Deloitte.

ACS Australia's Digital Pulse

Future directions for Australia's Technology workforce

2021

Deloitte Access Economics

Foreword

ACS is pleased to release the 2021 Digital Pulse which comes as Australia recovers from last year's COVID shutdowns. This year's report shows the opportunities and potential the ICT sector offers the nation over the next five years along with a snapshot of the industry's performance over the past twelve months.

Like many industries, the technology sector performed far better than expected at the beginning of the pandemic and the report highlights the role ICT professionals played in helping the nation's businesses stay on course.

Australia's better-than-expected economic performance over the past year was partly due to technology enabling businesses to adapt to a dramatically changing and uncertain environment. The pandemic illustrated the importance of government and private sector investment in IT, where industries with higher levels of digital literacy proved more resilient than those less adept.

The demand for workers was shown by employment growing more than three times greater than the broader workforce. The report also highlights that out of the 600 skills classifications in Australian industry, more than 75% of them require at least one technology aspect, illustrating how important the ICT sector is to society.

In the report, we also look at the 'hard' technology skills being demanded by industry along with the 'soft' skills expected by employers when they look to employing ICT workers.

The high levels of demand again illustrate the perennial ICT skills shortage facing the nation. This year's report estimates an impending gap between 60,000 extra workers needed per annum over next five years compared to the 7,000 students graduating with IT degree in 2019. This is something which may hold back Australia from achieving its full potential.

Another factor holding back Australia's ICT potential is the low levels of female participation. This year's Digital Pulse examines what the sector can do to bring the industry closer to gender parity and the opportunity this presents for the economy.

Once again, the report shows the importance of retraining Australian workers to fill new positions and the key role immigration has in filling short term skills gaps. With the increasing adoption of technologies such as Artificial Intelligence, autonomous vehicles and data analytics, the need for advanced skills is going to increase. The report suggests actions to build a workforce to meet the challenges of the mid-21st Century.

A prime case in point is the manufacturing industry where the push to reinvigorate Australia's advanced manufacturing capacity will be hampered if that sector's ICT employment continues to fall as it did over the past twelve months.

Similarly, the slowing of ICT employment growth in the Public Administration and Safety sector is an area for concern as the push to increase the public sector's digital capacity accelerates. In the report we examine the benefits of professionalisation of government technology workers and what that can deliver for citizens and taxpayers.

We would like to thank our partners at Deloitte Access Economics for their hard work in delivering this important report and driving policy discussion on building Australia's skills for the current and future global economy.

Ian Oppermann
President

Rupert Grayston
Chief Executive Officer

Contents

Glossary

Terminology	Definition
Information, Media and Telecommunications (IMT) sector	This industry is defined in the Australian Bureau of Statistics industry classification system based on the Australian and New Zealand Standard Industrial Classification 2006 (ANZSIC06). The division includes the following subdivisions: publishing (except internet and music publishing), motion pictures and sound recording activities, broadcasting (except internet), internet publishing and broadcasting, telecommunications services, internet service providers, web search portal and data processing services, library and other information services.
Professionalisation	Professionalisation is when individuals of a shared occupation agree to practices for education, codes of practice, ethical behaviour and standards for products and services.
Smart cities	Similar to smart places, smart cities use advanced technologies to help in planning and developing solutions for cities specifically. These initiatives are usually targeted at helping cities cope with increasing density, while optimising the use of resources.
Smart places	Smart places use technology to capture data and insights on the built and natural environment. It reflects a place-based approach to smart planning, in a street, neighbourhood, or region, in the city or in the country.
Technology sector	This terminology refers to workers and economic activity generated by both certain elements of IMT industry and the large number of technology workers outside the IMT industry (for example, software developers working in the banking industry). The definition excludes some employees in the IMT industry who are not technology workers (for example, publishers of print newspapers). In this study, employment figures for technology workers have been calculated using ABS occupation and industry classifications, based on the methodology used in previous editions of *Australia's Digital Pulse*. This methodology draws upon definitions and nomenclature developed by Centre for Innovative Industries Economic Research (CIIER) lead researcher, Ian Dennis FACS, and used in the ACS's 2008–13 statistical compendiums and other CIIER analysis. For a list of which occupations and industries have been classified as technology workers, refer to Table A.3.
The Internet of Things (IoT)	The Internet of Things, or IoT, refers to the billions of physical devices around the world that are now connected to the internet, all collecting and sharing data. The term "IoT device" is often used to refer to physical objects that are connected to the internet to either be controlled or communicate information.

Executive summary

In the year since the COVID-19 pandemic began, digital technology has become even more important to Australian businesses, workforce and economy. Retailers embraced e-commerce, schools and higher education providers transitioned to periods of online learning, and Australian workers were almost twice as likely to work from home in February 2021, compared to March 2020.

Some of these trends towards digital ways of working are unlikely to reverse any time soon. Home deliveries are expected to remain 25% higher than before March 2020 and more than half (56%) of all employed Australians want to maintain or increase the amount they currently work from home.

Technology workers are key to enabling this extra demand for digital infrastructure and services. *ACS Australia's Digital Pulse* provides an annual stocktake of Australia's digital economy and workforce. Prepared by Deloitte Access Economics, the series provides a detailed examination of digital workforce trends, aimed at informing public debate about this important area of our economy.

Despite the health and economic crisis, the technology workforce in Australia grew by 33,400 over 2020, reaching a new peak of 805,525 workers. This represents a 4.3% annual increase. By comparison, employment in professional industries grew by 1.3%, while the overall number of people employed in Australia shrank by 1.7%.

At a state level, the number of technology workers in New South Wales grew by just under 10% in the past year. Meanwhile, Victoria and Western Australia experienced a slight decline in their workforce. For Victoria, this is likely a result of the strong economic impact of the second lockdown, which significantly affected overall activity. In fact, total employment in Victoria fell by more than 2% during this same period.

The impact of COVID-19 had a varied effect for both technology workers and other workers across industries. Industries such as healthcare and education had the largest growth in both overall employment and employment in technology occupations in these industries. These industries experienced higher demand in 2020, yet also faced a greater risk of spreading the COVID-19 virus through the course of their work, necessitating a shift to online modes of delivery.

Meanwhile, some industries such as mining and agriculture experienced growth in overall industry employment yet did not increase their reliance on technology workers. For example, employment in technology occupations in mining and agriculture declined in the year. This slower digital transformation during the crisis may represent a lost opportunity for these industries.

Going forwards, the strong overall growth in Australian technology workers is expected to continue. By 2026, we forecast that there will be over 1.1 million technology workers in Australia, representing an average annual growth rate of 5.4%. This exceeds the forecast growth rate for the overall Australian workforce, which is expected to increase by 1.2% per annum over the same period.

More broadly, digital skills are increasingly needed across the economy. A recent survey of Australian workers found that 87% required digital skills for their role. This survey included the responses from managers, professionals, technicians and trades workers, community and personal service workers, clerical and administrative workers and sales workers.

As the growth of the technology workforce in Australia continues, the future development and use of technology relies on more than just additional workers. The future technology workforce needs to have the right skills and capabilities to meet the demands of businesses and Australian society more broadly. This year's edition of *Australia's Digital Pulse* focuses on three key areas to improve the quality, *and* quantity of technology workers.

The first area is to **ensure all Australian workers have the technology skills required by employers.**

Domestic completions in IT degrees have continued to rise to nearly 7,000 students, and IT was the fastest growing field of education with over 41,000 domestic enrolments in 2019. While COVID-19 has meant international student enrolments and completions decreased significantly, deteriorated labour market conditions and government initiatives are expected to incentivise further study by domestic residents.

But qualifications need to contain the relevant skills for industry. To identify the top technology skills demanded by the nation's employers, this report uses a custom dataset from Burning Glass on job postings in Australia. We find that skills in software programming were the most common technical skills required for technology occupations in 2020. The top software programming skills demanded included skills in SQL (requested in 14% of job postings), Java (10%) and DevOps (9%).

Not all skills for technology occupations demanded by employers are technical. More than half of the top 10 skills most demanded were soft skills – like communication (requested in 42% of job postings), teamwork (23%) and problem solving (18%).

Both technical and non-technical skills will be required if Australia is to make use of emerging technologies. For example, Australia is forecast to require an Artificial Intelligence (AI) specialist workforce of between 32,000 and 161,000 by 2030. This includes professionals in computer vision, robotics, data science, human language technologies, and other related fields.

Director of the Centre for Health Informatics, Professor Enrico Coiera believes that "the [AI] technologies we already have can improve the decisions we make. What we need most are people with the skills to understand and use the technology."[1]

Promoting gender diversity in the technology workforce must also play a key role in future development of the technology workforce.

Women make up 29% of employment in technology in Australia, compared to 47.5% in similar occupations in the professional, scientific and technical services (PST) industry.

Based on current trends, it would take over half a century (66 years) for technology occupations to reach the level of female participation in PST today. This edition of *Australia's Digital Pulse* shows the economic impact of halving the time for technology occupations to achieve this goal.

Modelling for this report finds that increasing diversity in the technology workforce would grow Australia's economy by $1.8 billion each year on average, over the next 20 years. This amounts to an $11 billion opportunity for Australia's economy in net present value (NPV) terms. In employment terms, it could create almost 5,000 full-time equivalent (FTE) jobs on average each year.

Increasing professionalisation could also promote the quality of technology workers in Australia. Professionalisation is when individuals of a shared occupation agree to practices for education, codes of practice, ethical behaviour and standards for products and services. While professionalisation is a hallmark of many occupations in healthcare, engineering and business, professionalisation of technology has been challenging because of the constant change in technologies themselves leading to difficulty defining the nature of the occupation.

There are also benefits for workers, businesses, purchasers of technology products and services and the community more broadly from professionalisation. Based on a broad literature review and consultation with ACS members, Deloitte Access Economics has identified three primary benefits of professionalisation: increased trust, improved capabilities, and efficiencies and innovation from promoting agreed standards on products or services. The benefits need to be weighed against the direct costs of implementing and complying with professional standards, and any consequences for innovation in a fast-changing set of occupations.

How can the technology workforce improve in these three areas? To promote development within the technology workforce in the directions outlined above, this year's *Digital Pulse* provides the following five key priority areas:

Continue to promote higher education courses in IT

Graduates of IT undergraduate and postgraduate degrees are a key source of technology workers. With international travel possibly not returning to pre-COVID levels until 2024, domestic enrolments and completions will be even more vital to supply the growing workforce. Both Australian and State Governments have provided incentives during 2020 to promote study in IT. This should continue to fill the current shortfall and to promote longer term growth in the technology workforce.

Deepen digital skills degrees for other occupations

A large number of workers, beyond the technology workers considered in this report, increasingly require digital skills to perform their tasks. Accreditation ensures graduates from IT degrees have access to the most relevant course content. Yet the course design for technology skills in other industries may vary, for example healthcare practitioners working with AI algorithms or big data. Consideration should be given to how technology components in other fields of study can promote consistency with principles and best practice in IT courses.

[1] Quote from consultation for this year's edition of Australia's Digital Pulse.

Encourage more women to enter and stay in the technology workforce

Increasing the number of women in the technology workforce has been difficult to achieve due to long-standing societal norms and stereotypes. Many initiatives have been proposed to challenge these norms, but may not have been trialled sufficiently or scaled up to have a significant impact. These initiatives are worth investigating and successful instances in Australia and overseas should be considered.

Challenging these norms should lead to more women studying IT and ready for careers in technology. Currently only one in five domestic IT graduates are women, or only one in three for international students. Increasing access to technology-based subject matter and encouraging STEM-related careers during school could have an effect on this pipeline.

In addition, a key source to technology workers could be reskilling women from other industries. For this to eventuate, it would require considering ways to encourage women to move into a technology role through additional life-long learning courses.

In the short term, more can be done to maintain the participation of already qualified women. Currently, the attrition rate for female technology workers is double that of men. Greater access to flexible work arrangements, particularly at senior management levels could prevent this attrition. Promoting more women to leadership positions or higher pay may require incentive and reward structures that are based on observable inputs - such as time worked – than outcomes. Management could prevent this attrition through parental leave policies to encourage mothers to return to work.

Investigate ways to assess IT capabilities of contractors for Government procurement and digital projects

Recent Australian Government reviews on digital transformation projects suggest they tend to be over budget and delayed. This can come at a significant cost, with about 10% of the Government procurement being spent on technology services or hardware in 2019-20. To improve performance of digital procurement and digital transformation projects more broadly, the Australian and State Governments should investigate ways to develop a greater understanding of ICT contractor capabilities to prevent further cost and time overruns. Professional certification provides one method to measure the capabilities of contractors that should be considered.

Promoting better outcomes for digital government projects will also require improving the digital capabilities of the public sector. A recent independent inquiry found almost two thirds of Australian public sector agencies cite skills and capabilities as a barrier to using data. As a result of the inquiry the Digital Transformation Agency has established the Digital Profession for the Australian Public Service (APS) to provide formal accredited training and recognition to professionals undertaking the program. Promoting the use of the Digital Profession throughout the APS should be considered by the Australian Government.

Re-energise digital strategies across Australia

COVID-19 saw many businesses and industries take significant leaps forward in digital capabilities. Yet this has not been the case in every sector or industry. There is a need to continue to build the momentum of digitisation seen through 2020 while supporting areas where digital transformation has not progressed as quickly.

There are many areas where Australia could strengthen the digital economy. Some examples include supporting connecting fibre to businesses contained in the next phase of the NBN rollout; incentivising further AI investment to access to the latest waves of emerging technology; promoting investment in smart cities infrastructure and ensuring interoperability for devices to maximise potential for data analytics; or promoting further digital transformation in small businesses through continued grant programs.

The Australian Government has understood the importance of this support, signalling further investment in the technology space in the 2021-21 budget additional to the $800 million already announced through the *Digital Business Plan* in September 2020. A recent Memorandum of Understanding between Austrade and FinTech Australia demonstrates the intention to develop the required commercial capabilities of the sector through export orientated skills and capabilities. The continuation of these types of investments would enable the Australian economy to attain the full benefits of digital technology.

1. Introduction

The *ACS Digital Pulse* series highlights the importance of the technology workforce in Australia and the demand for digital skills in a diverse range of Australian industries, such as agriculture, health, manufacturing and financial services.

The 2021 report represents the seventh edition in the *Digital Pulse* series.

In addition to profiling Australia's digital economy and workforce and the impact of COVID-19, this year's *Digital Pulse* analyses the economic impact of improving diversity in the technology workforce and examines the case for further professionalisation of the technology workforce.

The research is based on information from a range of sources, including:

- Data from the Australian Bureau of Statistics (ABS), both from publicly available data and a customised data request on the technology workforce
- Burning Glass Technology data on job advertisements in Australia
- Reports and statistics published by various Australian sources, particularly Australian Government Departments such as the Australian Taxation Office (ATO), Education, Immigration and Industry
- Consultations with the Centre of Health Informatics and the University of Adelaide's Faculty of Engineering, Computer and Mathematical Sciences.

The remainder of the report is structured as follows:

- Section 2 examines trends in the use of digital technology in response to COVID-19 and the impact on the technology workforce
- Section 3 explores the trends in technology-related qualifications in Australia and the most in-demand skills by Australian employers
- Section 4 outlines the benefits of increasing the gender diversity of the Australian technology workforce
- Section 5 discusses professionalisation in the technology workforce and identifies the benefits from and increasing level of professionalisation in the technology workforce.

2. Impact of COVID-19 on technology workforce

2.1 Digital trends

2020 was a turning point for the Australian economy and the Australian technology sector. The COVID-19 pandemic and physical restrictions led to the first recession in almost three decades, with unemployment peaking at 8% of the labour force in July 2020.

Within the space of a few months, the nature of work changed. Digital technology took centre stage as many businesses and industries looked to digital solutions and additional support from technology workers. This led to an acceleration of digitisation in several areas of the economy.

As Australia continues its recovery COVID-19 is expected to have lasting impacts on the economy and our use of digital technology. Figure 2.1 outlines some of the major areas of this transformation.

Figure 2.1: : Digital technology trends in Australia

Working from home
In many workplaces, COVID-19 led to a change in where people work. People with a job were 1.7 times more likely to work from home at least once a week in February 2021, compared to March 2020.[i] In fact, two in five (41%) Australian workers were still working from home in some capacity in early 2021.[ii]

While future patterns of work are uncertain, more than half (56%) of all employed Australians want the amount of working from home to stay the same or increase in the future.[iii] Employed women were more likely than employed men to want to increase the amount of work done from home.[iv]

e-Health services
Health businesses have also adapted to new digital methods of delivering services, such as expanding their use of e-health platforms and telehealth services. A survey of over 1,000 Australians found that 48% of respondents who visited their general practitioner between April and May did so virtually.[v] New technology platforms have also been adopted to support the provision of an integrated vaccination record system across Australia.[vi] While the use of e-health will remain a feature of Australia's healthcare system, it is expected to decline from its peak during the pandemic. Looking forward, only 8% of Australians report they would continue to use telehealth once the pandemic was over (but this share was 10% of over-45s).[vii]

e-Commerce
Limited access to physical stores drove growth in e-commerce throughout 2020. A survey of Australian businesses in August 2020 showed this shift to online activity increased average online revenue between $105,000 and $708,000 for small businesses.[viii] This shift to digital purchases is expected to persist, with home deliveries expected to remain 25% higher than before March 2020.[ix]

Online learning
Technology was crucial to the rapid adoption of online learning. Close to a quarter of tertiary students surveyed by Tertiary Education Quality and Standards Agency (TEQSA) reported technology made it easier to learn remotely in 2020.[x] However, the transition was not always smooth, with a number of issues reported such as a lack of engagement (reported by 29% of students surveyed), lack of academic interaction (34%), as well as IT problems (41%) hampering learning in 2020.[xi]

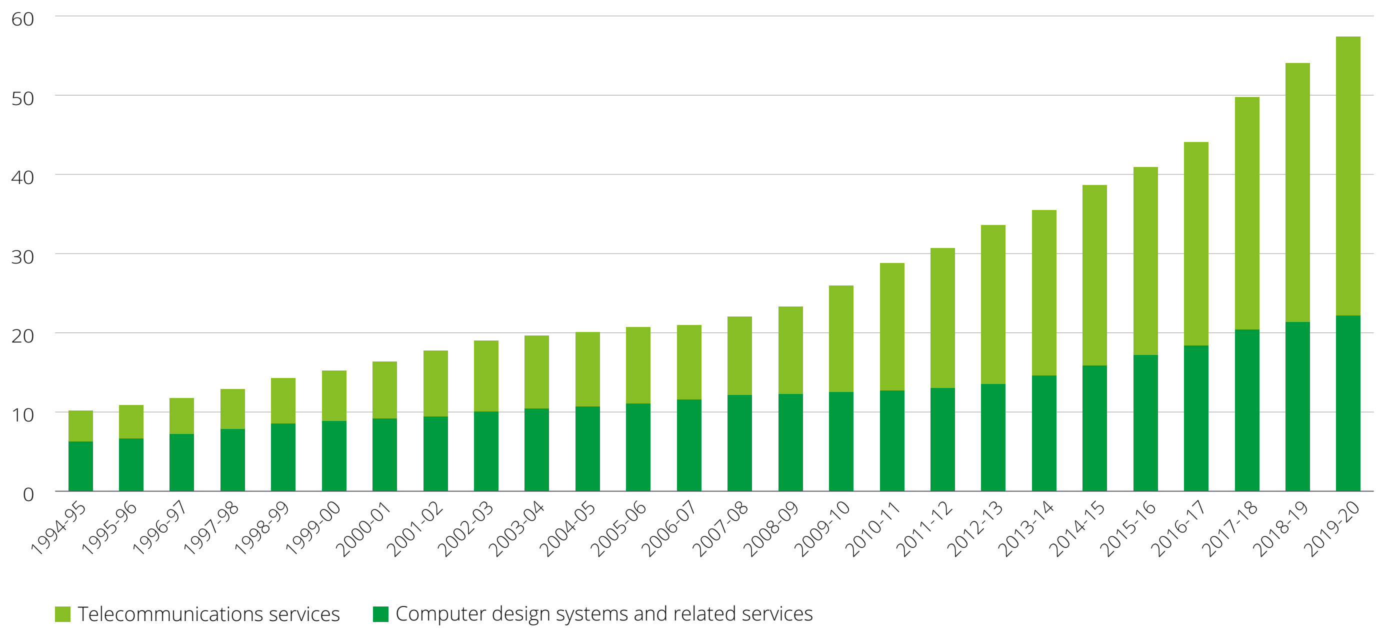
Digital government
Many Australians also revealed a preference for digital engagement with government. Australian Government websites received 1.7 billion visits during the first twelve months of the pandemic, with the majority (56%) of Australians preferring to access government information through digital channels.[xii] Only 11% of Australians preferred to access government information in-person.[xiii]

2.1.2 Estimating the contribution of ICT to Australia's economy

The accelerated trend towards digital technology supported the 6.0% growth of activity in the ICT sector between the 2018-19 and 2019-20 financial year. The growth of the sector can be measured by looking at its direct contribution to Gross Value Added (GVA), which measures the total value of the goods and services generated by an industry after accounting for the costs of production.

GVA estimates of telecommunications services and computer system design and related services suggest the ICT sector directly contributed $57.4 billion to Australia's economy in the 2019-20 financial year. The recent growth in economic activity supported by these industry subdivisions is part of a longer term trend in recent decades, shown in (Chart 2.1).

Chart 2.1: Estimated contribution of the ICT industry, 1994-95 to 2019-20 ($b)



Source: ABS Australian System of National Accounts (2020).[xiv]

2.2 Technology workforce

The strong demand and use for digital technology for the operation of the economy boosted demand for the technology workforce.

Despite the health and economic crisis, the technology workforce in Australia had 33,400 more workers in 2020 compared to 2019, reaching a new peak of 805,525 workers.[2] This growth represented a 4.3% increase in a year. By comparison, employment in professional industries grew by 1.3%, while the overall number of employed people shrank by 1.7%.

Over two thirds of the technology workforce is located within New South Wales (NSW) and Victoria. The impact of the COVID-19 crisis on technology workers varied by state and territory. NSW experienced strong growth of just under 10% in the past year. Meanwhile, Victoria and Western Australia have experienced a slight decline in their workforce. For Victoria, this is likely a result of the strong economic impact of the second lockdown, which significantly affected overall activity. In fact, total employment in Victoria fell by more than 2% during this same period.[xv]

[2] ABS industry classifications include an 'Information Mediaa and Telecommunications' (IMT) industry. However, in practice there are a large number of technology workers outside the IMT industry (for example, software developers working in the banking industry) and there are some employees in the IMT industry who are not technology workers (for example, publishers of print newspapers). In this study, employment figures for technology workers have been calculated using ABS occupation and industry classifications, based on the methodology used in previous editions of Australia's Digital Pulse. This methodology draws upon definitions and nomenclature developed by Centre for Innovative Industries Economic Research (CIIER) lead researcher, Ian Dennis FACS, and used in the ACS's 2008–13 statistical compendiums and other CIIER analysis. For a list of which occupations and industries have been classified as technology workers, refer to Table A.3. In this report, we use the term "technology workforce" to describe the group of workers previously called the "ICT workforce" in past editions of Australia's Digital Pulse.

