

THE INNOVATION IMPERATIVE

Risks and opportunities for
Queensland over the coming
decades of economic and
technological transformation

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Q-FORESIGHT

Q-Foresight is a research collaboration between the Queensland Government and the CSIRO's Data61 which uses strategic foresight and related methods to explore the future and help Queensland governments, industries and communities make wiser choices.

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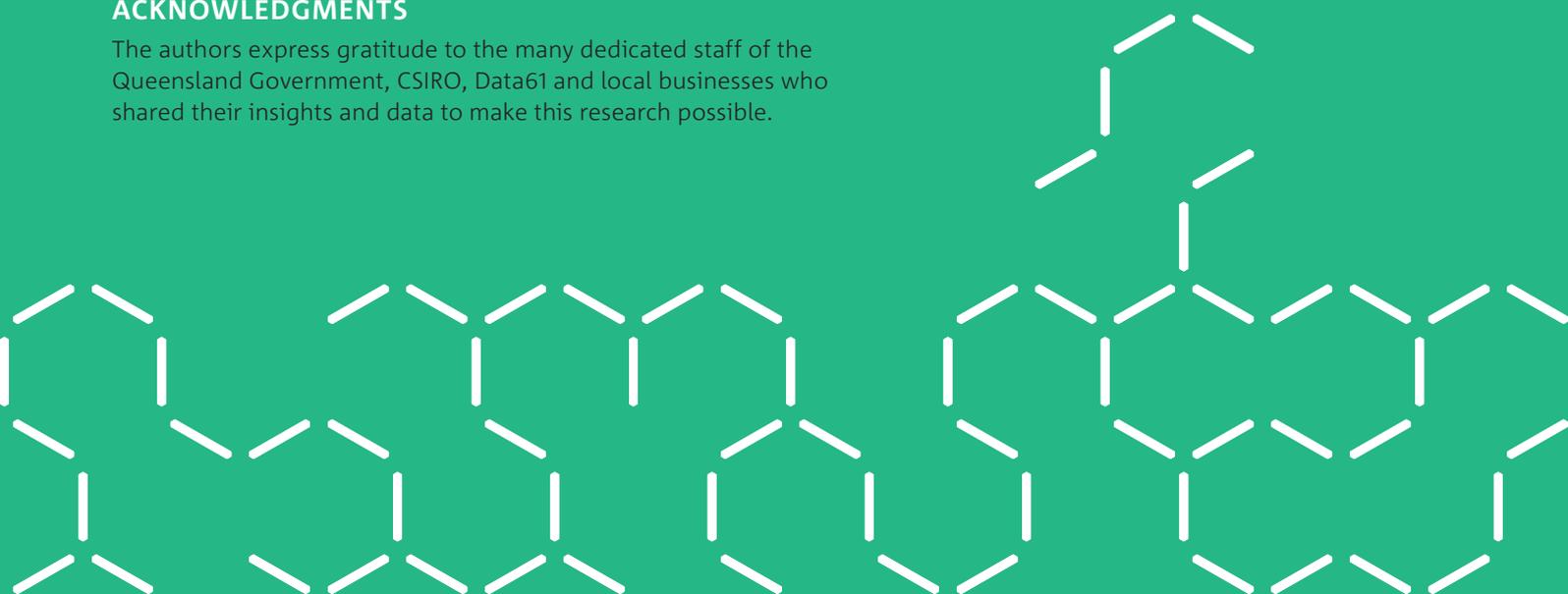
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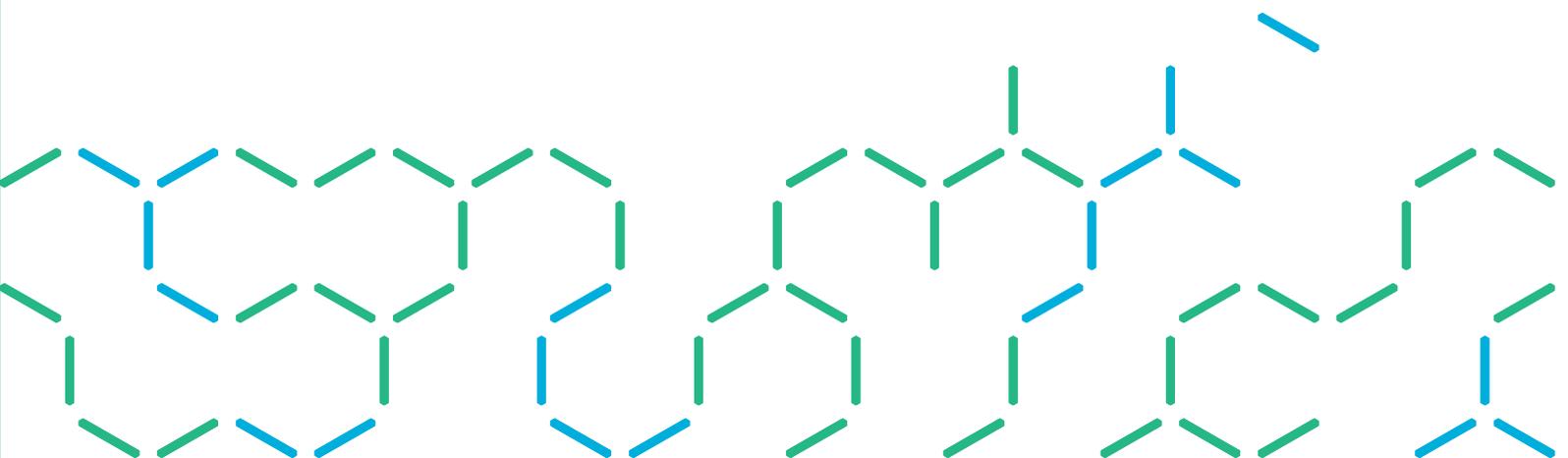
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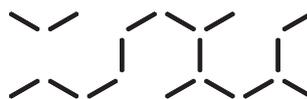


CONTENTS

Executive summary	4
Introduction	6
Shifting ground	7
Serving the world economy.....	7
The technology explosion.....	8
Burning platforms.....	8
On the move.....	9
Forever young.....	9
Flight to quality.....	10
Empowered and connected customers.....	10
Queensland snapshot.....	11
Innovation imperative	16
A tale of two cities.....	22
Steeled for success.....	22
Pivotal pathways	24
Future foundations.....	24
Future focus.....	25
Future frontiers.....	25
Endnotes	26



EXECUTIVE SUMMARY



Queensland's economy, which generates prosperity and supports our quality of life, will shift into a markedly different space over the next 20 years. Technology, emerging global markets, demographics, digitisation, cultural change and other driving forces are significantly reshaping the operational landscape for Queensland businesses, governments and communities.

If we stay put, and don't keep pace with these global changes, we risk being left behind. However, there is also opportunity. If we transition adeptly and intelligently into the digitally enabled economy of the future there are substantial rewards in terms of better jobs, higher incomes and improved lifestyles for Queenslanders.

This report explores what is at stake for Queensland in responding to this important period of rapid change and presents research findings about the potential impact on jobs, the economy and society. The report also recommends pathways to best position Queensland for the future.

Chapter One Shifting Ground outlines the effects of change being experienced across Queensland through global megatrends that are transforming the fundamental drivers of wealth creation and social development. These dynamics are resulting in increased automation, evolving consumer demand and new digitally-enabled business models. Further reverberations are being created through the explosion of technology, growing service sector economies and more mobile populations. The megatrends point to continued disruption and the need to anticipate and prepare for further change.

History has shown that those most able to foresee and adapt to change are most likely to succeed. While there are many factors at play, innovation is a critical variable in pursuing new opportunities and helping to remain competitive. Chapter Two Innovation Imperative outlines how our ongoing ability to innovate is key as it spurs new products and services and drives productivity growth. Success will involve all players in the innovation system and require us to be agile and prepared to depart from convention as the economy continues to evolve.

The stakes are high as signified in Chapter Three.

As Queensland operates in this ever-changing environment, parts of the economy will remain comparatively stable, other parts will shrink and new parts will form. Research estimates that approximately 868,000 current-day jobs are 'at risk', primarily from task automation over coming decades. 'At risk' doesn't mean the job will disappear, but it does mean that the person doing the job will need to transition their skills, either to continue in their position or to find a new one.

The forces of change will have a disproportionate impact on different regions and industries across the state. Research analysis has identified two distinct risks: first, the Brisbane region will have the largest absolute risk due to its concentration of population; and second, the relative impact will be more strongly felt in regional economies than in major cities. The regional risk is amplified by the limited capacity of these areas to absorb displaced workers. The bulk of jobs growth is also forecast to occur in South East Queensland with remote regions decreasing their workforces. Automation risk will also be variable across industries. 'At risk' industries face considerable transition challenges and include manufacturing, mining, construction, retail, warehousing, postal and administrative services industries.

There are also broader social and environmental issues to address. Increasingly ubiquitous technology and growing digital capabilities are generating health issues including the effects of a more sedentary lifestyle, the impact of screen time and changing interpersonal connections. There are associated economic problems in funding future health care and managing future workforce participation. Resolving environmental issues will continue to occupy future communities seeking to achieve a balance between protection and economic growth. Opportunities to export high-value nutritional food and engage international visitors with our natural wonders will be coupled with the challenges of water management, energy consumption and conservation.

