Australia's National
Science Agency

# The CSIRO Book

2025–26

What we do,
how and why we do it,
and the impact we deliver.

By our scientists and experts

## Copyright notice



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**Cover images: (left) Michael Rae and Mike Collins among the heliostat field that is central to CSIRO's concentrated solar thermal research and ambition to decarbonise our hard to abate industries and exports.**
**(right) Dr Niloofar Karimian is working in the lab with Jarosite, a potassium iron sulphate mineral often found in acid mine drainage environments, oxidised ore bodies. The mineral could play a crucial role in trapping toxic metals like arsenic and lead inside its structure. Her research also investigates the mechanisms by which goethite, an iron oxide mineral, interacts with phosphorus in natural and engineered systems – helping to resolve the long-standing 'phosphorus puzzle' by revealing how phosphorus is retained or released under varying environmental conditions.**

CSIRO acknowledges the Traditional Owners of the lands, seas and waters of the area that we live and work on across Australia. We acknowledge all Aboriginal and Torres Strait Islander peoples and their continuing connection to their culture and pay our respects to Elders past and present. CSIRO is committed to reconciliation and recognises that Aboriginal and Torres Strait Islander peoples have made and will continue to make extraordinary contributions to all aspects of Australian life including culture, economy and science.

**'Eternal Wisdom, Infinite Innovation'**
artwork by Rachael Sarra, working with Gilimbaa.

# Contents




**Pippa Soccio gets hands on in recruiting participants for Australia's largest-ever investigation of the energy use of people living in apartments, a group that has been traditionally neglected in energy studies.**

# Preface

Across millennia, science – our ability to ask questions of the world around us, seek answers through thought, observation, ideas and experimentation, build understanding progressively and communicate knowledge across generations – has shaped the world in astonishing ways.

As we enter the second quarter of the 21st century, we confront challenges that are complex, rapidly changing and profound. We need science, and trust in it, more than ever before.

CSIRO – Australia's national science agency – provides the science we need to flourish, now and in the future, to benefit our nation and the world.

## Trust and transparency

For science to have impact it must be trusted, and a key foundation of trust is transparency. That is the first purpose of *The CSIRO Book*. This book shines a light on what we are doing, and how and why we are doing it. It describes the full range of our research portfolio, including how we are approaching the work, our collaborators and the reasons the research matters for Australia.

The first section, science and technology for impact, outlines the broad areas on which our research is focused – Energy and Minerals, Food and Fibre, From Wonder to Discovery, Nature, One Health and Tech Economy. Although we have arranged our research into these 6 areas, they are not silos. For example, we have programs of research that tackle the most pressing and consequential risk to our way of life and indeed our very existence – climate change. Many of our programs of research are aimed at the wicked challenge of how we diversify our economy and assist Australian industries to be more productive and sustainable while striving for a healthier, more secure and optimised society. In this first version of the book, we also show how we contribute to important national priorities such as the National Science and Research Priorities.

Section 2 highlights CSIRO's stewardship of research infrastructure on behalf of the nation. This amplifies CSIRO's scientific, social and economic impact by strengthening the innovation ecosystem in Australia and globally. We aim to ensure our facilities are fit for purpose, allowing us to tackle current and emerging challenges. Our research infrastructure supports collaborative networks of researchers and users, attracting strong national and international partnerships.

The final section describes our role in the innovation system. This includes how we connect our science to society through working with Australian industry, especially small to medium-sized enterprises (SMEs), developing our pipeline of science, technology, engineering and maths (STEM) talent, working with Aboriginal and Torres Strait Islander people and their knowledge systems, and communicating both the process of science and its impacts.

## Catalysing collaboration

The second purpose of the book is to catalyse collaboration. Complex problems are seldom solved by individuals or single scientific disciplines, or even small teams or a single organisation, no matter its size.

Tackling difficult problems and generating impact across the community requires diverse groups of people who co-own the problem, share a common goal and ideally co-fund and co-deliver the solutions.

We have these coalitions in place in some research areas, and the book provides us with an opportunity to acknowledge and thank our collaborators and to raise our collective ambition. In other areas progress requires new partners, and the book provides a line of sight to our work and a bridge to collaborate.

We hope this book becomes a clarion call for the nation, bringing together Australians from all sectors – government, research organisations, private companies, nongovernment organisations and the general community.

We also know that there may be problems we are not aware of or addressing, or areas that would benefit from a different perspective. The book provides an invitation to challenge us to work with you on something new, inspiring all of us to strive, to dream, to ask "what if we could do THIS?"

## Demonstrate impact

The third purpose of the book is to report back on what we and our collaborators achieve and to reflect on our impact to evolve our portfolio. There are many important and compelling demands on public spending in Australia. CSIRO must repay the community's trust and investment in our work. We commit to do this by working transparently, creatively and collaboratively on the big problems that matter and by communicating our progress to you through pages of this book, the Corporate Plan and our Annual Report.

There are things this book is **not**.

The book is not carved in stone – it will change as our national priorities shift and as our science advances.

We hope that our ambitions – those lights on the hill – will guide us for many years. We also know that the world can change unexpectedly, as it did during the pandemic, and that may require new ambitions.

We expect our programs of research to evolve continuously as technology changes, as our work succeeds and we unlock new solutions, as new partners join us, and as new challenges and questions need answers. Therefore, to keep the book current, we will issue a new edition on a regular basis.

CSIRO is policy-agnostic and dedicated to providing the best possible models, data and scientific breakthroughs to guide the community and policymakers. We wholeheartedly welcome constructive debate, which is central to scientific inquiry and progress.

As you read *The CSIRO Book*, we hope you are as excited as we are about science and the role that it will play in your life and in the lives of future generations. We also hope that you are excited by and proud of the work of our staff and collaborators.

We appreciate your interest and welcome your feedback.
We rely on your continued trust and support.

**Dr Doug Hilton**
Chief Executive

**Doug takes part in the Welcome to Country smoking ceremony for the launch of our Stretch Reconciliation Action Plan (RAP).**

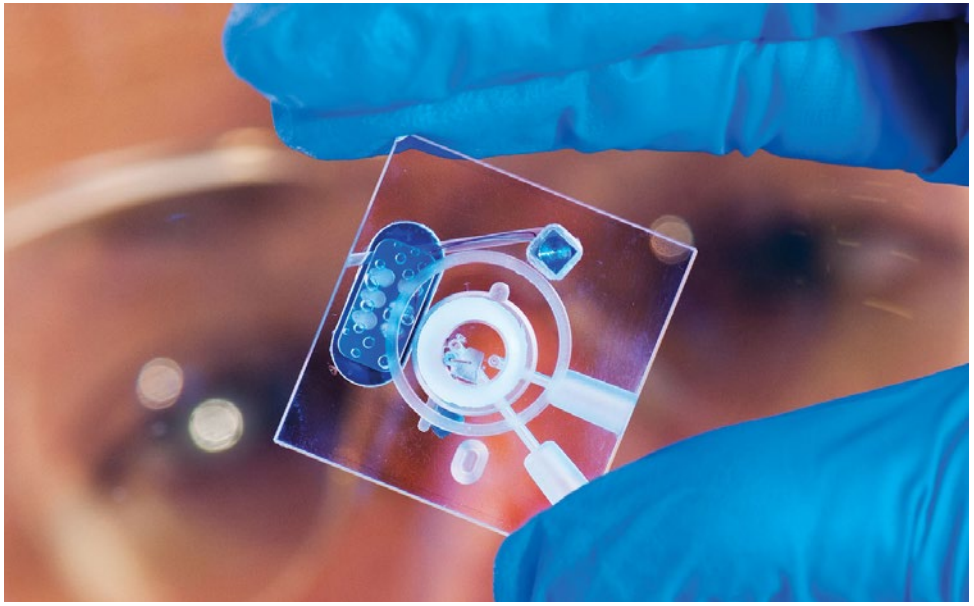
# Science and technology for impact

Impactful science and technology is crucial for Australia to address national and global challenges, drive sustainable prosperity and enhance innovation. Aligning research with societal and industry goals will help to secure a prosperous future, improve quality of life and solve complex issues.

**Technician Ludwig Monmusson preparing for core sample geomechanics tests at Kensington. Photo: Kess Media.**

# Our research portfolio

This book, written by our researchers and supporting teams, brings our science to life. It shows how we are looking to the future and focusing on the global challenges confronting Australia and the region.



CSIRO powers Australia's **productivity** by solving problems that matter. Whether we are developing artificial intelligence (AI) for smarter farms, robots for safer mines or breakthroughs that launch entire new industries, CSIRO helps turn bold ideas into economic firepower. Our work with small businesses and major sectors alike means innovation gets off the lab bench and into real-world use – fast.

When it comes to **sustainability**, CSIRO is on the front line. Our scientists are tackling climate change, restoring ecosystems and designing circular economy solutions that waste less and regenerate more. From helping farmers adapt to drought to engineering clean energy systems, CSIRO is making sure Australia can thrive without costing the planet.

Australia's **sovereign** strength depends on its ability to stand on its own when it counts – and CSIRO is a key player in that independence. We develop homegrown technologies for vaccines, defence and critical minerals. We protect our food systems and borders with cutting-edge biosecurity. We help to secure space and quantum capabilities that will define the future.

Science doesn't just solve problems – it shapes minds. CSIRO fuels national **optimism** by showing what's possible. We bring the future into focus, lift scientific literacy through education and outreach and inspire the next generation of thinkers and doers. Every breakthrough is a story of what Australia can achieve.

The macroeconomic and social context is something we will need to continuously monitor as we chart these future directions, as the risks we need to manage today may look very different from those we need to manage in the next 10–20 years.

## Research areas

Each chapter in this section focuses on one of our main areas of research activity and investment. We articulate the challenge to humanity within the research area; illustrate Australia's aspiration; and outline our ambitions – those lights on the hill that guide the direction of our research. In this book, we share our **Programs of Research** (summarised on the following page) – the specific and targeted initiatives CSIRO is undertaking to deliver solutions that move us towards those lights.

You will notice common threads that span our entire portfolio, enabling integrated ways of working and convening the best and brightest minds to tackle Australia's problems. These cross-cutting approaches focus on addressing and advancing:

- innovative and technology-driven solutions to address critical challenges in resource systems for value creation and productivity
- integrated approaches to human, animal and environmental health, ensuring the sustainability of ecosystems and agricultural systems
- enhanced efficiency and resilience across interconnected systems to enable a prosperous, competitive and secure future
- evidence-based understanding, monitoring and management of complex environmental and climate systems
- transformative technologies, capability and methodologies for observing and analysing complex systems in space and on Earth.

We aim to foster innovation by combining expertise and integrating diverse perspectives, leading to breakthroughs that a single field alone might not achieve. This approach accelerates problem solving, enhances adaptability and ensures that technological advances align with ethical, social and environmental considerations. You will also see how this integrated approach combines with the power of Indigenous science, knowledge systems and holistic thinking to connect multiple dimensions of human wellbeing and harmony with our natural environment to deliver impactful change. Demonstrations of CSIRO's work to combine such perspectives through our partnerships and collaborations with Aboriginal and Torres Strait Islander peoples are indicated throughout this book by the 'working together' symbol  to represent Indigenous science.

As the world faces increasingly interconnected challenges, combining different fields of science to solve problems will be the key to developing holistic, sustainable solutions for future generations.

## Contributions to National Priorities

Following the summary of our programs of research, we illustrate 2 examples of how our Research Areas contribute to our National Science and Research Priorities (NSRPs) and Future Made in Australia (FMiA) agenda.