Table 2.1: Technology workforce, by location of employment, 2020

Indicator	NSW	Vic	Qld	SA	WA	Tas	NT/ACT
Technology workers (no.)	314,083	246,163	111,574	36,775	52,084	9,400	35,445
Share of Australia's technology workforce (%)	39.0	30.6	13.9	4.6	6.5	1.2	4.4
Change from 2019 (no.)	24,730	-771	2,260	2,014	-738	1,364	4,492

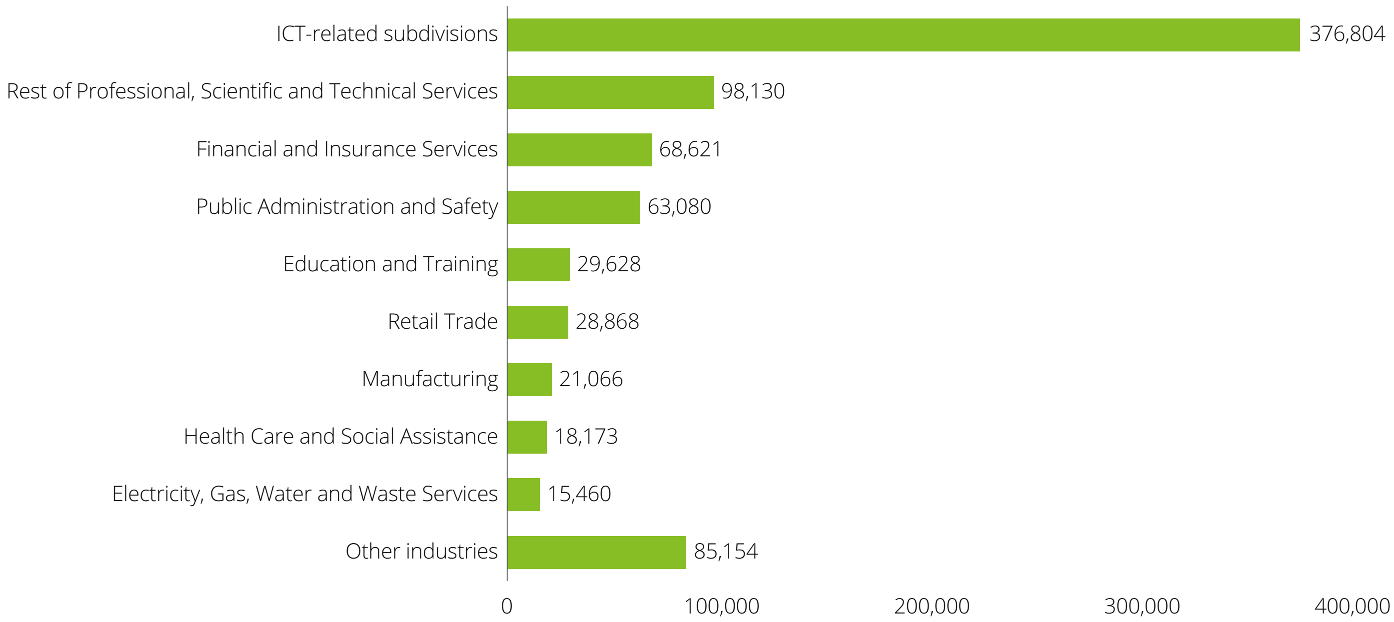
Source: ABS customised report (2021).

2.2.2 Technology workers by industry

The number of technology workers in ICT-related subdivisions (including computer system design, telecommunication services and internet service provision) grew by 7.0% to 376,804 technology workers in 2020 (Chart 2.2). Technology workers in the ICT-related subdivisions represented nearly half (47%) of the total technology workforce in 2020.

The remainder of the technology workforce was employed in other industries, primarily professional, scientific, and technical services (12%), financial and insurance services (9%), and public administration and safety (8%). While the proportion of technology workers in these other industries remains a small share, there has been an increasing use of technology by workers in these other industries. For instance, digital advertising expenditure reached a new record of $9.5 billion in 2020, partly driven by the COVID-19 restrictions. These trends suggest the increasing blurring of the distinction between what is considered in this report as technology and non-technology occupations in the Australian economy.

Chart 2.2: Technology workers by CIIER occupation groupings, 2020

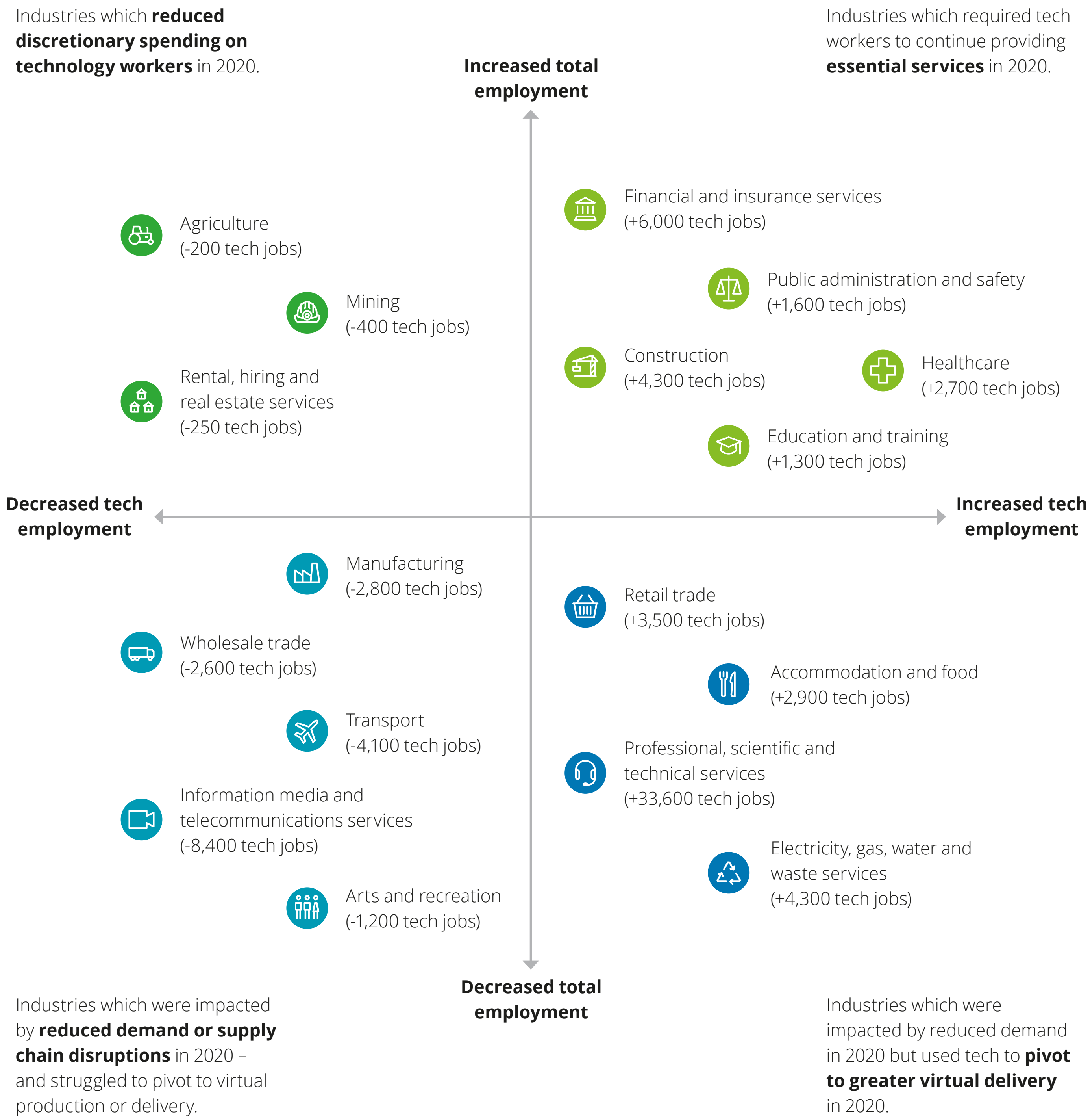


Source: ABS customised report (2021).

The impacts of the downturn varied for technology workers across different industries in 2020. Figure 2.2 captures the overall change in employment by industry (y-axis), as well as the change in technology employment by industry (x-axis).

A relatively higher position on the chart indicates stronger growth in overall industry employment, while a position closer to the right-hand side indicates relatively stronger growth in within-industry technology employment.

Figure 2.2: Changes in technology employment, by industry (2020)



Source: ABS customised report (2021).

Note: this chart includes the traditional Information, media and telecommunications (IMT) industry rather than the specific ICT-subdivisions industry referred to elsewhere in this report, including the previous section.

The industries with the largest growth in both overall employment and in technology employment tend to be **industries in the non-market sector and those less affected by the downturn** (situated in the upper right-hand quadrant of the chart). These industries experienced higher demand in 2020, yet also faced a greater risk of spreading the COVID-19 virus in the course of their work, necessitating a shift to online modes of delivery where possible. In **healthcare** for example, many workplaces now provide telehealth services, to help protect healthcare professionals and patients without foregoing the provision of care.

Some industries experienced growth in overall industry employment yet did not increase their reliance on technology workers (upper left-hand quadrant). For example, employment in technology occupations in **mining** and **agriculture** dropped, although the change was marginal (reflecting a decline of between 200-400 technology workers). It's possible this marginal drop reflects decreased discretionary spending on technology during the crisis. Slower digital transformation during the crisis may represent a lost opportunity for these industries.

Some industries experienced declines in both overall industry employment and technology employment (bottom left-hand quadrant). Losses were concentrated in industries most heavily impacted by movement restrictions and supply chain disruptions in 2020. This includes **transport** (4,100 technology jobs lost), **manufacturing** (2,800 technology jobs lost) and **wholesale trade** (2,667 jobs lost). **Arts and recreation** also saw a drop in overall employment and in technology employment. These industries struggled to pivot to virtual production or modes of delivery in part due to the nature of the industries themselves, which have traditionally emphasised physical production and delivery.

The **Information, media and telecommunications services** experienced a decline in jobs overall, and technology jobs, which it has a lot of. This was led by media, which was significantly affected by the downturn.

Other sectors are becoming more digitised and increasing their reliance on technology workers but have been impacted by the COVID-19 induced recession (bottom right-hand quadrant). **Retail** is an obvious example, with lockdowns preventing in-store purchases, while the shift to e-commerce has dramatically increased demand for technology workers in the sector. Likewise, the shift towards online food delivery platforms is increasing demand for technology workers in the **accommodation and food** industry (3,000 additional technology workers).

Some of these changes in technology employment in 2020 demonstrate a degree of acceleration or disruption compared to the trends displayed in the previous five years.

For professional industries and finance, the pandemic led to an **acceleration in the pace of growth** of the technology workforce compared to previous years. Table 2.2 shows that technology employment in the professional, scientific, and technical services industry grew by 9.8% in 2020 – 1.5 times faster than the average growth rate between 2014 and 2019. Technology employment in finance grew at a faster pace in 2020 at 9.7%, compared to an average rate of 8.5% between 2014 and 2019.

By comparison, growth in technology employment in the public administration and safety industry slowed in 2020 compared to the previous five years, falling from 5.4% growth between 2014 and 2019 to 2.7% in 2020.

Other industries which had **previously been expanding technology employment** experienced reductions in 2020. Table 2.2 shows that technology employment in the agriculture industry grew strongly at average rate of 18.1% in the five years to 2019 – but fell sharply in 2020, with a 14.7% decline in the year.

Technology employment in manufacturing also fell from an average rate of 5.6% growth between 2014 and 2019, to an 11.8% decline in 2020. Total employment in manufacturing also declined slightly over the previous five years and fell by a further 2.2% in 2020.

Table 2.2: Growth in technology employment and total employment, selected industries, 2014 to 2020 (CAGR)

	Growth in technology employment (%)		Growth in total employment (%)	
	2014 to 2019	**2019 to 2020**	**2014 to 2019**	**2019 to 2020**
Professional, scientific, and technical services	6.4%	9.8%	4.4%	0.0%
Financial and insurance services	8.5%	9.7%	1.5%	7.8%
Public administration and safety	5.4%	2.7%	2.7%	2.5%
Agriculture	18.1%	-14.7%	0.4%	6.3%
Manufacturing	5.6%	-11.8%	-0.8%	-2.2%

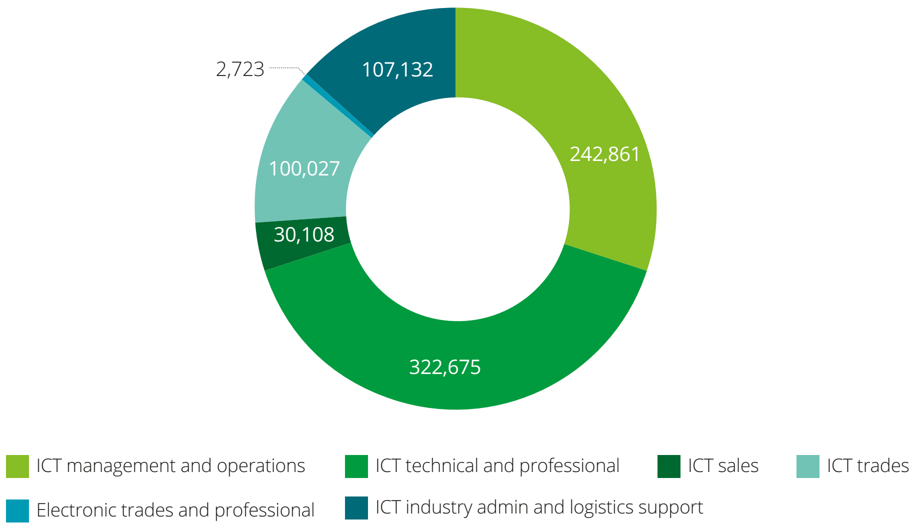
Source: ABS customised report (2021).

2.2.3 Technology workers by occupation

The impacts of the downturn varied for technology workers across different occupations. Growth was driven by a 7.9% increase in the number of ICT management and operations workers, making up nearly one third (30%) of the technology workforce in 2020 (Chart 2.3).

The number of ICT trades workers also increased 9.4% from 2019, pointing to increased demand for ICT support technicians across the economy. The number of ICT technical and professional workers also grew by 3.3%. On the other hand, ICT sales workers fell by 9.2%.

Chart 2.3: Technology workers by CIIER occupation groupings, 2020



Source: ABS customised report (2021).

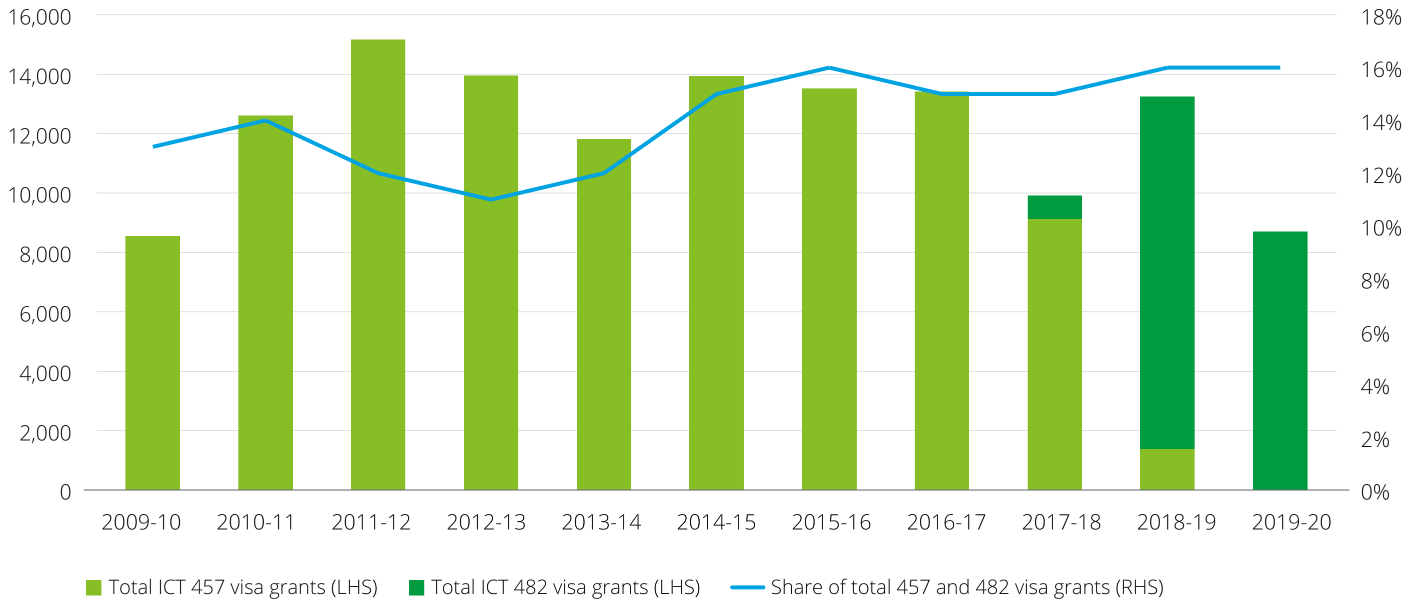
2.2.4 Migration

Previously, skilled migration has been a major source of talent for Australia's technology workforce. Despite the strong demand for the technology workforce, COVID-19 and border closures have disrupted skilled migration to Australia.

Partially capturing the impact of COVID-19, the number of temporary skilled migrants joining Australia's technology workforce decreased by more than 30% in the 2019-20 financial year compared to the previous year (Chart 2.4). Most of this reduction was in offshore visa grants, which decreased by over 40% from 2018-19 to 2019-20. Onshore visa grants experienced a smaller decrease of nearly 17% over the same period.

This brings the share of Australia's technology workforce employed under temporary skilled visas to approximately 1%. Overall, the share of temporary skilled visas granted to technology workers remained similar in 2019-20 to year before. ICT occupations were among the top categories of all visas granted; of the four most commonly granted occupations, three included software engineer, ICT business analyst and developer programmer.[xvii]

Chart 2.4: Subclass 457 (temporary skilled worker) and 482 visas granted to technology workers, FY2010–FY2020*



Source: Department of Home Affairs Temporary Work (Skilled) Visa Program pivot table (2021)[xvii]
*Excludes ICT industry admin and logistics support, for which breakdowns are unavailable; electronic trades and professional data is for all industries.

Australia's planned skilled migration intake was nearly 109,000 for 2019-20, influencing the number of new skilled migrant permanent visas.[xix,3] Planning levels for 2021 have been revised to allow more visas for family migration due to the closure of international borders. Although the number of skilled visas has been reduced, the Global Talent Independent Program was increased from 5,000 to 15,000 visas.[xx] The Global Talent Scheme is a relatively new program that was introduced in 2018 to fast-track permanent residency for highly skilled migrants in emerging industries such as cyber security, advanced digital and ICT. With these changes, the Australian Government has signalled a move away from the Skilled Independent Program in favour of other programs such as the Global Talent Scheme.

2.3 Enabling Australian smart cities

Nearly three quarters of Australia's population are in major cities.[xxi] The level and pattern of urbanisation can put pressure on a city's infrastructure and resources, and create problems such as increased congestion, air pollution, and social issues.

Without policy intervention, these problems will worsen as cities continue to grow. **So, how can cities cope with increasing density, while also optimising the use of resources and maintaining liveability?**

Smart city initiatives that incorporate AI and sensor technology offer assistance to these problems.[4] Smart cities use advanced technologies such as Artificial Intelligence (AI), Internet of Things (IoT) and sensor technology to collect and analyse data in real-time, helping councils, businesses and individuals make better, data-driven decisions.

For example, smart cities may deploy sensors to switch streetlights on and off as they are needed throughout the night. Smart garbage cans can send data to waste management companies to schedule pick-up when needed, as opposed to working on a pre-planned schedule.

These technologies are also being deployed in regional centres under the banner of 'smart places' to achieve similar benefits.

The popularity of smart city initiatives is growing around the world. The latest research suggests the market size of the global smart city industry is set to double, from US$411 billion in 2020 to US$821 billion by 2025.[xxii] In 2020, Standards Australia also published *Australia's Smart Cities Standards Roadmap*, outlining a series of insights and recommendations to support the introduction of smart cities standards and growth of smart cities in Australia.[xxiii]

[3] The skilled migration is a subset of the Australia's total planned migration intake. The total planned migration intake for Australia – including both family and skilled – was 160,000 permanent visas.

[4] The technology underpinning smart cities will in time extend beyond cities to regions and other places, and is increasingly referred to as *smart places*.

One requirement to realising the benefits of smart cities is having access to the right skills and planning to implement the technologies required. **Digital skills are required to understand and implement the digital solutions that make a city smart.**

Digital skills in Australia are in short supply. More than half of all Australians have little to no understanding of digital skills needed for smart city initiatives to be successful, such as coding, blockchain, AI and data visualisation.[xxiv] Digital skills have also been identified as one of the top four greatest skills gaps in the country.[xxv]

ACS is planning a three-year program of work focusing on AI and smart cities. This work covers AI professional frameworks and standards, to events and educational programs, to public awareness campaigns and building an online community. This investment recognises the importance of these emerging technologies for the future development of Australia's technology workforce.

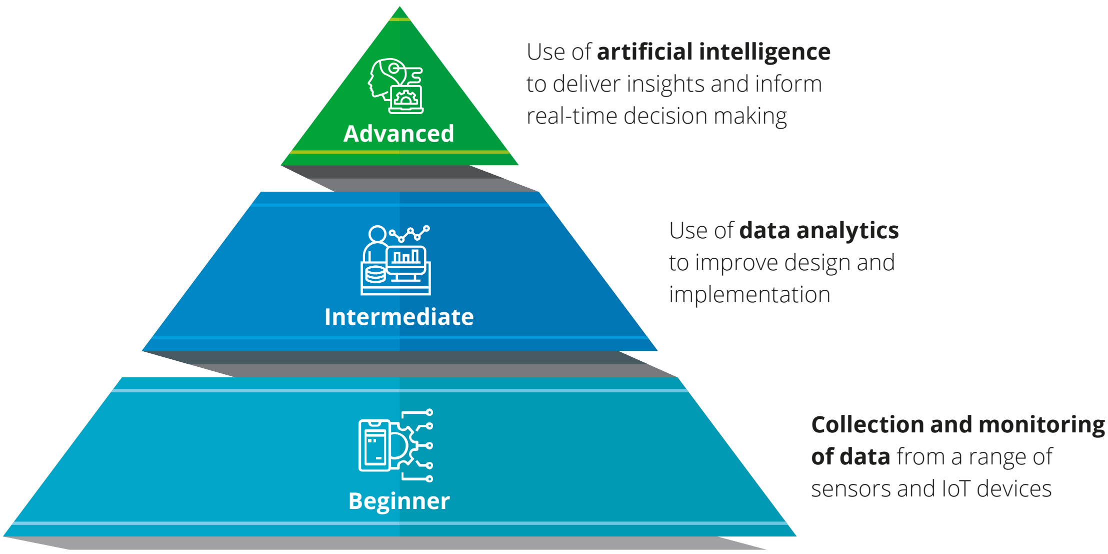
Figure 2.3 highlights how smart city technologies (and capabilities) can vary; ranging from foundational requirements in data collection and analysis, to deploying AI to inform real-time decision making. Without access to the required skills, it's unlikely Australia will be able to capitalise on the benefits of smart cities or any future initiatives and cutting-edge technologies, particularly from the more advanced forms of smart cities technology.

Some of the key occupations required to implement smart cities in Australia will include:

- Robotics specialists and industrial network engineers to plan and install sensors and IoT devices across a region
- Data scientists and platform developers to collect, monitor and analyse data captured
- Cyber security professionals at all levels and cloud architects to safely store data and protect citizens' privacy
- Experts from architecture, civil engineering, and construction to plan and build physical infrastructure to complement the smart city technology
- Digital anthropologists to interrogate and optimise how citizens interact with technologies and environments in smart cities.[xxvi]

In addition to skills, the implementation of smart cities technologies also depends on consumer trust in the security of data collection and storage systems. Privacy concerns may prevent some consumers from wanting to engage with smart city technologies. The Smart Cities Standards Roadmap highlights that governments and businesses should consider security-related standards as a foundation of smart cities policies.[xxvii]

Figure 2.3: Hierarchy of smart city technology



Source: Deloitte Access Economics (2021) and the Smart Cities Council Australia New Zealand (SCCANZ).[xxviii]

The economic, environmental and even social benefits of smart cities can be substantial, including:

- **Improving environmental sustainability:** energy efficient buildings, air quality sensors and renewable energy sources are providing cities with new ways to monitor and improve environmental sustainability.[xxix]
- **Reducing traffic congestion:** sensors that detect the speed and number of vehicles using public roads can detect traffic congestion and suggest drivers take an alternative route. This has the potential to cut commuting times by 15 to 20 percent on average.[xxx]
- **Protecting ageing infrastructure:** smart technology can transmit data showing adverse structural changes, identify tilts or cracks in buildings and bridges, and other potential infrastructure issues. These provide cities with predictive analytics to identify areas that need to be fixed before an issue arises.
- **Safety of residents:** technologies such as real-time analysis of surveillance camera videos and connected crime centres promote a safer community and reduce criminal activity in cities.
- **Health of residents:** smart technologies such as AI can assist with better diagnostics and treatment of patients in need of care. Healthcare robotics and AI can aid people to live longer in their own homes through advanced sensors.

Designing smart and sustainable built environments

Based at the University of Adelaide, the Faculty of Engineering, Computer and Mathematical Sciences, through its Sustainable Built Environment research theme, aims to improve the design of urban environments through appropriate use of technology. Led by Professor Veronica Soebarto from the School of Architecture and Built Environment, researchers use integrated data collection methods to analyse the relationship between the built environment and the users' needs and wellbeing.

One example is a project that examined the impact of housing quality on the wellbeing of older populations. A data monitoring system developed by a research team from architecture, in collaboration with RMIT University researchers, was installed in participants' homes to continuously track indoor air quality, temperature, and humidity. Residents also periodically provided attitudinal feedback on their comfort and wellbeing through a survey tablet. Results from the study were developed into evidence-based housing design guidelines to provide insights to building designers, planners as well as housing providers in designing housing for the older population to ensure comfort and safety in these often vulnerable demographics.

