GROUP OF EIGHT AUSTRALIA

Essential decisions for national success

Securing the Future of Australia's Engineering Workforce

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Foreword

Securing the Future of Australia's Engineering Workforce is critical.

The three recommendations in this report are vital to achieving that.

This formative work is the outcome of an Industry Summit convened by the Group of Eight (Go8) in December 2021. The summit had one responsibility – to identify the policy levers necessary to meet the demands of industry and to support Australia's more sovereign economic recovery.

Some 60 of the nation's experts – including senior executives from engineering intensive companies and from across the spectrum of large multinationals to SMEs; industry and engineering peak bodies, plus Go8 academic and research specialists participated.[1]

Go8 universities collectively educate 42 per cent of Australia's higher education engineering graduates, with seven Go8 universities ranked in the top 100 universities globally for engineering. It therefore matters within the Go8 how best to achieve what Australia needs and in strong partnership with industry.

The Go8 understands the size of that responsibility.

The Summit had been convened in response to widespread recognition and concern that Australia's engineering workforce is in crisis, and that only by working in university/industry/policy partnership could resolve it.

The stakes are high. Our ability to deliver on the ambitious infrastructure projects and industry sector plans to enhance sovereign capability announced by Government are at risk.

1 See Appendix 2 of this report for a full list of Summit participants

Foreword

While there was recognition at the Summit that there are several factors contributing to this current engineering workforce crisis – including migration settings, primary and secondary education pathways and gender disparity in the engineering workforce – the Summit deliberately focused on the core role of university education in producing engineers of the future to meet the needs of a more sovereign, more productive Australian industry.

The unanimous conclusion of Summit participants was that continuing with the status quo will result in failure and a new approach to engineering education in Australia is urgently needed.

The unanimous conclusion of Summit participants was that continuing with the status quo will result in failure and a new approach to engineering education in Australia is urgently needed.

The Summit has therefore endorsed three key recommendations for university engineering education which are necessary to avert the growing crisis and to double the quality delivery of domestic engineering graduates in Australia.

Summit participants called for an incoming Federal Government to act swiftly and decisively to work with industry and universities to adopt and implement the three recommendations.

It is clear that this solution requires targeted investment; however, this investment is dwarfed by the potential cost to Australia's future economy, geopolitical strength and societal well-being, if the status quo is maintained.

Summary of Recommendations

for Federal Government Consideration

Australia is facing an unprecedented engineering workforce shortage.

The Go8, which comprises Australia's consistently leading research-intensive universities, educates 42 per cent of the nation's domestic higher education engineering graduates. On 2 December 2021, the Go8, in collaboration with industry, convened the Go8 Engineering Workforce Summit to identify the policy levers necessary to generate a domestic engineering workforce capable of meeting the needs of Australian industry now and into the future.

Recommendations

- **Recommendation 1: A new model for funding engineering education.** An engineering education funding model that addresses necessary recurrent per student funding, research costs, and infrastructure and equipment costs in engineering.
- **Recommendation 2: National Priority Places for Engineering.** A model for increasing the engineering workforce pipeline with competitive funding for additional engineering places at universities framed by collaboration between industry, universities and government.
- **Recommendation 3: A National Industry, University and Government Engineering Council.** A body that comprises industry, universities and government representatives to identify immediate and strategic needs in the national engineering workforce; mechanisms for enhancing industry-university collaboration in engineering education and to set annual guidelines for the National Priority Places for Engineering (see Recommendation 2).

Summary of discussions

at the Go8 Industry Summit

The Australian model for the university education of engineers is broken and maintaining the status quo is not an option. The current engineering workforce pipeline is not sufficient to deliver the Australian Government's massive infrastructure investment over the forward estimates[2] and across a range of other current and emerging industries.[3]

> ***Skill shortages are one of the big national challenges that we face, and I think we need to acknowledge that and recognise it. I don't think there's any doubt that we do have a skills deficit that has emerged and continues to grow... Anyone who says we don't have a problem has a problem themself. The Federal government projections tell us that we'll need 27,000 new engineers over the next five years - that's about five-and-a-half thousand a year. If you take into account an attrition rate, retirement, dropout etc. of about 2.5 per cent that's another five-and-a-half thousand, that's 11,000 that we'll need a year, that exceeds what we now produce in Australia.***
>
> Innes Willox AM – CEO Ai Group

2 Analysis by Infrastructure Australia found that there will be a peak public infrastructure workforce shortage of 70,000 engineers, scientists, and architects out to 2025 relative to the $225 billion spend over the Federal, State and Territory 2020–21 Budget Forward Estimates – an increase of nearly $46 billion or 26 per cent.

3 For instance, according to the Reserve Bank of Australia, activity in the engineering dependent resources, construction, and manufacturing industries comprises approximately 25 per cent of Australia's economic output and resources and manufacturing 75 per cent of Australia's exports. https://www.rba.gov.au/snapshots/economy-composition-snapshot/

Put simply, Australia will need to double its domestic production of engineers.

