Australian Government
Department of Industry, Science and Resources

Critical Technologies Challenge Program

Round 1 – Stage 1 Feasibility

Applicant Information Package

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The purpose of this publication is to provide information for potential applicants for Round 1 Stage 1 Feasibility of the Critical Technologies Challenge Program.

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Frequently asked questions

Critical Technologies Challenge Program (CTCP) Round 1 Feasibility grant opportunity

The Program

1. How is the CTCP being delivered?

The CTCP is delivered via two rounds, both comprised of two stages. Stage 1 is Feasibility, and Stage 2 is Demonstrator. This document relates to Round 1, Stage 1 Feasibility grants (Feasibility).

Only projects that have completed the CTCP Feasibility stage can progress to CTCP Demonstrator stage.

2. How much grant funding is available?

The Stage 1 Feasibility grant opportunity offers funding of a minimum of $100,000, up to a maximum of $500,000. There is no requirement for matched funding or co-contribution. Up to $5.25 million is available for Feasibility grants.

3. What are the objectives of the CTCP?

The objectives of the CTCP are to:

- build productive collaboration between researchers and businesses by supporting co-designed projects that focus on market-led challenges that can be solved by quantum technologies
- accelerate the commercialisation of quantum technologies by supporting promising projects in the early stages of technological readiness when private investment is difficult to source
- de-risk the adoption of quantum technologies to solve nationally significant challenges across the economy
- foster gender equity and First Nations Peoples' participation in the quantum industry.

4. What are the objectives of the Feasibility grant opportunity?

The objective of the Feasibility grant opportunity (Stage 1 of the program) is to investigate how quantum technologies can provide an innovative solution to a market-led nationally significant challenge, in line with the broader objectives of the program (see Q3).

5. What are the intended outcomes of the Feasibility grant opportunity?

The intended outcomes are to validate the feasibility of the proposed solution for the development of a Demonstrator project, and to expand collaboration networks and partnerships in the quantum sector.

6. How does the CTCP work?

The CTCP will test solutions to market-led challenges of national significance using quantum technologies, potentially in conjunction with other advanced technologies, and accelerate quantum technologies from an early-readiness phase when private capital is hard to secure. Details of each of the available challenges can be found within this Applicant Information Package.

Entities can apply for a competitive grant on behalf of a joint (consortia) collaboration to undertake a Stage 1 Feasibility project in relation to their proposed solution or component(s) that contributes to a solution for a selected challenge. Grantees who have completed a Stage 1 Feasibility project may be invited to apply for a further competitive grant to complete a Stage 2 Demonstrator project.

7. Am I eligible to apply as the lead applicant?

Lead applicants must apply on behalf of a joint (consortia) collaboration.

To be eligible to apply as the lead applicant for a Feasibility grant, you must:

- have an Australian Business Number (ABN)
- be registered for Goods and Services Tax (GST)
- be an entity, incorporated in Australia.

You can find more information on eligibility in section 5 of the Stage 1 Feasibility grant opportunity guidelines.

8. What do lead applicant, joint (consortia) collaboration, project partner and project participants mean?

The Department of Industry, Science and Resources (DISR) can only sign an agreement with one organisation – the **lead applicant**. The lead applicant is the main driver of the project and the primary contact throughout the project.

Joint (consortia) collaborations are a group of two or more entities that have joined together to work on a particular project.

Project partners are eligible entities that work with the lead applicant and are involved in joint (consortia) collaborations but are not the lead applicant for the project. The grant opportunity guidelines specify the types of project partners that must be part of an application, to be eligible for the CTCP.

Project participants are all of the entities involved in joint (consortia) collaborations, including the lead applicant.

9. What requirements do the joint (consortia) collaboration need to meet?

Eligible applications must be on behalf of a joint (consortia) collaboration that contains at least:

- one Australian industry-based partner and
- one Australian research organisation.

Applicants for the Stage 1 Feasibility grant opportunity must include the lead applicant and at least one project partner: 2 project participants in an application as a minimum.

You can find more information on consortia requirements in section 5.2 and 8.2 of the Feasibility grant opportunity guidelines.

10. How long is the Stage 1 Feasibility stage?

The maximum project period for the Stage 1 Feasibility grants is 6 months.

11. Who owns the IP on completion of the project?

Grantees will retain intellectual property rights and the right to sell in domestic and global markets.

12. Are the CTCP grants competitive?

Yes, eligible applications are assessed against the assessment criteria outlined in section 7 of the Stage 1 Feasibility grant opportunity guidelines.

13. Is it essential that all project participants are based in Australia?

Consortia which include international organisations as project partners are welcome to apply. However, the lead applicant must have an Australian Business Number (ABN), be registered for GST and be incorporated in Australia.

Further details on eligibility for consortia and lead applicants is provided in section 5 of the Feasibility grant opportunity guidelines.