Smart devices also enable the capture of real-time feedback from users to improve the design of urban spaces. For example, in collaboration with researchers from the Hugo Centre for Population and Housing at the University of Adelaide, one project in 2020 gathered evidence on the use of public green spaces. A smart phone-based tool was used to collect geocoded location data, photographs, and qualitative comments from participants across eight local councils in South Australia. This enabled researchers to map the usage of green spaces over time, and capture insights otherwise missed on paper by planners. Professor Soebarto explains that this approach "enables the users of public spaces to provide real-life feedback about their experience – for example, it enables persons with disability to raise real-time alerts with infrastructure issues in public spaces."

As government interest in sustainable and smart built environment technologies continues to grow, Professor Soebarto identifies lack of data analysis and technology skills as a common challenge for organisations who may use the technologies. "We already have the knowledge and skills to develop data collection tools, technology and data analyses, but need users from different backgrounds to be trained in using them to aid decision making."

The security and privacy of data collected for smart city initiative will be required public accepatance. Professor Soebarto explains that "researchers often collect sensitive location and movement data, which must be collected with consent and stored securely. While details about research participants will always be kept confidential, the trust in the research and use of the data from participants is a prerequisite to effectively using the technology to improve our built environments."

2.4. Forecasts for the technology workforce

Deloitte Access Economics forecasts an increase in technology workers, consistent with the historical and recent high growth in the sector. We forecast the number of technology workers in Australia will pass 1 million in 2024 and **continue to grow to over 1.1 million technology workers in Australia in five years** (Table 2.1). Currently, technology workers represents 6.35% of the overall Australian workforce. If the current technology workforce was at 2026 levels, this would represent 8.69% of the overall Australian workforce in 2020.

By 2026, there will be nearly 300,000 more technology workers in the Australian workforce, representing an average annual growth rate of 5.4% (Table 2.1). This exceeds the forecast growth rate for the overall Australian workforce, which is expected to increase by 1.2% per annum over the same period.

Table 2.1: Employment forecasts by CIIER occupation groupings, 2020-26

Occupational grouping	2020	2026	Average annual growth, 2020-26
ICT management and operations	242,861	320,451	4.7
ICT technical and professional	322,675	470,140	6.5
ICT sales	30,108	32,030	1.0
ICT trades	100,027	130,923	4.6
Electronic trades and professional*	2,723	3,291	3.2
ICT industry admin and logistics support*	107,132	144,620	5.1
Total technology workers	**805,525**	**1,101,454**	**5.4**

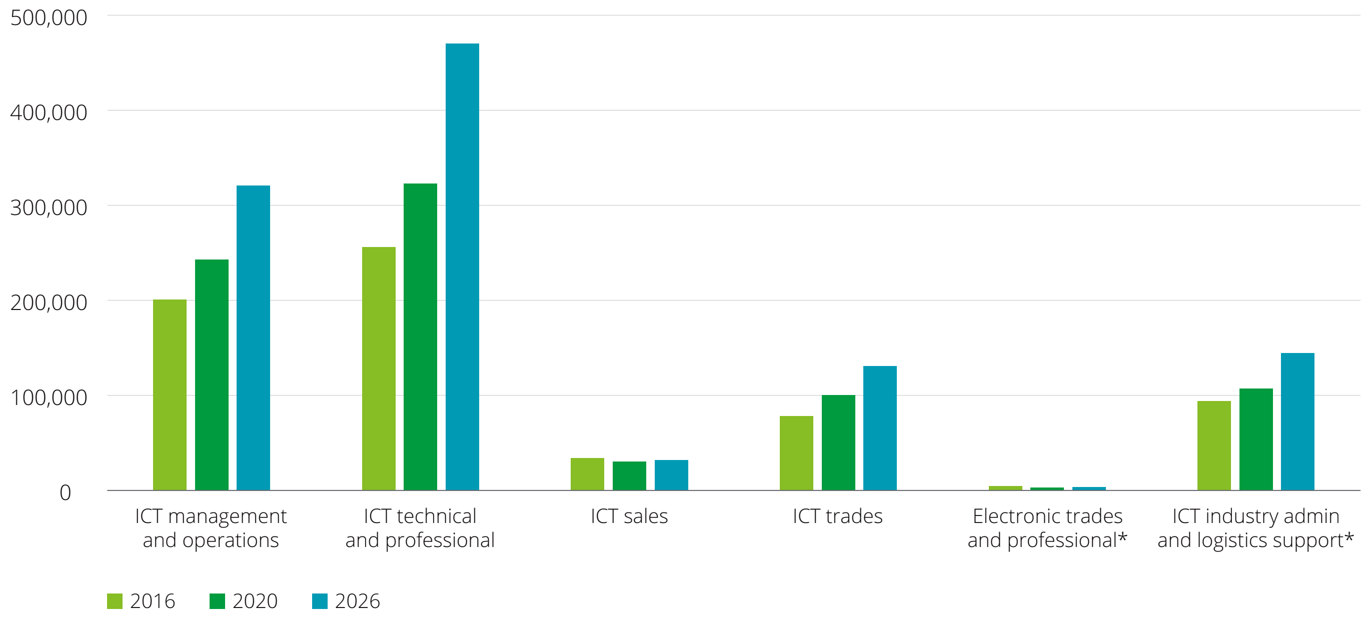
* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2021)

Nearly half of this growth is forecast to occur in ICT technical and professional roles (147,465 additional workers), while a further 26% of growth is expected to occur in ICT management and operations roles (77,590 additional workers) (Table 2.1 and Chart 2.5).

The specific occupations forecast to experience the largest increase in employment include software and applications programmers (65,200 additional workers between 2020 and 2026), graphic and web designers, and illustrators (27,300), and management and organisation analysts (25,200).

Chart 2.5: Historical and forecast technology employment, 2016-2026

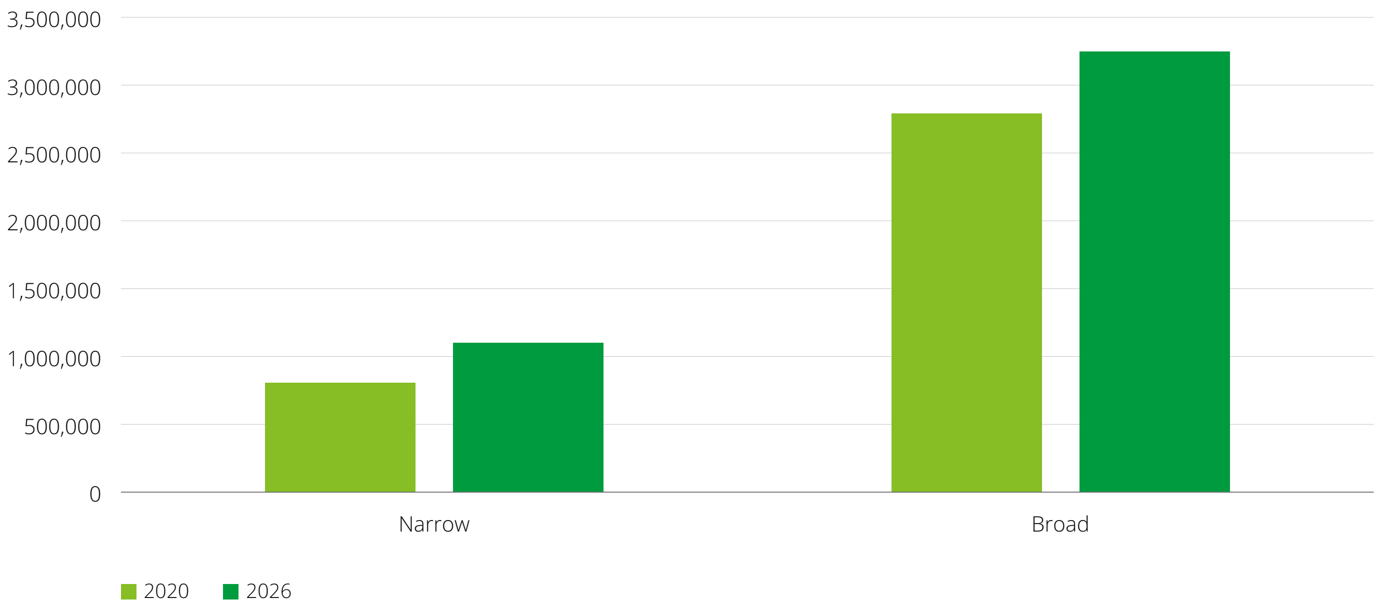


* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.
Source: Deloitte Access Economics (2021)

Many occupations require digital capabilities, even though they are not captured in the ACS definition of core ICT workers measured in this report. People like accountants, solicitors and scientists rely on technology skills to perform their work.

Deloitte Access Economics forecasts that demand for this broader category of digital workers will increase by around 455,000 workers between 2020 and 2026, representing an average annual growth rate of 2.6% (Chart 2.6).

Chart 2.6: Technology workforce growth under narrow and broad measures, 2020-26



Source: Deloitte Access Economics (2021)

3. Skills for the technology workforce

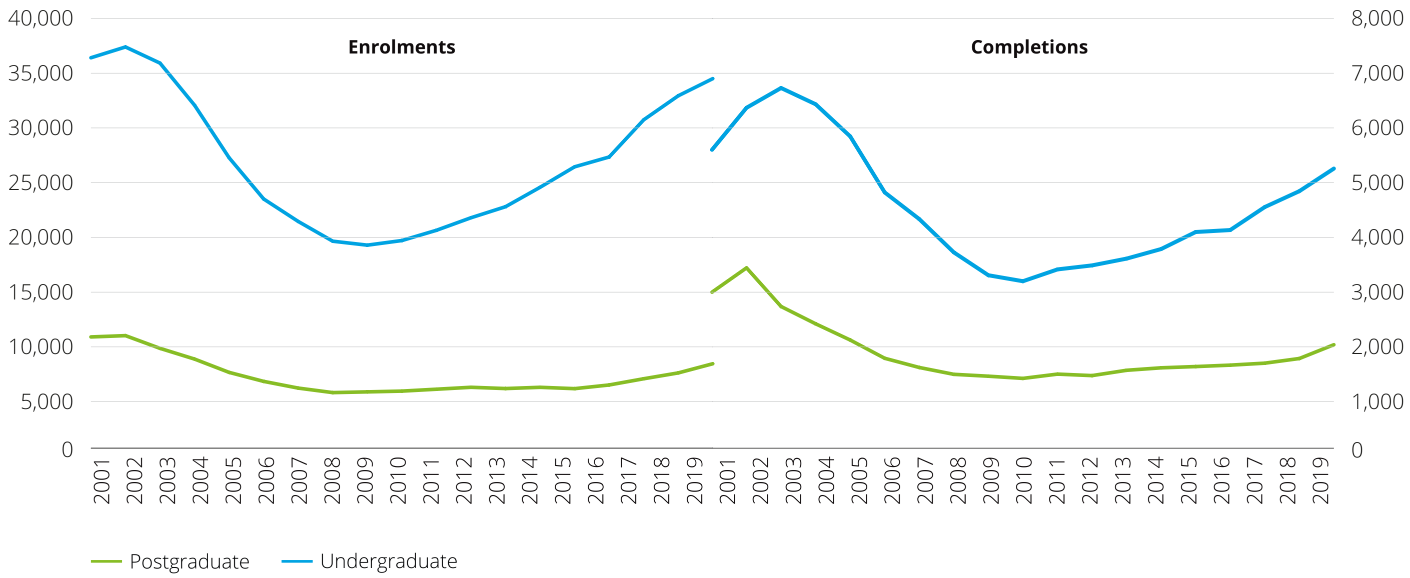
3.1 Current qualifications

A key source of technology workers includes graduates from ICT degrees and qualifications. These qualifications have traditionally come from universities and vocational training, which have both seen increases from 2018 to 2019.

3.1.1 Universities

Domestic enrolments in undergraduate and postgraduate IT degrees at Australian universities continued to increase in 2019, growing by 6.2% from 2018 to 2019. There were a total of 33,756 undergraduate enrolments, and a total of 7,713 enrolments in postgraduate studies. This reflects strong growth (averaging 9%) over the past three years, making it the fastest growing field of education for domestic enrolments. Domestic completion rates also continued to increase at a faster pace, growing by 10.5% over the year (Chart 3.1).

Chart 3.1: Domestic enrolments in, and completions of, IT degrees, 2001–2019



Source: Department of Education uCube (2020)

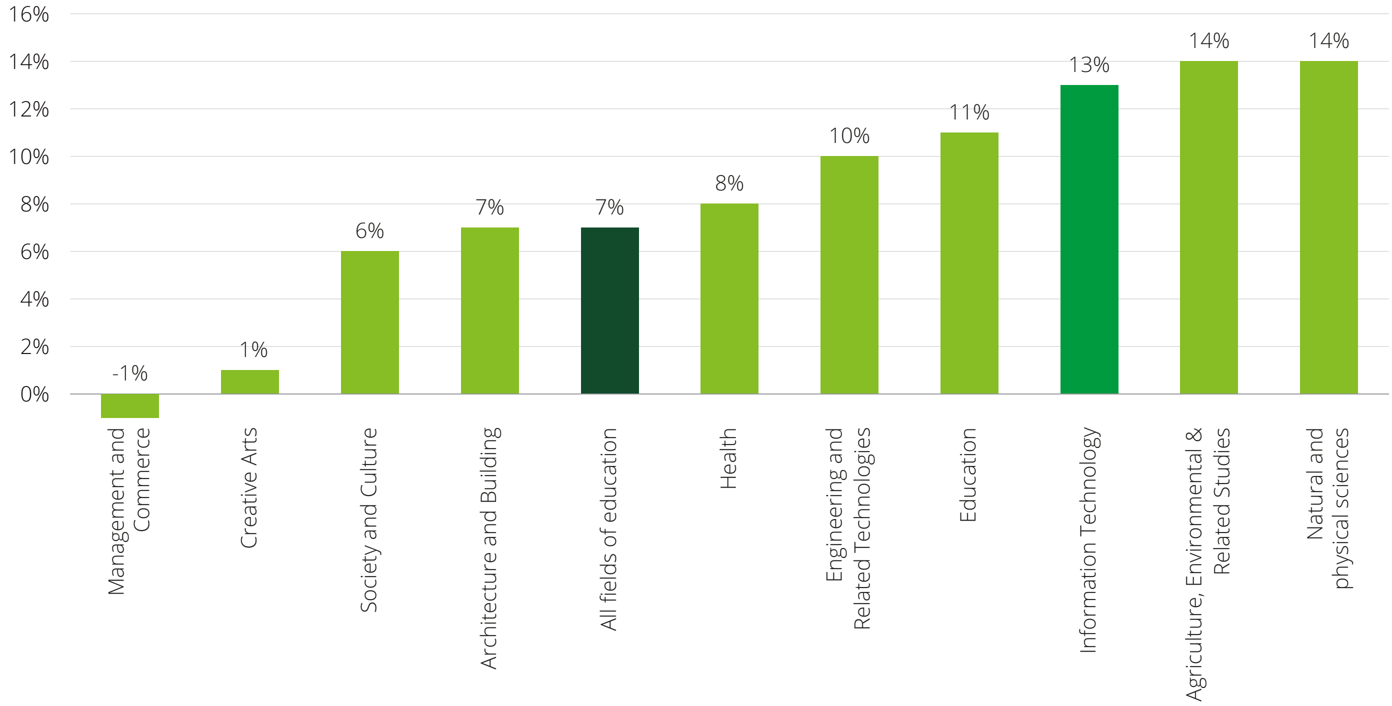
International enrolments in IT degrees experienced stronger increases than domestic enrolments in 2019, growing by 24% from 2018 to a total of 31,831 undergraduate enrolments, and a total of 43,840 postgraduate enrolments. Completion rates demonstrated even stronger growth, increasing by 37% from 2018 to 2019.

Obviously COVID-19 has impacted the education landscape in Australia. While international student enrolments and completions decreased significantly, the deteriorated labour market conditions is expected to incentivise further study by domestic residents.

The Australian government has incentivised continuing study through a $20 billion investment in higher education in 2021.[xxxii] This includes the implementation of the Job-ready Graduates Package, aiming to subsidise courses where there is demand in the labour market. IT is just one field of education that has been subsidised, with average fees decreasing by 18% or nearly $1,750.

Early admissions data from 25 universities showed a 5% increase in total domestic undergraduate enrolments this year compared to 2020. The biggest increases in new enrolments have been in the courses subsidised under the Job-ready Graduate Package. This includes IT, with commencing undergraduate enrolments in IT increasing by 13%, from 6,857 to 7,763 students (Chart 3.2).

Chart 3.2: Change in commencing domestic enrolments in IT degrees, 2020-21 (based on early admissions data)



Source: Department of Education, Skills and Employment (2021)

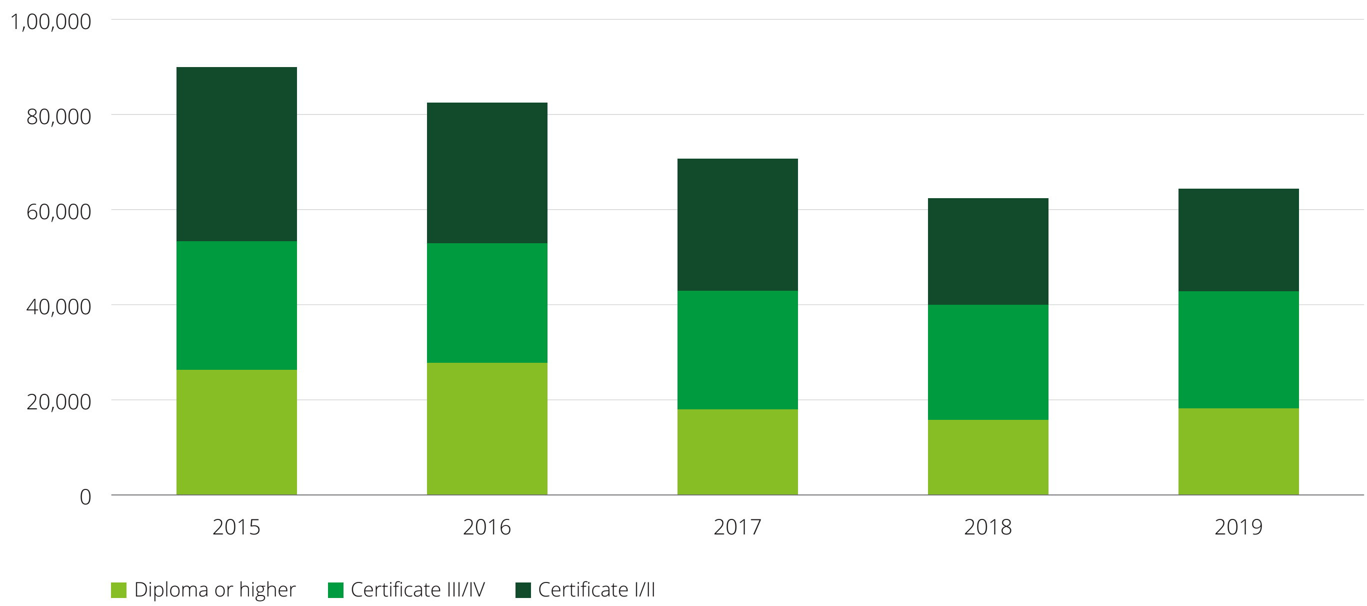
It should be noted that as this analysis is based on early admissions data, it does not include all university enrolment data. In addition, there is no early admissions data on international enrolments, which can be expected to decrease.

Despite strong growth in ICT qualifications, Australia will struggle to meet demand based on domestic completions alone. The increases in completions still fall short of the extra 60,000 technology workers needed on average each year to reach to our forecasted growth in the workforce, on top of replacing those who are retiring or changing employment industries. This means other avenues to the technology sector remain important, such as short courses which allow a transition into ICT or a quick return to open borders to fill the gaps with migrants.

3.1.2 Vocational training

Enrolments in entry-level Vocational Education and Training (VET) ICT subjects continued to decline in 2019, with enrolments in Certificate I/II courses falling by 4.3% on 2018, or over 40% from 2015. Although enrolments in Diploma and above courses rose 15.1% from 2018, they are still nearly 31% below 2015 levels. By comparison, enrolments in Certificate III/IV courses have remained relatively stable, rising 2.3% in 2019, or falling 8.8% since 2015 (Chart 3.3). Courses at this level tend to offer more job-specific training compared to the basic skills taught in introductory courses and may not require completion of an earlier Certificate I/II course. The change in composition of demand for vocational training courses may indicate that students are interested in gaining more job-specific skills compared to those offered in Certificate I/II courses.

Chart 3.3: Vocational Education Training (VET) ICT subject enrolments by qualification level, 2015–19



Source: NCVER Total VET Students and Courses (2018) DataBuilder (2021)

The National Skills Commission (NSC) was set up in July 2020 under the *National Skills Commissioner Act 2020* to inform Australia's labour market and its current, emerging, and future skills requirements. In addition to contributing to labour market information and relevant skills, the commission aims to improve Australia's VET system. The NSC has also developed the Australian Skills Classification Interface, which provides occupation profiles and skills clusters to demonstrate the linkages and distribution of skills across different industries and roles. Of the around 600 occupations within the skills classification, more than 75% have at least one technology tool relevant to the occupation.[xxxii]

3.2 Forecasts for qualifications

Consistent with the forecasted growth in the technology workforce from 2020 to 2026, demand for qualifications is also expected to increase. Deloitte Access Economics predicts that employers will demand over 520,000 more ICT qualifications in 2026. This demand for qualifications depends not only on forecasts for employment growth, but also on other labour market considerations such as the demand for workers with different levels of education. As a result, the largest growth in demand is forecast to occur for workers with the highest levels of qualifications. This includes an expected increase of approximately 230,800 workers with undergraduate degrees and 122,100 workers with postgraduate degrees in the technology workforce by 2026 (Table 3.1).

Table 3.1: Forecasts of total qualifications held by technology workers, 2020-26*

Qualification level	2020	2026	Average annual growth, 2020-26
Postgraduate	256,491	378,598	6.7
Undergraduate	533,230	764,058	6.2
Advanced diploma/Diploma	212,788	303,263	6.1
Certificate III and IV	147,152	200,685	5.3
Certificate I and II	68,147	95,195	5.7
Total	**1,217,808**	**1,741,799**	**6.1**

* One person may hold multiple qualifications.
Source: Deloitte Access Economics (2021)

Beyond the forecast growth in these formal qualifications and traditional pathways, there has been an increasing trend towards shorter form courses. In addition to higher education packages like the Job-ready Graduates package, the Federal Government is incentivising studying of IT through investments in short courses. This includes a commitment of $251.8 million for an additional 50,000 short course places in 2021.[xxxiv] These courses are focused on specific industries, including IT and science.

Building on Federal Government investments, State governments are incentivising shorter form courses focused on improving digital skills. One focus of the 2020-21 Victorian State Budget is the Digital Economy, with $64 million dedicated to the Digital Skills and Jobs Program over four years.[xxxv] The program funds short courses to support 5,000 reskilling jobseekers, with most of this activity expected to be in short-form, unaccredited, university-level credentials.[xxxvi] The program indicates government willingness to fund programs focused on digital skills development.

