# Engineering Australia's productivity

## Engineers Australia submission to the Productivity Inquiry

October 2022

ENGINEERS AUSTRALIA

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# Engineering Australia's productivity

Engineers Australia
11 National Circuit, Barton ACT 2600
Tel: +61 2 6270 6555
Email: policy@engineersaustralia.org.au

**engineersaustralia.org.au**

# Introduction

The engineering profession has a direct influence on national productivity. Engineers create the systems, products and services that enable people in almost all occupations to be more productive. They allow people to do more with less effort, time, materials, energy, health risks and environmental disturbance. Engineers don't just create them; they operate and maintain them. Engineers also help people to use systems, products and services more effectively. Therefore, the engineering profession is critical for improving Australia's productivity growth.

The factors identified by the Productivity Commission which will shape productivity growth in the future will all rely on the skills and experience of engineers. From advancements in the use of technology and data in the growing services sector, to improving digital infrastructure and transitioning Australia to a decarbonised economy, an engineer's ability to think critically and solve complex problems will be highly sought after. The expectations on engineers are growing. As well as having technical expertise, the modern engineer is expected to work in complex multidisciplinary teams, be digitally savvy, have good interpersonal skills and understand the social context of their work. In addition, engineers are expected to help develop social licence (trust), improve sustainability, and engage directly with a broad range of stakeholders.

The engineering profession currently faces many challenges, not just in the supply of skills, but also in commercialising innovation and creating value. More needs to be done to promote the value engineers generate in society, which can be distilled into three broad areas, creation, delivery and protection.

- Engineers create value through their plans, designs and innovations, which provides confidence that motivates the investment needed to turn them into reality.
- Engineers deliver value by planning, managing and coordinating the delivery of products, services and systems that reasonably match expectations.
- Engineers protect value through maintenance of systems and maintenance of trust.

A large part of an engineer's value lies in their ability to provide predictable results that match expectations, reduce risks and catalyse investment. This submission puts forward three areas which should be considered by the Commission in their review on ways Australia can improve productivity into the future.

## About Engineers Australia

Engineers Australia is the peak body for the engineering profession in Australia, constituted by Royal Charter to advance the science and practice of engineering for the benefit of the community. With over 110,000 members nationally we represent a profession that impacts the lives of Australians every day.

As Australia's signatory to the International Engineering Alliance, Engineers Australia maintains national professional standards, benchmarked against international norms. Under the Migration Regulations 1994, we are the designated authority to perform the assessment of potential migrant engineering professionals' skills, qualifications, and work experience to ensure they meet the occupational standards needed for employment in Australia.

## Further information

This submission draws from three policy papers released by Engineers Australia. These papers have undergone extensive consultation with our membership and key stakeholders within the engineering profession. It is recommended these papers are reviewed for further information.

- Commercialisation of engineering innovation
- Enhancing productivity in infrastructure delivery
- Strengthening the engineering workforce in Australia

# Summary of recommendations

## Engineering skills

- Reforms to increase Australia's teaching capability in STEM subjects, including offering programs to make it easier for mid-career STEM professionals to become maths, science or engineering studies teachers, increasing the number of maths and science teachers with relevant qualifications, and providing effective resources to out-of-field maths and science teachers.

- For government and industry to support engineering internships and graduate programs to retain qualified engineers in the profession.

- Provide Commonwealth Supported Places (CPS) for accredited engineering master's qualifications. This will help articulate other STEM bachelors' qualifications to the level of professional engineers and to help retain existing engineers in the workforce by upskilling them in new and emerging fields.

- In collaboration with industry and the tertiary sector, explore other innovative pathways to engineering qualifications.

- Review how programs can be supported that assist engineers returning to the workforce after a career break. This should also include what new programs could be developed help incentivise engineers working out of the profession to return to engineering.

- Reforms to Australia's migration program objectives to be more targeted, to attract migrants with the specific experience and skills required, increasing their employability.

## Engineering Innovation

- Address the below three reform principles identified as frequently missing from the grant process

    - Accessibility – provide a centralised repository of grants and programs for ease of access

    - Ease of application – simplify and streamline the application process for time-poor start-ups and transfer the burden of applying to government as much as possible, to alleviate resource requirements

    - Time sensitivity – reduce the time between a successful grant application and funds being transferred to start-ups

- Explore ways to promote greater collaboration within the Australian STEM start-up space

    - Develop partnerships with vibrant STEM ecosystems in the UK, US and other world-leading countries. Given the prevalence of venture capital funding abroad, these international partnerships should be leveraged to give Australian start-ups access to funding from overseas when it is not available domestically.