The Australian Government has made significant announcements with a nuclear submarine build, the Modern Manufacturing Strategy, the National Hydrogen Roadmap and the Australian Civil Space Strategy, as well as increasing our sovereign capacity across engineering dependent industries.

Success is dependent upon increasing the engineering workforce pipeline.

Industry has clearly stated that even without these future national challenges, the current engineering workforce is under pressure. The engineering workforce is so overworked and time-poor that innovation is becoming an out-of-reach luxury.

Skills demand for engineers is such that we are seeing the cannibalization of the workforce through poaching. This results in a marked increase in turn-over in engineering roles. This impacts productivity across all engineering dependent industries – and the economy more broadly – as new staff are recruited and then brought up to speed.

> ***What keeps me up at night is absolutely the skills shortage in our industry to deliver on this infrastructure pipeline.***
>
> Louise Adams - COO Aurecon

> ***Over the last two years we've doubled our turn-over rate ... What does that mean? Less productivity... your ability to work from within the global group becomes significantly reduced.***
>
> Andy Keough CSC - MD Saab Systems

Summary of discussions at the Go8 Industry Summit

These structural issues within the engineering workforce are not new, however COVID-19 and the changed funding arrangements for engineering education under the Job Ready Graduates program introduced in 2021 have brought the crisis to a head.

> ***We need to recalibrate how this issue is perceived. Irrespective of the pandemic, skill shortages have always been a pressing matter and something which needs to be addressed urgently.***
>
> Emilio Romeo – MD and CEO Ericsson Australia & New Zealand

The Go8 Summit noted both the pre-COVID reliance on overseas recruitment for engineering talent and that the majority of recent engineering completions at Australian universities were international students (56 per cent). Both of these pipeline elements have been heavily impacted by COVID-19 border restrictions.

There is also heightened international competition for engineering talent and evidence of a reluctance by highly-skilled engineers to relocate internationally – particularly to Australia from the Northern Hemisphere – with current and future border uncertainties due to COVID-19.

Skilled migration settings will be a crucial part of the solution for the engineering workforce pipeline post COVID-19. Important work, including the Engineers Australia report *Barriers to employment for migrant engineers*[4] has already been undertaken and therefore Summit discussion focused on what could be done to improve that part of the pipeline for which universities are responsible. The reduced international pipeline for the national engineering workforce highlights the need to significantly increase (double) the production of domestic engineers.

4 Barriers to Employment for Migrant Engineers; Research Report October 2021, Engineers Australia www.engineersaustralia.org.au

The Summit determined that consideration must be given to "who's on the bench" in terms of potential employees who could be fast -racked into the engineering workforce. This should include an assessment of educational pathway opportunities, including short courses, standard undergraduate accredited engineering courses, and "masters conversions".

Masters conversion degrees play the dual roles of "converting" a bachelor degree in a related discipline such as Science to an engineering qualification and also "converting" an engineering qualification unaccredited in Australia to a fully accredited qualification.

While many of these issues – particularly around the representation of women in the engineering workforce – were well understood to require solutions that should begin within the school system, it was recognised that university education of domestic students is central to all pathways into the engineering workforce.

The Job Ready Graduates (JRG) package was identified as a deterrent to increasing the output of fully accredited engineers – particularly in smaller, equipment intensive, and expensive disciplines – and funding has pushed universities to scale back on laboratory and field-testing engineering costs where possible.

The overall impact of the JRG was considered to have negatively influenced the development and provision of engineering education. Funding is limited to, at best, the average recurrent costs of pre-2020 engineering education with no provision for research and innovation, or the equipment and facilities needed to move into the industries of the 2030s and beyond (such as needed by AUKUS).

Essentially, the JRG model relies on the existing high performance of some of the leading engineering schools in the world at the Go8 to mask systemic underfunding that will eventually result in a downward spiral into national engineering mediocrity.

That the JRG has decreased total per student funding for engineering by over $4,500 or 16 per cent has not gone unnoticed by industry.

> ***... the cut to university places is just going to exacerbate the problem and on behalf of industry we have made that clear.***
>
> Innes Willox AM – CEO Ai Group

This diminished funding level has been set with reference to the median amount determined by a government cost-of-delivery benchmarking exercise. However, the application of this median as a cost benchmark for engineering education does not account for the specific institution or its location, the level of course (ie undergraduate/postgraduate), the discipline of engineering, the class size, or the location/type of course delivery. Evidence is emerging that each of these factors influence the cost of delivery of engineering.[5] This is also the experience of well-established international teaching cost benchmarking exercises such as the UK Transparent Approach to Costing (TRAC).[6]

Setting a median price forces universities to pursue large classes of standard engineering curricula in established engineering disciplines. This will not promote the type of innovation and inspired engineering workforce that Australia must have to be competitive and more sovereign as the geopolitical situation requires we must.

While universities have the flexibility to allocate more funding to engineering places from their overall Government funding envelope for domestic students, this would defund other disciplines. Industry representatives noted that defunding other disciplines would seriously undermine engineering education.

