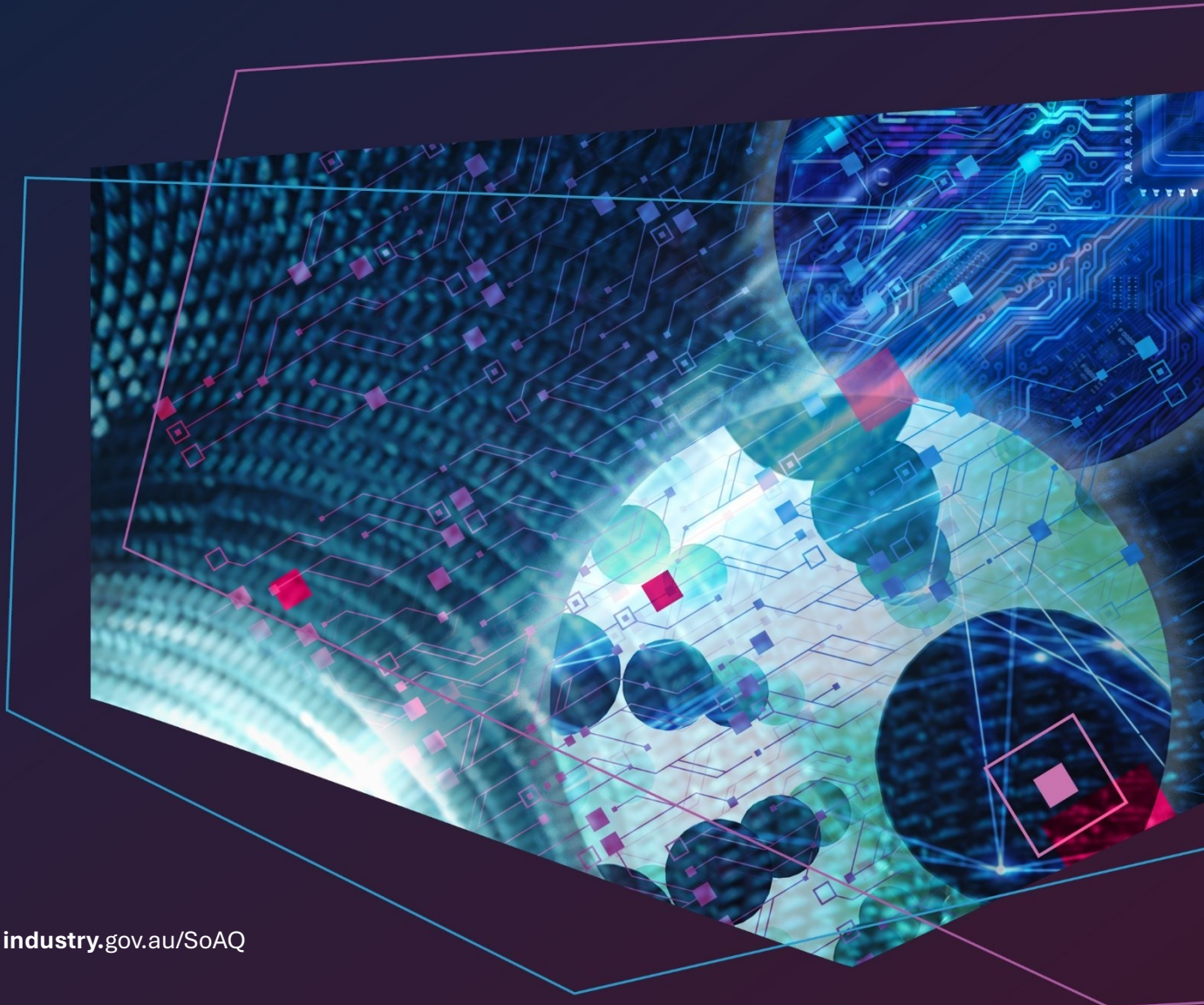




Australian Government
Department of Industry,
Science and Resources

State of Australian Quantum

November 2024



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Disclaimer

The purpose of this publication is to provide an overview of the progress and achievements of the Australian quantum sector in 2023–2024 in relation to the National Quantum Strategy.

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Minister's Foreword

The State of Australian Quantum report celebrates Australia's early achievements on the journey to be a leader of the global quantum industry by 2030. It reflects the determination and hard work across the quantum ecosystem, driving continued growth in Australia's quantum industry.

It is a great pleasure to be able to document and share Australia's quantum achievements since the launch of the National Quantum Strategy in May 2023.

We have a solid foundation in quantum research and development and our past 15 months attest to this. Our universities and research institutions are innovating to support future commercialisation of quantum technologies. Australian businesses are competing with the world's best.

We have taken immediate steps to secure Australia's leadership in quantum, including:

- investing \$18.4 million to create Quantum Australia, to grow Australia's quantum ecosystem
- investing \$15 million in Silicon Quantum Computing's Series A round to support the development of a quantum computer using silicon-based hardware.
- earmarking \$1 billion for critical technology companies including quantum companies through the National Reconstruction Fund
- committing \$36 million to critical technologies challenges, driving real world use cases for cutting edge quantum technologies
- investing \$470 million in equity and loans in PsiQuantum together with the Queensland Government to build its world first utility scale fault tolerant quantum computer in Brisbane, Australia and anchor industry growth onshore.

Step changes in computing, sensing and communication could deliver productivity gains across a wide range of industries. Quantum technologies will help us address the challenges we will face in the coming decades, like transitioning to net zero, discovering new drugs, and pioneering new treatments for disease.

Since the launch of our strategy, governments around the world have joined Australia in recognising the importance of building national quantum capability. Quantum is on the path to becoming a multibillion-dollar industry that could provide multitrillion-dollar benefits to the wider global economy. Australian companies are already leading record-breaking capital raising rounds. Bold action ensures Australia can be a frontrunner in the emerging global quantum marketplace.

This is not an area where we should be content to rely on the market to meet our needs. Instead, we should foster the growth of an onshore deep technology industry that spurs job creation and greater economic complexity. Australia is perfectly positioned to build a thriving quantum industry as a trusted international partner with a highly respected quantum workforce.

Australian quantum talent is leading companies and initiatives all over the world and here at home. None more so than our Chief Scientist, Dr Cathy Foley AO PSM, who has been a tireless and highly respected advocate for Australia's quantum potential. I want to thank her for all her work, developing the National Quantum Strategy, advising government and establishing industry events like the Quantum Meets series.

The Albanese Labor government is determined that Australia retains its competitive edge. Together, we will ensure Australia is a hub for quantum industries for years to come.



The Hon Ed Husic MP
Minister for Industry and Science

Australia's Chief Scientist Foreword

Since the launch of the National Quantum Strategy so much has happened for quantum in Australia. Our progress and momentum over the past year puts Australia in a great position and proves that we are serious about growing a vibrant and diverse quantum industry. In Australia, quantum is no longer a laboratory curiosity for the quantum intrigued: we are actively seeing the adoption of quantum technologies across broad industry sectors.

In the past year, quantum has become a common topic on the front pages of newspapers, in governments and in businesses – it's even discussed in taxis! Australian quantum science and technologies are winning awards, attracting investment, and increasing the number of products and services that offer quantum capabilities. Perhaps most importantly, we are showing how well the quantum sector works together in developing a thriving ecosystem, while boosting engagement with the wider community.

This year began with the annual Quantum Australia conference attracting international visitors as well as the local quantum community. It is now one of the global 'go to' quantum events. Another is the Quantum Australia consortium, with a breadth of representation across the sector, partnering to create a front door for Australian quantum technologies to drive the adoption of quantum in Australia.

A personal highlight has been the Quantum Meets series. These workshops have provided a valuable opportunity to explore how quantum technologies address real-world challenges in the broader economy. They have already fostered tangible collaborations and are building quantum literacy across several sectors – not least the opportunity to develop quantum capability to support the delivery of the 2032 Brisbane Olympic and Paralympic Games!

Quantum enthusiasm is not limited to the Australian Government. State and territory governments are supporting the growth of our quantum ecosystem too. They are investing in manufacturing infrastructure, attracting international investment, and developing strategies and policies to build research and businesses in quantum technologies in their jurisdictions. This includes the Queensland Government's announcement of the Queensland Quantum and Advanced Technologies Strategy, the Victorian Government's support for the establishment of a quantum diamond foundry, and the New South Wales Government's support for the Advanced Manufacturing Research Facility and Quantum Computing Commercialisation Fund.

The national approach of coordination, cooperation, and collaboration, ensures efforts across the states and territories and the Australian Government are harmonised and complementary.

We should be proud of our progress to date. It is thanks to the efforts across the entire quantum community that Australia is well positioned to becoming a leader in quantum. This includes the individuals taking risks to start up quantum businesses, universities supporting the quantum research programs, students pegging their careers on quantum, existing industries adopting quantum technologies, and governments backing this horse so it can be a winner.

As a result, we look to an exciting and transformative future, where quantum technologies will create new possibilities and solutions for all Australians.



Dr Cathy Foley AO PSM
Australia's Chief Scientist

Executive summary

Quantum technologies will have far-reaching strategic, economic and social impacts. Our quantum technology industry will be worth a projected \$6 billion and employ 19,400 Australians by 2045. The Australian Government supports quantum companies at every phase of growth. This includes investments in early stage and growth ready companies through programs like the Industry Growth Program and the National Reconstruction Fund (NRF). This also includes targeted investments in larger companies like the Commonwealth and Queensland governments' joint investment in PsiQuantum. Together, these efforts will drive additional revenue and job creation. Quantum technologies have important national security applications, and advances in computing and sensing could promote step-changes in a range of areas that impact the lives of all Australians.

The National Quantum Strategy (the strategy) charts a course to do just that. Since its launch in May 2023, Australia has taken steps toward fulfilling the strategy's vision:

In 2030, Australia is recognised as a leader of the global quantum industry, and quantum technologies are integral to a prosperous, fair and inclusive Australia.

The **State of Australian Quantum Report** gives an update on implementation of the strategy. This report:

- showcases the successes of Australian quantum researchers and businesses over the past year
- discusses challenges to address
- highlights the work underway across the Australian Government and state and territory governments to grow the national quantum sector
- gives an update on the strategy's measures of success, and
- signals next steps for the strategy.

In one year Australia's quantum initiatives have grown significantly

Since the launch of the strategy, we have seen major government investments and initiatives support the growth of the quantum sector, including the:

- joint Australian and Queensland Government investment of \$940 million in PsiQuantum to build its first utility-scale fault-tolerant quantum computer in Brisbane, locate its Asia-Pacific headquarters and support a range of local research and industry collaborations
- establishment of the National Reconstruction Fund (NRF), allocating \$1 billion for investment in critical technologies such as quantum
- \$18.4 million investment in Quantum Australia, a national initiative delivered by a consortium of industry, research and government organisations. Quantum Australia will promote industry growth, support collaborative research and strengthen Australia's position as a global quantum leader
- first round of the \$36 million Critical Technologies Challenge Program (CTCP). The CTCP supports Australian quantum businesses to work with researchers and end users to develop innovative solutions to challenges of national significance launched.

Meanwhile, quantum businesses have announced technology roadmaps, achieved milestones, completed successful capital raising rounds, and forged relationships with multinational technology businesses.

The public profile of quantum technologies has also been building. Since the launch of the strategy in May 2023, several public events have drawn attention to quantum technologies:

- In 2023, Professor Michelle Simmons AO was awarded the Prime Minister's Prize for Science for creating the field of atomic electronics, and for her discoveries in silicon quantum computing which are powering the world from the digital age to the quantum age.
- Dr Andrew Horsley won the Prime Minister's Prize for New Innovators in 2024 in recognition of his groundbreaking work on making quantum computing an everyday technology.
- Events like the Quantum Australia conference and the Quantum Meets series helped connect the quantum sector to the wider community.
- Events like the Quantum Tech Camp, hosted by Sydney Quantum Academy (SQA) and Quantum Girls, hosted by the University of Western Australia promoted careers in the quantum industry.

