if [you're] supplying out of Australia, Western Australia's easier.*

Labour

> *Getting welders is really difficult... just getting people that can work with metal...those trades have been decimated. [And] this whole [subcontractors] thing. We're going to need some revolutionary thoughts about this, right? It's going to crowd out potentially smaller manufacturers like us.*

> *The Victoria Local Jobs First model is quite good [where] the commissioner and the steel industry have a regular round table...I think that can play quite a good role in...mandating early engagement with local suppliers. We don't really have that structure or escalation point in other jurisdictions in Australia. And...there isn't a Federal equivalent really.*



RECOMMENDATION

Recommendation 3: Quarry supply

The Australian Government, in partnership with state and territory governments, should investigate ways to boost quarry output to meet local demand by working with states and territories to identify barriers and consider any national solutions to ensure adequate supply of quarry materials for infrastructure projects, via the Infrastructure and Transport Senior Officials' Committee.

Future actions

The Australian Government should:

- encourage jurisdictions experiencing quarry shortages to consider developing a program similar to Victoria's successful Quarry Approvals Coordinator model, to support applications to increase quarry supplies for priority infrastructure projects
- explore the options to improve data collection and transparency of national quarry supplies to support longer term planning.

RECOMMENDATION

Recommendation 4: Steel supply

The Australian Government, in partnership with state and territory governments, should undertake analysis of domestic steel production and fabrication capacity as part of broader Australian Government policy initiatives to strengthen and support sovereign supply chain capability and grow new capacity for future industries.

SPOTLIGHT

In the spotlight: Concrete

Capacity risk: Medium

Key risks

- Access to labour is the biggest issue facing the concrete industry. The COVID-19 pandemic slowed the flow of unskilled labour, driving acute shortages in concrete manufacturing workers and truck drivers.
- Access to trucks disrupts concrete production through upstream quarrying, and downstream cement production. Truck disruptions are dictated by overseas manufacturing, shipping supply chains, and competing international demand.
- It is difficult to obtain council approvals for urban batch plants, forcing concrete delivery trucks to travel further, causing avoidable congestion
- Lead times for concrete pipes are slowly improving since Reinforced Concrete Pipes Australia opened its Thornton site near Newcastle, but there is still a way to go before lead times match those prior to April 2020, when Rocla closed its last pre-cast manufacturing facility in Australia.

Supplier soundbites:

"We've been trying to get production [staff], admin staff, safety quality type staff. We've had to go to New Zealand for a production manager."

"The number one issue for us is drivers... We're still having trouble recruiting sufficient numbers."

"Trucking is probably our biggest constraint at the moment. Agitator drivers [and] cement tanker drivers [to take the products] to market"

"Concrete's bottleneck is still trucks. We've got trucks due in a couple of months that we ordered 18 months ago."

"If you were to order a road truck at the moment, [the lead time] is about 18 months to two years. Similarly, with big heavy mobile equipment for quarries, loaders and dump trucks, you're looking at probably two-year lead time. I can't see it changing any time soon."

"Looking at DAs...there's not many places in Sydney where we can build a concrete plant."

SPOTLIGHT

In the spotlight: Plant and equipment

Capacity risk: Medium

Key risks

- Most plant and equipment used in Australian construction is imported, with the exception of some locally made trucks and site equipment. Lead times are still significant but wait times for imports have lessened due to relief in international supply chains.
- Imports are growing strongly: 20% higher in 2021—22 than 2017—18 (the previous peak) according to Australian Bureau of Statistics trade data.
- Costs for plant and equipment have grown by a record 30% in the last 12 months, due to inflation in countries of manufacture and shipping cost increases.
- On top of labour shortages, finding skills to configure, service, maintain and operate plant and equipment is problematic, and will likely worsen due to increased competition for skills (particularly electrical and mechanical) to support Australia's decarbonisation plans.

Supplier soundbites:

"Offshore-based equipment [lead times] really have started to come back in to, I'd say, four to six months. And I think last time we were looking well over six to 12. Onshore, however, is causing us a lot of issues. So, site accommodation: lead times for those, well, they're just out of control. We're still talking close to 12 months."

"Certainly, from my perspective, and I've been in the game for 30 years, I've never seen price escalation ever, in what we've seen in the last 12 months... So we have products that are 30% more expensive than they were a year ago."

"The skill shortage is probably front and centre, both in terms of volume of people, but also the specific skills as well and some of the traditional skills. So, diesel mechanics, auto electrics, boiler makers are in short supply."

"Our biggest growth cycles have all been underpinned by immigration. We need to open up Australia to Southeast Australia."

"The WA state government has run a campaign, in England, to attract government workers... This was astounding, the average wage in Western Australia is double England."

SPOTLIGHT

In the spotlight: Timber

Capacity risk: Medium

Key risks

- Timber imports represent around 25% of market supply and are rising.
- Long-term population growth will increase timber demand for extra housing and non-residential buildings.
- The combined timber logging space in Australia is almost 50% smaller than 20 years ago. [12]
- Further downsizing is expected in 2024 when Victoria and Western Australia introduce forest logging bans.

SPOTLIGHT

In the spotlight: Cement

Capacity risk: Low

Key insights

- Cement is made by combining ground clinker with gypsum and other materials. Clinker is composite material made by burning limestone and other quarry products in lime kilns.
- The profitability of cement production has fallen with rising energy costs, and many cement plants, including 10 lime kilns, have closed over the last 30 years. There are now just five cement plants in Australia, operated by three companies, supplying around 95% of local cement demand.
- With two-thirds of Australia's lime kilns now closed, clinker imports have increased from 25% in 2010, to 43% in 2021. [13] If clinker imports continue to grow as anticipated, more local grinding facilities need to be built to handle the increasing volume.
- Overall cement production emits a lot of carbon, but without existing technologies to offset emissions, local cement supply is likely to decrease as carbon reduction policies increase.
- Cement supply is unlikely to suffer a fall in local production: instead, cement and clinker imports are predicted to rise, effectively 'exporting' Australia's carbon emissions to other countries and risking higher net emissions once transport is factored.

Supplier soundbites:

"China is two billion tonnes of cement. 55% of the world. Even in Asia, we're talking 15 to 17 million tonnes of capacity available for export. In essence, it's a growing economy out in Asia, there are new cement plants...if you love clinker, you can get it."

"I am losing some sleep over this... the public won't have a domestic cement industry unless we do something for safeguarding it. Because the current rules and safeguard mechanisms will pull it from the business, domestically."

"All we need to do is shut our kilns down and we'll contribute to Australia's lowering of our carbon, which is awesome, then we'll bring clinker in from overseas. Oh, it's 15% higher if we bring it in from over there because of the net amounts in transport. So world emissions are going to go up and Australia's emissions are going to go down."

SPOTLIGHT

In the spotlight: Plasterboard

Capacity risk: Low

Key insights

- Due to its relatively low price, bulky size and fragility, Australia meets most of its plasterboard demand through local supply.
- Industry confirms that the combined capacity of Australia's 11 local plants - nine on the east coast, two in Western Australia - can comfortably meet current demand.
- Labour and skills shortages challenge the plasterboard industry, with a limited pool of tradespeople capable of installing plasterboard fixtures.
- Plasterboard production and supply consumes significant quantities of gas, forcing the industry to endure high cost growth from recent global economic inflation.

SPOTLIGHT

Spotlight: Bitumen

Capacity risk: Low

Key insights

- Demand for bitumen, a key component of asphalt, has risen sharply following increased roads investment over the last 12 months.
- Most of Australia's bitumen is imported, and cost increases have been strong over the past decade due to international competition for construction commodities and changing oil prices.
- Sustainability is helping to drive awareness and interest in the application of plastics, rubber, and glass in road construction and maintenance.

There is need for national collection of local manufacturing and production outputs

There is currently no method for collecting or analysing data on local manufacturing and production outputs at the national level. This hinders governments' capacity to predict supply and mitigate for shortfalls that eventuate, and forces reactivity, cost escalations, and schedule delays when shortages transpire.

The Australian Bureau of Statistics began collecting and reporting on local manufacturing output data in 1991—92 through its Manufacturing Industry series (Catalogue Number 8221). The series was discontinued 2006—07 when neither industry nor government was willing to fund its ongoing production. [14]

Re-instating this series could enable governments to better track and mitigate future supply shortages. It may also enable a more coordinated approach to stage demand in line with project need and market capacity.

Recycled materials

Opportunity to increase adoption of recycled alternatives in construction

Infrastructure Australia's analysis indicates that, cost savings from the application of recycled alternatives in roads infrastructure range from 2% to 83% depending on geography, availability, time, and other measures.

Based on current technology and standards, approximately 27% of the conventional material tonnage could be replaced by using a range of recycled materials in major infrastructure road projects. This means replacing approximately 54 million tonnes of conventional materials with approximately 52 million tonnes of recycled materials. [15]

Recycling construction waste from major infrastructure projects can also save costs on disposal and landfill fees.

Regional and remote locations are often under-served

Access to replacement products can be hindered by the location of a project. Certain replacement products are not readily available throughout the country, and the concentration of facilities in metro areas has led to constraints for regional and rural areas.

Production methods and types of materials suitable for recycling may also vary depending on local conditions. For example, used tires discarded for extended periods under the outback Australian sun will need to be processed differently to tires that have been stored stock in a cool warehouse in a metro location.

The difficulty in achieving economies of scale can make manufacturing costs higher and limits throughput, which ultimately presents a barrier to improving the availability of facilities in regional and rural Australia.

Initiatives are currently underway to boost domestic capacity

To encourage a step change in use of recycled materials, government stakeholders have cited the need to:

- connect suppliers with customers so that demand and supply can grow concurrently through a mutual understanding and confidence for both parties to engage, reducing this gap in knowledge might help accelerate take up of some segments that are lagging behind others
- review government policies, standards, and specifications
- educate governments and industry on the commercial benefits.

Both the public and private sectors have started developing data driven tools to better match supply with demand and encourage greater participation in the circular economy. The National Waste and Resource Recovery Data Hub will make data more accessible for industry, government, and the public, and encourage the data community to interact and contribute to the information on the waste and resource recovery sector. [16]

Other jurisdictions are also working to implement policies and practices to support recycled materials. This includes:

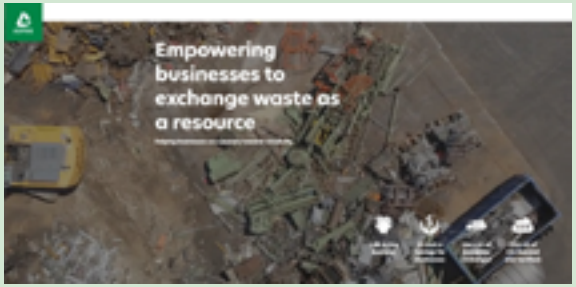
- In New South Wales - the Choose Circular procurement program encourages NSW Government agencies to preference recycled content in purchasing. The Protection of the Environment Policy, currently under development, will require all public authorities when commissioning public infrastructure projects to report on embodied carbon emissions and prioritise the use of low carbon recycled materials from waste generated in New South Wales.
- In Victoria – the Recycled First Policy requires all tenderers on Victorian major transport projects to demonstrate how they will optimise the use of recycled and reused materials within their bid. The ecologiQ initiative is integrating recycled content across Victoria's transport infrastructure projects and making the use of greener materials business-as-usual.

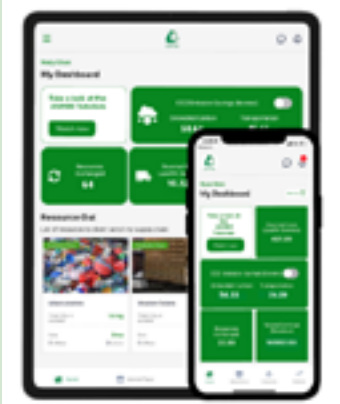
ASPIRE, a commercial spin off from the CSIRO and DATA61, launched its online platform to match demand and supply for 'waste materials' in 2020.

Recently, all levels of government have agreed to work together to identify the biggest opportunities to reach a circular economy in Australia by 2030, under the National Circular Economy Framework.[17] This work builds on the National Waste Policy, which in its 2022 Action Plan outlined a range of targets for governments to work towards, including action 4.01 – 'Determine use of recycled content in road construction to establish a baseline and allow reporting on actions to significantly increase recycled content use'.

CASE STUDY

Case study: ASPIRE





ASPIRE is an online platform that facilitates material resource exchange for recycled materials. It provides a matchmaking service by connecting supply with demand – organisations can list demand for a certain product, be connected and trade with suppliers.

It is ISO accredited to measure de-carbonisation credits that represent the total kilograms of embodied carbon emissions avoided through the use of a “waste” resource exchanged. The service provides a dashboard that offers a baseline of a businesses or agency’s environmental footprint, as well as tracking of revenue and costs.

Since its launch in 2020, the platform has facilitated over 31,000 transactions. It has assisted a range of Australian, state and territory and local government agencies help source recycled materials on their infrastructure projects.

By providing a circular economy marketplace, it aims to grow its impact by offering free exchange service for low value products, that would otherwise go to landfill. It also offers education and free access to small and medium enterprises and government agencies seeking to understand opportunities to source recycled materials in efforts to increase adoption.

RECOMMENDATION

Recommendation 5: Local materials production outputs

The Australian Government should track and analyse local manufacturing and production output by working with the Australia Bureau of Statistics to develop options for collecting data needed.

This could include reinstating funding for national longitudinal data collection of domestic manufacturing materials used in construction, per the now-discontinued Australian Bureau of Statistics Manufacturing Industry Collection Australia (Catalogue Number 8221.0).