5 *Working paper: What does it cost to educate a university student in Australia November 2021* Melbourne Centre for the Study of Higher Education and the Pilbara Group https://melbourne-cshe.unimelb.edu.au/research/research-projects/policy-and-management-in-higher-education/cost-of-delivery-of-teaching

6 https://www.trac.ac.uk/

Engineering graduates of the future will need a broad exposure to ethics, philosophy, anthropology and other disciplines through their accreditation-required electives, and highly valued double degrees to be equipped to design products that people demand and which will have a positive impact on society as well as the economy.

There are two other crucial elements of engineering education the Summit identified as unfunded: research and infrastructure/equipment costs.

The JRG explicitly severs the link between funding for university teaching of domestic students and its research activity – both of which are defining requirements of being classed as a university in Australia.

This issue is particularly acute for engineering as it is a specific requirement of accreditation for an engineering course that students complete a substantial research project.[7] Research is central to high-quality engineering for the future and is part of Australia's existing engineering DNA that needs to be fostered and not treated as unfunded, discretionary activity.

Increasingly, engineering will need to be fueled by inspiration, innovation and creativity – driven by a research culture in order to be internationally competitive.

> ***... but I worry about the potential for 'robbing Peter to pay Paul'. I would argue that to achieve greater scale of change, we need to focus on the branding of engineering and how to inspire students.***
>
> Dr Gareth Parker - Research Leader Cyber and Signals Intelligence, DST Group

7 See Engineers Australia documents *Stage 1 Competency Standard for the Professional Engineer* and *AMS-STD-10 – Higher Education* which can be downloaded from https://www.engineersaustralia.org.au/About-Us/Accreditation/AMS-2019

Summary of discussions at the Go8 Industry Summit

A critical feature of support for a world-class engineering education is access to leading edge equipment and infrastructure – as well as the maintenance of existing equipment and infrastructure.

Since the repurposing of the Education Investment Fund (EIF) there has been no ongoing Government funding for educational institutional infrastructure of this type.

Engineering students must have access to equipment for material characterization and testing, micro and nano device fabrication, wind tunnel facilities, robotics and automation platforms, drones and sensor systems, modern power systems to develop and test future grids.

They need to be able to undertake drop testing, to use ground penetrating radar, and to access modern high-performance computing – and that is expensive. They need experience in using this equipment to deliver the future digital twins for industry 4.0 and 5.0. This research infrastructure is expensive to build, to operate and maintain.

Since the repurposing of the Education Investment Fund (EIF) there has been no ongoing Government funding for educational institutional infrastructure of this type. Under the JRG the 16 per cent decrease in per student funding for engineering has removed any capacity to fund that infrastructure and equipment.

While the Government has introduced the National Priorities and Industry Linkage Fund (NPILF) to support industry engagement in education and research, the fact is that this limited (but not insubstantial) fund is to be applied across all disciplines for research, education and equipment, meaning that it is not a strategic solution for engineering education.

> ***We need to focus on solutions and actions. We should consider advocating for a national aspirational initiative to make paid work integrated learning opportunities for all students enrolled in STEM disciplines. We need industry to create these "jobs" and unis to offer WIL courses. Then we can go to the Governments and ask them to provide wage support for paid WIL. The Canadian Government has a very successful program which provides up to $5000 to companies for each WIL students they hire.***
>
> Professor Amit Chakma – Vice-Chancellor and President, University of Western Australia

Importantly, the Summit identified the need for industry and universities to collaborate on mechanisms such as work integrated learning, internships, and cadetships to increase the work-readiness of engineering graduates. This was highlighted in the AusIMM engineering workforce report – drafted by Rio Tinto, BHP and PWC.[8]

While industry does provide for some work experience and mentoring for graduates and students, more needs to be done to facilitate this activity at a national scale, particularly for SMEs who do not have the same resources as larger companies. The Summit identified the Canadian Co-op model as an example of world's best practice.

Industry-university collaboration is not only necessary for operational programs but also to identify national issues across the engineering workforce as they develop and then to facilitate national solutions. Government must be a partner in this collaboration.

8 A Critical Moment: The supply and demand of mining, metallurgical and geotechnical engineers in the Australian resources industry – An AusIMM report https://www.ausimm.com/globalassets/downloads/ausimm-future-workforce-2021.pdf

Detailed Recommendations

for Government Consideration

The Go8 Summit endorsed three recommendations.

While they could be considered individually, they are designed to be complementary, and it is recommended that all three be adopted and implemented. The recommendations form a comprehensive framework for the university education of Australia's future engineering workforce.

- **Recommendation 1:**
  A new model for funding engineering education

- **Recommendation 2:**
  National Priority Places for Engineering

- **Recommendation 3:**
  A National Industry, University and Government Engineering Council

1 A new model for funding engineering education

A comprehensive funding model for engineering education which covers three elements: appropriate recurrent per student funding, provision for research, and support for engineering infrastructure and equipment.