The challenges

1. What is a 'challenge' within the CTCP?

Challenges selected for the CTCP are of national significance and have been identified through consultation with industry and quantum experts. They have been approved by the Minister for Industry and Science.

Solutions (or components of solutions) to challenges must involve quantum technologies, potentially in conjunction with other advanced technologies. Details of each of the available challenges can be found within this Applicant Information Package.

2. How many projects will be funded across each challenge?

Funding is available for multiple projects across each of the challenges. However, the exact number of projects funded per challenge will depend on the number of quality applications received, and the amount of eligible expenditure requested by each application.

3. As lead applicant, can I apply for more than one of the challenges?

Yes, you can apply for multiple challenges, **however the lead applicant can only receive grant funding for one challenge in each round**. You will need to complete and submit a separate application for each challenge for which you wish to apply.

4. Can I be a project partner in more than one application for Stage 1 Feasibility funding?

Yes, you can be a project partner in more than one application for Stage 1 Feasibility grant funding.

5. What Technology Readiness Level is required for participation in the CTCP?

Feasibility project proposals with technologies commencing at Technology Readiness Level (TRL) 4 and aiming to achieve TRL 5 are required for Stage 1 of the CTCP.

Demonstrator project proposals with technologies commencing at TRL 5 and aiming to achieve TRL 6 or TRL 7 by the end of Stage 2 Demonstrator are required for Stage 2 of the CTCP.

Further information can be found in section 2.2 of the respective grant opportunity guidelines.

6. If multiple challenge solutions are similar, how will the final list of applications to be funded be determined?

The CTCP Assessment Committee will assess eligible applications against the assessment criteria (section 7 of the grant opportunity guidelines) and against other applications.

The Committee will consider your application on its merits, based on:

- how well it meets the criteria
- how it compares to other applications
- whether it provides value with relevant money.

If applications are scored the same, the Assessment Committee will consider value for money, alignment to the program objectives and distribution of applications across the available challenges to recommend applications for funding.

Further details on the grant selection process for this grant opportunity is provided in section 9 of the Feasibility grant opportunity guidelines.

7. Will further rounds have different challenges?

Selection of challenges for each round of CTCP is at the discretion of the Minister for Industry and Science.

Applications

1. How do I apply?

To apply, you must:

- submit your application through our online portal. (A sample of the application form is available to download at business.gov.au)
- provide all the information that is needed for us to assess your application
- address all eligibility and assessment criteria, ensuring each requirement has been considered
- include all mandatory attachments (templates can be found at business.gov.au.)

See section 8.1 of the Feasibility grant opportunity guidelines for more information on the required documents.

2. How much can I upload with my application?

Attachments are limited to 2MB per document, with a maximum of 20MB per application. Videos are not able to be submitted. We are unable to accept information provided outside of your portal application, unless that information is requested by the Department.

3. Who assesses my application?

DISR will assess whether applications meet the eligibility criteria.

Eligible applications are then assessed by the CTCP Assessment Committee against the assessment criteria as outlined in section 9 of the Stage 1 Feasibility grant opportunity guidelines.

4. Who decides which applications will receive grant funding?

The Program Delegate will decide which grants to approve for funding under the Feasibility grant opportunity, taking into account the recommendations of the CTCP Assessment Committee and the availability of grant funds. The Program Delegate is a Manager within DISR with responsibility for administering the program.

The Minister will decide which grants to approve for funding under the Demonstrator grant opportunity, taking into account the recommendations of the CTCP Assessment Committee and the availability of grant funds.

Further details on the grant selection process are provided in section 9 of the grant opportunity guidelines.

5. After the closing date, what is the timeframe for decisions?

A decision on the awarding of Feasibility grants is expected to take approximately 14 weeks after the closing date for applications. You can find more information on expected timing of grant opportunity processes in section 8.3 of the Stage 1 Feasibility grant opportunity guidelines.

6. Is there an opportunity to get feedback on the application prior to lodgement?

As this is a competitive grant program it is not appropriate for DISR to comment on individual applications prior to lodgement. If you have any questions during the application period, contact us at business.gov.au or by calling 13 28 46.

Delivery

1. When are the grant funds paid?

The approved Feasibility grant amount will be paid on execution of the grant agreement.

You must not commence your project until you execute a grant agreement with the Commonwealth.

You can only spend the grant on eligible expenditure you have incurred on an agreed project as defined in your grant agreement. At the end of the project, the Commonwealth may recover any unacquitted grant funding.

2. How will my project be monitored?

We will monitor the progress of your project by assessing reports you submit in accordance with the grant agreement. We may also conduct site visits to confirm details of your reports if necessary.

You can find more information on how your grant activity is monitored in section 13 of the Stage 1 Feasibility grant opportunity guidelines.