RECOMMENDATION

Recommendation 6: Recycled materials

The Australian Government, in partnership with state and territory governments, should continue to build capacity for increased uptake of recycled material products in infrastructure by adopting a national recycled first policy. This would capture information to:

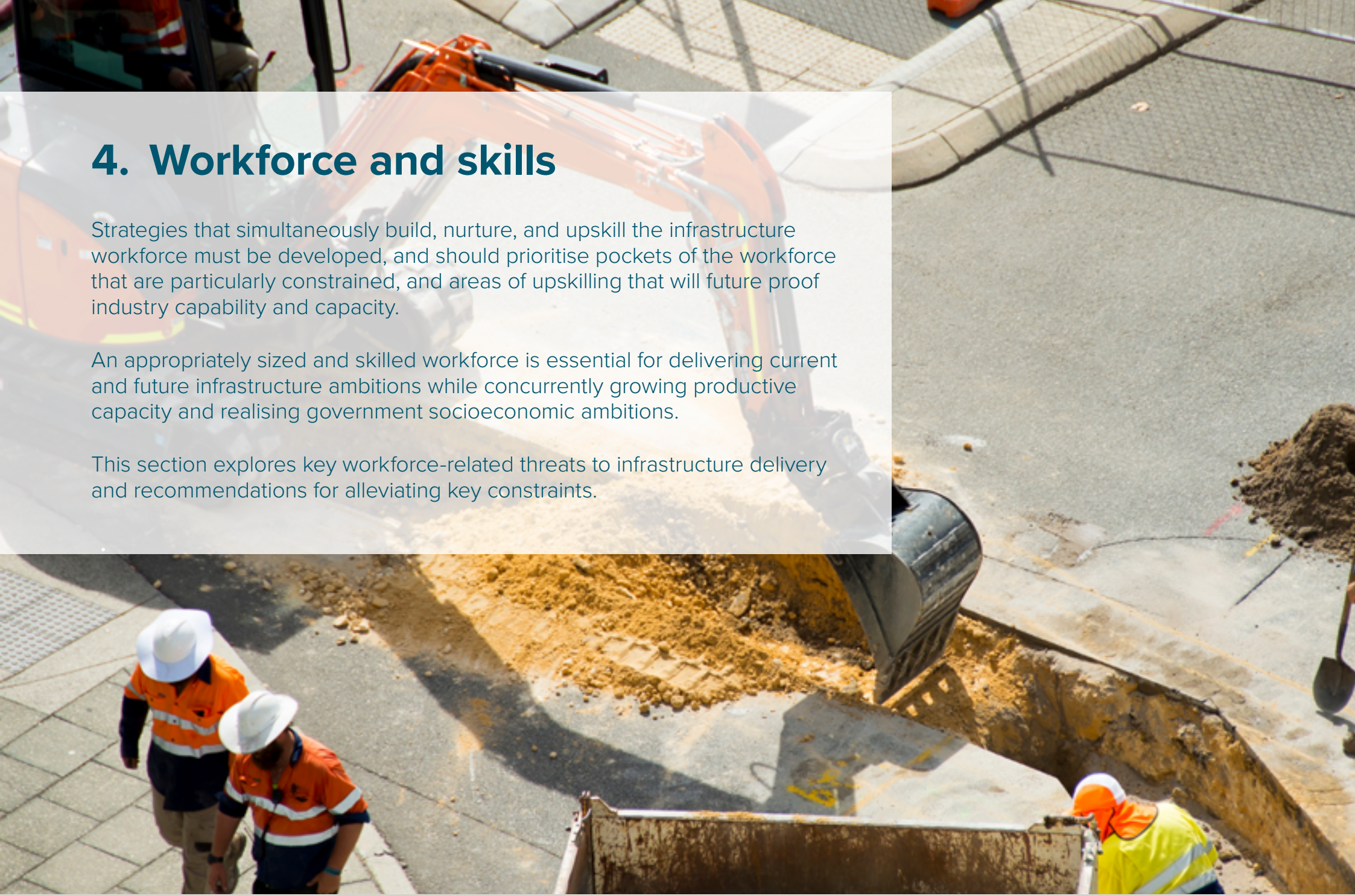
- build a baseline for use of recycled content, which has a current target 4.01 under the National Waste Policy Action Plan (2022)
- help better understand why recycled materials were not adopted on projects by identifying supply gaps, under-served areas and other barriers for potential government intervention.

4. Workforce and skills

Strategies that simultaneously build, nurture, and upskill the infrastructure workforce must be developed, and should prioritise pockets of the workforce that are particularly constrained, and areas of upskilling that will future proof industry capability and capacity.

An appropriately sized and skilled workforce is essential for delivering current and future infrastructure ambitions while concurrently growing productive capacity and realising government socioeconomic ambitions.

This section explores key workforce-related threats to infrastructure delivery and recommendations for alleviating key constraints.

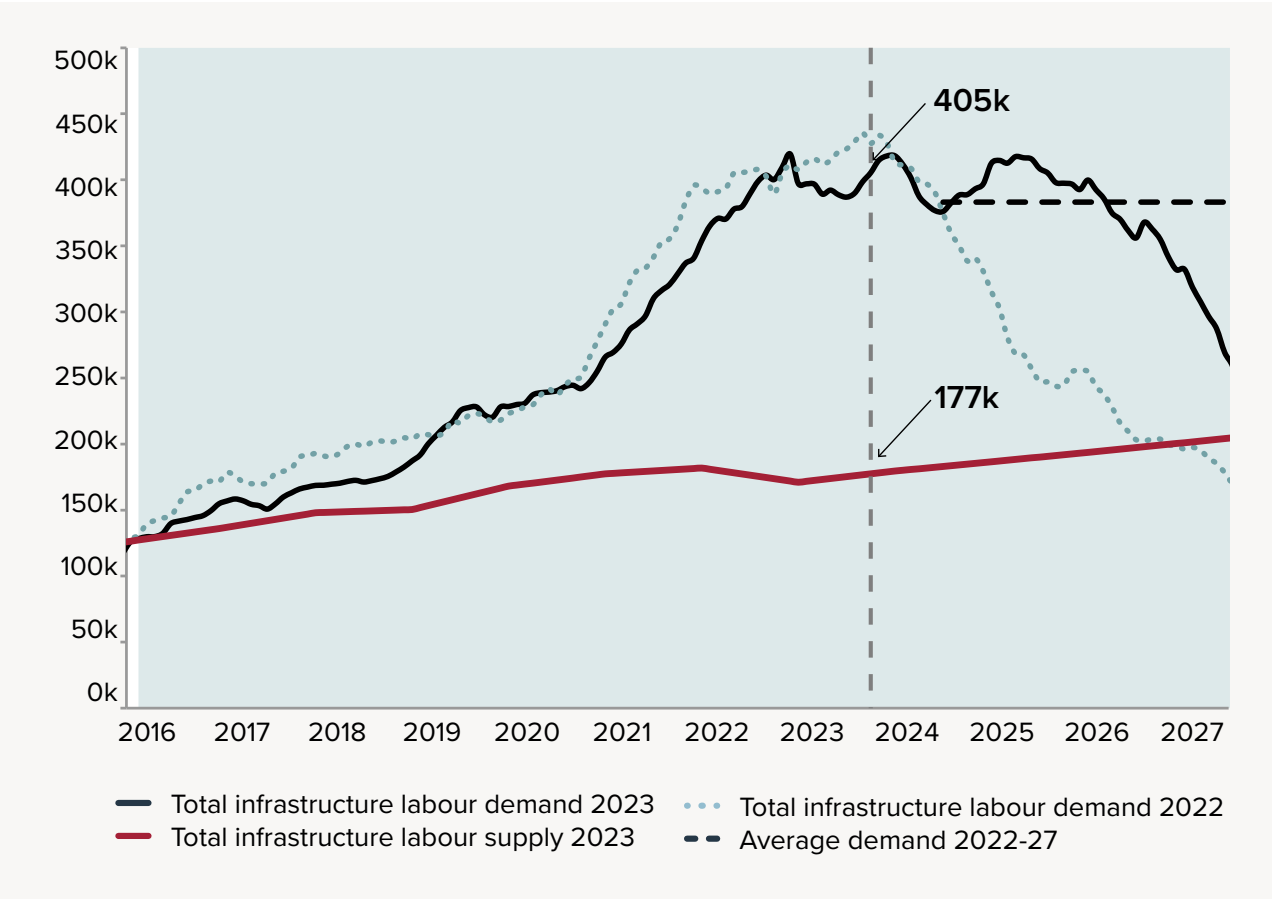


Key findings: Labour shortages

The projected shortfall of public infrastructure workers has increased to 229,000

A deficit of 229,000 public infrastructure workers is expected as of October 2023 – an increase of 15,000 in 12 months. With the existing workforce at 177,000 employees, this is a 129% shortfall of workers needed to meet demand. Shortages will continue to be significant until 2027 despite a smoother infrastructure pipeline and a 2024 peak as shown in **Figure 13**.

Figure 13: Demand and supply of public infrastructure workers



Note: Public infrastructure pipeline demand includes major public infrastructure projects, non-major public infrastructure projects, road maintenance projects and privately funded infrastructure for public use.

Source: Nous Group commissioned by Infrastructure Australia (2023).

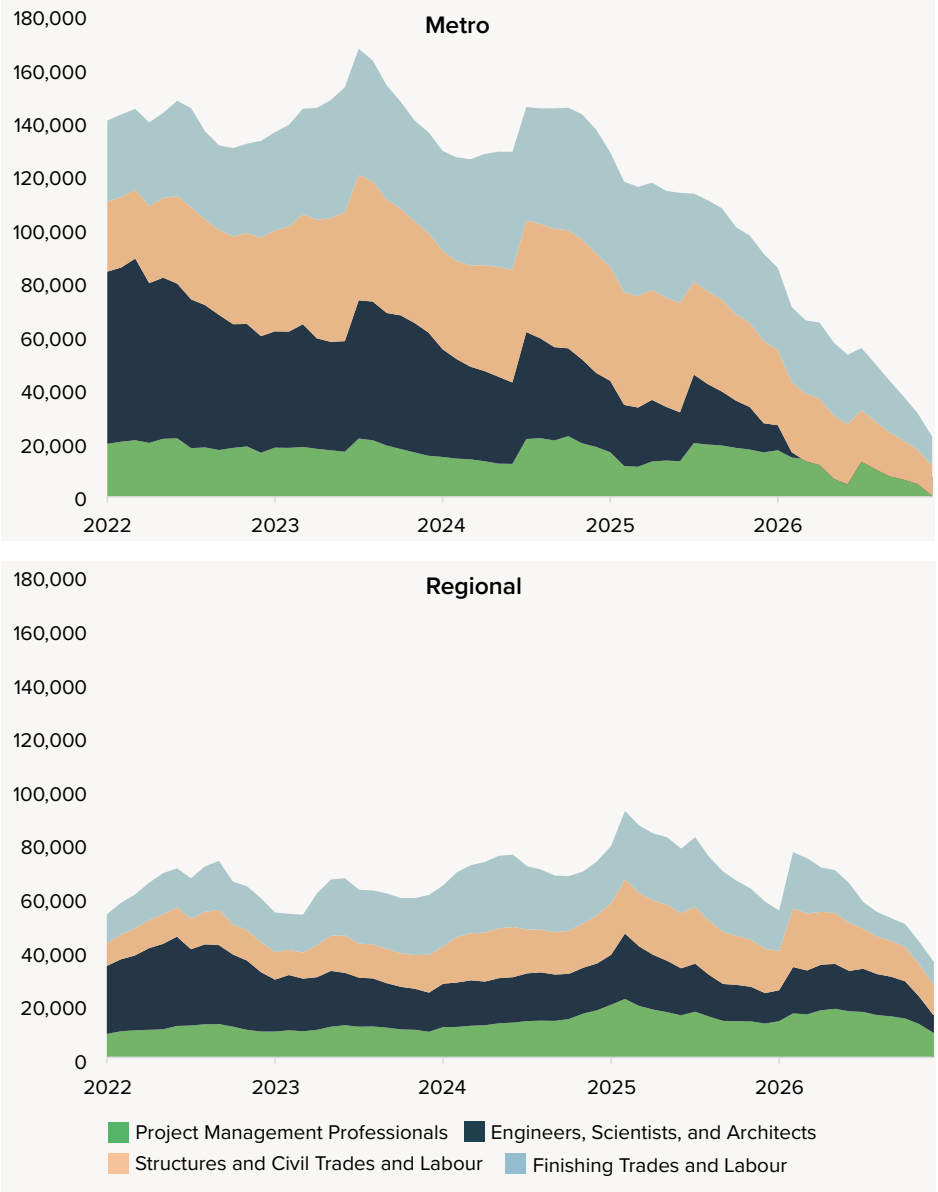
Shortages coincide across jurisdictions, driven mainly by major cities

Sydney and Melbourne account for much of the national shortfall. Sydney faces the deepest shortage until 2026 when a demand spike in Melbourne creates a comparatively deeper labour shortage.

Cities and regions have a similar mix of occupations in shortage

Figure 14 shows that the breakdown of total shortage by occupation group is similar in cities and regions, albeit on different scales. Since shortages roughly co-occur, it is not possible to 'borrow' labour from one area without increasing the shortage in the other.

Figure 14: Shortage by occupation group within capital city areas vs outer regions



Source: Nous Group commissioned by Infrastructure Australia (2023).

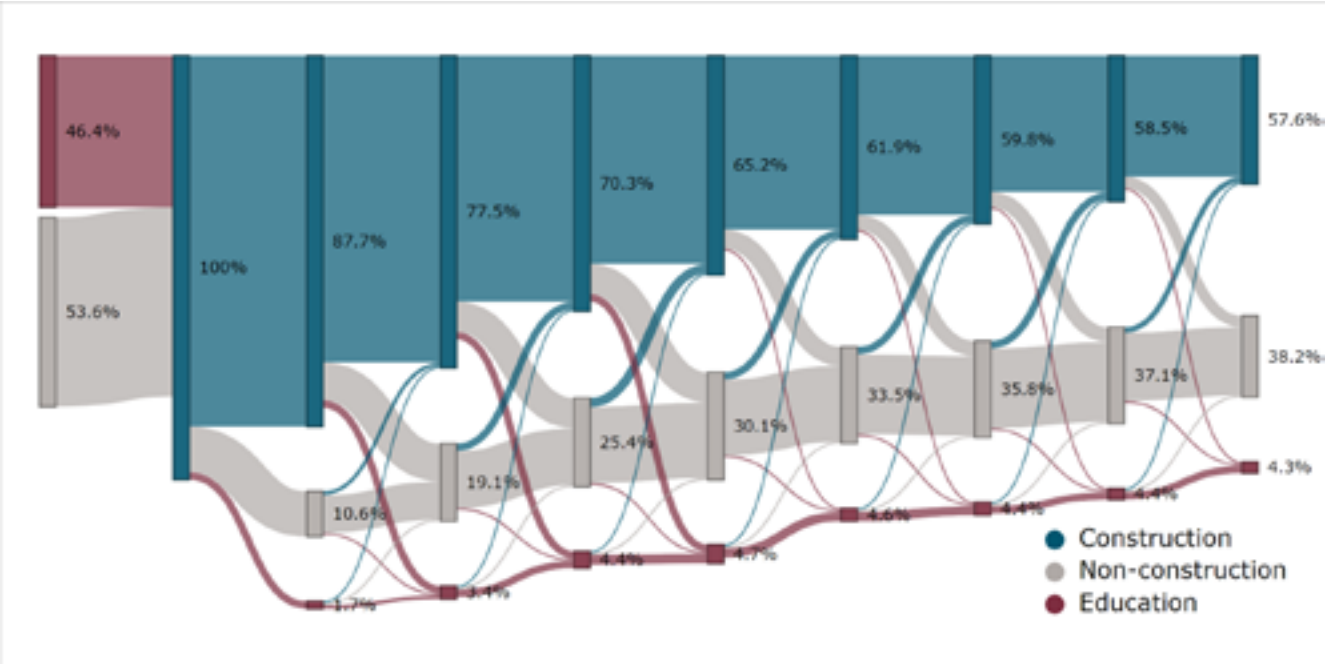
Attraction, retention, and upskilling in infrastructure careers

There is a long lead time for professionals entering construction, with a quarter exiting within 3 years

It takes approximately 3–4 years for a worker to enter into their first construction role. Of these, just over half arrive from a job in another industry, and just under half arrive from directly from education. Within eight years, 42% have left construction as shown in **Figure 15**, with 38% moving into a non-construction role and 4% into education.