    - Recognise the important role government plays, particularly in the early stages of developing a national STEM ecosystem. Consider providing grants not only for start-ups, but others in the start-up ecosystem to support industry collaboration and promote holistic development.

    - Recognising the limitations of the small Australian market, mechanisms should be explored to support start-ups to expand into the Asia-Pacific market, for example, by leveraging Austrade networks.

- Reduce the business licensing, registration and compliance requirements for engineering and STEM companies more broadly, particularly where there is no safety concern associated with the regulation.

## Productivity improvements in government funded infrastructure

- Governments must commit to long-term collaborative planning to mitigate the negative effects of short-term electoral cycles on infrastructure planning and delivery.

- Government and industry should develop an infrastructure industry best-practice guide mandating key policies to optimise benefits and minimise risk in infrastructure project management, delivery, and operations.

- The sector must better communicate the desired outcomes of projects and embed sustainability, resilience and circular economy principles at all stages of the asset lifecycle.

- Governments at all levels should reform their tendering processes to promote greater participation from SMEs.

- Engineers Australia recommends governments implement a consistent procurement framework across all levels and between all departments associated with interrelated infrastructure, applying the ISO 55000 series of standards for asset management for consistency across states and territories.

- Governments should avoid using non-standard contracts and provide visibility of contracts before tender, allowing sufficient time for review. Any required amendments to standard contracts must be subject to collaborative negotiation with industry stakeholders.

- Governments must allocate funding for training and upskilling of the labour force in digital skills. Part of this funding should support subsidised programs, to promote collaboration between industry and academia, fostering greater integration of current and emerging technologies. Commitment to increased targets for projects dedicated to innovation, practice improvement and development resulting in long-term benefits such as improved return on risk profile.

- Governments must provide a streamlined grants process and additional funding for start-ups and scale-ups to support innovation

# Contact

For further discussion about the points raised in this submission, please contact Michael Bell, Senior Policy Advisor at mbell@engineersaustralia.org.au or on +61 8 6214 6321.

# Engineering skills

At the heart of increasing productivity in Australia is having the required skills. As noted in the Productivity Commission's interim report a highly skilled workforce with strong cognitive skills including problem solving will be needed in a rapidly changing service economy.[1] This is further supported by the National Skills Commission which predicts cognitive ability to be highly sought after in the future.[2] The nature of engineering requires a strong cognitive ability making engineers sought by many employers in various industries, simply due to the value placed on the skills developed through an engineering education and an engineer's cognitive ability to think and to solve complex problems. Ensuring a strong pipeline of engineering skills is available is critical.

Australia is experiencing an engineering skills supply challenge which has been ongoing since the late 1980s. Currently, many sectors are experiencing a shortage of experienced engineers, but it is in the face of an economy-wide oversupply of qualified—but underutilised—migrant engineers and exacerbated by persistent challenges in the sources of domestic supply. Research shows Australia continues to experience long-term chronic and cyclical shortages in engineering skills. There are more qualified engineers within Australia than at any point in history, but proportionally less in engineering occupations.[3]The challenges are exacerbated by cyclical shortages which are experienced in line with economic cycles (that is, shortages are most acute during periods of high economic growth, as seen with the mining boom and current COVID induced stimulatory spending).

