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Strengthening the engineering workforce in Australia:

Solutions to address the
skills shortage in the short,
medium, and long term

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Solutions to address the skills shortage in the short, medium, and long term

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Foreword

At the time of writing this report, Australia is experiencing perhaps its greatest-ever engineering skills shortage. Greatest because of its scale (more than 50,000 engineers are estimated to be needed over the next few years), and its breadth, with all disciplines of the profession except biomedical engineering and nearly all sectors of the economy requiring more engineers. We have experienced engineering skills shortages in relatively recent history, in the 1980s and around 2012. But what is different this time arguably is the context – a labour and skills shortage that is impacting most of the economy and many professions and vocations, rising inflation, unprecedented disruptions to supply chains and the sheer scale of the demand for engineers, both presently and into the future, in terms of both the number of engineers we need and the number of sectors needing them.

Demand for engineering skills is strengthening due to a healthy forward infrastructure pipeline and a reliance of many national priorities on the engineering profession, including the clean energy transition and net zero emissions objectives, strengthening of sovereign supply chains and manufacturing capabilities, and the emergence of ‘new’ sectors such as nuclear-powered submarines capability and the civil space sector. These factors coincide with a general move towards integration of technology and engineered systems into most aspects of our daily lives.

Australia’s engineering workforce typically has two main supply channels – Australians who choose engineering for their tertiary education and career, and skilled migrant engineers. Supply from both channels is decreasing at a time when demand is increasing.

The global pandemic’s closed borders and Australia’s net negative migration over much of the last two years is partly to blame for an albeit temporary stemming of one important supply channel. Australia has relied on skilled migrant engineers for its engineering workforce for many years now with ~58 per cent of the engineering workforce in Australia having been born overseas. But increasing the number of skilled migrant engineers, alone, will not fix this part of the problem. Only around 40 per cent of skilled migrant engineers in Australia are employed in an engineering role indicating that skilled migrants need to be better supported to find work here that aligns with their qualifications and experience. Compounding the problem is a decline in the number of young Australians choosing to study engineering and the number of Australian school students choosing to study intermediate and higher-level mathematics at school, indicating the engineering skills and labour supply is likely to get worse before it gets better, especially if nothing is done.

Engineers Australia has been working to understand the engineering workforce and the factors that influence supply and demand. While the work is ongoing, we are now at a point in time where the initiatives that can strengthen our engineering workforce have been identified. This report is our comprehensive (but not quite exhaustive) collation of the initiatives that could (indeed should) be implemented to strengthen the engineering workforce in Australia.

The national conversation on the engineering skills shortage is an important one because it translates to longer project timelines and higher project costs. For many time-critical endeavours such as the transition to net zero emissions and circular economies, there is no time and money to spare. We look forward to ongoing conversations but above all, shared commitment from governments at all levels, the tertiary education sector, industry and the profession to work together to act to strengthen the engineering workforce. We hope this report is a useful contribution to informing those conversations and actions.

Jane MacMaster
Chief Engineer, Engineers Australia

August 2022

1. Executive summary

As the world continues to embrace technology in most aspects of our lives and as systems become more sophisticated and interdependent, our economy and society are more reliant on the engineering profession. It is therefore paramount current and future challenges in the supply of engineers are addressed. The quantitative and qualitative data indicates a shortage of engineering skills in the market, varying in degree across sectors, but impacting most engineering disciplines (except biomedical engineering). The current acute skills shortage is partly due to an increase in demand for engineering skills, at a time when international border closures have hindered skilled migrants arriving in Australia.¹ However, the explanation for the skills shortage is more complex and multi-faceted. There are structural, systemic reasons that explain why the engineering workforce supply channels are not keeping pace with demand.

The National Skills Commission predicts STEM occupations will increase by 12.9 per cent over the next five years.² At the same time, Australia's production of domestically trained engineers is declining. The decrease in commencements of engineering students means we are unlikely to see an increase in graduate levels until at least 2025, and this is unlikely at current rates without intervention.

With demand for engineering skills expected to continue to increase, our research shows Australia needs to address five areas to build an engineering workforce that can meet our current and future needs.

First, we need to encourage more young Australians to choose to study engineering for their tertiary education and pursue engineering as a career. Research shows one of the many required actions here is to raise awareness of what engineering 'is' and what engineers 'do'. We need to make engineering more real for school students and their parents/carers, teachers and careers advisers, and share positive messages about engineering as a career, that it is rewarding and fulfilling and contributes to making the world a better place (an important consideration for younger Australians). We also need to encourage the uptake of the pre-requisite subjects required for engineering study.

Second, we need to improve engineering study completion rates. Only ~25 per cent of four-year engineering qualification students complete their degree in the minimum time of four years and only ~50 per cent of commencing engineering students graduate with an engineering degree.³ There are many factors that explain the low completion rates and these are elaborated in this report.

Third, we need to actively retain engineers in the engineering workforce. Around 60 per cent of qualified engineers in Australia work in an engineering role.⁵ An engineering qualification is an asset for life and the engineering mindset and skillset, grounded in problem-solving, design and systems thinking skills are highly versatile and valued in the broader economy.

1 Demand drivers include ongoing and record levels of investment in public infrastructure, a resurgent demand for minerals, and the global transition to clean energy and adaption to climate change

2 'Australia's shift to a higher skilled, services-based economy' *Australian Government National Skills Commission* (accessed 3 February 2022) <https://www.nationalskillscommission.gov.au/sites/default/files/2021-12/Australia%E2%80%99s%20shift%20to%20a%20higher%20skilled%2C%20service-based%20economy.pdf>

3 Australian Council of Engineering Deans, *Australian Engineering Higher Education Statistics 2010-2020*, April 2022, p20 <http://www.aced.edu.au/downloads/ACED%20Engineering%20Statistics%20April%202022.pdf>

4 Analysis of Department of Education data on Engineering & Related Technologies commencements and completion for 2010-2020, available at <https://www.dese.gov.au/higher-education-statistics/student-data>

5 Engineers Australia, *Australia's Engineering Capability: How the last ten years will influence the future*, 2019, <https://www.engineersaustralia.org.au/sites/default/files/Australia%E2%80%99s%20Engineering%20Capability%20-%20digital%20-%2020190207.pdf>

Fourth, we need to re-examine our skilled migrant workforce and the systems that support it. Over 58 per cent of Australia's engineering workforce are born overseas, indicating long-term and persistent domestic supply challenges. Without taking action to shore up domestic supply, Australia will continue to be reliant on migrant engineering skills in the short to medium term. However, this brings its own complications. Research reveals migrant engineers in Australia are much more likely than their Australian born counterparts to work in non-engineering roles. Lifting the number of skilled migrant engineers coming to Australia is unlikely to boost Australia's engineering workforce unless we also provide better support systems once they are here, to help them find engineering work. This is critical as Australia is not the only country experiencing an increase in demand for engineers. Australia, the US, and the UK all produce relatively low levels of engineers compared to other OECD countries⁶.