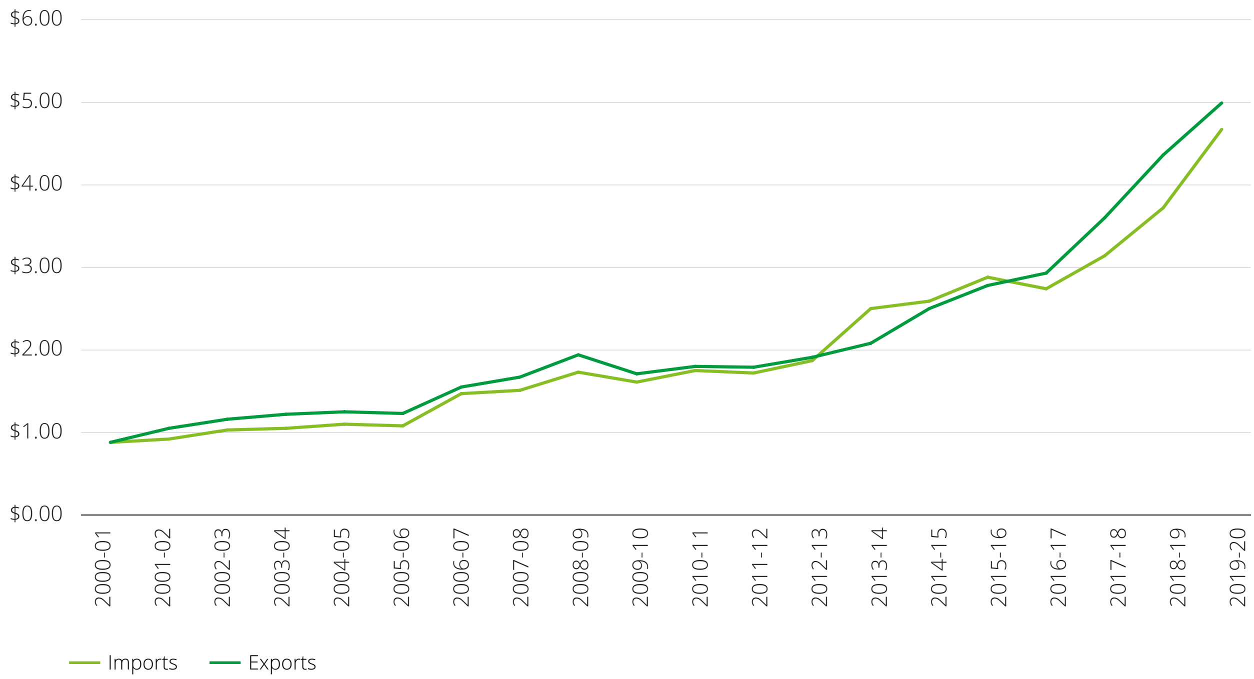
Business skills to promote ICT exports

Exports have been a key factor of growth for the technology sector in Australia. ICT exports totalled $4.99 billion in 2019-20, increasing by over 14% from the previous year (Chart 3.4). Meanwhile, ICT imports increased by just over 25% to reach $4.67 billion. The resulting trade surplus is $313 million.

The importance of exports to the growth of the technology sector means that a focus on developing export-oriented skills will be vital to continuing this growth.

The Australian Government has recognised the importance of export orientated skills and capabilities through a recent agreement to collaborate between the Australian Trade and Investment Commission (Austrade) and FinTech Australia. The Memorandum of Understanding (MoU) will build on the market insights and partnerships opportunities to key markets in the United Kingdom, Singapore and the United States.[xxxvii]

Chart 3.4: ICT exports and imports for Australia ($b), 2000-01 to 2019-20



Source: ABS catalogue 5368 (2021)[xxxiv]

3.3 Top skills demanded by employers

Building the supply of relevant technology skills in the workforce requires that qualifications align with the technology skills demanded by employers. To identify the top technology skills demanded by Australian employers, this report uses a custom dataset from Burning Glass on job postings in Australia in 2019 and 2020. This can be used to demonstrate the top skills required for technology occupations, as well as the top digital skills required across all occupations in the economy.

Data from Burning Glass

Burning Glass Technologies is a software company which uses job advertisement dat to deliver labour market analytics that allow employers, workers, and educators to make data-driven decisions. Using a proprietary AI tecnology, Burning Glass collect hundreds of millions of job postings and real-life career transitions globally, creating a standardised database to provide insight into labour market patterns in real-time.

To gain insight into the digital skills demanded of ICT workers and across the Australian labour market in 2020, Deloitte Access Economics analysed data available on the Burning Glass Labour Insight™ jobs platform. The Burning Glass database includes more than 10 million unique job advertisements (33 million in total) across 967 occupations in Australia and New Zealand between 2012 and 2020, drawn from more than 4,000 online sources across all states and territories. Burning Glass collects these advertisements, removes duplication, and interprets them based on natural languages processing and a sophisticated proprietary taxonomy of jobs and skills. This allows for a standardised view of the skills, experience, occupation, and industry for each job posting. In 2019 and 2020, Burning Glass collected job advertisements capturing 1,400 digital skills across seven digital skill areas , including:

- Baseline digital skills
- Software programming
- Computer networking
- Data analysis
- Digital design marketing
- Machining manufacturing
- Customer relationship management (CRM)

This job postings data shows that **while the number of technology workers increased in 2020, the number of ICT job postings declined.** There were approximately 70,000 postings for ICT jobs in 2020, down 19.5% from 2019. This mirrors the slower pace of growth in the technology workforce in 2020, at 4.3% over the year compared to 6.8% in 2019 (section 2.2). The decline in the number of postings may also point to the larger supply of ICT workers looking for work in 2020 – meaning that employers needed fewer job postings to fill a single position.

Examining the skills requested in 2020 shows that skills in software programming were the most common technical skills requested of ICT workers. The top software programming skills demanded included skills in SQL (requested in 14% of job postings), Java (10%), DevOps (9%) and Python (8%). Skills in computer networking were also among the top technical skills requested in ICT job postings, including skills in providing technical support (requested in 8% of ICT job postings) and Linux (requested in 7% of ICT job postings).

Soft skills made up more than half of the top 10 skills most demanded in ICT job postings in 2020 (Table 3.1). Communication skills were most commonly listed, requested in 42% of ICT job postings. This highlights that **employers are looking for technology workers who can bridge the gap between user needs and digital solutions and bring communication and collaboration skills as well as technical expertise to a role**. It may also highlight that technical digital skills tend to be more specialised, and are less commonly requested in ICT job postings relative to the soft skills which are generally requested across various ICT occupations.

The prevalence of broader skills reflect a trend in technology sector job postings. LinkedIn data used in previous versions of Australia's Digital Pulse supports this trend, with customer service making the top 10 skills possessed by ICT workers moving jobs from 2015 to 2017.[xxxix] In 2017, the top three skills possessed by ICT workers who moved jobs were also all soft skills, being customer service, management and leadership.[xl]

Table 3.1: Top ten skills demanded in ICT job postings, 2020

Rank	Skill	Job postings (no.)	ICT job postings requesting that skill (%)
1	Communication Skills	28,539	42%
2	Teamwork/Collaboration	15,232	23%
3	Problem Solving	12,259	18%
4	Planning	11,406	17%
5	SQL	9,789	14%
6	Customer Service	9,096	13%
7	Project Management	8,343	12%
8	Troubleshooting	7,372	11%
9	Writing	7,292	11%
10	Java	6,889	10%

Source: Burning Glass custom data (2021).

The number of ICT job postings **differed between industries in 2020**. The industry with the strongest demand for ICT workers was professional, scientific, and technical services, representing 24% of all job postings for ICT occupations in 2020. By comparison, agriculture, forestry, and fishing was the industry with the weakest demand for ICT workers, representing less than 0.5% of job postings for ICT workers in 2020. The number of job postings for ICT workers declined in every industry in 2020, except for construction – which posted a marginal increase to grow from 0.7% of ICT job postings in 2019 to 1.0% in 2020.

Examining the skills demanded in ICT job postings by industry shows that **while demand for soft skills is common across industries, the types of technical digital skills requested in ICT job postings differ by industry**. For example, Table 3.2 shows that the top technical skills requested in the mining industry were computer programming, systems engineering and DevOps – skills to support operations, collect, store, and analyse data. By comparison, ICT job postings in public administration and safety requested some technical skills in computer programming (such as SQL) and technical support, but more commonly requested ICT workers with management, relationship, and customer service skills. The skills demanded in ICT job postings in other industries are provided in Table A.30 in Appendix A.

Table 3.2: Top skills requested in ICT job postings: mining industry and public administration and safety, 2020

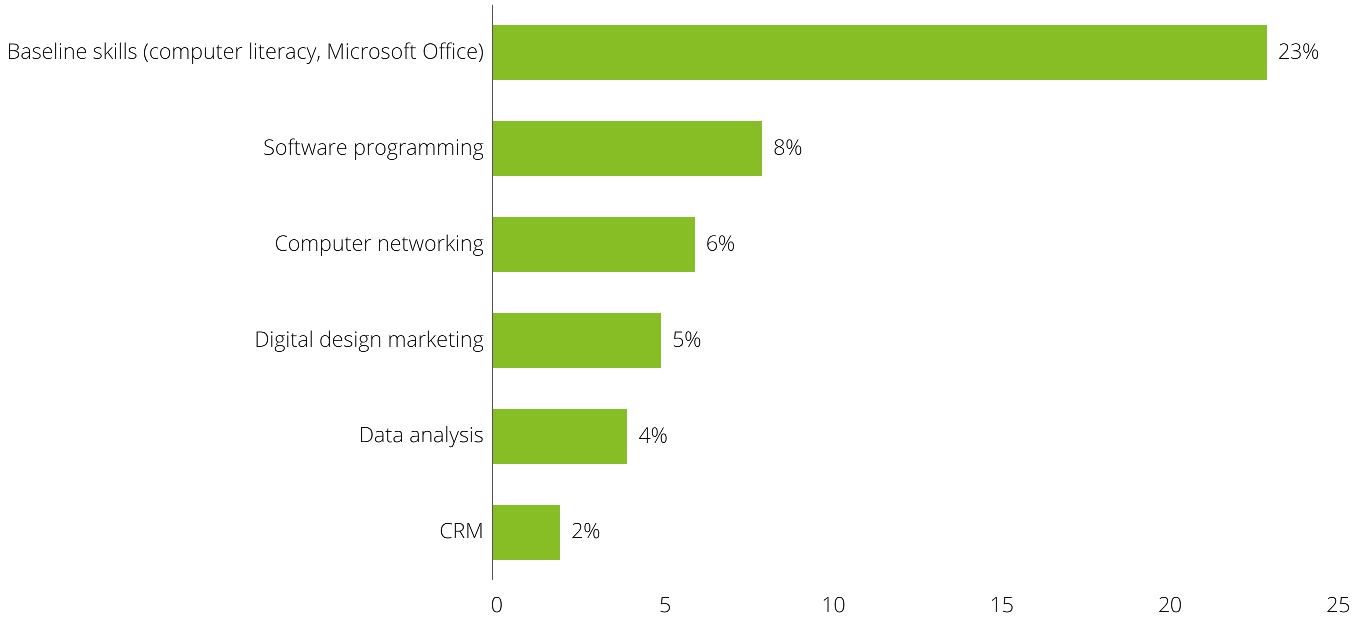
Rank	Mining	Public administration and safety
1	Communication Skills	Communication Skills
2	Planning	Planning
3	Teamwork/Collaboration	Teamwork/Collaboration
4	Problem Solving	Problem Solving
5	SQL	Research
6	SAP	Project Management
7	Writing	Customer Service
8	Customer Service	Building Effective Relationships
9	Systems Engineering	Technical Support
10	DevOps	SQL

Source: Burning Glass custom data (2021).

Across all occupations and industries, **baseline digital skills are foundational to workers in across many roles**. In 2020, the top digital skills requested in job postings across all occupations were baseline skills such as computer literacy and skills in Microsoft Office, requested in at least 23% of job postings of all occupations in non-ICT industries (excluding job postings in the information, media and telecommunications industry) (Chart 3.5).[5]

Technical digital skills are also in demand across all occupations and industries. At least 8% of all job postings across all occupations requested skills in software programming, and at least 6% requested skills in computer networking (Chart 3.5).

Chart 3.5: Digital skills requested across all occupation job postings and industries* (% of job postings requesting), 2020



*Excluding job postings in the information, media and telecommunications industry.
Source: Burning Glass custom data (2021).

[5] These figures include job postings for ICT occupations, but exclude job postings in the information, media and telecommunications (IMT) industry.

In some industries, **baseline digital skills may also be treated as assumed knowledge**. Only 13% of job postings in professional, scientific, and technical services requested skills in computer literacy in 2020, down from 14% of job postings in 2019. Rather than pointing to a decline in requests for computer literacy, this may point to an increasing expectation that computer literacy should be assumed knowledge across professional occupations.

By comparison, 29% of job postings in healthcare requested skills in computer literacy in 2020, up from 28% in 2019. This may point to the increased reliance on e-Health and telehealth services in the health sector in 2020.

3.4 Promoting the use of AI

AI is the development of computer systems able to perform tasks that normally require human intelligence. This can include tasks such as visual perception, speech recognition, decision-making and translation between languages.[xli]

AI is growing rapidly. Globally, revenue in AI is expected to grow by 13.2% each year between 2019 to 2024. Much of this growth is concentrated in the APAC region, where revenue is expected to reach US$29 billion by 2024.

Governments around the globe are investing heavily in AI. For example, in 2017 China released a New Generation AI Development Plan, which led to the establishment of several AI research centres and allocated US$950 million annually to fund strategic AI projects.[xliv]

Australia's investment in AI is modest in comparison. The Australian Government's 2018-19 budget included just under $30 million allocation in AI to be rolled out over four years.[xliii]

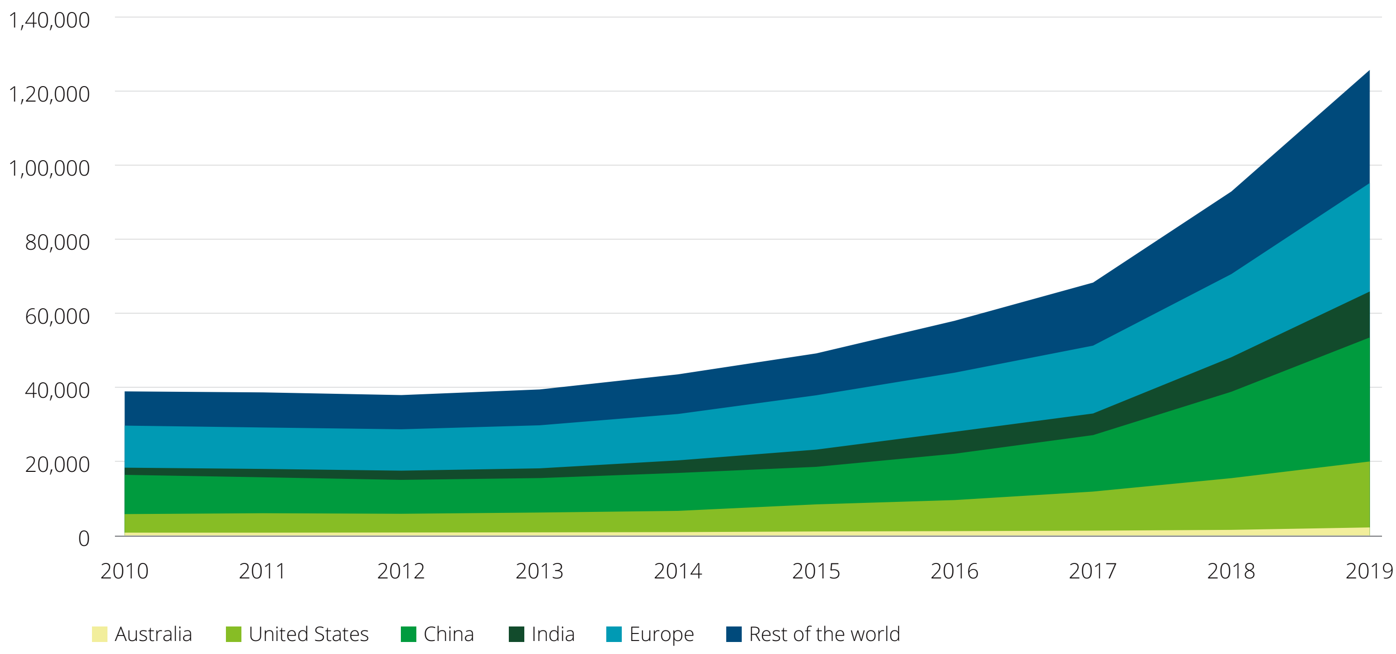
In part, this may be because the benefits of AI aren't as well recognised in Australia. Previous Deloitte research found that early adopters of AI in Australia were less ambitious about the potential impact of AI on their business, compared with other countries.[xliv]

But perhaps the biggest challenge is access to the right skills and capabilities. While there is already high demand for people with skills in AI, Australian businesses struggle to find people with the required expertise.[xlv] This challenge was also recognised in the Australian Government's call for views on Australia's AI Action Plan in 2020, which included the issue of how to best ensure Australians have the skills and capabilities needed for an AI-enabled future.[xlvi]

By 2030, it's estimated that Australia will require an AI specialist workforce of between 32,000 and 161,000. This includes professionals in computer vision, robotics, data science, human language technologies, and other related fields. These skills will be used across industries in occupations such as data analysts and machine learning engineers, data platform architects, business intelligence developers, and research scientists. Without access to the right skills, it's likely Australia will continue to fall behind its international counterparts in the development and deployment of AI technologies.

The low level of investment needed in building sustainable AI capabilities is also reflected in Australia's research output. Australia's share of global AI publications has declined slightly from 2.1% in 2012 to 1.7% in 2019 (Chart 3.6).

Chart 3.6: AI publications by region, 2010 to 2019



Source: OECD and Deloitte Access Economics (2021).[xlviii]

Another challenge in the adoption of AI technologies is the need to encourage consumer and business confidence in the safety and security of AI technologies. The Australian Government recognised this issue in the publication of the AI Ethics Framework, which outlines eight key principles for the ethical and safe design and use of AI systems.[xlix] Standards Australia also introduced An Artificial Intelligence Standards Roadmap in 2020, to provide a framework for the development of AI standards which are consistent with international practice.[l]

These voluntary standards will assist businesses to understand and safely apply AI technologies, as well as support consumer confidence in taking up in AI-enabled offerings. For example, implementing AI technologies in the healthcare industry will require practitioners to interpret and explain AI health technologies to help patients trust in new technologies to make healthcare decisions on their behalf.

Governments around Australia are also beginning to recognise data privacy issues and are working towards updating regulations and adopting new solutions. For example, the New South Wales Government adopted the ACS data sharing framework in 2020 when publishing data on COVID-19 cases.[li] The Office of the Australian Information Commissioner has also recommended that the Data Availability and Transparency Bill 2020 be updated to require that citizen data is de-identified.[lii]

ACS recognises the importance of AI technologies in Australia's technology landscape. Since 2018, ACS has been building a strong foundation of research in AI, including publishing three reports which analyse the development of this technology in the successive years.[6] In parallel, ACS has delivered multiple workshops, events and panel discussions about AI and launched an AI Hub in Docklands in 2019 which was attended by over 120 entrepreneurs.

Applying artificial intelligence at the Centre for Health Informatics

Healthcare is a major area for AI research and investment, with the potential to improve the diagnosis of disease and delivery of care to patients. The Centre for Health Informatics (the Centre) at Macquarie University is at the foreground of this research as one of the largest and longest running academic research groups in digital health.

The Centre has a diverse team of scientists from medicine, biomedical engineering, computer science, pharmacology, electrical engineering, data science, IT, philosophy, and nursing. The Centre also leads the Australian Alliance for Artificial Intelligence in Healthcare (AAAiH), which represents over ninety partners across academia, industry, consumers and government with the aim of translating AI technologies into health practice.

As Director of the Centre for Health Informatics, Professor Enrico Coiera describes AI as having "the potential to drive transformative change for some of our largest problems" in healthcare in Australia. For example, machine learning systems can be used to improve patient diagnosis by creating predictive models for a range of diseases. In 2020, the Centre produced an automated COVID-19 cough screening tool, using AI methods to estimate a person's chances of having COVID-19 based on acoustic data captured by a standard commercial smartphone. This can facilitate the rapid and scalable screening of a population.

To encourage the adoption of AI among healthcare practitioners, the Centre focusses on designing systems which are easy to use and minimise administrative tasks. For example, the Centre has undertaken foundational research to create a Digital Scribe, using speech recognition and AI methods to transcribe and summarise patient consultations. This technology should reduce the data entry burden for practitioners, which was found to be a significant factor leading to burnout in the United States. By reducing time spent taking notes and increasing the accuracy of consultation notes, the Digital Scribe aims to focus practitioners on their most valuable tasks of listening to and managing their patients in real time.

While the adoption of AI technologies by healthcare enterprises is growing, skills are a major constraint to implementing AI in practice. Professor Coiera says that "medical practitioners require pre-certification training to be ready to be safe and effective users of AI in routine care, as well as ongoing upskilling and retraining to keep pace with innovations." Professor Coiera also identifies a training gap among research scientists, who "require healthcare knowledge to customise AI solutions to the needs of different health practitioners and calibrate systems to the particular risks of patient care in different settings".

Professor Coiera believes that realising the benefits of AI in healthcare will require substantial investment in skills for healthcare workers. "We don't need wait for more innovations in AI to transform health care", says Professor Coiera. "The technologies we already have can improve the decisions we make. What we most need are people with the skills to understand and use the technology to realise the efficiencies and improved precision in decision-making that we expect from AI."

[6] These reports include *Artificial Intelligence: A Starter Guide to The Future of Business, Machine Learning Innovation, and Australia's Digital Pulse 2020.*

4. Gender diversity dividend

Improving gender diversity is critical to the success of business. Improving women's economic empowerment has been estimated to represent a US$12 trillion opportunity for the global economy.[liii]

Firms with higher levels of gender diversity have been shown to be relatively more productive and innovative. [liv,lv] In fact, businesses could record an average 2.1 percentage point increase in profitability through reaching gender parity in senior management alone.[lvi]

Despite these benefits, gender diversity in the technology sector continues to lag behind comparable industries. Women make up 29% of employment in technology in Australia, compared to 48% in similar occupations in the professional, scientific and technical services (PST) industry.[6]

In part, this is because a large proportion of jobs in the technology sector are in managerial and professional roles, which tend to be underrepresented by women across the economy. However, other technology occupations suffer from underrepresentation of women. This likely reflects long-standing gender stereotypes about suitable careers for men and women. In fact, gender imbalances do not just begin in university and TAFE courses, but high school (or perhaps even before this), where career aspirations and expectations are often set.[lvii]

Other reasons behind the gender gap in the technology sector explored in the 2015 edition of *Australia's Digital Pulse* include a narrow image of what it means to work in a technology-oriented field and the perception of the lack of flexibility in the workplace.[lviii]

Technology firms have made minimal progress in improving diversity in recent years. Since 2015, female representation in technology occupations has grown by 0.75% on average every year.

Improving the gender diversity could address the current digital skills gap facing the Australian workforce. Indeed, digital skills were identified as one of the top four largest skills gaps in the country.[lix] To improve access to digital skills the technology sector needs to expand its talent pool and tap into underutilised talent – namely women. This will be critical to longer term industry growth.

Deloitte Access Economics modelled the impact of increasing diversity in the technology sector in Australia. This analysis is intended to help inform the conversation around the importance of women in technology, by highlighting the benefits that result across the entire Australian economy.

Modelling for this report finds that increasing gender diversity in the technology workforce would grow Australia's economy by $1.8 billion every year on average, over the next 20 years. In employment terms, it would create almost 5,000 full-time equivalent (FTE) jobs on average.

Over a 20-year horizon, the net present value (NPV) of increasing diversity in technology amounts to an $11 billion opportunity for Australia's economy.

Further detail on the modelling used to calculate these estimates is provided in Appendix B.

Diversity can come in many forms – including gender, age, race, sexual orientation and people living with disability. Increasing diversity through these other dimensions could be expected to generate similar types of benefits outlined in this Section. This point has been made in relation to increasing age diversity in the technology workforce in previous editions of *Australia's Digital Pulse*.

This Section focuses on quantifying benefits associated from increasing the number of women in the technology sector. In doing so, this report does not capture the increasing number of people who identify as non-binary in relation to gender or the important value of increasing diversity, regardless of the associated economic benefits.

4.1 The current state of play

Although women hold around 47% of all employment positions in Australia, they are underrepresented in the technology sector. In 2020, women made up just 29% of the technology workforce (see Chart 4.1).

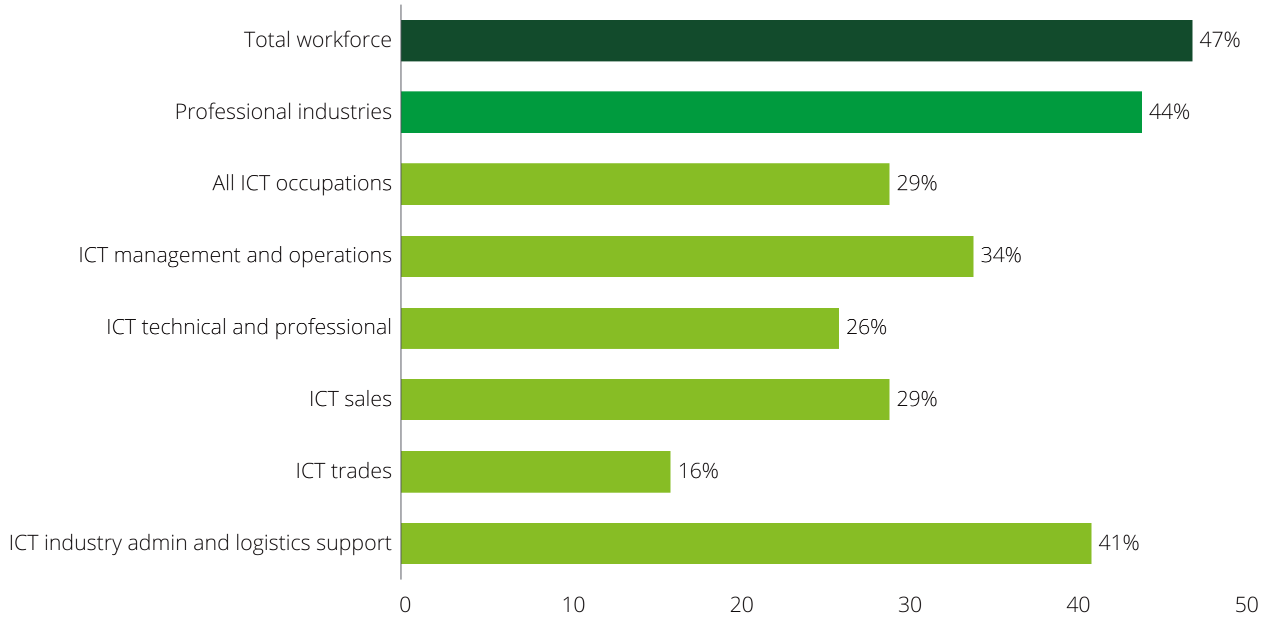
Within technology, women are most strongly represented in admin and logistics (41%) and management (34%) roles. In contrast, just 16% of trades roles are filled by women.