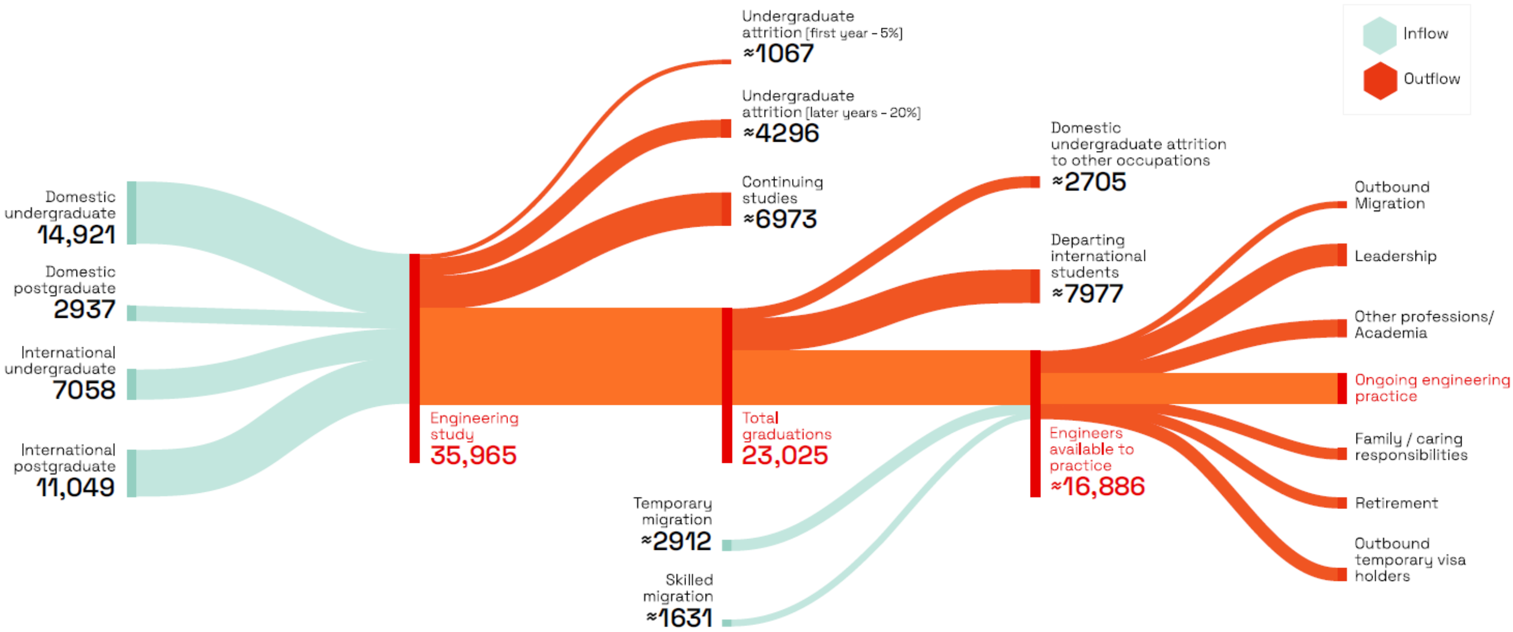
Demand for engineering skills is projected to increase dramatically over the coming years. Developing Australia's engineering capability is key to achieving increases in productivity. Engineers Australia's research shows Australia needs to address five areas to build an engineering workforce that can meet our current and future needs. The five categories of factors that influence the engineering workforce include:

1. **School education (primary and secondary)** – the factors that influence how many young Australians choose to study engineering for their higher education
2. **Engineering study (vocational and higher education)** – the factors that influence engineering graduation rates and skillsets
3. **Retention in the engineering workforce** – the factors that influence how many qualified engineers stay in the engineering workforce (work in an engineering role)
4. **Skilled migrant engineering workforce participation** – the factors that influence how many skilled migrant engineers work in an engineering role
5. **Demand forecasting** – how data on current and future demand of engineering skills can enable better workforce planning and inform career choices for Australians.

Australia's engineering workforce is made up of two supply channels, graduates from Australian universities (both domestic and international) and international skilled migration. This supply is affected by various outflows including attrition from students studying engineering and attrition from the engineering workforce. This is illustrated diagrammatically in Figure 1. Domestic engineering student commencements peaked in 2014 and have since been trending downward. This highlights that domestic supply channels are exhausted. Anyone who wants to study engineering and meets the entry criteria is already accepted to university. Therefore, the reforms need to focus on increasing the intake of domestic enrolments while also retaining engineers in the profession. Until the number of school students who study appropriate preparatory subjects increases, and more students (especially women) are inspired to become engineers, coupled with them wanting to remain in the profession, there is no more domestic supply available. With the development of a qualified engineer ready for independent practice[4] around a 10-year endeavour, skilled migration will remain essential to Australia's engineering capability, and as such, better utilisation of this cohort of engineers is needed.

