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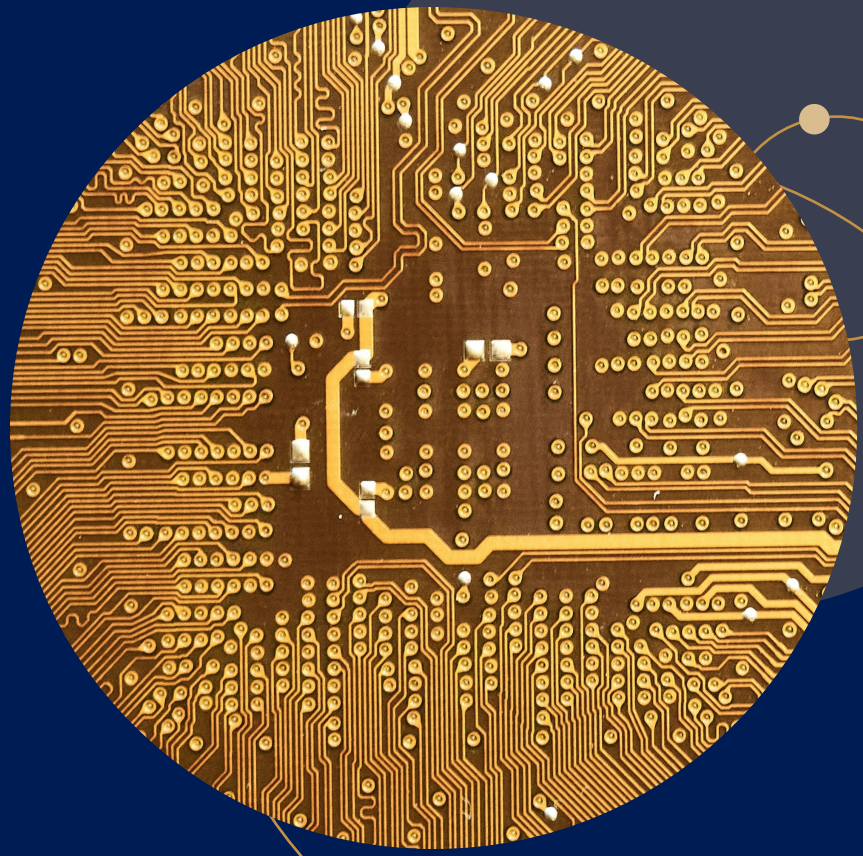
Australia's Quantum Moment

The case for strategic public investment in a transformative technology



LAUNCH REPORT – APRIL 2024

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This document is intended for general informational purposes only. The analysis in this report was commissioned by PsiQuantum, Corp. and prepared by Mandala.

Mandala is an economics research and advisory firm. Mandala specialises in combining cutting-edge data and advanced analytical techniques to generate new insights and fresh perspectives on the challenges facing businesses and governments.

Note: All dollar figures are Australian dollars unless indicated otherwise.

Executive summary

Australia needs a sophisticated "hybrid approach" to economic policymaking if we are to address 21st century challenges

Market liberalisation in the 1980s and 90s enabled Australia to develop a highly productive, highly competitive economy that saw major increases in Australian living standards.

But there has been a two-decade drought in major productivity-boosting economic reform. Global socioeconomic trends such as decarbonisation, digitisation, trade de-risking, and ageing populations mean that the pathway to future prosperity is uncertain. Today, productivity growth and income growth are stagnant.

21st century policy challenges increasingly require 'hybrid solutions': sophisticated combinations of government and market tools that promote equity and efficiency. Governments around the world are making large public investments to grow high-tech, high-value sectors that have positive externalities across industries and the economy. There is a case for investments in platforms and infrastructure that creates and extends a comparative advantage for Australia.

Quantum computing represents a unique and transformative opportunity for Australia, but substantial investments will be needed to realise its potential

The Government has identified critical sectors for support that can be strategically beneficial for Australia. These are sectors that have strong positive spillovers for other industries, the community and the economy and which the private sector will struggle to deliver, thus warranting government support.

This report outlines the benefits and advantages of Australia in converting a strong research base in quantum computing to a fully commercialised, world-leading industry. There are considerable opportunities to spur firms, innovations and capabilities by investing in underlying infrastructure. It is a clear area where a hybrid government-private approach will deliver substantial spillover benefits across the economy and community by building a new capability.

Close engagement across Australian governments is crucial for success, especially given the spillover benefits on offer, and the geostrategic and security implications at stake.

A utility-scale quantum computer built in Australia in the next decade will unlock transformational opportunities and advantages

A utility-scale, fault-tolerant quantum computer (FTQC) will generate substantial benefits for Australians over the coming decades. Public investment is crucial to realising the public good on offer.

These include economic benefits from a new technology; ecosystem benefits for the local quantum industry; research and innovation benefits across the economy; and geostrategic benefits.

The construction of a utility-scale FTQC could create 2,800 jobs for the local economy and $5.1B in economic benefits.

A fully-functioning, utility-scale FTQC could benefit sectors as diverse as health, security, climate, agriculture, finance, transport, and energy. It would establish Australia as a world-leader in a critical geostrategic technology, bringing benefits to the region and establishing new sovereign capabilities for Australia.

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21st century policy challenges increasingly require hybrid solutions: sophisticated combinations of government and market tools that promote equity and efficiency

1 Australia's 20th century economic policies built a rich economy, largely through trial and error…

- Like most economies, Australia began the 20th century with a highly protected, rigid, closed economy in which government intervention suppressed innovation, productivity and the growth in living standards.
- Australia's reforms in the second-half of the 20th century saw our labour, capital and product markets liberalised with fresh competition both domestically through the National Competition Policy and internationally through unilateral tariff cuts and multilateral trade liberalisation underpinned by the WTO framework.
- Prosperity skyrocketed and per capita incomes grew 6-fold from the 1980s but many were left behind. The 'losers' from reform were ignored and benefits were not shared equally. The economist Roy Green summarised the situation by saying that the result is not so much productivity-enhancing competition but innovation-stifling market concentration across a narrow set of sectors.

2 …but policy challenges in the 21st century increasingly need sophisticated hybrid solutions…

- Australian politics remains mired in the tired "government v markets" debate from the last century. The evidence, as shown in Australia by economics professor Bob Breunig, finds that hybrid policy solutions that combine government and market tools are often best at maximising welfare.
- Well-designed markets that harness the power of incentives with strategic investments by government will be vital to addressing the challenges of the 21st century.
- Left alone, markets will not solve climate change, stagnating productivity growth or growing inequality, and there is a risk that markets will unintentionally expose us to geopolitical risks and erode key capabilities.
- Hybrid solutions will be increasingly required. We need to be willing to break with old orthodoxies and pull new levers where they advance the national interest. This involves thinking differently about combining market tools with government action.

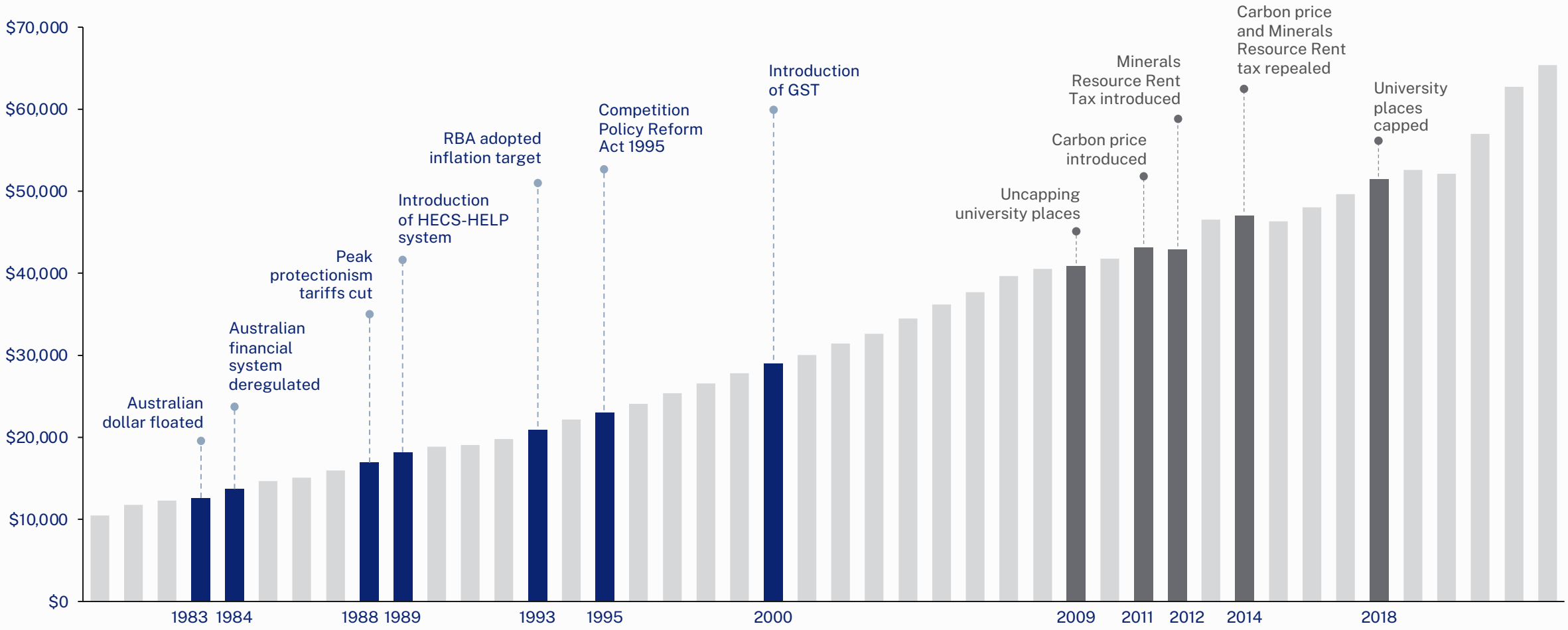
3 …There is a strong case for strategic public investment when there are big positive spillovers

- Hybrid solutions are often required when there are public goods or there are positive or negative externalities (or "spillovers").
- Negative externalities, like pollution from businesses that fuels climate change, requires government taxes and regulations.
- Positive externalities, like investments in assets that have spillover benefits to whole industries, communities and economies, require government subsidies and other supports.
- The commercialisation of new, highly valuable technologies will have substantial positive externalities across the Australian economy. Government support for this is a hybrid solution that will supply the public goods needed to lift growth, support productivity, boost incomes and create innovative new markets.

The reforms in the 1980s and 90s that liberalised markets and boosted domestic and international competition unlocked an unprecedented wave of prosperity

Exhibit 1: Australian GDP per capita

Purchasing power parity, international dollars per capita, current prices



Source: IMF (2023)

To improve its productivity, Australia will need to commercialise and innovate to supplement existing strengths in capability expansion and resource allocation

Exhibit 2: The three drivers of productivity growth

EXPANDING CAPABILITIES

- Spreading existing knowledge and technologies across the economy
- This has been enabled through government support for public infrastructure such as the NBN and human capital growth such as investments in skills training and education
- Australia has lagged somewhat in this area, however it has maintained an excellent skills system

ALLOCATING RESOURCES

- Improve allocation of resources within and between sectors and firms
- This has been supported by competition policy, a reduction in trade restrictions and the deregulation of the financial system
- Australia has been most successful at supporting a more efficient allocation of resources and has completed the most reforms in this space

COMMERCIALIZING INNOVATIONS

- Nurturing new knowledge and technologies to commercialisation
- Government traditionally uses R&D policy levers to drive this, but Australia has lagged peers in R&D spending
- Australia does have a considerable research output. However, it has historically struggled to commercialise this research and embed it into business practices

Australia has not traditionally been at the forefront of pioneering and commercialising new technologies but must innovate to improve productivity growth

Australia's economic policies have previously focused on these drivers and historically relied on diffusing existing technologies and optimising resource allocation to grow

The lack of diversification in Australia's export profile makes us more exposed to the energy transition and geopolitical risks

More than half of Australia's exports are in minerals and fuels, where Australia has a strong comparative advantage.