The proportion of women in technology is significantly lower than other comparable occupations. For example, after accounting for the occupational profile of technology, close to half (48%) of all workers in PST are women.[8]

[7] Reflecting female participation in PST excluding technology occupations and weighted by the occupational breakdown in the technology workforce (at the 1-digit ANZSCO level). See Appendix B for further details.

[8] Ibid.

Chart 4.1: Share of women in technology occupations, 2020



Source: ABS customised report (2021).
*Note: Reflecting female participation in PST excluding technology occupations and weighted by the occupational breakdown in the technology workforce (at the 1-digit ANZSCO level)

Technology firms have made some (albeit slow) progress towards improving gender diversity in recent years. On average, the proportion of female workers in technology has increased by 0.75% per year since 2016. Similarly, the proportion of females studying an IT degree at university has grown by 0.6% per year from 2010 to 2019.

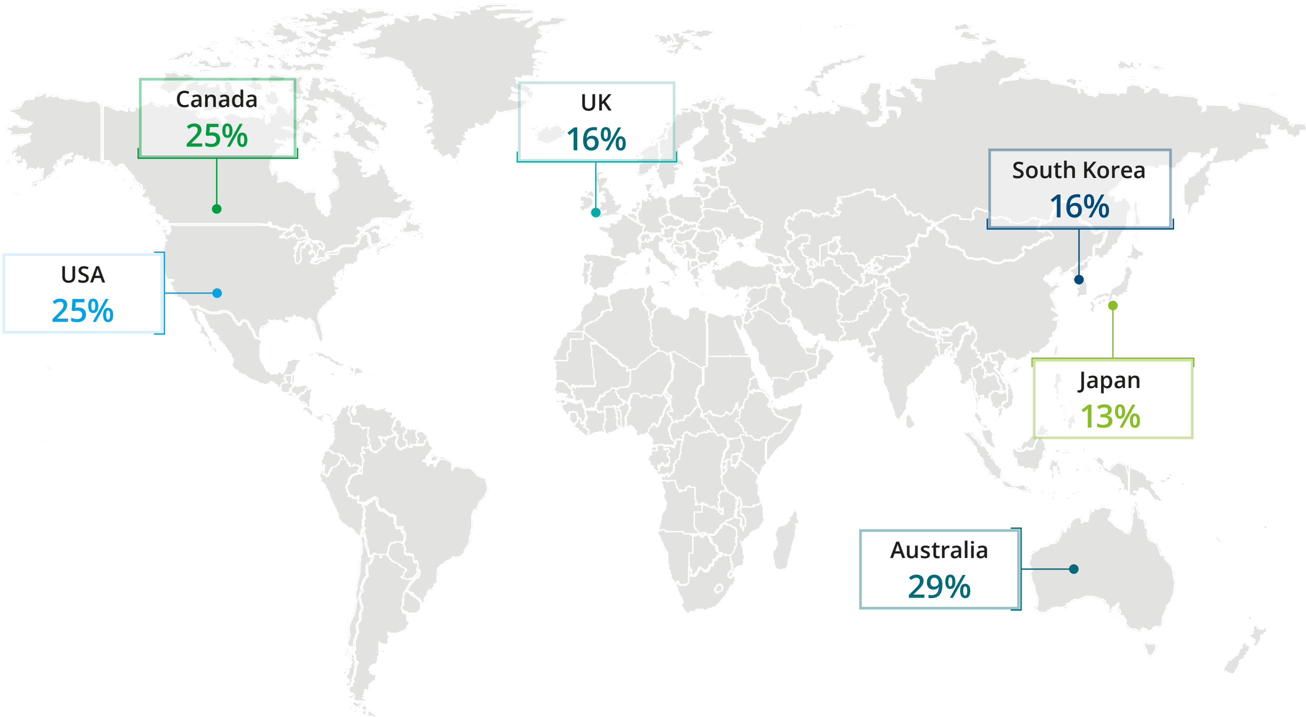
But this isn't fast enough to achieve gender diversity any time soon. Based on current trends, it would take 66 years to reach the level of female participation in PST today.

The lack of diversity in technology isn't a problem that is unique to Australia. The shares of technology that are women is low around the globe. Indeed, Australia hires a relatively larger share of technology workers that are women than many of its international counterparts (see Figure 4.1).

Women in tech

- Just **29%** of the technology workforce in Australia are women.
- The proportion of female workers in tech is growing by **less than 1%** each year.
- **One in five** graduates in information technology are women.

Figure 4.1: Female participation in the technology sector for select countries



Source: Deloitte Access Economics (2021) and Honeypot (2018)[lx].

Note: For all countries excluding Australia, this data is for 2018. The Australian figure is for 2020. The definition used in measuring the technology workforce for other countries is consistent with the approach taken in Australia's Digital Pulse

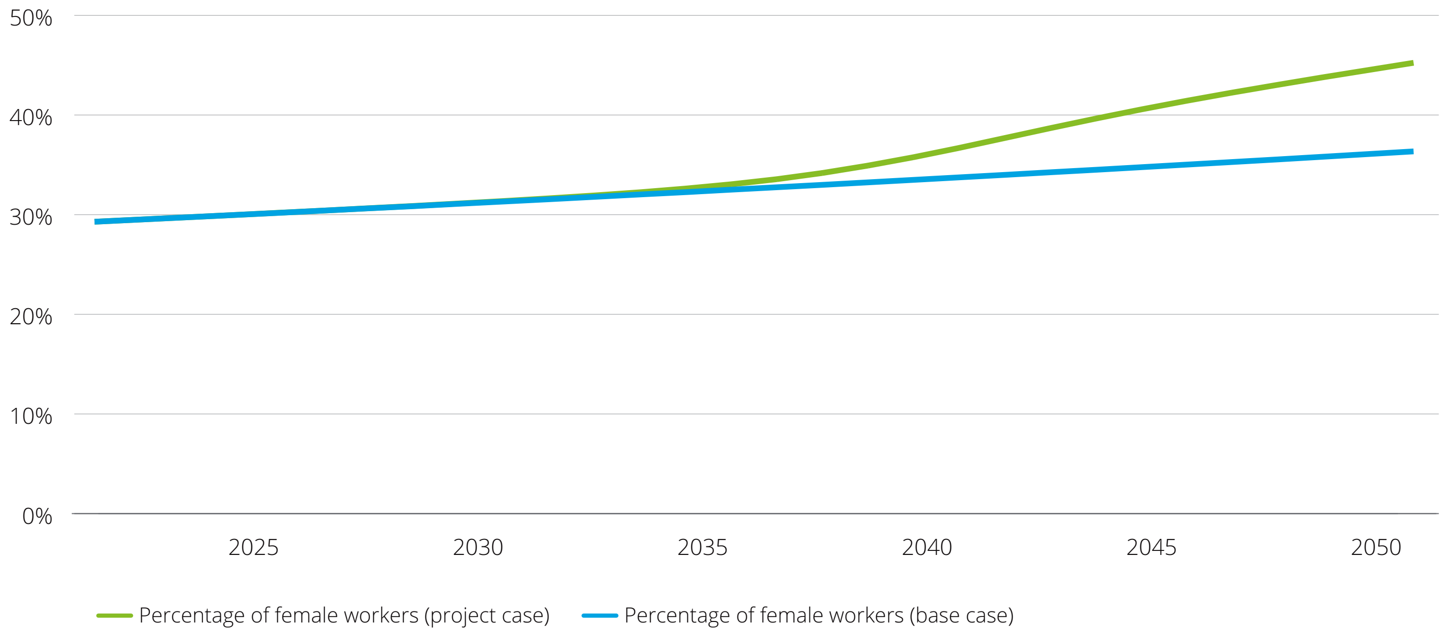
4.2 Size of the benefits

Modelling for this report captures the economic impact of increasing the number of women in the technology sector to the level of 48%. This target is based on the proportion of women currently employed in PST occupations.

We estimate an additional 382,000 FTE female technology workers will be required to reach the target level by 2053 (see Chart 4.2).[9] This estimate is based on current growth rates in female participation in technology, alongside employment forecasts.

[9] We assume it takes 33 years to reach the target level – or half the time it would have done otherwise (in the baseline scenario). See Appendix B for further detail.

Chart 4.2: Current and target female participation in technology (2020-53)



Source: Deloitte Access Economics (2021)

Increasing the share of women in technology contributes to economic growth in Australia in two ways. First, it allows a portion of existing female workers to move from other sectors into higher skilled occupations in technology, creating a productivity dividend. Secondly, it will encourage additional women to enter the workforce or increase their hours of work (their labour supply), lifting participation rates.

Participation and productivity are two of the three 'Ps' that contribute to longer term economic growth; the third is population.

Approximately 12% of the additional roles will be filled by women currently working part-time in the technology sector, who move into full-time work. The remaining 88% will be filled by female workers who move from other sectors and occupations.

Of course, skill requirements vary greatly across occupations, and some workers don't possess the appropriate skills to move into technology roles. We use O*NET data – a database which includes information about the skills required by occupation – to assess skill similarities across occupations. Based on this information, we assume those workers transitioning into the technology workforce come from the top 100 occupations with the most similar skillsets.

Women transitioning into technology receive higher wages on average. This occurs due to the highly skilled nature of technology occupations. Indeed, based on occupational-level wage data, we estimate that these occupational changes lead to a $5.4 billion net increase in labour income, or just under $16,000 per worker on average.

While the uplift in labour supply and labour productivity is centred in the technology sector, it catalyses an economic benefit across the Australian economy more broadly. Using computable general equilibrium (CGE) modelling, this report estimates the impact on output and jobs in Australia (see Appendix B for details).

This report estimates Australia's economy would be $1.8 billion larger every year on average as a result of increasing female participation in technology occupations, over a 20-year horizon. In employment terms, it would create close to 5,000 FTE jobs on average each year.

Of course, it takes time for policies aimed at increasing diversity to gain momentum, and progress may be slow initially. But as the number of female role models in technology increases, it will catalyse exponential growth in gender diversity across the sector more broadly. In fact, if the technology sector were to reach the target level of 47.5% female participation, Australia's economy could be as much as $21 billion larger every year, with more than 47,000 additional FTE employees. Further detail on the data and methodology are provided in Appendix B.

Every year where female participation in technology increases represents another year of economic gains. And these economic gains will persist, even if the rate of improvement slows or stops altogether. This means that even small changes in the level of female participation in technology today has the potential to create a long-lasting impact on Australia's economy.

This analysis also doesn't consider the broader innovation and productivity gains at the firm-level that result from having a more diverse workforce. This means that the economic benefit to Australia could be even larger.

4.3 Opportunities for impact

Modelling for this report highlights the economic opportunity associated with increasing the number of women in technology, and existing literature underscores the benefit of diversity for business performance. **So, what can be done to help enable the transition to a more gender diverse workforce?**

This Section explores some initiatives or areas that could encourage more women to enter and stay in technology occupations. Some of these are not new. Some of these ideas been raised before, but have not been tried extensively and could have an impact. These initiatives are worth investigating and successful instances in Australia and overseas should be considered.

ACS is also assessing the findings of this research and considering options to improve gender diversity in technology, including recommendations based on additional insights and research from its National Diversity and Inclusion Council.

There are many different reasons why female participation in the technology sector is low. Some come from broader societal gender norms and stereotypes. These norms are conditioned from an early age and can contribute to the uniform underrepresentation of women in STEM fields more broadly.[lxi]

While these norms manifest at the societal level, they can impact the technology industry directly through unconscious bias. Pre-empting bias by **promoting best practices around attracting, retaining and recruiting talent** can reduce the direct effect of these norms in technology.

Addressing these norms should also lead to more women studying IT degrees and being ready for careers. Current only one in five domestic IT graduates are women, rising to one in three for international students.[lxii] **Increasing access to technology-based subject matter** and encouraging technology-related careers during school could have an effect on this pipeline.

Early exposure to technology is especially important for women, who disproportionately arrive at university without previous exposure to computing.[lxii]

More immediately, more can be done to maintain participation of suitably qualified women. Currently, the attrition rate for female technology workers is double that of men.[lxiv] Lack of access to flexible work arrangements and conservative parental leave policies can cause women to drop out of the technology workforce. This can be difficult particularly at the senior management level, causing many women to self-select out of these roles. Greater **access to flexible work arrangements** could prevent this attrition, in addition to parental leave policies to encourage mothers to return to work.

In addition, a key source of increased female participation in the economic modelling was women reskilling from other industries. This would require consideration of ways to encourage women to move into technology through additional **life-long learning courses**.

Implementing these initiatives won't just mean a short-term fix. As more women join the technology workforce, it creates a role model effect. Indeed, previous research by Deloitte Access Economics found that a 1% increase in female senior managers is associated with a 0.1% increase in women in the workforce in the following year.[lxv] Adopting **board diversity goals** and setting up **mentoring programs** are some other ways firms can ensure women working in technology are seen by a broader audience. Promoting more women to leadership positions or higher pay may also require incentive and reward structures that are based on observable inputs – such as time worked – than outcomes.

What to know more?
There are range of resources available to help you better iunderstand gender equality issues in the workplace and what you can do to help, including but not limited to:

- **Australia's Workplace Gender Equality Agency:** htttps://www.wgea.gov.au/
- **Diversity Council Australia:** https://www.dca.org.au/topics/gender
- **Australian Gender Equality Council:** https://www.agec.org.au/

5. Benefits of professionalisation of the technology workforce

This section explores the potential for professionalisation in the technology workforce and identifies some of the key benefits from doing so.

5.1 What is professionalisation?

Professionalisation is when individuals of a shared occupation agree to practices for education, codes of practice, ethical behaviour and standards for products and services. Individuals usually receive some form of accreditation by a professional body and must participate in professional development over time to maintain their status.

Some occupations such as health practitioners, accountants, lawyers and engineers – have sought to develop a level of professionalisation within their occupation to maintain standards and trust of their clients. Some of these arrangements are summarised in Figure 5.1 below.

Figure 5.1: Forms of professionalisation in other industries

Accountant
There are three major accounting bodies with whom an accountant can gain accreditation, as well as several recognised international accounting bodies. The accreditation standards apply to approved accounting programs.

Health Practitioner
The Australian Health Practitioner Regulation Agency (Ahpra) works with 15 National Boards to ensure students are qualified and skilled to register under the National Accreditation Scheme (NRAS).

Engineer
Engineers Australia is the accreditation authority for tertiary engineering education in Australia and overseas. The Australian Engineering Accreditation Centre (AEAC) evaluates engineering programs and has a list of accredited programs.

Lawyer
After undertaking a course recognised by the relevant state/territory Law Society, students complete work placement. After 18 to 24 months of supervised practice, they can apply to the relevant Law Society for a Practicing Certificate.

Source: Deloitte Access Economics (2021)

Comparing these professions, technology managers and professionals are one of the largest cohorts when comparing the number of employed people in Australia (Table 5.1). This suggest potentially significant benefits from further professionalisation of these workers.

Table 5.1: Number of professional members compared to technology professionals

Profession	Number of professionals
Health practitioners	801,659
Technology managers and professionals	565,536
Accountant	195,800
Engineers	185,916
Lawyers	116,900

Note: technology professionals based on ICT management and operations and ICT technical and professionals for 2020, Health practitioners, accountants figures available for 2019, lawyer figures for 2021, engineer figures for 2016.
Source: Australian Government (2021)[lxvi], Ahpral[xvii], Engineers Australia (2020) [lxviii], Urbis (2019) [lxix], ABS (2021)[lxx]

However, other occupations that involve a degree of trust and specialist knowledge have not experienced the same degree of professionalisation. Economists and some scientists (e.g., epidemiologists) are not represented by a single organisation nor do they have any universally agreed structure and content for tertiary qualifications.

Technology workers require a high degree of technical knowledge and significant trust to undertake their work, however, professionalisation is limited. The case of professionalisation could be made on the basis of the significant impact of the occupations.

Technology experts design systems that can collect and analyse confidential and commercial information – like mobile payment apps or healthcare data – which could cause significant disruption if made publicly available.

More broadly, the systems and solutions developed by technology workers can be critical to the internal operation of businesses and the economy more broadly. This was only further reinforced by COVID-19 and the switch to even greater reliance on IT systems.

However, the rapidly evolving nature of technology means that laws or regulation struggle to keep pace with developments in the industry, so professionals must be entrusted to make ethical decisions as they emerge. The Honourable Michael Kirby AC, former Justice of the High Court of Australia, recognises the unique nature through the following quote:[lxxi]

> "No sooner is a conventional law made to address some of their [biotechnology and ICT] features, and to regulate those deemed necessary for regulaton by reference to community standards, the technology itself has changed."
>
> – The Hon Michael Kirby AC

With technology occupations changing all the time, it could be argued, professional standards would not keep up, restricting innovation and posing costs. In addition, as with any occupation, there are difficulties in getting consensus on set of knowledge and techniques, set up costs of professional bodies and individual costs for membership and ongoing professional development.

This section explores the potential for professionalisation in the technology workforce and identifies some of the key benefits from doing so.

5.2. Professionalisation in technology occupations

There are a range of initiatives currently being undertaken by ACS to increase professionalisation in the technology sector. These are captured under three main programs: higher education accreditation, migration skills assessment, and professional certification (Table 5.2).

Table 5.2: Forms of technology workforce professionalisation

Accreditation of higher education programs

ACS accreditation provides assurance that higher education technology courses meet certain defined standards.

Courses are evaluated on a range of measures, covering curriculum, teaching capability and linkages with industry. Overall, these measures are designed to capture whether a course can produce graduates with the knowledge and skills required of a technology professional.

While accreditation is voluntary, to date over 41 higher education institutions in Australia have had courses accredited. There are also two overseas universities – Sohar University and the University of South Pacific – that have had courses accredited by ACS.

These qualifications are also recognised internationally by the 8 signatories of the Seoul Accord.

Migration skills assessment

Skilled migration plays an important role in filling critical skills gaps in Australia's technology workforce.

Yet, industry standards can vary significantly from country-to-country. This can create difficulty in assessing whether a technology professional from overseas may have the required skills for technology roles in Australia.

ACS is authorised by the Australian Government to undertakes skill assessments for the purposes of skilled migration programs. The aim of these assessments is to determine whether those considering skilled migration have the right skills required to work as technology professionals in Australia.

There are a range of key criteria considered when assessing an applicant's suitability, covering their experience and qualifications. In particular, an applicant's qualification is checked against the Australian Qualifications Framework (AQF) to determine whether it is compatible. Qualifications are also checked to determine whether they are closely related to an Australian occupational category in technology.

Successful applicants are issued with a certificate that is taken to the Department of Home Affairs when applying for a visa.

Professional certification

Technology professionals can decide to get certified through ACS' professional certification program.

This program provides members with professional recognition of specialist skills from Australian Federal, State, and Territory Governments. Certified members can use the post nominal IP3P and corresponding certification logo, a mark of expertise.

ACS professional certifications are technology agnostic, recognising transferable skills and competencies. Applicants must also commit to a code of ethics, a code of professional practice, and continuing professional development (CPD).

Professionals applying for certification are assessed based on their qualifications and experience, skills and knowledge, and interviews with referees.

Technology workers can choose to become a Certified Technologist (CT) or a Certified Professional (CP).

Continuing Professional Development is mandatory for all certified ACS members. Certified Professionals (CP) must complete 30 CPD hours per year, while Certified Technologists (CT) must complete and report 20 CPD hours each year. Upon being awarded either certification, applicants may download the applicable logo below to include on their business cards.

To date, the number of certified professionals comprises only a very small proportion of the overall technology workforce. Given the benefits of certification, this may reflect a missed opportunity to drive better business outcomes in the technology sector.

Established governance and ethics

ACS promotes ethical behaviour amongst members through its *ACS Code of Ethics* and *ACS Code of Professional* Conduct. These documents provide agreed upon codes for behaviour in dealing with clients and promote members to consider the interests of the technology profession more broadly.

Source: ACS (2021).

There are also international efforts to promote professionalisation of technology workers. CREST began in the UK but now has an expanded presence in Australia, United States, Hong Kong, and Singapore.[lxxii] CREST qualification and certification is also promoted in the latest ASIC and Home Affairs guidance for penetration testing and cyber incident responders. Another international body is the Chartered Institute of Information Security Professionals, which aims to promote professionalisation of those working in cybersecurity. The CIISEC has many multinationals on the board as well as career models, body of knowledge and roles benchmarked against the SFIA framework.[lxxiii]

5.3 Benefits of professionalisation

Professionalisation comprises a range of different programs and initiatives. There are also broader benefits for the industry, purchasers of technology products and services and the community from professionalisation. Based on a broad literature review and consultation with ACS members, Deloitte Access Economics has identified three primary benefits of professionalisation: increased trust, improved capabilities, and efficiencies and innovation from standards (see Figure 5.2). Further detail on each of the three points are provided in the sections below.

Figure 5.2: Benefits of professionalisation

Source: Deloitte Access Economics (2021)

5.3.1 Increased level of trust with customers and the community

Professionalisation can increase the trust that both customers and the community have in the technology profession in a number of different ways. For example, professionalisation can:

- Provide evidence of a professional commitment
- Help validate the specialised knowledge attained by technology professionals
- Establish a standard of ethics within the industry.

A survey of over 1,000 Australians found the vast majority (86%), rate ethics as important or very important to a well-functioning society.[lxxv]

Currently, the technology sector is not recognised as a profession. The Ethics index found those working in emergency services, health, education and science are the most trusted in Australia while politicians, lawyers and business leaders are among the least trusted.[lxxvi]

While some technology businesses may be considered as business leaders, the lack of explicit recognition of technology occupations might suggest that 'professionalism' is not strongly associated with the sector. A global survey about attitudes towards technology more broadly saw a 4% decline over a year.[lxxvii]

While there are a range of intrinsic reasons for a business being ethical, there are also significant dividends for a business developing trust. A global survey also found that business ethics is three time more important driver for consumer trust in a company compared to competence.[lxxviii]

This can lead to financial benefits, with a 10% improvement in ethical behaviour has been shown to lead to an increase of between 2.7% to 6.6% in wages.[lxxix] Improving the ethical reputation of businesses (by one standard deviation) could lead to as much as a 7% increase in return on assets. [lxxx]

There can also be significant costs when not providing to the expectations of a client. A Queensland Auditor-General's report on ICT projects within the State found that 38% of projects were over budget and 53% faced extensions on time.[lxxxi] A Commonwealth Senate report also noted an increase in Commonwealth ICT projects that have run over budget or over time in the last five years.[lxxxii] The report recommended that the Government establish an independent audit of ICT subcontractors to identify whether government is taking on appropriate levels of risk. This recommendation aimed to improve contracting standards or better principles for the future.

The Senate report also identified improving the digital capabilities of the public sector as a priority.

Professionalisation can assist with the level of trust for technology workers. Research shows that most Australians consider professional membership associations to be highly ethical.[lxxxiii] Through certification, promoting commitment to industry standards and understanding of ethical issues that may come from using technology, could lead to an improvement in the standing of technology workers.

Professionalisation and the associated increase in trust, is a business and economic opportunity, but one of its benefits is that it also minimises risk. Part of the industry problems recently exposed by the royal commission into aged care, the royal commission into the financial services industry and the NSW inquiry into building standards have been ethical and professional failures.[lxxxiv, lxxxv, lxxxvi] While professionalisation does not remove wrongdoing entirely, it can provide the professional culture through promoting codes of ethics and professional conduct needed to minimise risk.