Due to the project-by-project nature of construction, workforce demand projections are reliable for one or two years out from the current date. This limits industry's ability to grow workforces to meet Australia's infrastructure demand and restricts the use of levers that could address potential shortages.

Figure 15: Pathways out of construction following first construction role



Source: Nous Group commissioned by Infrastructure Australia (2023).

The engineers, scientists, and architects occupation group has the deepest shortage and highest attrition rate

34% of sector engineers, scientists, and architects leave their occupation group within three years. This increases to almost 50% after five years - 34% of these leave the construction industry altogether - the highest rate for any occupation group.

Retention initiatives should prioritise engineers, as the group of professionals in highest demand.

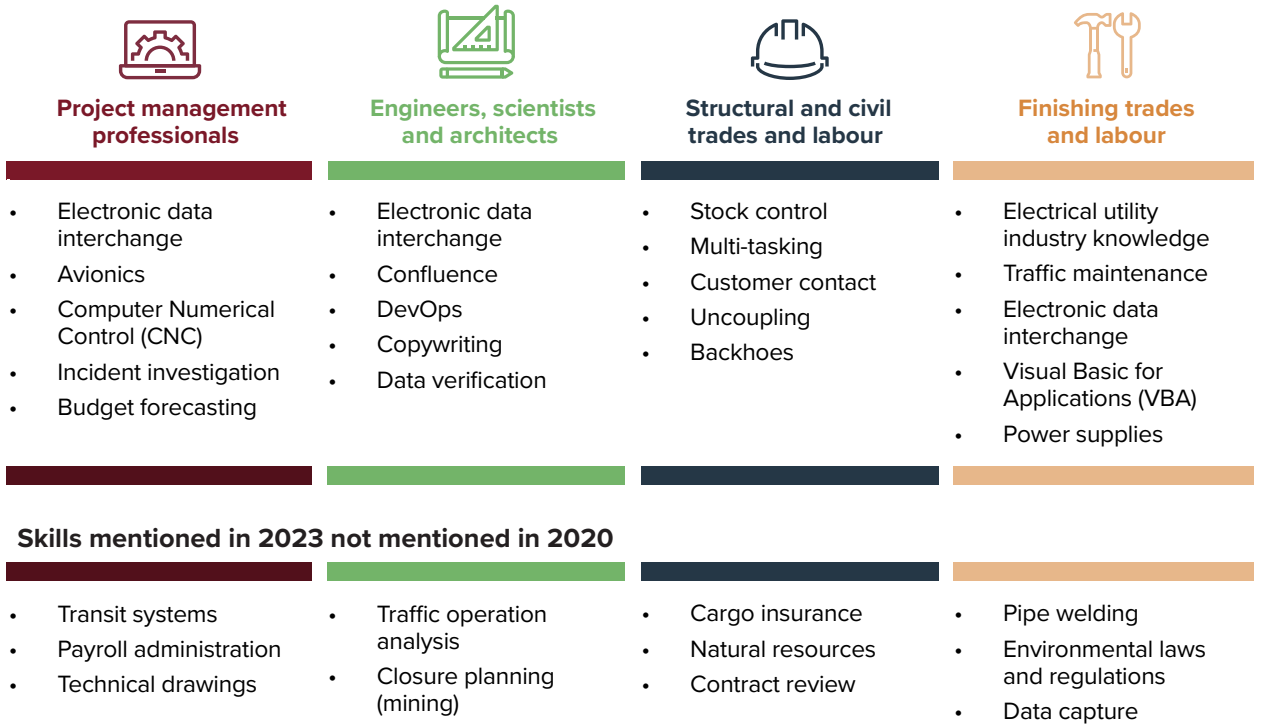
The workforce must continuously upskill to keep pace with evolving job designs and ways of working

2021 census data shows that in industries throughout Australia, people are working for longer, including those re-entering the workforce due to the COVID-19 pandemic. Between the 2016 and 2021 censuses, retirement rates fell 3%—7% in all key age groups between 45 and 64-years. Industry should consider the upskilling needs of the full spectrum of workers from new entrants to older employees to keep its workforce engaged and productive. **Figure 16** outlines the skills with the highest annualised growth share among job ads in which they are mentioned.

The impact on job designs driven by the COVID-19 pandemic and other global supply chain disruptions is seen in rising demand for skills relating to cargo insurance observed in structural and civil trades and labour job advertisements. Similarly, professional skills such as data capture and interchange in Excel and Visual Basic for Applications are observed in finishing trades and labour job designs, which are most likely driven by recruitment in areas such as regulation.

While demand for these newly identified skills is unclear, the speed of their arrival indicate that skill requirements evolve rapidly, and that job designs need time to settle.

Figure 16: Skills with strongest compound annual growth, 2020—2023



Source: Nous Group commissioned by Infrastructure Australia (2023).

Skills mentioned in 2023 but not in 2020 may not be strictly "new": they can have appeared in intervening years.

Workers need to feel confident and comfortable to adapt to continuously evolving workplaces, rapid digitisation, and broader structural economic changes. Upskilling workers may also improve workforce mobility, enabling workers to transfer skills and move across sectors to take advantage of changing market demand.

In support of this, workers must be given opportunities to upskill and/or re-skill via on-the-job training or short courses (microcredentials) to fill skills gaps that emerge during an individual's career continuum. This is particularly relevant to subcontractors, especially small-to-medium enterprises, who make up the majority of total workforce numbers and have the least capacity to invest in capability development.

Similarly, industry workforce planning should be future-focused to ensure employees are trained, upskilled, relevant, productive, and competitive.

Key occupations in shortage

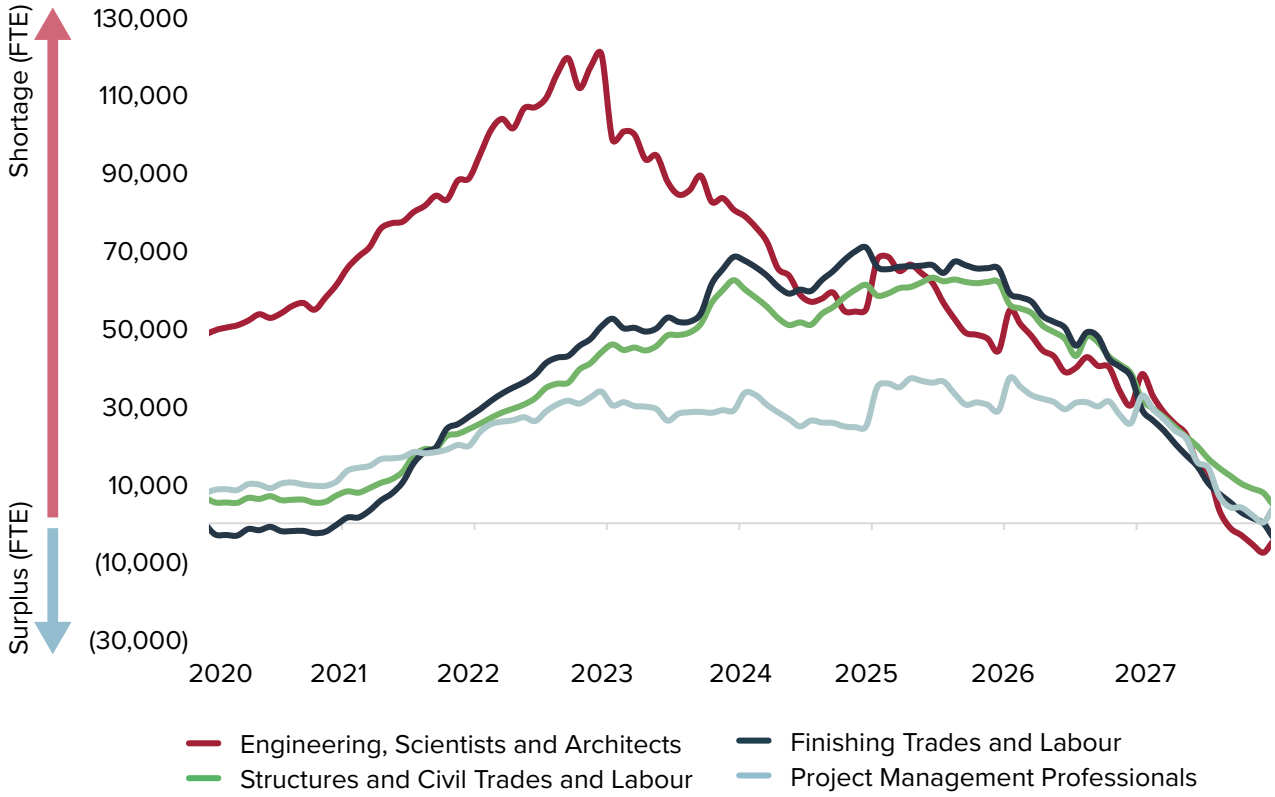
Engineers, scientists, and architects

The occupation group with the deepest shortage is still engineers, scientists, and architects

While past its peak based on the current pipelines, the shortage of engineers, scientists, and architects will outstrip other occupation groups until mid-2024—early 2025. See **Figure 17**.

Drawing on other workforces is not a viable option for alleviating the shortfall engineers, as it would reduce the adjacent workforce by half to fill the gap.

Figure 17: Projected shortage in the public infrastructure workforce by occupation group, 2020—2027



Source: Nous Group commissioned by Infrastructure Australia (2023).

Engineering occupations represent the major shortfalls

Labour market indicators of job advertisement analysis suggest that the key roles listed in **Table 3** are likely driving the shortages of the occupations they underlie.

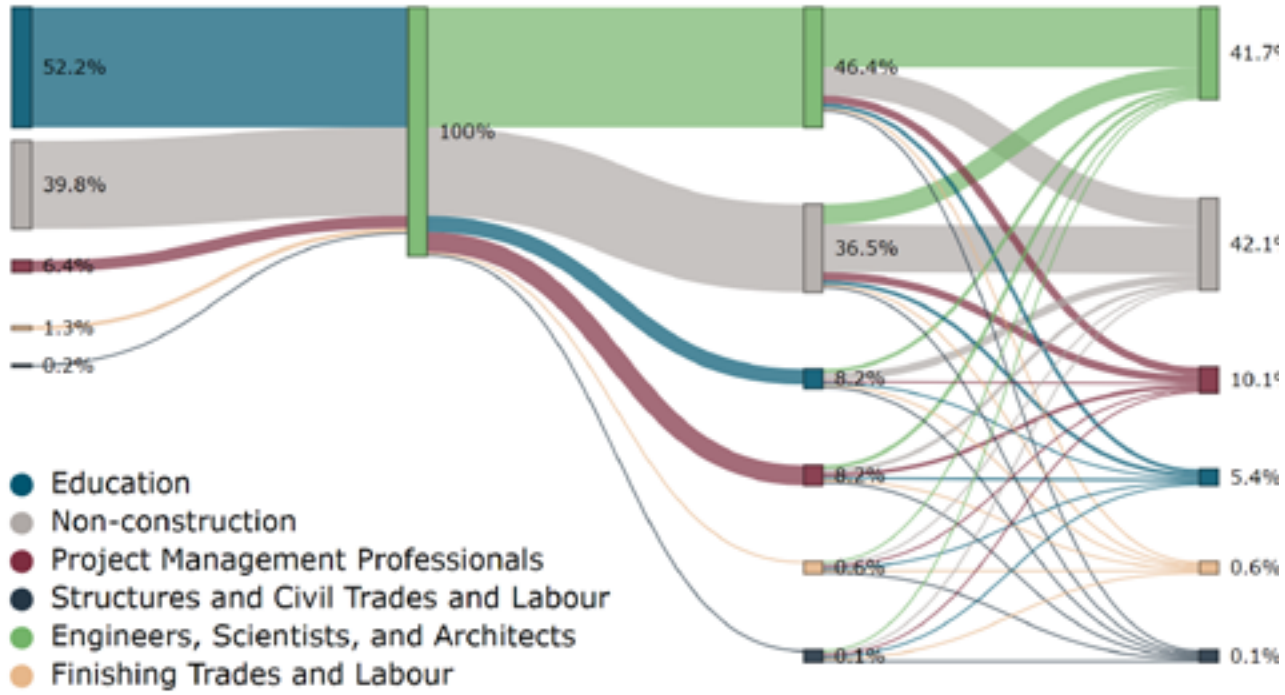
Table 3: Key roles in shortage underlying the top five engineer, scientist, and architect occupations in shortage (based on labour market indicators)

Occupation	Roles with labour market indicators of shortage*
Structural engineers	Lead structural engineers Structural designers
Civil engineers	Civil project managers Traffic and transport engineers
Land surveyors	Surveyors Senior surveyors
Geotech engineer	Geotech engineers
Other professionals	Senior engineers

Higher education is the main pathway for engineers, scientists, and architects entering construction

52% of engineers, scientists, and architects enter the construction industry directly from education (see the dark green bar in **Figure 18**). Higher education is the key source of supply for these occupations. Enlarging this pipeline is a critical lever for growing the workforces of these occupations in shortage.