[1] '5-year Productivity Inquiry: The Key to Prosperity' *Australian Government Productivity Commission* (July 2022)
[2] 'Skills and jobs of the future – the Four Cs' Australian Government National Skills Commission (accessed 3 February 2021) https://www.nationalskillscommission.gov.au/sites/default/files/2021-12/Skills%20and%20jobs%20of%20the%20future%20%E2%80%93%20the%20Four%20Cs.pdf
[3] Engineers Australia, Australia's Engineering Capability: How The Last Ten Years Will Influence The Future, 2019, p40
[4] Approximately five to seven years' experience post-graduation

**Figure 1: Inflows and outflows of Professional Engineers 2019**




This diagram is indicative only, providing provisional figures and best estimates from the data and research available. It is provided to illustrate the magnitude of inflows and outflows each year and is not an exact representation of the number of people entering and exiting the profession.

*Australian Engineering Higher Education Statistics 2009-2019, Australian Council of Engineering Deans, December 2020 & King, R, Working Paper: Pipelines into Professional Engineering Occupations, Australian Council of Engineering Deans, December 2021*

# STEM and engineering study

The development of an engineer begins early. Building greater awareness of STEM careers is necessary to ensure students are prepared to complete tertiary education (vocational and higher education) in engineering and enter the profession. Australia's ability to develop engineers domestically, is hindered by a reduction in Year 12 science and mathematics participation.[5] The number of Australian school students studying intermediate and advanced levels of maths is at all-time low.[6] Long-term commitment and planning by industry, government, schools, and the tertiary sector is required to rectify this.

Domestic supply is further hindered by the performance of Australia's early and secondary education system. The latest OECD Programme for International Student Assessment (PISA) results show Australian students' performance in mathematics has declined since 2003 (when Australia ranked 10th in the OECD) to 2018 (when Australia ranked 30th in the OECD). Performance in science has also been declining since 2012. Contributing to this is a teaching workforce for maths and science that needs more support. The State of Our Schools 2020 national survey reported 38 percent of secondary education teachers had taught outside their field of expertise, including mathematics, science, and technology.[7]

If reforms are not made to increase the availability of domestic students who have an interest in and prerequisites to undertake tertiary study in engineering, commencements will continue to decline, deepening current skills challenges and hindering Australia's future productivity. Encouraging young Australians to choose prerequisite subjects for engineering study (science and maths) and inspiring more young Australians to choose to study engineering for their tertiary education should be priorities.

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[5] Bell, M & Briggs, P. 'Engineering skills – supply and demand discussion paper' *Engineers Australia* (March 2022) https://engineersaustralia.org.au/sites/default/files/2022-03/Engineers-Australia-Skills-Discussion-Paper-20220310.pdf

[6] Australian Mathematical Sciences Institute, Year 12 Mathematics Participation Report Card, 27 April 2022 https://amsi.org.au/?publications=year-12-participation-in-calculus-based-mathematics-subjects-takes-a-dive

[7] O'Flaherty, Antonia. (2021) "Worrying' STEM teacher shortage with pressure felt in rural and remote schools' ABC News (accessed 9 February 2022) https://www.abc.net.au/news/2021-06-15/school-principals-dont-have-enoughmaths- science-teachers/100214738

For those that meet the requirements and undertake tertiary education in engineering, around 40 per cent of students don't complete their engineering qualification.[8] Reasons for this vary, however more needs to be done to support engineering students to complete their qualifications, including internships, graduate programs, and early career employment opportunities. It is only after an engineer has gained approximately five years' experience would they fulfil the current needs of employers for 'experienced' engineers.