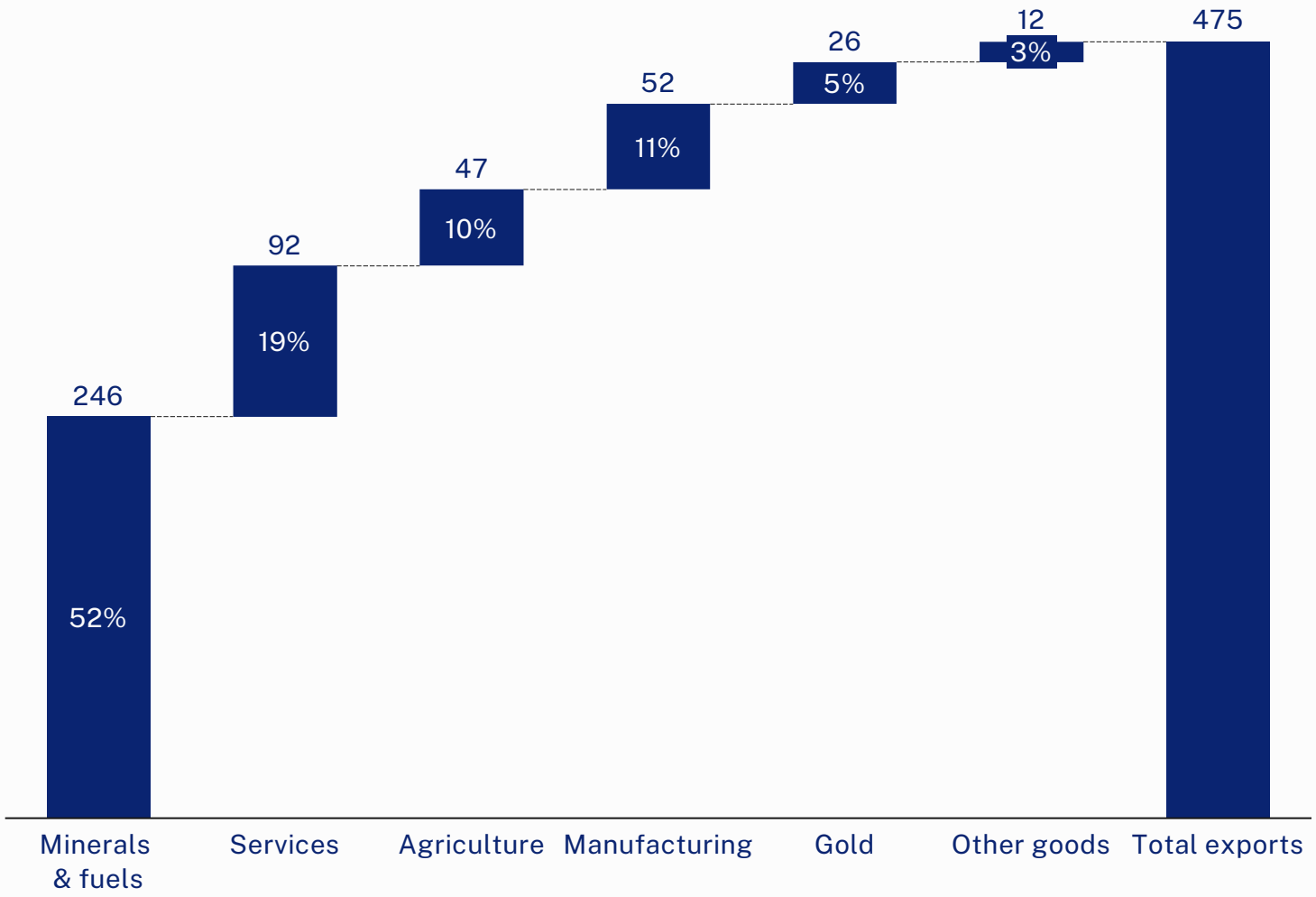
Consequentially, Australia's exports are highly concentrated. Softening global demand for Australia's resources can lead to severe economic pain.

A decarbonising global economy and a transition to renewable energy present long-term challenges to the export base. Geopolitical risk can also cut off key customer markets for Australia's minerals and fuels producers.

Diversifying and broadening Australia's export profile can help create a more robust and valuable basis for growth over the course of the next century.

Exhibit 3: Australian exports by sector

$AU billion and % of total exports, 2019-20



Source: RBA (2021); APH (2023)

The energy transition and race to net zero will require substantial changes to industrial practices

Diversifying the Australian economy away from fossil fuels is critical to support the net-zero transition. Australia's industrial base has traditionally been carbon intensive. In 2021-22, total exports of coal reached $114B, with the sector employing approximately 36,000 people that financial year.

Similarly, the Australian gas industry contributes around $60B directly to the economy, representing around 3% of GDP, and employs 42,000 people across the country.

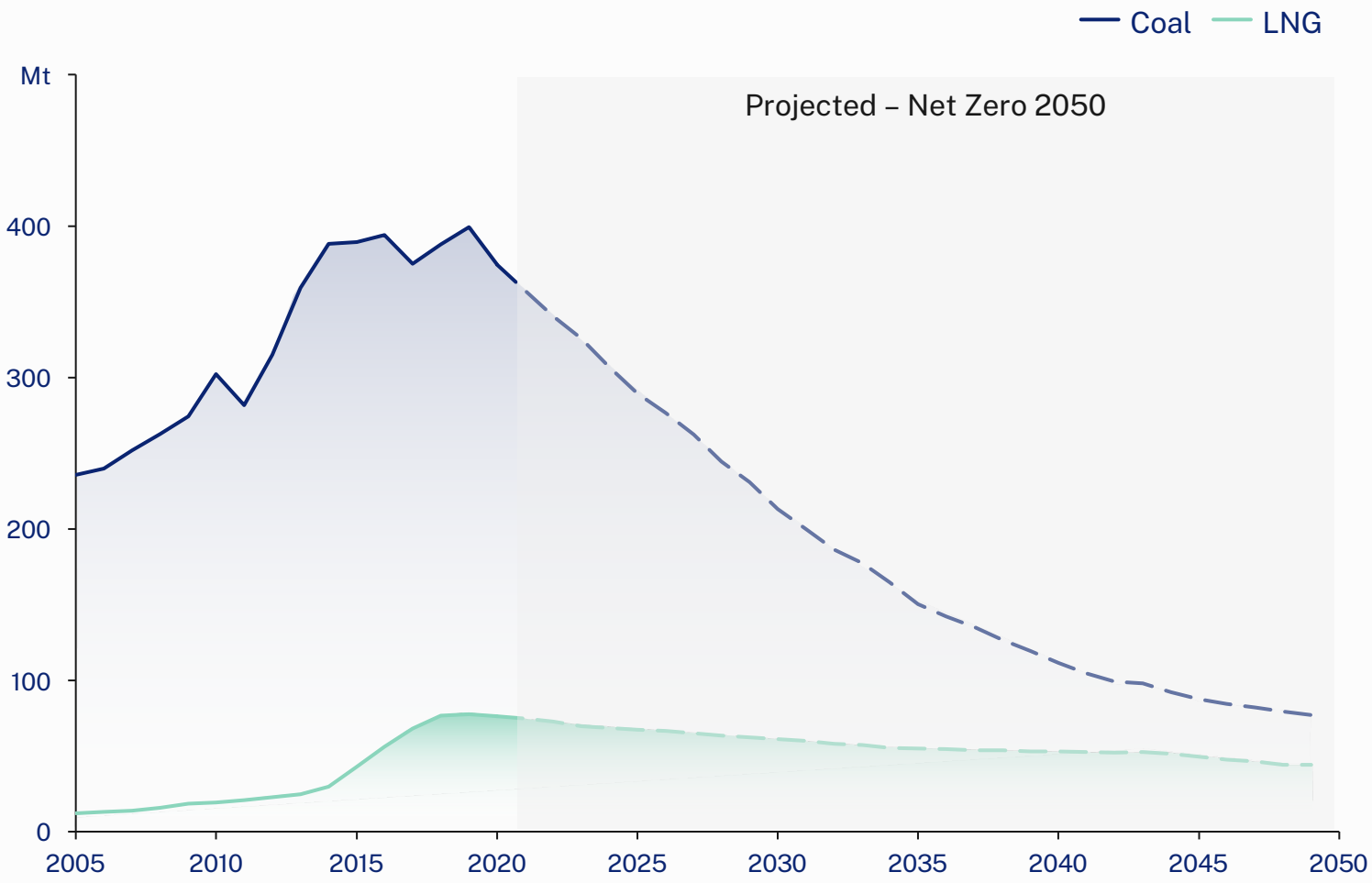
To meet its targets and to participate in valuable new clean industries, Australia will need to:

- transition away from high-emissions legacy industries;
- decarbonise valuable traditional industries;
- capture new value from creating and joining clean industries

By leveraging existing capabilities, Australia can successfully build a clean energy economy that benefits workers, existing sectors, and investors.

Exhibit 4: Australian coal exports by scenario

Mega tonnes of coal and LNG exports



Source: RBA (2021); APH (2023)

De-risking presents a challenge for Australia to diversify beyond its biggest trade partner

Western countries have recently begun to engage in a period of de-risking their economic relationships with China. This involves reducing dependencies, diversifying supply chains, while still engaging with the Chinese market.

China in turn is looking to bolster their industrial capabilities in strategic markets, such as through their Made in China 2025 policy.

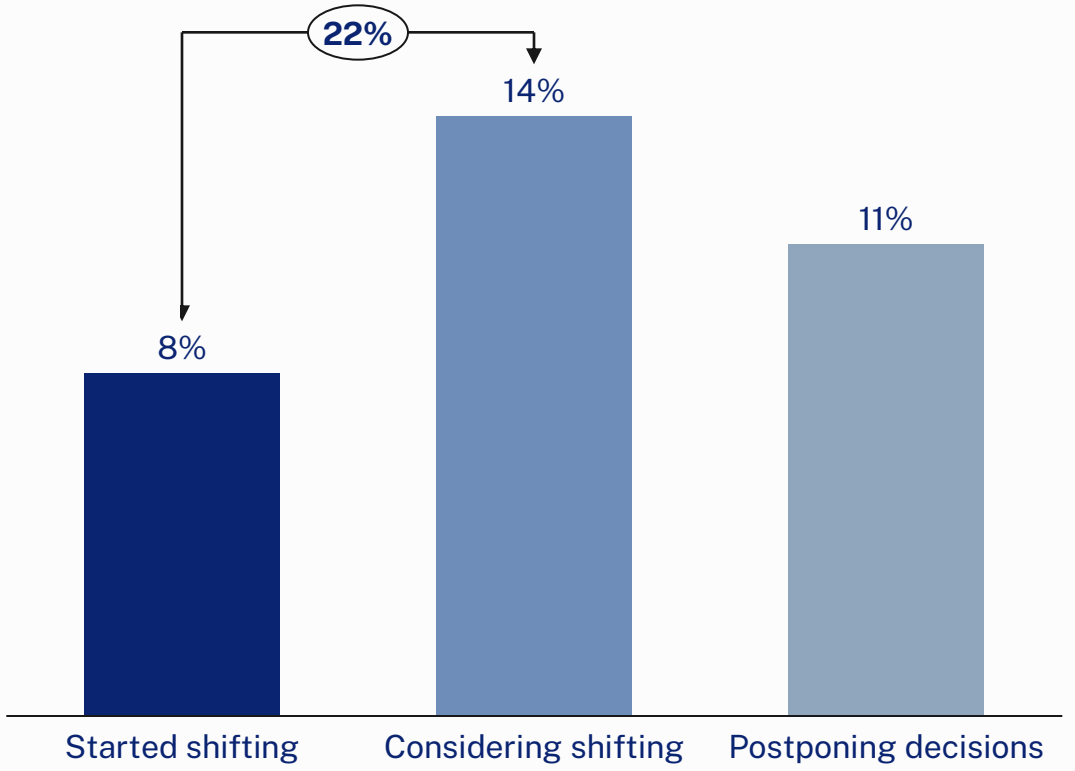
As a result, Western business owners are reconsidering the status of their investments in China, with 22% of European business owners stating they either have or are considering shifting future investments in China.

Australia has deep ties with the Chinese market which is the top destination for our exports. Changing geopolitical dynamics will require careful and considerate strategic decisions in investment and industry support, and the exploration of new markets.

Exhibit 5: European business owner sentiment to investments in China

% of responses

22% of European business owners have started shifting or considering shifting investments away from China



Source: European Chamber of Commerce in China (2023)

Governments worldwide are increasingly turning to industry policy interventions to meet challenges

To address environmental, strategic, economic, and social challenges, governments worldwide are increasingly engaging in industry policy.

This approach is most evident in high-tech and geo-strategically sensitive industries such as semiconductor manufacturing, clean energy technologies, and the defence sector. Governments worldwide are providing incentives such as those through the CHIPS Act and Inflation Reduction Act in the USA, and the European Chips Act in the EU.

In Australia, support for strategic sectors has been announced in line with international trends. This includes a $2B expansion in 2023 for critical minerals financing to support the clean energy transition (for a current total of $6B in Government investments).

Worldwide, industry policy interventions were relatively uncommon up to 2017 (rising from 34 interventions globally in 2010 to 228 interventions in 2017). From 2018 onwards these interventions rapidly increased in frequency, particularly following supply-shock challenges seen during COVID-19. In 2022, a total of 1,568 industry policy interventions were reported worldwide.