Figure 18: Pathways into and out of construction by events prior to or following first Engineering, Scientists, and Architects role



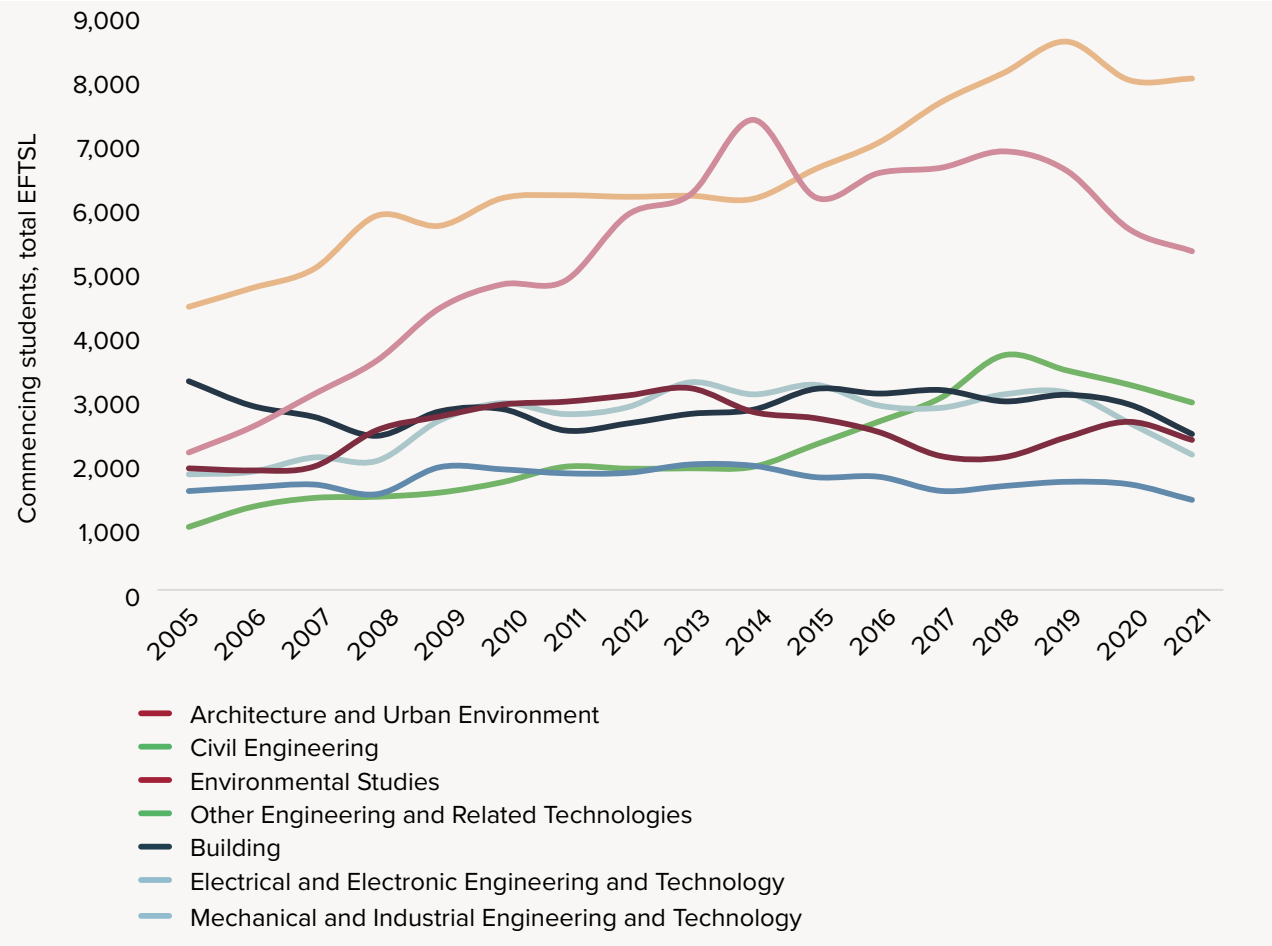
Note: An event transition is defined as a change in education or occupation when ordered by start date, with event 0 being their first construction role.
Source: Nous Group commissioned by Infrastructure Australia (2023).

Higher education enrolments are falling, so graduate pipelines must be secured

Figure 19 shows that enrolments appear to be falling in the last 10 years across certain fields of education that are expected to deliver 40—60% of graduates to the engineer, scientist, and architect occupation group.

Due to a healthy pipeline of architecture and urban environment graduates, architects are neither in shortage nor likely to enter shortage in the near term.

Figure 19: Historical enrolments for key fields of education over time



Source: TCSI data on higher education equivalent full-time student load (EFTSL).

Strategies to grow the pipeline of graduates should be targeted by field of education

Different fields of education have varying potential to contribute to the infrastructure workforce. **Figure 20** shows the fields of education where approximately 60% or more graduates are expected to go to infrastructure occupations.

The Australian Universities Accord's review of higher education is currently considering funding and contribution arrangements to meet Australian skills priorities including in infrastructure and other industries. This process includes a review of the Job-Ready Graduates Package. In developing a response to this work, it should be noted that up to 44% of graduates from infrastructure related fields of education do not transition into infrastructure employment.

Figure 20: Proportion of field of education's graduates, by expected destination

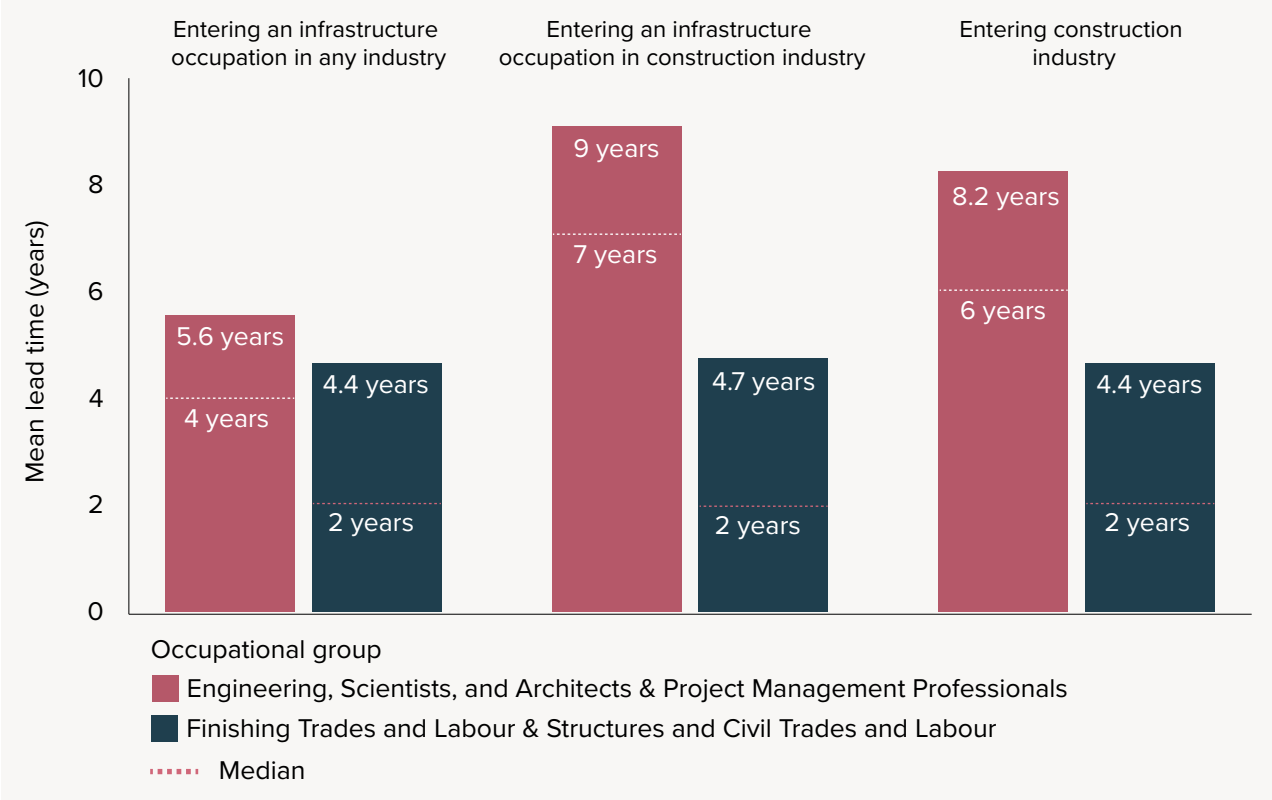
Field of education (narrow)	Engineering, Scientists, and Architects	Finishing Trades and Labour	Project Management Professionals	Structures and Civil Trades and Labour	Non infrastructure	Top non infrastructure destination	2nd-largest	3rd-largest
Architecture and urban environment	49%	<1%	6%	<1%	44%	Urban and regional planner	Policy and planning manager	Specialist managers
Electrical and electronic engineering and technology	47%	7%	3%	<1%	43%	Computer network and systems engineer	Technicians and trades workers	Sales representative
Environmental studies	49%	<1%	11%	<1%	41%	Environmental manager	Specialist managers	Urban and regional planner
Mechanical and industrial engineering and technology	60%	3%	3%	<1%	34%	Computer network and systems engineer	Industrial engineer	Sales representative
Civil engineering	78%	<1%	7%	<1%	15%	Specialist managers	Software engineer	Contract administrator

Source: Quality Indicators for Learning and Teaching (QILT) Graduate Outcome Survey 2021 (Table 6) and Graduate Outcome Survey 2022 (Table 7).

Engineers and managers need much more experience to enter occupations in infrastructure construction

Engineers and project managers take an average 9 years to enter into an infrastructure construction role compared to 5.6 years to enter an infrastructure role in any industry, as shown in **Figure 21**. This suggests an opportunity to improve employability skills for graduates coming directly from higher education and strengthen pathways for entering into an infrastructure construction career.

Figure 21: Mean lead time of engineers and managers entering the construction industry versus trades and labour



Source: Nous Group commissioned by Infrastructure Australia (2023)

Employers cite poor graduate 'soft' employability skills (such as digital, communication and teamwork) and lack of workplace experience as barriers to hiring graduates directly from education[18].

In addition to reviewing course design, indirect entry pathways could boost the pipeline and plug skills and/or experience gaps to ensure graduates are more 'work ready'. Providing credit recognition for pathways from outside higher education, such as from on the job learning and vocational education and training (VET), could also build the pipeline of occupations in shortage.

The Australian Universities Accord and the Employment White Paper have outlined the Australian Government's intention to build stronger pathways to industry from VET and higher education, such as recognition of prior learning. For construction, this could tie directly to accreditation requirements within occupations, as is the case in nursing and early education.

RECOMMENDATION

Recommendation 7: National Infrastructure Workforce Strategy

The Australian Government, in partnership with state and territory governments, should explore development of a national infrastructure workforce strategy that outlines how governments should work with industry to improve infrastructure worker attraction and retention, including women, and ensure growth of the workforce pipeline to meet demand.

The strategy should also consider how to improve workforce mobility for transferring skills and workers across sectors and locations in line with market demand.

To support this work:

- Jobs and Skills Australia should consider a national infrastructure workforce study in the context of its 2024—25 work plan and in consultation with relevant Jobs and Skills Councils
- relevant Jobs and Skills Councils should be encouraged to consider infrastructure demand in industry specific workforce plans and consider strategies to address workforce challenges and skills gaps, including greater support for upskilling workers through micro-credentialing and workplace training and supporting greater collaboration between higher education and VET to create new types of qualifications.

RECOMMENDATION

Recommendation 8: Boost the higher education pipeline

The Australian Government, in partnership with state and territory governments, should grow the pipeline of higher education candidates for the infrastructure sector by:

- targeting government investment to reduce the underlying shortage across the occupations most in shortage - currently - engineers and scientists, including addressing barriers limiting women's participation in these occupations
- exploring new credit recognition pathways to boost the higher education pipeline of engineers and scientists. This should include consideration of recognition of prior learning pathways from on the job learning and Vocational Education and Training.

There is a pool of qualified migrant engineers actively seeking an engineering job in Australia

A range of engineering occupations are available for permanent migration to Australia under the Australian Government's current Skilled Migration Scheme – including civil engineers, civil engineering draftsperson/technicians, electrical engineers, engineering managers, industrial engineers, structural engineers, construction estimators, and construction project managers.

To qualify for a skill migration visa, applicants must pass a Migration Skills Assessment to demonstrate the skills and experience required to work in Australia. Engineers Australia is responsible for assessing standards for engineering occupations.

Despite passing the Migration Skills Assessment, 47% of qualified migrant engineers were actively seeking an engineering job in 2021.[19] Likely employment barriers include a lack of local experience and professional network, and employers' reluctance to hire skilled migrant workers. More work is needed to understand why employers have not drawn from this pool of qualified engineers to meet demand.

Lessons learned from current initiatives should inform the development of national actions

Government initiatives to increase workforce participation of onshore skilled migrant are already underway, which will provide evidence for potential solutions. Some examples are provided below:

Often, initiatives outlined above are piloted in isolation, without reference to similar programs being conducted elsewhere across the country. There is an opportunity to coordinate best practice and evidence across these programs on what has worked.

Governments and employers should translate findings from the initiatives above into national level interventions that overcome the barriers that prevent qualified onshore skilled migrants securing engineering employment in Australia.

ANALYSIS

Existing government initiatives that increase workforce participation of onshore skilled migrants

- **Australian Government Skills Assessment Pilots -** aim to maximise workforce participation of onshore skilled migrants with unrecognised or under-recognised skills
  - Engineers Australia is one of the assessing authorities contracted to deliver pilots
  - Evaluation of pilots will examine barriers to employment and decipher whether skills assessment or improvement in employability skills helped a migrant with skills secure work commensurate to their skills
  - Pilots will conclude in February 2024 followed by an evaluation in June 2024.
- **Australian Government Review of Skills assessment processes –** currently underway to ensure the quality and timeliness of migration skills assessments. A discussion paper was released in October seeking stakeholder views on how to apply best practice principles and standards to ensure that skills assessments meet the needs of migrants, employers, industry, unions, and Government. [20]
- **Victorian Government Overseas-Qualified Professionals and Engineering Pathway Industry Cadetship (EPIC) Programs -** helps skilled migrants, refugees and asylum seeker engineers find work through a series of short courses covering employability, job seeking skills, and Australian workplace practices, as well as career mentoring and employment pathway planning services.
- **Queensland Government** (in consultation with Engineers Australia and Consult Australia) has developed a Guide for Employers to attracting and retaining engineers from migrant backgrounds.[21]
- **Engineers Australia's Global Engineering Talent Program –** targeted at engineers currently in Australia on a skilled migration visa who are unable to find work or are working in a position not commensurate with their skill and experience level.
  - Includes a six-week preparatory course through Engineering Education Australia with engineering standards-specific training, and a 12-week paid internship at an engineering firm.
  - The Northern Territory Government has contributed $198,000 to the program to help an initial 20 overseas-born engineers with a pathway to engineering employment in Australia. Queensland Government have co-funded up to 20 places for future clean energy related roles.