However, where there is risk there is also opportunity, as the Queensland economy is projected to potentially add an extra 1,000,000 new jobs to the workforce by 2038. These jobs may be in fields which complement new technology or in roles with a distinctly human focus such as caring or customer service¹; and some will be in currently unforeseen occupations. Technology advances also offer other benefits including stimulating workplace productivity gains, developing new goods and services to spur consumer demand, and potentially addressing the GDP growth gap resulting from an ageing workforce.²

MEGATRENDS

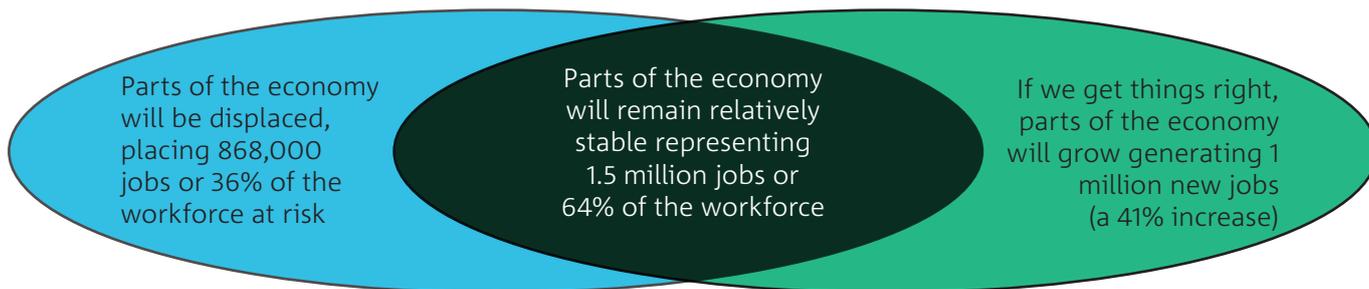


Figure 1: The shifting landscape in Queensland

The true test for Queensland's future will be in how well and how early we transition the parts of our economy at risk into spaces of opportunity. Worldwide, states and nations are stimulating innovative practices to diversify and grow their economies. Queensland has a proactive innovation agenda underway with solid foundations from which to build new services and businesses. A range of government programs are working to bolster the foundations for innovation including fostering talent and skills, improving digital capabilities, and providing financial incentives to commercialise research and development. Leveraging our strengths, building new capabilities and working collaboratively will position us to positively shape the future.

While much of the future is unknown, six key pathways are recommended in Chapter Four to help Queenslanders take advantage of the driving forces of change. The pathways are based on strategies to shift the dial on how we build on our foundations, direct our focus and pursue new frontiers.

1. Future-focused skills and aptitudes to foster innovators

The nature of jobs and employment is changing: existing occupations are evolving to meet new market demands and new occupations are emerging. Queensland must deploy future-focused education and training options to drive a knowledge-based economy. Skills such as creative thinking, customer service and entrepreneurship will be essential in sustaining future workforces.

2. Equality of innovation opportunity to support regions

Many regions across Queensland have strong expertise and experience in traditional industries, such as mining and agriculture, yet it can be challenging for them to diversify their economies into new and unfamiliar spaces. Focused effort on assisting regions to leverage existing and develop new markets will be key to future growth. The success of Queensland's ability to transform will depend on inclusive growth across its regions and our ability to bridge the divide.

3. Transformational technologies to drive growth

Queensland must prioritise investment in technologies that are necessary to diversify our economy. This includes expenditure on infrastructure to improve connectivity issues, research and development into emerging technologies as well as digital adoption to ensure that Queensland businesses (both big and small) can leverage new platforms and differentiate themselves in global markets.

4. Collaboration to deliver results

Sustained and meaningful collaboration between industry, the research sector, government and communities is imperative to realising new opportunities for wealth creation in Queensland. Such collaborations should be driven with a specific purpose or priority in mind to provide a strong strategic direction for the state.

5. Global customers to expand markets

There is a wealth of emerging opportunities for Queensland to export its products, services and expertise globally, particularly in the Asia Pacific region. A global outlook and international connections are critical for Queensland industries to expand their current markets and meet emerging consumer demands, particularly in areas such as food, minerals, medical services and tourism.

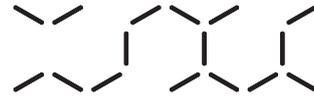
6. Frontier firms to create new opportunities

Supporting high-growth firms to Queensland will be key to attracting future talent and fostering greater innovation and R&D activity. A strong focus on experimentation and testing new directions will help businesses unlock latent potential and push industry boundaries.

Working collectively, the pathways aim to empower local communities to increase their innovation performance by expanding skill sets, building partnerships and diversifying industries. New connections are critical in a global economy where serendipity often leads to new ventures. Opportunities for Queenslanders to shape new demand should be pursued. This will require setting stretch goals that push our horizons and evolve into new markets and exports.

Responding to global change involves us all – individuals, businesses, research organisations, communities and governments. Joint participation and collaboration is essential for our innovation system to support economic transition in different sectors and regions. This report highlights the wealth of opportunities Queensland has to drive innovation and secure a prosperous future for generations to come.

INTRODUCTION



The local effects of global changes are having a real impact in Queensland communities. Improving our capacity to understand and adapt to these changes will give us the best chance to grow our economy and safeguard our way of life.

Strategic foresight involves the structured analysis of plausible future events to inform current-day strategy and policy decisions. This report applies strategic foresight to understand the drivers of change impacting the Queensland economy and how they could unfold over the coming 20 years.

This is the first report from the Q-Foresight program – a joint strategic foresight research initiative between the Queensland Government and CSIRO’s Data61 to inform long-term strategy and planning. Q-Foresight is designed to help Queensland’s governments, industries and community decision-makers see what might lie ahead and make informed choices.

The report includes four chapters:

- Chapter One looks at the shifts underway, describing a set of seven megatrends that will push Queensland to a new economic context.
- Chapter Two examines The innovation imperative and outlines why remaining competitive will require unconventional approaches.
- Chapter Three presents what is at stake, providing estimates of the number of jobs, incomes and taxes at risk for Queensland as well as the projected new jobs that could be created as it makes this transition.
- The report concludes with recommended pathways to reinforce Queensland’s innovation agenda and spark new economic growth.

This summary document provides an overview of the full research report which is available on request.

The research report draws on a range of disciplines and data sets including strategic foresight, statistical analysis and data modelling.

Strategic foresight is a multi-disciplinary field that draws upon economics, management science, operations research and planning theory. The CSIRO has developed its own generic strategic foresight process, which incorporates international research and practical experience from working with clients across the public and private sectors. This process was adapted to explore emerging trends for Queensland.

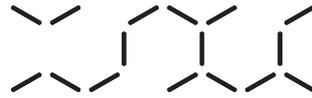
The percentage of occupations at risk of digital disruption by automation across industries (Australian Bureau of Statistics [ABS] Australian and New Zealand Standard Industrial Classification [ANZSIC] codes, level 1 grouping) was examined as well as data from a recent 2017 AlphaBeta study on the Australian labour market.³

The AlphaBeta risk probabilities were matched to 474 unique occupations in the Queensland economy as defined by the ABS Australian and New Zealand Standard Classification of Occupations 4-Digit Level codes. It is the most granular classification of occupations available. Estimates of incomes (salaries, wages and workers compensation) and taxes (payroll tax and fringe benefits tax) per worker per year were obtained using ABS Australian Industry 2015-16 data.⁴

Projected jobs growth was calculated using employment data projections from the Queensland Government Statistician’s Office (QGSO) by industry and by region for fiscal year 2015-16 and 2020-21. The QGSO derives its estimates from ABS data.

The projections are based on and consistent with the Queensland Government population projections, 2015 edition (medium series), State budget forecasts (2015–16) and a range of other assumptions and variables. The projections are produced on a no policy change basis and should not be considered as forecasts of future employment growth. Rather, they are long term projections of possible future employment growth derived from the range of assumptions and information used in their construction. The projections are compiled using the latest information available at the time of production. However, these components change over time and, therefore, direct comparisons should not be made between these projections and any future projections that may be published at a later date or other shorter term forecasts of employment growth.

SHIFTING GROUND



Megatrends are a concept used in the field of strategic foresight to describe powerful drivers of change reshaping the current business landscape and socio-economic context. They occur at the intersection of numerous trends with tighter spatial, temporal and typological definition; and typically express themselves over decadal timeframes.

The seven megatrends identified in this report are the driving forces causing Queensland's economic landscape to shift. They are associated with the growth of new industries and the decline of existing industries and have implications for how we stimulate innovation.

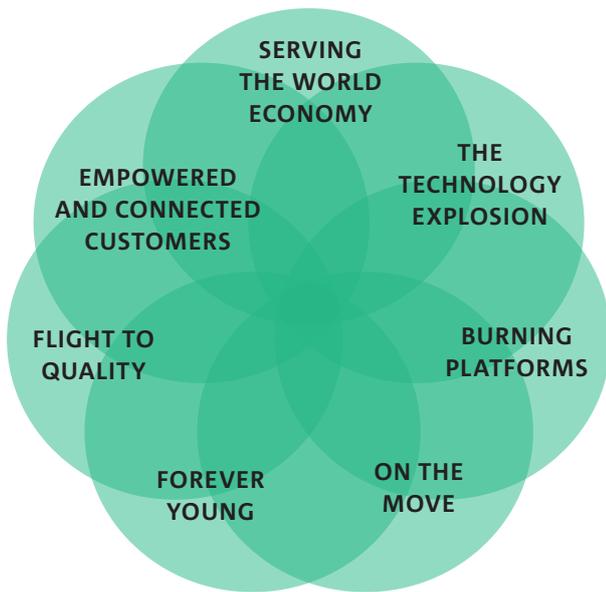


Figure 2: Interconnection of global megatrends.

Serving the world economy

Queensland's export destinations in the Indo-Pacific region are transitioning from industrialisation phases into advanced service sector economies. This shift has been driven by substantial growth in the middle-income bracket across Asia with further projected growth of 1.4 billion persons in 2015 to 3.5 billion by 2030.⁵ Since the year 2000 the share of the Chinese economy in the services sector has jumped from 40% to 52%. In India it jumped from 45% to 54%.⁶

Service sector growth is also evident in other Asia Pacific economies. India, New Zealand, and Vietnam have all demonstrated significant growth in their service sectors from 2000 to 2016 while Australia, Korea, Indonesia, Malaysia, the Philippines, Singapore and Thailand all have service sectors that represent a consistently growing proportion of their economies.⁷

New export markets signal a shift in demand. Service sector economies will want safe, provenance-assured, healthy and boutique foods. These economies will demand holidays, banking and finance services, education, healthcare and administrative services. The implication of this megatrend is an opportunity for diversification of exports with expansion in the service sector. Innovation is core to the testing, development and expansion of new industries selling new products and services.