Source: PMO 2023

Exhibit 6: Trend in global industry policy interventions

Number of industrial policy interventions

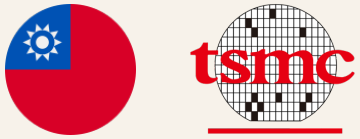
Source: Juhász, Lane, and Rodrik (2023)

Governments have intervened strategically to commercialise transformative new technologies that create valuable new markets

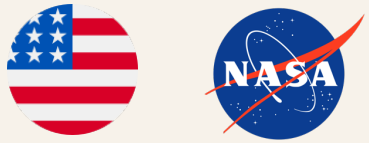
Commercialising new technologies is key to creating sustained productivity growth.

Driving Australia's ability to innovate and adopt new technology has broader benefits for the wider economy.

This pattern is evident over time in Australia and across peer countries where strategic public investments launched valuable new technology sectors.



Taiwan and TSMC



USA and NASA

South Korea and heavy industry

USA and Tesla

Australia and CSL

USA and Moderna

CASE STUDIES: **The maturation of other transformative technologies can offer lessons for this approach that can be applied to quantum computing**

Case studies of the development of important technologies – innovative, impactful technologies that have created new markets and industrial 'paradigm shifts' – provide important lessons for the development and commercialisation of quantum computing.

- Technologies become transformative when advanced scientific progress in a field coincides with a strong economic, strategic, industrial, and / or societal need.

- Transformative technologies are often public goods that will not be supplied by the private sector. They require public investments to achieve commercial scales.
- Deep technology is complex and difficult to incubate, requiring long development timelines and large and sustained investments

- The decisions of government lead to direct, tangible outcomes for companies and industries supported.
- This can include direct employment benefits, increasing production or construction, or growth in target industries or companies.

- While many investment decisions are made to drive a specific strategic goal, there are numerous, long-term, and wide-reaching benefits to the local and global economy and society at large.

CASE STUDY: **Government support for Tesla has driven the increased uptake of electric vehicles worldwide and economic growth in the United States and beyond**

HISTORICAL CONTEXT

2007

Economic and strategic context

The US economy emerges from the GFC with an automotive industry crisis. New ways to facilitate job creation and economic growth while keeping American manufacturers competitive is needed.

2015

Alignment with global targets

In line with global environmental targets, the US seeks to provide support in the transition to net zero emissions through investment in emerging technologies.

GOVERNMENT INTERVENTION

2007

Subsidies and tax credit

Tesla receives financial backing from US Federal and State Governments through a suite of diverse subsidies and tax credits amounting to US$2.9B.

$465M
loan

From 2008

TESLA

$2.9B
subsidies and credits

Discounted loan scheme

Tesla receives US$465M loan through the Advanced Technology Vehicle Manufacturing Program (ATVM) to bring the first zero-emission, zero-gas, full size electric vehicle to market.

OUTCOMES

2023

7th most valuable company globally

New behemoth

Tesla is the 7th most valuable company globally with a market capitalisation of US$782B in 2023.

American market leader

At 59.5%, Tesla has the majority market share in the United States EV market and 20% of the market share globally.

59%
market share in the US

SUBSEQUENT BENEFITS

As of 2023

65%
increase in EV share

Accelerated decarbonisation

Increased electrification results with a 65% increase in electric share of new vehicles registered in the US from 2022 to 2023.

New adjacent industries. The USA has become a leader in batteries, computer vision, charging technology, and vehicle software due to its leading position in EVs

Induced competition in a new market. Increased market competition, demonstrated in Toyota establishing EV plant for end-to-end manufacturing in Kentucky from 2025.

Notes: USD. Total subsidies received over 16 period.
Source: IEA (2023), Tesla (2021), Mandala analysis

CASE STUDY: **To rebuild an economy following war, the Korean Government funded specific firms to grow an entire industry in heavy and chemical manufacturing**

HISTORICAL CONTEXT

Economic and strategic context

The Korean War destroys South Korea's modest industrial base. Per capita income is 40% lower than India with a generalist, export-oriented growth strategy.

Need for industrial base

With US government withdrawal of troops, South Korea must develop a self-sufficient industrial base to stimulate the economy and guarantee its security.

GOVERNMENT INTERVENTION

Heavy and Chemical Industry (HIC) Policy

The South Korean government guarantees the loans of specific HIC firms, lowering borrowing costs, and reducing their effective marginal tax rates. Selected firms are also able to access foreign capital.

$247M invested

Construction and infrastructure costs

In 1974 the government establishes the Korea Industrial Complex Corporation to expedite the development of industrial regions.

SAMSUNG SAMSUNG HEAVY INDUSTRIES

HD HYUNDAI HEAVY INDUSTRIES

OUTCOMES

10% average annual real GDP growth

GDP growth

South Korea's real GDP growth averages 10% annually between 1962 and 1994.

8th largest military exporter in 2022

Top military equipment exporter

Military hardware exports grow by 74% between 2013 and 2022.

Successful car manufacturer

South Korea now exports 6.7% of all cars globally.

4th largest car exporter in 2022

SUBSEQUENT BENEFITS

Policy continues to have positive effects

Businesses that received the average HIC benefit grew by 8.6% year on year faster than other firms from 1982-2009 and that growth continues today.

Improved welfare

Without the HIC policy, South Korean welfare could be 10-17% lower.

New industries

South Korea is a leading manufacturer of electronics and has recently announced the development of an industrial complex specifically for the manufacture of batteries.

1950s | 1970 | 1974 | 1994 | 2022 | As of 2023

Notes: USD

Source: Kim (1991); Amsden (1992); Levchenko & Choi (2021); Kim, Lee & Shin (2021); Lane (2022), Mandala analysis

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The Australian government has identified high priority scientific and technological areas for economic development following a history of strong research investment

ADVANCED MANUFACTURING AND MATERIALS TECHNOLOGIES

Advanced manufacturing aims to optimise material performance using innovative techniques. This includes additive manufacturing processes, advanced methods for mineral extraction and processing, and the precision design and manufacture of integrated circuits.

AI TECHNOLOGIES

Machine learning, AI algorithms, and hardware accelerators enable autonomous problem-solving. AI has the potential to enhance efficiency, safety, and quality across many industries.

ADVANCED INFORMATION AND COMMUNICATION TECHNOLOGIES

Advanced ICT integrates telecommunications networks with new software to process and transfer data more swiftly and in larger volumes.

QUANTUM TECHNOLOGIES

(focus of this report)

Quantum technologies delve into the intricate behaviours of matter and light at the atomic and subatomic levels. These underlying principles pave the way for technological advancements previously deemed unattainable.

1. **Quantum Computing:** Using qubits to design the solutions for the most difficult to compute challenges.
2. **Quantum Communication:** Leveraging quantum principles to develop secure communication channels.
3. **Quantum Sensing:** Utilising quantum mechanics to achieve measurements with higher precision than classical methods, with applications in fields like mineral exploration, medical imaging, and navigation.

AUTONOMOUS SYSTEMS, ROBOTICS, POSITIONING, TIMING AND SENSING

This category involves using machines to execute tasks with minimal human intervention, as well as satellites and systems specialising in precise position, navigation, or timing data.

BIOTECHNOLOGIES

Biotechnologies use cellular and biomolecular processes for applications in healthcare and environment services. The field covers synthetic biology, which modifies biological components and systems (e.g. by DNA editing methods) to introduce novel applications.

CLEAN ENERGY GENERATION AND STORAGE TECHNOLOGIES

Clean energy generation and storage technologies offer renewable solutions for capturing, generating, storing, and utilising power. Energy storage aids in harmonising production with demand.

Source: DISER (2022)

After sustained support over two decades, Australia has created an ecosystem of high-quality quantum computing research ripe for commercialisation

The Australian Government has supported the development of a strong quantum computing research ecosystem over the last 20 years

2001 — **Gerard Milburn (UQ)** co-authors a paper that **demonstrates the feasibility of linear optical quantum computing** (i.e., quantum computing by photons, linear operations, and measurements).

2003 — The **ARC** funds the first **two Centres of Excellence (CoEs) for Quantum Computing**, with 7 CoEs in quantum or related fields being established over the period to 2021.

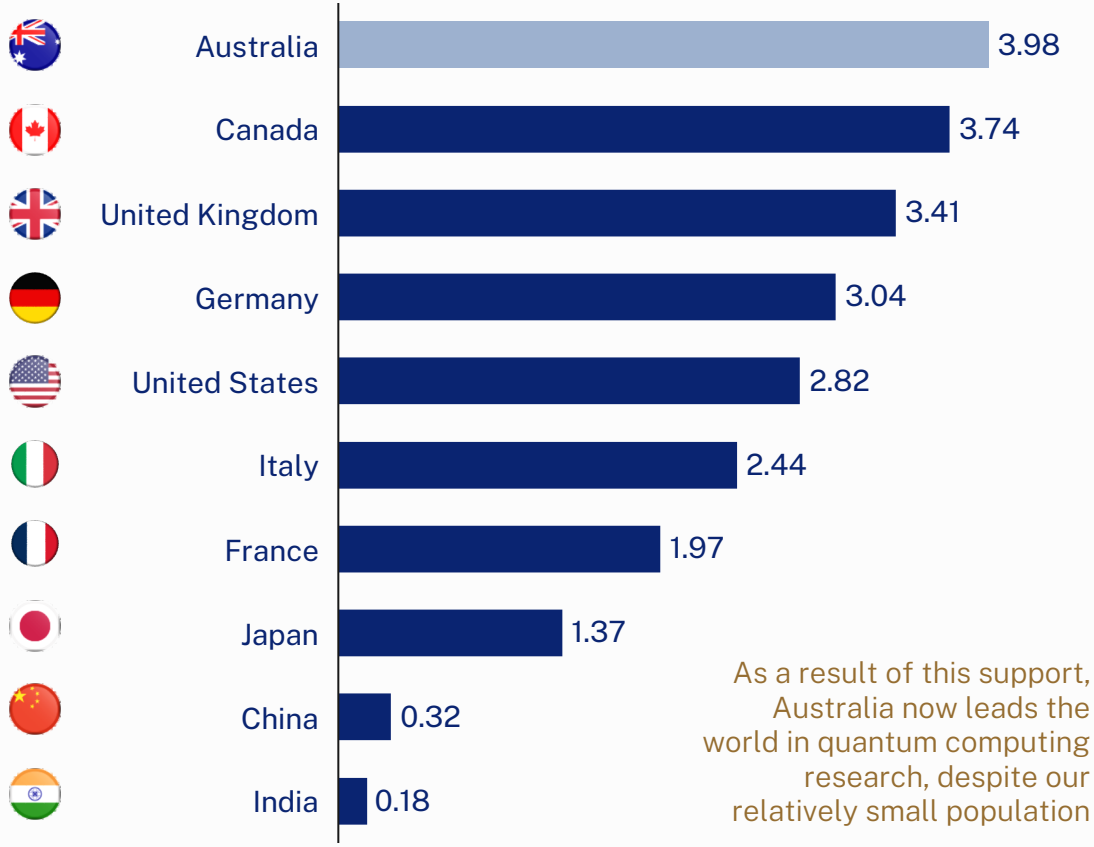
2010s — **Australia** develops into a global powerhouse of **quantum research** *(see right)*

2021 — The **Morrison Government** releases the Blueprint and Action Plan for Critical Technologies, identifying **quantum computing as one of nine technologies for focus**, with funding of $111M to support the sector.

2023 — The **Albanese Government** releases the **National Quantum Strategy**, supported by the National Reconstruction Fund providing $1B in targeted investment for critical technologies like quantum.

Exhibit 7: Quantum computing research production

Papers per 100,000 people, to October 2023



As a result of this support, Australia now leads the world in quantum computing research, despite our relatively small population

Notes: Papers per 100,000 people calculated from Scopus records using keyword "quantum computing"
Source: Roberson and Wright (2019); Scopus (2023); The World Bank (2023); Mandala analysis.

The Australian government has announced it will build the first ever error-correcting quantum computer

With the release of the National Quantum Strategy earlier this year, the Australian Government has committed to building the world's first error-corrected quantum computer. Developing this computer will provide significant economic, technology, and strategic benefits.

Economically, quantum computing is forecasted to have a global market of $92B by 2040 according to CSIRO's estimates. This means success will bring employment opportunities in high-skilled jobs, foreign investment and export opportunities.

The quantum industry will also require a significant ecosystem to supply and operate it. Building the first computer will give Australia a head start in developing value chains in cryogenics, photonics, software development, and semiconductor technologies.

Technologically, attempting to win this race will deepen Australia's knowledge in the industry. Success in this endeavour will ensure Australian scientists have access to quantum computers to solve previously intractable problems in biology, chemistry, and computer science.

Finally, building the first quantum computer will be critical in advancing Australia's strategic interests.

Source: CSIRO (2022)

Exhibit 8: Benefits to Australia from hosting the first fault-tolerant quantum computer

Growth in the following high demand domestic sectors:

- Printed Circuit Board Assembly, Electronics and Box Builds
- Optical components and pump lasers
- Cryogenic development tools, cryogenic vacuum chambers
- Quantum Optimal Control systems build and test

Support for the Australian higher education system in the following ways:

- PhD training
- Research agreements and partnerships with universities
- Mentorship programs
- Partnerships with global laboratories and research groups

This will involve the quantum computing field crossing the research commercialisation 'valley of death'

The 'valley of death' refers to the gap that exists between the research phase of an innovation and its commercialisation. This can be due to funding gaps, technical risk, market uncertainty, and regulatory hurdles.