There is more to do to grow Australia's quantum sector

To further unlock the growth of the quantum industry and adoption of quantum technologies, priority areas for further work include addressing:

- access to patient, trusted capital
- intellectual property arrangements inhibiting commercialisation of quantum technologies
- competition from other quantum markets for talent and investment
- low levels of awareness of quantum technology in the broader community.

Around the world, governments are realising the potential of quantum technologies and Australia can't be left behind. The themes and actions of the strategy, along with complementary initiatives across government, seek to address obstacles on the path to achieving Australia's quantum vision.

Quantum is a whole-of-nation effort

The policy levers, regulatory responsibilities and funding needed to deliver the strategy sit across many Australian Government departments. In addition to direct funding initiatives, quantum technologies have become a priority in major Australian Government programs, including the:

- Advanced Strategic Capability Accelerator (ASCA)
- Australia's Economic Accelerator program (AEA)
- Cooperative Research Centre – Projects program (CRC-P)
- Industry Growth Program (IGP).

Quantum researchers also continue to receive funding from longstanding programs, such as the Australian Research Council (ARC) Linkage and Discovery programs. Quantum academics have been awarded prestigious ARC Laureate Fellowships and we have seen investment in the establishment of new initiatives supporting quantum research and training, including:

- the ARC Centre of Excellence for Quantum Biotechnology
- the ARC Centre of Excellence in Optical Microcombs for Breakthrough Science
- new ARC Industrial Transformation Training Centres for future leaders in quantum computing at the University of Sydney, and for emergent quantum technologies at the University of Adelaide.

The Australian Government is continuing to align effort and initiatives to support the implementation of the strategy.

State and territory governments have been at the forefront of building Australia's quantum industry for years. This includes major investments in quantum companies, new facilities and infrastructure, as well as state strategies to capture the benefits of quantum technologies. States and territories are growing areas of local competitive advantage which build the capability of the entire nation.

International collaboration generates new opportunities for Australia

Australia has been working closely with international partners through bilateral relationships, multilateral arrangements and standards setting bodies. Major developments include:

- the establishment of the Quantum Development Group (QDG), to promote resilient and reliable supply chains, research and development collaboration and a quantum future underpinned by shared interests and values
- signing Joint Statements of Cooperation on Quantum Technologies with the United States and United Kingdom to enhance each country's capabilities through improved market access and knowledge sharing
- engagement with the Multilateral Dialogue on Quantum (MDQ) to coordinate international quantum efforts
- the establishment of the Quad Investors Network Centre of Excellence in Quantum Information Sciences to drive greater collaboration and market access between Australia, the United States, Japan and India
- the establishment of the Joint Technical Committee on Quantum Technologies to improve coordination of technical standards, reduce duplication and to help make best use of the expert resources around the globe.

This is just the beginning

Since the launch of the strategy, we have seen strong progress against its priorities, with positive collaboration across government, industry and research, but there is still more to be done. In addition to continuing to deliver existing initiatives, the next stage of the strategy's implementation will focus on:

- building Australia's quantum workforce
- the infrastructure needed by quantum academics and businesses to support research commercialisation
- understanding Australia's quantum supply chain to identify potential vulnerabilities and opportunities.

At a glance: Australia's quantum ecosystem

As at August 2024 unless otherwise noted



26 organisations are pursuing quantum technology research

16



universities

4



government
research agencies

6



ARC Centres
of Excellence

At least

53 facilities and laboratories



related to quantum
technology research
and development

38 quantum
businesses



Australian-headquartered
businesses



Overseas-headquartered
businesses with a
presence in Australia

Quantum businesses
have announced at least

22



new domestic collaborations
with partners across several sectors

19



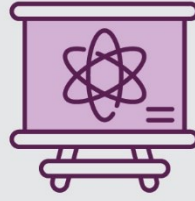
new international collaborations

since the launch of the
National Quantum Strategy
in May 2023

Australia has established



5 quantum-related international arrangements



27%

of Australians have heard of quantum technologies

Based on a May 2024 survey of a representative sample of the Australian public



24 Australian universities are teaching quantum subjects

6 offer specialised quantum degrees



Australian-headquartered quantum businesses have received at least

\$179 million

in private investment since the launch of the strategy in May 2023



Public funding for quantum technologies in Australia totals

\$231 million

since the launch of the strategy in May 2023

As at 7 November 2024

Excludes the Australian Government and Queensland Government investment in PsiQuantum

The Australian and Queensland governments announced a joint investment of

\$940 million in PsiQuantum in April 2024



to build its **world-leading utility-scale Fault Tolerant Quantum Computer**

and establish its Asia-Pacific headquarters in Brisbane

Progress

There has been an enormous amount of activity in Australia's quantum community to date. This activity has been guided by the strategy, other government programs and investments, and the Australian quantum community.

Ambitious investment shows Australia is committed to quantum

In April 2024, the Australian and Queensland governments announced a joint investment of \$940 million for PsiQuantum to build and operate its world-first utility scale, fault tolerant quantum computer in Brisbane, establish an Asia-Pacific headquarters and support a range of local research and industry collaborations. This is a major step forward in the growth of a thriving Australian quantum sector and shows Australia's long-term commitment to a prosperous onshore quantum industry. Australian businesses and researchers face strong incentives to move overseas. This investment shows we are focused on bringing talent, fostered through Australian universities, back onshore. It stimulates foreign direct investment and grows our sovereign capability. The investment is expected to yield a range of positive spillover benefits for the industry and the wider economy in the years to come.

As part of this investment, PsiQuantum will:

- setup its Asia-Pacific headquarters in Brisbane
- build and operate successive generations of its fault tolerant quantum computer in Brisbane
- create up to 400 highly skilled local jobs
- create partnerships with the local quantum industry and advanced manufacturing clusters
- create a dedicated climate research centre
- open new digital and advanced tech supply chain opportunities
- invest in university and research collaborations, including PhD positions, mentoring and internship opportunities.

In July 2023, the Australian Government invested \$15 million in Silicon Quantum Computing's (SQC) Series A round to support the development of a quantum computer using silicon-based hardware. It increased the total Australian Government investment in SQC to \$40 million, and further reflects a commitment to investing in opportunities to support the industry at different stages of company growth. This investment supports the Australian manufacturing of SQC's vertically integrated full stack quantum computing capability.

The National Reconstruction Fund creates a funding pathway for enabling capabilities

The Australian Government's \$15 billion NRF facilitates increased flows of finance into the Australian economy. Through targeted investments, the NRF will diversify and transform Australian industry and rebuild Australia's competitiveness across the manufacturing value chain. There are 7 Government identified priority areas of the Australian economy. One of these is enabling capabilities, which includes quantum technologies.

The NRF Corporation's target investment level for enabling technologies is \$1 billion. It highlights the Australian Government's commitment to maintaining a competitive advantage in deep technology industries and sustaining our national industrial and scientific progress. This supports the objectives of the strategy by fostering innovation and supporting industries to further develop quantum technologies. The NRF Corporation is engaging with quantum businesses to learn more about potential investment opportunities.

Quantum Australia will connect the Australian quantum technology sector to the wider community

In April 2024, the Australian Government awarded \$18.4 million to the University of Sydney to create an Australian centre for quantum growth, called Quantum Australia. Quantum Australia is a consortium of industry, research and government partners with nodes across the country. It will catalyse industry growth, support collaborative research and strengthen Australia's position as a global quantum leader. Quantum Australia's programs will include:

- The Quantum Ecosystem Development program, which will deliver a deeply connected quantum stakeholder landscape with improved understanding of the potential for quantum technologies.
- The Translation Accelerator program, which will grow the Australian quantum industry, unlock new use-cases for quantum technology, increase industry-academic research partnerships, and help grow the quantum workforce.
- The Entrepreneurship Support program, which will attract quantum entrepreneurs nationwide and internationally, supporting them on their journey from experts to founders.
- Programs such as a Quantum Safe Industry workshop, IP roundtable, and Elevating Quantum Women's Voices, which will ensure an equitable, ethical, and secure quantum ecosystem with opportunities for all Australians.

The launch of the Critical Technologies Challenge Program offers a practical pathway to demonstrate Australian quantum innovation

Round one applications opened for the \$36 million CTCP in May 2024. The CTCP fosters collaboration between Australia's quantum businesses, researchers and end-users to develop innovative solutions to the first set of nationally significant challenges:

- optimising the performance, sustainability and security of energy networks
- improving medical imaging and medical sensors to support diagnosis, treatment of disease and monitoring activities inside the human body
- enhancing communication with autonomous systems in varying environments
- optimising and reducing the impact of resource exploration, extraction, and mineral processing.

The 2 funding stages will build awareness and uptake of quantum technologies through quantum use cases in sensing, communications, and computing. The funding stages are:

- stage 1 – up to \$500,000 for feasibility projects
- stage 2 – successful feasibility projects will be invited to apply for an extra \$5 million to develop the demonstrator projects and proof of concept.

Round one saw a huge level of interest from the quantum technology sector and adjacent industries. The program has offered \$5.2 million in funding to 14 feasibility projects exploring how quantum technologies can improve the lives of Australians. Projects include:

- making a high-speed optical scanner for diabetes assessment
- using quantum computing for remote community energy systems with renewable energy sources
- developing resilient communications and navigation of autonomous systems without GPS
- creating a new quantum optical sensor which will enable selective mining of rare-earth elements in clay deposits
- developing diagnostic technology to detect the ‘Invisible Melanoma’.

ARC Centres of Excellence continue to grow Australia’s quantum industry

ARC Centres of Excellence are the backbone of Australia’s quantum sector. Through these centres, researchers, industry and government are working to develop multidisciplinary research and use cases for quantum technologies in areas like biomedical imaging, chemical design and clean energy.

For the next 8 years, biotechnology is expected to add up to \$8 billion gross value to the Australian economy by helping solve challenging research problems and re-design applications for this technology. Australia aims to be at the forefront of this development through the ARC Centre of Excellence in Quantum Biotechnology (QUBIC), Australia’s first Centre of Excellence applying quantum physics to biotechnology.

QUBIC translates research into commercialisation opportunities, paving the way for new markets using biotechnology. It also helps with skilling Australia’s future quantum professionals to add value to a high-potential industry.

Australia has other existing Centres of Excellence focused on quantum and related fields. For example, the ARC Centre of Excellence for Engineered Quantum Systems (EQUS) conducts world-leading research in quantum machines for practical applications. EQUS has made a measurable impact on Australia’s quantum capability by:

- contributing to more than 75 policy briefings and submissions to grow quantum literacy in government, business and the community
- identifying over 37 technologies potentially benefiting society
- investing more than \$1.6 million into 37 projects attracting \$2.5 million in in-kind investment.

Australian businesses and universities are attracting overseas investors and technology partnerships

In a challenging economic environment, several Australian businesses such as Silicon Quantum Computing, Diraq, Q-CTRL and Nomad Atomics announced successful capital raising rounds and collaborations with large technology businesses. The Australian National University also announced a memorandum of understanding with Fujitsu Australia Limited to give industry, government, research, academics and students in Australia access to a world-class quantum research facility.

Success story: Q-CTRL

Q-CTRL is a quantum technology software company. In October 2024, the company announced the successful expansion of its Series B Funding Round to \$166 million. This represents the largest aggregate Series B for a quantum software company to date and highlights the commercial and technological success of Q-CTRL in the emerging quantum industry.

In November 2023, the company announced its quantum infrastructure software as an option on the IBM Quantum Pay-As-You-Go plan. Q-CTRL's software is also integrated into Rigetti Quantum Cloud Services, Oxford Quantum Circuits Cloud QCaaS devices and Diraq's silicon quantum processors. The integration gives user-friendly functionality to address the main challenge facing quantum computing end-users: unreliable results from algorithms in today's hardware environment.

In October 2023, Q-CTRL announced a partnership with the Quad Investors Network for quantum technology training in Australia and the USA. The company's Black Opal quantum educational technology software will help supply the training.

Boosting awareness of quantum technologies is vital

Market research carried out in May 2024 showed less than a third of Australians are aware of quantum technologies. However, outreach from the quantum sector to the wider community is helping raise awareness of the opportunities quantum technologies present.