3. What happens if there are any changes during the project?

You should let us know if anything is likely to affect your project or organisation.

We need to know of any key changes to your organisation or its business activities. You must also inform us of any material changes in the circumstances of project participants.

We recognise that unexpected events may affect project progress. In these circumstances, you can request a variation to your grant agreement, including:

- changing project milestones
- extending the timeframe for completing the project but within the maximum 6 month period for Feasibility projects
- changing project activities.

Please note, the program does not allow for an increase of grant funds.

If you want to propose changes to the grant agreement, you must put it in writing before the project end date. We cannot consider changes after the project end date.

4. Where do I find information on the program and stages?

You can find all information about this program within the published grant opportunity guidelines on business.gov.au.

Need more information?

Visit business.gov.au or call 13 28 46.

Challenge 1

Optimise the performance, sustainability, and security of energy networks

Challenge Overview

In the 2022-23 period, the energy sector accounted for approximately 85% of Australia's net emissions, with electricity being a significant contributor, responsible for about one third of that amount. In parallel, the National Electricity Market has acknowledged the rise in electricity prices and anticipates further increases.[1][2]

This challenge aims to leverage quantum technologies to enhance the performance, sustainability, and security of Australia's energy networks. The integration of renewables into new and existing energy networks will also be considered as part of this challenge. Applicants will explore innovative solutions to address the complexity of energy networks and their management. Elements may include but are not limited to increasing efficiency and reliability, emissions reductions, and lowered energy prices. Maintaining high security standards of the network should be an integral feature of any solution.

This involves creating solutions that not only ensure a resilient and efficient energy network but also contribute to reducing overall energy costs for households and businesses, reducing the cost of living for Australians.

What is the relevance of the challenge to industry?

- Management and optimisation of a changing, increasingly decentralised electricity network.[3]
- Supports businesses to meet emission targets and Australia's goals of becoming a renewable energy superpower, while addressing environmental, social and governance related issues.[4]
- Increased security and reliability of critical infrastructure and critical energy supply chains.[5]
- More effective emergency management responses to catastrophic events.
- Reduce associated energy costs.

Please note that the possible solutions and expected benefits listed below are provided as suggestions. Certain suggestions may be more ambitious than others. Applicants should not feel limited to the suggestions listed below and are encouraged to present other innovative solutions which address the challenge.

[1] https://consult.dcceew.gov.au/electricity-and-energy-sector-plan-discussion-paper
[2] https://www.dcceew.gov.au/climate-change/publications/australias-emissions-projections-2023#:~:text=Australia%27s%20emissions%20trends&text=Between%202023%20and%202035%2C%20emissions,82%25%20national%20renewable%20electricity%20target
[3] https://www.energynetworks.com.au/resources/reports/electricity-network-transformation-roadmap-final-report/
[4] https://budget.gov.au/content/factsheets/download/factsheet_clean_energy-20230510.pdf
[5] https://www.cisc.gov.au/legislation-regulation-and-compliance/soci-act-2018#:~:text=Critical%20infrastructure%20is%20interconnected&text=This%20can%20affect%20our%20security,supply%20of%20food%20and%20groceries

Possible solution elements may include:

- **Load balancing** – quantum algorithms to optimise power loads across energy networks.
- **Fault detection and correction** – rapid detection, reporting and correction of faults in energy networks.
- **Security measures** – quantum cryptography or other quantum technologies to enhance cybersecurity.
- **Enhanced timing for synchronisation** – utilises quantum properties to achieve highly precise timing, enabling optimal coordination of events in energy networks.

Expected benefits:

- **Improved energy network efficiency** – optimise load distribution, reduce energy cost, and reduce wastage.
- **Enhanced energy network resilience** – minimise downtime, increased access to energy and improve reliability.
- **Reduction in energy costs** – improved cost of doing business and reduced cost of living.
- **Enhanced integration of renewable energy sources and ability to meet emissions targets in key markets**.

Intended technology end users or customers may include:

- Australian Energy Market Operator (AEMO) - (Western Australia and the Northern Territory are not connected to the National Energy Market)
- Energy providers
- Mining and resources
- Data centres

The policies and strategies listed below are provided for awareness of how this challenge aligns with broader government policy. Applicants do not need to address these policies within their application.

National policies and strategies that align with this challenge include:

National strategy, plan, or policy	Areas of alignment with this challenge
National Reconstruction Fund	Priority 5: Renewables and low emission technologies
Proposed National Science and Research Priorities	Priority 1: Transitioning to a net zero future Priority 5: Building a secure and resilient nation
Critical Technologies Statement	Solving national challenges here in Australia – Emissions reduction
List of Critical Technologies in the National Interest	Quantum technologies Clean energy generation and storage technologies
Net Zero Plan	Electricity and energy Industry
First Nations Clean Energy Strategy	Key priority under the National Energy Transformation Partnership.
National Disaster Risk Reduction Framework	Built environment
Powering Australia	National energy transformation partnership
Australia's Long-Term Emissions Reduction Plan	Achieve net zero emissions by 2050
The 2021 National Research Infrastructure Roadmap	Recycling and clean energy Environment and climate Frontier technologies and modern manufacturing
CSIRO Megatrends	Leaner, cleaner, and greener Adapting to climate change
Critical minerals strategy 2023 – 2030	Use our critical minerals to help Australia become a renewable energy superpower

The programs listed below are provided for awareness. Applicants do not need to address these programs within their application.