Recurrent per student funding – return total per student funding to pre-JRG levels

It is recommended that total per student engineering funding for universities is returned to the pre-JRG level of approximately $29,000 per year, while maintaining the student contribution amount at the current JRG levels to preserve the incentive for students to pursue engineering studies.

This would eliminate the conflicting incentives for students and universities for engineering education established under the JRG. As a result, there would be an increase in Government support per engineering student of 9 per cent over pre-JRG levels (to compensate for the decrease in student contribution) and 29 per cent over the current JRG arrangements. In dollar terms, based on reported 2019 Engineering Domestic Commonwealth Support Student load it is estimated that this would be a total (one year) increase of $63.7 million over pre-JRG arrangements (as in 2019) and $173.4 million over the JRG arrangements.

Recommendation 1:
A new model for funding engineering education

A 10 per cent research and innovation premium to support recurrent research activity in engineering education

Historically, base funding for teaching activity at universities has included a premium for research, as both are required activities for universities in Australia and to fulfil the aspiration that teaching should be informed by world-class research. The 2011 Lomax-Smith review of Base Funding in Higher Education[9] concluded that *something in the order of 6 to 10 per cent of base funding could reasonably be associated with activities relating to maintenance of base research capability.*[10]

The JRG has formally decoupled university base funding for teaching from the maintenance of base research capability. However, industry and the engineering profession have made it clear that research and innovation capability is a specific and mandatory requirement of engineering graduates and the university environment.

To that end, the Go8 is recommending a research premium of 10 per cent be added to the per student funding amount of engineering. This represents an additional annual cost of $88 million under JRG arrangements or $106 million under the Go8 proposed changes to per student funding.

9 Base Funding refers to the combination of Government support for teaching and student fees received by universities.

10 Page 84 Higher Education Base Funding Review: Final Report.

Engineering infrastructure and equipment costs – a matched funding Engineering Investment Fund (EngIF)

Engineering infrastructure and equipment is expensive to build and operate and maintenance costs are substantial. However, it is essential that engineering students have significant experience with this equipment during their education in order to be job-ready. While some of this equipment and infrastructure may be shared between institutions or accessed through programs such as the National Collaborative Research Infrastructure Strategy (NCRIS) – in the main this equipment needs to be held within a university.

There has been no ongoing fund for university infrastructure since the Education Investment Fund (EIF) was redirected into the Emergency Response Fund in 2019.

The Go8 recommends a competitive *Engineering Investment Fund (EngIF)* of $125 million per year that universities could apply for to purchase, build or maintain infrastructure and equipment vital for high-quality engineering education (including research). With the requirement of matched funding to grants from EngIF, the Government could ensure that universities identify priority infrastructure and equipment vital for the education of Australia's future engineering workforce.

2 National Priority Places for Engineering

A model is required to increase the engineering workforce pipeline with competitive funding for additional engineering places at universities framed by collaboration between industry, government and universities.

A key outcome of the Go8 Summit was the identification of the need for a step-change in the production of domestic engineers – to effectively double the current supply. It is clear that given the complexity of workforce requirements, additional engineering places should be targeted to industry needs in both engineering disciplines and specific qualification pathways and across reskilling short courses, bachelor degrees, and masters conversion qualifications.

To expand the engineering workforce pipeline, there must also be sufficient student demand for an engineering qualification.

Therefore, it is recommended that National Priority Places for Engineering be established as an extension of the general National Priority Places announced in the 2020 Budget.

A key outcome of the Go8 Summit was the identification of the need for a step-change in the production of domestic engineers – to effectively double the current supply.

National Priority Places for Engineering

This would include additional funding to support engineering places outside of current university Maximum Basic Grant Amounts under the Commonwealth Grant Scheme (CGS). The fund would be accessed by universities on a competitive basis, with universities making applications specifying number of places, specific engineering disciplines, and the level and duration of courses.

Applications would be assessed against scheme parameters explicitly aligned with industry needs. Successful universities could only access funding for the places actually delivered by recruiting suitably prepared additional students into their engineering programs.

It is important that this program be supported by additional funding rather than existing CGS allocations. Universities would have the option to apply for targeted funding to create additional engineering places without compromising the institutional autonomy provided by the standard CGS allocation.

National Priority Places for engineering would be funded at the standard per student engineering rate (see Recommendation 1). The quantum of funding for National Priority Places would depend on the ambition to expand the engineering pipeline, noting that to double the pipeline would require an estimated additional government investment of approximately $842 million per year at the per student funding rate outlined in Recommendation 1.

Universities would have the option to apply for targeted funding to create additional engineering places without compromising the institutional autonomy provided by the standard CGS allocation.

3 A National Industry, University & Government Engineering Council

A body comprising industry, universities and government representatives to identify immediate and strategic needs in the national engineering workforce, mechanisms for enhancing industry-university collaboration in engineering education, and to set the annual guidelines for the National Priority Places for Engineering.

Solving Australia's current and future engineering workforce crisis is a complex and rapidly evolving challenge. The solution requires collaboration between industry, universities and government.