With global competition for engineers increasing, Australia needs to maintain a reputation within the international engineering community as a good place to migrate, and a good place for our Australian-trained engineers to stay. For skilled migrants this needs to include clear pathways to permanent residency and the ability to find employment at a level commensurate with their skills and experience.

Finally, we need to explore ways of improving how the future engineering workforce is planned. Improved demand data, fed back to universities and schools, can help close the information loop and ensure the engineers that we need in the future are being trained now.

There are many factors that influence the number of engineers practising in Australia. This report summarises these factors according to the five categories discussed briefly above and summarised below, together with the initiatives that have been identified to build the engineering workforce that we need to cater to demand.

The five categories of factors that influence the engineering workforce:

01. School education (primary and secondary)
the factors that influence how many young Australians choose to study engineering for their higher education

02. Engineering study (vocational and higher education)
the factors that influence engineering graduation rates and skillsets

03. Retention in the engineering workforce
the factors that influence how many qualified engineers stay in the engineering workforce (work in an engineering role)

04. Skilled migrant engineering workforce participation
the factors that influence how many skilled migrant engineers work in an engineering role

05. Demand forecasting
how data on current and future demand of engineering skills can enable better workforce planning and inform career choices for Australians.

Resolving the engineering workforce challenges and pursuing the opportunities requires collaboration between all levels of government, industry, the tertiary education sector, and professional associations. The time to commence some focused initiatives is now. This report outlines the range of initiatives being considered by Engineers Australia for implementation in partnership with others. We invite feedback and collaboration as we pursue the next steps – engagement, prioritisation, development and implementation of the most impactful initiatives to strengthen the engineering workforce in Australia.

6 See figure 4

2. Summary of actions for government, industry and the tertiary sector

Section seven of this report summarises a comprehensive inventory of initiatives that can strengthen the engineering workforce. Below is a summary of the immediate actions governments, industry and the tertiary sector can take to assist in alleviating the current supply challenges and shore up future supply of engineers. Collaboration and partnership between all stakeholder groups will be required for the initiatives to be successful.

2.1. Government

01. All levels of government should work together 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.
02. Establish senior engineering roles within government to oversee, guide and advise on important engineering work and to ensure the engineering perspective is incorporated into policy decisions and planning.
03. Incentivise contractors to provide graduate programs and internships for engineers through procurement processes.
04. Offer engineering internships and graduate programs in agencies and departments which have an engineering capability.
05. Offer incentives for students to undertake engineering associate (2-year) and engineering technologist (3-year) qualifications.
06. Provide Commonwealth Supported Places (CPS) for accredited engineering master's qualifications to help articulate other STEM bachelors' qualifications to the level of professional engineers and to help retain engineers in the workforce by upskilling them in new and emerging fields.
07. Provide financial support to engineering students to help lift engineering study completion rates and reduce time-to-completion.
08. Provide financial support to STEM programs in schools which have been proven to be effective (please contact us for more information about these programs).
09. Provide more support to skilled migrant engineers who are already in Australia but who have been unable to secure an engineering job.
10. Provide support for existing programs that assist engineers returning to the workforce after a career break (e.g., STEM Returners) and fund new programs to help and incentivise engineers working out of field to return to engineering.
11. Provide support to schools to encourage more young Australians to choose to study maths and engineering studies.
12. Refine Australia's migration program objectives to be more targeted, to attract migrants with the specific experience and skills required, increasing their employability.



2.2. Industry

01. Consider specific initiatives to help retain engineers in the workforce including visibility of career pathways, upskilling and re-skilling opportunities through micro-credentials, providing mentoring and sponsorship opportunities, providing more attractive career opportunities and addressing imposter syndrome.
02. Consider where and how all occupational categories in the engineering team can be best utilised when undertaking workforce planning.
03. Identify ways to support the employment of skilled migrant engineers by offering employment opportunities to this cohort of engineers and assisting to address the barriers identified in Engineers Australia's [research report](#).
04. Offer mid-career engineers a senior 'sponsor' within the organisation to help develop their career pathway, offering opportunities for development and advancement.
05. Offer scholarships to engineering students to help lift engineering study completion rates, reduce time-to-completion and retain engineers in the engineering workforce.
06. Offer supportive graduate programs to recent graduates. Many engineering students, especially the high-performing students, secure a non-engineering job in their third or final year of studies. Engineering organisations need to compete with these organisations by providing attractive internship and graduate program opportunities.
07. Partner with local schools to provide support to school STEM programs and provide opportunities for early career engineers to engage with and inspire the next generation.
08. Provide supportive internship opportunities to engineering students. Please refer to Engineers Australia's [internships hub](#) for more information. The internships hub has been designed to help link internship opportunities in industry with students and tertiary education institutions. This is one of the most important ways industry can strengthen the engineering workforce because it helps keep engineering students in the profession and provides valuable work-integrated learning opportunities. Many students find it very difficult to find internship opportunities.
09. Provide work experience opportunities to school students who are interested in finding out more about our profession. Engineers Australia's guidelines to [Providing work experience to engineering students](#) can help industry to offering a rewarding experience.

2.3. Tertiary education

01. Advocate for Commonwealth Supported Places (CSPs) for the two-year post-graduate conversion master's, to encourage graduates from other STEM fields to become professional engineers.
02. Contact engineering students who withdraw from their course to determine if further support can retain them in their studies and/or inform these students of other engineering occupational categories (Associate, Technologist) that may appeal to them and retain them in the profession.
03. Explore other innovative pathways to engineering qualifications.
04. Help students to find graduate program employment opportunities by working with industry and government.
05. Promote the utility of engineering associate and technologist qualifications individually and as pathways to 4-year degrees for those who choose to extend their qualifications.
06. Provide support to engineering students to strengthen inclusivity, to diminish imposter syndrome (especially for female students) and to alleviate financial burden (e.g., through scholarships).
07. Use the Engineers Australia Internships Hub and other linkages to industry to assist students to find internship opportunities. The internships hub has been designed to help link internship opportunities in industry with students and higher education institutions. This is one of the most important ways the engineering workforce can be strengthened because it helps keep engineering students in the profession and provides valuable work-integrated learning opportunities. Many students find it very difficult to find internship opportunities.