National programs that align with this challenge include:

Blue Economy CRC – $70 million (2019–2029)

Future Battery Industries CRC – $25 million (2019–2025)

Future Energy Exports CRC – $40 million (2020–2030)

Heavy Industry Low–carbon Transition (HILT) CRC – $39 million (2021–2031)

Marine Bioproducts CRC – $59 million (2021–2031)

Regional Microgrids Program – renewable energy technologies, energy efficiency technologies and electrification technologies (2023)

International initiatives that align with this challenge include:

Switzerland Geneva Science and Diplomacy Anticipator (GESDA) – The Open Quantum Institute (OQI) three-year CERN-based pilot will build on the efforts to date to help unleash the full power of quantum computing for the benefit of all (2024)

UK Quantum Strategy Mission number 5 – By 2030, mobile, networked quantum sensors will have unlocked new situational awareness capabilities, exploited across critical infrastructure in the transport, telecoms, energy, and defence sectors (2023)

US Advanced Scientific Computing Research – for Research on Quantum Networks (2022)

Challenge 2

Improve medical imaging and medical sensors to support diagnosis, treatment of disease and monitoring activities inside the human body

Challenge Overview

The Australian Institute of Health and Welfare reports that the primary causes of mortality in Australia include coronary heart disease, dementia, and cerebrovascular disease. In 2020–21, 17.8 million (69%) Australians accessed 204.1 million Medicare-subsidised pathology tests, imaging scans and a range of diagnostic services.[6]

Chronic conditions pose a significant health burden, and often require ongoing management that can have a profound impact on individuals' quality of life. New technologies including those that can lead to earlier detection have the potential to reduce the mortality rates for these conditions.

In First Nations communities, where health disparities are more pronounced, these technologies could be instrumental in providing targeted interventions, thus contributing to closing the life expectancy gap between Indigenous and non-Indigenous Australians.[7]

This challenge invites applicants to harness the capabilities of quantum technology to advance the field of medical imaging and sensing. The challenge aims to explore innovative solutions that improve the lives of Australians by enhancing the precision, resolution, speed, contrast capabilities and depth of imaging techniques, thus advancing our understanding of the human body for improved diagnosis and medical treatments.

Applicants are encouraged to develop quantum–based approaches that advance, improve, or surpass classical methods, offering breakthroughs in resolution, sensitivity, and real–time data collection. Areas of interest may include, but are not limited to, the development of technologies that assist in medical diagnoses, molecule identification/interaction, improved sensitivity, and improved timing mechanisms.

What is the relevance of the challenge to industry?

- Reduction in size and cost of medical imaging devices (which are currently prohibitively large).[8]
- Quantum sensors may offer improvements in performance over classical systems.
- Identification of molecules may help improving diagnoses and identification of molecular interactions.
- Development of more sensitive and portable medical imaging devices.
- Increasing accessibility to medical equipment in remote regions.

[6] https://www.aihw.gov.au/reports/diagnostic-services/pathology-imaging-and-other-diagnostic-services
[7] Life expectancy gap - First Nations Closing the Gap
[8] www.aph.gov.au/Parliamentary_Business/Committees/Senate/Community_Affairs/Diagnosticimaging/~/media/Committees/clac_ctte/Diagnosticimaging/Report/report.pdf

Please note that the possible solutions and expected benefits listed below are provided as suggestions. Certain suggestions may be more ambitious than others. Applicants should not feel limited to the suggestions listed below and are encouraged to present other innovative solutions which address the challenge.

Possible solution elements may include:

- **Quantum–enhanced imaging techniques** – improve traditional imaging modalities (e.g., MRI, CT, PET, OPM[9]) with increased resolution, reduced scan time and enhanced contrast.
- **Quantum sensing for biomedical applications** – sensing for biomarker detection, disease monitoring, real time neurological measurements, improving on classical technologies.
- **Real time data processing** – quantum algorithms for rapid data processing and analysis, enabling real time extraction of important information.
- **Sport integrity** – quantum technologies to detect illicit substance and anomalous performances of athletes to ensure fairer practice.
- **Quantum cryptography** – protection of personal data.