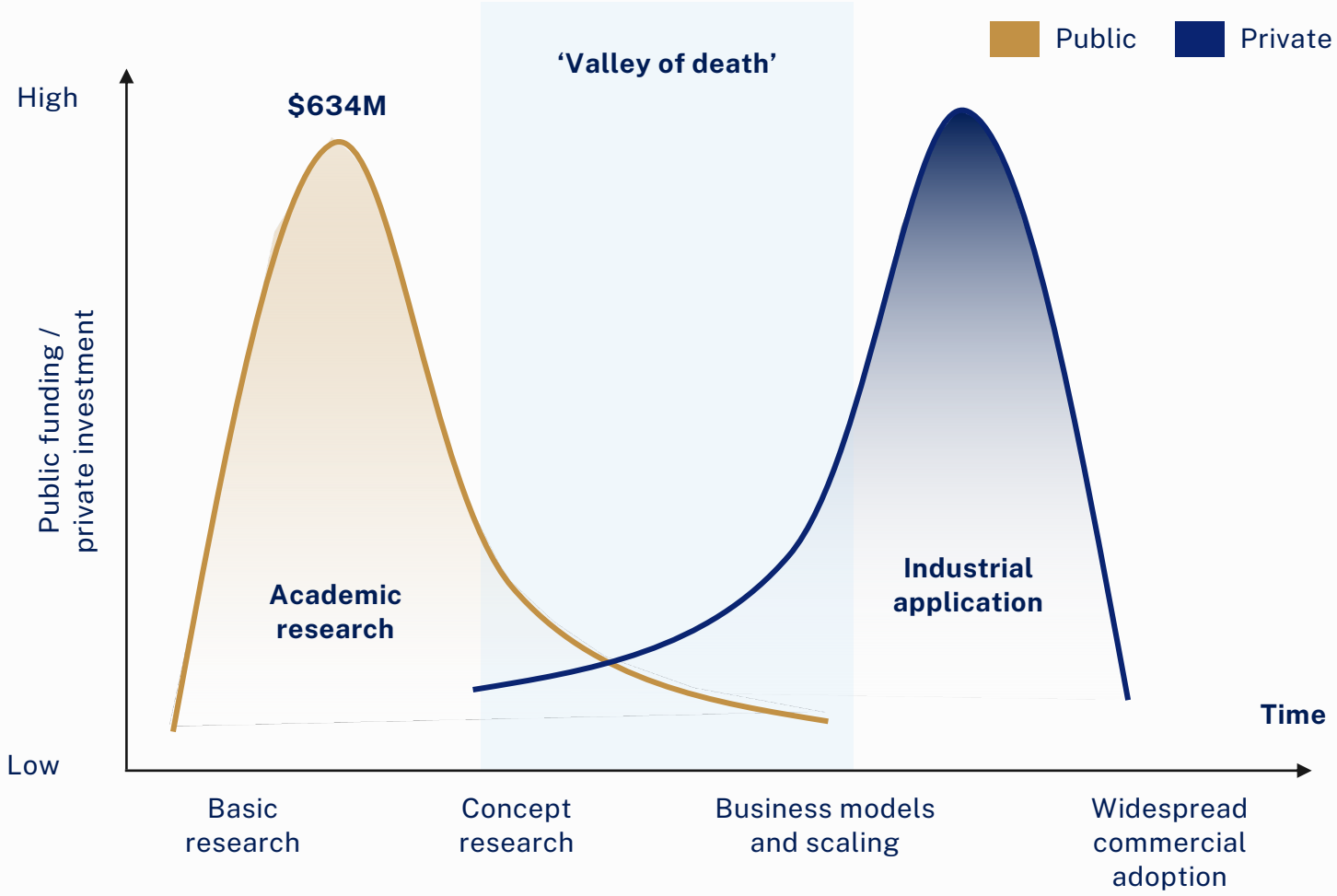
Australia has traditionally struggled to translate research leadership into sustained commercial outcomes.

Failing to do so for quantum computing would be a missed opportunity considering Australia's current distinctive strengths in quantum research.

The quantum industry is in the earliest stages of research commercialisation, with support for basic research in quantum computing totalling $634M. Building the first ever useful quantum computer would provide Australia the opportunity to lead the world in translating applied research into a completed commercialised product.

To bridge this gap, investment at scale is required which means that it must be targeted and cannot be spread thinly amongst different firms.

Exhibit 9: The Australian Government has contributed $634M in quantum computing research funding over the last 20 years, however direct investment will be required for the industry to cross the 'valley of death'



Notes: Total ARC funding for quantum-related research, 2002-2022
Source: ARC (2022), Mandala analysis

Global competitors have announced significant direct funding for specific projects to develop their quantum industries and build quantum computers

Australia's international peers have announced large direct investments to build quantum computers

USA

The 2018 National Quantum Initiative Act allocated $1B for US quantum research. This led to the National Quantum Initiative, supporting QIST development, workforce, and infrastructure projects like the QUEST program for quantum computing procurement and a $500M investment in building quantum computers.

Europe

The Quantum Technologies Flagship was launched with €1B to fund research. Late last year, €100M funding was announced for six sites to host the first EU quantum computers. Individual countries have announced additional funding for these sites with Germany announcing an additional €3B in 2023 to build a quantum computer.

China

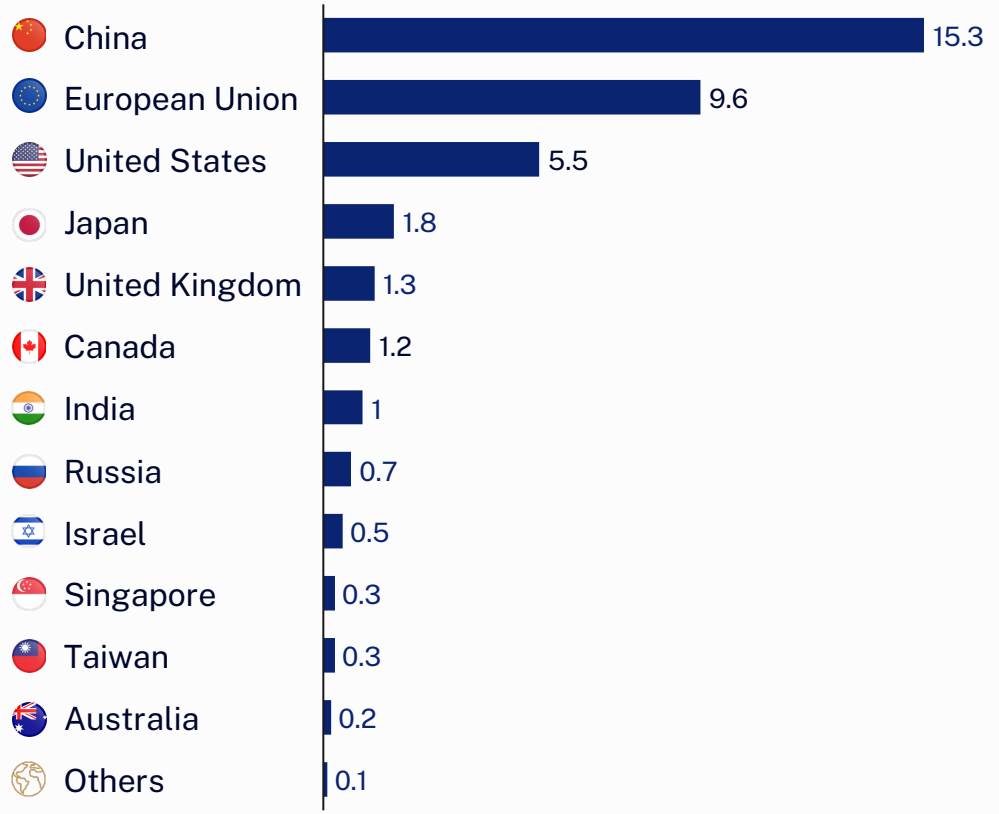
In 2021, the Chinese government enshrined quantum technology into the 14th Five Year Plan. This came alongside $15.2B in funding for research, training and the building of computers. China now has a dozen research institutes for quantum technologies, a doctoral program in quantum technology and the largest working quantum computer.

Australia

The National Quantum Strategy was released in 2023. In the wake of this report, $116M of funding was announced to help develop critical technologies, including quantum computing. This funding will focus on R&D and commercialisation. Australia is also developing a Quantum Workforce Strategy to support the skills gap.

Exhibit 10: Announced government funding for quantum computing

$US billion



Source: Canadian Institute for Advanced Research (2021); Mandala analysis.

With governments worldwide investing billions, Australia has the opportunity to partner with the most mature company

Quantum computing using a photonics platform was pioneered by Australian founders in Australia, placing it in a unique position to extend its advantage by building and hosting the world's first fault-tolerant quantum computer.

For a fault-tolerant quantum computer to work at utility-scale it will require computing power in the realm of one million qubits. The cost of constructing and operating such a piece of equipment will be significant, with cost estimates ranging at $2B and above for first-wave systems.

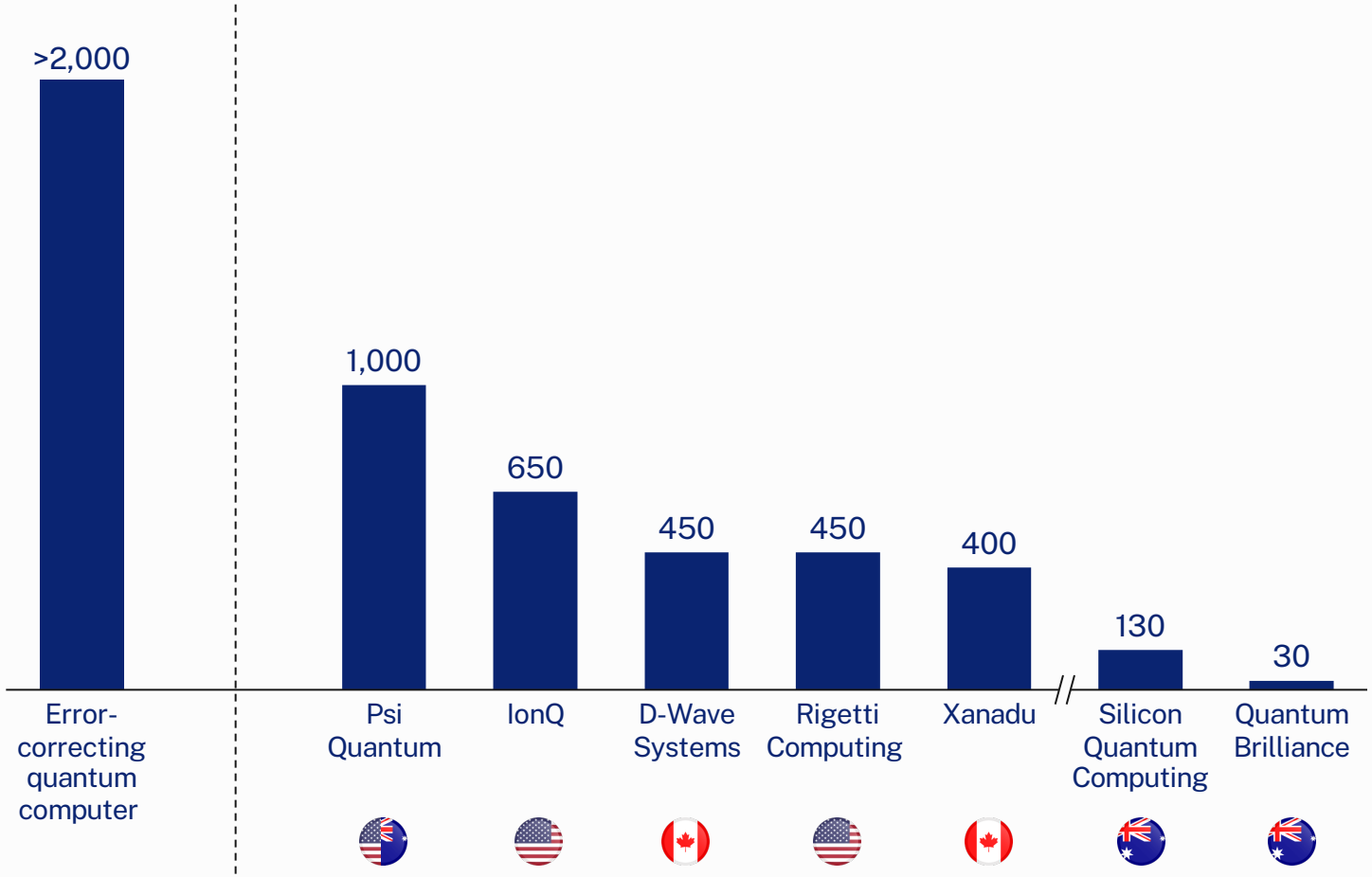
While other quantum computing firms in Australia and worldwide have the intent to build such a facility, the challenge of doing so and the existing scale of these firms mean the lead times are significant, with some forecasting reaching capability in the scale of decades.