## Summary of CSIRO Programs of Research

Note: This overview does not reflect the order of content in The CSIRO Book.

### Energy and Minerals

**Clean, reliable and affordable electricity**

*Electricity transition*

**Decarbonised industry, exports and transportation**

*Decarbonising industry and transport*

*Carbon-management technologies*

*Developing green metals production technologies*

**Sustainable prosperity from mineral resources**

*Growing Australia's mineral resources*

*Advanced technologies for a globally competitive Australian minerals industry*

**Value-added critical minerals**

*Reliable and responsible supply chains for critical minerals*

### One Health

**Strengthening capability for high-consequence infectious diseases**

*Mitigating the impact of infectious disease threats*

*Detecting dangerous emerging infectious diseases to protect Australia's livestock and people*

**One Health system digital transformation**

*Accelerating connected and informed healthcare*

*Artificial intelligence transforming health care and health research*

**Biosecurity**

*Transforming biosecurity systems and approaches*

*Protecting agricultural, environmental and cultural systems from impacts of high-consequence native and introduced biological threats*

**One Health at scale**

*Increasing healthy years of life for Australians*

### Food and Fibre

**Optimised crops and animals**

*Advanced breeding: develop crops and animals adapted to future farming environments and market opportunities*

*Engineering genomes: improve health, welfare and value of crops and animals*

**More value from foods and feeds**

*Value-adding to bioresources: innovating food, feed and by-product processing*

**Agricultural land stewardship**

*Resilient agricultural landscapes: improve mitigation and adaptation for resilient industries*

**Thriving farm businesses**

*Prosperous farms: create crop and livestock farming systems that adapt, endure and thrive*

*On-farm technologies: innovations and interventions that increase sustainable farm production*

*Aquaculture: grow and diversify the Australian aquaculture industry*

**Trusted and equitable food systems**

*Agri-food systems: accelerate transition to a more sustainable, trusted and equitable food system*

### From Wonder to Discovery

**Exploring the Universe**

*Radio astronomy and instrumentation*

*Space science and exploration*

**Wonder of life**

*Discovering and monitoring Australia's biodiversity*

### Nature

**Biological systems: Nature revealed and sustainably managed**

*Integrated ocean stewardship*

*Future water*

**Climate and environmental prediction: Navigating a dynamic environment**

*Foundational climate monitoring and understanding*

*Climate intelligence and advice*

*Environmental prediction*

**Engaging humanity: Building a thriving nature-positive nation**

*Managing sustainability transitions*

*Transformational analytics for recovery and resilience*

*Valuing and restoring biodiversity and healthy ecosystems*

*Pollution and waste*

### Tech Economy

**Building artificial intelligence for national challenges**

*Scientific discovery from human–AI collaboration*

*Next-generation AI and decision-making*

**Advancing robotics capability and adoption**

*Productive industries with human–robot teams*

**Trust in new technologies**

*Digital trust*

**Building cross-sector quantum technology platforms**

*Quantum technologies*

**Thriving Australian high-tech manufacturing**

*Thriving biotech industry*

*Advanced materials and processing for cleantech*

*Materials and systems for aerospace and defence*

*Bioengineering for a sustainable economy*

### Research infrastructure

**Understanding our Universe**

*Australia Telescope National Facility (ATNF)*

*Earth observation*

*SKA project*

*Spacecraft tracking and communication*

**Characterising structure and function**

*CSIRO Characterisation Network*

**Understanding our natural systems**

*Atlas of Living Australia (ALA)*

*Marine National Facility (MNF)*

*Marine Observing Systems*

*National Research Collections Australia (NRCA)*

**One Health approach to mitigating the impacts of disease**

*Australian Centre for Disease Preparedness (ACDP)*

**Harnessing the power of compute to solve research challenges**

*CSIRO High Performance Computing*

*Pawsey Supercomputing Research Centre*

### Connecting science and innovation to society

**A resilient innovation system with a skilled workforce and community trust**

*A strong and diverse science, technology, engineering and maths talent pipeline for Australia*

**Indigenous science**

*Delivering science solutions in partnership with Indigenous Australia*

*Meeting the objectives of the 2020 COAG CTG Agreement*

**Science and technology at the heart of Australian industry**

*Better science and technology decision-making*

*Safety and assurance of national infrastructure*

**Coordination and collaboration**

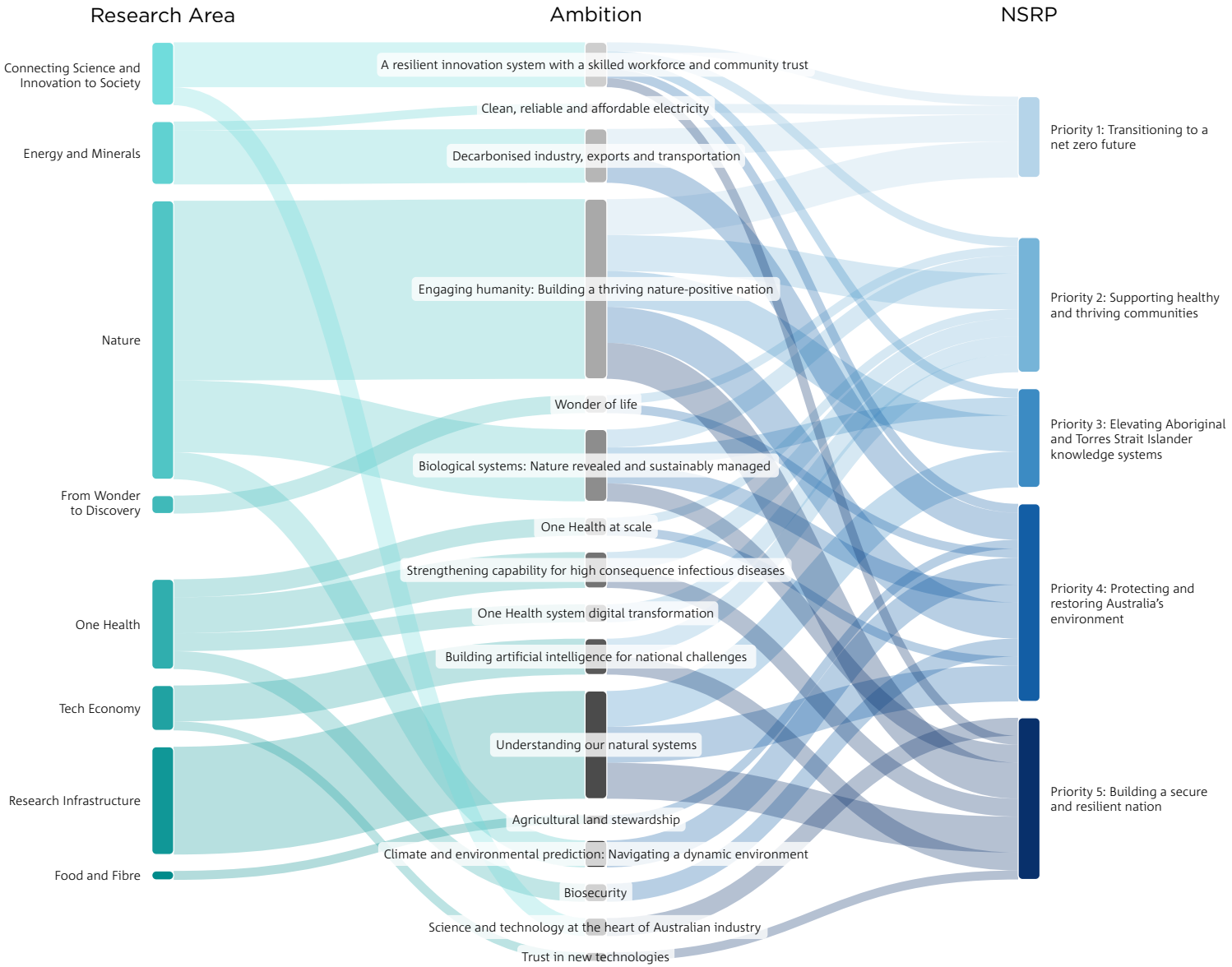
*Publishing trusted science*

*Innovation programs*

## Alignment with National Science and Research Priorities

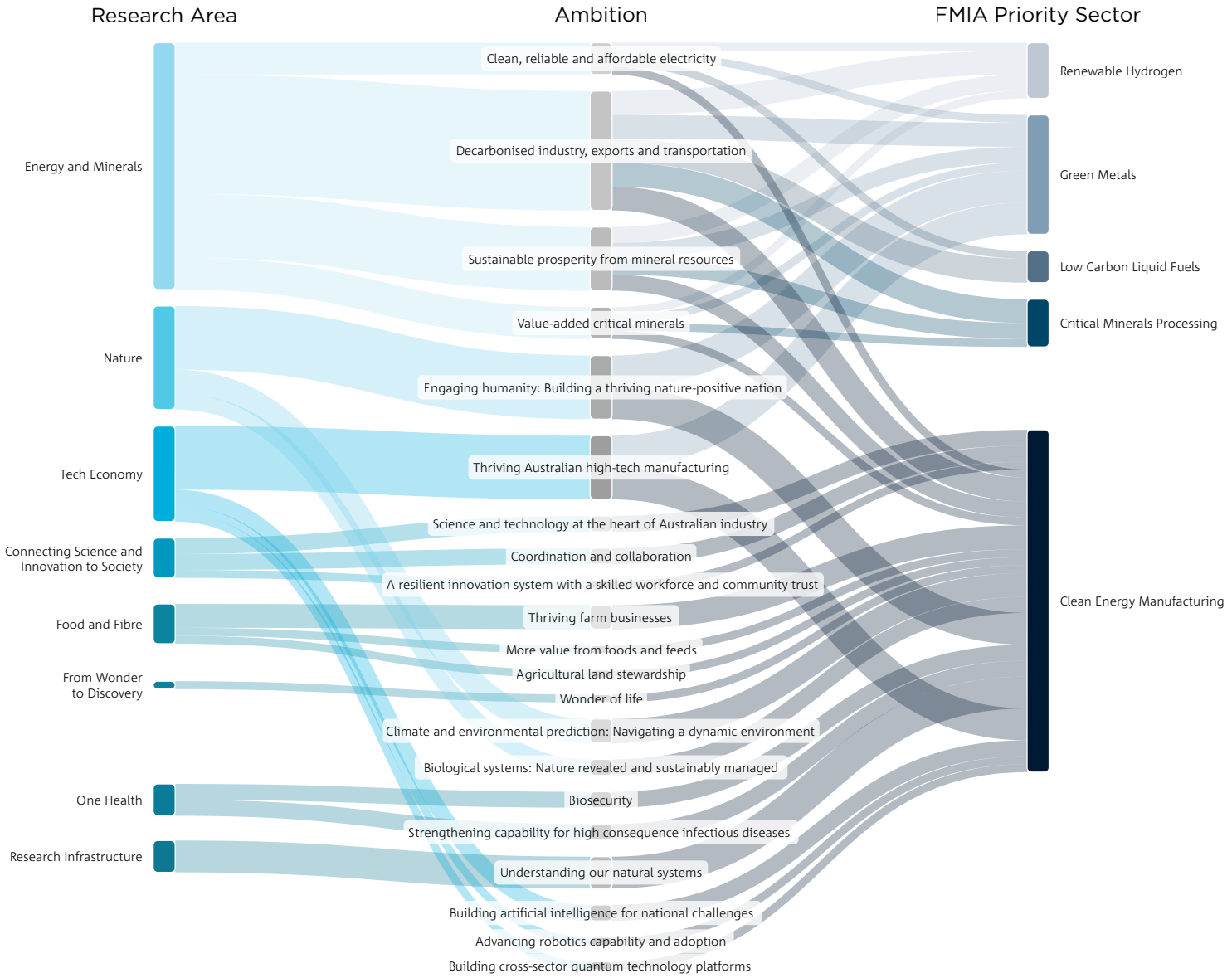
This diagram shows how the research ambitions from each research area connect to the National Science and Research Priorities.