Expected benefits:

- **Enhanced medical imaging** – achieve higher resolutions, faster scans, and improved diagnostics.
- **Enhanced disease detection** – improved diagnostic accuracy and precision, enabling earlier disease detection and resulting in reduced strain on the medical system.
- **Real time diagnostics** – enables rapid analysis of imaging and sensing data, for quicker diagnosis and timely decision making.
- **Streamlined imaging practices** – reduce the need for patients to remain still for extended periods during scans, leading to increased accuracy and shorter consultation durations.
- **Improved patient outcomes** – accurate and timely diagnostics, facilitating tailored, well informed treatment plans for improved patient outcomes.
- **Precision medicine applications** – ability to implement medical treatments personalised to individual patients, optimising effectiveness, and minimising side effects.

Intended technology end users or customers may include:

- Medical technology and device developers and manufacturers
- Medical staff and medical service providers
- Sporting clubs, organisations and official governing bodies

The policies and strategies listed below are provided for awareness of how this challenge aligns with broader government policy. Applicants do not need to address these policies within their application.

[9] Brookes, M.J., Leggett, J., Rea, M., Hill, R.M., Holmes, N., Boto, E. and Bowtell, R., 2022. Magnetoencephalography with optically pumped magnetometers (OPM-MEG): the next generation of functional neuroimaging. Trends in Neurosciences

National policies and strategies that align with this challenge include:

National strategy, plan, or policy	Areas of alignment with this challenge
National Reconstruction Fund Priorities	Priority 4: Medical science Priority 6: Enabling capabilities
Proposed National Science and Research Priorities	Priority 2: Supporting healthy and thriving communities
Critical Technologies Statement	Solving national challenges here in Australia – Health ageing
List of Critical Technologies in the National Interest	Biotechnologies Quantum technologies
CSIRO Megatrends	The escalating health imperative
The 2021 National Research Infrastructure Roadmap	Medical products Frontier technologies and modern manufacturing
Closing the Gap	Target 1- Everyone enjoys long and healthy lives Target 2 – Children are born healthy and strong

The programs listed below are provided for awareness. Applicants do not need to address these programs within the application.

National programs that align with this challenge include:

Advanced Manufacturing Growth Fund grant recipients – Core Technology Imaging Systems Manufacture

Research and Development Tax Incentive (R&DTI) – BluGlass gallium nitride (GaN) laser diode manufacturer (2009)

ARC Centre of Excellence for Nanoscale Bio Photonics – $29 million – This will explore nanoscale interactions between light and matter (2014–2020)

Digital Health CRC – $55 million (2018–2025)

CRC Projects selection round outcomes – Nanoparticle manufacturing and its application in brain cancer radiotherapy (2022)

Frontier Health and Medical Research Initiative – Opportunities for funding through Medical Research Future Fund (2022)CRC Projects selection round outcomes – AI-based Portable Digital Slit-lamp for Anterior Segment Eye Diseases (2023)

CRC Projects selection round outcomes – EDGy: Developing High–performing Satellite Control System Stellar Gyros – Gilmour Space Technologies Pty Ltd (2023)

International initiatives that align with this challenge include:

Canada[10] Internet of Things: Quantum Sensors (2021)

- Advanced quantum sensor for reliable adult neuromonitoring
- Photons in the brain: Imaging biophotons with quantum detectors
- Quantum bio–sensing for next generation health diagnostics.

Switzerland Geneva Science and Diplomacy Anticipator (GESDA) – The Open Quantum Institute (OQI) three-year CERN-based pilot will build on the efforts to date to help unleash the full power of quantum computing for the benefit of all (2024)

UK Using optically pumped magnetometers (OPMs) and magnetoencephalography (MEG) to create wearable brain scanner OPM–MEG system to improve epilepsy diagnosis and treatment (2023)

UK Quantum Strategy Mission number 3 – By 2030, every NHS Trust will benefit from quantum sensing-enabled solutions, helping those with chronic illness live healthier, longer lives through early diagnosis and treatment (2023)

UK Quantum Strategy Mission number 5 – By 2030, mobile, networked quantum sensors will have unlocked new situational awareness capabilities, exploited across critical infrastructure in the transport, telecoms, energy, and defence sectors (2023)

US Quantum Sensing Challenges for Transformational Advances in Quantum Systems (2022)

[10] https://nrc.canada.ca/en/research-development/research-collaboration/programs/funded-collaborative-rd-programs-initiatives

Challenge 3

Enhance communication with autonomous systems in varying environments

Challenge Overview

Australia has a strong telecommunications sector, evidenced by its $30 billion Internet of Things industry and its photonics sector that contributes $4.3 billion annually.[11] Australia also leverages autonomous systems across key sectors such as agriculture, healthcare, and mining, with these technologies predicted to contribute $19 trillion globally from 2020 to 2030. Such advancements could significantly enhance workforce productivity, particularly in regional areas, by up to 50%.[12]

The development of solutions that can operate in GPS/GNSS denied environments is becoming increasingly crucial. These solutions are vital for ensuring continuous operation and resilience across various industries, where traditional communication signals may be compromised or unavailable.