The technology explosion

Technology functionality and adoption will continue to grow exponentially over the next decade, reshaping Queensland's industries. For example, robotics and autonomous systems continue to improve efficiency often through labour replacement having profound impacts on the size and shape of the workforce. In 2017, robot installations in the Asia-Australia region were predicted to have increased by 21%, demonstrating strong growth globally.^{8,9} It is estimated that by 2020 the global stock of operational robots will reach 3 million units; a 67% increase from 2016.

The implication of the technology explosion is the change in our economy and workforce. Many job tasks will be automated (some involving artificial intelligence), new tasks will emerge, and some job roles will transition with new responsibilities. A recent study by the OECD finds that 14% of jobs are highly automatable and another 32% of jobs could face substantial change; placing 46% of jobs at some level of risk.¹⁰

Substantial change indicates that a significant portion of tasks essential for performing the job are likely to be automated. This could mean fewer people are required for the same level of output. It also means that workers in these jobs will need to acquire new skills and aptitudes to stay employed. There is an expectation that tasks which are rules-based, repetitive, clearly structured and well defined are most likely to be automated. Tasks which involve ambiguity, judgement, creativity, complexity and emotional intelligence are typically much harder to automate.

However, automation and digitisation are also creating jobs. Professions such as graphic designers, data scientists, cyber security specialists and many types of computer programmers have boomed in recent times. Industry 4.0 offers Queensland many new opportunities with data connectivity propelling advances in robotics and sensors in agriculture and manufacturing.

Our challenge is about how to transition Queensland's workforce and businesses to a new digitally enabled economy. We want the technologies of the future to be a boon for Queensland companies and workers not a source of competitive tension.



Burning platforms

Platform businesses are restructuring the economy, removing transaction costs and information asymmetries, whilst also opening up new sources of value creation. And the impacts can be sudden. For example, the rise of online streaming – the last video store in the Brisbane shire closed its doors for the final time on 14 February 2018.¹¹

Spending on research and development (R&D) is increasingly driving a company's growth, and technology companies are among those pursuing R&D investments most aggressively. In 2016 Amazon spent A\$20.6 billion on R&D compared to Queensland's entire business expenditure on R&D of \$2 billion in the same year.^{12,13} Amazon's technological capabilities will be brought to bear in the retail sector (which employs hundreds of thousands of Queenslanders) against existing incumbents.

Platforms of the future may be able to use distributed ledger technology to achieve new levels of direct transactions with existing firms. The implication for Queensland industry and government is to design business models which are competitive with the new digitally enabled online platforms.



On the move

People, freight, labour and data are all becoming increasingly mobile. The number of airline passengers travelling to Brisbane is predicted to increase from 26.6 million in 2017 to 45.1 million by 2031.^{14,15} Total freight volumes have quadrupled over the past 40 years in Australia and forecasts suggest that by the year 2030 freight volumes will increase by 2.5 times for containers passing through Australian shipping ports, by 1.8 times for road freight and by 1.9 times for rail freight.¹⁶

Current trajectories suggest demand for data is also set to explode, with the data downloads in Australia increasing from 400 thousand to 3 million terabytes from 2012 to 2017.¹⁷ This world of increasing mobility heralds opportunity for the tourism sector, freight and logistics companies and for the development of digital infrastructure.

Changes in mobility may also be associated with changes in landuse and settlement patterns with flow-on consequences for infrastructure, transport and regional economic activity. Overall Queensland will need to adapt to a much more mobile world.



Forever young

Queensland's population is ageing, with the number of people aged over 65 years set to rise from 13% in 2011 to 19-21% in 2036.¹⁸ This is associated with a declining share of the Queensland population active in the workforce. The rate of Queenslanders of working age (15-64 years) has been on the decline and is expected to shrink from 65% today to 61% by 2036.¹⁹

Queensland's aged dependency ratio (the number of persons aged 65 years and over per 100 persons aged 15-64) has increased sharply and is expected to rise from 19.3 in 2011 to between 31.3 and 33.9 by 2036.²⁰ By 2055 there will only be 2.7 working-age people for every non-working age Australian compared to 4.5 in 2015 and 7.3 in 1970.

Population growth combined with demographic ageing and chronic illness are set to cause Queensland's health expenditure to keep increasing. Over the period 2006 to 2016 Queensland had the highest average annual growth in health spending of 5.7% which was above all other Australian states and territories. Per capita spending on health increased in Queensland from \$4,825 per person per year in 2006 to \$6,900 in 2016 (in current prices).²¹ The implication of this megatrend is that innovation is critical to boost the productivity of a smaller workforce and find solutions for exploding demand for healthcare services within the confines of limited budgets. Within the space of health and ageing we need to innovate to find new ways of doing more with less.



Flight to quality

Income growth in the Asia Pacific is driving increased demand for high-quality mineral, food, education and tourism products and experiences, which Queensland is well positioned to supply. In Asia alone, daily protein consumption has risen from 47 to 78 grams per person from 1960 to 2013.²² Along with increasing concerns around food safety, provenance and health. Quality food is in growing demand.

Quality minerals are also in demand. Even though emerging economies in Asia have signalled a move towards renewables, coal for consumption in steel manufacturing is set to increase in India, Japan and South Korea.²³ Queensland's high-quality black coals which burn more cleanly are likely to experience higher demand. There is also likely to be growing demand for rare earth elements such as scandium (fuel cells), tantalum (mobile phones), niobium (super-conducting magnets) and cobalt (hybrid vehicle batteries) which have been discovered across Queensland.²⁴

High quality tourism experiences are also highly sought after. The global luxury travel market is expected to grow at a compound annual growth rate of 7% over the period of 2017-2021. Adventure travel accounted for more than 47% of the total luxury travel market in 2016, while personalised vacations (custom-made travel plans with personalised tours and experiences, as opposed to mass-market tourism) made up 29%.²⁵ The overall implication of this megatrend is that Queensland has opportunities to respond to the new premium markets of high income Asian nations.



Empowered and connected customers

Service providers increasingly use data to analyse, predict and customise their services, with worldwide expenditure on customer relationship management software increasing by 12.3% from 2014 to 2015.²⁶ The ability to access connected platforms and services will continue to empower customers to compare products and buy from a global marketplace.

The number and variety of connected personal devices is increasing. Shipments of connected home devices are expected to grow at a compound annual rate of 67% over the period 2014-2019, and make up 27% of the Internet of Things category by 2019.²⁷ Meanwhile, the market for wearable devices, such as smart watches and fitness trackers, is expanding rapidly, with projections of 20% growth over the next five years resulting in a \$29 billion USD global market in 2022, with sales of 243 million units.²⁸ These new devices are generating massive amounts of personal data, enabling companies to engage customers on a more personal level.

Citizens also have rising expectations for seamless digital services from government. For example, e-government services are increasingly in demand as citizens expect convenient, personalised, and easily accessible information and services. Australia has consistently performed well on the United Nation's e-Government Development Index currently ranking second in the world.²⁹

The implication of this megatrend is that Queensland public and private sector organisations need to deliver services to citizens and customers in a different marketplace. Digitisation carries opportunities to improve service delivery but also brings risks associated with data privacy and cybercrime. Digitisation will also change the nature of interactions between organisations and the people they serve.



Queensland snapshot

The effects of these global trends are being experienced across Queensland. While our domestic economy is dominated by service industries, the state's export economy is dominated by primary industry commodities. This unique contrast presents both opportunities and challenges for Queensland when seeking to respond to international trends.



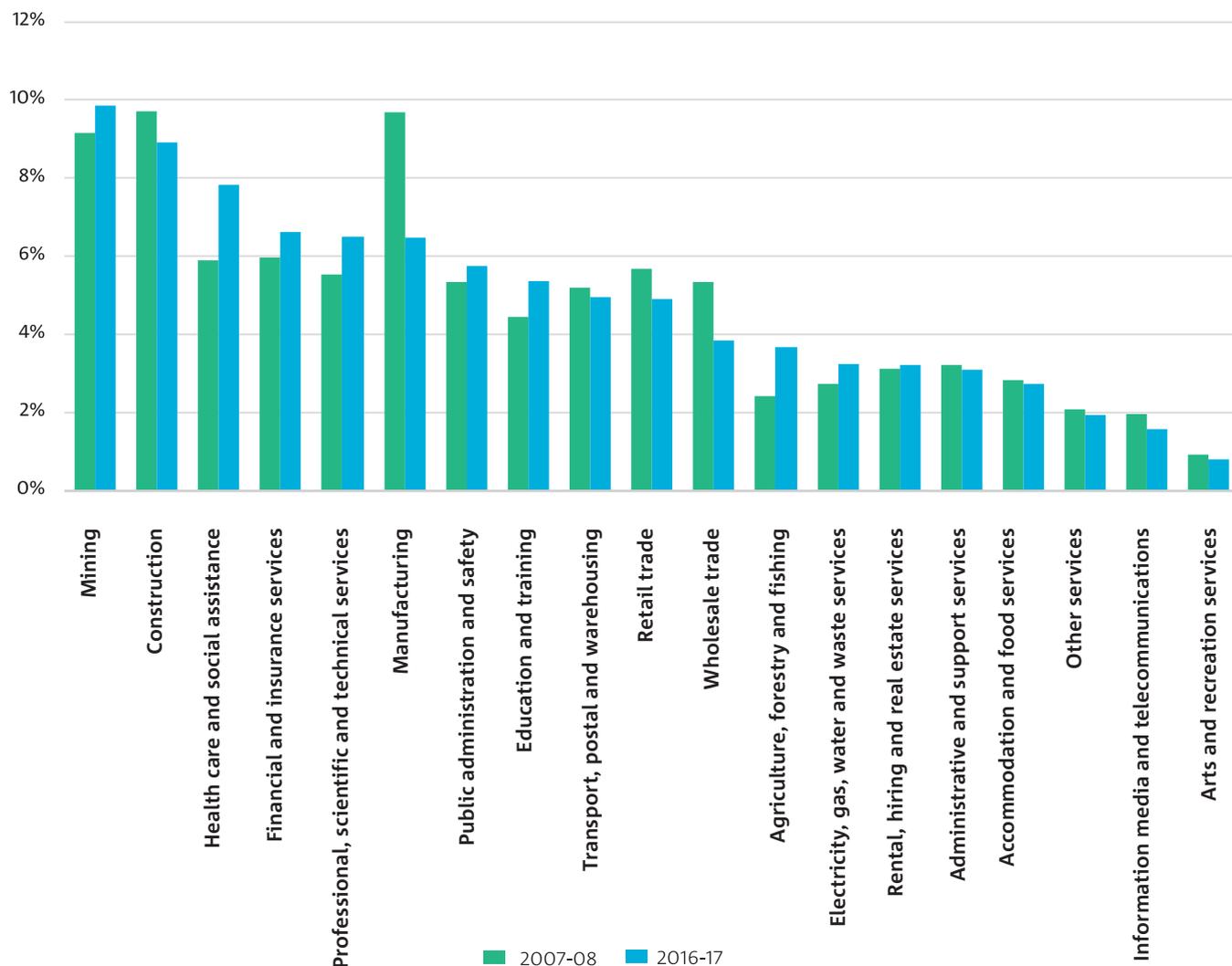


Figure 3: Queensland industries by share (percentage) of total economic output in 2007-08 and 2016-17.