To make these connections, we compared the wording of the research ambitions with the descriptors of each priority area. We used a method called 'cosine similarity', which measures how closely the 2 sets of words match in meaning. The diagrams only show the strongest matches – those that rank in the top 25% for similarity – so the connections are the ones where the research ambition and the priority area are most closely aligned.



## Alignment with Future Made in Australia priorities

This diagram shows how the research ambitions from each research area connect to the Future Made in Australia priorities.



# Energy and Minerals

**Challenge to humanity:** Responding to the global challenge of climate change and meeting net zero targets includes an urgent need to accelerate Australia's energy transition and decarbonise our economy. Rising demand for clean energy, electrification and sovereign supply security requires expanded production of critical minerals and the transformation of energy production, distribution and efficiency. Innovative solutions and novel technologies are needed to reduce costs and environmental impacts, preserve export returns, stimulate jobs and investment and promote greater social equity.

**Australia's aspiration:** Australia aspires to a sustainable and prosperous future with clean, low-cost and reliable energy and high-value, low-carbon mineral resources.

**CSIRO ambitions:** At CSIRO, we strive to inspire and shape technology development that drives low-cost electrification and decarbonisation of our major industries and exports in a competitive, low-carbon global economy.

**Ange Chen testing the fabrication process for perovskite-silicon tandem solar cells, a crucial technology that has potential to make solar energy more efficient and cost-effective.**

CSIRO brings the full potential of science and technology to create a future for Australia in which sustainable energy and mineral resources expand our prosperity. We transform how Australia sources, produces and uses its energy and mineral resources to drive the energy transformation, build innovative businesses and skills, and create new green minerals, materials and energy exports for a future low-carbon global economy, while practising exceptional environmental stewardship and driving social equity outcomes.

CSIRO's ambitions prioritise: (1) clean, reliable and affordable electricity, (2) decarbonised industry, exports and transportation, (3) sustainable prosperity from mineral resources, (4) value-added critical minerals and (5) shared community benefits.

### Clean, reliable and affordable electricity

Australia's enviable renewable resources are harnessed to transform our diverse, interconnected and remote electricty networks and scaled up to support greater industry, building, and transport electrification at the lowest possible cost to the consumer. Driving this transformation is the development and deployment of intelligent electricity systems capable of optimising supply and demand – which help to double Australia's energy productivity per unit of GDP – and the deployment of more than 100 gigawatt (GW) of energy storage solutions that increase grid throughput, stability and reliability powering millions of Australian homes. Australia's critical mineral resources and advanced manufacturing skills turbo-charge local, low-cost solar and battery manufacturing, with research helping Australia exceed 30% energy efficiency in solar photovoltaics with an install cost of 30 cents per watt. Through these improvements in clean energy supply, Australia achieves a global advantage from globally competitive clean energy production costs.

### Decarbonised industry, exports and transportation

Australia becomes a major producer of low-carbon fuels and heat. This underpins competitive production of chemicals and metals in Australia, including low-carbon liquid fuels, green ammonia and iron, and new energy exports that help to decarbonise the global aviation and marine transport sectors. This is supported by technological advances in low-emissions hydrogen production, resulting in Australia producing more than 30 Mt annually with production costs well below $2/kg. Our hydrogen and thermal energy research and technology suite, coupled with our advanced manufacturing and material sciences capabilities, support new high-skilled jobs in Australia that add to our highly competitive, renewable energy manufacturing portfolio.

The global economy, increasingly dependent on low-carbon, durable metals such as aluminium and steel, has found a reliable partner in Australia. As a green metal processing powerhouse, Australia upgrades more than 80% of its raw materials before exporting them to major partners, decarbonising our key export commodities.

We scale up a diverse portfolio of carbon management solutions, establishing our role as a global leader in helping return Earth's atmosphere to significantly reduced carbon dioxide ($CO_2$) levels. These solutions help to prevent the release of $CO_2$ in our hardest-to-abate industries and assist in the large-scale and long-term removal of legacy $CO_2$ from the atmosphere through novel removal systems, positioning Australia to become a leader in the emerging global carbon market. Captured $CO_2$ is turned into economic value, targeting captured $CO_2$ from air (direct air capture) at a cost well below $100/tonne and using $CO_2$ for the creation of low-carbon building materials and fuels.

## Sustainable prosperity from mineral resources

Australia emerges as a key player in the global movement for responsibly sourced mineral supply, delivering into transparent commodity markets that attract a premium. New mineral resource discoveries are enabled by fusion and modelling of data from geophysical, mineralogical and geochemical sensors to support new predictive capabilities and fully characterise orebodies where value can be maximised.

Low-impact mining practices provide for extraction, processing and refining from minerals through to materials for clean energy technologies essential for global development. The future minerals industry is more akin to a highly controlled precision mining and manufacturing process capable of dealing with geological uncertainty, where advanced technologies allow precise rock extraction, ore treatment and refining and significantly minimise waste. Improved environmental outcomes benefit local communities during and after mining.

As a green metal processing powerhouse, Australian mines are almost exclusively remotely operated, vastly improving mine worker safety.

Mining technologies are applied outside the minerals industry (e.g. space technologies, geoengineering, defence, public safety) for wider societal benefit and creation of new opportunities for the economy and workforce.

## Value-added critical minerals

Through innovative, low-impact extraction and processing methods, Australia expands economic return from its critical mineral resources and creates new supply chain opportunities with niche manufacturing of metals, alloys and products. This shift introduces transparent price competition and offers supply reassurance to technology manufacturers, paving the way for low-cost green products for global customers. Increased onshore value creation through refining and materials production adds substantial value to Australia's critical minerals exports.

Positioned as a recycling hub for the Asia–Pacific region, as technology advances and assets reach end of life across the globe, Australia leverages its metallurgy expertise to build a sophisticated processing capability to recover and repurpose 50% of the region's electronic and metal waste – a new source of critical and strategic minerals – and to extract new value from legacy mine tailings.

## Shared community benefits

Australia's approach to community and Indigenous engagement for new mining and energy projects is underpinned by a trusted evidence base, with diverse perspectives and societal needs informing the development and deployment of new technologies and infrastructure. Through persistent effort fostering of a more informed and engaged society, energy and mining science is seen to deliver additional benefits from its outputs, including co-designed business models.

Harnessing the power of science and technology, we build value while moving through the energy transformation to a cleaner, more prosperous and more equitable future. We are powered by a mineral resources and energy sector that supports a thriving and resilient Australia.

# Decarbonising industry and transport

PROBLEM STATEMENT: Decarbonising industry and transport sectors is risky, complex and challenging. How do we enable emissions reduction at a scale and cost that is affordable?

## SOLUTIONS

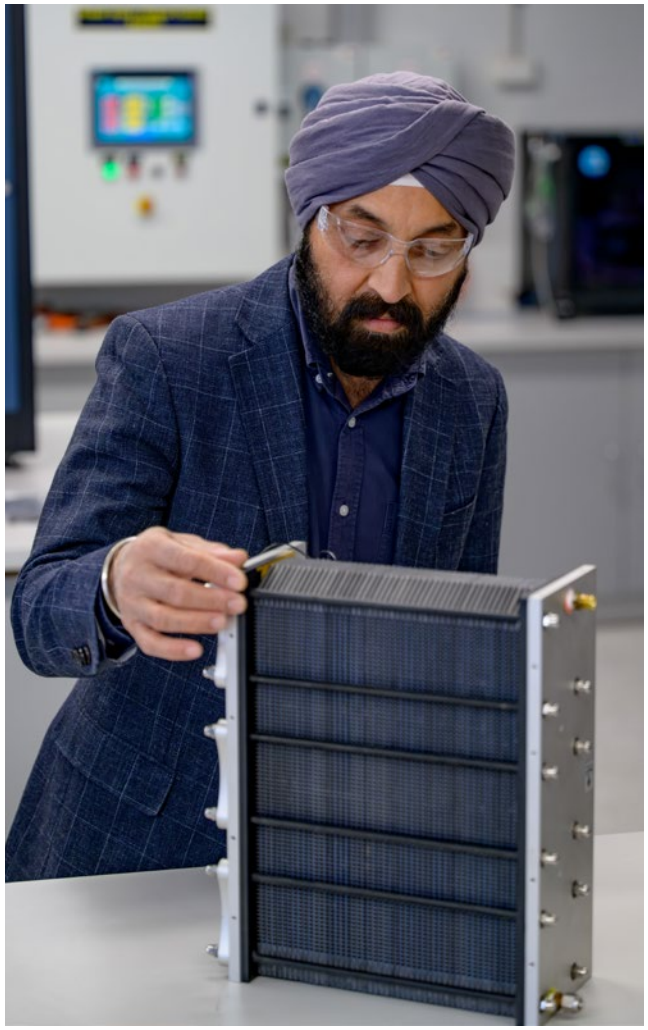
- Design new technologies and pathways for hydrogen and ammonia production, compression, use and storage to reduce cost and increase scale.
- Pilot and demonstrate activities to scale up and de-risk solar thermal and bioenergy pathways for renewable heat and fuels.
- Integrate low-carbon energy (heat, fuel, power) with existing industrial processes.
- Develop and demonstrate activities to support $CO_2$ capture and utilisation, including liquid fuels production (such as methanol).
- Techno-economic and life cycle analysis and modelling to support decision-making by industry and government stakeholders.

## IMPACT

By working with industry to de-risk decarbonisation strategies and lower the cost of new energy technologies, we will enable emissions reduction at scale from 2 of the hardest-to-abate sectors. This will support sustainable heavy industry and aviation sectors, creating new domestic manufacturing, export and value-adding opportunities.

## CURRENT COLLABORATORS

AREA, Australian Solar Thermal Research Institute, Australia-Singapore Low-Emissions Technologies, aviation and liquid fuel companies, BlueScope Steel, Central Research Institute of Electric Power Industry Japan, Endua, Fortescue, FPR Energy, Hadean, Heavy Industry Low-carbon Transition CRC, Monash University, National Renewable Energy Lab, RMIT University, TU Freiberg, TU Munich, University of Newcastle, University of NSW, University of Oxford.



**Dr Sarbjit Giddey, CSIRO's Senior Principal Research Scientist inspecting a fuel cell that converts hydrogen and oxygen (from air) into electricity, leaving only water as a byproduct. Photo: Kess Media**

# Carbon-management technologies

PROBLEM STATEMENT: Society expects emissions reductions from the energy sector to reach net zero by 2050 while guaranteeing affordable and secure energy supply. How can low-cost carbon capture and storage, along with emissions offsets, be developed in support of net zero emissions targets in the energy sector while ensuring lowest price and energy security?

The tripartite goal of emissions reduction–security–affordability is required to secure the social acceptance of a net zero target by 2050.