This challenge aims to explore innovative approaches for enhancing communication with autonomous systems operating in both GPS/GNSS –connected and GPS/GNSS denied environments. Applicants will develop robust communications solutions that ensure seamless interaction and data exchange between autonomous systems and their surroundings. Emphasis should be placed on enhancing connectivity, adaptability, resilience in diverse environmental conditions and advancing the capabilities of autonomous systems in real–world scenarios. Applicants are not limited to earth–based technologies and are welcomed to leverage sensing technology that could be deployed on satellites.

What is the relevance of the challenge to industry?

- Simplified navigation of autonomous vehicles in GPS/GNSS–connected and GPS/GNSS–denied environments.
- Improvements in personnel and equipment safety and tracking.
- Increased productivity in existing sectors.
- More accurate and stable asset and personnel tracking.
- Monitoring essential services such as electricity supply and transportation.

Please note that the possible solutions and expected benefits listed below are provided as suggestions. Certain suggestions may be more ambitious than others. Applicants should not feel limited to the suggestions listed below and are encouraged to present other innovative solutions which address the challenge.

[11] https://www.industry.gov.au/publications/list-critical-technologies-national-interest/advanced-information-and-communication-technologies
[12] https://www.industry.gov.au/publications/list-critical-technologies-national-interest/autonomous-systems-robotics-positioning-timing-and-sensing

Possible solution elements may include:

- **Quantum enhanced vehicle to vehicle communication** – improved efficiency, security, and reliability, ensuring connectivity even in GPS–denied environments.
- **Precision asset tracking** – enhanced precision and accuracy in the tracking of autonomous systems, encompassing real–time location monitoring, predictive maintenance, and fleet management, particularly in areas with limited (or no) GPS/GNSS availability.
- **Security and privacy measures** – improved ability to address security and privacy concerns associated with autonomous systems including communication and tracking, ensuring data integrity, confidentiality, and security of interactions.
- **Improved unmanned coordination methods** – improved abilities for drone and unpiloted technologies, allowing for greater autonomous functionality.

Expected benefits:

- **Faster vehicle to vehicle communications** – faster and more secure exchange of critical information between vehicles or autonomous systems.
- **Connectivity in remote and challenging environments** – ability to ensure connectivity even in remote or challenging terrains, and improved reliability of communication and tracking capabilities in areas previously underserved by traditional systems.
- **Improved fleet management and logistics** –improved efficiency in transportation of equipment and personnel through the ability to choose the best routes to avoid congestion – resulting in lower emissions and costs.
- **Potential for autonomous vehicle integration** – ability to create a foundation for the integration of autonomous vehicles into transportation networks, enabling safer and more efficient self-driving capabilities.
- **Enhanced road infrastructure planning** – improved tracking precision, providing data to inform and improve road infrastructure planning.
- **Improved worker safety when working with autonomous systems** – real-time monitoring of the location of human resources, and enhanced communication with navigation systems may allow more immediate responses to emergency situations.

Intended technology end users or customers may include:

- Agricultural companies.
- Logistics companies.
- Mining and resources.
- State and Territory governments.
- Vehicle or vehicle component manufacturers.

The policies and strategies listed below are provided for awareness of how this challenge aligns with broader government policy. Applicants do not need to address these policies within their application.

National policies and strategies that align with this challenge include:

National strategy, plan, or policy	Areas of alignment with this challenge
National Reconstruction Fund Priorities	Priority 3: Transport Priority 4: Value-add in the agriculture, forestry, and fisheries sectors Priority 5: Value-add in resources
Proposed National Science and Research Priorities	Priority 5: Building a secure and resilient nation
Critical Technologies Statement	Solving national challenges here in Australia –Manufacturing
List of Critical Technologies in the National Interest	Advanced information and communication technologies Quantum technologies Autonomous systems, robotics, positioning, timing, and sensing
CSIRO Megatrends	Increasingly autonomous Diving into digital
The 2021 National Research Infrastructure Roadmap	Frontier technologies and modern manufacturing

The programs listed below are provided for awareness. Applicants do not need to address these programs within the application.