3. Introduction

Engineers Australia was established in 1919 and is Australia's peak body for the engineering profession. We are a not-for-profit organisation, constituted by Royal Charter, to advance the science and practice of engineering for the benefit of the community. Our 115,000 individual members represent all disciplines and branches of engineering and all three of the profession's occupational categories (Professional Engineer, Engineering Technologist, Engineering Associate).

Engineers Australia has been undertaking a project to explore the engineering skills supply and demand challenges confronting the nation. It seeks to establish a thorough understanding of the supply and demand dynamics of the engineering workforce in Australia. While an engineering skills shortage is continuously referenced in conversations and reported by the media, Engineers Australia's research showed there is a significant cohort of migrant engineers, already in Australia, who have long-term difficulties in securing employment appropriate to their experience. This led to the hypothesis that the current shortage of engineers is more a long-term challenge in the supply and demand of engineering skills.

This report is the culmination of extensive consultation with Engineers Australia members, industry, government, and the tertiary education sector. Other initiatives underway within Engineers Australia related to the engineering workforce include STEM programs in schools and the forthcoming 15th edition of the *Engineering Profession: A Statistical Overview* which will follow the release of the census data later in 2022. The report will provide insights into the dynamics of the Australian engineering workforce over the last five years.

Our ongoing work aims to identify, prioritise and develop tangible initiatives to alleviate the current engineering skills shortage and build the engineering workforce for Australia's future.



4. History of engineering workforce shortages in Australia

The issues surrounding skills shortages in the engineering profession are not new with shortages being reported about every decade since the late 1980s. In the early 2000s a working group was convened at the request of the then Minister for Education and Youth Affairs to investigate the high level of skills shortages the industry was facing. In 2010 the Australian National Engineering Taskforce released a report *Scoping our future: Addressing Australia's engineering skills shortage* which indicated that Australia was experiencing a chronic shortage of engineers.⁷ In 2012 the topic of shortages of engineers and related employment skills was the focus of a [Parliamentary Inquiry](#). The findings of this inquiry, and the recommendations remain relevant today. The most significant conclusions of the senate inquiry were that the end of public-sector employment of engineers was a significant cause of the skills shortage (particularly providing graduate programs and cadetships) and that underutilisation of engineering graduates was a long term, structural feature of the profession.⁸ Regrettably, there has been no change.

The research indicates there is a long-term (chronic/structural) and cyclical shortage of engineers in Australia. The shortages of engineering skills is chronic in the sense that Australia has relied on overseas-born engineers to provide capability over many decades. As a result there is a growing divergence between the number of qualified engineers in Australia and those working in engineering occupations. There are more qualified engineers within Australia than at any point in history, but proportionally less in engineering occupations⁹. The shortage is cyclical in line with the boom-bust cycle typical of the modern western economy. The experience of shortages are most acute during periods of high economic growth, as seen with the mining boom and current COVID induced stimulatory spending.

7 Alicia Pearce, Karinda Flavell, Natacha Dao-Cheng. 'Scoping our future: Addressing Australia's engineering skills shortage' *Australian National Engineering Taskforce* (October 2010)

8 The shortage of engineering and related employment skills' *Parliament of Australia* (accessed 4 October 2021) https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Education_Employment_and_Workplace_Relations/Completed_inquiries/2010-13/engineering/report/index

9 Engineers Australia, *Australia's Engineering Capability: How The Last Ten Years Will Influence The Future*, 2019, p40



5. Research

To help understand two of the key factors contributing to a shortage of engineers, Engineers Australia commissioned two extensive pieces of research in the areas of women in engineering and the workforce participation of skilled migrant engineers.

5.1. Women in engineering research¹⁰

The engineering profession is the biggest employer of the STEM professions, however, has the smallest female representation of STEM vocations, with only 11.2 per cent of the engineering workforce being female (~16 per cent of engineering students are female and ~13 per cent of qualified engineers in Australia are female). To develop initiatives to overcome the persistent under-representation of women in engineering, in 2021 Engineers Australia commissioned research to understand why women pursue (or don't pursue) engineering as their area of study and potential career. The research revealed many fascinating insights. Some of the most important findings include:

01. Ninety per cent of women who didn't choose engineering as their field of further study either didn't consider engineering at all, or, only barely considered it.
02. Lack of familiarity with engineering was the most cited reason for women not choosing engineering as their field of further study.
03. There is a significant lack of positive perceptions about the profession (including perceptions around engineering being 'too difficult' to study and being very male-dominated) rather than being an impactful and fulfilling career option (despite female engineers reporting high job satisfaction compared to women in all other fields).
04. There is poor engagement by women in STEM subjects, particularly engineering studies throughout the school years.
05. Female respondents (engineering and non-engineering) overwhelmingly believe it is important for school students to hear from young women who are studying engineering or female recent graduates.
06. Engineering students feel less supported to do well in their tertiary engineering studies, compared to students working towards other qualifications.
07. Non-inclusive workplace culture and unequal opportunities remain issues for many female engineers (these reasons were listed as the case for leaving the profession by two-thirds of female engineers who left engineering roles).
08. Female engineers have a disproportionately high rate of imposter syndrome compared to men, and women in other fields. One in two female engineers reported experiencing imposter syndrome (doubting their own abilities and achievements) compared to one in three male engineers and one in three women in other fields.

The full [Women in Engineering Research](#) report can be found in the resources section of the Engineers Australia website.

10 Romanis, J. 'Women in Engineering: Identifying avenues for increasing female participation in engineering, by understanding the motivators and barriers around entry and progression' *Engineers Australia*, June 2022 <<https://engineersaustralia.org.au/sites/default/files/women-in-engineering-report-june-2022.pdf>>

5.2. Barriers to employment for migrant engineers¹¹

Over 58 per cent of Australia's engineering workforce were born overseas and most are skilled migrants. However, this cohort of engineers are significantly more likely than their Australian-born counterparts to be under or unemployed. Engineers Australia commissioned research to find out why and identify how to overcome the barriers to employment these engineers face. The research confirmed many overseas-born engineers do struggle to find work in industry and the ones that do, are often in roles not commensurate with their skill or experience level. From the research, seven main barriers to engineering workforce participation were identified:

01. A lack of local knowledge and experience
02. Perceived cultural differences in soft skills
03. Visa or sponsorship working rights issues
04. A lack of people who can 'vouch' for them locally
05. Certification queries
06. 'Flight risk' concerns
07. Tendency to hire from personal 'networks' for senior roles

Overcoming these barriers will help alleviate current and future skills shortages. Six opportunities to address these barriers have been identified:

01. Positioning migrant engineers as a collective talent pool and raising awareness of the size of the opportunity for employers;
02. Providing credible, trusted information on employment pathways for migrant engineers;
03. Increasing local networks by developing networking and sponsorship programs/ opportunities for migrant engineers;
04. Coordinating initiatives to build local knowledge and experience of migrant engineers;
05. Assisting humanitarian visa holders with their credentials assessment;
06. 'Making it easy' for employers to access the talent pool.