In 2023, Professor Michelle Simmons AO was awarded the Prime Minister's Prize for Science for creating the field of atomic electronics, and for her discoveries in silicon quantum computing which are powering the world from the digital age to the quantum age. Professor Simmons also presented the 2023 Boyer Lecture series on quantum computing, linking fundamental physics pioneered in Australia with extraordinary technological advancement and the future of computing, reaching a national audience.

In 2024, Dr Andrew Horsley of Quantum Brilliance received the 2024 Prime Minister's Prize for New Innovators. The award was in recognition of his groundbreaking innovations toward making quantum computing an everyday technology.

In May 2024, the SQA and Qubit by Qubit held the third annual Quantum Tech Camp in regional Australia. The camp hosted 52 high school students from under-represented groups from New South Wales, Queensland and Tasmania. It introduced the students to quantum technologies and other aspects of science, technology, engineering, and mathematics (STEM). The camp included guest speakers from the Australian and international quantum industry to highlight future employment opportunities.

Australia hosted events such as the Quantum Australia Conference and the Quantum Meets series. The Quantum Australia Conference was the biggest event in Australia's quantum calendar since 2022. It brought international quantum experts together to highlight advancements in and use of quantum technologies. The establishment of the Quantum Australia consortium means this important event will continue its reach across the country for another 3 years.

Success story: Sydney Quantum Academy

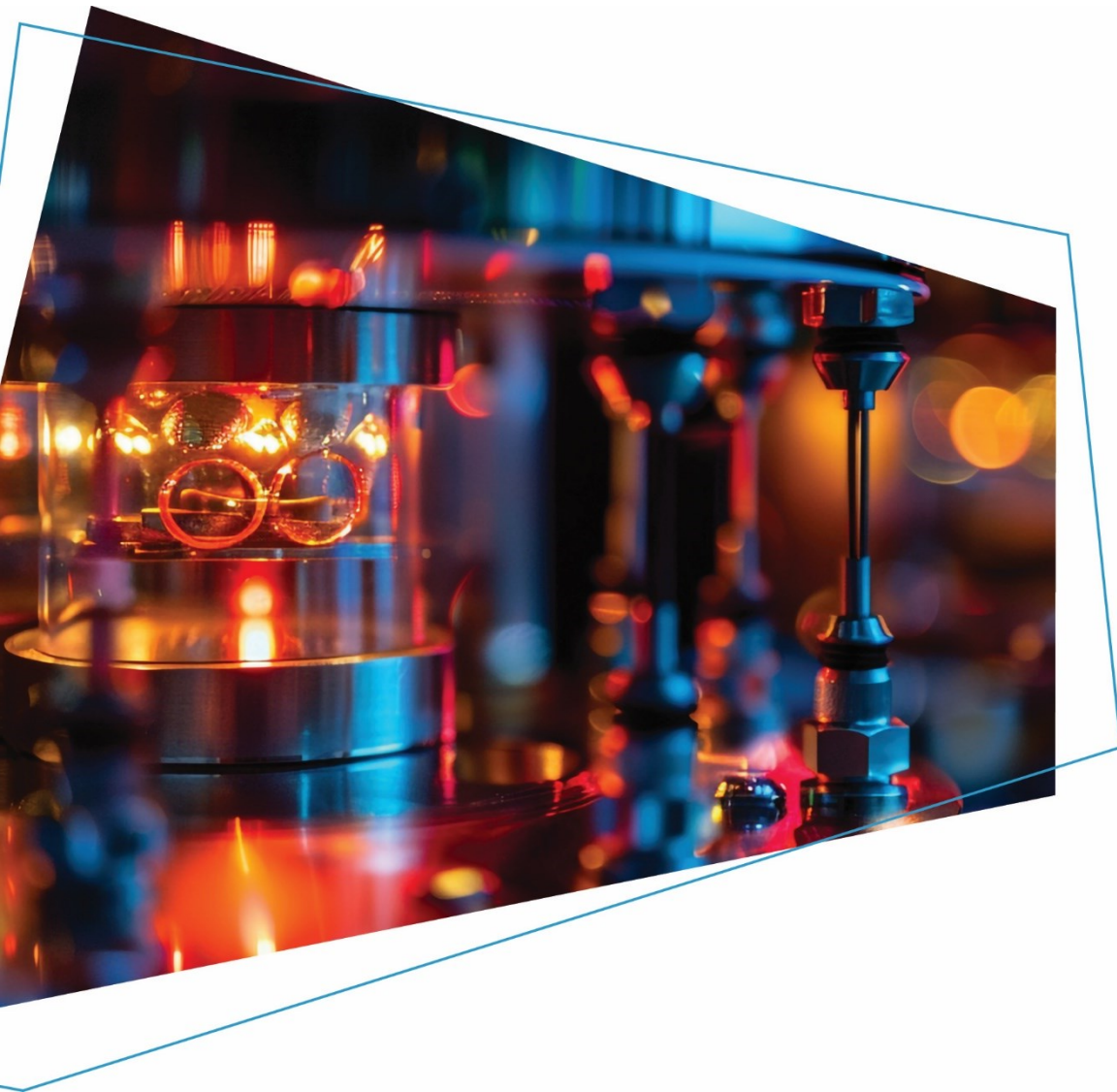
Sydney Quantum Academy is a partnership between Macquarie University, University of NSW, University of Sydney and University of Technology. The Australian Government funded Sydney Quantum Academy to manage the National Quantum Collaboration Initiative (NQCI), an action in the strategy.

The Academy staged the 2023 and 2024 Quantum Australia Conference and Careers Fair. These events brought together 829 researchers, industry players and government delegates from around the world. 69% of attendees found the event beneficial and would recommend it to others.

The Quantum Meets series brings together quantum experts with leaders from different sectors of the economy. Australia's Chief Scientist leads this series with coordination from the Commonwealth Scientific and Industrial Research Organisation (CSIRO). The events dive into the opportunities quantum technologies present to different sectors of the economy. They also create a platform for the Australian quantum industry to deepen connections with potential users and customers. Quantum Meets events help accelerate the translation of quantum technologies into applied solutions that could boost productivity and drive innovation across the economy.

The Quantum Meets series has connected the quantum sector with representatives from the sport, resources, space, energy, finance and biotechnology industries as well as the public service, with more workshops planned in the coming months.

From 2023 to 2025 the Post-Quantum Cryptography in the Indo-Pacific Program will engage with government and industry stakeholders to improve their post-quantum preparedness. The Australian Oceania Cyber Security Centre (OCSC), jointly owned by 8 Victorian universities, manages the program. OCSC is using cybersecurity capacity assessments, independent evaluations, local research, and educational programs to build regional capability.



Challenges

Australia's quantum sector has remarkable potential to contribute to advances in computing, communications, and sensing. However, realising the full potential of quantum technologies will involve responding to a number of challenges.

Tightening capital markets and limited domestic investment continue to impact quantum startups

Emerging technologies need more capital to grow and are inherently risky because of the large up-front capital costs. The limited availability of trusted, patient investment remains a growth barrier for the quantum industry. Inflation and rising interest rates have also resulted in increased costs across all facets of business (e.g. supplies, wages, contractors, licensing fees).

In response to this challenge, the Australian Government has prioritised measures connecting Australian quantum researchers and businesses to potential investors, customers and end users. In addition, the NRF has been established as a potential source of investment.

Intellectual property arrangements remain a challenge for quantum research commercialisation

Intellectual property (IP) arrangements can make commercialising quantum research inefficient. A misalignment between the priorities of research entities to control their IP and the needs of industry to efficiently exploit IP creates friction. To reduce risk of return on investment in commercialising IP, businesses (including spinouts or start-ups from research entities) need certainty of IP ownership and its secure long-term use or exclusivity of IP rights. Inefficient translation and commercialisation of research entities' IP could slow the growth of the quantum technology industry and could put Australia at a competitive disadvantage.

Working with universities to access research expertise and IP can be complex. The Australian Government has developed the Higher Education Research Commercialisation (HERC) IP Framework to facilitate research and commercialisation connections between universities and businesses. The framework provides educational information about IP in university-industry collaborative research, as well as standardised agreement templates to assist in the negotiation process. The government, supported by a Framework Advisory Committee, is currently reviewing the framework to assess how well it's supporting the navigation of IP negotiations between academia and Australian businesses.

Competition in the international quantum market is fierce

Australia is not alone in its ambition to develop domestic quantum capability and capture a share of the global quantum market. Since the launch of the strategy, our international partners and competitors have announced major quantum initiatives and national strategies to support local quantum players and attract overseas investment. Access to finance, collaborators, customers and infrastructure all play into considerations around market attractiveness. Delivering on the ambition of the strategy is crucial to making Australia a more attractive destination to keep local talent and attract the best from around the world.

We need stronger quantum literacy to support the strategy's ambition

Levels of quantum literacy in Australia are low. 73% of Australians have never heard of quantum technology, let alone the benefits it may give. This low level of literacy could slow adoption and development of quantum technologies across the economy and inhibit the growth of the talent pipeline. Stronger understanding of quantum technologies across government, businesses and the public will help ensure Australia is able to fully capture the economic and social benefits. The current low levels of quantum literacy, including across government and business, make it difficult for organisations to make informed decisions about when or how to adopt quantum solutions. Organisations like Quantum Australia, Questacon, CSIRO and SQA are critical to growing literacy and trust in quantum technologies and encouraging adoption of quantum solutions as they become available.



A whole-of-nation approach

Supporting the ambition of the strategy is a whole-of-nation effort requiring collaboration between Australian Government departments and state and territory governments. Since the launch of the strategy the Australian Government and states and territories have been working to leverage investment, avoid duplication and share information to deliver better outcomes for all.

The Australian Government has made quantum a priority

Responsibility for the implementation of the themes and actions in the strategy sits across several Australian Government departments. The Australian Government has a vital role to play as an anchor customer for quantum businesses and the innovations quantum technology could bring. This is because it has the potential to affect both government service delivery and impact aspects of public life that are regulated by a range of portfolios. In recognition of this, the Australian Government has taken an increasingly coordinated approach to quantum technology since the launch of the strategy.

The Australian Government has provided sustained support and funding for quantum technologies for over 20 years, announcing an estimated \$1.4 billion in funding to quantum researchers and firms through grants and procurements. Across Australian Government portfolios, quantum technology is one of the priorities in a range of program and policy initiatives worth around \$7 billion. These investments and commitments shine a light on Australia as a global leader in quantum technologies and the growth of Australia's quantum industry.

Quantum technologies are a priority in several major Australian Government initiatives, including:

National Reconstruction Fund (NRF) Enabling Capabilities Priority Area, which includes quantum among other technologies. NRF priority areas also inform the priorities of a range of other programs, such as the CRC-P, the Industry Growth Program and the Industrial Transformation Research Centres Program.

Advanced Strategic Capability Accelerator (ASCA). The 2024 ongoing Emerging Disruptive Technology program's approach to market aims to accelerate early-stage quantum technologies across quantum sensors, computing and enhanced communications to enhance future defence capabilities.

Australia's Economic Accelerator (AEA). AEA focus areas are designed to provide the Australian research community with clear targets against which to apply their expertise, capacity and talent. Quantum is one of 6 focus areas for the AEA for 2024–25.

The **Department of Industry, Science and Resources (DISR)** is responsible for coordinating delivery of the strategy and several related activities. These activities include managing flagship initiatives such as the government's investment in PsiQuantum, the Critical Technologies Challenge Program and the establishment of Quantum Australia (see Progress for more details on these initiatives).

The Australian Government is continuing to bolster the growth of quantum technologies and build a solid foundation of quantum research and infrastructure. For example, through initiatives such as the **Australian Research Council (ARC)** Linkage and Discovery programs and the National Collaborative Research Infrastructure Strategy (NCRIS), delivered by the **Department of Education**.