Group Leader, Dr Joel Sarout, at our Rock Mechanics laboratory in Kensington preparing an ultrasonic sensor for core sample testing. Photo: Kess Media

## SOLUTIONS

- Reduce high costs associated with carbon dioxide capture from waste gas streams and directly from the atmosphere for energy producers to de-risk capital investment in carbon capture and storage projects.
- Expand appraisals of depleted reservoirs and saline aquifer storages for owners of greenhouse gas injection and storage leases to increase storage options both within Australia and with our key energy trading partners.
- Establish cost-effective measurement, monitoring and verification methods for ensuring safe underground storage of carbon dioxide to enable government regulation and approval, and to generate the social acceptance of carbon capture and storage (CCS) project planning and development.
- Undertake relevant techno-economic assessments of low-emissions hubs (e.g. low-emissions hydrogen and CCS) to establish the business and economic assessments for transnational shipments of carbon dioxide into Australian waters for storage, and exports of cost-effective, low-emissions fuels.
- Provide technical and scientific advice to the Commonwealth Government (and state/territory governments where appropriate) to underpin bilateral negotiations on safe carbon dioxide transfer and storage.

## IMPACT

Through partnering with industry and government, net zero emissions targets will be achievable along with an affordable and secure energy supply, thereby maintaining economic activity in the national interest, meeting environmental standards and complying with government regulatory controls.

Our unique and extensive skill set and strong outward-facing government and industry relationships will yield ongoing and significant impact through technology commercialisation and tailored solutions to abate greenhouse gas emissions from industry sources and energy supply, including through the development of industry-led CCS projects over the next decade.

## CURRENT COLLABORATORS

ANSTO, Aramco, Australia Pacific LNG, BP, Chevron, ConocoPhillips, Curtin University, DCCEEW, DeepC Store, DISR, Empire Energy, Exxon-Mobil, INPEX, Japan Organisation for Metals and Energy Security, Kawasaki Heavy Industries, Ministry of Economy, Origin Energy, Osaka Gas, Petrobras, Petronas, Polytech-Paris, QGC/Shell, regional councils, RITE, Santos, School and Observatory of Earth Sciences, state/territory governments, Tamboran Resources, Total, Trade and Industry (Japan), University of Adelaide, University of Cergy-Pontoise, University of Strasbourg, University of WA, Woodside.

# Developing green metals production technologies

PROBLEM STATEMENT: How can Australia develop the capability and technology required to leverage our abundant mineral and renewable energy resources and become a competitive low-emissions producer of green metals?

## SOLUTIONS

- Develop and evaluate potential low-emitting iron-making technologies, especially those that could use low-grade Australian ores.
- Develop technologies to efficiently upgrade low-grade Australian ores to suit existing low-emissions iron-making pathways.
- Expand and strengthen green metal workforce skills (within industrial production base, CSIRO and universities) and seek to increase collaboration with industry.
- Invest in comprehensive green steel production piloting capabilities in Australia.
- Integrate low-cost renewable energy into novel green metals production technologies.

## IMPACT

Our innovative technologies will help safeguard the future of Australia's key export commodities in a global economy increasingly reliant on green metals. By leveraging Australia's abundant mineral resources and its renewable energy advantage, large-scale emissions reduction will be achievable. Additionally, new onshore pathways for transforming minerals into metals will create sustainable opportunities that support capability development, employment and local manufacturing.

## CURRENT COLLABORATORS

Australasian Institute of Mining and Metallurgy, AREA, BHP, DFAT via India Australia Green Steel R&D Partnership, DISR, Glencore, HILT CRC, Minerals Research Institute of Western Australia, Net Zero Mining, original equipment manufacturers and raw materials producers, Rio Tinto, Swinburne University.

**New company, FPR Energy, is commercialising CSIRO's next generation solar thermal technology to provide clean heat to help reduce industrial emissions, which account for 20 per cent of Australia's annual carbon footprint. The particle-based Concentrated Solar Thermal technology is capable of reaching temperatures up to 1200°C, an industry first.**

# Electricity transition

PROBLEM STATEMENT: Reliable, secure and affordable energy, provided though our electricity power systems, is essential to continued economic development and prosperity. How do we accommodate new generation, energy storage and loads; improve sector productivity with increased asset utilisation; and increase energy efficiency, all while decarbonising the sector and strengthening resilience to extreme weather events?

## SOLUTIONS

- Update electricity system operational approaches to enable operation with a changing generation, energy storage and load mix. Tackle the challenges faced by the electricity system operator – managing the impacts and opportunities of renewable energy, electrification, hydrogen production, new data centre loads and other technology trends – by providing analysis, new control room tools and enhanced forecasting models.
- Improve electricity system productivity by unlocking flexibility and energy storage within commercial buildings. Develop a market for load flexibility by establishing energy data platforms and analytics.
- Provide information to inform better decisions for residential property energy efficiency, including building energy efficiency rating tools to support energy efficiency improvements.
- Whole-of-system approaches to technology development and system performance, including integrated ultra low-cost solar systems and new long-duration energy storage solutions.
- Develop national sociotechnical research infrastructure to provide enduring, holistic data and transdisciplinary analysis capabilities to support Australia's energy and net zero transformation.

Dr Kate Cavanagh demonstrates the use of the Electric Vehicle Emulator. This equipment can emulate an electric vehicle, an EV charger or monitor the charging of an EV.

## IMPACT

By working with industry to strengthen resilience to extreme weather events and adaptability to changing generation and loads, we will ensure reliable, secure and affordable electrical energy is available to underpin Australia's economic prosperity. For a fixed emission reduction envelope over the next 2.5 decades, an emission reduction from the electricity sector would allow hard-to-abate sectors to reduce more slowly and keep emission reduction targets.

## CURRENT COLLABORATORS

AIRAH, Australian Energy Market Operator, AREA, Clean Energy Ministerial/Mission Innovation, DCCEEW, DFAT, distributed network service providers, International Energy Agency Smart Grids program, National Science Foundation, RACE (Reliable, Affordable Clean Energy).

# Grow Australia's mineral resources

PROBLEM STATEMENT: To resource the future, we need to discover mineral deposits at increasing depths beneath the Earth's surface. How do we support the minerals industry to find new deposits as they become increasingly difficult to locate?

## SOLUTIONS

- Transition from detection methods to predictive techniques by enhancing mineral systems knowledge, deposit formation and discovery.
- Develop new technologies and workflows to improve the rate of exploration success through shallow to deep sedimentary cover >50 m and <2000 m.
- Develop miniature sensors, including using quantum technologies, to image the deep Earth.
- Map the mineralogy and properties of the Earth's surface and subsurface.
- Create accessible software and comprehensive characterisation solutions to pinpoint the location of mineral deposits.
- Advance physics-informed 3-4D modelling, data science and national data repositories to improve confidence in decision-making.

## IMPACT

Developing exploration tools for the Australian landscape will improve exploration success rates, bolster our resource base and minimise environmental impact. These innovations will position Australia as a leader in emerging exploration technologies and will secure sustainable mineral resources for future generations.

## CURRENT COLLABORATORS

ANSTO, ARC Training Centre in Critical Resources for the Future, Australian and international universities, Geoscience Australia, international space agencies and research organisations, mineral resources companies, Minerals Research Institute of Western Australia, MinEx CRC, NCRIS – AuScope, SMEs, state geological surveys and water agencies.

**Geologists from CSIRO are refining the way we search for and locate nickel-rich deposits at Serpentine Bay, WA and in other regions to reduce the impact on the environment and increase our economic opportunities from critical energy metals.**

# Advanced technologies for a globally competitive Australian minerals industry

PROBLEM STATEMENT: How can we sustain a globally competitive Australian minerals industry with a strong social and environmental licence, despite declining ore grades, rising extraction costs and increasing metal demand?

## SOLUTIONS

- Integrate sensing, characterisation, geomechanics, machine automation and data analysis through the entire mine for full mine digitisation, yielding optimised decision-making and enhanced safety.
- Develop abatement and treatment technologies for mine emissions, such as methane and wastewater.
- Develop new preconcentration methods (e.g. ore sorting, selective mining and ore/waste stockpile recovery) to reduce mine waste.
- Develop and improve mineral processing and refining methods for commodities (e.g. iron ore, alumina), generating high-quality product for competitive advantage.


**Senior Experimental Scientist Helen Powell at the Geoscience Drill Core Research Laboratory. The Laboratory gives researchers the ability to derive more data and knowledge from drill cores to unlock Australia's critical minerals.**

## IMPACT

Our innovative technologies will reduce mining's environmental impact by minimising or recycling waste and reducing water and energy consumption. They will also enable step-changes in mine economics, ensuring sustained national income and industry resilience in the face of global competition, while meeting societal expectations of responsible operations. This will bring benefits to local, regional and Indigenous communities during and after mining activities and will contribute to broader national prosperity.

## CURRENT COLLABORATORS

ACARP, BHP, China Coal Technology and Engineering Group, Chrysos, DataMine, Gekko, NextOre, Queensland Alumina Ltd, Rio Tinto, University of Newcastle, University of NSW, University of Queensland, University of Wollongong.

# Reliable and responsible supply chains for critical minerals

PROBLEM STATEMENT: Critical minerals are in high demand, driven by the energy transition and national security needs. However, current global supply chains are neither reliable nor consistent with modern social responsibility expectations. How can we develop new scientific knowledge and low-impact technologies to redress these supply chain shortcomings and realise substantial onshore value addition from Australia's critical mineral resources?

## SOLUTIONS

- Develop new analytical techniques to improve the characterisation of critical mineral ores, concentrates and high-purity chemicals.
- Develop bespoke knowledge and tools for use by critical mineral exploration companies.
- Develop novel high-efficiency/low-waste technologies for primary or secondary ore processing (waste heaps, tailings).
- Develop novel high-efficiency/low-waste technologies for value-added critical mineral production or recycling from end-of-life products.
- Provide trusted analysis to Australian industry and governments and increase R&D collaborations with like-minded international partner countries.

## IMPACT

The new scientific knowledge and low-impact technologies we develop will increase the responsible supply of critical mineral ores and value-added critical materials. This will increase the reliability and sustainability of global supply chains, while boosting export income and creating new jobs.

## CURRENT COLLABORATORS

ANSTO via Australian Critical Minerals R&D Hub, Curtin University, DFAT via India Australia Critical Minerals R&D Partnership, DISR, Geoscience Australia, Iluka, Korea Institute of Geoscience and Mineral Resources, Lynas, Mineral Commodities, Minerals Research Institute of Western Australia, Panasonic, Tivan, Worley.

**Critical minerals, like magnesium (pictured), are essential raw materials for technologies like EVs, renewables, electronics, and advanced medical and defence systems. We're working across the minerals value chain, delivering R&D to accelerate mineral discovery, increase extraction efficiency and deliver sustainable mineral processing with enhanced environmental, social and governance.**

# Food and Fibre

**Challenge to humanity:** There will be 2 billion extra people on the planet to feed and clothe by 2050. Australia must remain a major contributor to global food and fibre production through our agriculture and food sectors, which are foundational to the health of Australia's economy, landscapes and people.

**Australia's aspiration:** The agricultural sector's future health and prosperity hinges on being a trusted, reliable and preferred supplier to domestic and growing export markets, such as Southeast Asia, which increasingly value healthy nutrition and natural fibres produced with demonstrably less planetary impact.

**CSIRO ambitions:** At CSIRO, we partner to innovate with Australia's agriculture and food sectors using cutting-edge science and technology. We aim to ensure Australian agriculture thrives in new climates and markets, growing healthy and productive landscapes that support vibrant rural communities.

We will do this by focusing on: (1) optimising crops and animals, (2) generating more value from foods and feeds, (3) assisting farm businesses to thrive, (4) supporting outstanding stewardship of our valuable agricultural land and (5) enabling trusted and equitable food systems.