5.3.2 Improved digital capabilities of the workforce

Professionalisation can develop capabilities of technology workers required to perform their job effectively.

Accreditation is the first step; helping to align content across higher education courses and ensuring graduates have the right mix of skills and knowledge to meet industry demand.

Accreditation of higher education provides students with reassurance that the courses they are undertaking meet market needs, while also providing greater certainty for employers on the skills of recent graduates.

The benefits of having a skilled workforce are substantial. **For the average Australian business, improving the quality of human skills among staff could lead to an increase of revenue of over $90,000.**[lxxxvii]

Evolving skills needs of the technology industry can be assisted through accreditation providing guidance on content for emerging subject matter as well. Courses seeking accreditation must continually adapt to cover new developments. For instance, the ACS also recently introduced specialised accreditation in cyber security in response to growing demand for this type of expertise.

The ACS skills assessment for migration also contributes to improving the capabilities of Australia's technology workforce. Ensuring those migrants entering Australia have the skills required by businesses increases the technology skills available in the workforce.

This is an important process as skilled migrants across all industries are often mismatched to roles, with 23% of permanent skilled migrants in Australia working in a role that is below their skill level. This mismatch is costly, with at least $1.25 billion in wages foregone for permanent skilled migrants between 2013 and 2018.[lxxxviii] Attending to this skills mismatch is even more important following international border restrictions caused by COVID-19, with many employers not being able to find workers with the necessary skills.

Professionalisation also promotes the **ongoing development of skills** during a career through continual professional development. The CT and CP programs professional development requirements promote upskilling and reskilling on an annual basis which can contribute to professionals being aware of new developments.

While professional development is important in any industry, it is arguably even more important in technology occupations. The rate of technological change is accelerating, with the World Economic Forum estimating the half-life of professional skills is approximately five years.[lxxxix] Continuous learning is therefore a large part of working any professional occupation, particularly in the technology industry.

The benefits of certification for building capabilities in the workforce are well recognised. In a survey of over 1,700 procurement officers, more than nine in ten thought certification helped build the knowledge and skills of professionals.[xc]

ACS also seeks to encourage businesses to develop the required digital skills in their workforce. Benchmarking of the existing baseline of skills and any potential gaps with current of future needs allows businesses to understand the necessary investments to develop skills.

5.3.3 Enabling efficiencies and innovation through standards

Standards Australia (SA) defines standards as 'voluntary documents that set out specifications, procedures and guidelines that aim to ensure products, services and systems are safe, consistent and reliable'.[xci]

These standards can be applied to physical hardware to create consistency in the specifications of IoT devices or applied to Internet Protocol and software life cycle processes to define the process required for developing and maintaining software systems.

ACS promotes the development and use of standards in the technology industry through representation at standards organisations such as the International Federation for Information Processing (IFIP) technical committees and SA working groups.

Standards can lead to greater efficiency for business and industry by promoting an agreed set of technical requirements and quality of a product. This reduces the potential trading costs of buyers who must understand slight variations in similar products or unnecessary product differentiation.

For technology like IoT devices, standardisation of devices could expand the potential use of devices, leading to a greater number of data points and information available for data analytics. This could unlock many of the higher value added benefits of IoT devices and smart cities explored in Section 2.

Greater use of standards can also promote new incremental innovations in the technology workforce. Incremental innovation involves improving the design or use of existing technology. Standards. Promoting the adoption of an existing type of technology can increase the returns to incremental innovation than if there is greater differentiation between technology types.

The diffusion of industry knowledge is a key ingredient to increasing productivity. Productivity, in turn, contributes to economic growth. Recent research by Standards Australia revealed that a 1% increase in the production of standards was associated with a 0.17% increase in GDP.[xcii]

Applying this increase to the relevant subdivisions for the technology industry would **mean that a 1% increase in standards would translate into approximately $97 million dollars annually in gross value added.[10]**

However, Standards Australia recognises that the inappropriate use of standards can hinder productivity through reducing choice, reducing competition and creating technical barriers to trade. More fundamentally, a focus on incremental reform could come at the expense of more radical innovation. It is therefore important that the contribution of Standards to digital technology in Australia is monitored to ensure a competitive and innovative technology industry remains in Australia.

5.4 Promoting professionalisation

Accessing the benefits described above requires continued professionalisation of the technology workforce. While accreditation has become increasingly widespread across Australia's education institutions, the number of certified technology professionals remains small compared to the technology workforce.

Promoting greater certification requires a demand for this process among purchasers of technology products or by employers. While professionalisation can develop organically as purchasers place requirements for certification and accreditation, it can be difficult for the demand to be displayed when there are not high levels of certification.

Yet there is a strong demand for improving the outcomes from major technology projects. One previous international study found that on average, large IT projects are 45% over budget and 7 % over time, while delivering 56 percent less value than predicted.[xciii]

The Senate report on IT project delivery found these trends had been experienced in public sector procurement over the last five years.[xciv]

The Australian Government is in a unique position to fast track professionalisation in the workforce to potentially improve the performance of IT projects. The Australian Government purchase of computer services, software and IT and telecommunications hardware accounted for $3.4 billion in 2019-20, which accounts for 10% of its procurement expenditure.[xcv] This significant purchasing power represents an important opportunity.

The Australian Government should investigate ways to develop a greater understanding of ICT contractor capabilities to prevent further cost and time overruns. Professional certification provides one method to measure the capabilities of contractors that should be considered.

Promoting better outcomes for digital government project will also require improving the digital capabilities of the public sector. A recent independent inquiry into the public sector found two thirds of Australian public sector agencies cite skills and capabilities as a barrier to using data.[xcvi] As a result of the inquiry the Digital Transformation Agency has established the Digital Profession for the Australian Public Service (APS) to provide formal accredited training and recognition undertaking the program. Promoting the use of the Digital Profession throughout the APS should be considered by the Australian Government.[xcvii]

[10] The two relevant subdivisions for the technology industry are telecommunication services and computer design and related services. The ABS estimates of Gross Value Added for these subdivsions was over $57 billion for 2019-20.

Beyond Government, the technology industry should also investigate incentives and additional value for certification. This could involve providing certified members to preferential professional insurance rates, better access to ongoing education opportunities or exclusive access to professional networking events.

Any potential benefits of promoting further professionalisation need to be weighed against the direct costs of implementing and complying with professional standards. Another issue is considering professionalisation in the context of innovation. One the one hand, professionalisation has the potential to drive innovation through standards but could also constrain more fundamental innovation that occurs in a fast changing environment.

While professionalisation may not be a panacea for improving performance of IT procurement, it could be useful to ensure contracting occurs with those with the right skills and understanding of required ethical considerations to improve outcomes.

Endnotes

i. Australian Bureau of Statistics, Household impacts of COVID-19 survey, February 2021 (17 March 2021) <https://www.abs.gov.au/statistics/people/people-and-communities/household-impacts-covid-19-survey/latest-release>.

ii. Australian Bureau of Statistics, Household impacts of COVID-19 survey, February 2021 (17 March 2021) <https://www.abs.gov.au/statistics/people/people-and-communities/household-impacts-covid-19-survey/latest-release>.

iii. Australian Bureau of Statistics, Household impacts of COVID-19 survey, February 2021 (17 March 2021) <https://www.abs.gov.au/statistics/people/people-and-communities/household-impacts-covid-19-survey/latest-release>.

iv. Australian Bureau of Statistics, Household impacts of COVID-19 survey, February 2021 (17 March 2021) <https://www.abs.gov.au/statistics/people/people-and-communities/household-impacts-covid-19-survey/latest-release>.

v. Greg Hunt, 'Australians embrace telehealth to save lives during COVID-19', Department of Health (20 April 2020) <https://www.health.gov.au/ministers/the-hon-greg-hunt-mp/media/australians-embrace-telehealth-to-save-lives-during-covid-19>.

vi. Roy Chiang, 'Newly developed platform sends vaccination records to Australian Immunisation Register, Healthcare IT News (10 March 2021) <https://www.healthcareit.com.au/article/newly-developed-platform-sends-vaccination-records-australian-immunisation-register>.

vii. Deloitte, TMT Predictions 2021 (2021) <https://www2.deloitte.com/au/en/pages/technology-media-and-telecommunications/articles/tmt-predictions.html>.

viii. Deloitte Access Economics, Australia's eCommerce revolution: how it saved businesses in COVID-19 and future strategies to thrive (report commissioned by Australia Post, October 2020) <https://auspost.com.au/content/dam/auspost_corp/media/documents/ecommerce-report-2020.pdf>.

ix. Deloitte Access Economics, Australia's eCommerce revolution: how it saved businesses in COVID-19 and future strategies to thrive (report commissioned by Australia Post, October 2020) <https://auspost.com.au/content/dam/auspost_corp/media/documents/ecommerce-report-2020.pdf>.

x. Tertiary Education Quality and Standards Agency, Foundations for good practice: The student experience on online learning in Australian higher education during the COVID-19 pandemic (November 2020) <https://www.teqsa.gov.au/sites/default/files/student-experience-of-online-learning-in-australian-he-during-covid-19.pdf?v=1606442611>.

xi. Tertiary Education Quality and Standards Agency, Foundations for good practice: The student experience on online learning in Australian higher education during the COVID-19 pandemic (November 2020) <https://www.teqsa.gov.au/sites/default/files/student-experience-of-online-learning-in-australian-he-during-covid-19.pdf?v=1606442611>.

xii. Deloitte, Blueprint for Enhanced Citizen Experiences (report commissioned for Adobe, March 2021), <https://itwire.com/guest-articles/study-reveals-1-7-billion-reasons-for-australian-governments-to-improve-digital-experiences-for-citizens.html>.

xiii. Deloitte, Blueprint for Enhanced Citizen Experiences (report commissioned for Adobe, March 2021), <https://itwire.com/guest-articles/study-reveals-1-7-billion-reasons-for-australian-governments-to-improve-digital-experiences-for-citizens.html>.

xiv. Australian Bureau of Statistics, Australian System of National Accounts, 2019-20 financial year (30 October 2020) < https://www.abs.gov.au/statistics/economy/national-accounts/australian-system-national-accounts/latest-release#data-download>.

xv. Australian Bureau of Statistics, Labour Force, Australia, February 2021 (18 March 2021) <https://www.abs.gov.au/statistics/labour/employment-and-unemployment/labour-force-australia/latest-release>.

xvi. CMO, IAB: Australia's digital advertising market makes big comeback to grow in 2020, <https://www.cmo.com.au/article/686452/iab-australia-digital-advertising-market-makes-big-comeback-grow-2020/#:~:text=Australia's%20digital%20advertising%20market%20experienced,by%20significant%20video%20advertising%20spend>.

xvii. Department of Home Affairs, Temporary resident (skilled) report (31 December 2020) <https://www.homeaffairs.gov.au/research-and-stats/files/temp-res-skilled-quarterly-report-311220.pdf>.

xviii. Department of Home Affairs, Temporary Work (skilled) visa program – Datasets (2021), <https://data.gov.au/data/dataset/visa-temporary-work-skilled>.

xix. Committee for Economic Development of Australia, A good match: Optimising Australia's permanent skilled migration (2021) <https://www.ceda.com.au/Admin/getmedia/150315bf-cceb-4536-862d-1a3054197cd7/CEDA-Migration-report-26-March-2021-final.pdf>.

xx. Committee for Economic Development of Australia, A good match: Optimising Australia's permanent skilled migration (2021) <https://www.ceda.com.au/Admin/getmedia/150315bf-cceb-4536-862d-1a3054197cd7/CEDA-Migration-report-26-March-2021-final.pdf>.

xxi. Australian Bureau of Statistics, Regional Population (30 March 2021) <https://www.abs.gov.au/statistics/people/population/regional-population/2019-20>.

xxii. International Data Corporation, 'Worldwide Smart Cities Spending Guide', IDC Trackers (accessed 30 March 2021)

xxiii. Standards Australia, Smart Cities Standards Roadmap (August 2020) <https://www.standards.org.au/getmedia/bfe42f98-011e-4798-8fa5-5b70c8a2a6bd/SA_Smart_Cities_Roadmap.pdf.aspx>.

xxiv. Deloitte Access Economics, On your marks: achieving skills for the jobs of tomorrow (report commissioned by RMIT Online, January 2021), <https://online.rmit.edu.au/insights/2021>.

xxv. Deloitte Insights, The path to prosperity: Why the future of work is human (2019), <https://www2.deloitte.com/au/en/pages/building-lucky-country/articles/path-prosperity-future-work.html>.

xxvi. Teena Maddox, '16 tech jobs that will be needed for the future of smart cities' Tech Republic (22 January 2016) <https://www.techrepublic.com/article/16-tech-jobs-that-will-be-needed-for-the-future-of-smart-cities/>.

xxvii. Standards Australia, Smart Cities Standards Roadmap (August 2020) <https://www.standards.org.au/getmedia/bfe42f98-011e-4798-8fa5-5b70c8a2a6bd/SA_Smart_Cities_Roadmap.pdf.aspx>.

xxviii. Smart Cities Council Australia New Zealand (2021) <https://anz.smartcitiescouncil.com/>.

xxix. OZICOM, Air quality monitoring sensors for smart city infrastructure (n.d.) <https://oizom.com/usecase/smart-city-air-quality-monitoring-system/>.

xxx. McKinsey Global Institute, Smart cities: digital solutions for a more liveable solution future (2018), <https://www.mckinsey.com/industries/capital-projects-andinfrastructure/our-insights/smart-cities-digital-solutions-for-amore-livable-future>.

xxxi. Alan Tudge, 'Job-ready Graduates package sees more Aussies enrolling in key courses', Department of Education, Skills and Employment (25 March 2021) <https://ministers.dese.gov.au/tudge/job-ready-graduates-package-sees-more-aussies-enrolling-key-courses>.

xxxii. Alan Tudge, 'Job-ready Graduates package sees more Aussies enrolling in key courses', Department of Education, Skills and Employment (25 March 2021) <https://ministers.dese.gov.au/tudge/job-ready-graduates-package-sees-more-aussies-enrolling-key-courses>.

xxxiii. National Skills Commission, A snapshot in time: The Australian labour market and COVID-19 (1 July 2020) < https://www.nationalskillscommission.gov.au/snapshot-time-australian-labour-market-and-covid-19-report>.

xxxiv. Dan Tehan, 'Budget 2020-21: Investing in Education and Research', Department of Education, Skills and Employment (6 October 2020) <https://ministers.dese.gov.au/tehan/budget-2020-21-investing-education-and-research>.

xxxv. Victoria State Government, The 2020-21 Victorian State Budget (24 November 2020), <https://djpr.vic.gov.au/about-us/news/the-2020-21-victorian-state-budget>.

xxxvi. Victoria State Government, The 2020-21 Victorian State Budget (24 November 2020), <https://djpr.vic.gov.au/about-us/news/the-2020-21-victorian-state-budget>.

xxxvii. Austrade, Fintech agreement boosts fast-growing sector (30 March 2021) <https://www.austrade.gov.au/news/media-releases/2021-media-releases/fintech-agreement-boosts-fast-growing-sector>.

xxxviii. Australian Bureau of Statistics, International Trade in Goods and Services, Australia, February 2021 (18 March 2021) <https://www.abs.gov.au/statistics/economy/international-trade/international-trade-goods-and-services-australia/feb-2021>.

xxxix. Deloitte Access Economics, Australia's Digital Pulse (report commissioned for Australian Computer Society, 2016-2018) <https://www2.deloitte.com/au/en/pages/economics/articles/australias-digital-pulse.html>.

xl. Deloitte Access Economics, Australia's Digital Pulse (report commissioned for Australian Computer Society, 2018) < https://www2.deloitte.com/au/en/pages/economics/articles/australias-digital-pulse.html>.

xli. Deloitte, Artificial intelligence: why businesses need to pay attention to artificial intelligence? (November 2017) <https://www2.deloitte.com/content/dam/Deloitte/in/Documents/technology-media-telecommunications/in-tmt-artificial-intelligence-single-page-noexp.pdf>.

xlii. Australian Bureau of Statistics, International Trade in Goods and Services, Australia (1 April 2021) <https://www.abs.gov.au/statistics/economy/international-trade/international-trade-goods-and-services-australia/latest-release>.

xliii. Ministers for the Department of Industry, Science, Energy and Resources, Budget 2018 - New opportunities and jobs for Australian industry (8 May 2018) <https://www.minister.industry.gov.au/ministers/cash/media-releases/budget-2018-new-opportunities-and-jobs-australian-industry>.

xliv. David Binning, 'A CIO's guide to AI: Australian artificial intelligence suffering from arrested development', CIO (31 March 2020), <https://www.cio.com/article/3535408/a-cio-s-guide-to-ai-australian-artificial-intelligence-suffering-from-arrested-development.html>.

xlv. Australian Government, Australia's AI Action Plan: discussion paper (2020) <https://consult.industry.gov.au/digital-economy/ai-action-plan/>.

xlvi. Australian Government, Australia's AI Action Plan: discussion paper (2020) <https://consult.industry.gov.au/digital-economy/ai-action-plan/>.

xlvii. CSIRO Data61, Artificial Intelligence: Solving problems, growing the economy and improve our quality of life (2019) <https://data61.csiro.au/en/our-research/our-work/AI-roadmap>.

xlviii. OECD, Live data from partners: AI publications vs GDP per capita by country, region, over time (2021) <https://oecd.ai/data-from-partners?selectedTab=AIResearch>.

xlix. Department of Industry, Science, Energy and Resources, AI Ethics Principles <https://www.industry.gov.au/data-and-publications/building-australias-artificial-intelligence-capability/ai-ethics-framework/ai-ethics-principles>.

l. Standards Australia, An Artificial Intelligence Roadmap (2020) <https://www.standards.org.au/getmedia/ede81912-55a2-4d8e-849f-9844993c3b9d/1515-An-Artificial-Intelligence-Standards-Roadmap12-02-2020.pdf.aspx>.

li. ACS, Government must de-identify shared data (25 March 2021) <https://ia.acs.org.au/article/2021/government-must-de--identify-shared-data.html>.

lii. ACS, Government must de-identify shared data (25 March 2021) <https://ia.acs.org.au/article/2021/government-must-de--identify-shared-data.html>.

liii. McKinsey & Company, & Lean In, Women in the Workplace (2020) <https://www.mckinsey.com/featured-insights/diversity-and-inclusion/women-in-the-workplace>.

liv. Letian Zhang, 'An Institutional Approach to Gender Diversity and Firm Performance', Organization Science (forthcoming) <https://www.hbs.edu/ris/Publication%20Files/An%20Institutional%20Approach%20to%20Gender%20Diversity%20and%20Firm%20Performance_4c0479f3-9d13-4af8-82da-7f1713af940d.pdf>.

lv. Rocio Lorenzo et al, 'How Diverse Leadership Teams Boost Innovation, Boston Consulting Group (23 January 2018) <https://www.bcg.com/en-us/publications/2018/how-diverse-leadership-teams-boost-innovation>.

lvi. Deloitte Access Economics, Westpac Diversity Dividend Report (report commissioned for Westpac, October 2017) <https://www2.deloitte.com/au/en/pages/economics/articles/diversity-dividend-westpac.html>.

lvii. Levy, G. D., Sadovsky, A. L., & Troseth, G. L., 'Aspects of young children's perceptions of gender-typed occupations', Sex Roles: A Journal of Research (2020) 42(11-12), 993–1006. <https://psycnet.apa.org/record/2000-02490-003>.

lviii. Deloitte Access Economics, Australia's Digital Pulse (report commissioned for Australian Computer Society, 2015) < https://www2.deloitte.com/au/en/pages/economics/articles/australias-digital-pulse.html>.

lix. Deloitte Insights, The path to prosperity: Why the future of work is human (2019), available at <https://www2.deloitte.com/au/en/pages/building-lucky-country/articles/path-prosperity-future-work.html>.

lx. Honeypot, 2018 Women in Tech Index (2018) <https://www.honeypot.io/women-in-tech-2018/>.

lxi. Levy, G. D., Sadovsky, A. L., & Troseth, G. L., 'Aspects of young children's perceptions of gender-typed occupations', Sex Roles: A Journal of Research (2020) 42(11-12), 993–1006. <https://psycnet.apa.org/record/2000-02490-003>.

lxii. Australian Bureau of Statistics, Census (2016) enrolments data (2016) <https://www.abs.gov.au/websitedbs/censushome.nsf/home/tablebuilder>.

lxiii. The College Board, AP program participation and performance data (2017) <https://research.collegeboard.org/programs/ap/data/participation/ap-2017>.

lxiv. Hewlett, S.A., Sherbin, L., with Dieudonné, F., Fargnoli, C., & Fredman, C., Athena Factor 2.0: Accelerating female talent in science, engineering, & technology. New York: Center for Talent Innovation (2014) <http://www.talentinnovation.org/publication.cfm?publication=1420>.

lxv. Deloitte Access Economics, Westpac Diversity Dividend Report (report commissioned for Westpac, October 2017) <https://www2.deloitte.com/au/en/pages/economics/articles/diversity-dividend-westpac.html>.

lxvi. Australian Government, Job Outlook (2021), <https://joboutlook.gov.au/occupations/accountants?occupationCode=2211>.

lxvii. Australian Health Practitioner Regulation Agency, Annual report 2019-20 (2020) <https://www.ahpra.gov.au/Publications/Annual-reports/Annual-Report-2020.aspx>.

lxviii. Engineers Australia, The engineering profession – a statistical overview, <https://www.engineersaustralia.org.au/Government-And-Policy/Statistics>.

lxix. Urbis, 2018 National profile of solicitors (2019) <https://www.lawsociety.com.au/sites/default/files/201907/2018%20National%20Profile%20of%20Solicitors.pdf>.

lxx. Australian Bureau of Statistics, Labour Force, Australia, Detailed (22 April 2021) <https://www.abs.gov.au/statistics/labour/employment-and-unemployment/labour-force-australia-detailed/latest-release>.

lxxi. Weckert, J. and Lucas, Richard, Professionalism in the Information and Communications Technology Industry (Australian National University E Press 2020)

lxxii. CREST, Assurance in information security, <https://www.crest-approved.org/>.

lxxiii. Chartered Institute of Information Security Professionals, The home of cyber <https://www.ciisec.org/>.

lxxiv. Governance Institute of Australia, Ethics Index 2020 (2020) <https://www.governanceinstitute.com.au/advocacy/ethics-index-2020/>.

lxxv. Governance Institute of Australia, Ethics Index 2020 (2020) <https://www.governanceinstitute.com.au/advocacy/ethics-index-2020/>.

lxxvi. Edelman, Edelman Trust Barometer 2020, <https://www.edelman.com/sites/g/files/aatuss191/files/2020-01/2020%20Edelman%20Trust%20Barometer%20Global%20Report_LIVE.pdf>.

lxxvii. Edelman, Edelman Trust Barometer 2020, <https://www.edelman.com/sites/g/files/aatuss191/files/2020-01/2020%20Edelman%20Trust%20Barometer%20Global%20Report_LIVE.pdf>.

lxxviii. Deloitte Access Economics, The ethical advantage: The economic and social benefits of ethics to Australia (report commissioned by The Ethics Centre, November 2020) <https://www2.deloitte.com/au/en/pages/economics/articles/ethical-advantage-economic-social-benefits-ethics-australia.html>.

lxxix. Deloitte Access Economics, The ethical advantage: The economic and social benefits of ethics to Australia (report commissioned by The Ethics Centre, November 2020) <https://www2.deloitte.com/au/en/pages/economics/articles/ethical-advantage-economic-social-benefits-ethics-australia.html>.

lxxx. Queensland Auditor General, Delivering successful technology projects (2020) <https://www.qao.qld.gov.au/sites/default/files/2020-09/Delivering%20successful%20technology%20projects%20%28Report%207%E2%80%942020%E2%80%9321%29.pdf>.

lxxxi. Senate Standing Committee on Finance and Public Administration, Digital delivery of government services (2018) <https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Finance_and_Public_Administration/digitaldelivery/Report>.

lxxxii. Governance Institute of Australia, Ethics Index 2020 (2020) <https://www.governanceinstitute.com.au/advocacy/ethics-index-2020/>.

lxxxiii. Royal Commission, Royal Commission into aged care quality and safety: Final report (2021) <https://agedcare.royalcommission.gov.au/>.

lxxxiv. Royal Commission, Royal Commission into misconduct in the banking, superannuation and financial services industry: Final Report (2019) <https://financialservices.royalcommission.gov.au/Pages/default.html>.

lxxxv. NSW Parliament, Regulation of building standards, building quality and building disputes (2019), <https://www.parliament.nsw.gov.au/committees/inquiries/Pages/inquiry-details.aspx?pk=2540#undefined>.

lxxxvi. Deloitte, Soft skills for business success (2017) <https://www2.deloitte.com/au/en/pages/economics/articles/soft-skills-business-success.html>.

lxxxvii. CEDA, A good match: Optimising Australia's permanent skilled migration (2021), <https://www.ceda.com.au/Admin/getmedia/150315bf-cceb-4536-862d-1a3054197cd7/CEDA-Migration-report-26-March-2021-final.pdf>.

lxxxviii. World Economic Forum, Skill, re-skill and re-skill again. How to keep up with the future of work (2017) <https://www.weforum.org/agenda/2017/07/skill-reskill-prepare-for-future-of-work/>.

lxxxix. Prier, E, McCue, C, and Behara, R, 'The value of certification in public procurement: The birth of a profession?' (2010) 10 (4) Journal of Public Procurement 512

xc. Standards Australia, What is a Standard? (2021) <https://www.standards.org.au/standards-development/what-is-standard>.

xci. Standards Australia, Research Paper: The Economic Benefits of Standardisation (n.d.), <https://www.standards.org.au/StandardAU/Media/SA-Archive/OurOrganisation/News/Documents/Economic-Benefits-of-Standardisation.pdf>.

xcii. Department of Finance, Statistics on Australian Government Procurement Contracts (2020), <https://www.finance.gov.au/government/procurement/statistics-australian-government-procurement-contracts->.

xciii. Department of Finance, Statistics on Australian Government Procurement Contracts (2020), <https://www.finance.gov.au/government/procurement/statistics-australian-government-procurement-contracts->.

xciv. Department of Finance, Statistics on Australian Government Procurement Contracts (2020), <https://www.finance.gov.au/government/procurement/statistics-australian-government-procurement-contracts->.

xcv. Australian Government, Our public service our future: Independent review of the Australian Public Service (2019), <https://www.pmc.gov.au/sites/default/files/publications/independent-review-aps.pdf>.

xcvi. Digital Transformation Agency, Digital Profession <https://www.dta.gov.au/help-and-advice/digital-profession>.