Source: Australian Bureau of Statistics⁸²

Measured by economic output, mining (10%), construction (9%), health care and social assistance (8%) are Queensland's largest industries (see figure 3). Together these industries account for 27% of Queensland's economic output and lead other industries including manufacturing (6%) and agriculture, forestry and fishing (4%).

When measured by employment levels, Queensland's largest industries are health care and social assistance, retail trade and construction. In the 10 years to 2018, employment in health care and social assistance has grown dramatically with a 75% increase (see figure 4).

Service industries saw the largest increases in employment levels over the past decade including health care and social assistance, education and training, and professional, scientific and technical services.

The value of Queensland's exports has grown sharply in recent years, up 30.4% from 2015-16 to 2016-17. While the majority of this growth was driven by service exports, the state's export profile remains dominated by mining and agriculture, similar to Western Australia.

Other Australian states, like New South Wales and Victoria, have positioned services industries as their key exports. These states generated \$33.9 and \$20.9 billion, respectively in service exports in 2016-2017, compared with Queensland,

which generated \$13.2 billion. Whilst service-sector exports from Queensland are currently lower they are growing with a 6.4% rise on the previous year.

Queensland's capacity to adapt to change relies on development of our skills and aptitudes. As the state's population continues to grow, current levels of educational attainment present areas for improvement.

Queensland's resident population in December 2017 was 4.97 million people representing growth of 1.7% over the preceding year. This is above the national population growth rate of 1.6%. Over half of the state's population growth is driven by overseas (36%) and interstate (28%) migration.³⁰ Queensland boasts a reputation as a lifestyle destination with many of the state's coastal regions exhibiting a larger proportion of seniors.³¹

However, Queensland's levels of educational attainment lag that of other Australian states such as New South Wales and Victoria.

While 77.0% of Queenslanders aged 15-64 in 2017 held a Year 12 or other qualification at a Certificate III level or above, compared with 75.4% for New South Wales and 77.0% for Victoria,³² the proportion of Queenslanders aged 20-64 with a bachelor degree level of qualification or above (26.5%) is lower than the Australian average (31.1%).³³

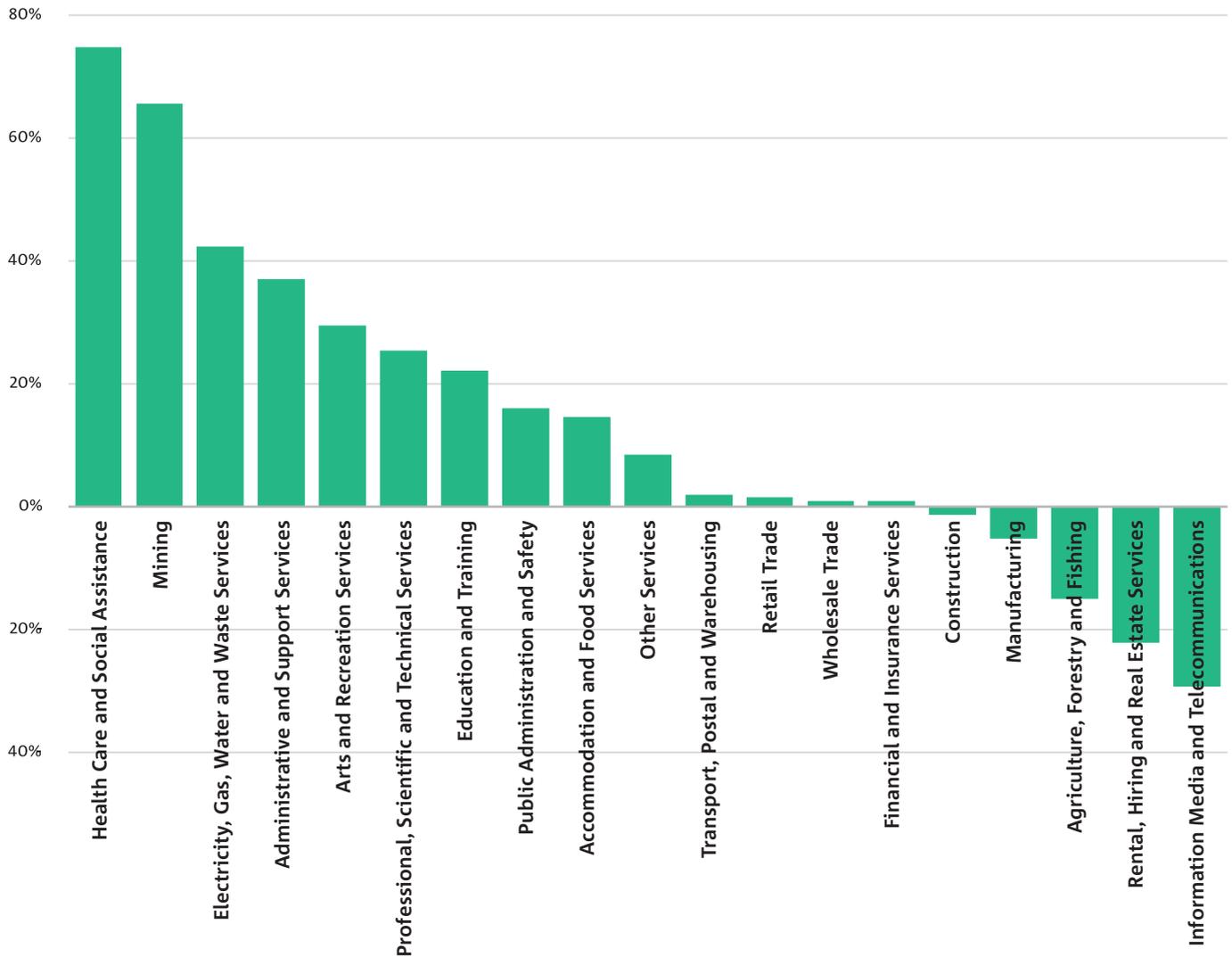


Figure 4: Queensland industries by share (percentage change) of total employment from 2008 to 2018.

Source: Australian Bureau of Statistics⁸³

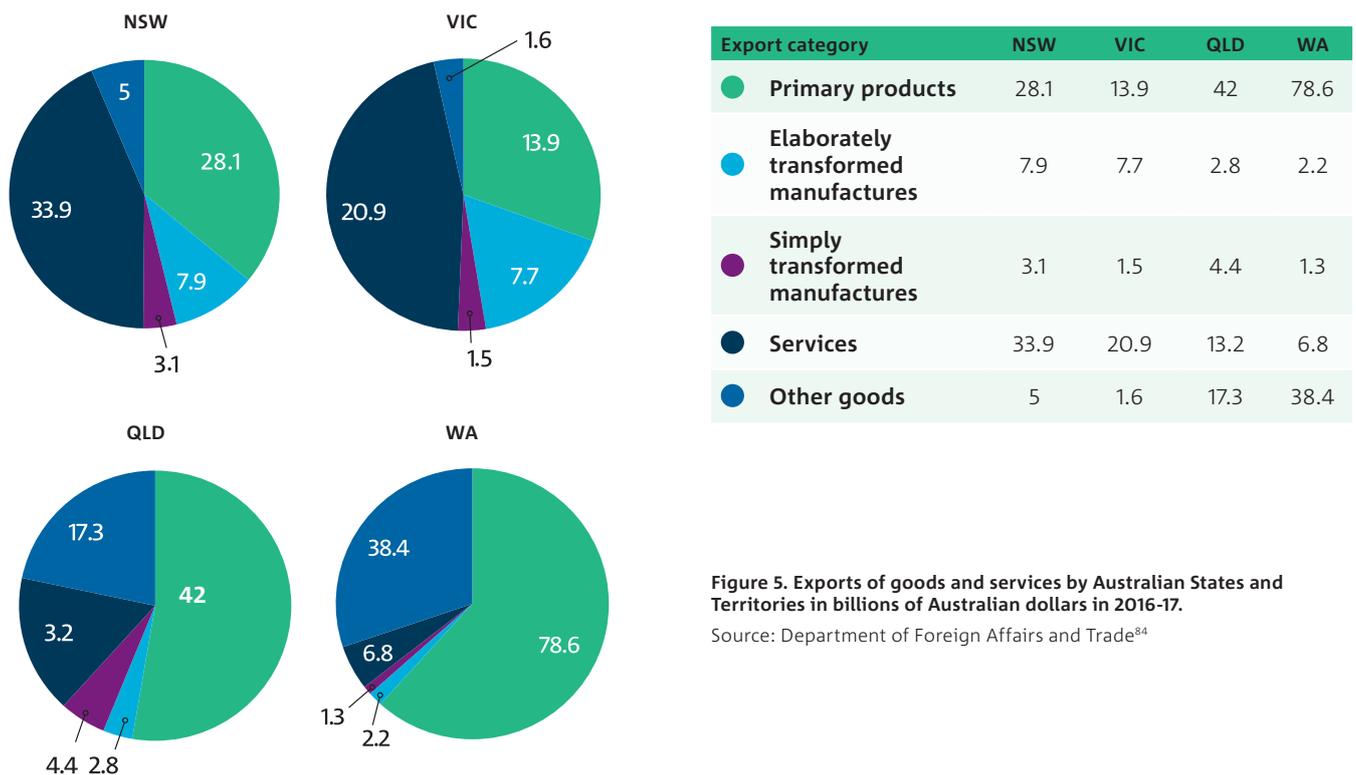


Figure 5. Exports of goods and services by Australian States and Territories in billions of Australian dollars in 2016-17.