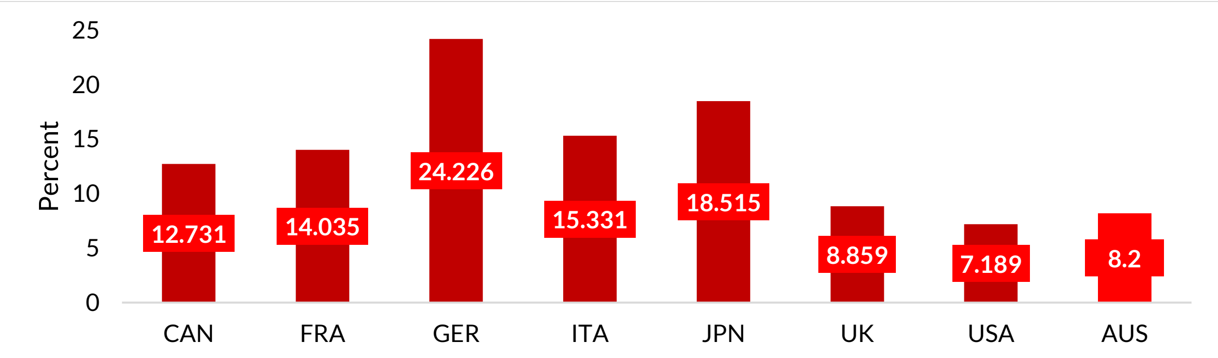
## Retention in the profession

To ensure adequacy of engineering skills supply over the long term, efforts should be made to increase utilisation of recent graduates and retain engineers at all stages in their career in the profession. Investing in the domestic supply of engineers is critical to the long-term sustainability of engineering skills. Engineers Australia's analysis shows there are many more people with engineering bachelor qualifications in Australia than there are people reporting working in an engineering role. The exact reasons why so many engineers don't remain in the profession are unknown. However, the nature of engineering requires a strong cognitive ability which is sought by many employers. In addition, salaries and the prestige associated with working in certain industries and occupations may be greater outside the profession. Investing in engineering graduate employment outcomes, supporting engineers return from career breaks and increasing career opportunities for mid-senior level engineers will lessen future skills shortages.

## Greater utilisation of migrant engineers

Due to domestic supply challenges, skilled migration will remain essential to the nation's engineering capacity in the short and medium term. Currently, over 58 per cent of engineers in the Australian labour force were born overseas, however, migrant engineers are much more likely than their Australian born counterparts to work in non-engineering roles. Improving the employment outcomes of migrant engineers is crucial for Australia to be seen as a destination of choice. An increase in demand for engineering skills globally puts additional pressure on Australia's reliance for skilled engineering immigrants. As seen below, Australia, the USA and the UK all produce lower levels of engineering graduates compared to other G7 countries.

**Figure 2: Comparison of the percentage of engineering graduates in G7 countries[9]**




Continuing large scale intakes of qualified engineers will not significantly develop Australia's engineering capability and capacity unless better support systems are provided to help them secure engineering work when they are here. Without these support systems, increased skilled migration may start to harm Australia's reputation as a country with good employment prospects for migrant engineers.

Engineers Australia agrees with the Productivity Commissions insights that *'Tight labour market conditions in Australia strengthens the need for workers to be allocated to their highest valued use. It also highlights the*

[8] 'Student Data' Australian Government *Department of Education* (accessed 2 August 2022) <https://www.dese.gov.au/higher-education-statistics/student-data>
[9] Source: 'Tertiary Graduates by Field' *OECD Data* (accessed 3 February 2022) https://www.oecd.org/statistics/compare-your-country.htm

*importance of access to skilled labour from other countries, which can help alleviate demand pressures and enhance productivity by improving the quality and diversity of skills in the labour market'*[10]

Migrant engineers are often not working in positions commensurate to their skill and experience level. Research conducted by Engineers Australia identified seven main barriers to engineering workforce participation for migrant engineers. These are:

1. A lack of local knowledge and experience

2. Perceived cultural differences in soft skills

3. Visa or sponsorship working rights issues

4. A lack of people who can 'vouch' for them locally

5. Certification queries

6. 'Flight risk' concerns

7. Tendency to hire from personal 'networks' for senior roles

Overcoming these barriers will help alleviate current and future skills shortages. The full Barriers to Employment for Migrant Engineers report can be found in the resources section of the Engineers Australia website.

The Australian Government's Jobs and Skills Summit held in September 2022 highlighted the need for reforms to Australia's migration program. In addition to greater support being needed for migrant engineers who find themselves under or unemployed, action needs to be taken to modify Australia's migration program to ensure a better fit for the policy objectives. Australia migration policy needs to be more focused on employment outcomes of the skilled immigrants entering the country. As it stands, there are several areas where the system can be skewed away from experience, limiting the employability of skilled migrant engineers.

# Recommendations

The Productivity Commission should consider:

- Reforms to increase Australia's teaching capability in STEM subjects, including offering programs to make it easier for mid-career STEM professionals to become maths, science or engineering studies teachers, increasing the number of maths and science teachers with relevant qualifications, and providing effective resources to out-of-field maths and science teachers.