Australia will need to invest strategically in quantum computing firms that have the capacity to drive first-wave quantum computing capabilities.

Securing first-wave capabilities will open an extremely valuable set of benefits to Australia. Investment, talent, next-generation innovations, and other clustering effects will accrue locally. This also ensures Australia can maintain a geostrategic advantage and are not dependent upon other nations.

Exhibit 11: The current level of funding for private firms is insufficient for developing an error-correcting computer

$AU million, total funding amount



Note: Major US technology companies are also investing heavily in quantum computing. Microsoft, Google, Amazon, IBM, and HCL have committed substantial resources towards developing quantum capabilities.
Source: Crunchbase (2023) Mandala analysis

Australia has a highly successful research base that will benefit from an anchor partner

Following two decades of successful research investment in quantum computing (totalling $634M in ARC research funding), Australia has a strong quantum computing research ecosystem.

The highly successful ARC Centre of Excellence for Quantum Computation and Communication Technology (CQC^2T) gave way to multiple companies including the Silicon Quantum Centre (SQC), Diraq, QuintessenceLabs and Aqacia. Such companies and similar entities like Quantum Brilliance, and research centres such as the Future Qubit Foundry and the Centre for Engineered Quantum Systems are focusing on developing different aspects of quantum computing systems.

A large investment in an anchor company can enhance the whole sector's infrastructure, stimulate innovation, and raise industry standards. This uplift typically generates increased interest and demand in the sector, indirectly benefiting small and medium competitors by creating a more vibrant market and opening new opportunities for collaboration and growth.

Markets that attract anchors initially benefit from first-wave advantages, gaining accelerated commercialisation and application pathways that are denied to other lagging peers.

Exhibit 12: Benefits of an anchor partner to the local quantum computing ecosystem

RESEARCHER	ACHIEVEMENTS	EXAMPLE BENEFITS OF AN ANCHOR PARTNER
Michelle Simmons Silicon Quantum Computing	Simmons' firm, Silicon Quantum Computing, developed the first single-atom transistor and the first integrated circuit made with atomic precision.	• Support for domestic supply chains to ensure a cheaper, more reliable supply of enabling technologies • Significant workforce development that will make it easier for local firms to hire talent • A significant anchor will further support the local research ecosystem with contributions to leading Australian universities • An anchor will also crowd-in further significant international investments into the Australian quantum ecosystem • Improved access to high quality cryogenic capabilities for the local ecosystem
Stephen Bartlett The University of Sydney Nano Institute	Bartlett is the head of the University of Sydney's Nano Institute and the Future Qubit Foundry which is developing next-generation qubits	
Marcus Doherty Quantum Brilliance	Doherty is the Chief Scientific Officer at Quantum Brilliance that has developed the world's first room-temperature diamond-based quantum computer.	
Andrew White EQUS	White is the Director at the Centre for Engineered Quantum Systems and set the standard for quantum logic gates.	
Michael Biercuk Q-CTRL	Biercuk is the CEO and founder of Q-CTRL, a pioneering Australian company creating quantum infrastructure software.	
Vikram Sharma Quintessence Labs	Sharma is the founder Quintessence Labs, a leader in quantum-enhanced cybersecurity technologies.	

CASE STUDY: **During the space race, the US Government directed public and private efforts to achieve the clear goal of landing a man on the moon**

HISTORICAL CONTEXT

Economic and strategic context

The American-Soviet space race sees the U.S. attempt to prove superior economic and scientific capacity over the Soviet Union.

1949

Scientific context

Advances in flight following the Second World War lead to Russian man Yuri Gagarin becoming the first person to orbit the Earth by 1961.

1961

GOVERNMENT INTERVENTION

Direct procurement

Through NASA, the government awards contracts to private corporations to design, test, manufacture, and deliver the components and systems for the Apollo missions. This contracting approach by government directly shapes the aerospace industry.

1961

Infrastructure investment

The scale of the Apollo program necessitates significant capital investment in supporting infrastructure, with funding from the US government.

$49B
infrastructure assets In 2022

OUTCOMES

20,000
private firms engaged

Private firms

An estimated 20,000 private firms engage in the Apollo programs through NASA contracts. These include companies like General Motors and Northrop Grumman.

1969

Employment and economic impact

By 2021, The US space economy accounts for 0.6 percent of total US GDP, employing a total of 360,000 people in the private sector.

2021

360,000
people employed

SUBSEQUENT BENEFITS

Spin-off technologies from the Apollo space program

Freeze dried food; flame resistant textiles; fluid recycling techniques which simplified dialysis and water filtration systems that have reduced water borne illnesses.

As of 2023

Adjacent technologies

Cheaper and more effective satellites have brought benefits to global communication.

Top private space companies are based in the US

Which has over 5,000 space-focused companies.

5,000
US space companies

Notes: USD
Source: The Guardian (2016); Forbes (2021); BEA (2023); NASA (2022), Mandala analysis

PsiQuantum presents Australia an opportunity to lead the world in building the first utility-scale quantum computer

INTENT AND AMBITION

CAPABILITY AND SCALE

MATURITY

REQUIREMENT

Successful companies will have **clear intent and ambition, with a precise strategy and tightly defined goals**.

Successful companies will possess the **technical and engineering capability to scale operations** from a proof of concept to a commercially viable product.

Successful companies will need to possess **the commercial maturity to immediately commence construction and operations.**

PSIQUANTUM CAPABILITY

PsiQuantum is **solely focused on creating the world's first fault-tolerant quantum computer**, acknowledging the likely reality that **only a handful of operators will ultimately exist worldwide**.

PsiQuantum is not a research exercise – it is focused on commercial success. Unlike existing major tech firms where quantum computing is a fringe activity, PsiQuantum is singularly devoted to realizing the **world's first fault-tolerant quantum computer**.

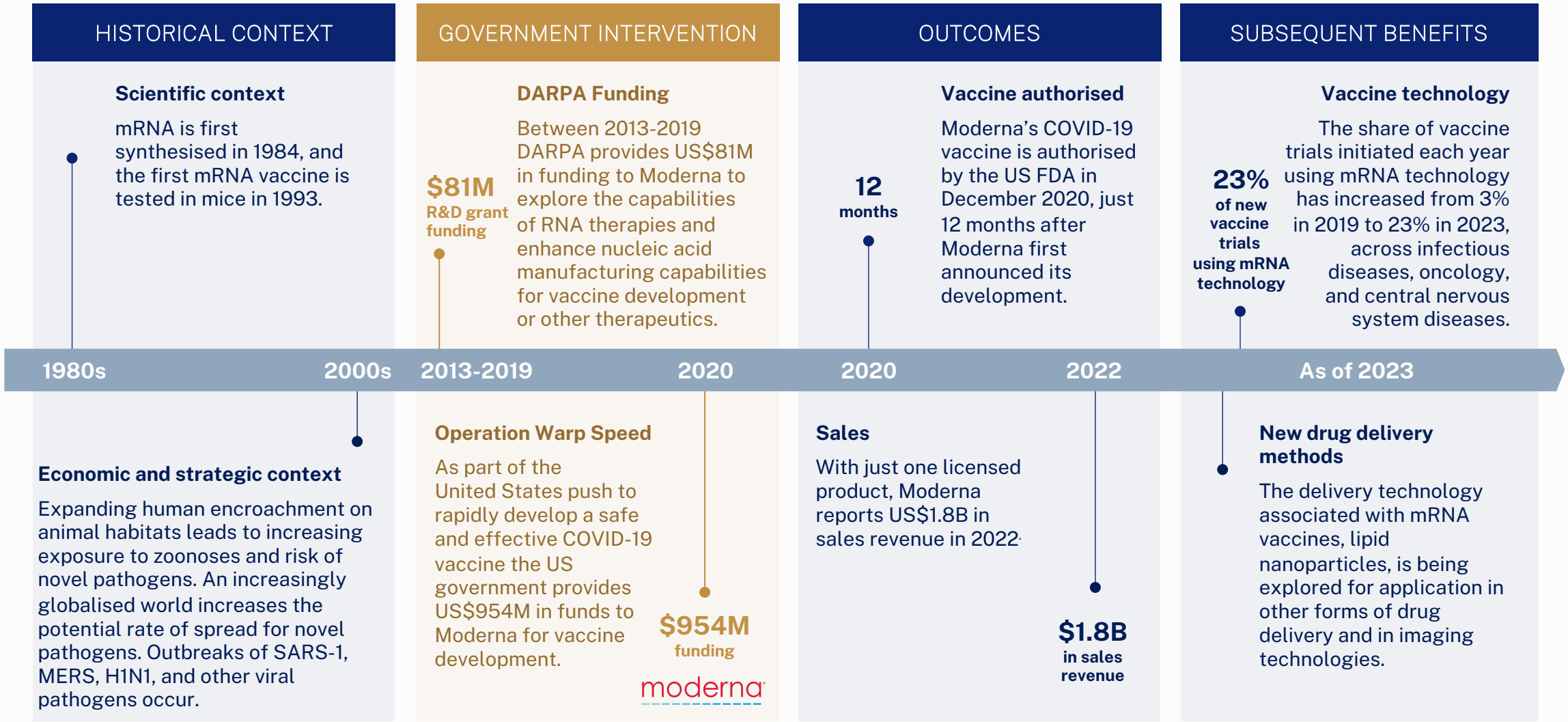
PsiQuantum is **leveraging established manufacturing processes and infrastructure from conventional silicon chip foundries** to build its large-scale, fault-tolerant quantum computer, with thousands of wafers already produced.

A photonics-based approach also means **existing cryogenic systems are sufficient for its cooling needs**, accelerating the pace of maturing towards **utility-scale systems**.

PsiQuantum is a **mature enterprise with an established workforce and engineering processes** and has been identified by top technology investment firms, such as BlackRock, Microsoft M12, Temasek, and Blackbird.

Governments worldwide have also validated PsiQuantum's approach: for example, DARPA in the USA have provided a five-year funding agreement.

CASE STUDY: **The promise of rapidly scalable nucleic acid technologies was realised using substantial US government funding to commercialise Moderna's technologies**



Notes: USD. Moderna received DARPA grants in 2013 and 2020 for development of RNA therapeutics. Under Operation Warp Speed, the US Government agreed to reimburse Moderna for 100 percent of the allowable costs incurred by the Company for conducting the program described in BARDA contract 75A50120C00034 to support the continued research and development of vaccine candidate mRNA-1273 (total of $954M).

Source: Dolgin (2021); Moderna (2013); Moderna (2020); Congressional Research Service (2021); Moderna Annual Report (2022); Clinical Trials Arena (2023), Mandala analysis

Contents

The Australian government can generate economic, research and innovation, and geostrategic benefits from a useful quantum computer

DIRECT OUTCOME

1. Direct economic benefits

- GDP/GSP impacts
- Employment impacts including jobs in construction, advanced manufacturing and research
- Investment/FDI impacts

2. Ecosystem benefits

- Localised advanced manufacturing capabilities
- Increased demand for quantum computing goods and services
- Agglomeration effects

SUBSEQUENT BENEFITS

3. Research & development and industrial benefits

- Climate
- Healthcare
- Energy
- Agriculture
- Finance
- Transportation
- Advanced manufacturing

4. Geostrategic benefits

- Global competition and power
- Security
- Geoeconomic advantage

Growing Australia's **economy** with a utility-scale fault tolerant quantum computer

$5.1B
of additional economic activity for the Australian and Queensland economies

2,800 jobs
supported across the Australian and Queensland economies

Growing high-value, high-tech **industries** across the nation

$1.1B for manufacturing, **$1.7B** for research, **$1.4B** for operations, **$1.1B** for manufacturing industries

Contributing to quantum computing **industry growth**

Generation of **demand for key high-tech sectors** such as photonics and cryogenics

Supporting Australia's high value **research ecosystem**

Increasing **opportunities** for quantum computing **researchers and students**

Providing **geostrategic benefits** to Australia and our regional partners

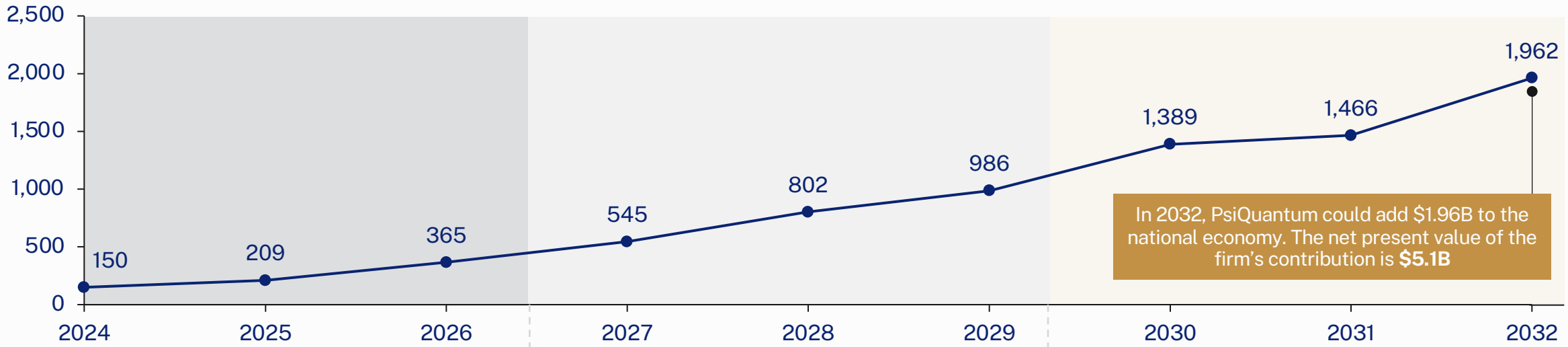
Solving challenging **analytical and optimisation problems** across many sectors, including energy, healthcare, and financial services

Note: All figures are contained in this report and discussed in subsequent chapters.