Source: Department of Foreign Affairs and Trade⁸⁴

International research continues to point to science, technology, engineering and maths (STEM) as critical disciplines for future success. Queensland's school student performance in STEM, as measured by national science literacy scores, has steadily risen between 2009 and 2015, and participation rates in maths and science subjects have also increased.^{34,35} Despite this improvement, the state's performance remains below that of New South Wales and Victoria.

The Office of the Queensland Chief Scientist has identified that 21% of the Queensland workforce had a STEM qualification in 2016.³⁶ While this is on par with the other Australian states, it remains below the OECD average of 22%. Rates of high school students studying STEM subjects have increased in Queensland. While total enrolment in STEM undergraduate courses at universities has also increased, the Office reported a fall in Information Technology (IT) enrolments of as much as a third since 2003.³⁷

Business development and growth in emerging fields will also help fuel our economy. Queensland has recently gained a reputation as a 'startup state', rocketing ahead in the past few years to become a leader in Australia's entrepreneur tech scene.³⁸

Startup activity has increased dramatically in Queensland, from 16.5% in 2015, 19.5% in 2016 to 20.8% in 2017.³⁹ As a proportion of startups, Queensland has now surpassed Victoria (14.4%) and is second only to New South Wales (44%). Uniquely, Queensland has the highest proportion of startups located outside its capital city, reflecting the strong innovation potential of Queensland's regions.⁴⁰

Knowledge-based activities drive innovation, particularly the commercialisation of research and development where new thinking propels new products and services or improves productivity. However, the business finance needed to fuel innovative research, development and execution is at comparatively low levels in Queensland. Business expenditure on R&D has fallen in Queensland from a high of \$2.679 billion in 2010-11 to \$1.955 billion in 2015-16.⁴¹ Mining (\$505 million), manufacturing (\$361 million) and professional, scientific and technical services (\$431 million) industries represented the largest contributors to Queensland's business expenditure on R&D in 2015-16.

As a percentage of Gross State Product (GSP), Queensland's business expenditure on R&D fell from 0.9% in 2013-14 to 0.62% in 2015-16.⁴² While falls were recorded in most other Australian states, Queensland's performance against this measure remains well below New South Wales (1.19%) and Victoria (1.14%) and also trails states such as Western Australia (0.87%) and South Australia (0.77%).

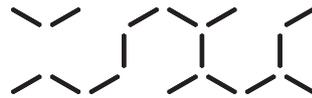
Despite lower R&D expenditure by business, the 2017 National Australia Bank (NAB) Innovation Index rated Queensland as equal first among Australian states for radical innovation. That is the development of a new business, product and/or process that transforms a business which is in contrast to incremental innovation – an improvement to an existing product, service or process.⁴³

Access to venture capital to commercialise innovations and scale Queensland startups also remains a challenge. Queensland ranks poorly compared to New South Wales and Victoria, with only 9% of venture capital (\$32 million) and 7% of private equity (\$249.88 million) invested in the state in 2016.⁴⁴ This fell further in 2017 with only 2% of venture capital (\$6.54 million) and around 7% (\$249.83 million) of private equity investment flowing to Queensland.⁴⁵

Alternative funding sources such as traditional loans do not appear to link to innovation in Queensland. Over the past 10 years, commercial lending in Queensland has been dominated by the 'purchase of real property' (35.1%) and 'revolving credit' (includes credit cards) (21.3%).⁴⁶ Lending for plant and equipment, usually acquired for the purpose of expanding or upgrading equipment to improve processes, has averaged 8.8%.



INNOVATION IMPERATIVE



New sources of growth are vital to future economic development, and innovation is a critical variable in pursuing new opportunities. The benefits can be significant, as innovation-active Australian businesses were found to be 40% more likely to increase income and profitability, twice as likely to export, and two to three times more likely to report increased productivity, employment, and training.⁴⁷

While in times of rapid change, familiarity can often ease feelings of being overwhelmed and out of our depth, failure to adapt can have grave consequences. The window of opportunity created by the convergence of global trends will not remain open for long. Nor has it been ignored by other states and nations. The importance of this juncture has seen them invest heavily in economic and industry development.

International and local evidence suggest that innovation is the key to successfully adapting to change. Innovation is critical to transformation and an important economic driver. Success is commonly achieved by building on and diversifying existing strengths, using new thinking to tackle problems, seeking different perspectives to generate new products and services, and having a greater risk appetite for experimentation.

Innovation is at its simplest where an idea finds a useful application. The OECD Innovation Strategy⁴⁸ defines innovation as new ideas applied to products, processes, marketing or an organisation. It can be technological or non-technological, and often opens new markets, creates new businesses, and addresses social and environmental challenges.

Innovations can also be distinguished by whether they are sustaining or disruptive.⁴⁹ Sustaining or incremental innovation is a process by which small-scale improvements are made to a product in order to gradually grow its customer base and market share. Disruptive or radical innovation is where a product or service takes root initially in simple applications at the bottom of a market and then relentlessly moves up market, eventually displacing established competitors.⁵⁰ Both help to stimulate economic development.

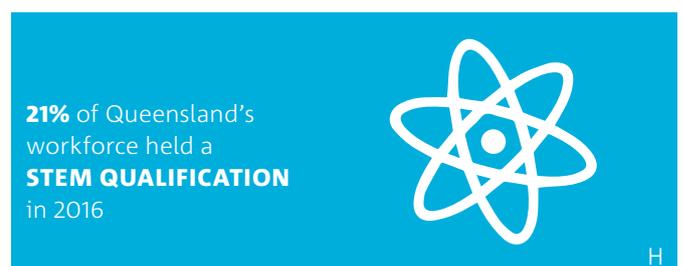
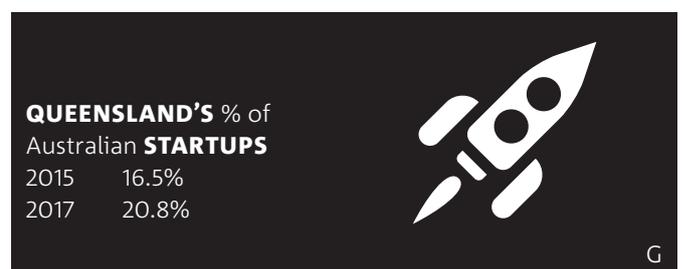
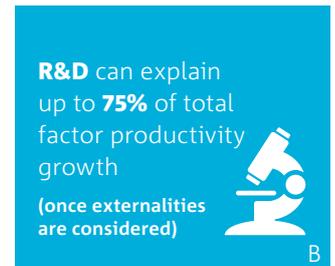
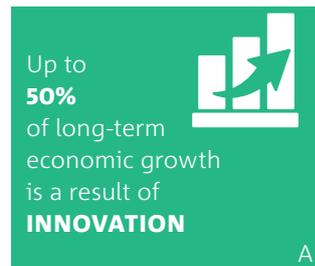


Figure 6: Innovation in action – Queensland, Australia and internationally.⁵¹

Many studies have identified economic transformation through innovation as one of the only options to significantly boost and maintain growth and improve long-term economic resilience. An OECD economic assessment of Australia in 2017 placed improved innovation at the centre of future prosperity: 'merely maintaining long-run average productivity growth jeopardises [this] success; a renewed emphasis on structural reforms in particular those that help boost Australia's capacity to absorb and generate innovation is required'.⁵² Queenslanders also recognise the value of innovation, with a recent survey noting that 69% of participants strongly agreed that innovation is important for Queensland's future.⁵³

While innovation is not a new concept, it requires renewed and deliberate focus. As the very nature of change is changing, with trends producing more complex impacts than we can realistically predict, we must bolster our ability to innovate.

There is much we can learn from individuals, organisations and nations who have achieved innovation success in the past. The OECD and World Bank highlight six dimensions relevant to innovative entrepreneurship: access to finance, access to knowledge, market environment, access to labour, entrepreneurial capabilities and culture, and regulatory framework.⁵⁴

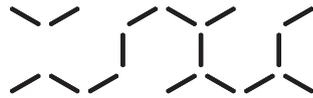
A strong innovation ecosystem based on the active development and maintenance of these dimensions is essential. As global competition intensifies, new market structures form, demand patterns continue to change and more real-time business is undertaken, the ability to nurture innovators who can convert ideas and organisations who lead solution adoption will set economies apart.⁵⁵

Queensland will need to be increasingly agile both in mindset and operations. Our outlook must always be global as the movement of people, ideas and capital is more mobile. Business will be reimagined with changing models of exchange and dissolving industry boundaries. Consumers will demand bespoke products and services to be available on a global scale. Quality design and customer service will be increasingly profitable activities with new innovation key to ongoing competitiveness. Individuals, organisations and communities will require resilience throughout the transformation process as opportunities will not be uniform nor guaranteed.

We also need to lift our gaze to the horizon and anticipate the types of skills and attributes we will need for the jobs of tomorrow, many of which have not yet been created. Strong foundations will include creativity, problem solving skills and the ability to adjust to new environments. Our processes should encourage open innovation and foster multidisciplinary teams where collaboration promotes different perspectives and new thinking.

Innovation and entrepreneurs have featured throughout Queensland's economic history and current government programs are working to grow the innovation ecosystem. While gains have been achieved, innovation is not a 'set and forget' activity. Galvanising our efforts is necessary to maximise our ability to capitalise on our ideas and secure economic competitiveness over the longer term.