Trades and labour

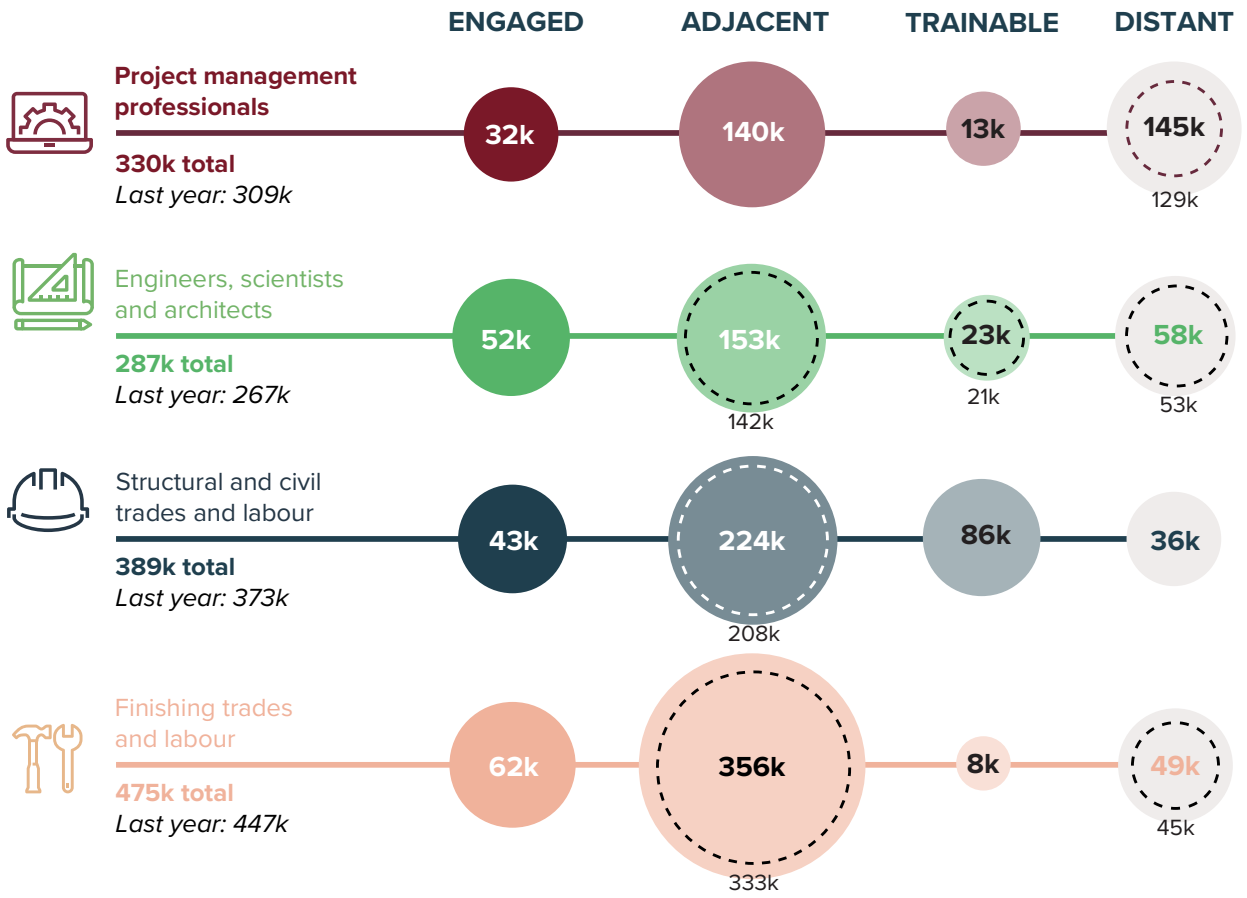
A rising shortage in trades and labour is yet to peak

Referring to **Figure 17**, shortages in both trades and labour occupation groups are increasing, affecting more roles than 12 months ago. Peak shortage is yet to arrive following a shifting of project demand to later pipeline years.

Trades and labour growth has outpaced other occupation groups, but public infrastructure has not attracted a share of the incremental labour pool

Figure 22 shows that trades and labour lead in overall workforce growth, though much of this is in parts of the workforce not directly engaged on public infrastructure. This is most pronounced in finishing trades, where the engaged workforce is estimated to have contracted slightly.

Figure 22: Overall workforce growth between 2022 and 2023 by infrastructure occupation group



Source: Nous Group commissioned by Infrastructure Australia (2023). Numbers may not sum due to rounding.

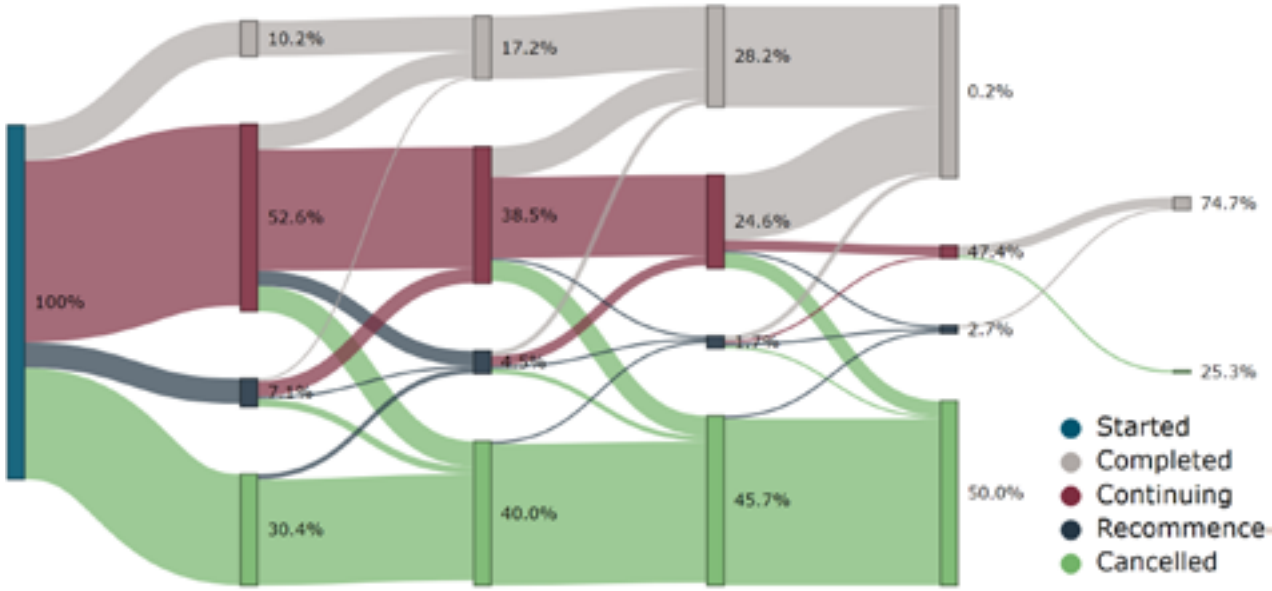
VET is a critical pathway into trade and labour occupations, but inflows are dropping

Lower VET projections in 2023 compared to 2022 have been partially offset by an unexpected increase in delayed retirements. Despite this, increasing the VET pipeline is pivotal to growing the trades and labour workforce engaged in public infrastructure.

Around half of students who commence an apprenticeship or traineeship do not complete it

Each year from 2015 to 2020, an average of 16,800 students cancelled their public infrastructure-related traineeship or apprenticeship, equalling roughly 50% of courses cancelled once commenced – see **Figure 23** – which is slightly lower than the completion rate for all trades combined (53%)

Figure 23: Pathways for apprentices and trainees commencing between 2015—18



Source: NCVER Apprentices and Trainees Data, sample of 162,444 training contracts.

The most effective time to intervene is within the first two years

79% of all apprentice and traineeship cancellations happen within two years of commencement, and 86% of recommencements occur within the same period – see **Figure 23**. Conversely, students who persist for two years after starting a course are much more likely to complete their training.

Leakages in the first two years represent a critical intervention point for intercepting and guiding students to completion.

Around a third of VET students starting in programs relevant to public infrastructure move to other occupational groups

Almost 34% of students who start in a structures and civil trades and labour program will move to other occupations, compared to 27% of students starting in a finishing trades and labour program.

Interventions to increase completions should be targeted at pathways with completers most likely find employment in their intended occupations

Several VET courses have above average completion rates but below average transition rates into intended occupations, and vice versa. **Figure 24** organises pathways according to these characteristics to illustrate areas of leakage and potential opportunity.

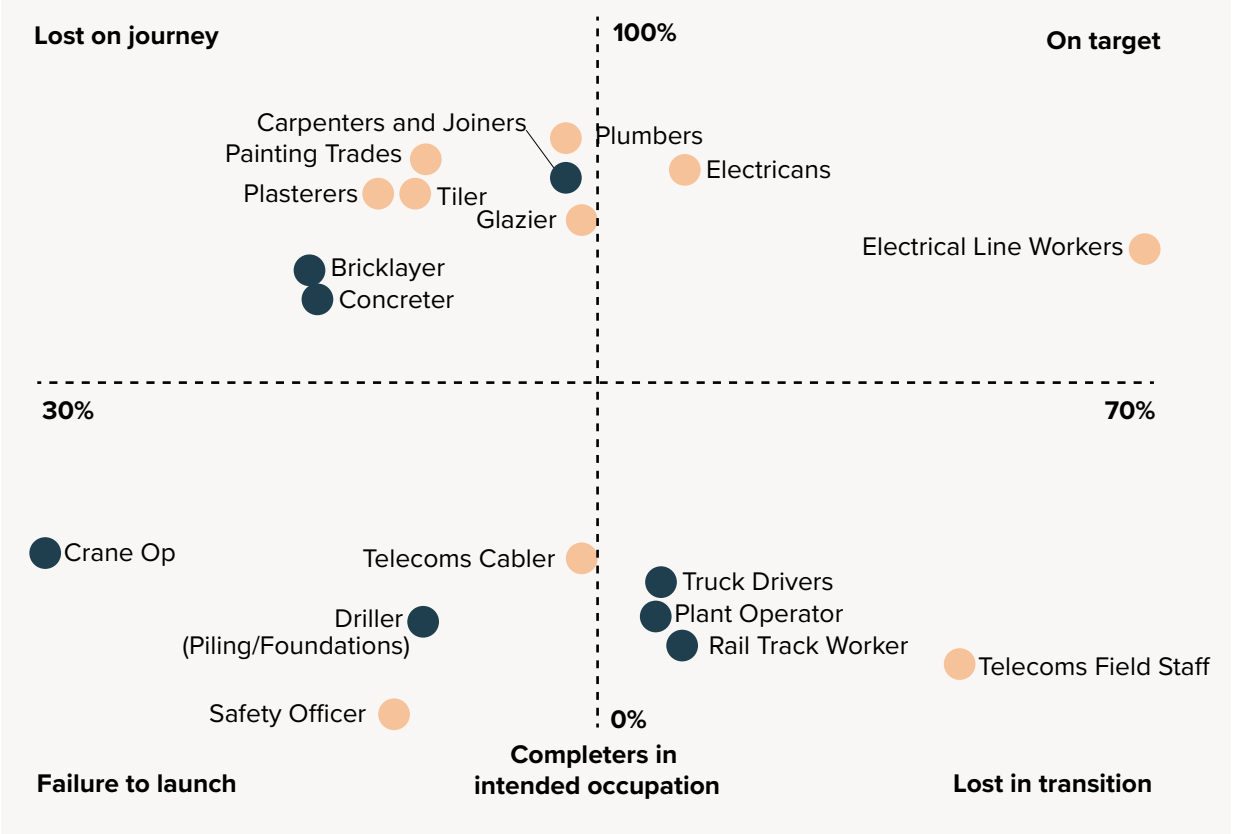
The 'Lost on the journey' quadrant includes pathways with a completion rate under 50%, and more than 60% of completers working in their intended occupation. Interventions to improve completion rates leading into these occupations should deliver best results to boost employees in occupations.

Contrastingly, the 'Lost in transition' quadrant includes pathways with a completion rate under 50%, and less than 24% of completers working in their intended occupation.

The 'On target' quadrant includes pathways with strong completion rates and rates of completers working in intended occupation.

Finally, the 'Failure to launch' quadrant have pathways with under average rates of completion and completers working in intended occupation.

Figure 24: Occupations by completion rate for all relevant programs and the proportion of students who enter their intended occupation



Source: [1]NCVER Student Outcomes Survey Data, sample of 34,435 student outcomes. Excluded general construction labourer roles due to small sample size relative to observations in Apprentices and Trainees data (<1% of observations in Apprentices and Trainees data).
[2]NCVER Apprentices and Trainees data, sample of 162,444 training contracts.

RECOMMENDATION

Recommendation 9: Onshore migrant engineers

The Australian Government, in partnership with state and territory governments, should place more qualified migrant engineers in engineering jobs, by working with industry and employers to identify actions to overcome barriers preventing businesses from employing onshore skilled migrants, including women migrants.

Future actions

The Australian Government should:

- consider developing a national program of wraparound services to increase employability of overseas qualified migrant engineers. This should take into consideration existing programs such as Victoria's Overseas Qualified Professionals and Engineers Australia's Global Engineering Talent Program to help migrant engineers secure work
- the above actions should build on the lessons learned and evidence base gathered from relevant initiatives underway to maximise workforce participation for onshore skilled migrants.

RECOMMENDATION

Recommendation 10: Supply of apprentices and trainees

The Australian Government, in partnership with state and territory governments, should increase supply of apprentices and trainees in infrastructure occupations by:

- encouraging the relevant Jobs and Skills Councils to include identification of barriers and opportunities to increase completions in their 2024 workplans. Interventions should be targeted at pathways most likely to lead to employment in the intended occupations
  - working with states and territories to continue developing equitable innovative, flexible pathways for entering, remaining, and progressing in infrastructure careers. Options for exploration include new micro-credentials, higher apprenticeships[22], and strategies that address skills gaps and improve foundation skills to reduce lead times into jobs.

5. Improving construction productivity

A long-term plan is needed to tackle chronic factors that undermine the productivity of Australia's construction industry.

Productivity growth is a basic requirement for improving the capacity of the market to maximise the value and benefit of public infrastructure investments.

The analysis and recommendations in this section provides a launchpad for discussing the development of a long-term strategy for government to support productivity growth in Australian construction.