The National Industry, University and Government Engineering Council responsibilities should include:

- Regular meetings to identify the current and rapidly emerging trends and need in the engineering workforce.
- Setting the requirements and parameters for the program of National Priority Places for Engineering (see Recommendation 2) to ensure its clarity, transparency and effectiveness.
- Identify current and future opportunities in the engineering workforce to allow better targeting of promotion of engineering careers.
- Provide advice on industry-university engagement in engineering education – including consideration of options such as internships, work integrated learning, cadetships and successful international models such as the Canadian "co-op" model.

Appendix 1: Background on Australia's Engineering Workforce

The make-up of Australia's engineering workforce is highly complex.

In 2019, Engineers Australia estimated that there were more than 185,000 employees in the various engineering occupations.[11] This included professional engineers, engineering technologists, and engineering associates working in a wide variety of roles and industries.

This complexity of Australia's engineering sector is also reflected in the *Engineering 2035* initiative of the Australian Council of Engineering Deans (ACED). This is a long-term project that considers the changing nature of professional engineering practice and the implications this has for engineering education in Australia.[12]

In recent years it has become increasingly evident that there are significant current and future shortages across the range of engineering occupations, all of which have material implications for a post COVID Australian economic rebound and for the Government's determination to deliver a more sovereign nation.

11 *The Engineering Profession: A Statistical Overview* Fourteenth Edition, June 2019 see http://www.engineersaustralia.org.au/

12 http://www.aced.edu.au/downloads/Engineering%20Futures%202035_Stage%201%20report%20for%20ACED_May_16_2019.pdf

Appendix 1:
Background on Australia's Engineering Workforce

The National Skills Commission (NSC) in its *2021 Skills Priority List* listed 13 engineering occupations in its highest priority list of *Occupations in current national shortage, with strong future demand.*[13] The NSC *Labour Market Information Portal (LMIP)* models that by 2025 there will be a need for over 40,000 additional engineering professionals, not including software engineers.[14]

These workforce shortages are also confirmed for specific industry sectors, for example the increase in infrastructure spending by State and Federal Governments will require an increasing supply of engineers.

Analysis by Infrastructure Australia found that there will be a peak public infrastructure workforce shortage of 70,000 engineers, scientists, and architects out to 2025 relative to the $225 billion spend over the Federal, State and Territory 2020–21 Budget Forward Estimates – an increase of nearly $46 billion or 26 per cent.[15,16]

The Australasian Institute for Mining and Metallurgy (AusIMM) forecasts strong future demand for engineering graduates to meet the needs of Australia's mining industry.

The Deloitte report *ACS Australia's Digital Pulse: Future directions for Australia's Technology workforce 2021* predicts a huge increase in workforce – including engineers – for emerging technology sectors such as AI which could require a specialist workforce of as many as 161,000 by 2030.[17]

In what could be described as the perfect storm, while engineering workforce demand is set to increase dramatically, COVID-19 border restrictions have introduced additional constraints on the workforce pipeline.

13 https://www.nationalskillscommission.gov.au/2021-skills-priority-list

14 https://lmip.gov.au/default.aspx?LMIP/EmploymentProjections

15 *Infrastructure workforce and skills supply – October 2021* published by Infrastructure Australia

16 *Australian Infrastructure Budget Monitor 2020–21* published by Infrastructure Partnerships Australia

17 https://www2.deloitte.com/content/dam/Deloitte/au/Documents/Economics/deloitte-au-economics-australias-digital-pulse-2021-160621.pdf

Pre-COVID an estimated 16,000–20,000 engineers came to Australia annually through temporary or permanent migration pathways.

In addition, international students comprised over half (56 per cent) of Australia's higher education engineering graduates.

That fact alone highlights the urgent need for Australia to strengthen its sovereign capacity to build a sustainable engineering workforce.

As demand for the engineering workforce is set to increase, so too are the salary outcomes for engineering graduates in both the short and long-term.

Department of Education, Skills and Employment (DESE) income data (2018) shows the median income of 2016 bachelor graduates in engineering was $63,000 – fourth behind medicine, dentistry, and teacher education. For engineering bachelor graduates of a decade earlier (2007) the median 2018 income was $112,900 second only to medical graduates.[18]

The role of universities

Universities are only one part, albeit a critical part, of the engineering workforce pipeline that extends from school education through to the senior levels of many different industries.

Australian universities provide qualifications across the broad engineering workforce of engineering technologists, engineering associates and professional engineers accredited by Engineers Australia. In terms of the core cohort of professional engineers, there are several pathways facilitated by universities:

18 *Graduate incomes: Insights from administrative data October 2021* Phil Aungles, Gabrielle Hodgson and Simon Parbery – Department of Education, Skills and Employment (DESE)

Appendix 1:
Background on Australia's Engineering Workforce

- **Foundation:** Undergraduate engineering programs leading to a bachelor degree with honours is the standard pathway to becoming an accredited professional engineer and typically takes four years.
- **Conversion:** A conversion masters typically takes two years and converts a bachelor degree in a program related to Engineering such as Science or Mathematics, into an accredited qualification as a professional engineer. In the case of the University of Melbourne this is the standard route to becoming an accredited professional engineer.
- **Reskilling:** To upskill already accredited professional engineers there are a number of options including microcredentials, graduate certificates, graduate diplomas, and masters degrees – taking anywhere from a few weeks to two years.