HIGH STAKES



The global megatrends and growing role of innovation in securing economic competitiveness identified in this report suggest substantial change for the Queensland economy.

One of the main drivers of change is digital disruption including automation of tasks, resulting in widespread role transition and requiring workers to reskill. There is a challenging and far-reaching period of transition ahead of our economy.

If we don't succeed in making this transition, many jobs – and the income and tax revenue they generate – are at risk. 'At risk' doesn't mean the job will disappear, but it does mean that the person doing the job needs to transition their skills, either to continue in their position or to find a new one. It is also important to acknowledge that the jobs 'at risk' approach relates to available technological capabilities rather than actual utilisation of technology, and that workplaces will all adjust differently to new divisions of labour.⁵⁶

Importantly, new jobs will also be created. The megatrends are associated with opportunity as well as risk. These jobs may evolve from existing roles with higher cognitive tasks, or they may result from expanding consumer demand for new products and services, or they may relate to new professions as yet unforeseen.⁵⁷

We modelled the estimated jobs at risk and the potential for growth (see the full research report for full modelling and data details). We stress that this is not a forecast of job loss nor income loss, but rather an estimate of what's at stake if Queensland fails to transition to a digitally enabled and globally connected economy impacted by business models and market dynamics over the coming decades. These are estimates of how much economic activity we need to transition.

We first modelled the potential impact of task automation on job, income and revenue loss for Queensland. We used published studies of task automation risk associated with digital technology to estimate an overall risk percentage for 474 unique occupation types in the Queensland economy. We then mapped this against the 2016 Census by the Australian Bureau of Statistics (ABS) to get estimates of jobs at risk by industry and geographic region. We matched data on salaries and taxation from the ABS to the occupation by industry to get estimates of economic value at risk.

We estimate that 867,667 Queensland jobs, representing 36% of the workforce, are at risk of disruption from digitisation and automation of the economy over the

coming 20 years. These jobs generate salaries, wages and superannuation, and workers compensation payments totaling \$50.9 billion per year and government revenue in the form of payroll taxes and fringe benefits taxes (FBT) of \$1.8 billion per year (37% of the State's total revenue). The potential loss of these jobs, incomes and tax revenues would have a devastating impact on Queensland's economy and society. It is vital that this section of our economy transitions securely over the coming 20 years. However, we also note the potential for growth with the Queensland economy projected to create over one million new jobs over the coming 20 years. This points towards a period of rapid transition with substantial risk and opportunity.



Figure 7: Some jobs are placed at risk while new jobs will be created. This diagram summarises economic activity (jobs, income, tax revenue) at risk and the new jobs projected for creation in Queensland (by 2038) due to digital transformation, economic change and other driving forces.

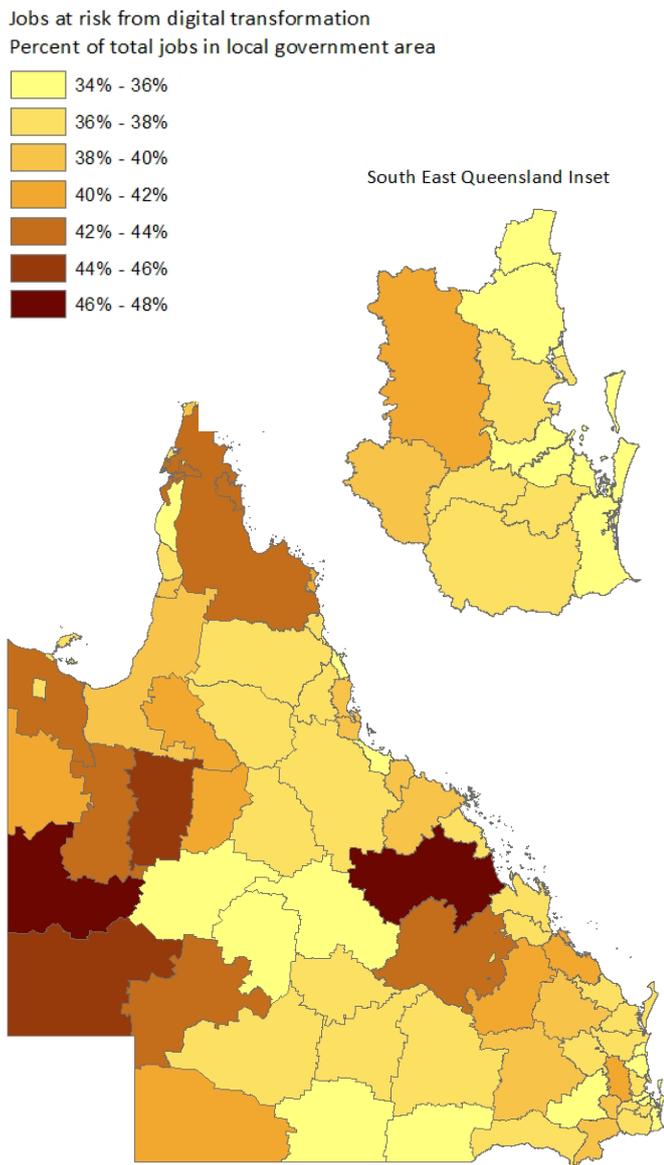


Figure 8: the percentage of jobs ‘at risk’ across Queensland’s regions, 2017-18 to 2037-38.

To map regional variation in jobs risk we used data from the most recent national census on 474 unique occupation types by local government areas. Combining this with our task-risk estimates allowed us to generate estimates of the percentage of workers at risk by each region. As to be expected, the distribution of potential impact is not uniform across the state. Some regions are at higher risk than others due to the nature of jobs/tasks and absorptive capacity; this refers to the capacity for workers to get another job in the same region when they leave their existing job.

Regions at greatest risk are those outside South East Queensland and include Mackay-Isaac-Whitsunday; Cape York-Gulf regional-North West; Central Queensland; Somerset and Darling Downs-Maranoa. Reflecting Brisbane having the largest share of Queensland’s population, this region is expected to have the largest number of affected workers, relative to the rest of the state. This places South East Queensland at greatest absolute risk of workers displaced due to automation. However, remote areas outside of South East Queensland have smaller populations and economies, and therefore have lower absorptive capacity for displaced workers. This will amplify the potential flow-on effects and require specific focus on dedicated and differentiated responses for each region.

The risk distribution is even more uneven across industries. The model estimates that 70% of the manufacturing workforce in Queensland is at risk over the coming 20 years. Mining, accommodation and food services, construction, wholesale trade and transport, postal and warehousing are all industries containing high risk occupations. Technology will substantially automate tasks within these jobs while also creating new jobs. The workforces face considerable transition challenges. By comparison, healthcare, professional services and education have a lower risk of automation, with less than 33% of jobs impacted.

However industries that embrace new opportunities from digital technology and automation and support workers with relevant training may find more cognitive tasks that lead to more meaningful work and increased productivity.⁵⁸ These changes could help grow existing industries and develop new markets.

We then modelled the potential for digitisation and technology change to promote job growth in Queensland. The Queensland Government Statistician's Office (QGSO) provides projections of regional jobs growth and change out to the year 2041. These projections are generated from macroeconomic models which use historic trend data. They can be considered projections of jobs growth and change based on what we've experienced over the past decades projected into the future using statistics and a computable general equilibrium model.

The modelling indicated that the Queensland economy is projected to add an extra one million new jobs to the workforce by 2038. However, these jobs are not guaranteed for Queensland and should not be considered as forecasts of future jobs growth. Jobs growth over the past 20 years depended on innovation, good decisions and hard work within industry and government spheres. This enabled Queensland to capitalise on economic trends such as the mining boom and strong growth in tourism. While the sources of opportunity and the market dynamics will be different, the opportunity for future economic growth and job creation, is similar.

Multiple studies have identified that digital technologies, including automation, and demographic changes herald the creation of a range of new jobs and professions. An AlphaBeta report noted that automation could significantly boost Australia's productivity and national income—potentially adding up to 2.2 trillion Australian dollars in value to our economy by 2030.⁵⁹ Technology-driven productivity gains may stimulate higher levels of cognitive tasks or service offerings within jobs leading to new roles, or consumers may seek increased human contact in fields where we persuade, negotiate with or care for others.^{60,61}

There are other potential gains from technology advances including more efficient service delivery, safer work environments, more meaningful employment, and collaboration to solve significant challenges such as ageing societies, energy efficiency and environmental protection.^{62,63}

These potential economic outcomes also herald growing social issues. Technology advances have already generated significant health issues including the effects of our digital lifestyles, limited exercise and changing interpersonal skills.

For example, screen time and knowledge/office work in the digital economy is associated with sedentary behaviour and health risks for young and old Queenslanders. According to the Australian Bureau of Statistics, children aged 5-17 years spend 136 minutes per day on screen-based activity.⁶⁴ Adults spend an average of 39 hours per week (excluding sleep) engaged in sedentary behavior with almost 10 hours of this time spent seated at work using a computer.

This is having an impact on wellbeing with 59% of the Queensland adult population failing to achieve a healthy level of physical activity. Physical inactivity is associated with higher incidence of cardiovascular disease and diabetes.⁶⁵

Other impacts of digitisation are being observed. These include increased online distraction in the workplace with impacts on productivity,⁶⁶ stress and anxiety associated with social media usage,⁶⁷ cybersecurity concerns and privacy breaches.⁶⁸ For most Queenslanders there is no "unplug" option and innovation is needed to solve these emerging challenges associated with digital technology.

Another challenge associated with digital transformation relates to equality of opportunity and the distribution of benefits across society. The Gini Coefficient is a widely accepted measure of wealth distribution where a higher score translates to increased inequality. Queensland's Gini Coefficient, as computed by the Australian Bureau of Statistics, has increased slightly over the past two decades indicating an increase in wealth disparity.⁶⁹

Some researchers argue that digital technology is associated with a shift in asset ownership plus an economic shift from labor to capital.⁷⁰ Due to scalability technology can concentrate wealth to fewer people. However, digital technology could also be associated with the removal of barriers to market entry and a more level playing field.