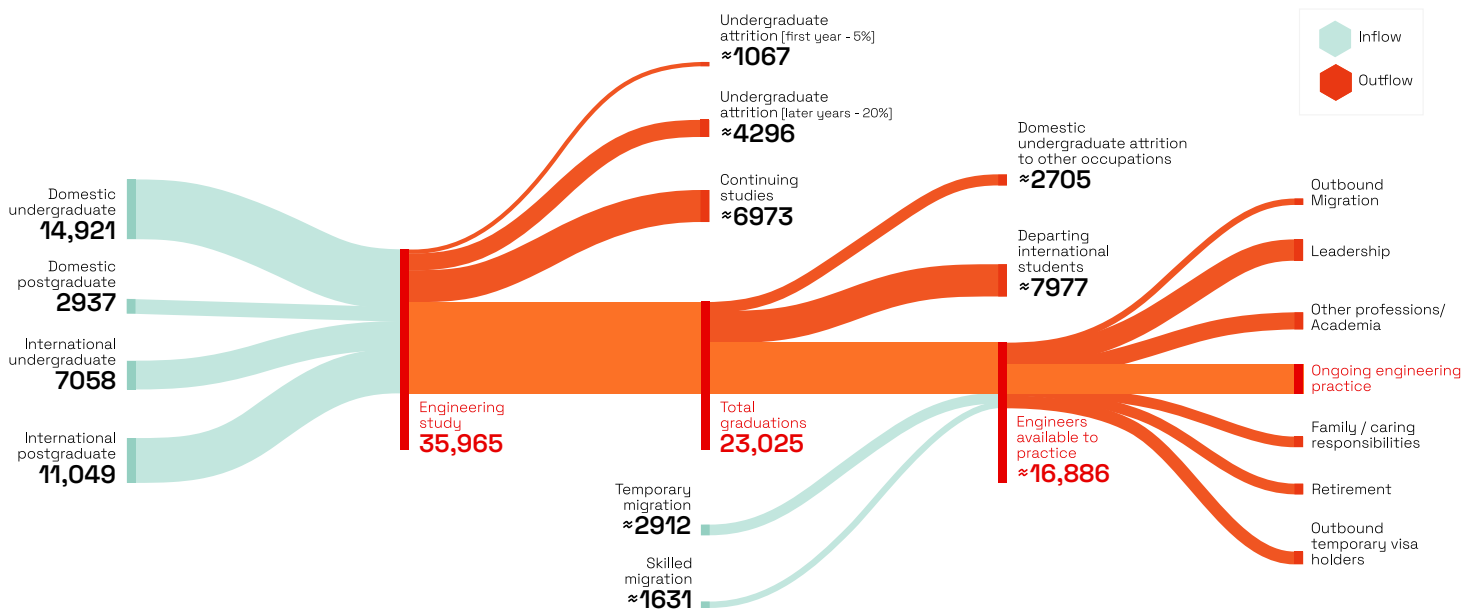
The full [Barriers to Employment for Migrant Engineers](#) report can be found in the resources section of the Engineers Australia website.

11 Romanis, J. "Barriers to Employment for Migrant Engineers; Research Report' *Engineers Australia*, October 2021 <<https://engineersaustralia.org.au/sites/default/files/resource-files/2021-10/barriers-employment-migrant-engineers.pdf>>

6. Factors influencing the engineering workforce

The pool of available engineering skills in Australia is influenced by two supply channels (graduates from Australian universities, both domestic and international, and international skilled migration). It is also influenced by various 'outflow' channels including attrition from students studying engineering (students who commence but don't compete an engineering qualification) and attrition from the engineering workforce. This section of the report provides a brief commentary about these 'inflow' and 'outflow' channels, which are summarised diagrammatically in Figure 1, according to the five categories of factors which influence these inflows and outflows (summarised in Table 1).

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

6.1. Factors that influence the number of young Australians who choose to study engineering

The development of an engineer begins early. Building teachers', students', parents' and careers advisors' awareness of the profession and corresponding career opportunities combined with promoting STEM subjects at the school level are necessary to ensure students are prepared to complete an engineering qualification and enter the profession.

Research conducted by Engineers Australia reveals Australia's ability to develop engineers domestically, is hindered by a reduction in Year 12 science and mathematics participation.¹²

¹² 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>

Increasing take-up of STEM subjects and building awareness of the engineering profession early in a person's education is critical to boosting the pipeline of engineers. The Australian Mathematical Sciences Institute (AMSI) reports that the number of Australian school students studying intermediate and advanced levels of maths is at all-time low.¹³ This requires long term commitment and planning by industry, government, schools, and the tertiary sector.

Domestic supply is also hindered by the performance of Australia's early and secondary education system, which is reported to be declining on several fronts. 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.¹⁴ Domestic engineering student commencements peaked in 2014 with graduations peaking approximately four years later. Commencements and completions have since been trending downward. This highlights the severity of the supply constraints hindering the profession. If commencements do not increase, shortages will continue and deepen while demand remains high. 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.

Figure 2: Engineering study commencements and graduations for professional engineers