As well as the NRF and the AEA, there are other initiatives across government that support research translation and commercialisation, including for quantum technologies. These include the Industry Growth Program, the CRC-P program, the ARC's Industrial Transformation Research Centres Program, and the ARC Industry Fellowships programs. The Australian Space Agency's Moon to Mars initiative takes a more targeted approach, focusing its efforts on harnessing emerging technologies like quantum to accelerate Australia's space capabilities.

The impact of quantum technologies on national security is an ongoing consideration for the Australian government. The **Department of Defence's** ASCA initiative connects and streamlines Defence innovation, science and technology systems, driving capability development and acquisition pathways. One of the first opportunity statements released by ASCA included a focus on quantum technologies. The **Department of Home Affairs** is leading the Australian Cyber Security Strategy, which includes a roadmap to help realise the Australian Government's vision to become a world leader in cyber security by 2030. Its plan of action deals explicitly with the future challenge posed by quantum computing on contemporary cryptography, and the importance of adopting post-quantum cryptographic standards.

Success story: QuantX Labs

QuantX Labs is a world-leader in high-precision timing and quantum sensor technologies. In June 2023, the company received \$3.7 million from the Australian Government's Moon to Mars Demonstrator Grant to develop and demonstrate quantum tech-enabled precision timing reference instruments. These instruments can improve the accuracy of positioning systems such as GPS. They can also improve productivity in critical sectors like agriculture, resources and defence.

In September 2023, QuantX received the SME of the Year award at the Australian Defence Industry Awards. The company has been developing quantum sensors and clocks to support Australian Defence Forces.

Efforts are underway across Australian Government portfolios to grow Australia's quantum workforce. Some notable programs include DISR's Next Generation Quantum Graduates Program, which funds up to 20 PhD scholarships, and the National Quantum Collaboration Initiative to inform future quantum workforce planning. The Global Talent Program managed by the Department of Home Affairs aims to attract skilled migrants with an internationally recognised and exceptional record of outstanding achievement in an eligible field such as quantum technologies. Australian quantum businesses can apply to sponsor a permanent visa to fill skills in short supply by targeting overseas talent.

Australia's science agencies are also building capability and expertise in quantum technologies. The **Commonwealth Scientific and Industrial Research Organisation (CSIRO)** is building capability and expertise in several research fields to play a key role in the emerging global quantum industry. These fields include quantum software and algorithms, devices, simulation and quantum biology.

See [Appendix A](#) for more detail on the federal programs supporting the ambition of the strategy.

States and territories are growing local quantum ecosystems

Since the launch of the strategy in May 2023, state and territory governments have strategically invested and developed initiatives to grow the quantum sector in alignment with the strategy's themes and actions. These investments and initiatives build research capabilities, accelerate and support commercialisation of quantum technologies, develop Australia's quantum workforce and support the growth of Australian quantum businesses.

Major state and territory-led investments and initiatives include:

- the launch of Queensland's Quantum and Advanced Technology Strategy and the investment in PsiQuantum to anchor its first fault tolerant quantum computer in Australia
- support from the Victorian Government to create a quantum diamond foundry
- support from the Australian Capital Territory Government to create a quantum hub
- progress towards the opening of Stage 2 of the Advanced Manufacturing Research Facility in New South Wales.

For a detailed overview of the work happening in states and territories, see [Appendix B](#).

Success story: Quantum Brilliance

Quantum Brilliance specialises in diamond quantum technologies, including compact quantum computing accelerators that operate entirely at room temperature.

In September 2024, Quantum Brilliance announced a major strategic collaboration with Oak Ridge National Laboratory to jointly pioneer hybrid and massively-parallelised quantum computing, including the integration of a cluster of Quantum Brilliance's quantum computers into the Advanced Ecosystem Testbed at the Laboratory's High Performance Computing facility. The Australian Capital Territory Government has supported this partnership through its Priority Investment Program which enabled Quantum Brilliance to establish a pilot production line for their quantum computers in Canberra. This production line will support the additional export of quantum devices to Europe in 2025.

In February 2023, Quantum Brilliance raised \$26 million from investors. These include Breakthrough Victoria, Main Sequence, Investible, Ultratech Capital, MA Financial, Jelix Ventures, Rampersand and CM Equity. This funding helped the company expand overseas and work with new partners – such as Nvidia, to develop a hybrid quantum-classical computing software – and to further the development of quantum diamond materials applicable across diamond quantum technologies.

International

Australia is a partner of choice for international collaboration

Australia has established a global leadership position in quantum technology through partnerships, agreements and activities with likeminded partners. We are a partner of choice for international collaboration, reflected in a growing list of international alliances, partnerships and joint statements of collaboration.

For example, in September 2024 UK-based quantum computing company Quantum Motion announced the establishment of a new quantum lab at Cicada Innovations in Sydney, drawn to Australia by the availability of excellent quantum talent. Shortly after, Canadian firm BTQ technologies announced a strategic research collaboration with Macquarie University to advance quantum algorithms and secure communications.

Fora such as the MDQ and activities under the Joint Statements of Cooperation on Quantum Technology with the United States and United Kingdom have laid the foundation for investment, market access opportunities for our businesses, and greater opportunities for our researchers. Australia also plays a leading role in efforts to ensure appropriate global governance of this nascent technology that is in line with our national interests and values.

Success story: QuintessenceLabs

QuintessenceLabs specialises in quantum cybersecurity technology, advancing protection of sensitive data through quantum random number generation, quantum key distribution, and quantum-resilient cryptography. QuintessenceLabs is Australia's first quantum startup, with a customer base that includes Fortune 500 and equivalent organisations and products deployed to more than 20 countries.

On 30 April 2024, QuintessenceLabs announced a partnership with Carahsoft, a Master Government Aggregator in the United States that delivers IT solutions to government agencies at the federal, state, and local levels. This collaboration bolsters Carahsoft's support for the public sector by equipping it with quantum-safe cybersecurity capabilities it can deliver to clients.

The establishment of the Quantum Development Group helps us promote and protect quantum technologies with like-minded partners

Launched in July 2024, the QDG is a group of high-level government representatives from Australia, Denmark, Finland, France, Germany, Japan, the Republic of Korea, the United Kingdom, and the United States. The group aims to coordinate approaches to promote resilient and reliable supply chains, research and development collaboration, and a quantum future underpinned by shared interests and values. The focus of this group complements the goals set out in the strategy.

The Joint Technical Committee on Quantum Technologies is developing standards to accelerate the development and adoption of quantum technologies

High-quality, industry-led technical standards will support economic growth by improving market access and facilitating international trade and innovation. The Australian Government supports development of quantum technologies standards in industry-led, multistakeholder, consensus-based forums like the International Electrotechnical Commission and International Organisation for Standardisation's Joint Technical Committee 3 (JTC 3).

JTC 3's scope includes quantum information technologies (quantum computing and quantum simulation), quantum metrology, quantum sources, quantum detectors, quantum communications, and fundamental quantum technologies. It will improve coordination, reduce duplication and help make best use of the finite expert resources in Australia and around the globe. Australia's early and ongoing engagement with JTC 3 ensures that Australian quantum expertise, experience and interests are reflected in the international standards development process.

The Quad Investors Network Centre of Excellence in Quantum Information Sciences aims to accelerate investment in critical and emerging technologies

The Quad Investors Network (QUIN) was created to accelerate investment in critical and emerging technologies for the Indo-Pacific region. The QUIN brings together investors, corporations, and public institutions across India, Japan, Australia and the United States to support its mission.

Through collaboration and investment, the QUIN marshals private sector partners to create joint ventures and co-investment into technology opportunities with strategic potential. The QUIN launched their Centre of Excellence in June 2023. The Centre of Excellence aims to link together people and institutions across the Quad countries to promote greater technological collaboration, market access, and cross-border investment.

Next steps

There has been substantial progress and achievement since the launch of the strategy. It will be important to maintain this momentum and continue to work together to deliver on existing initiatives. At the same time, the work to date provides a solid foundation for addressing opportunities in other areas identified as priorities.

Establishing world-class quantum infrastructure

The strategy includes a commitment to a national audit of quantum-related research infrastructure. The audit is underway and is improving our understanding of existing infrastructure and capabilities. It will help identify gaps and infrastructure accessibility issues in Australia and give insights into how to address these. Stakeholders have already indicated that greater access to testbeds, nanofabrication facilities, shared cryogenics, test and evaluation capabilities and specialist engineering advice would support prototyping and manufacture of quantum devices, particularly for early-stage companies. More than 50 existing labs and facilities across the country have capabilities in fabrication, characterisation, testing and more.

Ensuring quantum researchers and businesses have the materials and components they need

The strategy also commits to monitoring supply chain challenges and opportunities facing the quantum sector. The nascency of the sector means supply chains are still developing, and future needs and strengths are hard to predict. By improving our understanding of the sources of key inputs associated with quantum technologies we can begin to prepare for potential future disruptions and shortages. The Australian Government is also working to identify potential export opportunities for Australian producers of components and materials in the growing global market.

Success story: Silicon Quantum Computing

Silicon Quantum Computing is the only company globally that manufactures qubits with atomic precision in silicon. In 2024, SQC provided customer access to its quantum machine learning processors, having built the full software-hardware stack. It has also demonstrated the highest fidelity operation of Grover's algorithm across any quantum computing hardware platform to date.

SQC works closely to build a strong supply chain in Australia working with Silex Systems, who has developed proprietary laser isotope separation technology to produce isotopically pure silicon for commercial applications.

On 17 August 2023, the Quantum Silicon Production Project was launched. Silicon Quantum Computing has partnered with Silex as part of a 3.5-year, \$5.1m project from the Defence Trailblazer program. The project will establish an end-to-end manufacturing facility for ~99.998% isotopically purified silicon creating sovereign capability in this critical resource in Australia.

Growing Australia's quantum workforce

Talent is critical to Australia's competitive advantage in quantum technologies and growth of the Australian quantum ecosystem. We will need more skilled workers to meet anticipated future demand. The growth of the quantum workforce needed to meet even conservative future workforce estimates presents a clear challenge. The Australian quantum industry will hire most of its future employees from a highly competitive STEM job marketplace, which has intense competition from overseas.

There are opportunities to get ahead of the curve and start to build the talent pool for the growth of Australia's future quantum industry at all stages of the STEM pipeline.

Measures of success

As we implement the strategy, the Australian Government will continue to monitor the progress against the listed measures of success. The quantum sector is still emerging, and some indicators have a publication lag time, which presents challenges in collecting data to support ongoing measurement. The Australian Government is identifying and collating available data to measure the quality of outcomes in the strategy. This data supports the benchmarking process, which needs continual improvement and iteration. To set useful targets, we need a full suite of measures of success data on the growth and performance of Australia's quantum industry. Targets will be set for the measures of success following the establishment of all benchmark metrics.

The following table includes available data points, and facts and figures to show, where practicable, progress against the Measures of Success. We expect the data coverage for the measures of success indicators will grow as data becomes available. Note: the table on the following pages presents a mix of metrics we will continue to monitor and point-in-time insights. The metrics shaded grey are point-in-time insights that give further context relevant to the indicators, but which may not form part of our long-term data collection strategy.

As at August 2024 unless otherwise noted

Indicator: Australia is realising the transformational impacts of quantum technologies across finance, healthcare, agriculture, environment, energy, defence, transport, resources, space and other sectors

Since the launch of the strategy, quantum businesses announced 22 new domestic collaborations.*

Advanced Navigation:

- awarded a Moon to Mars Initiative: Demonstrator Mission grant by the Australian Space Agency for their Light Detection, Altimetry and Velocimetry (LiDAV) technology, which seeks to develop advanced navigation technologies, such as quantum sensing
- received a grant from Department of Defence to advance domestic manufacturing capability for photonic chips
- received a Cooperative Research Centres Project (CRC-P) grant through Round 15 in partnership with the University of Technology Sydney and Transparent Earth Geophysics (formerly CMG Operations) to test their LiDAV technology in real world environments on ground vehicles, drones and light aircraft.

Advanced Navigation and Mog Laboratories:

- are involved in the ARC Centre of Excellence in Optical Microcombs for Breakthrough Science to explore optical frequency combs by building on the latest breakthroughs in physics.