> *" Improved productivity, when this also encompasses quality improvements, is the key method for reducing the costs of output to customers, improving business returns in the shorter run, and providing more infrastructure for a given spend."*

Source: Productivity Commission, 2014 [23]

Productivity: Key findings

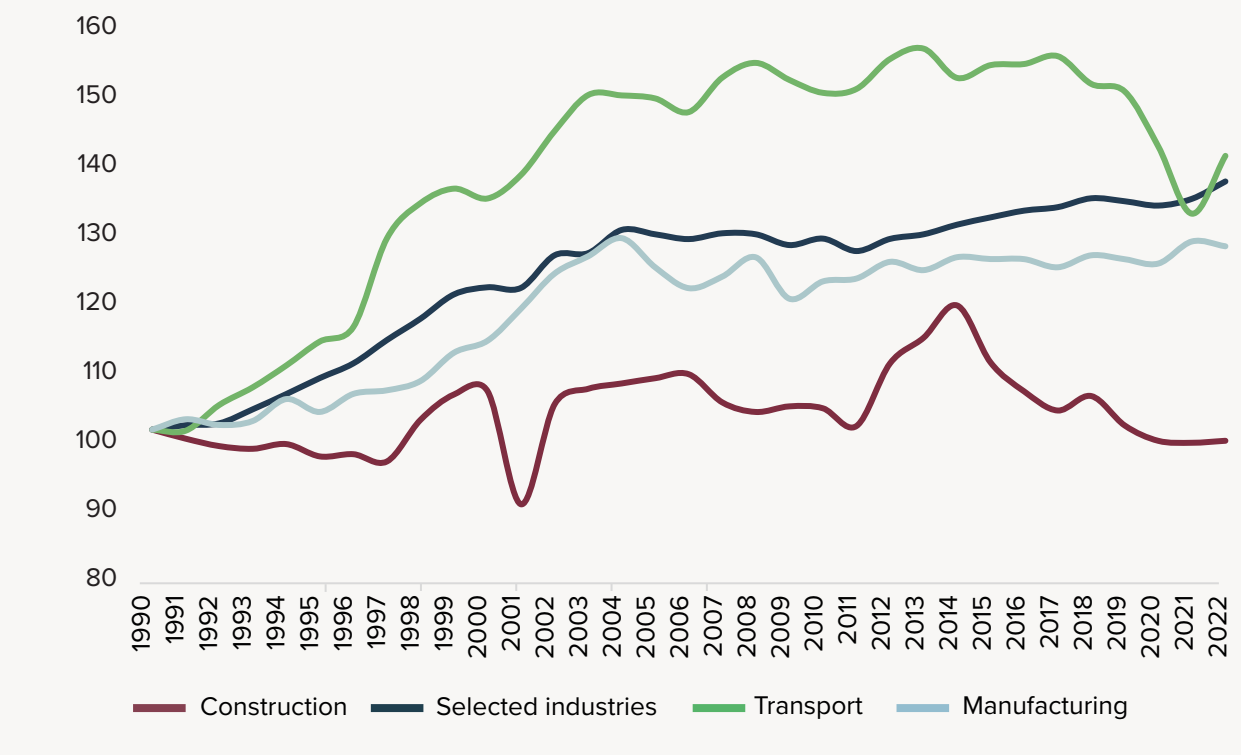
Construction sector multifactor productivity has stagnated for 30 years

Figure 25 shows that the construction industry has not achieved sustainable productivity growth over time compared to neighbouring industries such as transport and logistics, and manufacturing. [24]

To an extent, stagnant productivity can be counterbalanced with additional resources. However, when resources are scarce, cost increases and schedule delays erode investment value and exert unsustainable pressure on industry to deliver more with the same resources.

Given transport, housing and energy will be facing similar capacity constraints in delivering their infrastructure pipelines, and the transferability of construction skills, relatively small percentage gains in productivity could reap large benefits across all sectors and contribute to the Australian Government's key priorities – housing, workforce, education, skills and training.

Figure 25: Construction industry multifactor productivity by sector to year ended June



Selected Industries includes the following: Agriculture; Forestry and Fishing; Mining; Manufacturing; Electricity; Gas; Water and Waste Services; Construction; Wholesale Trade; Retail Trade; Accommodation and Food Services; Transport, Postal and Warehousing; Information, Media and Telecommunications; Financial and Insurance Services; Arts and Recreation Services.

Source: Australian Bureau of Statistics data (2023).

The first step to progress is determining what to measure

Construction productivity measures the rate of production efficiency as a ratio of output of work completed and resources inputs. Measuring construction productivity is challenging as there is no one 'standard' construction product. Output can be influenced by changes to design approaches over time, as well as cultural and workplace factors such as skills shortages, lack of proper tools and equipment, ineffective or inefficient systems or contractual terms and specifications.

More in-depth analysis is needed to unpack the barriers and drivers for this extended period of productivity stagnation in the construction industry in Australia.

ANALYSIS

Existing governments initiatives that measure, understand, and/or improve productivity

- The Australian Bureau of Statistics tracks and publishes a high-level multi-factor productivity baseline for construction and comparable industries. However, the high-level productivity metrics applied does not help identify specific drivers or levers available to government and industries to alter the trends observed.
- Infrastructure Australia gathers and analyses data for over 8,000 infrastructure projects through its Market Capacity Intelligence System.
- States and territories track infrastructure investment performance through assurance programs and outcome business plans, using increasingly advanced data and analytical capabilities to improve project delivery. For example, Infrastructure NSW assesses infrastructure program and project performance using non-labour input data collected in its Investor Assurance Framework.[25]

There is an opportunity for governments to develop a national view of construction productivity in consultation with industry. A national baseline underpinned by agreed metrics would help government and industry better understand the drivers behind the productivity stagnation as reported by the Australian Bureau of Statistics.

A consistent measurement and analysis of productivity through more direct comparison of projects and pilots would create the necessary evidence base to inform future interventions to boost productivity. Currently, project level information is collected inconsistently by governments and their agencies across the country, establishing a national productivity baseline would help overcome the limitations of differing data protocols and support meaningful design, implementation, and measurement of potential national-level interventions to boost industry productivity.

In addition, a common data framework would support:

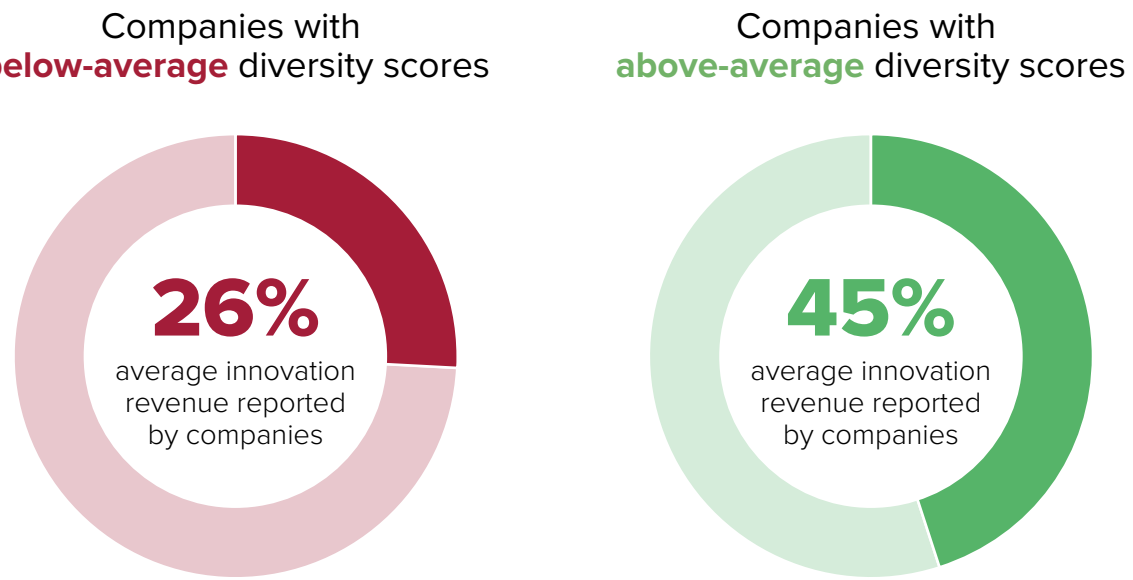
- techniques that improve cost and delivery efficiency, such as ‘should cost’ modelling, Building Information Modelling, and simulated pre-construction rehearsals [26]
- greater upfront planning between governments and industry through data sharing and digital integration [27]
- cost savings between 20%—30% through the use of digital twins. [28]

Women's construction participation is still low despite evidence of diversity benefits

A growing body of evidence quantifies the business advantages of diverse workforces:

- Increased gender diversity on boards and in senior executive positions is associated with better financial performance[29]
- Closing the gender gap has the potential to add $28 trillion to the value of the global economy by 2025 – a 26% increase. [30]
- **Figure 26** shows that companies with more diverse management teams have been found to have 19% higher revenues due to innovation [31]

Figure 26: Companies with more diverse leadership teams report higher revenue



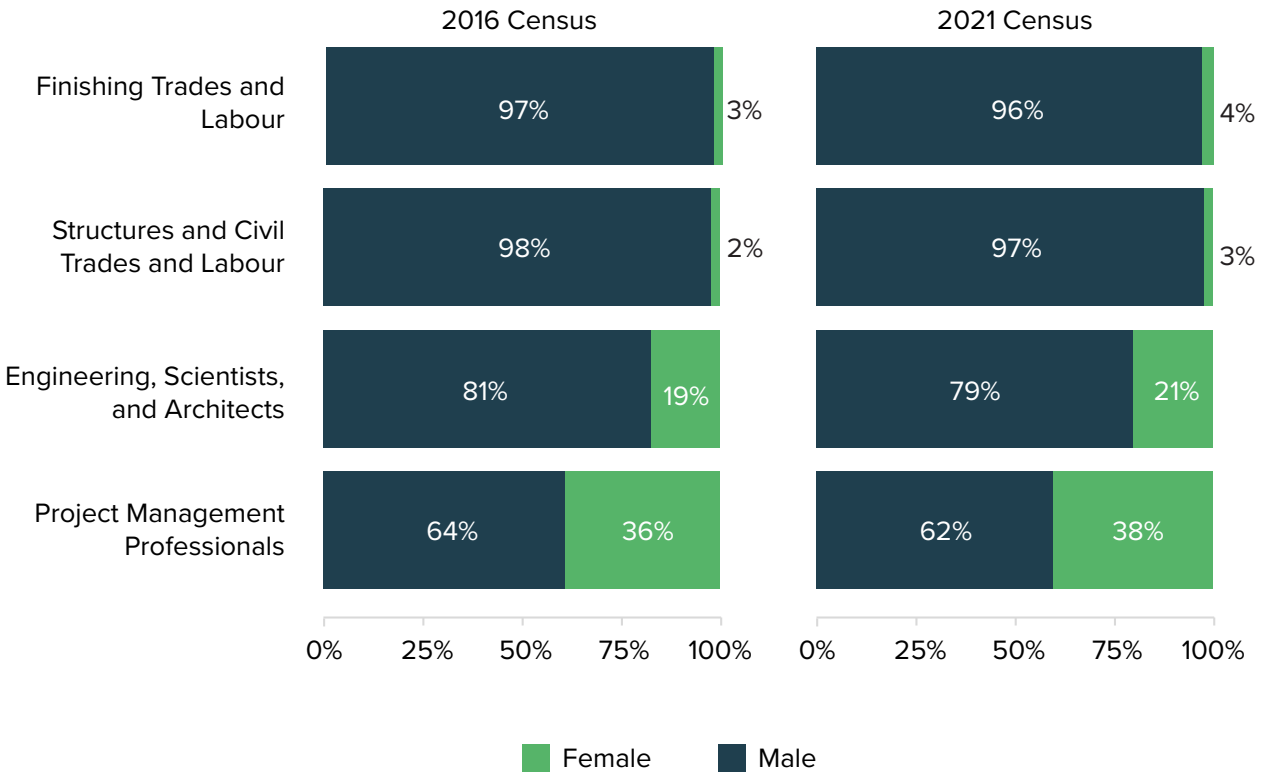
Source: BCG (2018)

- Corporations that embrace gender diversity on their executive teams are 21% more likely to experience above average profitability and 27% more likely to outperform peers in longer-term value creation.[32]
- Firms with more diverse boards have stronger dynamic capabilities, making them more resilient, productive, profitable, and enabling of innovative cultures. [33]
- Women's representation has the potential for activating cultural and behavioural changes such as reductions in aggressive behaviour and bullying, greater attention to detail, better planning and organisation, and improved communication when dealing with clients. [34]

According to 2021 census data, 14% of the construction workforce are women, compared to 12% reported in 2016. While there has been growth in most occupations, progress is slow.

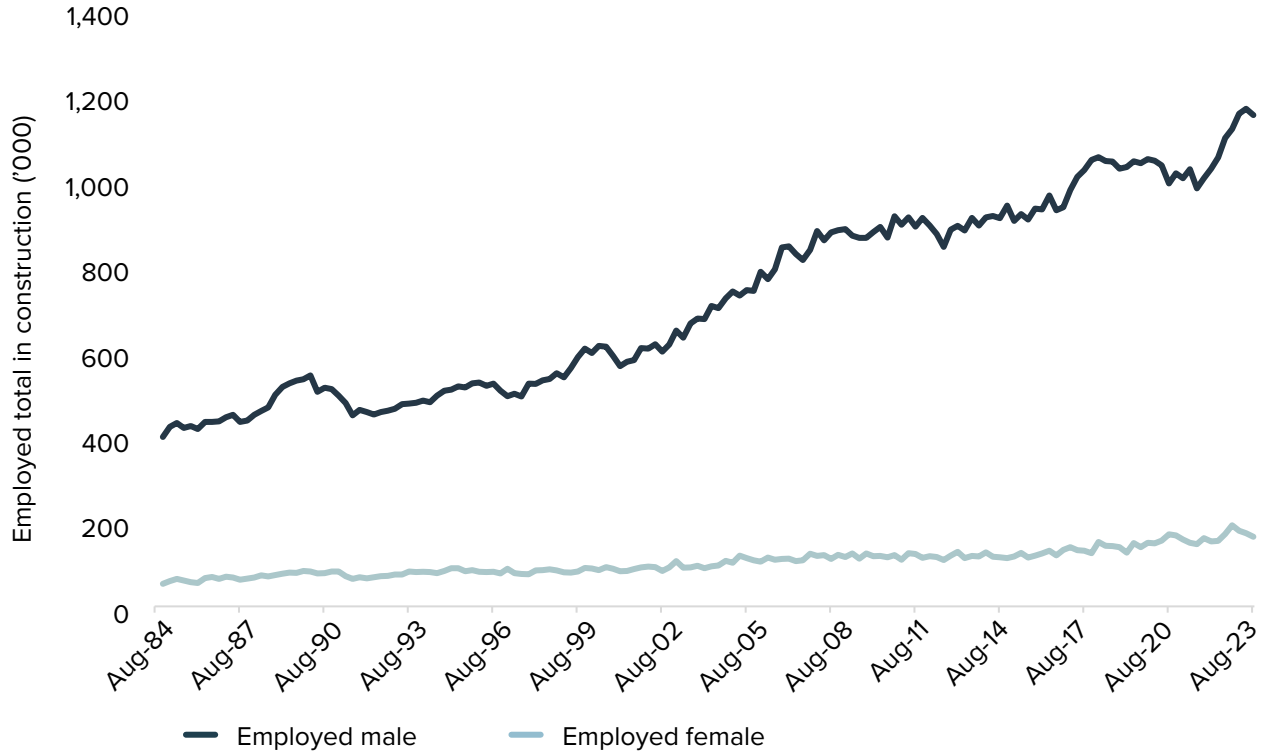
See **Figure 27.**

Figure 27: Gender distribution of workforce, 2016—2021



Source: Australian Bureau of Statistics (2016 and 2021 census).