National programs that align with this challenge include:

iMove CRC – $55 million (2017–2027)

SmartSat CRC – $55 million – (2019–2026)

Blue Economy CRC – $70 million (2019–2029)

CRC Projects selection round outcomes – Digital Interferometry Optical Gyroscope for autonomous navigation (2020)

Transformations in Mining Economies CRC – $29.5 million (2020–2030)

CRC Projects selection round outcomes – Wireless mining conveyor technology to improve safety and reduce outages (2021)

Moon to Mars Supply Chain program - Australian Space Agency (2021)

International initiatives that align with this challenge include:

UK Quantum Strategy Mission number 4 – By 2030, quantum navigation systems, including clocks, will be deployed on aircraft, providing next-generation accuracy for resilience that is independent of satellite signals (2023)

UK Quantum Strategy Mission number 5 – By 2030, mobile, networked quantum sensors will have unlocked new situational awareness capabilities, exploited across critical infrastructure in the transport, telecoms, energy, and defence sectors (2023)

Challenge 4

Optimise and reduce the impact of resource exploration, extraction, and mineral processing

Challenge Overview

The Australian mining sector is a cornerstone of the Australian economy and generated $455 billion in export revenue for the 2022-2023 financial year.[13] By leveraging advanced technologies in critical mineral extraction and processing, the sector has the potential to increase its value by an additional $9.4 billion.[14]

The urgency to find and process more minerals is becoming even more important due to the depletion of easily accessible resources. With over 60% of Australia's resource projects being conducted on lands that are subject to Native Title claims or determinations[15] the need for less invasive exploration techniques is critical. Advancements in exploration and mining techniques will enable the industry to preserve First Nations people's Country, culture and cultural heritage and the environment. This challenge invites applicants to explore optimisation of resource exploration, extraction, and mineral processing through the innovative application of quantum technologies. Solutions may address the transition towards net zero, through optimisation of existing systems. The challenge seeks solutions that leverage quantum advancements to maximise resource efficiency, minimise waste and reduce the environmental impact associated with traditional mining practices.

Existing solutions within the mining sector may be able to be optimised using quantum technologies. Alternatively, existing quantum capabilities used in the mining sector may be adapted to solve different problems. Applicants may also develop new tools to address issues such as deep exploration, water intrusion, in-situ extraction, inherent mass variabilities and mineral content.[16]

What is the relevance of the challenge to industry[17]?

- Resource extraction can have major environmental and social consequences, and impact social license to operate.[18]
- The transition to net zero requires further development of decarbonisation technologies, many of which could benefit from quantum systems.
- Responsible and ethical exploration.
- Less invasive data collection, lowering the impact on the environment and the community. This may allow industry to better plan mining operations and reduce the upfront costs associated with the exploration phase.

[13] https://minerals.org.au/resources/mining-delivers-record-455-billion-in-export-revenue-in-fy23/
[14] https://www.industry.gov.au/publications/list-critical-technologies-national-interest/advanced-manufacturing-and-materials-technologies
[15] https://www.industry.gov.au/publications/critical-minerals-strategy-2023-2030/our-focus-areas/3-first-nations-engagement-and-benefit-sharing
[16] https://www.csiro.au/en/work-with-us/industries/mining-resources/resourceful-magazine/issue-28/the-exploration-toolkit
[17] https://www.csiro.au/en/work-with-us/industries/mining-resources/Resourceful-magazine/Issue-29-May/Quantum-computing-and-mining
[18] https://spectra.mhi.com/how-quantum-technology-could-change-heavy-industry#:~:text=The%20higher%20capabilities%20in%20optimization,resources%2C%20redefining%20supply%20chain%20efficiency

- Reduced upfront expenses may help to make previously unprofitable extraction sites profitable in the future, allowing for expanded site viability.
- Real-time sensing of minerals to reduce energy and waste from transportation to surface and/or processing of low-grade deposits.

Please note that the possible solutions and expected benefits listed below are provided as suggestions. Certain suggestions may be more ambitious than others. Applicants should not feel limited to the suggestions listed below and are encouraged to present other innovative solutions which address the challenge.

Possible solution elements may include:

- **Quantum algorithms for efficient extraction** – optimised resource exploration and extraction processes, focussing on maximising resource utilisation and minimising environmental impact.
- **Quantum algorithms for efficient transport** – algorithms could allow for the optimisation of transportation routes, reducing the associated costs.
- **Ecosystem–friendly extraction techniques** – development of extraction techniques that minimise disruption to local ecosystems, biodiversity, and habitats.
- **Quantum enhanced geological exploration** – enhanced geological exploration processes, improving the accuracy and efficiency of resource identification.
- **Integration with existing mining infrastructure** – development of solutions that seamlessly integrate with existing mining infrastructure, ensuring practical implementation and industry adoption.
- **Quantum sensors** – development of solutions to monitor carbon emissions (e.g., methane and carbon dioxide) to improve safety and environmental outcomes.
- **Quantum gravity sensing** – enables more precise detection of mineral deposits while minimising environmental disruptions in exploration activities.
- **Quantum enhanced electric vehicles** – electric vehicles will continue to be more prevalent on mining sites. Their increased use will lead to a growth in the need for assistive technologies that value-add current technologies.
- **Quantum gyroscope** – Exploration needs in GPS/GNSS denied environments may create a market need for technologies offering high-precision location data gathering tools, such as a quantum gyroscope.