Diraq:

- received a CRC-P grant through Round 14 in partnership with the University of NSW Sydney and Perceptia Devices to create a quantum control unit that can integrate with Diraq's quantum logic unit.
- partnered with the University of New South Wales to support an Australian Research Council Industry Laureate Fellowship grant of value \$3.8m plus \$1m from Diraq, led by UNSW Professor Alex Hamilton, to develop hole-based silicon qubits of direct relevance to Diraq's R&D roadmap.
- partnered with the University of New South Wales to support an Australian Research Council Early-Career Industry Fellowship for Dr Nard Dumoulin Stuyck in 2024, related to the development of Diraq's silicon-CMOS-based quantum computing technology.

Diraq and Q-Ctrl:

- are delivering 3 projects together – Diraq will develop its silicon quantum computing hardware and Q-CTRL has integrated its quantum infrastructure software solutions into Diraq’s silicon quantum processors.
 - Two projects are funded by the NSW Office of the Chief Scientist and Engineer’s Quantum Computing Commercialisation Fund.
 - One project funded from the United States Army Research Office.

Q-Ctrl:

- partnered with the Department of Defence to develop quantum sensors for quantum-enhanced positioning and navigation capabilities for military platforms
- received a CRC-P grant through Round 15 in partnership with the Australian National University and Transparent Earth Geophysics (formerly CMG Operations) to build novel technology for airborne gravity surveys.

Q-Ctrl and Silanna Semiconductor:

- are involved in the ARC Centre of Excellence in Quantum Biotechnology to develop quantum technologies to observe biological processes.

Quantum Brilliance:

- received an ARC Linkage grant in partnership with La Trobe University and RMIT University to develop a scalable manufacturing process for diamond quantum technology.

QuintessenceLabs:

- received an ARC Linkage grant in partnership with the University of Newcastle and the University of Sydney to develop quantum key distribution.

Silicon Quantum Computing:

- received an ARC Early Career Industry Fellowship program grant with Dr Sam Gorman in collaboration with UNSW for developing small footprint scalable sensors for the state preparation and measurement of semiconductor spin qubits
- partnered with Silex to establish a \$16 million production plant for purity enriched silicon to provide Australia with a sovereign supply of quantum silicon
- contracted by Transport for NSW to design bespoke quantum hardware solutions that could be used to solve optimisation problems on Sydney’s complex public transport network
- used its quantum machine learning processor to trial new scam and fraud detection approaches with the Commonwealth Bank of Australia
- used its quantum machine learning processor to help Telstra trial new approaches to detect anomalies in network performance.

QuantX Labs:

- awarded a Moon to Mars Initiative: Demonstrator Mission grant by the Australian Space Agency leading a consortium on industry and academic teams in the KAIROS mission, which seeks to build a next-generation atomic clock and place it in orbit
- received an ARC Early Career Industry Fellowship grant for Dr Sarah Scholten for developing a high-performance atomic clock suited for operation on a satellite in collaboration with the University of Adelaide.

* Based on publicly available information

7 Quantum Meets events were hosted by Australia's Chief Scientist, CSIRO and DISR.

Events were hosted with the sports, resources, space, energy, finance and public service sectors.

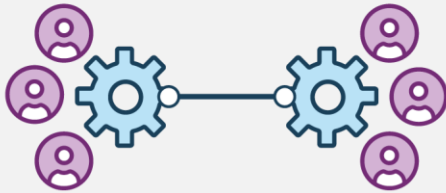
Attendance included:*

- 45 people from 24 quantum businesses
- 95 people from 24 universities and ARC Centres of Excellence
- people from 109 businesses and non-government organisations outside of the quantum sector.

* People and organisations present at multiple events are only counted once

7 Quantum Meets events

Bringing together quantum expertise with end users



Attended by

300 people from
157 organisations

As at November 2024

The Australian quantum industry has 27 suppliers of quantum technology.*

The Sydney Quantum Academy's *National Quantum Industry and Workforce Development Review* (November 2023) reported that 27 Australian businesses self-identified as suppliers of quantum technology:

- 59% were suppliers of quantum computing hardware.
- 59% were suppliers of high-level quantum computing software (quantum algorithms, applications).
- 41% were suppliers of low-level quantum computing software (control, error correction, fault tolerance).
- 30% were suppliers of quantum communications technology.
- 30% were suppliers of quantum cryptography technology.
- 30% were suppliers of quantum sensing technology.
- 26% were suppliers of quantum simulation technology.
- 11% were suppliers of quantum imaging technology.
- 7% were suppliers of quantum metrology technology.

* Some of these suppliers are providing multiple types of quantum technology to industry.

26 suppliers are providing quantum technology to other industries.*

The Sydney Quantum Academy's *National Quantum Industry and Workforce Development Review* (November 2023) noted that 26 suppliers reported providing quantum technology to other industries:

- 46% were suppliers to the science and research sector.
- 35% were suppliers to the information technology sector.
- 31% were suppliers to the defence sector.
- 31% were suppliers to the banking, financial services and insurance sector.
- 23% were suppliers to the energy, resources and utilities sector.
- 23% were suppliers to the education and training sector.
- 19% were suppliers to the government sector.
- 15% were suppliers to the telecommunications sector.
- 15% were suppliers to the health, medical and life sciences sector.
- 15% were suppliers to the automotive sector.
- 15% were suppliers to the aerospace and aviation sector.
- 12% were suppliers to the manufacturing sector.
- 12% were suppliers to the chemicals sector.
- 12% were suppliers to the business services and consulting sector.
- 8% were suppliers to the travel and transportation sector.
- 8% were suppliers to the pharmaceuticals sector.
- 8% were suppliers to the logistics sector.
- 4% were suppliers to the legal sector.
- 4% were suppliers to the construction, infrastructure and real estate sector.
- 4% were suppliers to the agriculture sector.

* Some of these suppliers are providing quantum technology to multiple sectors.

26

quantum businesses



supply quantum technology to **clients in other industries**

As at November 2023

Indicator: Australia has a strong quantum technology industry

38 quantum businesses operate in Australia.

Of these, 14 are Australian businesses with headquarters in Australia, primarily focused on supporting, developing or commercialising quantum technologies:

- Analog Quantum Circuits
- Archer Materials
- Diraq
- Eigensystems
- H-bar
- Luminere Systems
- Mog Laboratories
- Nomad Atomics
- Q-Ctrl
- Quantum Brilliance
- QuantX Labs
- QuintessenceLabs
- Redback Systems
- Silicon Quantum Computing.

There are also 11 Australian businesses with headquarters in Australia, involved in the quantum technologies industry but it is not their core business:

- Advanced Navigation
- Aqacia
- Elemental Instruments
- Jovian Tech
- Liquid Instruments
- Modular Photonics
- Phasor Innovation
- QSpectral Systems
- Senetas
- Silanna Semiconductor
- Silex Systems.

There are 13 foreign-headquartered businesses operating in the Australian quantum industry:

- Amazon Web Services
- Arqit
- D-Wave
- Flawless Photonics
- Google AI
- IBM Quantum
- Infleqtion
- NEC
- PsiQuantum
- QDX Technologies
- Quantum Motion
- Rigetti
- Xanadu.

Since the launch of the strategy, Australian-headquartered quantum businesses received at least \$179.0 m in private investment.*

* As at 07 November 2024, excluding the Australian Government and Queensland Government investment in PsiQuantum. Source: Pitchbook.

There are 26 Australian research organisations focused on quantum technologies including:

6 Centres of Excellence

- ARC Centre of Excellence for Dark Matter Particle Physics
- ARC Centre of Excellence for Engineered Quantum Systems
- ARC Centre of Excellence for Gravitational Wave Discovery
- ARC Centre of Excellence in Optical Microcombs for Breakthrough Science
- ARC Centre of Excellence in Quantum Biotechnology
- ARC Centre of Excellence for Quantum Computation and Communication Technology.

16 Universities

- Australian National University
- Curtin University
- Griffith University
- Macquarie University
- Monash University
- Queensland University of Technology
- Royal Melbourne Institute of Technology University
- Swinburne University of Technology
- University of Adelaide
- University of Melbourne
- University of New South Wales
- University of Queensland
- University of Sydney
- University of Technology Sydney
- University of Western Australia
- University of Wollongong.

4 Government research agencies

- Australian Nuclear Science and Technology Organisation
- Commonwealth Scientific and Industrial Research Organisation
- Defence Science and Technology Group
- National Measurement Institute.

From the release of the National Quantum Strategy to 7 November 2024, the Australian Government, along with State and Territory Governments, announced \$231.8 million in grants, tenders and investment for the quantum sector, not including the investment in PsiQuantum.

In financial year 2021–22, quantum technology firms spent at least \$38.7 million on research and development.

Indicator: Australia remains a leader in quantum research and has established strong pathways to commercialise and industrialise that knowledge

Between 2000 to 2022 quantum technologies patents originating from Australia included:

- **1474 applications** filed globally since 2000
- **384 patent families** filed globally since 2000.

Australia ranks highly in patent filing in quantum technologies

From 2000 to 2022:

- Australia ranked 13th as a source of quantum sensing patents
- Australia ranked 9th as a destination of quantum sensing patents
- Australia ranked 12th as a source of quantum computing patents
- Australia ranked 8th as a destination of quantum computing patents
- Australia ranked 22nd as a source of quantum communication patents
- Australia ranked 9th as a destination of quantum communication patents
- Australia ranked 14th as a source of quantum application patents
- Australia ranked 9th as a destination of quantum application patents.

Australia is ranked 11th among OECD countries across 2018 to 2022 for number of scholarly papers in quantum physics, and ranked 6th for citation impact.

Australia's share of publications cited in patent applications compared to the OECD average expressed as a percentage is 127%.

Indicator: Australia has high quantum literacy, leading businesses to identify and generate broad use cases and attracting talent into career paths at early stages

In May 2024, a representative sample of the Australian public was surveyed to gauge attitude and awareness towards quantum technologies, working in the quantum industry, and undertaking training or study relevant to working in a quantum company.*

- 27% of Australians have heard of quantum technologies.
- 13% of Australians claim to have very little knowledge about quantum technologies.
- 8% of Australians claim to have some knowledge about quantum technologies.
- 2% of Australians claim to have quite a bit / expert knowledge of quantum technologies.

* Survey responses were weighted to ensure the representation of state, age group and gender matched Australian demographics.

73% of Australians* working in technical fields would definitely, or probably, consider working at a business involved in the quantum industry in a role that matches their skills, compared to 52% across all fields.

Out of those who said they would not consider working in the quantum industry:

- 52% said not interested / not relevant to my kind of work / not my area of interest / happy with my current job / not thinking of changing jobs
- 28% said lack of skills / expertise / qualifications / knowledge / experience in the field
- 13% said not a tech savvy person / too hard / not smart / clever enough
- 6% said lack of trust in quantum technologies.

* Survey responses were weighted to ensure the representation of state, age group and gender matched Australian demographics

39% of Australians* would definitely, or probably, consider studying or training in a field where they could work for a quantum business.

Out of those who said they would not consider studying or training relevant to working in a quantum company:

- 77% said they are not in the workforce, and/or are not looking to change the industry they work in
- 19% said they do not have time to do training / study, and/or do not have ready access to training / study where they live
- 11% said they would need to know what the benefits of training / study would be
- 5% said they doubt they would need further training / study.

Note that some respondents stated more than one reason.

* Survey responses were weighted to ensure the representation of state, age group and gender matched Australian demographics.

Indicator: The quantum industry is supported by mature talent pipelines through the secondary, VET and tertiary sectors; adjacent industries; overseas, where Australia is a destination of choice for talent

In 2023, 67 quantum PhD theses were published in Australia.

Based on theses in the Australian National Library's Trove database with quantum as a keyword in the subject.

In 2023, 78,214 university degrees were completed in the fields of Natural and Physical Sciences, Information Technology, and Engineering and Related Technologies.

Including:

- 5,365 postgraduate by research degrees
- 21,359 postgraduate by coursework degrees
- 45,774 Bachelor degrees
- 5,716 other undergraduate degrees.