## Improved crops and animals

Australia is renowned for its crop and animal agriculture. This has been achieved through decades of breeding for crops and animals that thrive in Australian conditions. Without selective breeding, crops and animals are at increased risk of pests and disease, climate stress and welfare concerns. These risks will evolve more rapidly in coming decades. Traditional genetics and breeding are too slow to respond to this pace of change. Over the last decade science has accelerated and powerful new approaches exist that could help us deliver faster and more precise genetics and breeding.

At CSIRO, we're dedicated to delivering improved genetics to our crop, livestock and aquaculture industries that are fit for emerging climates and markets.

Here's what we currently aim to achieve:

- **Advanced breeding** – We are speeding up the delivery of crops and animals that will thrive in agricultural systems of the future through data-driven breeding and selection techniques.
- **Engineering genomes** – Our research delivers novel traits that boost productivity, profitability and resilience in crops and animals, using precision genomic technologies that are faster, better targeted and more flexible than traditional breeding.

## More value from foods and feeds

Australian agricultural exports are mostly bulk commodities, such as grain and animal protein. This means economic value from manufacturing consumer products is captured by international companies selling products back to Australian supermarkets and, ultimately, consumers.

We're on a quest to boost the economic and nutritional value of Australian food and feed to help Australian industries capture more value through ingredient premiums and innovative, onshore food manufacture. Novel food science is solving how to use natural resources more efficiently to create highly nutritious food. This will help us to improve health outcomes for Australians while responding to changing diets and reducing our reliance on imported ingredients.

Here's what we currently aim to achieve:

- **Innovating food, feed, and by-product processing** – We are harnessing new technologies to transform Australian primary produce and food waste into valuable products and sustainable feeds. Through innovation and growing globally competitive food and feed manufacturing industries, we're supporting a circular economy that benefits everyone.

## Thriving farm businesses

Australian farmers are among the most innovative in the world; however, they face increasing challenges to remain profitable. Farm businesses need to make effective management decisions within their production system that consider risks around weather, biosecurity threats, input prices, market shifts, available workforce, social licence and regulations.

Our ambition is to ensure that now and into the future, Australian farms continue to lead the world in profitability and production of healthier crops, animals and farms.

Here's what we currently aim to achieve:

- **Prosperous farms** – Our science will support farmers to make the best management decisions for their conditions and business with accurate data and farming systems knowledge.
- **Production shifts** – We're designing novel technologies that produce more food and fibre from fewer resources, ensuring future profitability and sustainability.
- **Aquaculture** – We're working to increase Australian aquaculture production, profitability and diversity to build sustainable seafood protein sources.

## Agricultural land stewardship

Enhancing landscape value for future generations is critical to Australia's agricultural productivity and communities. Regional-scale interactions between biodiversity, biosecurity, soil health, water availability and climate need to be monitored and managed to maintain a thriving agriculture industry in Australia. Ambitious, national-scale industry transitions are under way to help Australia meet expectations of global markets in sustainability credentials and export biosecurity.

We're dedicated to building partnerships to provide the evidence needed for agrifood and fibre systems to navigate shifts and meet expectations of sustainably managed landscapes. Our work supports industry transition and market access, ensuring that sustainable and ethical practices are recognised.

Here's what we currently aim to achieve:

- **Resilient agricultural landscapes** – We are responding to market and community demands that agricultural practices meet expectations for emissions reduction and other sustainability and animal welfare requirements. We are catalysing pathways for agricultural businesses to build and demonstrate sustainability in new industries and markets and support thriving communities.

## Trusted and equitable food systems

There is growing societal and market pressure on agrifood systems in Australia and the Asia-Pacific region to sustainably deliver nutritional security and food safety. However, gaps in food system function and governance challenge equitable access, decrease nutrition quality and erode trust in the provenance, safety and ethics of food and fibre.

Our research is building trusted evidence on food system performance, trends and trade-offs. We are working towards food systems that are prosperous, nutritious, sustainable and equitable.

Here's what we currently aim to achieve:

- **Agrifood systems** – We are partnering with community, industry and government to enhance food system performance and build networks that enable diverse stakeholders to address risks and challenges. We are co-designing initiatives for food system improvements by providing knowledge, tools to guide decisions and strategies that shape policies and create incentives.

# Advanced breeding: developing crops and animals adapted to future farming environments and market opportunities

PROBLEM STATEMENT: Farmers are under pressure to stay productive and profitable, while at the same time dealing with rapidly evolving challenges of climate change, disease threats, rising input costs and resource scarcity. Delivering new genetics through breeding needs to anticipate this broad range of factors as well as addressing animal welfare, consumer requirements and regulatory changes. How do we optimise and accelerate breeding to meet these fast-moving challenges?

## SOLUTIONS

- Convert Australian cotton industry to new high-yielding varieties with improved water use and insect pest resistance.
- Develop data-based platforms for breeding companies and farmers to enhance speed, precision and effectiveness of genetic selection.
- Identify traits for improved crops and animals using AI-supported gene identification pipelines to enhance disease resistance and climate-resilient productivity.

## IMPACT

Australian breeding industries and farmers will have access to crop and animal genetics through breeding approaches that are fit for purpose for a wide range of constraints and opportunities. This will enhance animal and crop resilience, contributing to farming enterprise viability and the sustainability and profitability of agriculture.

## CURRENT COLLABORATORS

Aquaculture companies, crop breeding companies, livestock industry groups, rural research and development corporations, universities.

# Engineering genomes: improving health, welfare and value of crops and animals

PROBLEM STATEMENT: We lose much of our productivity to pests and diseases, are heavily reliant on chemical sprays and climate change is making production more challenging. Some of the crops and animals we rely on for food and fibre are unable to access their full biological potential due to limited genetic diversity and breeding approaches. How can we use genome engineering to accelerate genetic progress through precise changes to genomes, incorporating novel genetic variation and synthetic traits not found in nature?

## SOLUTIONS

- Introduce innovative genetic solutions for pest and disease resistance into crops, ensuring yields and farmer prosperity and reducing the use of agrochemicals.
- Transform Crops are transformed into bio platforms that deliver replacement or supplementary products for food, fuel, industry and pharma applications at scale.
- Heat resilience and other animal welfare improvements are achieved through novel trait or characteristic development.
- Novel functionalities are engineered into crop plants to address challenges to human health, resource use and climate resilience.

## IMPACT

Australian crop and animal breeding programs will have access to the latest science and technology. New agricultural products, beyond traditional food and materials, will generate alternative revenue streams for farmers and benefit regional communities. This will also contribute to meeting UN Sustainable Development Goals and national capacity building.

## CURRENT COLLABORATORS

Aquaculture companies, crop breeding and biotech companies, livestock industry groups, multinational biotech companies, philanthropic organisations, rural research and development corporations, universities.

# Value-adding to bioresources: innovating food, feed, and by-product processing

PROBLEM STATEMENT: Despite being a global leader in agricultural production, producing enough to feed 75 million people, Australia lacks substantial domestic food processing and manufacturing capabilities and generates over 28 million tonnes of agriculture and food waste, representing a value loss of at least a $36 billion. How can we help Australian industries create value-added products domestically and reduce or repurpose agricultural and food waste to unlock new value streams?

## SOLUTIONS

- Derive value-added products from Australia's strengths in commodity production and by upcycling food waste.
- Develop new food and feed formulations using novel ingredient sources to access evolving markets and meet international trade demand and regulatory requirements for price, nutrition, sustainability, and quality.
- Develop advanced fermentation technologies to reduce sugar and alcohol content in beverages, supporting healthier consumer choices.
- Create new ingredients from precision fermentation, molecular crop farming and bio-based processing systems to expand value creation pathways.
- Develop, optimise or scale technology platforms for domestic manufacturing to maximise value of by-products and minimise environmental footprint
- Introduce digital decision support, compliance and modelling tools to de-risk adoption of solutions and enable market access.

## IMPACT

The greater offering and introduction of new value-added foods and feeds will drive economic growth, provide upskilling opportunities and open access to new markets and export opportunities. Upcycling agricultural and food by-products will reduce the cost and amount of agriculture and food waste and enhance the value of by-products, all while balancing sustainability, safety and food security. These initiatives will increase access to healthy foods, strengthen Australia's food manufacturing sector and advance environmental sustainability through production efficiencies and the adoption of circular economy models.

## CURRENT COLLABORATORS

Agribusiness, cooperatives and hubs, federal and state governments, food companies (including start-ups and SMEs), industry associations, national food networks, rural research and development corporations, statutory agencies, universities.

# Prosperous farms: creating crop and livestock farming systems that adapt, endure and thrive

PROBLEM STATEMENT: Australian farming systems are complex combinations of many interdependent components; shifting any one component, such as changing crop mixture or rotation, can impact on the entire system. How can we make large, step-change shifts in farming systems to create greater opportunities for production and address the challenges of increasing costs, greater climate variability and pressure to adopt more sustainable practices?

## SOLUTIONS

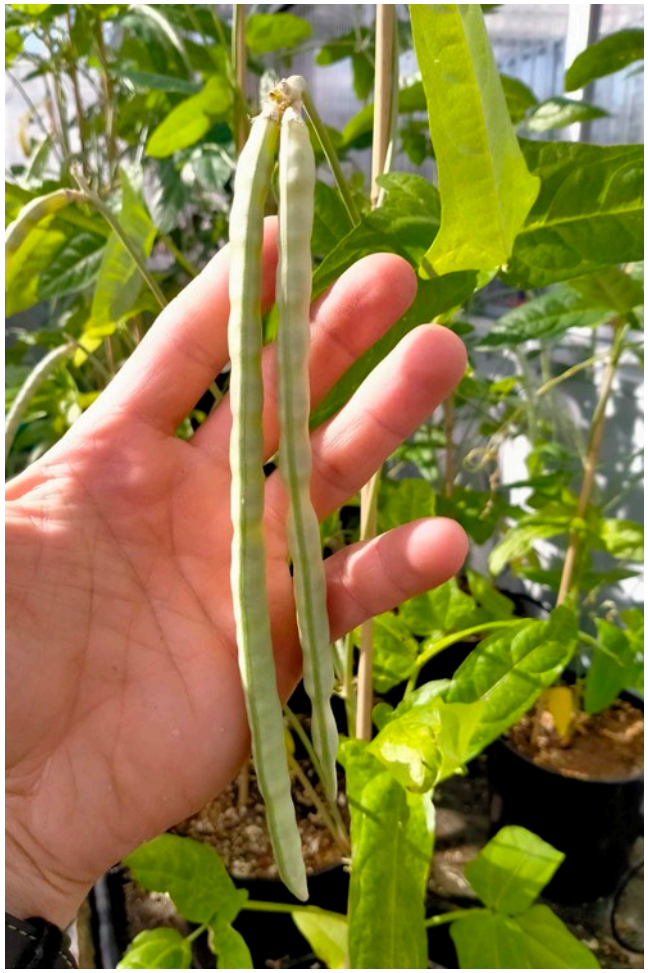
- Use long-term big data from farming systems trials to inform modelling and simulation platforms that help to mitigate impacts of climate change.
- Ensure farm managers have access to AI-supported decision-making tools to help manage complex operations and maximise sustainable farm productivity, with minimal risk.
- Harness the functional properties of crop, livestock and soil biology to ensure persistent soil health on farms despite ongoing climate challenges.
- Design farming systems to minimise inputs including chemicals, fossil fuels and labour.

## IMPACT

Farmers will increase the resilience of their agricultural businesses to climate change and market and regulatory volatility. This will contribute to the long-term, sustainable success of farming enterprises and, in turn, contribute to thriving regional communities.

## CURRENT COLLABORATORS

Agribusiness, digital agriculture start-ups, finance industry organisations, regional grower groups, rural research and development corporations, state governments, universities.