There is a need to consider policy mechanisms that ensure all Queenslanders benefit from the digital revolution.

The OECD and World Bank have identified that increasing concern about the sustainability of economic growth patterns is driving demand for greener models of growth.⁷¹ Innovation can help address environmental challenges, create new markets for green technologies and spur advances in energy, water and waste management.⁷²

For example, one of the most significant environmental benefits of innovation-led structural change is the declining energy intensity of our industries. Broadly speaking energy intensity is the ratio of energy consumed to outputs created within each industry. A recent Australian Government report found that the energy intensity of the economy has been declining due to energy efficiency gains (e.g. better lightbulbs) and structural shifts from mining and manufacturing into the service sector.⁷³

Typically service and knowledge sector industries consume much less energy to create the same amount of economic output. Today's economy is more environmentally efficient. Over the past few decades energy consumption has been growing more slowly than Australia's economy. The improved environmental efficiency of a service sector and knowledge economy is one of the benefits arising from innovation.

Stories of economic growth and decline from around the world illustrate the potential for harnessing the opportunities that change brings; or serve as a warning for those unable to adapt.



A tale of two cities

What happens when we fail to innovate? Detroit, Michigan and Pittsburgh, Pennsylvania are striking examples of different responses by similar economies facing global pressures: one which struggled to adapt and entered a vicious cycle of decline, and another which successfully built on existing expertise to diversify and transition into new industries.

Detroit was the previous hub for car manufacturing, but this changed when countries such as Japan and Germany developed more innovative car designs and manufacturing processes.^{74,75} Market share losses combined with processes of decentralisation, automation, and a slow response to the need for new fuel-saving technologies,⁷⁶ saw Detroit suffer more than 130,000 job losses from 1948 to 1967.⁷⁷ Unemployment peaked at 28.4% in 2009⁷⁸ and the city filed for bankruptcy in 2013.

This example contrasts with Pittsburgh, which has been able to successfully transition from steel production to the provision of steel technologies. As the steel industry declined in the 1980s, many former steel mill employees became contractors, forming small companies to provide products and services to the remaining operational mills.⁷⁹ The 'de-verticalisation' of the Pittsburgh steel industry also led to a higher level of coordination between various organisations: for instance, university R&D programs now collaborate with steel technology suppliers.

Today, the Pittsburgh region is home to the 'Pittsburgh Steel Technology Cluster' and a thriving technical education, information technology and medical services sector, with a close-to-average unemployment rate of 4.0% as of April 2018.⁸⁰

Many Queensland companies are also adapting and finding new ways to grow their business. Local innovators can be found in every field and are achieving success with a pragmatic attitude and diversified outlook.



Steeled for success

Spend five minutes in the company of Des Watkins and you will feel more inspired and energised about the future. As the owner of family-run Watkins Steel, you may expect him to be bleak about the impact of technology and automation on a manufacturing business. But nothing could be further from his experience.

Based in Brisbane, 50-year old Watkins Steel specialises in small to mid-size structural steel, metal work, urban artscapes, architectural structures and refurbishments. Three years ago, recognising the potential of digital technologies, the company started its transformation from traditional steel fabrication to technology services offering 3D laser scanning, design and data collection.

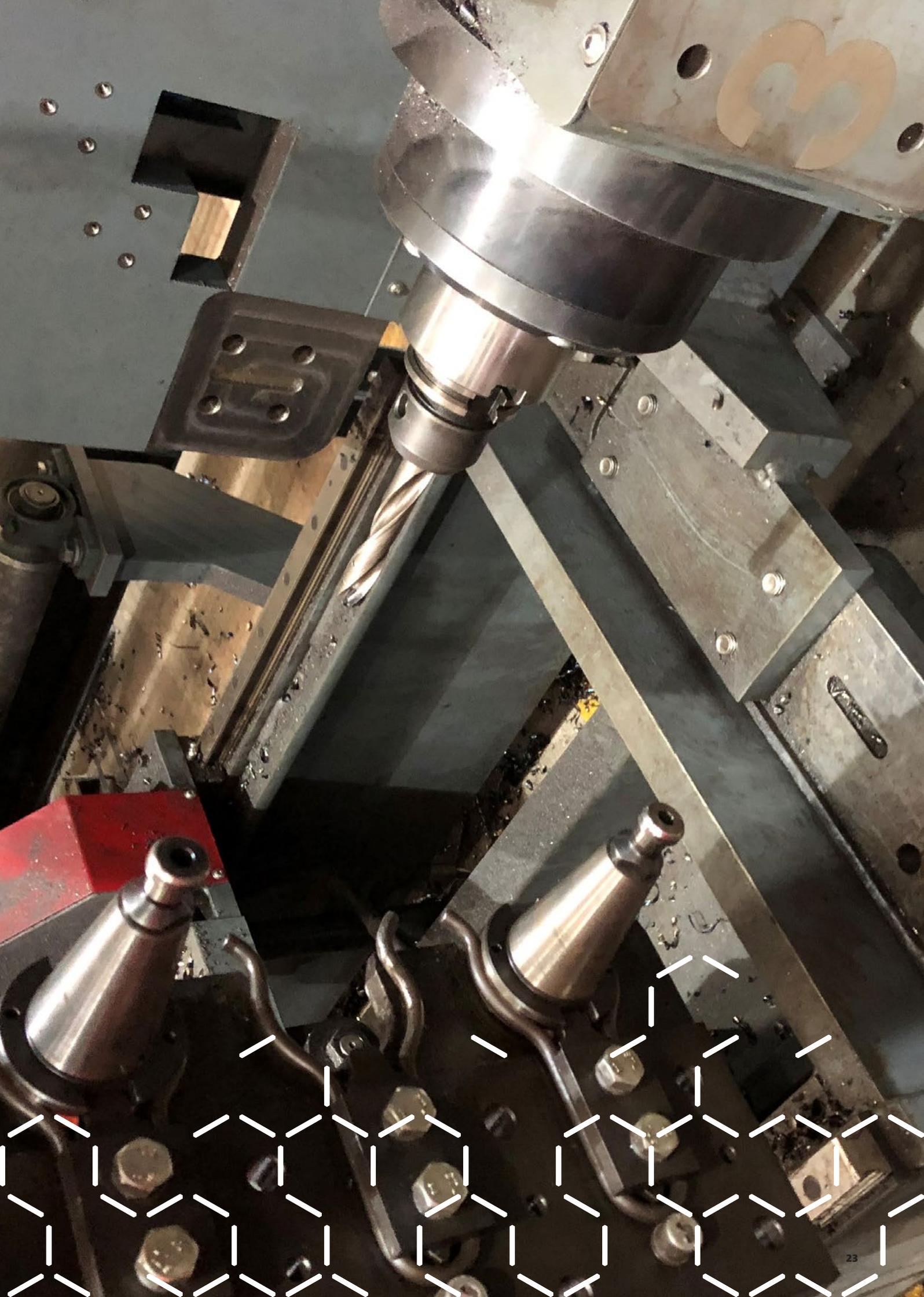
Watkins Steel has developed a unique digital workflow that links the entire fabrication and installation process from start to finish, connecting digital equipment, software and people, for improved steel detailing. Des characterises the transition between old and new, as going from the shop floor to the up-stairs office, where traditional hard-hats are replaced with cutting-edge HoloLens (augmented reality) technology.

As the company adopted new technology, the business doubled in size and for every new piece of automated equipment installed another 10 people have been employed. Des highlights the fact that no jobs were lost through the technology transition and some boiler makers are now the company's technology experts.

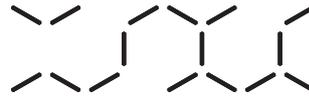
As 1,500 man hours were removed from the factory floor through the automated equipment, staff undertook new roles using their expert knowledge of steel and the fabrication process. Investment in staff retention, and professional development has allowed the company to expand its capabilities, continue to learn and opened new business opportunities.

Watkins Steel has grown beyond humble South East Queensland beginnings to enter global markets. The staff have built global networks and participate in international networks to tap into the latest developments.

Des recognises that taking this kind of leap can be scary as there are so many unknowns. But he argues that if you do your homework, experiment and work with the opportunity, the rewards are there to be taken.



PIVOTAL PATHWAYS



Queensland is at a crucial point in time in its economic development. The juncture created by the convergence of global megatrends points to the real risks facing our workforces, industries and regions. Substantial loss of jobs, incomes and tax revenues due to digital disruption would have a severe impact on Queensland communities. However, as local and international examples have illustrated, only by harnessing the opportunities created by change will we help our transformation and long-term economic resilience. The challenge will be to buffer the transition effects and ensure future benefits are integrated across the state.

The megatrends highlighted in this report showcase a range of opportunities that could help Queensland grow and transform its economy, as well as emerging threats that will need to be mitigated. These include an explosion of digital technologies, rapid growth of platform technologies, and an emerging world of empowered and informed global consumers changing the way in which governments and corporations interact with their citizens and customers. The rapid growth of Asian economies, increased mobility of people, labour, freight and data, and the heightened demand for high-value and boutique goods and services, opens up new ways for Queensland to operate on the global stage.

To take advantage of these driving forces of change, Queensland must prioritise investment in innovation and transformation. There is much to be gained. From developing trusted markets in food distribution to meet growing demands of the Asian middle-class, to reducing the environmental strain on the Great Barrier Reef by using renewable energy to diversify the energy mix, to leveraging Queensland's strengths in healthcare to develop better ways of treating and preventing illness and disease.

It is through increased investment in, and development of, services and knowledge-based sectors and exports that other international economies have successfully transitioned to new sources of wealth generation.

Six pathways are recommended to shift the dial in how we respond to change by building on existing foundations and exploring new frontiers.

FUTURE FOUNDATIONS

It is vital that Queenslanders are equipped with the skills that fuel innovation and become lifelong learners, able to acquire and apply knowledge across a variety of fields. A diversity of learning modes and experiences will help individual employability and assist workforce productivity as organisations can tap into a wealth of capabilities.

As change will not take place uniformly across the state, activities will need to support those disrupted occupations and regions to participate in new growth.