- For government and industry to support engineering internships and graduate programs to retain qualified engineers in the profession.

- Provide Commonwealth Supported Places (CPS) for accredited engineering master's qualifications. This will help articulate other STEM bachelors' qualifications to the level of professional engineers and to help retain existing engineers in the workforce by upskilling them in new and emerging fields.

- In collaboration with industry and the tertiary sector, explore other innovative pathways to engineering qualifications.

- Review how programs can be supported that assist engineers returning to the workforce after a career break. This should also include what new programs could be developed help incentivise engineers working out of the profession to return to engineering.

- Reforms to Australia's migration program objectives to be more targeted, to attract migrants with the specific experience and skills required, increasing their employability.

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[10] '5-year Productivity Inquiry: The Key to Prosperity' *Australian Government Productivity Commission* (July 2022)

# Engineering innovation

Even though Australia has one of the world's most educated and wealthy populations, the nation is an underperformer in commercialising engineering innovation locally. Historically, when innovation has occurred, Australia has failed to commercialise it domestically, losing the benefits of jobs and other opportunities overseas. Engineers play a vital role in the development and utilisation of data and technology, which in turn can provide strong productivity gains. Without the development and effective utilisation of technologies, particularly in the service sector, productivity gains are unlikely to be seen.

The Productivity Commission highlights the need to maintain momentum in the use of data and digital technologies to achieve productivity increases. To ensure the success of engineering-based industries in Australia, and to stay globally competitive, reforms are needed to support Australia's ability to commercialise innovation, particularly innovation which can contribute positively to productivity. To improve Australia's capacity to commercialise STEM innovation, three core issues need to be addressed.

1. Improving models of collaboration and ecosystem development
2. Reforming grants processes and tendering for government contracts
3. Reducing regulation and incentivising investment in STEM start-ups in line with global best practice.

Australia runs the risk of falling further behind other OECD countries when it comes to the future of the engineering profession and the wave of jobs, innovation and economic growth that it will engender. Reforms are required to reinvigorate the STEM ecosystem and encourage the commercialisation of engineering innovation.

## Incentivisation of STEM innovation

Australian innovation needs to be incentivised to help develop productivity improving technologies. There are numerous government grant programs, however consultations with the engineering community shows systemic inefficiencies continue to inhibit their impact. Founders of STEM start-ups have repeatedly noted challenges around finding appropriate grants and relevant programs, the administrative burden and bureaucratic process of applying for grants, and the long wait time between applying, being accepted and receiving the funds. There is also a significant disparity between large and small players, because larger firms can dedicate significant time and money to apply for grants, while smaller start-ups, which are arguably in more need of such funding, are unable to invest sufficient human capital to apply.

Grants programs should be easy to use for applicants, have minimal administrative processes, and take a risk-based approach to probity checks. This should be part of a larger, integrated framework to create systems that promote innovation and ensure compliance is not a burden on start-ups. Given start-ups are time-sensitive in nature due to their limited capital and liquidity limitations, funds should be transferred quickly to have a meaningful impact. Waiting six months for funding after a successful application can mean the difference between survival or dissolution.

## Innovation ecosystem

The regulatory and compliance burden for engineering start-ups is frequently higher than for start-ups in other sectors due to the regulated nature of the industry. This can hinder development and commercialisation of technologies. In contrast, pure technology firms often have little regulation, which enables them to scale rapidly and reduces the capital investment required. STEM start-ups that are at the nexus of innovative technology and traditional engineering practice are frequently mired in regulatory or legal uncertainty. Where clear laws and regulations do exist, they increase costs, dissuade investors, and can hinder the development of start-ups.

# Collaborating to improve innovation

Collaboration is crucial to the effective development of innovation through STEM start-ups. There are several examples where State and Federal governments bring people and organisations together to create STEM focused start-up ecosystems. The Aerotropolis precinct (NSW) and Lot 14 (SA) are two of the standouts which have already shown great potential.11 While progress has been made in creating start-up and STEM ecosystems, if Australia is to take full advantage of the wealth and innovation benefits that come from a vibrant start-up ecosystem, it will be critical to find ways to accelerate this ecosystem development to become more competitive internationally.