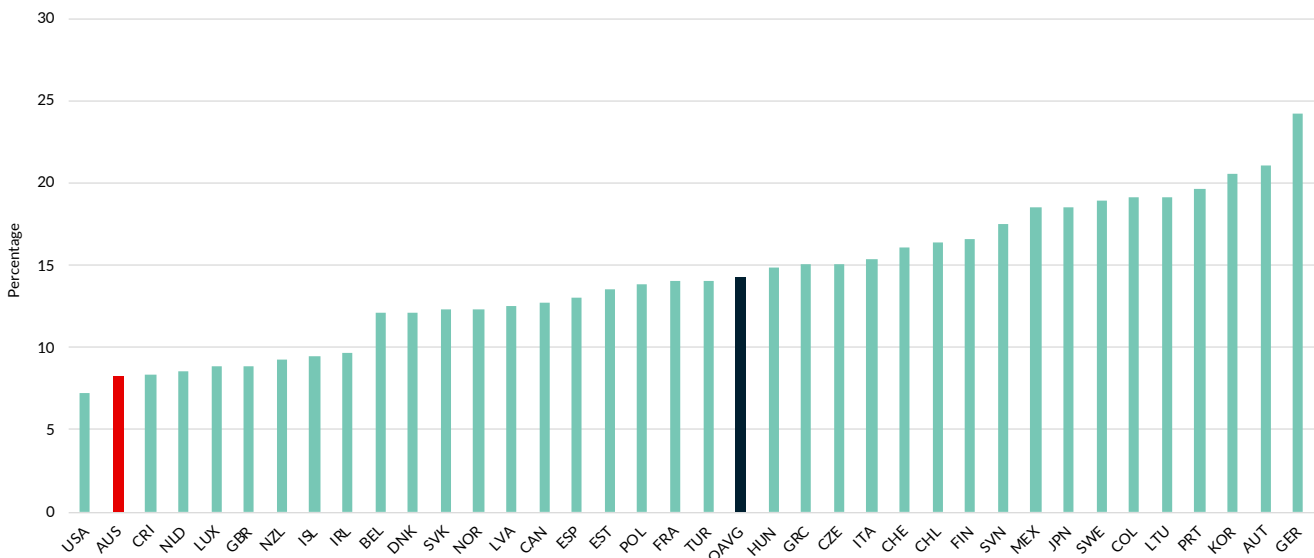
13 Australian Mathematical Sciences Institute, Year 12 Mathematics Participation Report Card, 27 April 2022 <https://amsi.org.au/?publications=year-12-participation-in-calculus-based-mathematics-subjects-takes-a-dive>

14 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-enough-maths-science-teachers/100214738>

6.2. Factors that influence engineering graduation rates

Once an individual has decided to undertake tertiary-education study in engineering, it is a decade-long process to become an engineer who is competent to practice independently. The path of a professional engineer commences with a four-year undergraduate degree. Data shows only 25 per cent of graduates complete their study in the 'minimum' time.¹⁵ It also indicates only around 50 to 60 per cent of commencing student finish with an engineering qualification meaning around 40 per cent of students don't complete their engineering qualification.¹⁶ Once graduated it takes approximately five to seven years of post-graduate experience before an engineer is considered competent for independent practice^{17, 18}. Internships, graduate programs, and early career employment opportunities are a critical part of an engineer's development. It is only at the stage of independent practice an engineer would fulfil the current needs of employers for 'experienced' engineers (anecdotally we are hearing that the demand for 'experienced' engineers is higher than for graduate engineers).

Figure 3: Comparison of engineering graduates across the OCED (all engineering occupational categories)¹⁹



15 Australian Council of Engineering Deans, Engineering Statistics December 2020, p20 http://www.aced.edu.au/downloads/ACED%20Engineering%20Statistics%20Dec%202020_v2.pdf

16 'Student Data' Australian Government Department of Education (accessed 2 August 2022) <<https://www.dese.gov.au/higher-education-statistics/student-data>>

17 International Engineering Alliance, Graduate Attributes and Professional Competences version 4, 21 June 2021 <https://www.ieagrements.org/assets/Uploads/IEA-Graduate-Attributes-and-Professional-Competencies-2021.1-Sept-2021.pdf>

18 Engineers Australia, Australian Engineering Competency Standards Stage 2 - Experienced Professional Engineer, https://www.engineersaustralia.org.au/sites/default/files/2022-07/professional-engineer-stage-2-2012_0.pdf

19 Source: OECD (2022), Tertiary graduates by field (indicator). doi: 10.1787/9af26c71-en (Accessed on 01 August 2022)

6.3. Factors that influence retention in the engineering workforce

The supply of engineers is further hindered by 'pull' factors out of the profession. Analysis from the 2016 census shows approximately half of all engineering bachelor graduates, if they were working, were not working in engineering occupations. 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 engineering profession. The desirability of engineering graduates is demonstrated by the 2020 and 2021 Australian Government's Employment Satisfaction Surveys (ESS) in which graduates of engineering and related technologies scored the highest overall satisfaction.

Simply increasing intakes of undergraduate engineering students is unlikely to solve the problem. Investing in internships and graduate engineers will help to keep more of this cohort in the profession and develop the skills of an 'experienced' engineer which are always in demand. Greater investment in international students who graduate locally should also be made. Developing this pool of engineers and making it easier for them to transition to a permanent migration visa can further assist in boosting the supply of domestically trained engineers working in Australia.

6.4. Factors that influence workforce participation of skilled migrant engineers

Due to the domestic supply challenges discussed above, skilled migration will remain essential to the nation's engineering capability and capacity in the short and medium term. At the 2016 census, over 58 per cent of engineers in the Australian labour force were born overseas. Currently, migrant engineers in Australia are much more likely than their Australian born counterparts to work in non-engineering roles. The government's migration policy is set to meet the objective of enhancing domestic capability, however, a shortage of engineering skills is reported even with a latent supply of overseas-born engineers struggling to find work at their skill and experience level. Improving the employment outcomes of migrant engineers is crucial for Australia to be seen as a destination of choice. This is particularly critical as global demand for engineers increases and as other developed nations start to rely more on migrant engineers to shore up their own supply. 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.