1. Future-focused skills and aptitudes to foster innovators

The nature of jobs and employment is changing: existing occupations are evolving to meet new market demands and new occupations are emerging. Queensland must deploy future-focused education and training options to drive a knowledge-based economy. Skills such as creative thinking, customer service and entrepreneurship will be essential in sustaining future workforces.

2. Equality of innovation opportunity to support regions

Many regions across Queensland have strong expertise and experience in traditional industries, such as mining and agriculture, yet it can be challenging for them to diversify their economies into new and unfamiliar spaces. Focused effort on assisting regions to leverage existing and develop new markets will be key to future growth. The success of Queensland's ability to transform will depend on inclusive growth across its regions and our ability to bridge the divide.

FUTURE FOCUS

More globally mobile populations and the scale of evolving business models highlight the importance of connectivity. Personal networks and the ability to connect and collaborate through digitally-enabled platforms will be key to ongoing business competitiveness.

Development of niche emerging areas that tap into and extend Queensland expertise will fuel growth. This development will involve a range of stakeholders sharing knowledge and collaborating across networks and platforms.

3. Transformational technologies to drive growth

Queensland must prioritise investment in technologies that are necessary to diversify our economy. This includes expenditure on infrastructure to improve connectivity issues, research and development into emerging technologies as well as digital adoption to ensure that Queensland businesses (both big and small) can leverage new platforms and differentiate themselves in global markets.

4. Collaboration to deliver results

Sustained and meaningful collaboration between industry, the research sector, government and communities is imperative to realising new opportunities for wealth creation in Queensland. Such collaborations should be driven with a specific purpose or priority in mind to provide a strong strategic direction for the state.

FUTURE FRONTIERS

While Queensland has a range of existing strengths on which to build, there are benefits to further diversification to create new services and markets in niche fields. Creativity and design will be important for wealth generation and opportunities for Queenslanders to shape demand should be pursued. This will involve setting stretch goals that push our horizons and evolve into new markets and exports.

5. Global customers to expand markets

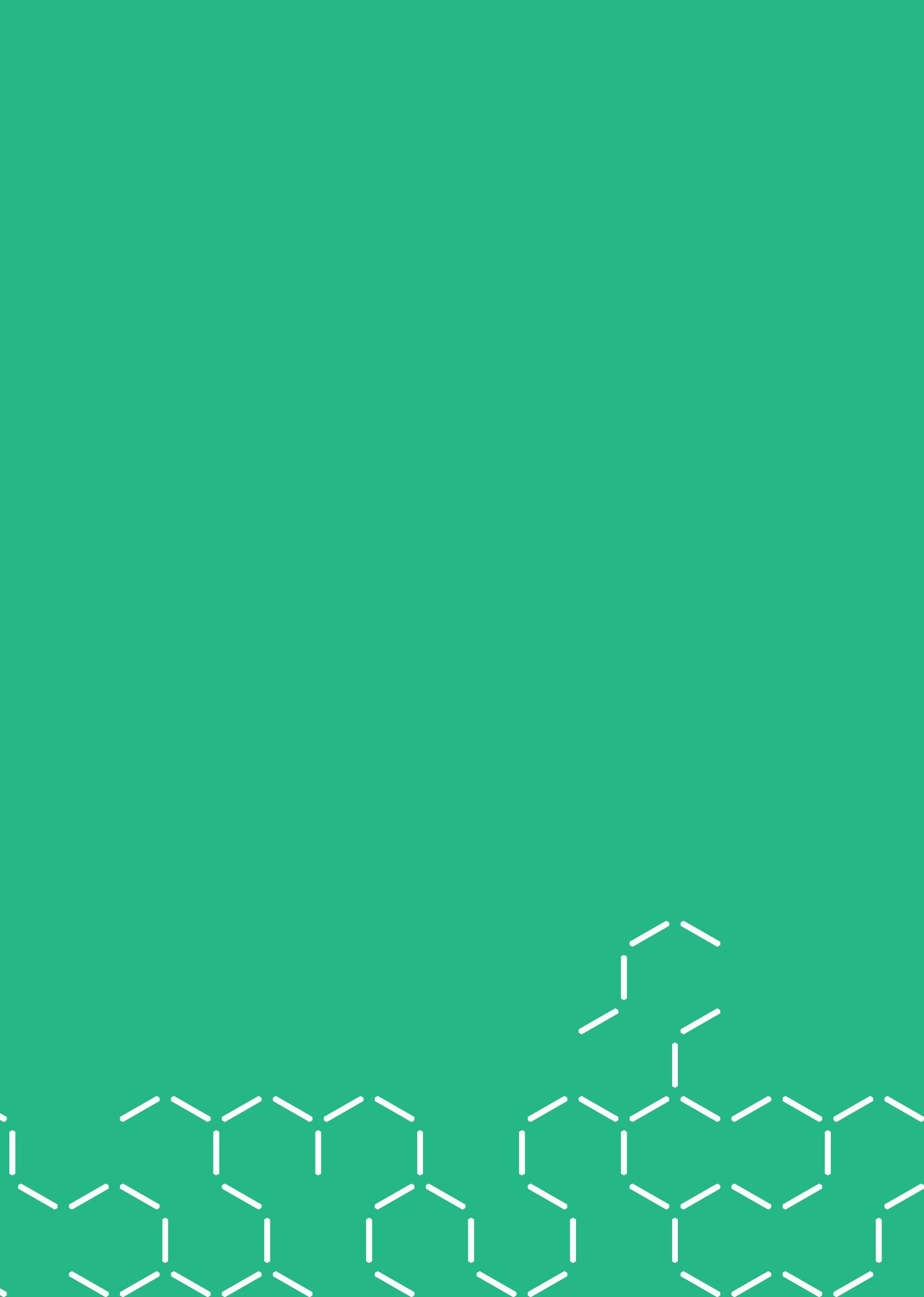
There is a wealth of emerging opportunities for Queensland to export its products, services and expertise globally, particularly in the Asia Pacific region. A global outlook and international connections are critical for Queensland industries to expand their current markets and meet emerging consumer demands, particularly in areas such as food, minerals, medical services and tourism.

6. Frontier firms to create new opportunities

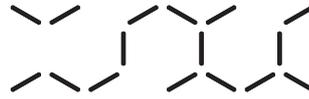
Supporting high-growth firms to Queensland will be key to attracting future talent and fostering greater innovation and R&D activity. A strong focus on experimentation and testing new directions will help businesses unlock latent potential and push industry boundaries.

It is often acknowledged that innovation does not occur in isolation. It is an iterative process involving multiple perspectives and much discussion. It benefits from user testing and continuous improvement. Likewise, these pathways require participation by all Queenslanders to ensure the greatest breadth of opportunity.

It is the responsibility of industry, governments and communities to identify a detailed portfolio of activity and priorities for Queensland over the next 20 years. Recent work in this space has already begun to identify new opportunities for Queensland to grow its economy making the most of its sources of competitive advantage.⁸¹ This work, together with the opportunities highlighted in this report, signal the wealth of opportunities that Queensland can explore to boost our chances of a successful transition.



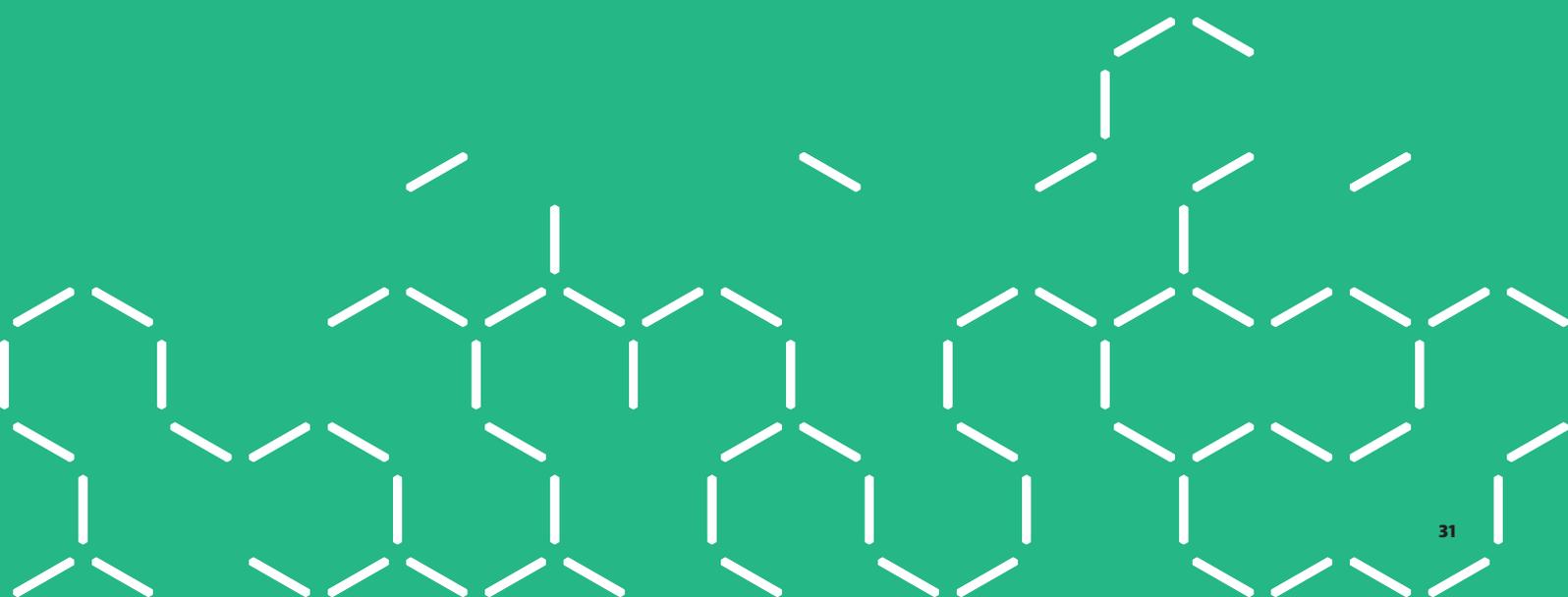
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