# Recommendations

- Address the below three reform principals identified as frequently missing from the grant process
    - Accessibility – provide a centralised repository of grants and programs for ease of access
    - Ease of application – simplify and streamline the application process for time-poor start-ups and transfer the burden of applying to government as much as possible, to alleviate resource requirements
    - Time sensitivity – reduce the time between a successful grant application and funds being transferred to start-ups
- Explore ways to promote greater collaboration within the Australian STEM start-up space
    - Develop partnerships with vibrant STEM ecosystems in the UK, US and other world-leading countries. Given the prevalence of venture capital funding abroad, these international partnerships should be leveraged to give Australian start-ups access to funding from overseas when it is not available domestically.
    - Recognise the important role government plays, particularly in the early stages of developing a national STEM ecosystem. Consider providing grants not only for start-ups, but others in the start-up ecosystem to support industry collaboration and promote holistic development.
    - Recognising the limitations of the small Australian market, mechanisms should be explored to support start-ups to expand into the Asia-Pacific market, for example, by leveraging Austrade networks.
- Reduce the business licensing, registration and compliance requirements for engineering and STEM companies more broadly, particularly where there is no safety concern associated with the regulation.

[11] Longley, P. 'Commercialisation of engineering innovation' *Engineers Australia* (April 2022)

# Productivity improvements in government funded infrastructure

Governments around Australia should consider ways they can influence enhancements to productivity where they are the main client.  A key area of focus for government should be as the primary client for infrastructure. Adequate infrastructure is essential to support a sustainable, liveable, and productive Australia. Infrastructure spending has been a key policy initiative in stimulating the economy post-pandemic. Overcoming the impediments of longstanding flaws in project planning, procurement and capability, and the barriers to the uptake of innovative design and new technology, should be a focus and is needed to improve productivity in the sector.

Reforms and investment are needed in Australian infrastructure innovation with a particular focus on the three areas below. Without action, longstanding flaws in project governance and planning, procurement and barriers to the uptake of innovation and technology, will continue to impede productivity and delivery.

## Project governance and planning

Australia is relying on governments to improve the management of project pipelines to boost our economy in the wake of the COVID-19 pandemic and to ensure we are future-ready. Collaborative, long-term planning of infrastructure is vital to economic prosperity. Governments at all levels must commit to continuous improvement through best-practice project governance, planning, procurement, and delivery. Federal, state and territory governments must also commit to a coordinated project pipeline through collaboration, thorough application of risk management practices, a mature approach to project governance and procurement, and funding for infrastructure investments.

## Best practice procurement

Infrastructure projects are mostly medium-to-long-term endeavours, making the procurement processes difficult. Tendering and contracting issues regularly prevent small-to-medium-sized enterprises (SMEs) from equitable participation. Involvement of SMEs is good for projects and the economy by developing our sovereign capability, creating jobs, and increasing innovation. Currently, there is too much focus on de-risking, which pushes providers to do what they know works, rather than taking strategic risks to reduce costs or deliver innovative solutions.

A way to encourage more diverse participation is to develop baseline infrastructure first, with a structured return on investment, before proceeding to the next level of value-adding infrastructure. Ensuring that project bidders are shortlisted promptly can also assist by limiting the time and money spent by companies that are identified as unsuitable.

## Digital infrastructure and innovation

Broad uptake of digital technologies at all phases of asset lifecycles will enhance productivity in infrastructure delivery and operation. The use of digital twins, smart sensors, building information modelling systems, digital engineering and digital asset management tools will ensure Australia is future ready and that our infrastructure can be managed efficiently, sustainably, and effectively. The benefits of digital technologies include enabling more collaboration and coordination between teams and stakeholders and increasing innovation through improved data capture.

## Recommendations:

- Governments must commit to long-term collaborative planning to mitigate the negative effects of short-term electoral cycles on infrastructure planning and delivery.

- Government and industry should develop an infrastructure industry best-practice guide mandating key policies to optimise benefits and minimise risk in infrastructure project management, delivery, and operations.

- The sector must better communicate the desired outcomes of projects and embed sustainability, resilience and circular economy principles at all stages of the asset lifecycle.

- Governments at all levels should reform their tendering processes to promote greater participation from SMEs.

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- Governments must provide a streamlined grants process and additional funding for start-ups and scale-ups to support innovation

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