6.5. Demand forecasting

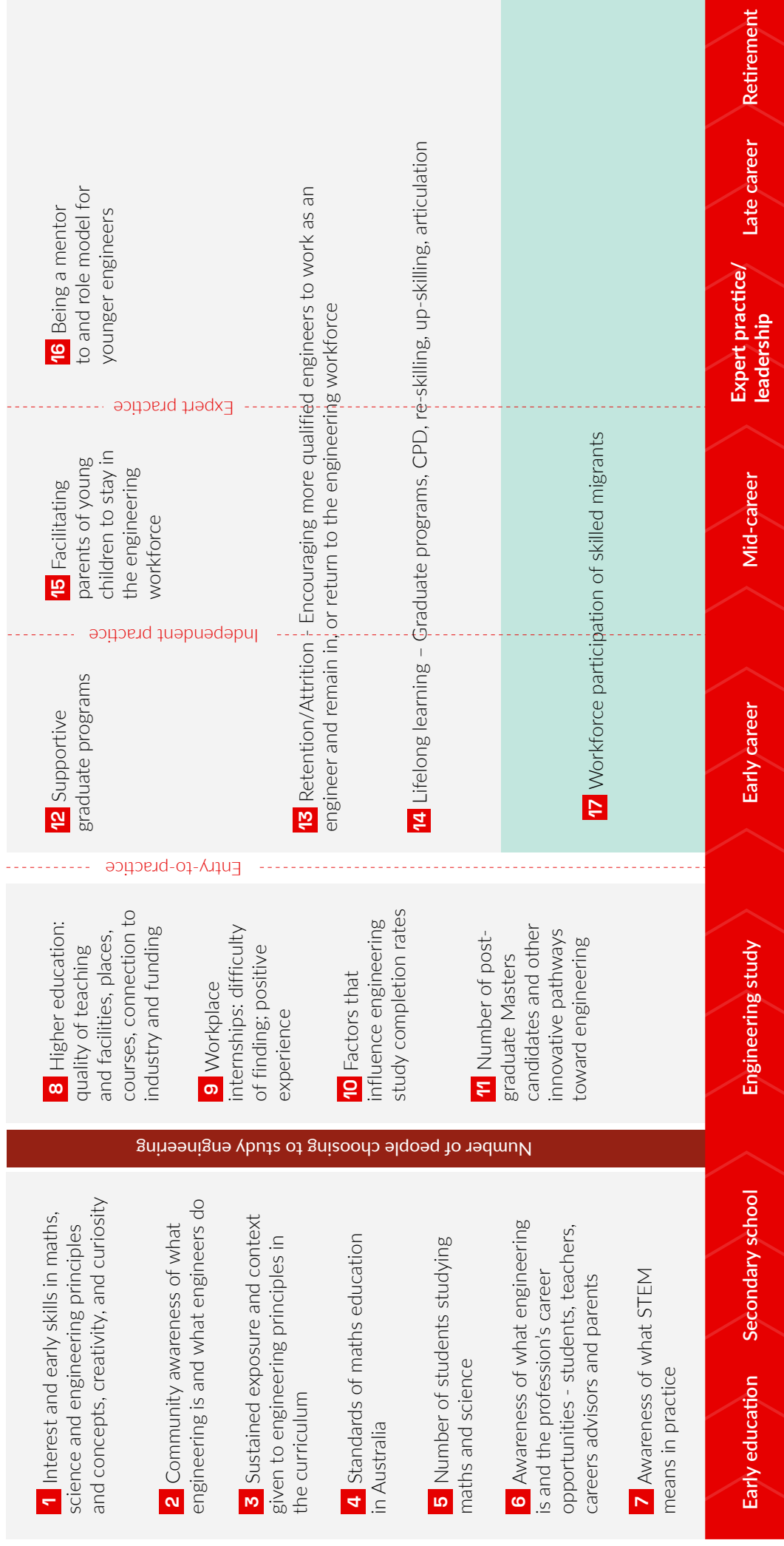
Most information relating to a shortage of skills comes from qualitative data based on anecdotal evidence regarding businesses' recruitment activities. Understanding current and future demand of engineers is critical to forecasting the number of engineers needed through domestic qualifications and skilled migration.

Better quantification of the anticipated demand for engineers over the next decade is needed to accurately focus on the sectors requiring the greatest supply. Without accurate information we could contribute to the unintended adverse consequence of students being encouraged to study certain engineering qualifications then finding minimal employment opportunities after graduation (as we are currently experiencing with biomedical engineers and as we have seen historically with other professions such as dentistry and veterinary science).

Table 1 summarises the factors that influence the inflows to, and outflows from the engineering workforce according to the five categories of factors discussed above.

Table 1: Summary of factors influencing the profession

Table 1 summarises the factors that influence the inflows to, and outflows from the engineering workforce according to the five categories of factors discussed above.





7. Initiatives to strengthen the engineering workforce

The research, analysis and consultations conducted to date have culminated in an inventory of tangible, outcomes-focused initiatives (both existing initiatives and possible future initiatives) which would alleviate the severity of current and future skills shortages within the engineering profession in Australia.

The initiatives inventory is structured in five tables that map back to the categories of factors that influence the inflows and outflows of the engineering workforce (see section six). The inventory provided in the tables below are comprehensive but not exhaustive. The next steps will focus on determining which initiatives should be prioritised and which organisations and people could be mobilised to develop and/or implement the initiatives in partnership for the most impact.

7.1. School years (early education, primary and secondary)

The development of an engineer begins early. Starting in primary school, it is vital to build student awareness of engineering and how it contributes to society, as well as providing a grounding in mathematics and science subjects. The table below captures the factors that influence the number of school students who choose engineering for their tertiary education, and existing and possible future initiatives to increase the number of Australians who choose to study engineering.

Table 2: Inventory of initiatives during school years

Influencing factors	Possible future initiatives	Existing initiatives & resources
1 Interest and early skills in maths, science and engineering principles and concepts, creativity, and curiosity	<ul style="list-style-type: none"> – Advocating for government to help teachers, students and parents to better understand 'jobs of tomorrow' and the career opportunities available through studying engineering – Annual children's book award and engagement during book week – Develop/collate engineering resources for teachers, careers advisors and parents. – Promotion of engineering and engineers through literature, e.g. <ul style="list-style-type: none"> – Under the stars, Professor Lisa Harvey Smith – Big Universe, Professor Lisa Harvey Smith – EngiBear book series (Andrew King) 	<ul style="list-style-type: none"> – EA Junior Club – Engineering is Elementary Program – Engineers Australia's STEM Strategy 2019-2023

Influencing factors	Possible future initiatives	Existing initiatives & resources
<p>2 Community awareness of what engineering is and what engineers do</p>	<ul style="list-style-type: none"> - Promotion of the engineering profession (engineering is a creative, fulfilling and purposeful profession). - School presentations, with an emphasis on a narrative/storytelling approach and focusing on early career engineers as the presenters - Social media campaign(s) with influencers targeted at school children and/or their parents (TikTok, YouTube, Instagram) - TV programs showcasing engineering <ul style="list-style-type: none"> - For children, fun and engaging - For the broader community, showcasing engineering principles (e.g. Lego Masters) 	<ul style="list-style-type: none"> - Bespoke content created for school students, career advisors and teachers through Engineers Australia's partnership with Year 13 and Explore Careers. - Engineers Australia's 2022 campaign 'Engineering. Making life happen.'
<p>3 Sustained exposure and context given to engineering principles in the curriculum</p>	<ul style="list-style-type: none"> - Contextualising engineering in standard learning areas (including providing support/resources to teachers) - Encouraging more schools to offer engineering studies in Years 9 and 10 as well as Years 11 and 12 (particularly to showcase the profession to more girls). - Engineering in the community posters in all classrooms. - Work with the Australian Curriculum, Assessment and Reporting Authority to promote the use of the word 'engineering' more in the Technology Learning Area (compulsory only to Year 7) 	<ul style="list-style-type: none"> - Submission to the Australian Curriculum Review - Technology Learning Area (compulsory only to Year 7)
<p>4 Standards of maths education in Australia</p>	<ul style="list-style-type: none"> - Engage with celebrity mathematics teachers and prominent engineers to promote the wonders of mathematics to inspire learning and to make maths more tangible and 'real' - Explore how out-of-field maths teachers can be supported (including how they can showcase mathematics through engineering stories) - Improve OECD PISA rankings through awareness and targeted initiatives (work with the Australian Mathematical Sciences Institute and others on these initiatives) - Increase number of maths teachers with maths qualifications (including making it easier for mid-career professionals to become a maths, science or engineering studies teacher) advocate for government intervention/support - Increase participation in the Australian Maths Trust, Australian Mathematics Competition - Qualified engineers providing maths tutoring services to Years 7- 9 students to help lift standards of mathematics and to provide exposure to engineering stories 	