# On-farm technology: innovations and interventions that increase sustainable farm production

PROBLEM STATEMENT: While Australian farmers have a long history of harnessing technologies to increase on-farm productivity, increasing climate risk and the need to shift towards more sustainable farming practices present a complex combined challenge. How do continually innovate to co-deliver on productivity and sustainability goals in fluctuating conditions?

## SOLUTIONS

- Develop innovations that close the gap between potential and achieved farm productivity.
- Introduce new technologies that raise the productivity of Australian farming systems (e.g. soil improvement strategies, sprayable biodegradable mulches, biofertilisers, novel livestock feed additives).
- Design new technologies that enhance crop and livestock production sustainability (e.g. smart fertilisers, bacterial nitrification inhibitors, antimethanogens).
- Incorporate breakthrough technologies into Australian farming systems (e.g. green ammonia synthesis for fertiliser or fuel).

## IMPACT

Australia's agriculture sector will remain highly competitive for future decades with on-farm innovations that improve a specific aspect of the farming system (e.g. yield or livestock growth rate). These innovations will help to increase profitability and reduce the environmental impact of Australian farms.

## CURRENT COLLABORATORS

Agribusiness, agtech start-ups, biotechnology companies, regional grower groups, rural research and development corporations, state governments, universities.

# Aquaculture: growing and diversifying the Australian aquaculture industry

PROBLEM STATEMENT: Seventy per cent of the seafood we consume, including 100,000 tonnes of white-flesh fish, is currently imported. With wild fisheries unable to meet increasing consumer demand, how do we sustainably grow Australia's aquaculture sector and meet the rapidly growing demand for sustainably sourced protein?

## SOLUTIONS

- Remove bottlenecks to current species and bring new species to market to start replacing white-flesh fish imports with local products.
- Apply learnings from at-scale work internationally to the Australian context, growing Australia as a world leader in aquaculture.
- Develop situation-appropriate, sustainable, on-land aquaculture production systems for strategic and remote areas.*
- Design novel systems and sustainable aquafeeds by incorporating novel inputs and increased circularity.
- Develop a set of frameworks and credentials for sustainable aquaculture practices.

## IMPACT

Opportunities will be created for Aboriginal and Torres Strait Islander communities and new Australian businesses to access domestic markets to reduce seafood imports and international seafood markets to diversify revenue opportunities. The sustainability of aquaculture production systems will be increased, reducing pressure on wild-caught fisheries.

## CURRENT COLLABORATORS

Aboriginal and Tores Strait Islander communities and businesses, agribusiness, aquaculture companies, rural research and development corporations, state and territory governments, universities.

*INDIGENOUS SCIENCE

# Resilient agricultural landscapes: improving mitigation and adaptation for resilient industries

PROBLEM STATEMENT: Agricultural industries are increasingly impacted by events beyond the farm gate, with changing climates, biodiversity, biosecurity, soil health, water availability, community values, policy and regulation all happening at landscape scales. How can we span multidisciplinary sciences and diverse stakeholders across regions and sectors to monitor these changes and translate them to inform and enable thriving agriculture and food industries in Australia?

## SOLUTIONS

- Combine data and partnerships with scientifically informed interpretation to enable robust decision-making and learning on how to develop more resilient and adaptive agricultural landscapes and supply chains in Australia.
- Deliver climate risk assessments the provide clear and consistent evaluation of national climate risks across primary industries and inform adaptation plans.
- Derisk low-carbon liquid fuels to provide new opportunities to land users and value chain partners.
- Embed soil health information, climate knowledge and action into regional and national decision-making, improving food security and supporting livelihoods.
- Design state-of-the-art landscape-scale monitoring, reporting, and verification frameworks to enable the tracking of greenhouse gases and landscape resilience over time, supporting credible data-driven decision-making processes.

## IMPACT

Public and private sector partners will manage landscapes using evidence to build well-informed pathways to low-emission futures and interventions for multiple benefits to agriculture, the environment and their communities.

## CURRENT COLLABORATORS

Aboriginal and Torres Strait Islander peoples, agribusiness, agtech companies, aviation and mining companies, civil groups and universities, Commonwealth and state governments, finance institutions, grower groups, international governments, policy analysis groups.

# Agrifood systems: accelerating the transition to a more sustainable, trusted and equitable food system

PROBLEM STATEMENT: Across Australia and the Asia-Pacific, our food systems are oriented towards economic efficiency and safety, yet current food systems are characterised by unacceptable levels of waste, hidden environmental costs, nutritional insecurity and growing inequity. How do we help ensure our food system also delivers sustainability, equity, safety, and nutritional outcomes alongside economic prosperity?

## SOLUTIONS

- Integrate diverse sources of evidence, including industry, research and Aboriginal and Torres Strait Islander partners, to define and regularly assess the state of our national food system.
- Provide analysis, scenarios and demonstrator systems to support food system intervention and investment choices that are informed of risks and trade-offs.
- Co-design metrics on access and nutrition with Aboriginal and Torres Strait Islander peoples to inform Indigenous-led frameworks, enabling prosperity and agency.*
- Identify lessons from nutrition-sensitive fisheries management in the Asia–Pacific to inform government policy and serve as a model for healthy aquatic food systems across the region.
- Work with partners in the Asia-Pacific to inform policy and support inclusive and sustainable growth goals.

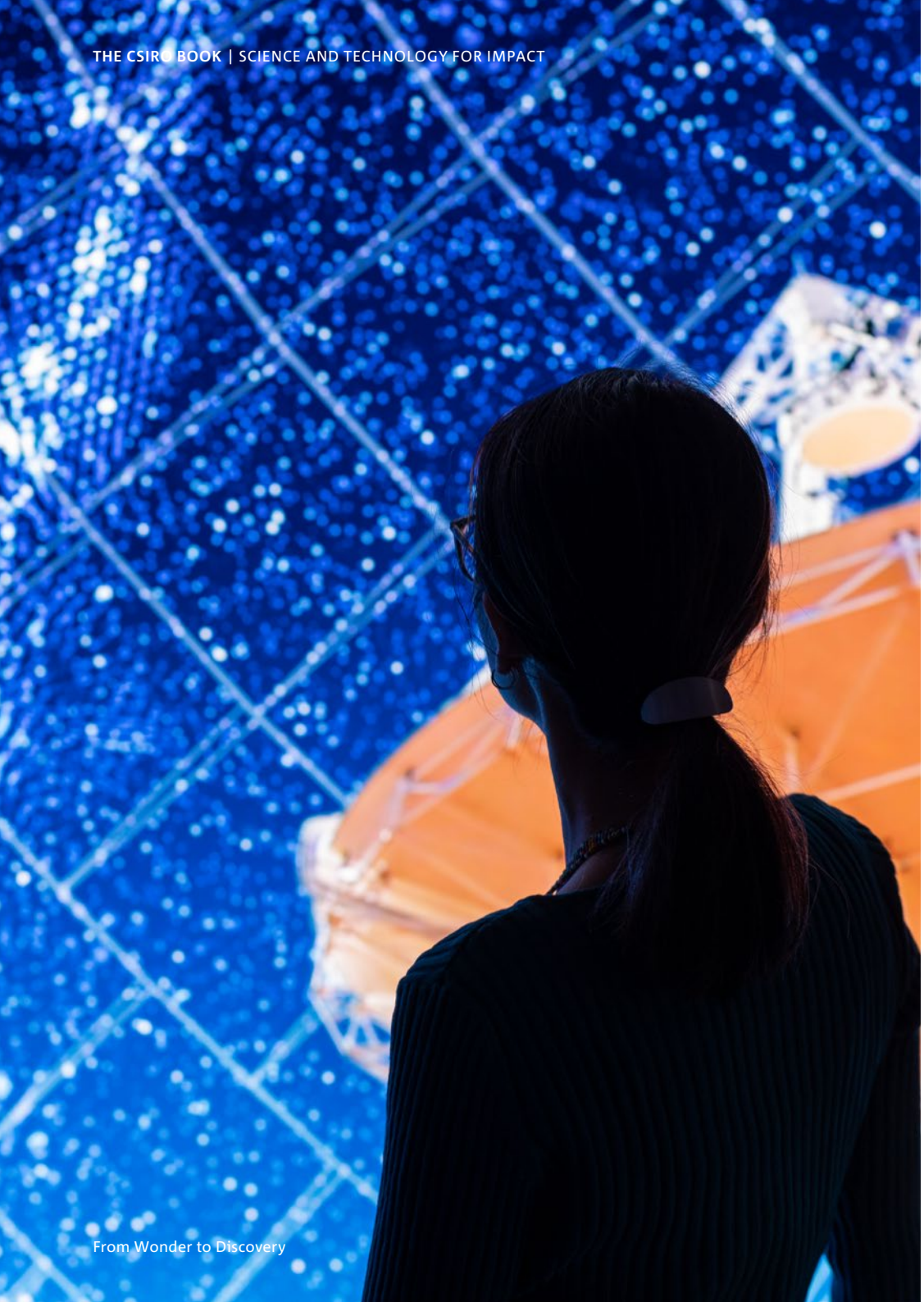
## IMPACT

Agriculture and regional food systems will meet a wide range of societal needs alongside food production. Improved social and environmental performance of food systems will ensure continued market access. Through better evidence and more effective measures of system performance, policy can be better directed with coherence improved across multiple portfolios (e.g. environment, agriculture, energy, health).

## CURRENT COLLABORATORS

Aboriginal and Torres Strait Islander communities and businesses, agribusiness, civil society organisations & NGOS, Commonwealth Government, industry groups, local communities in Asia-Pacific, policy analysis groups, private research companies, professional organisations, state and local governments, universities.

*INDIGENOUS SCIENCE



# From Wonder to Discovery

**Challenge to humanity:** A quintessential part of being human is curiosity – asking questions about the land and oceans and the animals and plants around us, the planet we live on and the Universe that we glimpse every night. Answering those questions inspires hope and wonder and often requires technological breakthroughs that have unanticipated benefits.

**Australia's aspiration:** Australia, our home, is a remarkable continent of vast, ancient landscapes, huge ocean territories, unique biodiversity and clear unpolluted skies. There remains much to discover about Australia and much of the Universe can only be discovered from Australia.

**CSIRO ambitions:** At CSIRO, we will (1) use our unique position in the southern hemisphere to support space exploration and drive innovation in remote sensing to allow us to see the Universe and the Earth in new ways, (2) radically accelerate how we discover, understand, and manage Australia's biodiversity across land and seascapes. Using new science and engineering, combined with deep knowledge about animals, plants, fungi and microorganisms, we will discover species, understand their evolution and measure the diversity of ecosystems at scale and speed, and (3) unlock the unknown, imagining breakthroughs that seem like science fiction and making them a reality.

## Exploring the Universe, understanding the Earth

By effectively managing and improving the quality of telescopes and tracking stations spanning the Australian continent, and connecting with those on other continents and with new telescopes on the Moon and Mars, we are deepening our understanding of the Universe, developing our understanding of the first stars and galaxies, finding the missing dark matter and probing the cradles of life around young planetary systems.

From space, we can observe our own planet in unprecedented detail and use this knowledge to understand the possibility of life on the millions of other planets in our Galaxy. The new technologies and data streams developed along the way are being adopted in diverse ways to the benefit of the nation and our neighbours in the region, from assisting in disaster response to managing natural resources.

We will ensure Australia's continued leadership in radio astronomy and continue to grow our connections with international partners such as NASA and the European Space Agency. We are inspiring the next generation of STEM students, scientists, engineers and space explorers, and contributing to the global quest for answers to the most profound questions about the Universe and our place within it.