These commitments will bring $5.1B in direct economic activity, the bulk of which will flow to Queensland

Exhibit 13: Economic activity generated by the project by year

GVA per year, $AUD millions, current prices



1 ANCHOR PUBLIC INVESTMENT

Phase 1 is implementing initial investments, including from the government. This will be spent in Queensland on the construction and development of facilities, locally manufactured parts for generation 1 of the FTQC and R&D.

2 PRIVATE INVESTMENT ACCELERATION

Further potential phases would follow to develop subsequent generations of FTQC, attracting substantial pools of private investment (which PsiQuantum has already proven to be able to raise). This would source locally manufactured parts from a maturing value chain.

3 MATURING FTQC ECOSYSTEM

Potential new iterations of the FTQC would generate more substantial revenues than the initial build. These revenues will be reinvested into parts and facilities for a maturing FTQC with wider applications, growing the market for quantum computing.

Sources: Mandala analysis

The economic activity will be spread across the economy, from R&D to manufacturing

The establishment of a utility-scale quantum computer will involve investment and spending over the course of the 9 years between 2024 and 2032. This will create $5.1B in direct economic contribution.

This economic contribution will be split between five categories: commercial and business development; research and development; operations; construction; manufacturing and installation.

Commercial and business development refers to spending on sales, marketing and other administrative tasks and is worth $0.7B. This is significant as it will involve developing highly specialised research products in a variety of industries.

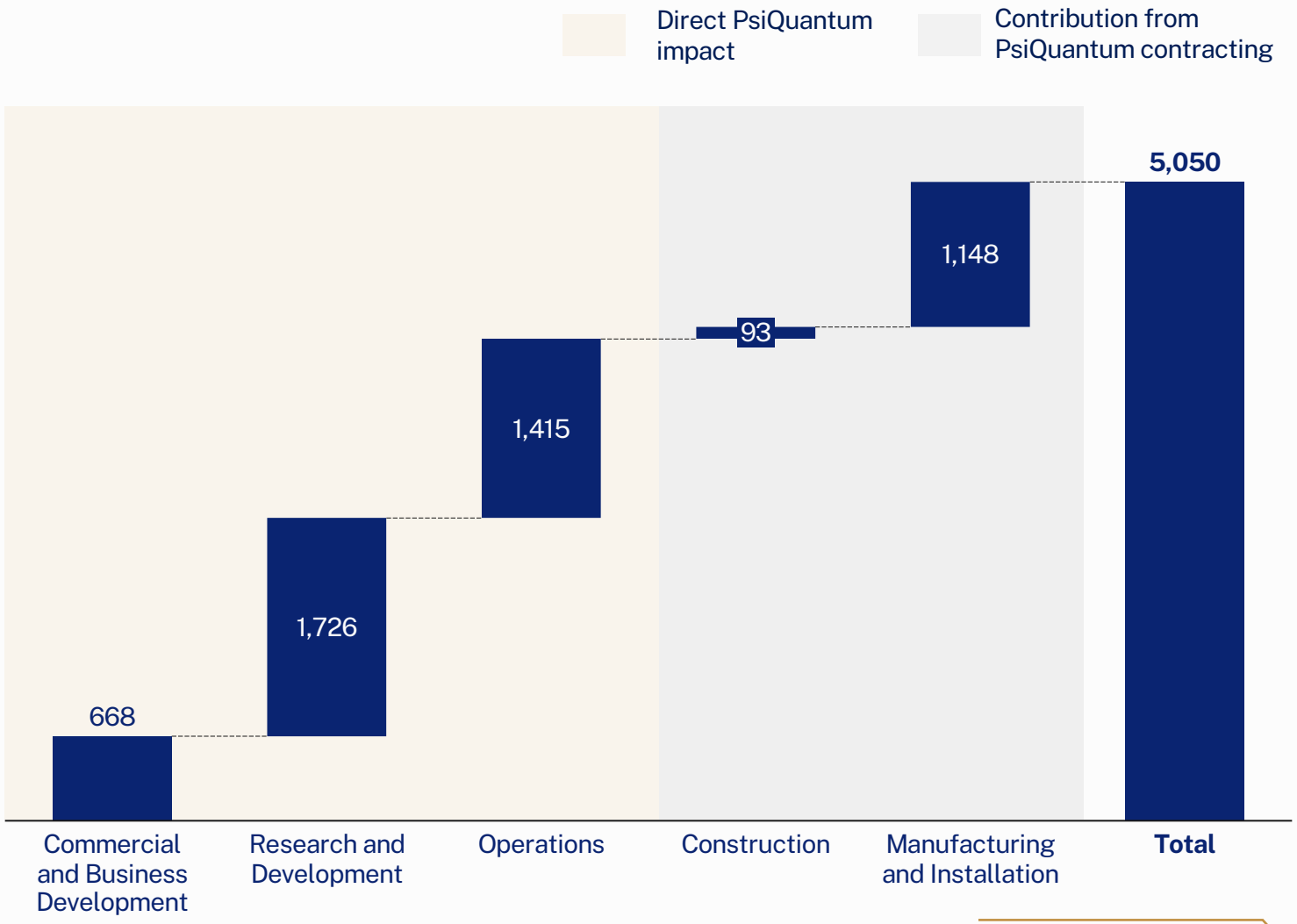
Research and development spending refers to the significant spending on quantum scientists and engineers who will develop the underlying technology and is worth $1.7B.

Operations spending is worth $1.4B and refers to the ongoing work required to support the use of the quantum computer. Construction spending will bring in $0.1B in value and refers to spending on developing facilities.

Finally, manufacturing and installation spending is worth $1.1B in economic value and refers to spending on the components of the quantum computers that PsiQuantum plans to develop onshore and their installation.

Exhibit 14: Economic contribution

$AU millions 2024 dollars, net present value between 2024-2032 of project



Source: ABS (2023); Mandala analysis

With an operational facility, the total jobs created could peak at least 2,800 FTE in 2031

The establishment of a utility-scale quantum computer will bring in a significant number of jobs over the lifetime of the project. These jobs will vary over time, peaking in 2031 at 2,800 FTE.

These jobs are split between the roles directly employed by PsiQuantum and the roles created by PsiQuantum's direct expenditure. These roles will require workers across all skill levels from construction and manufacturing to quantum research.

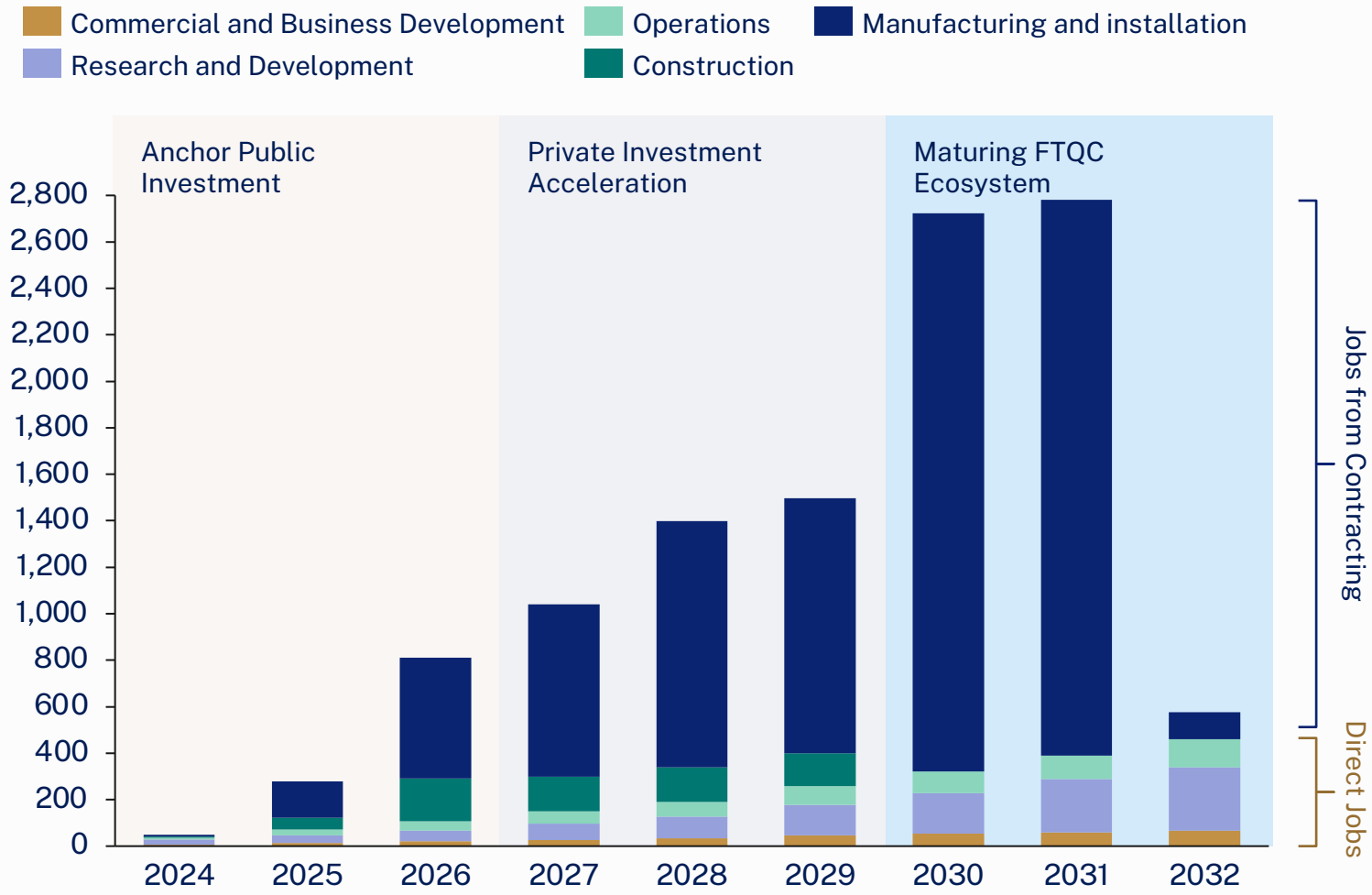
Jobs in construction will involve the building of the facilities that house manufacturing and research functions. These facilities will have substantial requirements meaning a significant number of construction jobs will be required

Jobs in manufacturing will involve creating critical, high-tech components in photonics packaging and silicon wafer deposition. These jobs are highly skilled and well-paying and do not necessarily require a university degree.

Jobs in R&D and operations will focus on innovating quantum hardware designs and producing algorithms to utilise the hardware most effectively. These jobs will require deep scientific knowledge, be globally attractive and well paying.