390,856 university degrees were being studied in the fields of Natural and Physical Sciences, Information Technology, and Engineering and Related Technologies in 2023.

Including:

- 29,185 postgraduate by research degrees
- 86,122 postgraduate by coursework degrees
- 257,510 Bachelor degrees
- 18,039 other undergraduate degrees.

158,392 university degrees were commenced in the fields of Natural and Physical Sciences, Information Technology, and Engineering and Related Technologies in 2023.

Including:

- 6,499 postgraduate by research degrees
- 49,576 postgraduate by coursework degrees
- 90,215 Bachelor degrees
- 12,102 other undergraduate degrees.

63,360 domestic students applied to study an undergraduate university degree in the fields of Natural and Physical Sciences, Information Technology, and Engineering and Related Technologies in 2021.*

- 58,486 students received an offer in these fields.
- 41,114 students accepted an offer in these fields.

* Students studying in multiple out of a) Physical and Natural Sciences, b) Information Technology and c) Engineering and Related Technologies, are counted multiple times.

Australia has 8 specialised quantum technology university degrees:

- Adelaide University
 - Master of Materials Engineering (Quantum)
- Australian National University
 - Master of Quantum Technology
- University of New South Wales
 - Bachelor of Engineering (Honours) (Quantum Engineering)
- University of Queensland
 - Master of Quantum Technology
- University of Technology Sydney
 - Bachelor of Advanced Science (Quantum Technology)
 - Bachelor of Computing Science (Honours) (Quantum Information Sciences)
- University of Western Australia
 - Bachelor of Advanced Computer Science (Honours) (Quantum Computing)
 - Master of Physics (Quantum Technology and Computing)

24 Australian universities are teaching quantum subjects:

- Australian National University
- Curtin University
- Flinders University
- Griffith University
- James Cook University
- Macquarie University
- Monash University
- Queensland University of Technology
- Royal Melbourne Institute of Technology University
- Swinburne University of Technology
- University of Adelaide
- University of Melbourne
- University of New England
- University of Newcastle
- University of New South Wales
- University of Queensland
- University of South Australia
- University of Southern Queensland
- University of Sydney
- University of Tasmania
- University of Technology Sydney
- University of Western Australia
- University of Wollongong
- Western Sydney University



390,856 students were enrolled in quantum and quantum-related university degrees* in 2023

This includes:



158,392
new students



78,214
completed Degrees

* Natural and physical sciences, information technology, and engineering and related technologies

Indicator: Australian quantum researchers and businesses can access the infrastructure, manufacturing and materials to advance and grow their field

There are currently at least 53 facilities and laboratories relevant to quantum technology research and development in Australia.

These include:

- Photonics systems
- Nano/micro fabrication facilities
- Characterisation infrastructure
- High performance computing capability
- Thermal systems
- Benchmarking, testing and simulation facilities
- Electronic systems

Indicator: Australia is recognised as an international leader in quantum technologies and has deep relationships with key partners, enabling the transfer of knowledge, capital and business

Australia has established 5 quantum-related international arrangements:

- Joint Statement of the United States of America and Australia on Cooperation in Quantum Science and Technology
- Joint Statement of the United Kingdom and Australia in Cooperation in Quantum Technologies
- UK-Australia Cyber and Critical Technology Partnership
- Australia-Denmark Strategic Partnership Agreement
- Australia–United Kingdom–United States Partnership (AUKUS) Quantum Arrangement (AQuA)

Australia is also participating in international quantum groups, including:

- International Electrotechnical Commission and International Organization for Standardization Joint Technical Committee 3 – Quantum Technologies
- OECD Global Forum on Technology (GFTech)
- Quad Leaders Critical and Emerging Technology Track Working Group
- Multilateral Dialogue on Quantum (MDQ)
- Quantum Development Group (QDG)
- NATO Transatlantic Quantum Community (TQC)
- World Economic Forum (WEF) Quantum Economy Network

At least 19 new international collaborations involving Australian quantum businesses since the launch of the strategy:

- Q-Ctrl and Qatar's Hamad Bin Khalifa University have partnered on building the next generation quantum workforce.
- Q-Ctrl has been awarded a grant by the United Kingdom's Small Business Research Initiative Quantum Catalyst Fund Competition to deliver quantum-hardware-optimised algorithmic solvers to the Department for Transport and Network Rail.
- Q-Ctrl has partnered with the United States Geological Survey to explore quantum computing and quantum sensing applications for geological sciences.
- Q-Ctrl has partnered with Oxford Quantum Circuits in the United Kingdom to improve the performance of quantum algorithms and integrated Q-CTRL's performance-management software into Oxford Quantum Circuits Cloud QCaaS devices.
- Q-Ctrl announced a partnership with the Indian state of Tamil Nadu to kickstart quantum education in the state.
- Quantum Brilliance has partnered with the Hartree Centre in the United Kingdom to integrate quantum accelerators with high-performance computing.
- QuantX Labs has partnered with Surrey Satellite Technology Limited in the United Kingdom, combining the next-generation optical atomic clock technology with advanced satellite engineering for the Moon to Mars KAIROS mission.
- Advanced Navigation has signed an MoU with Hanwha Defence Australia and Hanwha Aerospace to propel military navigation technology forward.
- QuintessenceLabs has deployed its Trusted Security Foundation key and policy manager appliance in Equinix's International Business Exchange data centre to help organisations strengthen their defences against the cryptographic threats posed by quantum computing.
- QuintessenceLabs has partnered with Italy's Sysnet Telematica to implement quantum-proof solutions for Sysnet's security and control products.
- QuintessenceLabs has partnered with API3 on quantum random number generation.
- QuintessenceLabs has partnered with Singapore's ST Engineering to develop quantum-resilient solutions for infrastructure and communications platforms.
- QuintessenceLabs has partnered with Carahsoft Technology Corp. in the United States to help the public sector build a quantum-resilient security posture.
- Pawsey Supercomputing Research Centre announced it will deploy Nvidia's CUDA Quantum computing platform at its National Supercomputing and Quantum Computing Innovation Hub to study quantum machine learning, chemistry simulations, and image processing for radio astronomy.
- Quantum Brilliance has announced a strategic collaboration with Oak Ridge National Laboratory in the United States. This will see Quantum Brilliance's quantum cluster integrated into Oak Ridge's high-powered computing facility.
- Quantum Brilliance, in collaboration with ParityQC, has been awarded a contract from the German government to develop the world's first mobile quantum computer by 2027.
- India's Visvesvaraya Technological University will begin to integrate reconfigurable instrumentation from Liquid Instruments into its engineering education curriculum.
- Diraq has partnered with imec in Europe, the world's largest silicon chip R&D foundry, to demonstrate the highest accuracy silicon qubit device ever manufactured using standard 300mm wafer-scale manufacturing.
- Diraq has partnered with GlobalFoundries (GF) in the USA to design an integrated circuit that combines Diraq's spin qubit technology with GF's 22FDX transistor technology, providing a pathway to quantum processor chips containing millions of qubits.

78 active quantum ARC grants with international collaborations.

On 1 August 2024 there were 78 quantum-related ARC grants with international collaborations, across 25 countries, including 24 ARC grants started in 2024:

- 50 collaborations with the United States
- 30 collaborations with Germany
- 23 collaborations with the United Kingdom
- 18 collaborations with Japan
- 16 collaborations with France
- 14 collaborations with Canada
- 12 collaborations with Switzerland
- 10 collaborations with the Netherlands
- 9 collaborations with Italy
- 8 collaborations with Austria
- 8 collaborations with Denmark
- 8 collaborations with Singapore
- 6 collaborations with China
- 5 collaborations with New Zealand
- 5 collaborations with Sweden
- 4 collaborations with Belgium
- 4 collaborations with the Republic of Korea
- 3 collaborations with Poland
- 3 collaborations with Spain
- 2 collaborations with the Czech Republic
- 1 collaboration with Brazil
- 1 collaboration with Finland
- 1 collaboration with India
- 1 collaboration with Russia
- 1 collaboration with South Africa.

78

active quantum-related Australian Research Council grants



with international research collaborations across **25 countries**

As at August 2024

Indicator: Australia’s approach to quantum technologies supports national interests, is inclusive and aligns to Australian values

In May 2024, a representative sample of the Australian public was surveyed to gauge their attitudes towards quantum technologies.*

Sentiment about quantum technologies:

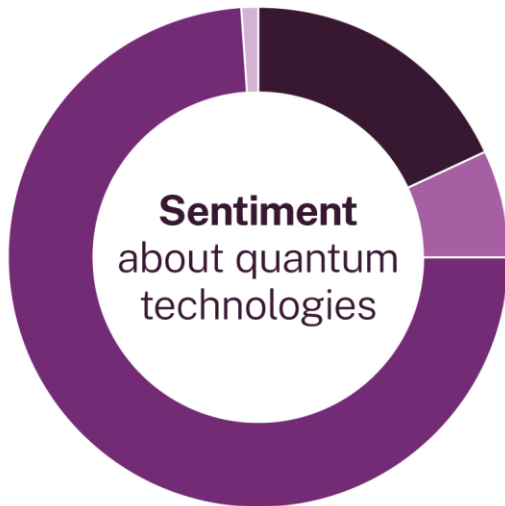
- 74% of Australians said they don’t know how they feel about quantum technologies.
- 18% of Australians have a positive sentiment towards quantum technologies.
- 7% of Australians have a neutral sentiment.
- 0.7% of Australians have a negative sentiment towards quantum technologies.

Trust in quantum technology development:

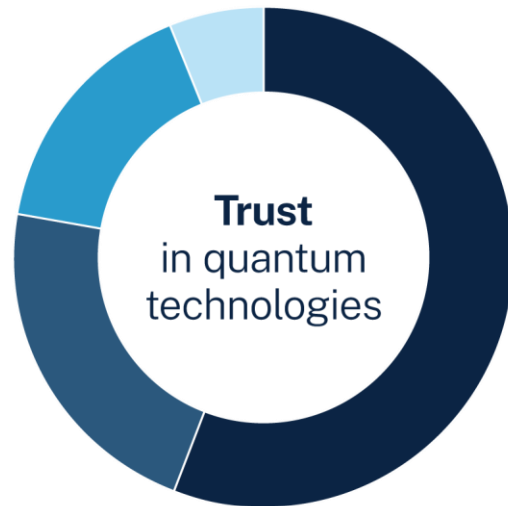
- 56% of Australians completely trust or somewhat trust developments in quantum technology.
- 6% of Australians completely distrust or somewhat distrust developments in quantum technology.

* Survey responses were weighted to ensure the representation of state, age group and gender matched Australian demographics.

Australians’ feelings toward quantum technologies



18% positive 7% neutral
74% unsure 0.7% negative



56% trust 22% neutral
16% unsure 6% distrust

Based on a May 2024 survey of a representative sample of the Australian public

In May 2024, a representative sample of the Australian public was surveyed to gauge how much they trust various sources of information about quantum technologies.*

Scientists scored 1st out of 12 sources:

- 82% of Australians trust completely or somewhat trust scientists as a source of information about quantum technologies.
- 4% of Australians distrust completely or somewhat distrust scientists as a source of information about quantum technologies.

Independent government research agencies scored 2nd out of 12 sources, and scored slightly higher than academic publications:

- 75% of Australians trust completely or somewhat trust independent government research agencies as a source of information about quantum technologies.
- 7% distrust completely or somewhat distrust independent government research agencies as a source of information about quantum technologies.

* Survey responses were weighted to ensure the representation of state, age group and gender matched Australian demographics.

Trusted sources of information on quantum technologies



Scientists

trusted by

82%



**Government
research agencies**

trusted by

75%



Universities

trusted by

71%

Based on a May 2024 survey of a representative sample of the Australian public

Strategy themes and actions

The strategy has 5 themes each with a set of 13 actions to progress over 7 years. These actions position Australia for success and guide achieving the vision set out in the strategy.