Here's what we currently aim to achieve:

- **Radio astronomy and instrumentation** – Growing capability in radio astronomy to deepen our understanding of the Universe and deliver translational impact for Australia.
- **Space science and exploration** – Advancing the use of satellite-derived data to understand the Earth and benefit the environment, industry and society, and using space-related technologies to better understand our Solar System and deliver global impact.

## Wonder of life

Human life depends entirely on the goods and services provided by Earth's biodiversity – the air we breathe, the plants and animals we eat, the water we drink, our economies and the spiritual sustenance we derive from nature. Australia is a biodiversity hotspot, yet we are ignorant about most of it: how it works, and how we can ensure it continues to nurture and sustain our lives. We must make it easier to manage biodiversity by revealing its full and wonderful complexity quickly and at scale for everyone's benefit.

Our unique biodiversity reflects our continental-scale geographical and evolutionary history, as well as tens of thousands of years of Aboriginal and Torres Strait Islander peoples' custodianship. Australians believe it is the responsibility of the current generation to leave nature healthy for future generations. Despite this responsibility, we lack critical understanding: only 30% of our biodiversity has been named and classified. Discovering and sharing the beauty and complexity of our biodiversity generates wonder and connects the community to science, enables targeted actions to reverse the decline in global biodiversity and provides the foundation for discovery of new foods, medicines and pesticides.

*'What cannot be seen cannot be easily valued.'* Most Australian biodiversity is unknown and under-explored. Building on 65,000 years of discovery and on our invaluable national collections, we fill in the gaps, documenting the remaining biodiversity present on this remarkable continent before it is lost. By combining new technologies and approaches with deep and detailed knowledge about the plants and animals that make up our ecosystems, we are reinventing the tools, practices and concepts underpinning species discovery and characterisation. This will have provided an unprecedented understanding of Australia's biodiversity by 2050, creating a detailed picture of the origins and evolution of our native species and the extent of introduced and invasive species, and shining a light on the resources contained in our biodiversity and supporting its sustainable use.

*'Uncertainty is a killer for decision-making.'* We will invent new approaches to measuring biodiversity based on biomolecules, drones, and remote and autonomous sensing. We will develop new ways of integrating insights across multiple data streams which will allow governments, industry and landowners to make confident decisions and conduct interventions for environment, health and agriculture. In summary, we aim to discover and monitor Australia's biodiversity to support its management across Australia's vast and diverse land and sea environments.

## From science fiction to reality

Every now and then there are discoveries that, rather than providing incremental but important benefit, have the potential to radically transform the world. Some recent examples are the ability to rapidly create new vaccines using mRNA technology or the quantum computing revolution. Although to many in the community these breakthroughs may seem to have happened overnight, the reality is that they required many years of effort from research teams who could see the potential before anyone else and who had the resources and determination to stick at the problem.

CSIRO, with its collaborators will be able to build programs that ask, 'What if we could make science fiction a reality?'. Some of these programs will be created by expanding current work that is subscale; others will be built from scratch.

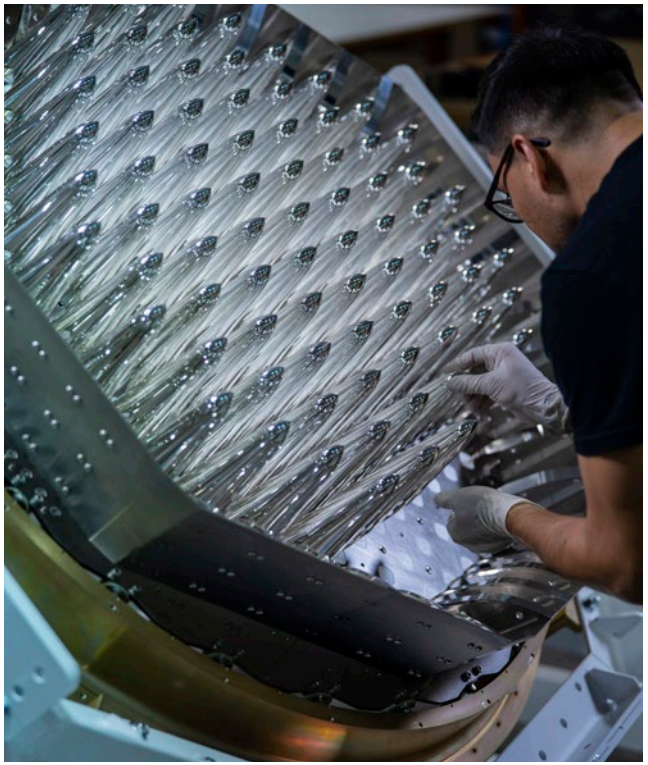
## Our call to action from you!

We are calling for science ideas from Australia and the world... from researchers, engineers, technologists, and creative thinkers in CSIRO and our broader national and global family of current and future collaborators.

If you have a curious thought bubble, a science fiction itch that you cannot scratch, or a future problem that we could solve together and at scale... then engage with us via RPortfolio@csiro.au

# Radio astronomy and instrumentation

PROBLEM STATEMENT: How do we grow capability in radio astronomy to deepen our understanding of the Universe and deliver impact for Australia?



**Our expertise in astronomy instrumentation development includes designing and constructing the specialised telescopes and equipment needed to receive and amplify radio waves from space to better understand the Universe.**

## SOLUTIONS

- Operate the Australia Telescope National Facility (ATNF) as the platform for development of new radio astronomy instrumentation in Australia.
- Have astronomers and engineers work together to maximise science impact by designing and building bespoke instrumentation.
- Develop specialist in-house capability in firmware, software, and analytics and big data.
- Provide global leadership in spectrum management, monitoring and radio frequency interference mitigation.
- Establish partnerships with national and international institutions that explore the Universe in radio and other wavelengths.
- Translate radio technologies and facilities into commercial use.

## IMPACT

**Science:** Development of phased array receivers and rapid signal detection technologies for our Australian SKA Pathfinder (ASKAP) telescope has enabled discovery, localisation and characterisation of mysterious fast radio bursts; these research outcomes have been published in *Nature* and *Science* and were recognised with the 2021 Prime Minister's Prize for Physical Science, awarded to a CSIRO technologist. Our development of a novel multibeam receiver for Murriyang, CSIRO's Parkes radio telescope, made Australia a leader in pulsar research; we are currently working on a new game-changing receiver for Murriyang.

**Global:** ATNF expertise is making a critical contribution to the success of the SKA project, and ATNF-designed and built instruments have been successfully exported, supporting international research collaboration and science diplomacy.

**Social:** Our infrastructure and radio astronomy research results will inspire the community and Australia's future STEM workforce and we will partner with Indigenous communities on whose Country our telescopes are located.

**Economic:** Deep understanding of radio waves – developed via radio astronomy – led to the invention of fast Wi-Fi, bringing direct financial benefit to Australia and the telecommunications industry. More recently, phased array receiver technology developed for our ASKAP telescope has been successfully spun-out by Quasar Satellite Technologies for space domain awareness and satellite tracking.

## CURRENT COLLABORATORS

Astronomical Society of Australia, Astronomy Australia Limited, Australian Communications and Media Authority, Department of Education, DISR, ESA, industry (in the context of spacecraft tracking), International Astronomical Union, International Telecommunication Union, Japan Aerospace Exploration Agency, NASA, SKA Observatory.

# Space science and exploration

PROBLEM STATEMENT: How can we use space-related technologies to better understand the Earth and our Solar System, to benefit the environment, industry and society and deliver global impact?

## SOLUTIONS

- Advance the use of satellite-derived data to provide nationally consistent information on water quality, bushfires, national environmental accounting and other significant challenges.
- Develop new satellite data analytics techniques for a variety of Earth observation applications.
- Establish end-to-end Earth observation capability optimised for Australian environmental conditions.
- Use the ATNF to better understand the near-Earth space environment, including behaviour of objects in orbit and the effects of space weather.
- Connect space and planetary science goals to technical innovations to create novel scientific instruments and payloads for the space environment.
- Attract strong international partnerships to help drive national innovation and achieve global impact.

## IMPACT

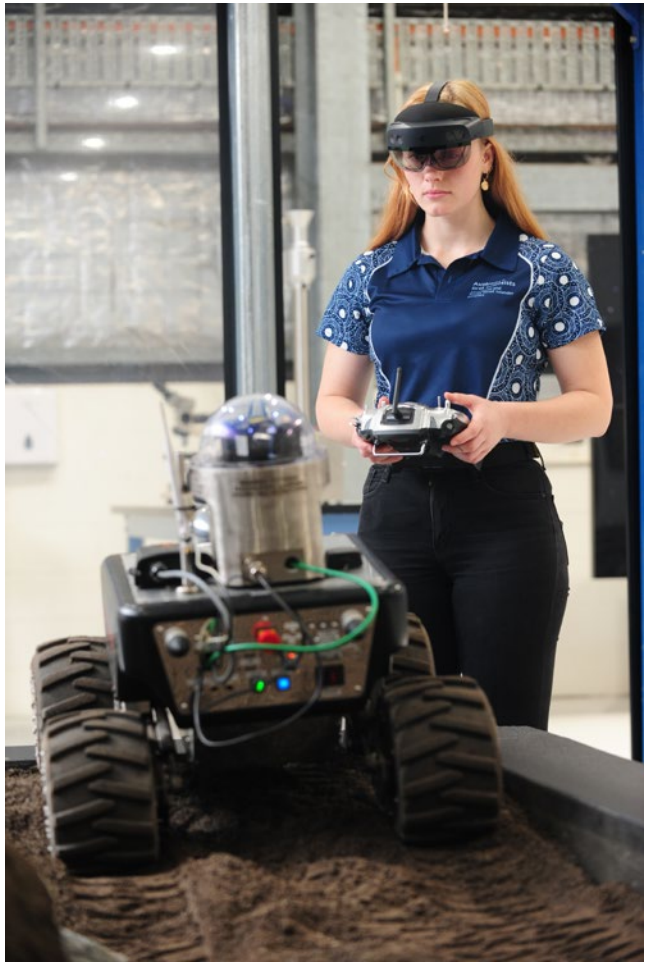
**Environmental:** The development and increased uptake of Earth observation services will contribute to climate innovation, food and water security, disaster monitoring and improved resource management, including improving data-driven decision-making for inland and coastal water quality.

**Economic:** The use of our radio telescopes for a range of space object tracking purposes, including lunar missions, near-Earth asteroids and space debris, has commercial and national security applications and will contribute to the safe and sustainable use of the space environment. Research on how the ATNF can be used to significantly improve space weather forecasts will have flow-on benefits to industry sectors including satellite operations, aviation and terrestrial electricity distribution.

**Science:** Adoption of new technologies by international space missions will support scientific inquiry, such as determining the properties of lunar regolith and the geology and structure of lunar and Mars' lava tubes; contribute to our understanding of the solar system and Earth; and facilitate future space exploration, including human exploration.

## CURRENT COLLABORATORS

Aquaculture operators, Australian Space Agency, BOM, DCCEEW, disaster recovery managers, European Space Agency, Geoscience Australia, German Aerospace Center, Japan Aerospace Exploration Agency, NASA, SmartSat CRC, UK Space Agency, United States Geological Survey, universities and commercial space industry nationwide and internationally, Vietnam National Space Center, water utility managers.



We're generating new technologies for use in space that hold the potential to generate significant benefits and commercial benefits here on Earth, including robotic systems that help humans perform dangerous tasks.