Australia lags in OECD terms

In 2019, university students completed 21,735 qualifications in the broad field of Engineering and Related Technologies at bachelor level (58 per cent) and postgraduate coursework (42 per cent).[19]

In OECD terms this is not a strong performance with Australia ranking third lowest in terms of engineering graduates as a proportion of all graduates.[20]

Of the 21,735 qualifications 9,711 or **fewer than half (45 per cent) were domestic students** and of these 7,754 were at Bachelor level. As context, this represents just half of Canada's annual production of domestic graduate engineers.

19 DESE uCube http://highereducationstatistics.education.gov.au/

20 OECD Education at a Glance 2020, Tertiary Graduates by Field

Not only does Australia lag significantly behind our international competitor countries in producing engineering graduates, over the five years to 2019 the Full Time Equivalent (FTE) of domestic students enrolled in coursework higher education engineering qualifications did not increase significantly.

Over the same five-year period, overseas student FTE increased by 63 per cent across the university sector and by 69 per cent at the Go8. At the Go8 there was also a concentration of enrolments from key international markets with 57 per cent of enrolments from China, 15 per cent from Malaysia and 6 per cent from India in 2019.

Diversity in the Engineering Workforce

One of the longstanding and well-recognised challenges in the broad engineering workforce is to increase access to talent by diversifying the workforce. This is particularly the case with respect to gender.

The Engineers Australia statistical overview of the engineering workforce indicates that on 2016 census figures only 11 per cent of Australia's engineering workforce was female. While this is a slight increase on the census figures from a decade earlier – where only 8 per cent was female, there were over 140,000 more men employed in engineering occupations in 2016 than women.

The Engineers Australia statistical overview of the engineering workforce indicates that on 2016 census figures only 11 per cent of Australia's engineering workforce was female.

Appendix 1:
Background on Australia's Engineering Workforce

With university enrolments, in 2019 17 per cent of domestic bachelor enrolments in Engineering were by women and while this is up from a low of 13.6 per cent in 2012, Engineering and IT have by far the lowest representation of women amongst all broad fields of education.[21]

Go8 universities are leaders in encouraging women into engineering training with 23 per cent of all domestic undergraduate bachelor enrolments by women at the Go8 compared to under 15 per cent outside the Go8.

Go8 universities are leaders in encouraging women into engineering training with 23 per cent of all domestic undergraduate bachelor enrolments by women at the Go8 compared to under 15 per cent outside the Go8.[22]

It should be noted that the lack of gender diversity in the engineering workforce and engineering education is not an issue only for Australia. In the UK only 14 per cent of the engineering industry is female[23] and 18 per cent of undergraduate university enrolments in engineering and technology are female.[24] Similarly in Canada female undergraduate enrolment in engineering was 23.4 per cent in 2019.

21 The next lowest is Architecture and Building where 38 per cent of domestic bachelor enrolments are by women.

22 Noting that the University of Melbourne and the University of Western Australia are not represented in these figures due to their respective accredited engineering programs operating at the postgraduate level.

23 *Mapping the UK's Engineering Workforce September 2020* UK Engineering Council www.engc.org.uk/workforce

24 UK Higher Education Statistics Agency https://www.hesa.ac.uk/

Government and its Financial Support

For engineering education, the Job Ready Graduates (JRG) package introduced by Government in 2021 has made it financially significantly more difficult for universities to increase the numbers in engineering education. While the cost for students to study engineering has reduced by 18 per cent at the same time total per student funding received by universities for engineering has decreased by 16 per cent or over $4,500 per student per year.

The single funding benchmark for engineering has been set by a modelled median cost of delivery of engineering education. This same cost model is set across all 10 engineering and technology disciplines, 70 subdisciplines, across all 36 public universities delivering some form of engineering education – regardless of location of campus or class sizes – and across all qualification levels from sub-bachelor to postgraduate.

Go8 internal data suggests that postgraduate engineering education is significantly more expensive than undergraduate education – although the Government has not released benchmarking of postgraduate engineering education costs so that this can be verified across the sector.

A recently released detailed cost of education study conducted by the Melbourne Centre for the Study of Higher Education and the Pilbara Group notes that:

> *The analysis in this paper raises questions about whether the current Commonwealth funding model reflects the real costs of delivering higher education courses in Australia and whether it should be reviewed by focusing on a more granular analysis than can be achieved through broad average costs.*[25]

25 *Working paper: What does it cost to educate a university student in Australia November 2021* Melbourne Centre for the Study of Higher Education and the Pilbara Group https://melbourne-cshe.unimelb.edu.au/research/research-projects/policy-and-management-in-higher-education/cost-of-delivery-of-teaching

Appendix 1:
Background on Australia's Engineering Workforce

It also suggests that engineering costs are potentially higher than the government benchmarking levels.