THEME 1	Thriving research and development, investment in and use of quantum technologies.
Action 1.1	Design new programs to incentivise the continued growth of quantum use cases in sensing, communications, and computing. The goal of these programs should be to fast-track projects using quantum and other advanced technologies to solve significant national challenges.
Progress to date	<p>Round one applications opened for the \$36 million Critical Technologies Challenge Program in May 2024. The CTCP fosters collaboration between Australia’s quantum businesses, researchers and end-users to develop innovative solutions to the first set of nationally significant challenges:</p> <ul style="list-style-type: none"> • optimising the performance, sustainability and security of energy networks • improving medical imaging and medical sensors to support diagnosis, treatment of disease and monitoring activities inside the human body • enhancing communication with autonomous systems in varying environments • optimising and reducing the impact of resource exploration, extraction, and mineral processing.
Action 1.2	Support initiatives to drive ecosystem growth, support commercialisation and enhance domestic and international links with strategic partners. The government will seek out and support initiatives involving consortiums of universities, quantum companies and industry translating quantum research into commercial outcomes.
Progress to date	<p>On 27 April 2024, the University of Sydney was announced as the successful grantee under the Australian Centre for Quantum Growth Program. The new national centre, Quantum Australia will help the Australian quantum industry by:</p> <ul style="list-style-type: none"> • supporting the adoption, development and commercialisation of quantum technologies and fostering collaborative research and development to encourage innovation • building connections and promoting collaborations across industry, research and government in the quantum ecosystem, both nationally and internationally • increasing awareness and educating industries across the broader economy and society of the implications and opportunities of emerging quantum technologies • supporting the responsible and inclusive development of quantum technology in Australia.

THEME 1 **Thriving research and development, investment in and use of quantum technologies.**

Action 1.3 Grow a pipeline of quantum companies and technologies for potential future investment through the \$15 billion National Reconstruction Fund, with a minimum \$1 billion earmarked for investment in critical technologies.

Progress to date The National Reconstruction Fund Corporation (NRFC) was established on 18 September 2023 by the *National Reconstruction Fund Corporation Act 2023*. The NRFC supports 7 priority areas of the Australian economy.

The Industry Growth Program opened on 27 November 2023. The program supports Small and Medium Enterprises to carry out commercialisation or growth projects that build Australian capabilities in priority areas for the National Reconstruction Fund.

THEME 2 **Securing access to essential quantum infrastructure and materials**

Action 2.1 Conduct a national audit of quantum-related infrastructure enabling quantum research. The audit will identify capability gaps and areas for dedicated investment, including access to quantum computing capabilities.

Progress to date Work on this action is in progress

Action 2.2 Actively monitor supply chain challenges and opportunities affecting Australia’s quantum industries and move to address these wherever possible.

Progress to date Work on this action is in progress

THEME 3 **A skilled and growing quantum workforce**

Action 3.1 Deliver the National Quantum Collaboration Initiative and quantum technology talent PhD scholarships, to lay the foundations for a nation-wide model for academic collaboration.

Progress to date The National Quantum Collaboration Initiative report has been delivered

Action 3.2 Release a quantum workforce report, including modelling to identify workforce and educational needs for our quantum sector and adjacent industries. The report will include skills taxonomies for quantum professionals and other adjacent occupations.

Progress to date Work on this action is in progress

THEME 3 A skilled and growing quantum workforce

Action 3.3 Integrate quantum science into programs growing STEM awareness in schools, universities and VET, in collaboration with federal, state and territory education bodies. This will strengthen pathways and promote uptake into quantum and adjacent careers and will include initiatives to lift the participation of women, Aboriginal and Torres Strait Islander people and other underrepresented groups.

Progress to date Work on this action is in progress

Action 3.4 Explore measures to attract global quantum talent and position Australia as a top destination to build a thriving quantum career. This includes actively promoting Australia as a destination for professionals in quantum and adjacent industries, including through targeted incentives, skilled migration and talent attraction programs.

Progress to date Work on this action is in progress

THEME 4 Standards and frameworks that support national interests

Action 4.1 Work across government to ensure that regulatory measures and frameworks are fit for purpose to maximise opportunities and manage risks while protecting Australia's national interests.

Progress to date Ongoing engagement and collaboration between the Australian Government and state and territory governments

Action 4.2 Explore options to strengthen collaboration and opportunity for industry with our established partners through existing arrangements and potential partnership arrangements, including AUKUS, the Quad, and other regional and special bilateral agreements.

Identify and consider opportunities to grow Australia's regional leadership through collaborative programs of research, science diplomacy and provisioning access to infrastructure.

Progress to date

- Establishment of the Quantum Development Group
- Joint Statement of Collaboration with the United Kingdom
- Multilateral Dialogue on Quantum meeting
- Establishment of the Quad Investors Network
- Developments in the Quad and AUKUS Pillar II contexts

THEME 5 **A trusted, ethical and inclusive quantum ecosystem**

Action 5.1 Work with industry, academia and states and territories to develop principles to support the responsible and inclusive development and use of quantum technologies.

Progress to date Work on this action is in progress

Action 5.2 Ensure that Australia is actively represented in international quantum standards-setting bodies. Continue to work with industry to boost participation in international quantum standards development.

Progress to date Establishment of the Joint Technical Committee on Standards

Appendix A: Support for quantum across the Australian Government

The Australian Government has given sustained support and funding for quantum technologies for over 20 years. The Government is progressing the ambition of the strategy across multiple portfolios, with a range of activities supporting investment, connection and growth in Australia's quantum ecosystem.

The **Australian Research Council (ARC)** bolsters the growth of quantum technologies through its Linkage and Discovery programs. In 2023, the ARC announced the following will each receive \$35 million:

- Centre of Excellence QUBIC
- Centre of Excellence in Optical Microcombs for Breakthrough Science.

Other ARC Centres of Excellence focused on quantum or related fields include:

- gravitational wave discovery
- dark matter particle physics
- engineered quantum systems
- quantum computation and communication technology
- future low energy electronics technologies
- nanoscale biophotonics
- exciton science.

The ARC also awarded the following Industry Laureate Fellowships to:

- Scientia Professor Alexander Hamilton of the University of New South Wales for his project 'Unleashing the combined power of electrons and holes in quantum computing'
- Professor Andrea Morello of the University of New South Wales for his project 'Establishing practical quantum information in higher dimensions'.

Starting in 2024, \$29.8 million is dedicated to funding 6 Industrial Transformation Training Centres under the ARC's Industrial Transformation Research Program to encourage close connections and collaboration between university-based researchers and industry. Two Industrial Transformation Training Centres will be dedicated to quantum technologies to develop research capability for the future quantum workforce to advance solutions relevant to the Industrial Transformation Priorities:

- future leaders in quantum computing at the University of Sydney
- current and emergent quantum technologies at the University of Adelaide.

The **Australian Trade and Investment Commission (Austrade)** promotes Australia as a prime destination for international investors and connects Australian quantum businesses with global markets. It leads initiatives such as the Landing Pads program which provides market-ready scaleups with an operational base and customised support for overseas expansion. It also offers Australian businesses with market insights, expansion strategies and introductions to networks and venture capital. The Export Market Development program offers funding up to \$770,000 to support Australian small-to-medium sized enterprises (SMEs), including quantum startups, to help export in international markets.

The Department of Defence (Defence) leads the \$3.4 billion Advanced Strategic Capability Accelerator (ASCA) to accelerate delivery of capability to Australia's Defence Force. Through its programs, Defence partners with businesses and researchers to co-design projects to transform Australia's defence innovation ecosystem and create advanced technologies for national security.

Quantum technologies play a vital role in the defence innovation ecosystem and enable a distributed network of quantum computers, communications, and sensing technology. In November 2023, ASCA called for industry and academia round one submissions as part of the Emerging Disruptive Technologies program. This round will focus on the science and technology outlook from the Defence innovation, science and technology priorities. Chosen partners have been invited to co-design work packages with Defence.

In July 2023, Defence announced a partnership with the Australian quantum company Q-CTRL to develop quantum sensors to improve positioning and navigation capabilities. The partnership shows the important connection the Australian quantum industry has with government and highlights our capacity to translate research into real world applications.

The Department of Education (Education) has helped build a solid foundation of quantum technologies research and infrastructure to ensure Australia remains competitive in a rapidly advancing field.

In October 2023, Education announced funding of \$47 million to the Australian National Fabrication Facility. This included \$4.5 million specifically to create cutting edge fabrication facilities to prototype quantum devices. The funding is part of the National Collaborative Research Infrastructure Strategy (NCRIS), which delivers open access to infrastructure for the research sector. Education also gave \$5 million in funding to the Pawsey Supercomputing Centre to support high-performance computing resources for quantum simulations and data analysis in quantum research.

In July 2024, the Australian Government announced \$180 million in funding through the first round of Australia's Economic Accelerator (AEA) grants. The AEA is a \$1.6 billion Australian Government program to support the translation and commercialisation of research in areas of national priority for the economy. The AEA's initial 6 focus areas include quantum technologies.

The **Department of Home Affairs** (Home Affairs) manages immigration policies and programs such as the Global Talent Program. This program aims to attract skilled migrants with an internationally recognised and exceptional record of outstanding achievement in an eligible field such as quantum technologies. Australian quantum businesses can apply to sponsor a permanent visa to fill skills in short supply by targeting overseas talent.

Home Affairs also leads the Australian Cyber Security Strategy. This Strategy includes a roadmap to help realise the Australian Government's vision to become a world leader in cyber security by 2030. Its Plan of Action deals explicitly with the future challenge posed by quantum computing on contemporary cryptography, and the importance of adopting post-quantum cryptographic standards.

The Department of Industry, Science and Resources (DISR) has a central role coordinating delivery of the strategy and several strategy related activities, including:

- managing flagship initiatives under the strategy, including the Government's investment in PsiQuantum, the Critical Technologies Challenge Program, and the establishment of Quantum Australia (see Progress for more details on these initiatives)
- taking steps to grow the quantum workforce through the delivery of the Next Generation Quantum Graduates Program, which funds up to 20 PhD scholarships
- funding the National Quantum Collaboration Initiative to inform future quantum workforce planning.

DISR is responsible for a range of other programs and policies that also support the ambition in the strategy including:

- The Industry Growth Program, which provides advice and matched grant funding for small to medium sized businesses and startups to commercialise their ideas and grow their businesses. The program helps to encourage early-stage investment in government identified priority areas such as enabling capabilities.
- The CRC-P program, which supports industry-led research collaborations to develop a product, service, or process that solves industry problems, benefits SMEs and includes education and training activities.
- To support a Future Made in Australia, the Government has invested \$38.2 million over 8 years (plus \$1.3 million per year ongoing) to support a thriving, skilled and diverse STEM workforce. This includes providing more funding to expand existing programs within the Industry and Science portfolio. It responds to the recommendations of the independent Pathway to Diversity in STEM Review released in February 2024.

- The Moon to Mars initiative, managed by the Australian Space Agency. This initiative offers phased investments in Australia's critical tech priorities, such as quantum communications and sensing technologies, using space as an enabler. The \$150 million program will help Australian businesses build capacity to supply products and services into domestic and international space industry supply chains that could support Moon to Mars initiatives. This program has funded projects in optical communications and quantum enabled timing and navigation systems.

As Australia's national science agency, the **CSIRO** is creating capability in several quantum research fields, such as quantum software and algorithms, devices, simulation and quantum biology, quantum machine learning, quantum security, and quantum software, to support the transition of Australia's digital economy to the quantum era. As at August 2024, CSIRO employs around 150 people working on quantum and quantum adjacent technologies.

- The Quantum Technologies Future Science Platform (QT-FSP) has made investments to support initiatives that will build capability across emerging quantum technologies. It has engaged postdoctoral researchers in sensing, communications, algorithms, software, biotech and batteries. The QT-FSP has partnered in the Sydney Quantum Academy's PhD program and jointly hosting quantum events.
- CSIRO hosted the first Australian Quantum Communications Forum in March 2024 and organised the inaugural International Conference on Quantum Energy in December 2023.
- CSIRO has begun new research projects with a focus on understanding the social and ethical considerations associated with developing and deploying quantum technologies. This is essential if Australia is to exploit the full potential of quantum science and develop responsible and transformational technologies that will give a benefit to society.
- CSIRO is assessing the preparedness of Australian industries to adopt and use quantum technologies through a project titled 'Understanding quantum readiness across Australian industry sectors', which will contribute to a responsible and safe quantum ecosystem. The research will also inform the development of future public dialogue by investigating where gaps in knowledge, awareness and preparedness exist for further study.