Appendix A: Statistical Compendium

At a glance – Australia

Table A.1: Summary of key national statistics

Indicator	Statistic	Period
Technology workers in Australia (actuals)	805,525	2020
Of which: ICT-related industry subdivisions	376,804	2020
Other industries	428,720	2020
Of which: Technical, professional, management and operational occupations	568,614	2020
Other occupations (including trades and sales)	236,911	2020
Technology workers' proportion of total workforce	6.35%	2020
Forecast size of technology workforce	1,101,454	2026
Inbound temporary migration of technology workers (457 and 482 visas granted)	8,695	2019-20
Net migration inflow of technology workers	20,664	2015–16
Female share of technology workers	29%	2020
Older workers' (aged 55+) share of technology workers	9%	2020
Businesses' ICT research and development expenditure	$6.75bn	2017–18
Total ICT service exports	$4.99bn	2019-20
Total ICT service imports	$4.67bn	2019-20
IT university enrolments by domestic students	41,469	2019
IT university completions by domestic students	6,998	2019
IT university enrolments by international students	75,671	2019
IT university completions by international students	18,361	2019

Source: ABS catalogues 5368.0 (2020) and 8104.0 (2020) and customised report (2020), Department of Education U-Cube (2020), Department of Home Affairs Temporary Work (Skilled) Visa Program pivot table (2021)

At a glance – states and territorieas

Table A.2: Summary of key state statistics

Indicator	NSW	Vic	Qld	SA	WA	Tas	ACT	NT
Technology workers in Australia (2020)	314,083	246,163	111,574	36,775	52,084	9,400	30,948*	4,497*
Of which: ICT-related industry subdivisions	146,689	120,086	50,122	19,537	21,628	4,160	N/A	N/A
Other industries	164,394	126,078	61,451	17,238	30,456	5,240	N/A	N/A
Of which: Technical, professional, management and operational occupations	217,746	180,754	74,861	23,564	36,130	6,225	20,748*	3,376*
Other occupations (including trades and sales)	96,337	65,409	36,712	13,211	15,955	3,175	5,874*	956*

Indicator	NSW	Vic	Qld	SA	WA	Tas	ACT	NT
Technology workers' proportion of total workforce (2020)	7.8%	7.4%	4.5%	4.4%	3.9%	3.7%	N/A	N/A
IT university enrolments by domestic students (2019)	14,031	12,772	7,964	2,483	2,032	392	1,497	190
IT university completions by domestic students (2019)	2,647	2,113	1,150	325	385	54	300	7

* While the 2019 labour force data from the ABS contained combined figures for the NT and the ACT for confidentiality reasons, NT employment has been separated from ACT employment at an aggregate and occupational level using the Deloitte Access Economics employment forecast model.

Sources: ABS customised report (2020), Deloitte Access Economics (2020) and Department of Education U-Cube (2020)

At a glance – ICT employment

Table A.3: CIIER classification of technology workers at the four-digit Australian and New Zealand Standard Classification of Occupations (ANZSCO) level

ICT management and operations
1351 ICT managers
2232 ICT trainers
2247 management and organisation analysts
2249 other information and organisation professionals
2621 database and systems administrators, and ICT security specialists
2632 ICT support and test engineers
ICT technical and professional
2324 graphic and web designers, and illustrators
2611 ICT business and systems analysts
2612 multimedia specialists and web developers
2613 software and applications programmers
2631 computer network professionals
2633 telecommunications engineering professionals
3132 telecommunications technical specialists
2600 ICT professionals nfd
2610 Business and Systems Analysts, and Programmers nfd
2630 ICT Network and Support Professionals nfd
3130 ICT and Telecommunications Technicians nfd
ICT sales
2252 ICT sales professionals
6212 ICT sales assistants
ICT trades
3131 ICT support technicians
3424 telecommunications trades workers

Electronic trades and professional*
3123 electrical engineering draftspersons and technicians*
3124 electronic engineering draftspersons and technicians*
3423 electronics trades workers*
ICT industry admin and logistics support*
All other occupations where the employee works in an ICT-related industry subdivision (telecommunications services; internet service providers, web search portals and data processing services; and computer system design and related services)

* For these occupations, only workers employed in the ICT-related industry subdivisions (telecommunications services; Internet service providers, web search portals and data processing services; and computer system design and related services) are counted as technology workers

Sources: Australian Computer Society and CIIER

Table A.4: OECD's broad measure of ICT-skilled employment at the four-digit ANZSCO level

1111 chief executives and managing directors	2349 other natural and physical science professionals
1112 general managers	2512 medical imaging professionals
1311 advertising and sales managers	2600 ICT professionals nfd
1320 business administration managers not further defined (nfd)	2610 business and systems analysts, and programmers nfd
1322 finance managers	2611 ICT business and systems analysts
1323 human resource managers	2612 multimedia specialists and web developers
1324 policy and planning managers	2613 software and applications programmers
1332 engineering managers	2621 database and systems administrators, and ICT security specialists
1335 production managers	2630 ICT network and support professionals nfd
1336 supply and distribution managers	2631 computer network professionals
1351 ICT managers	2632 ICT support and test engineers
1419 other accommodation and hospitality managers	2633 telecommunications engineering professionals
1494 transport services managers	2710 legal professionals nfd
2210 accountants, auditors and company secretaries nfd	2711 barristers
2211 accountants	2712 judicial and other legal professionals
2212 auditors, company secretaries and corporate treasurers	2713 solicitors
2220 financial brokers and dealers, and investment advisers nfd	3100 engineering, ICT and science technicians nfd
2221 financial brokers	3123 electrical engineering draftspersons and technicians
2222 financial dealers	3124 electronic engineering draftspersons and technicians
2223 financial investment advisers and managers	3130 ICT and telecommunications technicians nfd
2232 ICT trainers	3131 ICT support technicians
2241 actuaries, mathematicians and statisticians	3132 telecommunications technical specialists
2242 archivists, curators and records managers	3400 electrotechnology and telecommunications trades workers nfd

2243 economists	3420 electronics and telecommunications trades workers nfd
2244 intelligence and policy analysts	3423 electronics trades workers
2246 librarians	5100 office managers and program administrators nfd
2247 management and organisation analysts	5121 office managers
2249 other information and organisation professionals	5122 practice managers
2251 Advertising and marketing professionals	5211 personal assistants
2252 ICT sales professionals	5212 secretaries
2320 architects, designers, planners and surveyors nfd	5321 keyboard operators
2321 architects and landscape architects	5510 accounting clerks and bookkeepers nfd
2322 cartographers and surveyors	5511 accounting clerks
2326 urban and regional planners	5512 bookkeepers
2331 chemical and materials engineers	5513 payroll clerks
2332 civil engineering professionals	5521 bank workers
2333 electrical engineers	5522 credit and loans officers
2334 electronics engineers	5523 insurance, money market and statistical clerks
2335 industrial, mechanical and production engineers	6111 auctioneers, and stock and station agents
2336 mining engineers	6112 insurance agents
2341 agricultural and forestry scientists	6212 ICT sales assistants
2342 chemists, and food and wine scientists	6399 other sales support workers
2343 environmental scientists	7123 engineering production systems workers
2344 Geologists and geophysicists	2349 other natural and physical science professionals
2345 life scientists	

Source: OECD (2012)

Table A.5: Technology workers by industry and CIIER occupational grouping, 2020

	ICT management and operations	ICT technical and professional	ICT sales	ICT trades	Electronic trades and professional	ICT industry admin and logistics support	Total technology workers
Industry divisions							
Agriculture, forestry and fishing	282	1,040	-	-	-	-	1,322
Mining	3,033	2,550	-	1,511	-	-	7,094
Manufacturing	8,233	11,123	269	1,441	-	-	21,066
Electricity, gas, water and waste services	8,603	5,150	137	1,570	-	-	15,460
Construction	3,198	3,886	-	4,837	-	-	11,921
Wholesale trade	3,870	6,094	1,887	2,827	-	-	14,677

	ICT management and operations	ICT technical and professional	ICT sales	ICT trades	Electronic trades and professional	ICT industry admin and logistics support	Total technology workers
Retail trade	6,904	9,557	7,585	4,822	-	-	28,868
Accommodation and food services	1,712	2,569	-	441	-	-	4,722
Transport, postal and warehousing	4,600	4,955	378	1,263	-	-	11,196
Rest of information media and telecommunications*	2,447	4,577	-	1,210	-	-	8,234
Financial and insurance services	30,850	31,763	186	5,822	-	-	68,621
Rental, hiring and real estate services	2,108	1,516	35	115	-	-	3,774
Rest of professional, scientific and technical services**	50,825	42,426	486	4,393	-	-	98,130
Administrative and support services	4,583	3,066	382	1,740	-	-	9,770
Public administration and safety	31,784	21,832	235	9,230	-	-	63,080
Education and training	11,281	12,972	107	5,268	-	-	29,628
Healthcare and social assistance	9,520	6,298	-	2,895	-	-	18,713
Arts and recreation services	1,417	3,343	-	915	-	-	5,674
Other services	1,130	2,217	158	3,264	-	-	6,771
ICT industry subdivisions							
Telecommunications services	8,111	18,952	5,029	17,009	901	36,441	86,443
Internet service providers, web search portals and data processing services	803	3,139	118	390	-	4,955	9,406
Computer system design and related services	47,568	123,649	13,117	29,064	1,822	65,735	280,955
Total technology workers	**242,861**	**322,675**	**30,108**	**100,027**	**2,723**	**107,132**	**805,525**

* Excluding telecommunications services, and internet service providers, web search portals and data processing services, which are separately identified as ICT industry subdivisions.

** Excluding computer system design and related services, which is separately identified as an ICT industry subdivision.

Source: ABS customised report (2020)

Table A.6: Technology employment forecasts by occupation grouping, 2020–26

Occupation grouping	2020	2026	Average annual growth (%)
ICT management and operations	242,861	320,451	4.7
ICT technical and professional	322,675	470,140	6.5
ICT sales	30,108	32,030	1.0
ICT trades	100,027	130,923	4.6
Electronic trades and professional*	2,723	3,291	3.2
ICT industry admin and logistics support*	107,132	144,620	5.1
Total technology workers	**805,525**	**1,101,454**	**5.4**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2021)

Table A.7: Technology skills forecasts by occupation grouping, 2020–2026

	2020	2026	Average annual growth (%)
ICT management and operations			
Postgraduate	96,838	133,805	5.5
Undergraduate	175,340	235,660	5.1
Diploma or Advanced Diploma	68,811	93,838	5.3
Certificate III or IV	40,967	52,549	4.2
Certificate I or II	19,231	26,402	5.4
ICT technical and professional			
Postgraduate	104,423	165,552	8.0
Undergraduate	245,002	374,698	7.3
Diploma or Advanced Diploma	86,504	131,531	7.2
Certificate III or IV	45,308	64,120	6.0
Certificate I or II	22,001	32,995	7.0
ICT sales			
Postgraduate	5,652	6,614	2.7
Undergraduate	13,100	15,572	2.9
Diploma or Advanced Diploma	5,546	6,203	1.9
Certificate III or IV	4,202	4,335	0.5
Certificate I or II	2,121	2,292	1.3

	2020	2026	Average annual growth (%)
ICT trades			
Postgraduate	29,081	44,585	7.4
Undergraduate	56,110	78,064	5.7
Diploma or Advanced Diploma	28,907	38,971	5.1
Certificate III or IV	34,324	48,762	6.0
Certificate I or II	15,347	20,420	4.9
Electronic trades and professional*			
Postgraduate	258	366	5.9
Undergraduate	665	848	4.1
Diploma or Advanced Diploma	715	878	3.5
Certificate III or IV	1,344	1,730	4.3
Certificate I or II	502	607	3.2
ICT industry admin and logistics support*			
Postgraduate	20,239	27,676	5.4
Undergraduate	43,014	59,217	5.5
Diploma or Advanced Diploma	22,304	31,841	6.1
Certificate III or IV	21,008	29,188	5.6
Certificate I or II	8,944	12,478	5.7

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2020)

Technology worker migration

Table A.8: Temporary skilled migration (457 & 482) visa grants for technology occupations, 2014–15 to 2019–20

	2014–15	2015–16	2016–17	2017–18	2018–19	2019-20
1351 ICT managers	939	918	852	524	708	437
2232 ICT trainers	10	15	22	16	28	16
2247 Management and organisation analysts	1,445	1,345	1,362	990	1,218	974
2249 Other information and organisation professionals	452	399	350	177	183	171
2252 ICT sales professionals	527	531	604	376	557	405
2324 graphic and web designers, and illustrators	472	411	459	220	219	128
2611 ICT Business and items analysts	2,098	2,208	2,125	1,709	2,334	1,579
2612 multimedia specialists and web developers	162	133	121	55	106	97
2613 Software and applications programmers	5,231	4,984	4,909	3,900	5,241	3,023

	2014–15	2015–16	2016–17	2017–18	2018–19	2019-20
2621 Database and systems administrators, and ICT security specialists	383	385	424	269	383	267
2631 Computer network professionals	272	260	294	257	469	289
2632 ICT support and test engineers	767	854	864	829	956	705
2633 telecommunications engineering professionals	127	99	81	48	70	71
3123 electrical engineering draftspersons and technicians	351	353	305	177	234	206
3124 electronic engineering draftspersons and technicians	112	91	71	N/A	N/A	N/A
3131 ICT support technicians	320	291	273	143	176	134
3132 telecommunications technical specialists	52	43	79	99	155	75
3423 electronic trades workers	115	80	94	90	168	100
3424 telecommunications trades workers	102	121	117	38	45	18
Total technology workers*	**13,937**	**13,521**	**13,406**	**9,917**	**13,250**	**8,695**

* Excludes ICT industry admin and logistics support, for which breakdowns are unavailable; electronic trades and professional data is for all industries.

Source: Department of Home Affairs 457 and 482 Visa Statistics (2021)

Table A.9: Net migration of technology workers dataset is no longer published.

ICT higher and vocational education

Table A.10: Domestic enrolments and completions in IT degrees, 2001–19

	Course enrolments		Course completions	
	Undergraduate	**Postgraduate**	**Undergraduate**	**Postgraduate**
2001	35,661	10,161	5,451	2,850
2002	36,647	10,280	6,219	3,294
2003	35,172	9,118	6,580	2,588
2004	31,323	8,139	6,283	2,272
2005	26,527	6,923	5,696	1,976
2006	22,762	6,101	4,672	1,642
2007	20,709	5,488	4,185	1,474
2008	18,905	5,077	3,577	1,349
2009	18,545	5,143	3,159	1,315
2010	18,966	5,213	3,050	1,275
2011	19,902	5,386	3,266	1,353
2012	21,047	5,562	3,339	1,326
2013	22,055	5,447	3,463	1,423

	Course enrolments		Course completions	
	Undergraduate	**Postgraduate**	**Undergraduate**	**Postgraduate**
2014	23,829	5,560	3,638	1,468
2015	25,700	5,438	3,949	1,491
2016	26,596	5,774	3,985	1,517
2017	29,993	6,342	4,405	1,553
2018	32,188	6,875	4,695	1,638
2019	33,756	7,713	5,108	1,890

Source: Department of Education U-Cube (2020)

Table A.11: International enrolments and completions in IT degrees, 2001–19

	Course enrolments		Course completions	
	Undergraduate	**Postgraduate**	**Undergraduate**	**Postgraduate**
2001	17,009	10,225	2,993	3,558
2002	20,843	11,238	4,157	4,821
2003	21,701	11,087	5,659	4,337
2004	20,683	12,638	6,010	3,586
2005	17,480	13,512	5,213	5,428
2006	15,475	11,580	5,021	5,635
2007	14,415	10,265	4,433	4,258
2008	14,236	10,964	3,715	4,369
2009	15,113	12,104	3,851	4,009
2010	15,018	11,435	4,120	5,037
2011	15,108	9,452	3,996	4,528
2012	14,495	8,992	3,749	3,385
2013	13,978	10,908	3,673	3,223
2014	14,152	13,742	3,617	3,573
2015	14,217	15,406	3,516	4,537
2016	16,063	17,953	3,602	5,263
2017	19,488	24,368	4,046	5,604
2018	25,314	35,664	5,007	8,392
2019	31,831	43,840	5,941	12,420

Source: Department of Education U-Cube (2020)

Table A.12: Government-funded VET subject enrolments in the IT field of education, 2015–19

	2015	2016	2017	2018	2019
Diploma or higher	26,285	27,790	17,970	15,805	18,190
Certificate IV	11,080	10,765	10,870	11,170	12,305
Certificate III	15,965	14,285	14,085	12,930	12,355
Certificate II	16,755	13,305	12,970	10,425	9,730
Certificate I	19,840	16,310	14,740	12,085	11,805

Source: National Centre for Vocational Education Research (2020)

Women in technology

Table A.13: Female technology workers by industry, 2020

	Female technology workers	Percentage of female technology workers	Percentage of female workers in all occupations
Industry divisions			
Agriculture, forestry and fishing	996	75	33
Mining	2,336	33	17
Manufacturing	8,088	38	29
Electricity, gas, water and waste services	3,520	23	24
Construction	2,141	18	14
Wholesale trade	4,652	32	34
Retail trade	9,259	32	55
Accommodation and food services	2,035	43	55
Transport, postal and warehousing	3,627	32	21
Rest of information media and telecommunications*	2,573	31	40
Financial and insurance services	21,120	31	49
Rental, hiring and real estate services	2,190	58	50
Rest of professional, scientific and technical services**	34,349	35	43
Administrative and support services	3,509	36	49
Public administration and safety	20,340	32	49
Education and training	10,198	34	71
Healthcare and social assistance	8,592	46	78
Arts and recreation services	2,330	41	48
Other services	1,623	24	45

	Female technology workers	Percentage of female technology workers	Percentage of female workers in all occupations
ICT industry subdivisions			
Telecommunications services	20,893	24	24
Internet service providers, web search portal and data processing services	1,869	20	20
Computer system design and related services	67,928	24	24
Total technology workers*	**234,169**	**29**	**47**

* Excluding telecommunications services, and internet service providers, web search portals and data processing services, which are separately identified as ICT industry subdivisions.

** Excluding computer system design and related services, which is separately identified as an ICT industry subdivision.

Source: ABS customised report (2021)

Older technology workers

Table A.14: Older technology workers by CIIER occupation grouping, 2020

	Number of ICT workers aged 55+	Percentage of total technology workforce
ICT management and operations	43,325	10
ICT technical and professional	34,829	6
ICT sales	4,307	14
ICT trades	13,396	13
Electronic trades and professional	11,457	25
Total technology workers*	107,313	9

* Excludes ICT industry admin and logistics support, for which breakdowns are unavailable; electronic trades and professional data is for all industries.

Source: ABS customised report (2021)

ICT research and development

Table A.15: Business expenditure on R&D, 2011–12 to 2017–18

	2011–12	2013–14	2015–16	2017–18
Information and computing science	$5,496,165	$6,073,221	$6,634,394	$6,747,648
Engineering	$8,686,256	$7,474,231	$5,538,180	$4,710,279
Technology	$1,235,487	$1,689,446	$1,409,803	$1,958,471
Medical and health sciences	$941,159	$1,123,956	$1,253,415	$1,791,237
Chemical sciences	$425,941	$565,758	$632,619	$654,046
Agricultural and veterinary sciences	$455,372	$533,754	$404,003	$431,150
Earth sciences	$122,476	$286,511	$166,626	$231,970
Environmental sciences	$281,155	$270,044	$158,043	$170,354
Built environment and design	$231,743	$238,591	$152,082	$162,413
Commerce, management, tourism and services	$144,273	$227,088	$110,793	$158,118
Other fields of research	$301,295	$346,838	$199,338	$421,899

Source: ABS catalogue 8104.0 (2019)

Table A.16: Government expenditure on ICT R&D, 2011–12 to 2018-19

	2011–12	2013–14	2015–16	2017–18	2018–19
Commonwealth ICT R&D expenditure	$314,437,000	$240,828,000	$247,462,000	$254,504,000	$262,306,000
Commonwealth ICT share of R&D expenditure	13%	10%	11%	12%	12%
State and territory ICT R&D expenditure	$8,596,000	$12,778,000	$20,882,000	$38,627,000	$2,496,000
State and territory ICT share of R&D expenditure	1%	1%	2%	3%	0.2%

Source: ABS catalogue 8109.0 (2020)

Trade in ICT services

Table A.17: Exports and imports of ICT services, 2012–13 to 2019–20 ($bn)

	2012–13	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019-20
Exports	1.91	2.08	2.50	2.78	2.93	3.60	4.36	4.99
Imports	1.87	2.50	2.59	2.88	2,74	3,14	3,72	4.67

Source: ABS catalogue 5368.0 (2020)

Detailed state figures

Table A.18: State breakdown of technology workers by industry, 2020

	NSW	Vic	Qld	SA	WA	Tas	ACT*	NT*
Industry divisions								
Agriculture, forestry and fishing	551	396	200	-	154	22	N/A	N/A
Mining	876	-	1,999	569	3,592	58	N/A	N/A
Manufacturing	8,500	7,831	1,883	1,107	1,360	197	N/A	N/A
Electricity, gas, water and waste services	5,090	5,137	2,884	517	1,319	367	N/A	N/A
Construction	4,355	2,700	2,595	660	1,420	75	N/A	N/A
Wholesale trade	7,372	3,795	2,028	526	540	75	N/A	N/A
Retail trade	11,331	11,856	3,411	664	1,112	207	N/A	N/A
Accommodation and food services	2,230	1,472	672	252	-	96	N/A	N/A
Transport, postal and warehousing	2,811	5,443	1,874	189	493	152	N/A	N/A
Rest of information media and telecommunications**	4,595	1,460	1,306	486	162	119	N/A	N/A
Financial and insurance services	39,260	21,106	4,762	739	2,136	370	N/A	N/A
Rental, hiring and real estate services	1,076	999	1,153	-	412	57	N/A	N/A
Rest of professional, scientific and technical services***	37,685	29,842	13,769	4,258	7,777	1,232	N/A	N/A
Administrative and support services	3,642	2,168	2,490	407	737	44	N/A	N/A
Public administration and safety	13y,637	11,389	11,017	4,209	5,539	1,195	N/A	N/A
Education and training	11,685	8,953	3,913	1,502	1,664	552	N/A	N/A
Healthcare and social assistance	6,133	6,864	2,931	806	1,186	227	N/A	N/A
Arts and recreation services	1,852	2,672	823	185	-	97	N/A	N/A
Other services	1,713	1,999	1,742	161	852	98	N/A	N/A
ICT industry subdivisions								
Telecommunications services	31,474	28,381	11,164	5,948	6,381	1,374	N/A	N/A
Internet service providers, web search portals and data processing services	4,423	1,979	1,636	594	648	-	N/A	N/A
Computer design and related services	113,792	89,276	37,322	12,995	14,600	2,787	N/A	N/A
Total technology workers	**314,083**	**246,163**	**111,574**	**36,775**	**52,084**	**9,400**	**30,948***	**4,497***

* While the 2019 labour force data from the ABS contained combined figures for the NT and the ACT for confidentiality reasons, NT employment has been separated from ACT employment at an aggregate level using the Deloitte Access Economics employment forecast model.