One likely, and unfortunate consequence of this pricing regime is that the viability of delivering smaller and more expensive engineering programs will become less viable in the current resource constrained environment.

According to the ABS $5.3 billion or 29 per cent of all investment in R&D by business in Australia takes place in Engineering and a further $7.1 billion or 39 per cent in Information and Computing Sciences.[26]

Under the JRG funding model the education of the next generation of domestic engineers has been formally decoupled from research activity

According to the ABS $5.3 billion or 29 per cent of all investment in R&D by business in Australia takes place in Engineering...

Another significant change in the JRG changes is that it formally separates the teaching and research enterprises at universities. This is particularly important for engineering fields which are all driven by innovation.

that is at the heart of engineering in Australia. In its place the Government has introduced a National Priorities Industry Linkage Fund (NPILF) to support industry engagement across **all disciplines** potentially including but not limited to research activity.

26 ABS Research and Experimental Development, Businesses, Australia, 2019–20

On average the NPILF will support industry engagement activity by approximately $300 per student per year – not a meaningful substitute for resourcing for a broad-based research-engaged education.

This is particularly an issue in the context of the *Blueprint for Critical Technologies* released by the Prime Minister on 17 November 2021.[27] The Blueprint is strongly based on science, technology, and research. Indeed, two of the four pillars of the Blueprint refer to the knowledge and skills to take advantage of critical technologies (Pillar 1) and investment in research and commercialisation of critical technologies (Pillar 2). Of the nine critical technology areas of initial focus under the Blueprint all are heavily dependent on engineering.[28]

Demand for Engineering Education

Under the JRG in 2021 there has been only a modest increase in domestic undergraduate applications and acceptances for engineering over the first COVID-19 pandemic year 2020. More broadly, and even under the previously uncapped enrolment system of the preceding decade there has been little movement in the number of applications and acceptances for engineering.[29]

This is indicative of the significant challenge in increasing student demand for engineering courses to a level that will satisfy future workforce needs.

27 https://www.pmc.gov.au/resource-centre/domestic-policy/blueprint-critical-technologies

28 These areas are: Critical minerals extraction and processing; Advanced Communications; Artificial Intelligence; Cyber security technologies; Genomics and genetic engineering; Novel antibiotics, antivirals and vaccines; Low emission alternative fuels; Quantum technologies; and Autonomous vehicles, drones, swarming and collaborative robotics.

29 In 2012 there were 19,344 applications and 13,158 acceptances for undergraduate courses in the broad field of education for Engineering and Related Technologies. This compares to 19,1665 applications and 12,655 acceptances in 2021. Department of Education, Skills and Employment (DESE) Undergraduate Applications, Offers and Acceptances Publications.

Appendix 2: List of Participants

at the Go8 Industry Summit on 2 December 2021

Louise Adams	Chief Operating Officer	Aurecon
Dr Kym Baker	General Manager	Patheon by ThermoFisher
Jason Bamert	Associate Director, Education and Healthcare Industries	Optus
Professor Nick Birbilis	Deputy Dean, College of Engineering and Computer Science	Australian National University
Chris Bridges-Taylor	Executive Director B&R Enclosures	Chairperson of QMI Solutions
Nicole Brook	AusIMM Board Director	Australasian Institute of Mining and Metallurgy
Professor Ian Burnett	President, Australian Council of Engineering Deans	Dean, Faculty of Engineering and Information Technology, University of Technology Sydney
Peter Burnton	Australasia Bridges and Civil Structures Skills Leader	ARUP
Lucia Cade	Chair	South East Water
Professor Julie Cairney	Pro Vice-Chancellor (Research Enterprise & Engagement)	University of Sydney
Professor Mark Cassidy	Dean, Faculty of Engineering and Information Technology (FEIT)	University of Melbourne
Professor Amit Chakma	Vice-Chancellor and President	University of Western Australia
Professor Vicki Chen	Executive Dean, Faculty of Engineering, Architecture and Information Technology	University of Queensland
Manuel Cifuentes	Head of Asset Management	BHP
Dr Cristina Cifuentes	Senior Director	Oracle Labs Australia

Professor Elizabeth Croft	Chair Go8 Deans of Engineering	Dean, Faculty of Engineering, Monash University
Peter Deliopoulos	Managing Director	PDMedical
Peter Derbyshire	Director of Policy and Government Relations	Australian Academy of Technology & Engineering
Michael Edwards	Chief of Technology	Raytheon Australia
Georgette Elston	Education and Skills Lead	BAE Systems
Dr Bronwyn Evans AM	Chief Executive Officer	Engineers Australia
Professor Katrina Falkner	Executive Dean, Faculty of Engineering, Computer and Mathematical Sciences	University of Adelaide
Professor Margaret Gardner AC	Chair, Group of Eight	Vice-Chancellor and President, Monash University
Nicola Grayson	Chief Executive Officer, Consult Australia	Group Convenor, Champions of Change Coalition
David Hawkins	Chairman and Managing Director	BASF Australia and New Zealand
Joanne Heyes	Global Practice Lead, Technical Capability	BHP
Professor Peter Høj AC	Vice-Chancellor and President	University of Adelaide
Brendan Howard	General Manager, Technical Capability	Rio Tinto
William Hutchinson	Chairman, Thomas Global Systems	Member, National Executives of the Australian Industry Group (Ai Group), Director of Export Council of Australia