Influencing factors	Possible future initiatives	Existing initiatives & resources
5 Number of students studying maths and science	<ul style="list-style-type: none"> – Work with the Australian Mathematical Sciences Institute, Government and others to develop initiatives to inspire teachers and students about maths and its practical applications 	<ul style="list-style-type: none"> – Engineers Australia calls on government at all levels to increase teacher capability STEM subjects
2 6 Awareness of what engineering is and the profession's career opportunities—students, teachers, careers advisors and parents	<ul style="list-style-type: none"> – Engineering-related resources for careers advisors, parents, teachers and students – Positioning an engineering degree as an 'asset' that you have 'for life' <ul style="list-style-type: none"> – The development and benefit of an engineering skillset and mindset – Creative, solving the world's most complex problems – A career that is challenging (in the right way) and fulfilling – Allows for a positive contribution by making the world a better place – Provide access to more engineering role models (appropriately targeted to the audience) 	<ul style="list-style-type: none"> – Mapping Engineering Skills to the curriculum. – Women in Engineering Research identifies how awareness of the profession can be improved – Year 13
7 Awareness of what STEM means in practice	<ul style="list-style-type: none"> – Developing new STEM Programs (where there are gaps) and promotion of existing STEM programs that are effective, including: <ul style="list-style-type: none"> – Making Discover Engineering program a national priority – Provide school students work experience opportunities <ul style="list-style-type: none"> – Develop guidance for industry on how to make work experience engaging and rewarding for the students. – Consider extending Engineers Australia's internships hub to include work experience opportunities for high school students – Providing more access for students to converse with engineers and hear stories of engineering work and its application in the real-world. 	<ul style="list-style-type: none"> – CSIRO STEM Professionals in Schools program – Khan Academy – Power of Engineering – Re-Engineering Australia Foundation, F1 in schools STEM challenge – STAR portal



7.2. Engineering Study

Several factors impact an individual's choice to undertake and successfully complete a tertiary engineering qualification. These need to be addressed to boost the pipeline of domestically trained engineers entering the market.

Table 3: Inventory of initiatives during engineering study

Influencing factors	Possible future initiatives	Existing initiatives & resources
<p>8 Higher education: quality of teaching and facilities, number of Commonwealth Supported Places (CSP), courses, connection to industry, funding</p>	<ul style="list-style-type: none"> – Advocate for Commonwealth Supported Places for engineering master's qualifications – Develop and communicate demand signal from industry to help promote the areas of engineering that will be in demand when students graduate – Establish a conduit for industry to provide guidance to the tertiary sector about evolving workplace requirements – Government incentives for students to undertake associate and technologist qualifications – Incentives for students to undertake mathematics teaching qualifications 	<ul style="list-style-type: none"> – Directing Universities' investment in skills
<p>9 Workplace internships</p> <p>Many engineering students find it difficult to find internships. Internships need to be designed so they are positive experiences and help retain graduate engineers in the engineering workforce</p>	<ul style="list-style-type: none"> – Internships <ul style="list-style-type: none"> – Industry and governments to offer internships to students in all years of study to showcase the breadth of engineering and help retain – Advocate for internships to be paid to support students who are working and studying 	<ul style="list-style-type: none"> – Engineers Australia internship hub – Engineers Australia's mentor program

Influencing factors	Possible future initiatives	Existing initiatives & resources
<p>10 Factors that influence engineering study completion rates</p> <p>Only ~25 per cent of professional engineering students complete their qualification in the minimum time of four years and only ~50 per cent of engineering students graduate with an engineering qualification)</p>	<ul style="list-style-type: none"> - Encourage more support and inclusion for engineering students, for example, addressing imposter syndrome early - Improved financial support for engineering students. A large proportion of engineering students work out of economic necessity and the high number of contact hours for an engineering qualification together with the difficulty of finding their internship, means that the time to complete their studies can extend well beyond the minimum time <ul style="list-style-type: none"> - Increase youth allowance - Scholarships - Universities to engage students who have discontinued engineering study to find out how they can be supported to graduate, e.g. explore ways students can consider another field of engineering or occupational category and recognise prior learning 	
<p>11 Number of postgraduate Masters candidates and other innovative pathways</p>	<ul style="list-style-type: none"> - Building more awareness of Associate and Technologist occupational categories - Explore other innovative educational pathways to engineering (e.g. NUW Alliance program) - Promote or advocate for incentives for scientists or other STEM professionals to undertake two-year conversion master's to become qualified professional engineers, thus providing relative short timeframes to produce qualified engineers 	<p>Paper – <i>Engineering Occupational Categories</i>, Engineers Australia (forthcoming)</p>

7.3. Retention in the engineering workforce

Increasing the number of qualified engineers is only a part of the solution to the engineering skills challenge. Retaining engineers in the workforce at all stages (early career, mid-career and late career) is critically important for maintaining an engineering workforce supply that meets demand. Increasing the number of entrants to the profession without improving long term retention will result in a meaningful increase in the size of the engineering workforce given only ~60 per cent of qualified engineers in Australia work in an engineering role.