Figure 28: Employment by gender in construction 1984–2023



Source: Australian Bureau of Statistics data, released 26/10/23, reference period Sept 2023.

As the total number of the construction workforce increases, women's participation in construction continues to grow at a slower rather than men, see **Figure 28**.

Some governments are tackling women's participation by mandating gender diversity targets on major infrastructure projects. For example, the NSW Government Infrastructure Skills Legacy Program includes a mandatory target for women in trade roles (2%) for all NSW Government projects over $100 million. NSW has also launched a Women in Construction strategy which is piloting increased targets on major NSW Government infrastructure projects, doubling the target for women in trade-related work from 2% to 4%, and introducing a new target of 7% of the workforce to be women in non-traditional (on-site) roles. The NSW Women in Construction Program also includes funding for innovative industry led initiatives to help attract and retain women in the construction sector.[35,36]

One recent example of the private sector success in addressing workforce diversity is John Holland attaining gender parity on the Hobsons Bay Main Upgrade (one of Melbourne's largest wastewater projects) as it aims for 40% women's workforce participation by 2025. [37] Other private sector success stories by companies such as Fulton Hogan, JHG, Laing O'Rouke and Lendlease can be found on the Construction Industry Culture Taskforce website.[38]

In infrastructure-related education, National Centre for Vocational Education Research data shows that women students accounted just under 5% of 7,729 trainee and apprenticeships started in 2015—2018. Compared with male counterparts, women apprentices dropped out at a higher rate, while women trainees graduated at a higher rate, and in a shorter time. It is difficult to draw conclusions from these findings however, due to the small number of female enrolments.

Poor culture seems to be a key factor deterring greater women's participation and productivity uplift in construction. Increasingly, young men are reporting they, too, are also deterred from joining the industry.

Addressing the range of cultural problems in the construction industry will likely support greater participation, as well as overall workforce productivity uplift. It is estimated that culture problems, including workplace injuries, mental health issues, suicides, extended working hours, and lack of diversity, together contribute almost $8 billion in annual economic losses. [39]

The Women's Economic Equality Taskforce estimates that specifically addressing barriers for women in the workplace could add $128 billion to the Australian economy through boosting women's workforce participation and productivity growth.[40]

Low women's participation is one of several cultural issues the Construction Industry Culture Taskforce aims to improve through its Culture Standard (others include long work hours and poor mental health). The Construction Industry Culture Taskforce is a sector-wide working group focused on lifting construction productivity and performance. Founding members include the Australian Constructors Association (on behalf of industry), the Victorian Government and NSW Government. Since its establishment, the Australian Government has joined the taskforce and other jurisdictions have also expressed interest.

Stage 1 research and testing of interventions to improve workplace culture is close to completion, with conclusions providing an evidence base for decision making and delivery by the Construction Industry Culture Taskforce.

Industry needs to collectively invest in innovation to grow capacity at a scale beyond individual company growth plans

Construction is one of the least innovated sectors in Australia, often lagging other economies in the uptake of new techniques: for example, prefabricated construction constitutes 3%–5% of Australia's construction industry, compared to 80% in Sweden, 20% in Netherlands, 12%–16% in Japan, and 9% in Germany.

A recent survey of construction in Australia shows that over 50% of respondents are yet to adopt critical productivity enhancing technologies such as digital twins, artificial intelligence, machine learning and robotics. [41] Further work is needed to unpack the reasons behind poor industry update of new technologies and construction methods, including for example, the scale and size of these opportunities within the domestic market.

The Australian Government is already investing in productivity uplift by monitoring and increasing uptake of critical technologies of national interest including, among others, advanced manufacturing and materials, artificial intelligence, autonomous systems and robotics, and clean energy generation and storage. More consideration should be given to how these broad policy directions can be embedded in how governments fund, prioritises and delivers public infrastructure projects.

RECOMMENDATION

Recommendation 11: A national productivity baseline

The Australian Government, in partnership with state and territory governments, should enable measures to uplift construction industry productivity by:

- commissioning a productivity study to better understand the drivers and barriers.
- working with states and territories, to agree on:
  - productivity metrics and indicators to measure infrastructure productivity diagnostics
  - a national collection and baseline, and regular reporting of productivity metrics for the public infrastructure pipeline to Infrastructure and Transport Senior Officials.

RECOMMENDATION

Recommendation 12: Improve workplace culture and participation

The Australian Government, in partnership with state and territory governments, should increase participation and improve workplace culture for all in construction by:

- establishing national monitoring of key measures to increase women's participation, for example through FFAs such as the Land and Transport Infrastructure Agreement
- identifying national approaches to increase participation in construction, including considering evidence from the Construction Industry Culture Taskforce pilots' application of the Culture Standard in procurement across jurisdictions
- encouraging broader participation by jurisdictions in the Construction Industry Culture Taskforce
- including increasing women's participation and addressing assorted culture issues on the National Construction Industry Forum's 2024 work plan.

CASE STUDY

Case study: Using digital construction to safely remove level crossings

ACCIONA used infrastructure construction management software - SYNCHRO Control and SYNCHRO 4D – to safely remove 20 level crossings and construct 13 new stations on Melbourne's Frankston Line.

The ACCIONA team established a connected data environment and created a digital twin to gather pre-construction insights, monitor construction, and streamline workflow and delivery.

While prior strategies lacked context, connectedness, and visual construction sequencing, SYNCHRO helped ACCIONA reduce staging time and drafting requests by 67% and 88%, respectively.

Source: Bentley [42]

CASE STUDY

Case study: Drones Bridge Inspection Program

- The Transport for New South Wales Drone Bridge Inspection Program was designed to modernise bridge maintenance by addressing the unique set of issues and challenges posed by traditional inspection methods. These included access safety risks, traffic disruptions, and high personnel and community costs.
- The program's deployment of AI-powered drones is an Australian first, along with the training of 20 pilots in both metropolitan and regional areas provided this new solution to carry out inspections safer, more efficiently, less disruptive, and more cost-effective for our workers and communities.
- The program delivered substantial cost savings and shorter inspection timeframes. For example, the elimination of elevated work platforms at the Sydney Harbour Bridge trial saved $5,000 per day, with a reduction from 7 weeks to less than 2 weeks for under-deck inspection. The program has also supported emergency response initiatives, such as supporting post-flood inspections from the recent NSW state of emergency.
- Following success of the program, NSW has initiated transport-wide specification for the use of drones in bridge inspection with the goal of establishing a new industry standard and replicable best practices for other public sector agencies and the industry to follow.

Source: Transport for NSW

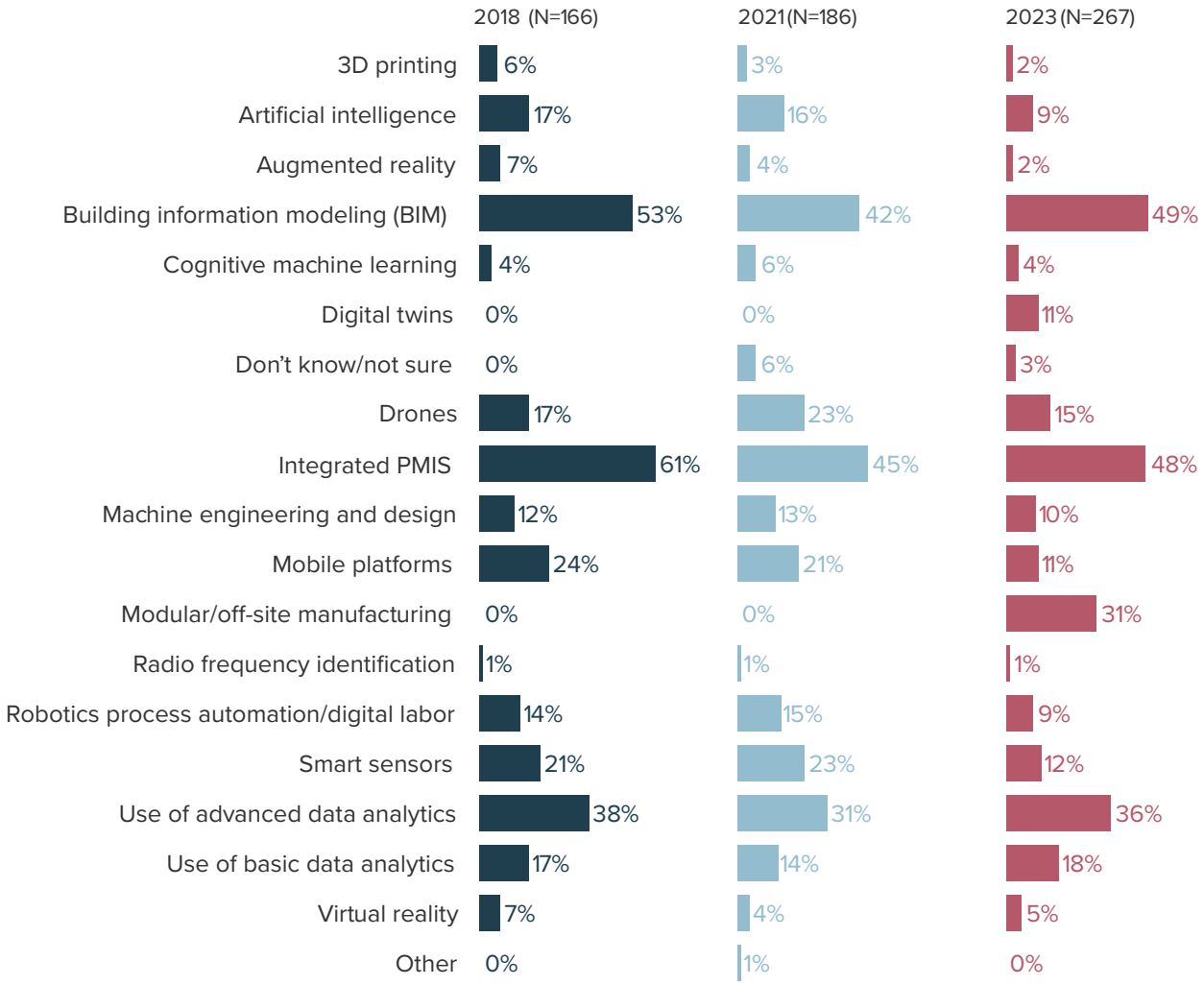
Research on the productivity benefits of construction innovation is wide-ranging, and will continue to evolve with the increasing breadth, scale, and potential of technologies:

- Modern methods of construction and new technologies are key drivers of productivity growth, efficiency and quality improvements.[43]
- Prefabricated construction systems have been found to be more cost efficient than on-site construction, due to reductions in labour costs, material costs, and construction waste.[44]
- Digital product platforms improve project management and stakeholder communication.[45]
- AI and robotics increase efficiency, productivity, and safety by streamlining task sequences, performing hazardous jobs, and using algorithms to predict and prevent safety hazards.[46]
- A Gross Floor Area concession effective in attracting developers to enter the green building market in Hong Kong.[47]

Figure 29 shows the increasing recognition among industry on the ROI potential of digital twins and modular/offsite manufacturing.[48]

Despite the benefits of innovation and risks of doing nothing, underlying factors limit take-up of digital construction techniques, including low awareness and/or understanding of the advantages of new and different techniques, outdated procurement processes and attitudes, manufacturing capacity limitations, and/or low pipeline visibility that suppresses industry's appetite for capability investment.

Figure 29: Technologies with potential to deliver the greatest overall ROI



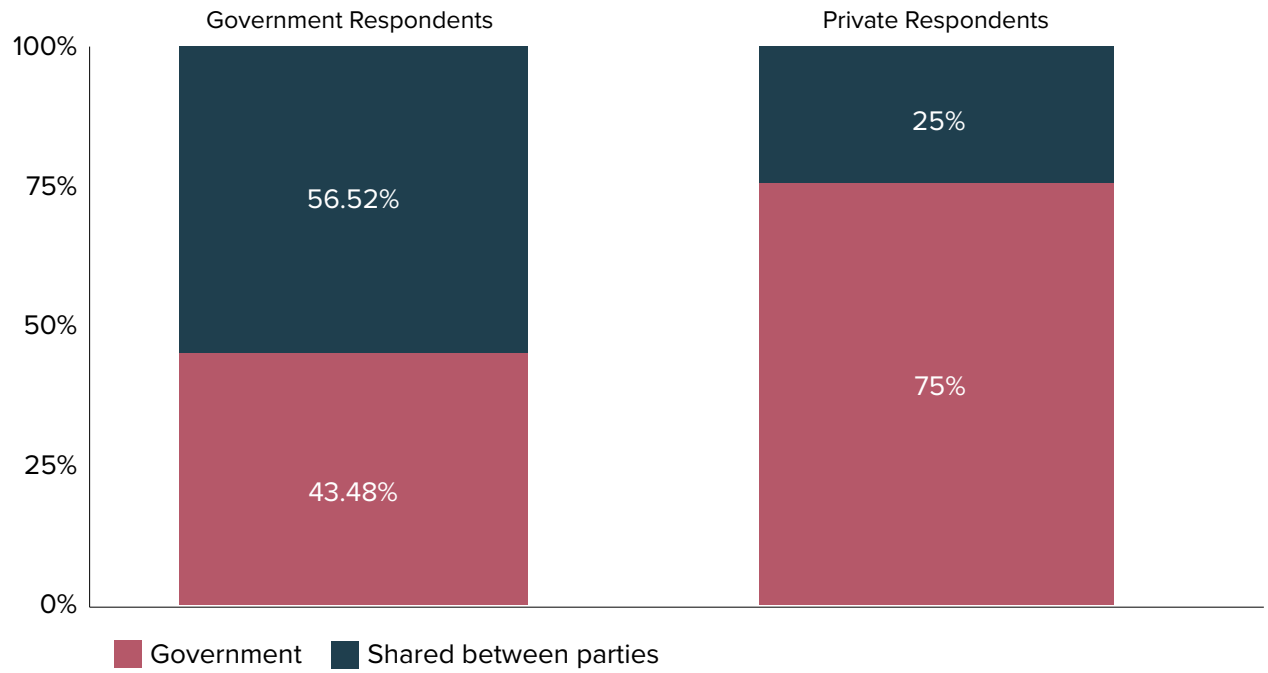
Source: KPMG (2023)

Defective risk practices must be addressed to relieve pressure on market capacity

For a third consecutive year, industry tells us that risk identification and allocation are the greatest impediments to market capacity, a finding first reported in the debut edition of *Infrastructure Market Capacity* in 2021.