** Excluding telecommunications services, and internet service providers, web search portals and data processing services, which are separately identified as ICT industry subdivisions.

*** Excluding computer system design and related services, which is separately identified as an ICT industry subdivision.

Sources: ABS customised report (2020), Deloitte Access Economics (2020)

Table A.19: NSW technology employment forecasts by CIIER occupation grouping, 2020–26

	2020	2026	Change	Average annual growth rate (%)
ICT management and operations	90,534	117,532	26,998	4.4
ICT technical and professional	126,246	180,409	54,163	6.1
ICT sales	11,702	12,265	563	0.8
ICT trades	38,105	48,931	10,826	4.3
Electronic trades and professional*	611	740	129	3.3
ICT industry admin and logistics support*	46,886	56,616	9,730	3.2
Total technology workers	**314,083**	**416,492**	**102,409**	**4.8**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2021)

Table A.20: Victoria's technology employment forecasts by CIIER occupation grouping, 2020–262020–26

	2020	2026	Change	Average annual growth rate (%)
ICT management and operations	75,493	99,942	24,449	4.8
ICT technical and professional	103,970	153,407	49,437	6.7
ICT sales	9,123	9,809	687	1.2
ICT trades	26,538	34,270	7,732	4.4
Electronic trades and professional*	1,291	1,528	237	2.9
ICT industry admin and logistics support*	29,749	47,136	17,387	8.0
Total technology workers	**246,163**	**346,092**	**99,929**	**5.8**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2021)

Table A.21: Queensland's technology employment forecasts by CIIER occupation grouping, 2020–26

	2020	2026	Change	Average annual growth rate (%)
ICT management and operations	31,644	43,177	11,533	5.3
ICT technical and professional	42,969	64,402	21,433	7.0
ICT sales	4,882	5,387	504	1.7
ICT trades	18,049	24,493	6,445	5.2
Electronic trades and professional*	248	319	71	4.3
ICT industry admin and logistics support*	13,782	19,490	5,708	5.9
Total technology workers	**111,574**	**157,268**	**45,694**	**5.9**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2021)

Table A.22: South Australia's technology employment forecasts by CIIER occupation grouping, 2020–26

	2020	2026	Change	Average annual growth rate (%)
ICT management and operations	9,839	12,738	2,899	4.4
ICT technical and professional	13,414	19,384	5,969	6.3
ICT sales	1,714	1,657	-57	-0.6
ICT trades	5,435	6,990	1,555	4.3
Electronic trades and professional*	311	375	64	3.2
ICT industry admin and logistics support*	6,062	7,071	1,009	2.6
Total technology workers	**36,775**	**48,215**	**11,440**	**4.6**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.
Source: Deloitte Access Economics (2021)

Table A.23: Western Australia's technology employment forecasts by CIIER occupation grouping, 2020–26

	2020	2026	Change	Average annual growth rate (%)
ICT management and operations	17,821	24,418	6,597	5.4
ICT technical and professional	18,127	27,559	9,432	7.2
ICT sales	1,908	2,112	204	1.7
ICT trades	6,920	9,543	2,623	5.5
Electronic trades and professional*	182	226	44	3.7
ICT industry admin and logistics support*	7,126	8,322	1,195	2.6
Total technology workers	**52,084**	**72,179**	**20,095**	**5.6**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.
Source: Deloitte Access Economics (2021)

Table A.24: Tasmania's technology employment forecasts by CIIER occupation grouping, 2020–26

	2020	2026	Change	Average annual growth rate (%)
ICT management and operations	2,866	3,518	652	3.5
ICT technical and professional	3,303	4,554	1,252	5.5
ICT sales	171	199	28	2.6
ICT trades	1,981	2,522	541	4.1
Electronic trades and professional*	56	73	17	4.4
ICT industry admin and logistics support*	1,023	1,495	472	6.5
Total technology workers	**9,400**	**12,362**	**2,961**	**4.7**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.
Source: Deloitte Access Economics (2021)

Table A.25: Northern Territory's technology employment forecasts by CIIER occupation grouping, 2020–26*

	2020	2026	Change	Average annual growth rate (%)
ICT management and operations	2,080	2,706	626	4.5
ICT technical and professional	1,108	1,657	548	6.9
ICT sales	344	327	-17	-0.9
ICT trades	677	988	312	6.5
Electronic trades and professional**	7	9	1	2.5
ICT industry admin and logistics support**	281	462	181	8.7
Total technology workers	**4,497**	**6,148**	**1,651**	**5.4**

* While the 2019 labour force data from the ABS contained combined figures for the NT and the ACT for confidentiality reasons, NT employment forecasts have been produced separately from ACT employment forecasts using the Deloitte Access Economics employment forecast model.

** Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2021)

Table A.26: Australian Capital Territory's technology employment forecasts by CIIER occupation grouping, 2020–26*

	2020	2026	Change	Average annual growth rate (%)
ICT management and operations	12,585	16,419	3,835	4.5
ICT technical and professional	13,537	18,768	5,231	5.6
ICT sales	263	274	11	0.7
ICT trades	2,323	3,187	863	5.4
Electronic trades and professional**	16	21	5	4.3
ICT industry admin and logistics support**	2,223	4,029	1,806	10.4
Total technology workers	**30,948**	**42,698**	**11,750**	**5.5**

* While the 2019 labour force data from the ABS contained combined figures for the NT and the ACT for confidentiality reasons, NT employment forecasts have been produced separately from ACT employment forecasts using the Deloitte Access Economics employment forecast model.

** Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2021)

Table A.27: State breakdown of net overseas migration of technology workers dataset is no longer published.

Table A.28: State breakdown of domestic enrolments and completions in IT degrees, 2019

	Course enrolments		Course completions	
	Undergraduate	**Postgraduate**	**Undergraduate**	**Postgraduate**
NSW	11,262	2,769	2,647	704
Vic	10,218	2,554	1,538	575
Qld	7,007	957	917	233
SA	2,163	320	254	71
WA	1,213	819	146	239
Tas	352	40	50	4
NT	148	42	7	0
ACT	1,288	209	165	64
Multistate	105	3	17	0

Source: Department of Education U-Cube (2020)

Table A.29: State breakdown of international enrolments and completions in IT degrees, 2019

	Course enrolments		Course completions	
	Undergraduate	**Postgraduate**	**Undergraduate**	**Postgraduate**
NSW	10,707	10,915	1,794	3,416
Vic	13,975	20,863	2,416	5,666
Qld	2,790	7,084	639	2,294
SA	1,132	1,380	224	250
WA	986	1,464	337	261
Tas	810	1,179	212	267
NT	145	102	24	30
ACT	1,141	793	255	221
Multistate	145	60	40	15

Source: Department of Education U-Cube (2020)

Detailed state figures

Table A.30: Top skills requested in ICT job postings, by industry, 2020

Rank	Education and training	Electricity, gas, water and waste	Financial and insurance services
1	Communication Skills	Communication Skills	Communication Skills
2	Research	Planning	Teamwork/Collaboration
3	Teamwork/Collaboration	Teamwork/Collaboration	Planning
4	Planning	Problem Solving	Problem Solving
5	Problem Solving	SQL	SQL
6	Project Management	Stakeholder Management	Stakeholder Management
7	Technical Support	Project Management	Java
8	Customer Service	Energy Industry	DevOps
9	Writing	Building Effective Relationships	Customer Service
10	SQL	Budgeting	Project Management

Rank	Healthcare and social assistance	Information media and telecommunications	Manufacturing
1	Communication Skills	Communication Skills	Communication Skills
2	Problem Solving	Teamwork/Collaboration	Teamwork/Collaboration
3	Teamwork/Collaboration	Problem Solving	Systems Engineering
4	Customer Service	Software Engineering	Problem Solving
5	Project Management	Planning	Software Engineering
6	Planning	Customer Service	Planning
7	Microsoft Office	Creativity	Customer Service
8	SQL	Java	Project Management
9	Technical Support	Troubleshooting	Software Development
10	Writing	Communication Skills	Writing

Rank	Mining	Professional, scientific and technical services	Public administration and safety
1	Communication Skills	Communication Skills	Communication Skills
2	Planning	Teamwork/Collaboration	Planning
3	Teamwork/Collaboration	Problem Solving	Teamwork/Collaboration
4	Problem Solving	Planning	Problem Solving
5	SQL	Customer Service	Research
6	SAP	Project Management	Project Management
7	Writing	Writing	Customer Service
8	Customer Service	Troubleshooting	Building Effective Relationships
9	Systems Engineering	SQL	Technical Support
10	DevOps	Sales	SQL

Rank	Mining
1	Communication Skills
2	Teamwork/Collaboration
3	Amazon Web Services (AWS)
4	Software Development
5	Problem Solving
6	Python
7	SQL
8	Planning
9	Troubleshooting
10	Cloud Computing

Source: Burning Glass custom data (2021).

Appendix B: Modelling the economic impact of gender diversity in technology

Chapter 4 estimates the economic impact of increasing female participation in the technology sector. This Appendix describes in further detail the data, assumptions and methodology underpinning these results.

The aim of the modelling was to determine the net impact of increasing diversity in the technology workforce up to level of 47.5% (the target rate). This figure was calculated based on the level of female participation in the Professional, Scientific and Technical (PST) industry (excluding technology occupations) and weighted by the occupational profile of the technology workforce.

To calculate the net impact of increasing diversity in the technology workforce, we calculated the difference in employment and labour income in a business as usual scenario (the base case) with a scenario where diversity in technology was increasing (the project case). Further detail on these two scenarios are provided below.

The base case

Modelling for this report finds that in 2020, just 29% of the technology workforce were female. Under a business as usual scenario, we assume the level of female participation improves at the current rate of 0.75% per annum. This was calculated based on the change in the level of female participation between 2014-20.

Based on current trends, it's estimated that it would take 66 years for female participation in the technology workforce to reach the target rate. The supply of technology workers in the base case is based on Deloitte Access Economics forecasts.

The project case

In the project case, we model the impact of reaching the target rate in half the expected time, or 33 years.

The increase in female participation is assumed to occur through the attraction of net additional female workers to the tech workforce, as opposed to female workers being hired in place of men. This means the aggregate supply of technology workers is higher in the project case than in the base case (in addition to the level of female participation also being higher).

Relative to the base case, it's estimated approximately 382,000 additional full-time equivalent (FTE) female technology workers will be required to reach the target level by 2053.

The benefits of increasing diversity

Increasing female participation in the technology sector yields two main benefits for the economy more broadly. First, it will encourage some women to enter the workforce or increase their hours of work (their labour supply), lifting participation rates. Second, it allows a portion of existing female workers to move from other sectors into higher skilled occupations in technology, creating a productivity dividend.

Increased labour supply

The uplift in labour supply was determined based on the difference between the current proportion of male part-time workers in technology occupations (26%) compared to part-time female technology workers (11%), drawing on data from the 2016 Census (at the 4-digit ANZSCO level). In the project case scenario, it's assumed the proportion of female part-time tech workers is equivalent to men.

The average female part-time worker in tech works 22 hours,[11] and the ABS defines a full-time worker as anyone that usually works 35 hours per week or more. This means that on average, every part-time worker in tech represents 0.63 in FTE employment terms.

For every female part-time tech worker that moves to full-time work, there is an increase of 0.37 in FTE employment. In total, we estimate that just over 122,000 female part-time workers will move into full-time work, representing an increase of roughly 45,000 workers in FTE terms.

We assume the increase across the technology workforce occurs in parallel with the current occupational breakdown within the industry. The increase in labour supply at the occupational level is shown in Table B.1.

[11] Based on hours worked data from the ABS Census (2016).

Table B.1: Change in labour supply across occupations (1-digit ANZSCO)

Occupation	Change in labour supply (FTE)
Managers	3,331
Professionals	28,974
Technicians	5,910
Clerical and administrative workers	5,992
Sales workers	846
Total increase in labour supply	**45,053**

Source: Deloitte Access Economics (2021)

Higher labour productivity
The remaining supply of additional female workers are assumed to move from other sectors into highly skilled occupations in technology, creating a productivity dividend.

To determine which occupations female workers will move from, O*NET data was used. Developed in the United States, O*NET is a comprehensive system for exploring information about jobs and includes information about skills by occupation. Importantly, O*NET data includes information about skill requirements by occupation.

O*NET data was mapped to Australian occupational categories, to compare skill requirements across occupations. It was assumed the top 100 occupations with the most similar skill requirements to technology will be the occupations female workers move from.

The increase in productivity was captured as a net increase in labour income. This was modelled by taking the wage difference between technology occupations and the 100 occupations female workers move from, using wage data from ABS 6306.0.

Based on this modelling, the net increase in labour income was estimated to be $5.4 billion (in 2020 prices).[12] The breakdown of the change in labour income across occupations is shown in the Table overleaf. It is noted that for certain occupations – clerical and admin workers, as well as sales workers – the difference in wages is negative. However, in aggregate, the net change in labour income is positive.

Table B.2: Change in labour income across occupations (1-digit ANZSCO)ANZSCO)

Occupation	Change in labour supply (FTE)
Managers	$233,568
Professionals	$0.79
Technicians	$36,487
Clerical and administrative workers	-$0.07
Sales workers	-$201
Total increase in labour supply	**$536,050**

Source: Deloitte Access Economics (2021)

[12] This was inflated to 2020 prices using a wage price inflation rate of 1.04.

Computable-general equilibrium (CGE) modelling

The economic impact of increased female participation in technology occupations was calculated using through the Deloitte Access Economics Regional General Equilibrium Model (DAE-RGEM).

The DAE-RGEM is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium (CGE) model of the world economy with bottom-up modelling of Australian regions. The model is based upon a set of key underlying relationships between the various components of the model, each which represent a different group of agents in the economy.

CGE modelling is useful in estimating net benefits when the activity concerned is likely to create opportunity costs for other industries or a significant change in aggregate demand, such as transitions of labour supply between occupation where economy-wide general equilibrium effects are likely to be important. This model captures the dynamic relationships between sectors in the economy and is used to estimate the net increase of economic activity to the Australian economy It accounts for the opportunity cost of providing this labour supply to technology occupations and produces the value added for the Australian economy.

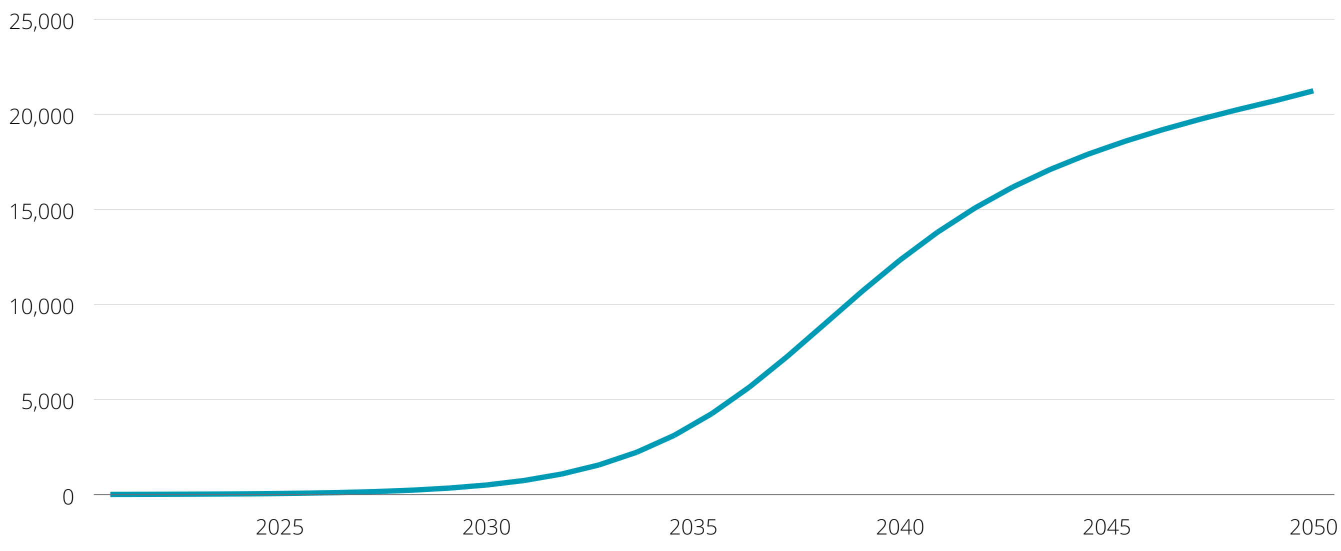
The CGE model assumes the shock to labour supply and labour income shown in the tables above are phased in over a period of 33 years, from 2020-53, following an s-shaped fashion.

Results

It's estimated that increasing diversity in the technology workforce will grow Australia's economy by $8 billion on average ever year, noting that the benefits vary significantly over the 33-year time horizon. For example, for the first 20 years, the increase to output is just $1.8 billion every year on average (compared to $17 billion on average in the remaining 13 years).

The net change in output across the 33-year period is shown in the chart below. In year one, Australia's GDP is just $0.08 billion larger than under the baseline scenario, compared to over $21 billion in the final year.

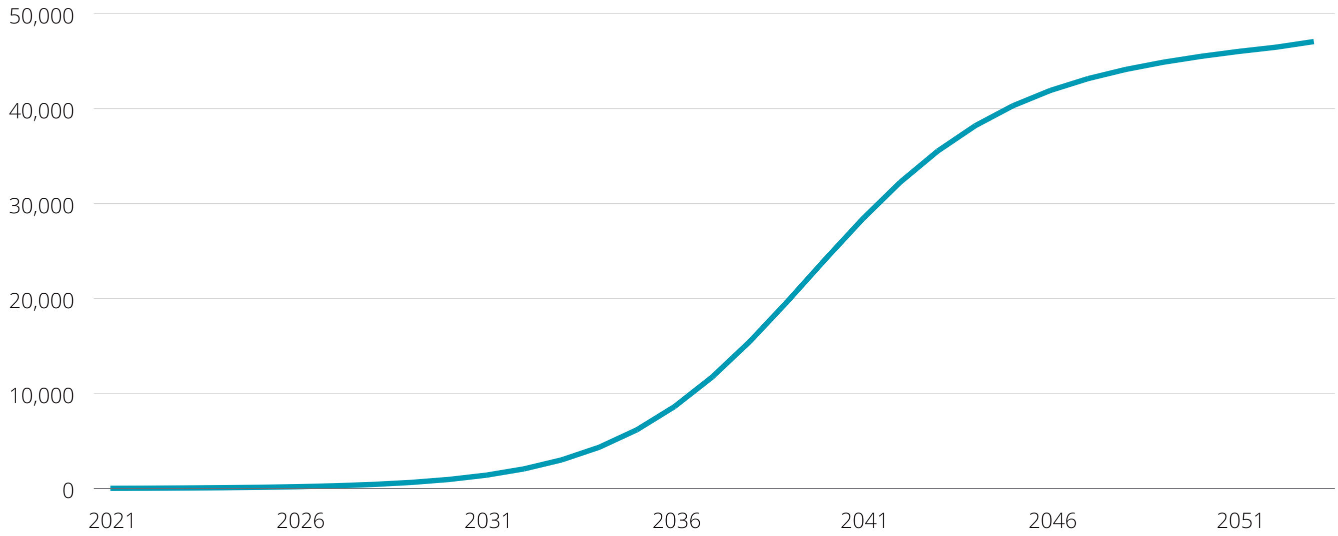
Chart B.1: Net increase in output (2021-53)



Source: Deloitte Access Economics (2021).

Increasing diversity in technology also creates employment benefits for the Australian economy. Modelling for this report finds that it creates an additional 19,200 FTE jobs on average every year over the 33-year horizon, and just under 5,000 in the first 20 years (see Chart B.2). In the final year, the increase in FTE employment is over 47,000.

Chart B.2: Net increase in FTE employment (2021-53)

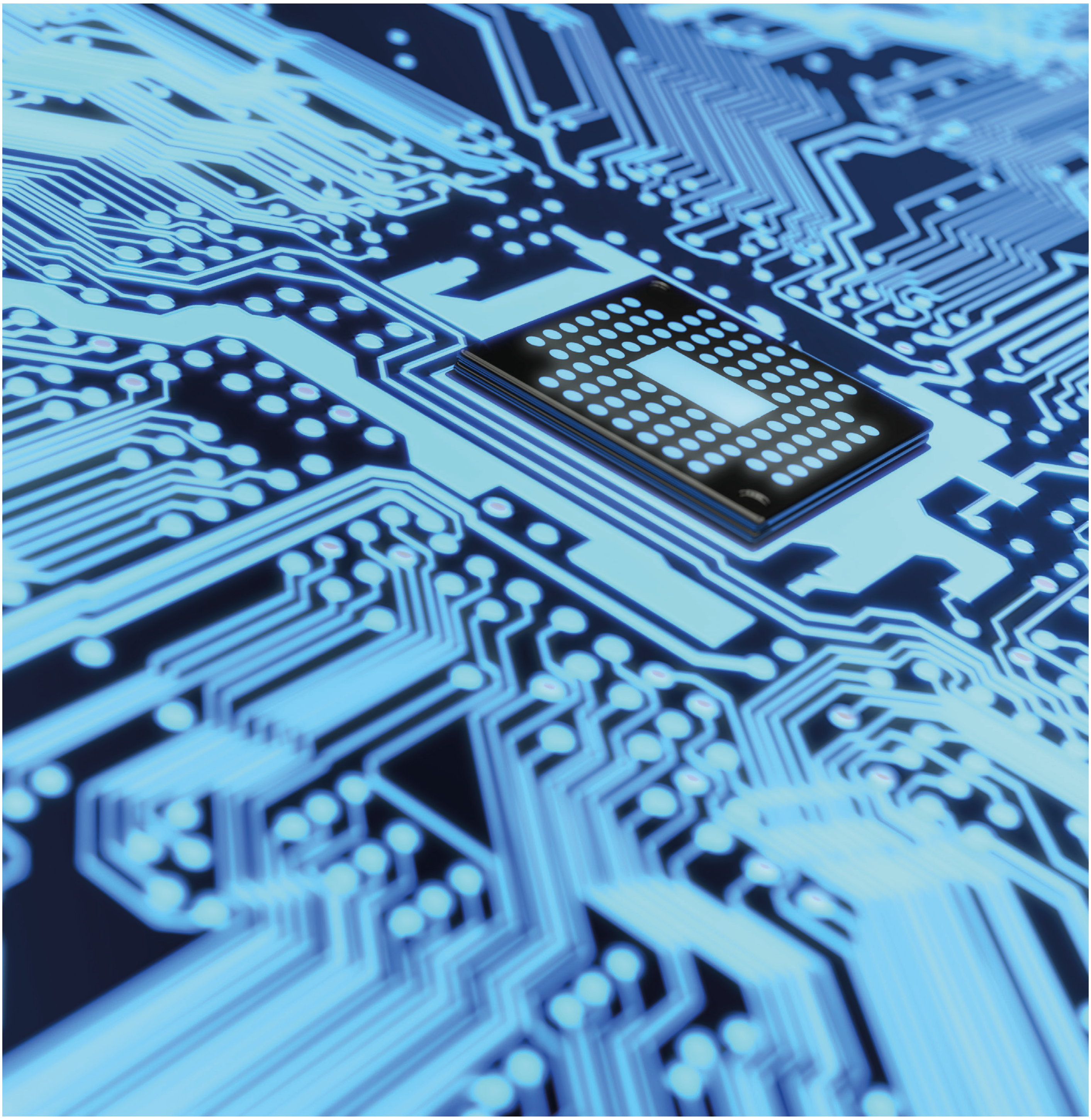


Source: Deloitte Access Economics (2021).

Limitation of our work

General use restriction

This report is prepared solely for the Australian Computer Society (ACS) by Deloitte Access Economics (DAE). This report is not intended to and should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. The report has been prepared for the purpose analysing Australia's digital economy and workforce. You should not refer to or use our name or the advice for any other purpose.



Deloitte.

Deloitte Access Economics
CAN: 149 633 116
Grosvenor Place
225 George Street
Sydney NSW 2000
Tel: +61 2 9322 7000
Fax: +61 2 9322 7001

Australian Computer Society
ABN: 160 325 931
International Tower One, Level 27
100 Barangaroo Avenue
Sydney NSW 2000
Tel: +61 2 9299 3666
Fax: +61 2 9299 3997

Designed by CoRe Creative Services. RITM0679791.