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Andy Keough CSC	Managing Director, SAAB Systems	Board Member, South Australian Skills Commission
Roger Leigh	Director Implants Mechanical	Cochlear
Megan Lilly	Executive Director	Ai Group
Derick Luus	Head of Maintenance Strategy	BHP
Jane MacMaster	Chief Engineer	Engineers Australia
Karin Maier	Assistant Secretary	Global Business and Talent Attraction Taskforce
Professor Iven Mareels	Director, A/NZ Centre for Applied Research	IBM Research Australia, Melbourne Research Laboratory
Ingrid Marsh	Director, Partnerships and Business Development	Cicada Innovations
Professor Penny Martens	Deputy Dean of Graduate Research	UNSW Sydney
Major General (Ret) Fergus McLachlan AO	Adjunct Professor of Practice at Monash University	Director and Adviser in the Defence and National Security Industry
Stephen Millar	Managing Director and Chief Executive Officer	GME Pty Ltd
Dr Dean Moss	Chair, Go8 Innovation and Commercialisation Group	Chief Executive Officer, Uniquest
Dr Gareth Parker	Research Leader Cyber and Signals Intelligence	DST Group
James Phillis	Chief Executive Officer	SMEC, ANZ
Catherine Port	Principal, Program Advisory	Aurecon
Samantha Read	Chief Executive Officer	Chemistry Australia

Neil Readshaw	Chief Security Officer	Anonyome Labs
Emilio Romeo	Managing Director and Chief Executive Officer	Ericsson Australia & New Zealand
Professor Brian Schmidt AC	Deputy Chair, Group of Eight	Vice-Chancellor and President, Australian National University
Misha Schubert	Chief Executive	Science & Technology Australia (STA)
Brett Scodova	Head of Technology Strategy	BHP
Professor Tim Sercombe	Dean and Head of School Engineering	University of Western Australia
Dr Greg Sheehan	Global Lithium Director, Principal Consultant	Hatch
Emily Sloan	Project Officer	Monash University
Stuart Sneyd	President	AsiaPacific, Metso-Outotec
Stephanie Somerville	Engagement Coordinator	Australian Power Institute
Paul Sonnekus	Manager Engineering Systems	BHP
Professor Deborah Terry AO	Vice-Chancellor and President	University of Queensland
Vicki Thomson	Chief Executive	Group of Eight
Ms Kylie Walker	Chief Executive Officer	ATSE
Scott White	Head of Industry and Innovation	Airbus
Innes Willox AM	Chief Executive	Ai Group
Professor Willy Zwaenepoel	Dean, Faculty of Engineering	University of Sydney

Appendix 3: Profile of the Go8

The Group of Eight (Go8) represents Australia's eight consistently leading research-intensive universities. It is the main policy development and advocacy unit of its members. It also plays a leading role in wider policy development and national and international areas such as national security.

The Go8 also operates internationally as a member of the GRIUN – the global research intensive universities network – whose members comprise the world's most elite universities.

The Go8 universities are:

- The University of Queensland
- UNSW Sydney
- The University of Sydney
- The Australian National University
- The University of Melbourne
- Monash University
- The University of Adelaide
- The University of Western Australia

- Go8 universities are in the top tier internationally with seven ranked in the top 100 universities in the world and seven in the top 100 globally for Engineering.[30,31]
- Collectively, the Go8 members educate over 425,000 students and over one in three international students that study at Australian universities do so at a Go8 university.
- Go8 members produced over 115,000 graduates in 2019 including 43 per cent of the nation's graduates in Engineering and Related Technologies.

30 2021 Academic Ranking of World Universities

31 2022 Times Higher Education Rankings 2022 for Engineering

- In research, the Go8 spends $6.5 billion on R&D including over $770 million on research in the fields of Engineering and Technology.
- To prosecute this research agenda, the Go8 has nearly 23,000 researchers and 31,000 higher degree by research students. In 2019 the Go8 graduated 4,800 PhDs, representing 51 per cent of the national total.
- This research is conducted at a standard that sees over 99 per cent of Go8 research rated as world class or above by the Australian Government's official university research audit Excellence in Research for Australia (ERA). ERA also rated five Go8 members at the maximum rating of 5 (well above world standard) for research in engineering.

GROUP OF EIGHT AUSTRALIA

MEMBERS

THE UNIVERSITY OF WESTERN AUSTRALIA

MONASH University

Australian National University

THE UNIVERSITY of ADELAIDE

THE UNIVERSITY OF MELBOURNE

UNSW SYDNEY

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

THE UNIVERSITY OF SYDNEY

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