Whole of Government Quantum Network

To ensure quantum activities are coordinated and complementary, DISR created a Whole of Government Network on Quantum (the network) in late 2023. The network is fostering greater collaboration and is improving quantum literacy in government. The network aims to:

- share information on existing and emerging opportunities and challenges for developing and adopting quantum technologies in Australia
- distribute quantum related information
- identify synergies and collaborate on activities, to reduce duplication of effort and maximise policy and program alignment.

The network includes members from:

- Austrade
- Australian Border Force
- Australian Research Council
- Australian Signals Directorate
- CSIRO
- Department of Agriculture, Fisheries and Forestry
- Department of Defence
- Department of Education
- Department of Finance
- Department of Foreign Affairs and Trade
- Department of Health and Aged Care
- Department of Home Affairs
- Department of Industry, Science and Resources
- Department of Infrastructure, Transport, Regional Development, Communications, and the Arts
- Department of the Prime Minister and Cabinet
- Geoscience Australia
- IP Australia
- National Measurement Institute
- Office of National Intelligence
- Office of the Chief Scientist
- Services Australia
- Treasury.

Appendix B: Building local and national quantum ecosystems

Since the launch of the strategy in May 2023, state and territory governments have made strategic investments and developed initiatives supporting the growth of the quantum sector and alignment with the themes and actions identified in the strategy. These actions help ensure Australia's recognition as a leader of the global quantum industry. They also reinforce quantum technologies are integral to a prosperous, fair, and inclusive Australia.

The Australian Capital Territory, New South Wales, Queensland, South Australian, Victorian, and Western Australian Governments all support the Quantum Australia consortium. Other notable examples of state and territory government support include:

- In October 2023, the Queensland Government released the \$83.7 million Queensland Quantum and Advanced Technologies Strategy. The strategy has 5 key pillars to further develop Queensland's deep science capability, research commercialisation, quantum workforce development, engagement and missions, and investment. In the 2024–25 Queensland Budget, an extra \$6 million was provided for the Queensland Quantum Academy.
 - In June 2024, 5 quantum advanced technologies programs under the Queensland Quantum and Advanced Technologies Strategy were launched, including:
 - Quantum and Advanced Technologies Commercialisation Infrastructure Program for testing and fabrication infrastructure to support prototyping and small batch productions of quantum and advanced technology. Funded projects include:
 - \$7.5 million to Griffith University to expand the Queensland Microtechnology Facility's ability to fabricate power electronics products for industry and kick-start a new compound semiconductor industry in Queensland
 - \$6.3 million to the University of Queensland for the National Advanced Photonics Facility, the first Australian commercial capability in manufacturing and processing nanophotonics and optomechanics
 - \$4 million to CSIRO to enable the advanced packaging of integrated photonic chips, giving Queensland a unique 'design to device' fabrication capability for integrated photonics
 - \$5.9 million to the University of Queensland for the National Quantum Computing Testbed Facility to support development of products for the global quantum computing supply chain
 - \$3.4 million to the University of Southern Queensland for the National Cryogenic Electronics Measurement Facility, an Australian-first industry-accessible cryogenic facility for development of quantum products
 - \$762,825 to the University of Queensland for the Queensland Photon Detector Characterisation Facility, to develop the next generation of visible and near infrared photon detectors for quantum sensing and computing applications, which will be unique in working at room temperature.
 - Quantum and Advanced Technologies Talent Building Program to attract and keep expertise that focuses on ensuring a diverse future workforce.
 - \$3.8 million to fund a total of 88 scholarships, including for Honours, Masters, and PhD students.
 - Quantum Decarbonisation Mission to accelerate the development and application of quantum technologies that contribute to decarbonisation.
 - One \$10 million grant awarded to the University of Queensland for the Queensland Quantum Decarbonisation Alliance.

- Quantum 2032 Challenge to showcase Queensland quantum technologies at the Brisbane 2032 Olympic and Paralympic Games. Funded projects include:
 - \$999,855 to the University of Queensland to develop quantum-enabled low field magnetic resonance imaging for high-performance sport
 - \$594,331 to Griffith University to advance quantum sensors for the ultrasensitive measurement of iron
 - \$999,808 to the University of Queensland to develop low-cost portable quantum magnetoencephalography (MEG) for immediate concussion diagnosis of athletes on the sports field
 - \$832,411 to the University of Southern Queensland to develop hybrid quantum-wearable sensor technology for monitoring and screening youth athletes' movements for injury prevention
 - \$911,110 to the University of Queensland to develop a quantum exo-garment for unrivalled measurement of muscle function in sport
 - \$498,029 to the University of Queensland to develop novel quantum sensors for the identification and detection of chemical and biochemical warfare agents
- Quantum and Advanced Technologies Co-investment Program supporting co-investment in relevant science and translation initiatives. Funded projects include:
 - \$1.08 million co-investment to support the Queensland node of Quantum Australia.
- The Queensland Government, along with the Australian Government, invested \$470 million in equity and loans to jointly fund the PsiQuantum to build a fault tolerant quantum computer in Brisbane.
- In January 2023, the New South Wales Quantum Computing Commercialisation Fund program was announced and gave \$6.8 million in grants to:
 - Diraq to commercialise a cloud accessible 10-qubit quantum computing processor
 - Q-CTRL to build hybrid quantum computing software as a service solution for the financial sector
 - Quantum Brilliance to commercialise their quantum computer emulator software allowing researchers to design and test quantum algorithms on classical computers.
- In May 2024, the New South Wales Government released the Quantum Algorithms and Applications Study. Commissioned by the Office of the New South Wales Chief Scientist and Engineer and authored by Professor Michael Bremner and Associate Professor Simon Devitt from the University of Technology Sydney (UTS), the study explores the potential impact of quantum computing on New South Wales. The study presents a pathway for commercialising a quantum computer, and probable algorithms and use cases for the technology in New South Wales.
- In February 2023, the University of Sydney announced \$7.4 million investment to expand its quantum technology facilities to create the Future Qubit Foundry at the Sydney nanoscience Hub. The facility will use the University of Sydney's research experience in advanced quantum technologies and position it to contribute to the next-generation design of qubits.
- Following \$37 million in investments in quantum businesses through Breakthrough Victoria in 2023, the Victorian Government continues to support the growth of the Melbourne quantum ecosystem. Funding provided through the Industry R&D Infrastructure Fund supports the establishment of a Quantum Diamond Foundry that would focus on creating a world-first certified supply of quantum diamond materials for advanced applications.
- The Australian Capital Territory Government's support has been crucial in the establishment of the Quantum Optical Ground Station at Mt Stromlo. Launched in December 2023, the Quantum Optical Ground Station is a first for Australia. The station is equipped with advanced instrumentation including adaptive optics and quantum technology allowing high performance and enhanced security.

- The Canberra quantum ecosystem continues to be supported by the Australian Capital Territory Government. This is through targeted investments in quantum businesses and capabilities through its Priority Investment Program. Businesses supported include Quantum Brilliance, Nomad Atomics and Liquid Instruments.
- The Australian Capital Territory Government has commenced a co-design process with the sector to develop a quantum hub to strengthen regional expertise, stimulate engagement, and attract focused investment and talent..
- The Western Australian Government supports its local node of Australian National Fabrication Facility based at the University of Western Australia. It undertakes research and innovation in advanced microelectronic, optoelectronic and photonic materials, devices and systems.
- The International Centre for Radio Astronomy Research at the University of Western Australia is demonstrating secure and ultra high-speed communications. This will allow free-space quantum communications such as space-to-ground quantum key distribution. Commercialisation of this research is taking place through a Department of Defence-funded partnership with Electro Optic Systems.

State and territory governments also play an important role in quantum workforce development including:

- Sydney Quantum Academy (SQA) continues to create programs and events to develop a diverse quantum workforce and build Australia’s quantum economy.
 - In November 2023 it released the National Quantum Industry Workforce Development Review sharing insights on Australia’s quantum landscape and skills and workforce needs.
 - The SQA offered the Undergraduate Research Scholarship Program to 38 successful applicants in 2023–24.
 - In February 2024, it hosted the Quantum Australia conference and career fair with record attendance.
- South Australia’s Industry Doctoral Training Centre (IDTC) pilot program and Future Industry Making Fellows Scheme (FIMFS) also support workforce development:
 - Based on the UK Centres of Doctoral Training model, the IDTC pilot program aims to support the translation of research into industry. One of 2 streams of the pilot focusses on the industrial application of quantum technologies, with \$1 million specifically dedicated to this quantum stream.
 - The FIMFS supports early and mid-career researchers of outstanding research calibre with the potential to attract and keep highly skilled research talent to South Australia. In the last year, it awarded a fellowship to an influential quantum thought leader. This fellowship will support working with academia and industry on building sovereign capability in photonics, which has applications in quantum sensing.
- Queensland’s Quantum and Advanced Technology Strategy, and Queensland Quantum Academy both support students in quantum and advanced technology areas.
 - The \$3.81 million Quantum and Advanced Technologies Talent Building Program grants scholarships to build talent in the quantum and advanced technologies ecosystem. It includes targeted funding for underrepresented groups.
 - A further \$6 million is available for establishment of the Queensland Quantum Academy to fund quantum technology-related materials and introduce learning opportunities in schools and TAFE.
- The Quantum Girls project managed by the University of Western Australia addresses skills shortage and gender imbalance in STEM. The project will train female teachers and enrol female students across the nation. Over the last year, Quantum Girls has run events at schools and National Science Week.

Additionally, states and territories have been active in supporting facilities that help technology industries, including quantum.

- The New South Wales Government invested \$3 million in the Advanced Prototype Packaging Facility (APPF). Located at the UTS and the University of Sydney, the APPF will service a range of priority industries, including quantum computing. The APPF will develop commercial grade packaged semiconductor and photonic device prototypes. It includes a suite of tools for prototype packaging development, including testing and qualification capabilities, and cutting across technology platforms.
- The Advanced Manufacturing Research Facility in New South Wales called for first projects in research and development in technologies which need advanced manufacturing techniques. This program supports crucial infrastructure to allow research and development of semiconductors and quantum computing technologies.
- Launched in August 2023, the Semiconductor Sector Service Bureau brings together academics, industry, and officials. The Bureau aims to support and grows the New South Wales and Australian semiconductor sector from devices all the way through to end-user applications.

States and territories also have programs supporting their local venture capital ecosystems, which quantum businesses can access. Examples include:

- The Australian Capital Territory Government announced a new Venture Capital Fund to help innovative small to medium Canberra enterprises including quantum businesses commercialise and scale.
- The Queensland Government's \$130 million Venture Capital Development Fund managed by Queensland Investment Corporation attracted 10 Venture Capital funds. These included deep technology investors Main Sequence Ventures, Antler and Salus Ventures.
- The Western Australian Government's WA Venture Support pilot program builds up Western Australia's venture capital ecosystem, which quantum businesses can access.

Improving national coordination on quantum

Coordination with state and territory governments occurs through the State and Territory Working Group on Quantum. This group brings together economic development agencies from the states and territories and DISR to manage and collaborate on the growth of the national quantum ecosystem.

Agencies represented include:

- The Australian Capital Territory Chief Minister, Treasury and Economic Development Directorate
- The Office of the New South Wales Chief Scientist and Engineer
- The Office of the Queensland Chief Scientist
- The Office of the Victorian Lead Scientist
- The South Australian Department of Trade and Investment
- The Tasmanian Department of State Growth
- The Western Australian Department of Jobs, Tourism, Science and Innovation
- The Northern Territory Department of Industry, Tourism and Trade.