Generally, most infrastructure project risks are shared by government and industry, though parties do not agree on certain allocations: **Figure 30** shows that 75% of the private sector believe governments should carry planning risks exclusively, compared with 43% of government respondents. [49]

Figure 30: Survey respondent views on risk ownership in project planning



Source: Infrastructure Australia (2021)

Since the conventional starting point to selecting a procurement strategy seeks to minimise risk to governments by offloading risk to the private sector - often with minimal upfront information and from an adversarial standpoint that rewards 'lowest price' - construction companies must price higher levels of risks into tenders, and/or transfer risks onto subcontractors with neither the skills nor means to manage. [50]

Fixed-priced contracts help the public sector to mitigate the risks of unknown risks and final cost blow-outs. However, they have become increasingly problematic for the building sector, particularly when paralleling higher input costs, tougher lending conditions, input shortages, and broad project delays. Consequently, construction company insolvencies remain historically high.

Poor risk practices lead to poor solutions, higher end user costs, unmet outcomes and unplanned disruptions. A survey by KPMG indicates that respondents consider risk practice standardisation, accurate risk reporting, and clearly defined risk culture as important drivers of successful portfolio-wide risk management. [51]

The productivity benefits of effective risk practices are well researched:

- Companies that regularly collaborate with their suppliers can achieve higher growth, lower operating costs, and greater profitability than industry peers. [52]
- Collaborative delivery models, where appropriate - such as alliance contracting - promote collaboration and cooperation, fair sharing of risk-reward, unanimous decision-making, a no-blame culture, and trust-based relationships. [53]
- Supportive procurement practices promote simplification and standardisation, design and delivery innovation, and local participation across projects.

RECOMMENDATION

Recommendation 13: New technologies and modern methods of construction

The Australian Government, in partnership with state and territory governments, should encourage increased uptake of new technologies and modern methods of construction by:

- prioritising projects that adopt productivity enhancing technologies and/or methods to progress national priority objectives, such as emissions reduction, boosting domestic workforce capability, boosting sovereign capability, and/or strengthening local supply chain resilience for funding. (A potential mechanism includes as part of the project selection process under the Land and Transport Infrastructure Federal Funding Agreement)
- investigating ways to promote best practice and facilitating sharing of emerging best practice.

RECOMMENDATION

Recommendation 14: Risk allocation between parties

The Australian Government, in partnership with state and territory governments, should develop national guidance on best practice risk identification, management and allocation between parties during procurement and contracting processes, including:

- mitigation strategies for common risks by project type
- guidance for making procurement decisions
- guidance on standard contracting solutions that efficiently identify and allocate risk between parties.

Summary of key methodologies

This section summarises the main methodologies used to gather, analyse, and prepare the information for this report. Appendix A contains full methodologies for all information presented in this report, including those summarised below.

Summary of key methodologies

Demand-side analysis

Analysis concerning the demand of major public infrastructure is based on the aggregation of project-level data to create a combined view of Australia-wide infrastructure, with data current as at March 2023. This combined view comprised Identifiable publicly funded infrastructure projects which met certain criteria for inclusion. Projects were included in the database if the investment value was above a threshold capital cost (over $50 million for South Australia, Tasmania, the Northern Territory and the Australian Capital Territory, and over $100 million for all other Australian states). The periods covered were between 2014–15 and 2031–– that is, projects were included on the basis that there was (or would be) construction activity across those ten years.

Most data on public infrastructure is sourced from states and territories infrastructure agencies (as opposed to private industry sources). This also extends to a partnership with the Australian Department of Infrastructure, Transport, Regional Development and Communications and the Arts – the Department have provided budgeted transport infrastructure project expenditure from 2017–18 onwards. The exception to this is the energy and fuels sector. While previous editions of the Infrastructure Market Capacity report relied on Australian Energy Market Operator projections of the installed generation capacity of its Integrated System Plan, this report draws on actual private and public energy project data as more realistic representations of demand. With regard to transmission activity, the 2021 dataset on transmission line projects collated by the University of Technology Sydney has been retained in this report.

Furthermore, the collation of project-level data has expanded during the development of this report. Identifiable projects that are privately-funded across all value ranges have been added to the project database. While these projects are not reported in the five-year pipeline of major public infrastructure projects, the entire project database is examined in Section 2: Understanding demand.

For each project, the database includes information, where available, on the following fields:

- Location (including jurisdiction)
- Investment cost (or megawatts for energy projects)
- Project stage (preconstruction stages, under construction or completed)
- Project schedule
- Funding source (public, private, mixed)
- Project type (project classification)

A full description of the methodology used to find and collate this data is in Appendix A.

Supply-side analysis: non-labour

There is no single source of quantitative 'truth' for the supply capacity of critical non-labour infrastructure inputs. This includes concrete and quarry products, other construction materials or construction plant and equipment. Because quantifying supply is challenging, Infrastructure Australia has combined published production and trade data with industry surveys and interviews obtained as follows:

Detailed surveys of builders and civil contractors

Tier 1 industry survey - conducted over March and May 2023, this survey consisted of 30 minute individual telephone interviews with larger builders and civil contractors. With the ability to deliver larger infrastructure projects – including 'megaprojects' valued over $1 billion – these companies are more likely to operate across multiple state jurisdictions.

2023 CCF Tier 3 member survey – In May 2023 the National Branch of the Civil Contractors Federation (CCF), at the behest of Infrastructure Australia, coordinated a survey of its own member base. The CCF is the peak body representing Infrastructure Australia's civil construction industry, with approximately 2,000 contractor and associate members nationally. The CCF is predominantly populated by smaller and medium sized contractor businesses located throughout metropolitan and regional Australia. 63% of CCF Tier 3 member survey respondents reported that their maximum contract size was under $20 million (and over half reported a maximum contract size of under $5 million).

Deeper industry interviews with the wider supply chain

These industry soundings, conducted between April and June 2023, allowed more time and discussions for deeper probing of challenges with major infrastructure industry suppliers. These soundings helped pinpoint where capacity challenges were already apparent or at risk, their potential causes as well as possible solutions that would help mitigate capacity risk. For this report, these interviews were held with:

- suppliers of quarry materials, cement, concrete and related products
- steel producers and fabricators,
- representatives and suppliers of other input industries including bitumen and plasterboard
- distributors of plant and construction equipment
- representatives from the timber industry

Workforce and skills

The fundamental question addressed by this report is to what extent the current and projected supply of labour can support Australia's proposed investment in public infrastructure. To understand this, it was necessary to clearly define the occupations and skills that underpin this workforce and to estimate the numbers of workers available at different points in time, including projections for the future. The broad approach was:

- to estimate numbers of workers in or near the infrastructure workforce as determined by official statistics and our own forecasts or modelling based on those statistics
- to confront these estimates with additional data (such as job advertisements) that provides extra information on Variables (such as skills) not covered by the official statistics, and extra granularity (such as estimates down to the level of 'roles', below existing ANZSCO unit groups) on variables which required further detail than official statistics provided.

The analytical work has two elements: developing classifications and making estimates. The two elements overlap, as we used data-based estimates to define our classifications, but it is useful to understand the steps separately.

Two key classifications were developed for this work and are used throughout the report. These classifications build on the standard classifications used for occupation and industry: the Australian and New Zealand Standard Classification of Occupations (ANZSCO) and the Australia and New Zealand Standard Industrial Classification (ANZSIC). Using data to categorise, combine (and in some cases add) our final occupational classifications added additional granularity to the standard measures. The two classifications are:

- Which occupations and roles are relevant to public infrastructure?
- Which parts of the workforce in relevant occupations are engaged in, adjacent to, trainable for or distant from public infrastructure?

These classifications were developed to capture the full range of occupations that contribute to public infrastructure in a single streamlined taxonomy. They also support a more nuanced view of the labour force that recognises the portability of skills across and between sectors. Finally, the addition of roles provides a level of granularity which is not present in ANZSCO but which is critical to understanding skill needs.

There were six key pieces of data analysis that built on those classifications, seeking to estimate:

1. Historical and current labour supply
2. Anticipated workforce attrition
3. Future labour supply
4. Workforce shortages
5. Skill profiles
6. Demographics.

The methods used for these two classifications and six pieces of analysis are outlined in more detail in Appendix E: Workforce and skills methodology.

The most important data sources across the project were the 2021 Census and the ongoing Labour Force Survey, to quantify where supply matched demand until 2036; and job advertisement data from Lightcast as an indicator of demand. Each of these data sources has its own strengths and weaknesses, which limits the conclusions that can be drawn:

- The Census is comprehensive but infrequent; it is self-completed and depends on respondents identifying their own occupation and industry.
- The Labour Force Survey is carefully calibrated to definitive population totals and has higher quality consistent use of classifications, but it is based on a sample.

- The job advertisements are also a sample, but of a varying and unknown proportion of the full quantum of demand – varying not just over time but also by occupation and industry.
- The classification of job advertisements to industry and occupation is done by a statistical / machine learning algorithm based on analysis of the original text, introducing its own statistical noise.

Key limitations of the analysis can be understood in several categories:

- Measurement noise – such as Census respondents misclassifying their industry or occupation in a way different to any misclassification that takes place in the Labour Force Survey
- Processing noise – such as the Lightcast machine learning algorithm misclassifying the occupation of a job advertisement
- Analytical assumptions – such as assuming that the proportions of detailed job titles within an ANZSCO unit group in the workforce reflect the proportion of those titles appearing in job adverts for that ANZSCO unit group; or that the proportion of people in each industry working in each occupation at the time of the Census (the best source at that level of granularity) has not changed materially since.

Every effort has been made to control for these problems, as outlined in the detail below, but significant uncertainty and limitations are inevitable.

Workforce and skills – Professional Pathways

To inform strategies to address shortages among professional roles in the infrastructure industry, Nous conducted additional analysis to determine significant flows between occupations within and surrounding the infrastructure industry. This analysis leveraged Lightcast's Social Profiles data for Australia, which scrapes professional experience from Social media. It comprises anonymised real-world career profiles that include information on educational background and the specific jobs held by individuals throughout their careers.

To do this it was necessary to define the set of career profiles that are relevant to public infrastructure and to distinct occupational groups. This allows us to estimate the proportion of individuals that experience key events of interest, and accordingly, to make inferences about problems facing infrastructure professionals and likely interventions. The primary objectives of this analysis were as follows:

- Origins and Transitions: Determine the sources and destinations of individuals involved in infrastructure occupations, shedding light on their career mobility patterns.
- Tenure and Retention: Ascertain the duration of individuals' engagement in relevant occupations and evaluate the extent to which the workforce is retained within the industry over time.
- Professional Pathways: Identify the crucial occupational trajectories that serve as major conduits for individuals pursuing a career in the infrastructure sector.
- Lead Time and Components: Analyse the time required to progress to specific occupations, considering factors such as relevant occupations, unrelated occupations, and educational pursuits.

Key limitations of this analysis include:

- Sample size varies by occupation, and very noticeably by occupational group. Different individuals are more or less likely to fill out and/or maintain their professional Social media, and there are different incentives to do so across occupations. The analysis assumes that this does not Bias within-occupation results.
- Similarly, not all key fields of interest can be populated; in particular, the industry of a role and the ANZSCO it maps to cannot always be ascertained. Again, the analysis assumes that this does not Bias within-occupation results.

Workforce and skills – Trades Pathways

To help address shortages in trades and labouring roles, this analysis seeks to identify where apprentices and trainees (A/T) are dropping out and the most effective interventions to address these points.

In doing so, it was necessary to define the students that are relevant to public infrastructure, and events of interest. This enables estimation of the number of students that have commenced, cancelled,

completed, or are continuing their studies at points in time. The training someone commences only explains part of a student's journey into the workforce, so further analysis was undertaken to estimate where apprentices and trainees go when cancelling or completing courses.

To understand this, the proportions of each subset who would then go on to further study or transition into the workforce was estimated. The broad approach was:

- to map student pathways throughout their studies by each year from commencement, and then estimate the stock of those who have completed and cancelled at each point in time
- to estimate the proportions of students who go on to pursue other studies after dropping out of their apprenticeship or traineeship
- to estimate the proportions of students that transition into a given occupation after completing their apprenticeship or traineeship.

This analysis combines four datasets provided by the NCVER. To map student pathways, the Apprentices & Trainees data is used in isolation. To understand what students are doing after dropping out, a combination of enrolments data (i.e. the Total Vet Activity data) and completions data (i.e. the Program Completions data) is used to identify if students commence another course. Of those who complete a course, the Student Outcomes Survey data is used to estimate what occupations students transition into after an apprenticeship or traineeship.

While these data sources have clear strengths in tracking the movements of students during and after studies, there are limitations when combining them:

- Studies often take 2–4 years to complete, so there is insufficient data to analyse the pathways for the cohorts of students commencing after 2019.
- The NCVER does not enable or permit cross-linking of all of these data sets at the individual student level, in part due to privacy concerns. This means that only proportions of non-completers that go on to further study in the Apprentices & Trainees data can be approximated, rather than detailed journeys.
- The Student Outcomes Data is self-completed and is a sample of students. This is itself only an approximation of where completers go after study.

Pathways analysis methodology is outlined in more detail in Appendix E: Workforce and skills methodology.

A note on overall methodology limitations

Infrastructure Australia's market capacity analysis provides an aggregated national view of infrastructure demand and supply. It is not intended to provide detailed regional level or project basis analysis. Our accompanying analytical tools were designed with and for government to undertake deeper analysis of their infrastructure pipelines at the regional and individual project level.

Infrastructure Australia forecasts resource demands across plant, labour, equipment, and materials by applying a top-down method based on high-level 'project types'. It incorporates cost and time assumptions for project types developed through analysis of comparable projects and expert input.

Forecasts for the dollar value of resources required by individual projects are generated by applying industry typical cost and time breakdown assumptions on a per-project-type basis. To provide demand forecasts in real units (e.g., tonnes, FTEs, cubic metres), dollar values are converted using unit rate norms, reflecting the cost per unit resource.

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