Expected benefits:

- **Resource efficiency and maximisation** – precise and targeted resource exploration and discovery, extraction, together with maximised resource utilisation and efficiency and transformation of resource extraction processes.
- **Environmental conservation** – reduced environmental impacts, increased sustainability of mining practices.
- **Waste reduction and sustainability** – reduced waste generation through efficient extraction techniques, contributing to a more sustainable and responsible mining industry and secondary prospectivity through using mine waste. This may include recycling of tailing dams.
- **Geological exploration enhancement** – improved accuracy and efficiency of geological exploration, allowing more informed decision making.
- **Long term resource management** – increased sustainability of mining practices, ensuring the longevity of mining resources and operations.

- **Ecosystem restoration** – improving on post mine rehabilitation practices to restore disturbed land.
- **Water conservation** – optimised management of tailing dams and post mine rehabilitation practices helps conserve water resources by reducing contamination and optimising water usage in mineral processing operations.

Intended technology end users or customers may include:

- Mining and resources
- Mining equipment manufacturers
- Landscape restoration companies

The policies and strategies listed below are provided for awareness of how this challenge aligns with broader government policy. Applicants do not need to address these policies within their application.

National policies and strategies that align with this challenge include:

National strategy, plan, or policy	Areas of alignment with this challenge
National Reconstruction Fund Priorities	Priority 1: Value–add in resources Priority 5: Renewables and low emissions technologies
Proposed National Science and Research Priorities	Priority 1: Transitioning to a net zero future
Critical Technologies Statement	Solving national challenges here in Australia – Manufacturing Solving national challenges here in Australia – Emissions Reduction
List of Critical Technologies in the National Interest	Advanced manufacturing and material technologies Quantum technologies Autonomous systems, robotics, positioning, timing, and sensing Clean energy generation and storage technologies
CSIRO Megatrends	Increasingly autonomous Diving into digital Leaner greener and cleaner Adapting to climate change
Net Zero Plan	Industry
Australia's Long-Term Emissions Reduction Plan	Achieve net zero emissions by 2050
The 2021 National Research Infrastructure Roadmap	Resources technology and critical minerals processing Frontier technologies and modern manufacturing
Critical minerals strategy 2023 – 2030	Create diverse, resilient, and sustainable supply chains through strong and secure international partnerships

The programs listed below are provided for awareness. Applicants do not need to address these programs within the application.

National programs that align with this challenge include:

MinEx CRC – $50 million (2018–2028)

Future Battery Industries CRC – $25 million – (2019–2025)

SmartCrete CRC – $21 million (2020–2027)

Transformations in Mining Economies CRC – $29.5 million (2020–2030)

Future Energy Exports CRC – $40 million (2020–2030)

Heavy Industry Low–carbon Transition (HILT) CRC – $39 million (2021–2031)

CRC Projects selection round outcomes – Extracting critical minerals and rare earths from bauxite residue (2021)

CRC Projects selection round outcomes – High value–added manufacturing from polymetallic critical minerals (2021)

International initiatives that align with this challenge include:

Canada Internet of Things – Quantum mining: coherent quantum imaging tools for process mineralogy analytics (2023)

UK Quantum Strategy Mission number 5 – By 2030, mobile, networked quantum sensors will have unlocked new situational awareness capabilities, exploited across critical infrastructure in the transport, telecoms, energy, and defence sectors (2023)

Information of interest

Department of Industry, Science and Resources (DISR): The National Quantum Strategy
https://www.industry.gov.au/publications/national-quantum-strategy

DISR: National Reconstruction Fund
https://www.industry.gov.au/news/national-reconstruction-fund-diversifying-and-transforming-australias-industry-and-economy

DISR: List of Critical Technologies in the National Interest
https://www.industry.gov.au/publications/list-critical-technologies-national-interest

DISR: National Science and Research Priorities
https://consult.industry.gov.au/sciencepriorities2

DISR: Diversity in STEM
https://www.industry.gov.au/news/review-recommends-more-ambitious-and-strategic-action-increase-diversity-stem

DISR: A national and international approach – including QUAD and AUKUS
https://www.industry.gov.au/publications/national-quantum-strategy/national-and-international-approach

DISR: Joint Statement of the United Kingdom and Australia on Cooperation in Quantum Technologies
https://www.industry.gov.au/publications/joint-statement-united-kingdom-and-australia-cooperation-quantum-technologies

DISR: Joint Statement of the United States of America and Australia on Cooperation in Quantum Science and Technology
https://www.industry.gov.au/publications/joint-statement-united-states-america-and-australia-cooperation-quantum-science-and-technology

Australian Research Council (ARC)
https://www.arc.gov.au/

Office of Chief Scientist
https://www.chiefscientist.gov.au/