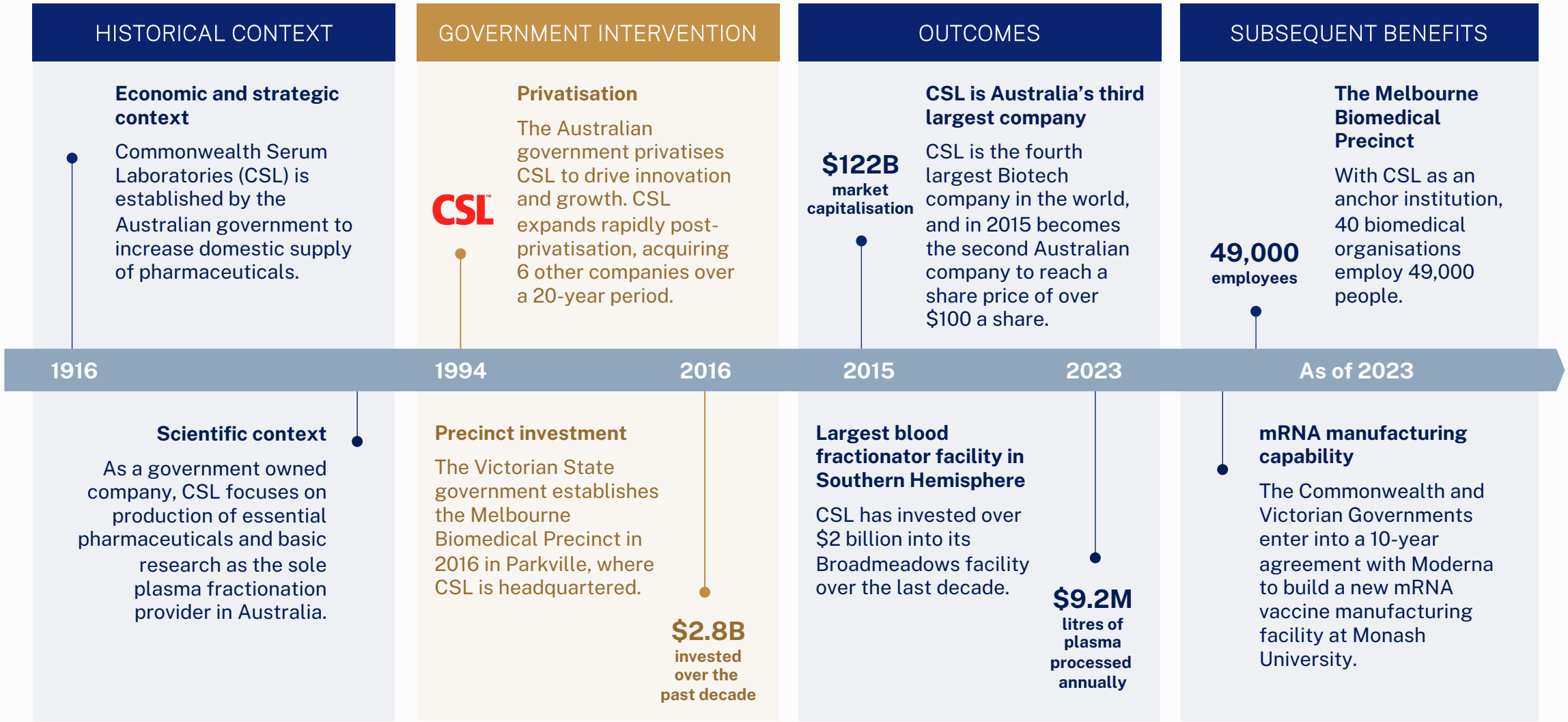
Exhibit 15: Total employment by year

Full-time equivalent (FTE) workers



Source: Mandala analysis.
Notes: See appendix for employment calculation assumptions

CASE STUDY: **With CSL as an anchor institution, Parkville in Melbourne has grown into a biomedical research and innovation hub**



Notes: AUD
Source: Redrup (2023); Victorian Government (2019); Commonwealth Government (2022)

Construction of the first utility-scale quantum computer will yield broad research and innovation benefits

Building a quantum computer will require growth in supporting input industries and advances in capabilities and technologies.

The challenge of a utility-scale quantum computer will necessarily drive innovation and growth in high-tech, high-value sectors such as optical networking, advanced photonics packaging, cryogenics, and semiconductor packaging and assembly.

There will also be broader sectors, such as additional industries contracted such as sheet metal, cabling, electronic and electro-mechanical assembly that will be engaged across the construction and operations stages.

Investing in an anchor like PsiQuantum is not a zero-sum exercise – it will drive significant progress for the rest of the quantum ecosystem in Australia and in the large network of supply chains that feed a quantum computing sector.

It will also support efforts by research groups and other quantum computing firms to grow and innovate in the sector as they have access to better suppliers, talent, and infrastructure.

Exhibit 16: Supporting industries predicted to see growth

OPTICAL NETWORKING

PsiQuantum's portfolio of patents that have **substantial value** outside quantum computing can be leveraged as optical networking technologies to **improve bandwidth and power consumption** in telecommunications and data centres.

ADVANCED PHOTONICS PACKAGING

PsiQuantum will work with partners to build and scale a **photonics packaging facility** in Australia, creating a regional packaging hub and spurring the growth of Australia's **A$4.3B** photonics industry.

CRYOGENICS

Photonic quantum computing requires extremely cold temperatures for the detectors to operate. **Cryogenic facilities and technicians** will be required to support PsiQuantum.

SEMICONDUCTOR PACKAGING & ASSEMBLY

PsiQuantum is establishing partnerships with local companies to **enhance domestic semiconductor packaging** and growing the semiconductor supply chain domestically beyond fabrication.

Construction and operation of a utility-scale quantum computer will bring significant benefits to the Queensland economy and research ecosystem

RESEARCH SCHOLARSHIPS AND GROWTH IN QUANTUM EDUCATION

This project will support the higher education system in Queensland through:

- **PhD scholarships** and internships
- **Research agreements** with universities
- **Mentorship programs**
- **Partnerships** with laboratories and research groups

GLOBAL MARKET REACH FOR THE LOCAL INDUSTRY CLUSTER

A large, global anchor institution like PsiQuantum can expand local quantum computing groups to **global value chains**, facilitating demand and increasing competition in a nascent industry.

GREATER INNOVATION IN QUANTUM ACROSS THE INDUSTRY

Hosting a utility-scale quantum computer in Queensland will provide the local quantum research ecosystem access to **world-leading facilities** and bring together the top researchers.

GENERATION OF HIGH SKILLED JOBS FOR QUEENSLANDERS

The construction phase will **generate jobs for Queenslanders** in areas such as:

- Construction and installation
- Manufacturing
- Operations and management

The operations phase will see important employment opportunities for researchers in quantum computing and other fields.

INCREASED ECONOMIC ACTIVITY FROM CONSTRUCTION AND OPERATION PHASES

The **economic benefits** of the construction and operations phases will largely flow to the Queensland economy.

GROWTH OF NEW INDUSTRIES TO SUPPORT QUANTUM COMPUTING

Hosting the first utility-scale quantum computer in Queensland will provide exposure to the **local supporting industries**, including but not limited to:

- Construction
- Optical networking
- Photonics
- Cryogenics

With a functioning, utility-scale quantum computer, Australian users can access applications which provide step-change advantages over peers

Exhibit 17: Potential benefits for the Australian economy through highly novel innovations, lower costs, and the creation of new value chains

CLIMATE

- Quantum computing will allow meteorologists to improve the accuracy and granularity of weather models enabling better prediction of extreme weather events
- Quantum computing could also enable more accurate modelling of CO_2 solvents, reducing the cost of carbon capture significantly

HEALTHCARE

- Quantum computing will support molecule modelling to more effectively design and test therapeutic molecules, creating new treatment opportunities at much lower costs
- By applying quantum computers to machine learning algorithms, researchers will be able to improve the diagnostics of medical imaging

ENERGY

- Quantum computing will enable optimisation modelling of energy systems. This would support more relatable and efficient grids by improving the scheduling and dispatch of resources
- Quantum computing could also be used to optimise photovoltaics by better modelling the efficiency of new materials like perovskite-silicon that can be commercialised

AGRICULTURE

- Quantum computers can be used in chemical simulations. This can improve catalyst designs that can improve the efficiency and sustainability of feedstock
- Quantum computing could also be used to improve risk and weather models, helping farmers identify the ideal crops for specific tracts of land and to better target resources

FINANCE

- Quantum algorithms can speed up and improve computationally expensive Monte Carlo simulations which are used in risk management
- These same approaches have applications in insurance to improve the speed and accuracy of risk pricing

TRANSPORTATION

- Quantum computing can be used to model chemical interactions at the atomic level. This will allow engineers to eliminate sources of potential waste and maximise efficiency
- Quantum computing can also be used in transportation optimisation problems. This would be used to improve public transport networks for faster and more efficient commuting

There are significant geostrategic benefits to Australia constructing the world's first utility-scale quantum computer

BENEFIT 1

Global Competition & Power

- Australia will have a strategic lead in an increasingly competitive geopolitical environment being shaped by critical technologies.
- The rate of investment and speed of development could fundamentally shift the regional balance of power.
- Investment in quantum technology by China, the US, France, Germany, the EU, India and Russia currently exceeds Australia's investment by a factor of 10-100.

BENEFIT 2

National Security

- Australia will be host to the technology, skills, intellectual property and infrastructure that will be much in-demand and needed around the world, able to set standards and protocols for a transformative technology.
- Leads to an advantage in quantum warfare, communications, and peacekeeping through its advanced precision military application to protect the national interest.
- Gives Australia influence over the ethical application of quantum technology.

BENEFIT 3

Geoeconomic Advantage

- Advanced capability over global competitors to mine resources and raw materials, protecting demand for Australia's key exports.
- Protects Australia's financial systems in the digital economy from global threats including to security of cryptocurrencies.
- Retention of quantum talent rather than attrition of researchers and workforce to global competitors.

Source: ASPI (2021); Krelina (2021); Australian Government Department of Industry, Science and Resources (2023); CSIRO (2022); ASPI (2021); AFR (2019)

CASE STUDY: **To bridge the funding gap in the private market and meet their strategic goals, the Taiwanese government provided significant direct support to TSMC**

HISTORICAL CONTEXT

1947 — Scientific context

First transistor demonstration occurs at Bell Labs.

By the late 1950s, researchers at Bell Labs discover the process for coating silicon wafers.

1970s — Economic and strategic context

Taiwan's economy is dominated by agriculture and simple electronic assembly.

The Government sought to expand Taiwan's participation in the electronics value chain.

GOVERNMENT INTERVENTION

1976 — R&D Funding

The Taiwanese government identifies the semiconductor industry as a high-value add industry with strategic importance. It founds the Institute for Technology Research Institute to focus on semiconductor research.

1987 — Direct investment

TSMC is founded with an $100M initial investment by the Taiwanese Government. TSMC is selected for their clear vision and plan for the future of the industry, and the government provides the vital funds that the private sector was unwilling to.

$100M direct investment

OUTCOMES

2021 — Resources concentrate

84% market share

The market identifies TSMC's technical leadership in the field, with revenue market share rising from <1% in 2009 to 84% in 2021, overtaking Intel to become the biggest semiconductor manufacturer in the world.

14th most valuable company in the world

TSMC is the 14th most valuable company in the world with a market capitalisation of US$454B.

$454B market capitalisation

SUBSEQUENT BENEFITS

As of 2023 — Geostrategic relevance

90%

For Taiwan, the dominance of TSMC globally ensures their continued geopolitical relevance. 90% of the world's most advanced semiconductors are produced in Taiwan.

Expanding advanced manufacturing worldwide

$45B committed for new facilities

TSMC has committed US$45B for constructing new advanced manufacturing facilities worldwide (in Germany, Japan, and the United States).

Notes: USD.
Source: The Economist (2021); The Economist (2023); Mandala analysis

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Key inputs, assumptions and data sources

Key inputs, assumptions and sources

Slide	Value	Method Summary	Assumptions and Source
29	Economic activity generated by the project by year	○ Economic activity was estimated using internal PsiQuantum spending projections. Economic activity refers to the gross value added (GVA) by the project, i.e., the contribution of the project to GDP per year. ○ From the projections, spending for each year was aggregated into 5 mutually exclusive categories: commercial and business development, research and development, operations, construction, manufacturing and installation. ○ To derive the GVA for the commercial and business development, research and development and operations categories we used forecasts of spending by year and multiplied them by an appropriate spending:GVA ratio. These ratios were derived for each category using the input-output tables and choosing an appropriate industry. ○ To derive the GVA for the construction and manufacturing and installation categories, we used forecasts of spending by year and multiplied them by an appropriate revenue:GVA ratio. These ratios were derived for each category using the input-output tables and choosing and appropriate industry ○ The two different approaches reflect whether the spending category would be undertaken by PsiQuantum or a contractor	○ ABS (2023) *National Accounts Input-Output Tables*. ○ Commercial and Business Development Spending:GVA Ratio: 0.68 ○ Research and Development Spending:GVA Ratio: 0.57 ○ Operations Spending:GVA Ratio: 0.60 ○ Construction Revenue:GVA Ratio: 0.23 ○ Manufacturing and Installation Revenue:GVA Ratio: 0.37
30	Economic contribution	○ Economic contribution was derived by taking the net present value of GVA per category per year	○ Net present value estimates apply a discount rate of 7%
31	Total employment by year	○ Employment in the commercial and business development, research and development and operations categories came from PsiQuantum employment forecasts ○ Employment in the construction and manufacturing and installation categories was derived using forecasts of GVA by year and multiplied them by an appropriate GVA:employee ratio. These ratios were derived for each category using the input-output tables and choosing and appropriate industry ○ Note, if employment in all industries was derived using GVA:employee ratios, employment in 2031 would be 9,200. Mandala has chosen to use PsiQuantum internal forecasts in order to be conservative in our assessment	○ ABS (2023) *National Accounts Input-Output Tables*. ○ Construction Jobs: GVA Ratio: 5.54 ○ Manufacturing and Installation: 4.85

Source: Mandala analysis.