Table 4: Inventory of initiatives to retain people in the workforce

Influencing factors	Possible future initiatives	Existing initiatives & resources
<p>12 Supportive graduate programs</p> <p>Graduate programs can help retain recent graduates in the engineering workforce and help to provide a positive first few years in the profession as well as provide the opportunities required for a graduate to progress to an experienced engineer competent to practice independently</p>	<ul style="list-style-type: none"> - Graduate program practice guide to inform positive graduate experiences - Improved funding to support graduate programs (this could include financial or tax incentives for SMEs to employ graduates) - Mentoring programs - More government graduate programs 	<ul style="list-style-type: none"> - Calling on the Commonwealth Government to incentivise commonwealth contractors to provide graduate programs and internships through its procurement processes. - Engineers Australia micro-credentials' endorsement framework
<p>13 Retention/attrition</p> <p>Encouraging more qualified engineers to work as an engineer and remain in, or return to the engineering workforce. Only ~60 per cent of qualified professional engineers work in an engineering role.</p>	<ul style="list-style-type: none"> - Address imposter syndrome in the workplace - Communicate to engineering students the benefits of consolidating their engineering qualification by working in an engineering role before leaving the engineering workforce - Consider incentives to retain engineers in an engineering role - Development of a credential to recognise technical expertise - Encourage sectors to provide visibility of career pathways - Industry to address culture of excessive hours and low pay to be more appealing to the next generations (some sectors) - Monitor and address the gender pay gap - Raise awareness of unequal workplace opportunities and non-inclusive workplace culture (given 2 in 3 female engineers who leave engineering roles cite these as reasons) and develop/implement programs to address - Support engineering organisations to engage with third and final year students in the way that banks and management consultancies currently do 	<ul style="list-style-type: none"> - Advocate for government to develop targeted policies that encourage women and mature engineers to remain in, or return to, the engineering workforce. - Advocate for government to develop targeted policies that encourage women and mature engineers to remain in, or return to, the engineering workforce. See for example STEM Returners. - Advocating for the government to consider creating senior technical engineering roles in the Australian Public Service. This measure would ensure that highly qualified technical engineers may continue to build upon specialist knowledge while enjoying career progression in the public sector. - Champions of Change STEM group which looks to deliver gender equity in the STEM workplace - See the Construction Engineer Learning and Development Guide for an example of a sector providing visibility of a career pathway

Influencing factors	Possible future initiatives	Existing initiatives & resources
<p>14 Lifelong learning - CPD, re-skilling, up-skilling, articulation</p> <p>Visibility of career pathways and awareness of career opportunities is an important driver of retention in the engineering workforce. Learning and other opportunities can help to retain engineers in the workforce by opening up new opportunities.</p>	<ul style="list-style-type: none"> – Promote Engineers Australia micro-credentials endorsement framework and course finder – Raise awareness about the EA Capabilities Framework and associated micro-credentials to help engineers upskill – Supporting and coordinating development of industry critical micro-credentials 	<ul style="list-style-type: none"> – Continuing Professional Development – Engineers Australia Capabilities framework (forthcoming) – Engineers Australia micro-credentials' endorsement framework and course finder: Micro-credentials
<p>15 Facilitating parents of young children to stay in the engineering workforce</p>	<ul style="list-style-type: none"> – Develop and provide resources to engineering organisations to help parents/ carers balance work and other responsibilities – Support STEM returners program 	<ul style="list-style-type: none"> – Partnership with STEM returners
<p>16 Mentors, role models and sponsors for junior and mid-career engineers and engaging with schools to inspire students about mathematics and engineering and to help teachers contextualise the curriculum with engineering examples</p>	<ul style="list-style-type: none"> – Explore whether engineers can provide maths tutoring to school students (and use this opportunity to inspire students about maths and engineering) – Provide opportunities for senior engineers to sponsor or mentor junior and mid-career engineers 	



7.4. Skilled Migrants

Supply challenges can be partly alleviated by supporting skilled migrant engineers who are currently living in Australia, who are not working in an engineering role, to find an engineering job. Skilled migrant engineers are significantly more likely to be under or unemployed than their Australian-born counterparts.²⁰ Addressing the influencing factors impacting this cohort will assist with current shortages by tapping into the underutilised pool of skilled migrants that are already in Australia.

Table 5: Inventory of initiatives to support skilled migrants

Influencing factors	Possible future initiatives	Existing initiatives & resources
17 Address barriers to workforce participation of skilled migrants	<ul style="list-style-type: none"> – Advocate for changes to Australia’s migration policy, e.g., improved pathways for permanent residency – Create central hub for migrant engineers to access Australian workforce and employment information – Develop awareness of available Visa fact sheets for industry to make it easier to navigate the skilled migrant system – Look to expand programs such as the Victorian Government Engineering Pathway Industry Cadetship for refugee and asylum seeker engineers – Support and/or raise awareness of programs that are designed to assist skilled migrants and refugees entering the Australian workforce 	<ul style="list-style-type: none"> – Addressing Barriers to Employment for Migrant Engineers – Australian Government’s skills assessment pilots – Engineer Australia skilled migrant program pilot to address the 7 key barriers to skilled migrant engineer workforce participation (forthcoming) – Engineers Australia’s submission to the Department of Home Affairs on Planning Australia’s skilled migration program – Kaleidoscope mentoring program in Western Australia – Workforce and engagement solutions through Community Corporate
<ul style="list-style-type: none"> i. A lack of local knowledge and experience ii. Perceived cultural differences in soft skills iii. Visa or sponsorship working rights issues iv. A lack of people who can ‘vouch’ for them locally v. Certification queries vi. ‘Flight risk’ concerns vii. Tendency to hire from ‘networks’ for senior roles 		

20 Romanis, J. ‘Barriers to Employment for Migrant Engineers’ *Engineers Australia* (October 2021) <https://www.engineersaustralia.org.au/sites/default/files/resource-files/2021-10/barriers-employment-migrant-engineers.pdf>



7.5. Demand forecasting

Engineer’s Australia’s research has identified the need for improved data across all sectors to help understand current and future demand. Having the means to capture and analyse this data, and importantly sharing this data with the tertiary education sector and schools, will assist in ensuring the engineering workforce needs, now and in the future, are targeted through Australia’s domestic education channels and our skilled migration program.

Table 6: Inventory of initiatives to develop forecasting of demand

Influencing factors	Possible future initiatives	Existing initiatives & resources
Data to understand the demand and inform decisions.	<ul style="list-style-type: none"> – Develop a mechanism/forum to feed the demand data back to the tertiary education sector and schools. – Expand Engineers Australia’s Vacancy Report to bring together industry forecasts with other work (such as Infrastructure Australia’s Market Capacity Report) – Obtain better data from members and industry on the employment market, probably at an aggregate level, in a repeatable way 	<ul style="list-style-type: none"> – ACED Working Paper: Shortages of Engineers and Supply Projections – Clean Energy at Work – Engineers Australia’s Vacancy Report – Infrastructure Australia workforce and skills supply – The Australian Energy Employment Report – The Group of Eight: Securing The Future of Australia’s Engineering Workforce

8. Next steps

Engineers Australia is in the process of prioritising the initiatives outlined in this report and commencing development and implementation of the highest priority initiatives we are best placed to drive. Many actions identified will require collaboration between various stakeholders and we will continue to coordinate further discussion and action.

Engineers Australia welcomes the opportunity to discuss the ideas outlined in this paper with interested parties. If you would like to engage with the work being undertaken, please contact policy@engineersaustralia.org.au.

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