Department of Agriculture, Fisheries and Forestry

1 Australia needs to change its economic approach to adapt to new challenges

- Effective deregulation in the 1980s and 90s enabled Australia's economy to develop a highly productive, highly competitive economy. Australia's cultivation of a world-leading resources sector along with a strong skills system, fast uptake of new technologies, and smart macroeconomic policymaking means that its citizens enjoy among the highest living standards in the world.
- However, there has been a two-decade drought in economic reform. Global socioeconomic trends such as accelerating decarbonisation, digitisation, trade de-risking, and ageing populations mean that the pathway to future Australian prosperity is uncertain. Today, its productivity growth is already stagnant.
- Increasingly, governments around the world making large public investments to grow high-tech, high-value sectors to capture new waves of growth and build strategic capabilities.

2 Quantum computing represents a unique and transformative opportunity for Australia but it will need to make a substantial investment to realise its potential

- The Albanese Government has identified critical sectors for support that can be strategically beneficial Australia. These sectors include critical minerals processing and manufacturing, AI, biological technologies, and quantum computing. Each have been supported by successive governments in intensive R&D support.
- This report outlines the benefits and advantages of Australia in converting a strong research base in quantum computing to a fully commercialised, world-leading industry.
- Close engagement from both the Commonwealth and Queensland governments is crucial for success, especially given the size of the public investment, the economic benefits on offer, and the geostrategic and security implications at stake.

3 A utility-scale quantum computer built in Australia in the next decade will unlock sweeping opportunities and advantages

- A utility-scale, fault-tolerant quantum computer (FTQC) will generate very significant benefits for Australians over the coming decades.
- These include economic benefits from a transformative new technology; ecosystem benefits for the local quantum industry; research and innovation benefits across the economy; and geostrategic benefits.
- The construction of a utility-scale FTQC could yield 2800 jobs for the local economy and $5.1B in economic benefits.
- A fully-functioning, utility-scale FTQC could see benefits in sectors as diverse as health, security, climate, agriculture, finance, transport, and energy, and would establish Australia as a world-leader in a critical geostrategic technology, bringing benefits to the region and establishing sovereign capacity for Australia.

Quantum computing and the agricultural sector

- Quantum computing will bring significant opportunities for the Department of Agriculture, Fisheries and Forestry. These include optimising crop modelling, supporting precision agriculture and assisting in supply chain optimisation. By tapping into these opportunities, the agricultural sector stands to see significant advancements in productivity, sustainability, and overall resilience.

Opportunities:

- **Enhanced Crop Optimisation:** Quantum computers can efficiently model complex genetic and environmental interactions. By analysing the interplay of crop genetics, soil health, and climate variables, farmers can be provided with insights to select optimal crop varieties for given conditions, enhancing yields and resilience against pests or adverse weather.
- **Precision Agriculture and Resource Allocation:** Through quantum algorithms, vast datasets from satellite imagery, soil sensors, and drones can be processed at unprecedented speeds. This allows for real-time monitoring and precise decision-making regarding irrigation, fertiliser application, and pest control. As a result, resources can be used more efficiently, leading to reduced costs and increased sustainability.
- **Supply Chain and Market Predictions:** Quantum computing can assist in processing complex market trends, transport logistics, and supply chain variables, offering predictions with higher accuracy. This ensures that agricultural produce gets to markets more efficiently, reduces wastage, and helps farmers respond rapidly to market demands.

Department of Climate Change, Energy, the Environment and Water

1 Australia needs to change its economic approach to adapt to new challenges

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Quantum computing and the Department

- Quantum computing presents opportunities for the Department of Climate Change, Energy, the Environment and Water. Through quantum advancements, the Department can gain deeper insights into climate modelling, optimise energy systems, and enhance environmental and water resource management.

Opportunities:

- **Precision in Climate Modelling:** Quantum computers, with their ability to process intricate datasets rapidly, can refine climate models, enabling more accurate predictions of climate patterns and effects. This can inform proactive strategies to mitigate and adapt to climate change impacts.
- **Optimisation of Energy Systems:** Quantum algorithms can facilitate the design and analysis of complex energy systems, aiding in the optimisation of energy storage, distribution, and consumption. This is especially relevant for integrating renewable energy sources into the grid effectively.
- **Enhanced Environmental and Water Management:** Quantum computing can process vast amounts of environmental data to monitor ecosystems in real-time, predict ecological shifts, and optimise water resource distribution. This ensures sustainable management of Australia's natural resources.
- By leveraging the capabilities of quantum computing, the Department of Climate Change, Energy, the Environment and Water can spearhead Australia's journey towards a sustainable future, underpinned by cutting-edge technology and informed decision-making.

Department of Defence

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Quantum computing and the Department

- Quantum computing presents opportunities for the Department of Defence, with opportunities to improve strategic intelligence, bolster cybersecurity, and develop next-generation defence capabilities. Such quantum-driven advancements can significantly elevate Australia's defence readiness and strategic position.

Opportunities:

- **Strategic Intelligence and Decision-making:** Quantum computers can rapidly process vast amounts of data, enabling swifter intelligence gathering and analysis. This translates to real-time situational awareness and more informed decision-making in dynamic defence scenarios.
- **Enhanced Cybersecurity Protocols:** The advent of quantum computers challenges existing encryption methods, but concurrently, quantum encryption offers unparalleled security against even quantum-driven threats. Adopting quantum-resistant cryptographic measures will ensure the Department's communications and data remain impervious to breaches.
- **Advanced Defence Technology Development:** Quantum computing can aid in the simulation and development of advanced defence technologies, from material science for more resilient armour to efficient algorithms for autonomous defence systems. Such innovations can drastically improve operational efficiency and effectiveness on the battlefield.
- Tapping into the capabilities of quantum computing, the Department of Defence can establish Australia as a global leader in defence technology and strategy, ensuring both proactive and reactive readiness against evolving threats.

Department of Health and Aged Care

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Quantum computing and the Department

- Quantum computing presents opportunities for the Department of Health and Aged Care the chance to revolutionise healthcare analytics, drug discovery, and patient care management. These advancements can catalyse more accurate diagnostics, tailored treatments, and improved patient outcomes.

Opportunities:

- **Revolutionised Healthcare Analytics:** Quantum computers can process vast medical datasets at unparalleled speeds. This can lead to quicker and more accurate disease outbreak predictions, patient health trend analyses, and efficient resource allocations in health crises.
- **Accelerated Drug Discovery:** One of the most promising applications of quantum computing is in the field of drug discovery. Quantum algorithms can simulate complex molecular and chemical reactions, potentially shortening the time required to discover and bring new drugs to market.
- **Enhanced Patient Care in Aged Care:** Quantum computing can optimise patient care workflows and predict individual patient needs, ensuring timely interventions and personalised care plans. For aged care, this could mean improved monitoring of chronic conditions and forecasting potential health risks, thereby enhancing the quality of life for the elderly.
- By tapping into the capabilities of quantum computing, the Department of Health and Aged Care can drive healthcare innovation, ensuring the Australian populace benefits from the latest in medical technology and care strategies.

Department of Foreign Affairs and Trade

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Quantum computing and the Department

- Quantum computing presents opportunities for the Department of Foreign Affairs and Trade including support for intelligence, enhance data protection in international communications, and superior global trade analytics.

Opportunities:

- **Diplomatic Intelligence Analysis:** Quantum computers, given their ability to process vast amounts of data rapidly, can assist in deciphering complex geopolitical trends, thereby informing Australia's foreign policy decisions with deeper insights and real-time intelligence.
- **Secure International Communications:** As global diplomacy increasingly relies on digital communication, the importance of secure channels cannot be overstated. Quantum cryptography promises ultra-secure communication methods, resistant to potential quantum decryption threats, ensuring the confidentiality of diplomatic exchanges.
- **Trade and Economic Forecasting:** With the capability to analyse enormous datasets and complex algorithms swiftly, quantum computing can provide more accurate predictions of global market trends. This can aid DFAT in navigating trade negotiations, understanding market shifts, and optimising Australia's international economic strategy.
- Harnessing the potential of quantum computing will empower the Department of Foreign Affairs and Trade to lead with foresight in a rapidly evolving global landscape, fortifying Australia's position in diplomatic and trade arenas.

Department of Home Affairs

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Quantum computing and the Department

- Quantum computing presents opportunities for the Department of Home Affairs in data processing, risk analysis, and cybersecurity improvements. By leveraging quantum advancements, the Department stands to benefit from enhanced data security, border control efficiencies, and advanced threat detection.

Opportunities:

- **Strengthened Data Security:** Quantum computers can potentially undermine current cryptographic standards, making certain encryption methods obsolete. However, with the advent of quantum-safe encryption and quantum key distribution, the Department can establish ultra-secure data protection protocols, ensuring the confidentiality of sensitive information.
- **Efficient Border Control Operations:** Quantum algorithms can rapidly process vast datasets, allowing for quicker background checks, visa processing, and threat assessments. This would mean swifter, yet thorough, screenings at border entries, streamlining the flow while maintaining security.
- **Advanced Threat Detection and Intelligence:** Quantum computing can assist in deciphering complex patterns in data, providing real-time intelligence on potential security threats, both digital and physical. This can inform proactive strategies to safeguard Australian borders and interests.
- The Department of Home Affairs can position itself at the cutting edge of security and operational excellence with quantum capabilities

Department of Treasury and the Department of Finance

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Quantum computing and the Department

- Quantum computing will bring opportunities for the Department of the Treasury and the Department of Finance, particularly in regulation of the financial services sector. By harnessing quantum technology, the Departments and their agencies can achieve unprecedented precision in financial modeling, risk assessment, and regulatory compliance, ushering in an era of enhanced financial stability and transparency for Australia.

Opportunities:

- **Refined Financial Modeling:** Quantum computers can swiftly process vast amounts of financial data, allowing for the creation of intricate and highly accurate economic models. This provides deeper insights into market trends, asset valuations, and potential economic shifts, empowering the Department to make informed policy decisions.
- **Enhanced Risk Assessment:** With the ability to analyse complex financial systems in real-time, quantum computing can pinpoint vulnerabilities within the financial sector. This leads to early identification of systemic risks and equips regulators with the tools needed to preempt potential financial crises.
- **Robust Data Security and Encryption:** As financial data is particularly sensitive, the quantum-driven challenge to existing encryption methods necessitates the adoption of quantum-safe encryption. This ensures the Department's financial records and transactions remain secure against advanced cyber attacks.

Department of Infrastructure, Transport, Regional Development, Communications and the Arts

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Quantum computing and the Department

- Quantum computing presents opportunities for the Department of Infrastructure, Transport, Regional Development, Communications and the Arts. Through harnessing the capabilities of quantum technologies, the Department can improve infrastructure planning, enhance transport efficiency and revolutionise communication systems.

Opportunities:

- **Advanced Infrastructure Planning:** Quantum computing can process large and intricate datasets swiftly, facilitating a more comprehensive and nuanced analysis of infrastructure projects. This enables more precise projections of infrastructure needs, costs, and impacts, streamlining decision-making and implementation processes.
- **Efficient Transport Systems:** Quantum algorithms can optimise transportation routes, traffic management, and logistics. This has the potential to reduce congestion, improve fuel efficiency, and promote the timely movement of goods and people across the nation.
- **Revolutionised Communications:** Quantum communication systems offer unparalleled security and speed. As cyber threats become more sophisticated, the Department can lead in deploying quantum-safe communication networks, ensuring both the privacy and integrity of national communications.

Department of Industry, Science and Resources

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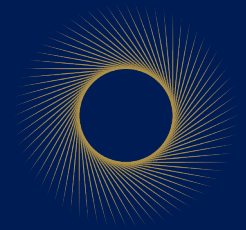
Quantum computing and the Department

- Quantum computing presents opportunities for the Department of Industry, Science and Resources. These include greater innovation in industry and support optimising resource management. These quantum capabilities promise to reshape Australia's industrial landscape, bolster scientific research, and optimise resource allocation.

Opportunities:

- **Fostering Innovation in Industries:** Quantum computing, by enabling faster and more complex problem-solving, can spur innovation across various sectors, from advanced manufacturing to biotechnology. This can position Australia at the forefront of global industrial advancements, attracting investments and fostering economic growth.
- **Optimised Resource Management:** The extraction, processing, and allocation of resources can benefit from quantum algorithms that provide optimal solutions to logistical challenges. This means more efficient mining operations, streamlined manufacturing processes, and reduced waste.
- By embracing the potential of quantum computing, the Department of Industry, Science and Resources can lead Australia's charge into a new era of industrial innovation, scientific discovery, and resource optimisation.



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