# Discovering and monitoring Australia's biodiversity

PROBLEM STATEMENT: How do we discover, understand and measure our biodiversity to support its management across Australia's vast and diverse land and sea environments?

## SOLUTIONS

- Develop and adopt multidisciplinary approaches, including Indigenous knowledge, to understand the processes creating and sustaining Australia's biodiversity.*
- Combine AI with the vast data stores held in biological collections to accelerate discovery and understanding of Australia's remarkable biodiversity.
- Enable targeted and responsive environment management through molecular science, engineering, data sciences and autonomous devices that rapidly assess ecosystem health, change and threats.
- Provide government, industry and communities with decision-making tools, cutting-edge guidance and scientific solutions for biodiversity management.

**Our National Koala Monitoring Program, using Traditional Knowledge and citizen science, will result in long-lasting capability to monitor and assess trends in koala populations across the entire species range.**

## IMPACT

Through innovative science, technology and Indigenous knowledge, we are supporting evidence-based understanding and management of Australia's remarkable biodiversity. Environmentally, our science will reduce species extinction risk, promote sustainable fisheries and forestry, and reduce the risk of biosecurity breaches. Economically, it will ensure sustained benefits from natural resources through their cost-effective and optimal management. Societally, it will enable continued human enjoyment of nature and builds appreciation of scientific and Traditional Knowledge of biodiversity.

## CURRENT COLLABORATORS

Commonwealth and state governments, international science organisations, national and international data infrastructure, philanthropic institutions, SMEs, universities.

*INDIGENOUS SCIENCE

Nature

# Nature

**Challenge to humanity:** Humanity's growing demand for food, water, energy and materials places enormous pressure on nature. Worldwide, people's lives, livelihoods and prosperity are threatened by the compounding crises of climate change, biodiversity extinctions, pollution and human population growth. Our challenge is to meet these growing demands while maintaining the natural systems that provide our material, cultural and spiritual needs.

**Australia's aspiration:** Nature-focused knowledge and management, informed by science and Indigenous knowledge, will support Australia to make evidence-based decisions and interventions that protect and enhance our unique natural environments and thrive in a changing climate.

**CSIRO ambitions:** At CSIRO, we will build capacity, capability and partnerships to enable us to ensure that the best of Australia's innovation sector is engaged in solving the current and emerging environmental crises facing our nation.

CSIRO's ambitions will emphasise: (1) advancing biological systems, (2) climate and environmental prediction and (3) engaging humanity.

## Biological systems: nature revealed and sustainably managed

Australia's unique biodiversity enriches our lives and provides the clean water, air, food and materials that sustain our economy. Yet our activities have created a biodiversity crisis, with increasing numbers of species threatened, ecosystems degraded and economic values in jeopardy.

Our ambition is to apply innovative technologies in computation, engineering, genomics, remote sensing, modelling and AI to accelerate how we understand and manage Australia's natural assets across protected areas, production zones, the ocean, and in our cities and regions. Respectful partnerships and collaborations with Aboriginal and Torres Strait Islander people to embed Indigenous knowledges and values will increasingly underpin our work.

CSIRO is dedicated to creating a nature-positive future, capitalising on our foundational scientific infrastructure, partnerships with industry, governments and communities and our unique multidisciplinary research capabilities.

Here's what we currently aim to achieve:

- **Integrated ocean stewardship** – We are transforming how we manage biodiversity, fisheries, and aquaculture to develop our sustainable ocean-based 'blue economy'.
- **Future water** – Through national leadership in science for water, we are delivering impact in the equitable use of water, sustainable and productive industries, safe communities and healthy ecosystems.

## Climate and environmental prediction: navigating a dynamic environment

Earth's atmosphere is changing, creating new, often unpredictable impacts on nature and societies. Governments, business and communities across Australia and our region need ways to anticipate environmental changes, including shocks, and to reduce their impacts. Environmental prediction systems need to improve so that decision-makers are better informed of present and future environmental hazards.

CSIRO's ambition is to track essential climate variables to ensure that Australian and global efforts to reduce climate change and the impacts of damaging pollutants are effective. We develop technologies that increase the scale and efficiency of our oceanographic, atmospheric and climate monitoring. We are designing new ways to capture and store carbon emissions.

Our aim is to ensure that Australia is prepared for and has the know-how to avoid or minimise impacts of environmental change and shocks.

Here's what we currently aim to achieve:

- **Essential climate measurements** – The effectiveness of global mitigation efforts on climate change must be monitored to inform national strategies across multiple sectors. We innovate to increase the efficiency of our region's climate observing systems, supporting early warning networks and improving our ability to predict changing Earth systems.
- **Climate intelligence and advice** – Developing and drawing on advanced modelling systems to assess physical risks associated with future emission pathways, we are supporting Australia and our neighbours to anticipate, prepare for and reduce the impacts of climate change. We provide fit-for-purpose climate intelligence to government, business and other stakeholders, enabling timely and effective decisions.
- **Environmental prediction** – Our rapidly improving predictive modelling supports the management of present and emerging environmental hazards. We develop ocean forecasts and atmospheric pollution tracking, including bushfire and smoke warnings.

## Engaging humanity: building a thriving nature-positive nation

Australia's environment is under pressure. Our population is growing, ageing and vulnerable to a changing climate. Our production systems, economic mechanisms and lifestyles are impacting the natural assets that generate our wealth and support our wellbeing. Society, business and governments need innovations that will reduce our environmental footprint and better manage natural assets across all our complex socioeconomic systems, while increasing the resilience of natural, built and social systems.

A major challenge is understanding how to transition society and the economy to achieve greater sustainability, leading to climate resilience, a reduced resource footprint and increased circularity. CSIRO can play a unique role guiding this future. Our ambition is to use a multidisciplinary approach and landmark infrastructures to tackle this wicked problem and transform Australia into a living laboratory for sustainable industries, communities and resource use.

Here's what we currently aim to achieve:

- **Transitioning to sustainability** – We identify pathways for transitioning societal, economic, and technical systems to more sustainable modes of production and consumption, be it from fossil to cleaner fuels or from linear to circular economies. Our interdisciplinary teams discover how to initiate, accelerate and guide sustainability transitions while supporting human wellbeing.
- **Transformational analytics for recovery and resilience** – We create analytical platforms for sectors such as agriculture, energy and critical infrastructure to manage their exposure to risk from unprecedented climate change.
- **Valuing biodiversity and healthy ecosystems** – By enabling industry, government and communities to measure, monitor and value ecosystems we transform the way we use, manage and restore ecosystems.
- **Reducing chemical impacts** – We support Australia's transition to a future of low-impact chemicals and wastes through programs of monitoring and responses to contaminants, innovative remediation and storage technologies, and chemical re-use technologies.

# Integrated ocean stewardship

PROBLEM STATEMENT: Development of the blue economy requires improved biodiversity, fisheries and pollution management at a time where new activities are also leading to a crowded ocean and historical patterns can no longer be relied upon to inform environmental decision-making. How can we resolve objectives and harmonise planning with integrated marine management, while investigating transitions in fisheries, offshore renewable energy, decommissioning through prediction, intervention and restoration to enhance the blue economy?

## SOLUTIONS

- Improve triple bottom line outcomes for the marine environment, industries and coastal communities.
- Work with industries, managers and Traditional Owners to co-develop approaches that achieve multiple objectives.*
- Reduce loss of waste to the Australian ocean by 80% by 2030.
- Develop risk-based frameworks for integrated management, including new activities such as offshore renewables, deep-sea mining and marine $CO_2$ removal, and include western science and Traditional Knowledge in these approaches.*
- Improve the status of marine species and habitats, using population and habitat status assessments to support testing of interventions, and co-design recovery strategies for endangered species and important habitats.

## IMPACT

Sustainable use and development of Australia's marine resources and natural capital will benefit all Australians. Wiser use of shared spaces will reduce conflict between ocean industries and for communities seeking a healthy ocean.

## CURRENT COLLABORATORS

ACIAR, Australian Fisheries Management Authority, Blue Economy CRC, DAFF, DCCEEW, DFAT, Fisheries Research Development Corporation, Indonesian and Philippines government agencies, philanthropic organisations, Seafood Industry Australia, SPC, state fisheries bodies, universities.

*INDIGENOUS SCIENCE

# Future water

PROBLEM STATEMENT: How do we secure and protect Australia's water resources for the continued prosperity of Australia and the region?

## SOLUTIONS

- Advance predictive hydrological and ecosystem models to support water management, and implement plans to adapt to an increasingly dynamic and changing climate and climate system.
- Undertake integrated assessments to prioritise investments for infrastructure to deliver safe and secure water to regions, protect natural environments and support sustainable productivity and growth for industries.
- Deliver trusted environmental information and fit-for-purpose assessment methods to support decisions at the nexus between water and energy security for the transition to a net zero future.
- Advance remote, field and laboratory capabilities for improved measurement, data analysis and enhanced predictions of hydrological and ecological systems undergoing change.
- Develop and deliver cutting-edge digital technologies to uplift water and environmental management.
- Use Indigenous science, knowledge and values for water and the environment to empower people, build capacity and improve water science.*

**The River Murray near Renmark, South Australia, where we have been researching evapotranspiration techniques in our portfolio of research over the last 18 years.**

## IMPACT

CSIRO will continue to be a national leader in delivering science for water security, delivering impact in the equitable use of water, sustainable and productive industries, safe communities and healthy ecosystems.

## CURRENT COLLABORATORS

ACIAR, AIMS, BOM, Commonwealth Environmental Water Holder, DCCEEW, DIRDCA, Geoscience Australia, Google, Great Barrier Reef Foundation, Hunter Water, Melbourne Water, Murray–Darling Basin Authority, NEMA, state governments (NSW, NT, QLD, SA, VIC), universities, World Bank, World Wildlife Fund.

*INDIGENOUS SCIENCE

# Foundational climate monitoring and understanding

PROBLEM STATEMENT: How do we monitor the changing Earth system across our region, efficiently and at scale, so we can improve our understanding and ability to predict future change (in the Earth system), and track and evaluate the effectiveness of climate mitigation and adaptation interventions?

## SOLUTIONS

- Conduct observation and monitoring as the body with national responsibility for observing essential climate variables across our region, including atmospheric composition (greenhouse gas and aerosol concentrations), ocean biophysical (ocean heat, sea level and biogeochemistry-carbon) and some terrestrial biosphere variables.
- Develop, test, adapt, calibrate, validate and optimise deployment of *in situ* and remotely sensed observing infrastructure, so that our essential climate variable monitoring networks are measuring what is required, where required, as cost-effectively as possible.
- Develop, test and apply analysis methodologies for data from observations and models to improve understanding of climate variability and change, and the interactions and processes that drive changes in climate forcing and hazards.
- Lead and collaborate on the development of data standards for data formalisation and exchange, ensuring interoperable, analysis-ready data are available across national and international communities.

## IMPACT

Sustained monitoring of Australia's essential climate variables will inform evidence-based policies and climate action, ultimately playing a key role in protecting ecosystems, economies and human health from the adverse effects of climate change. The observations will underpin scientific research on climate systems, building an understanding of climate forcing for our region, and the robustness of our natural systems, while also supporting necessary climate model improvements. These will allow policymakers, scientists and stakeholders to detect trends, monitor and predict climate variability and change, assess and disclose climate-related risks, and evaluate the effectiveness of climate mitigation and adaptation efforts.

The approach will foster international collaboration by providing a common foundation for climate-related decision-making, in support of international agreements such as the Paris Agreement and similar protocols.

## CURRENT COLLABORATORS

AAD, AAPP, ACCESS-NRI, AIMS, ANSTO, ARC Centre of Excellence 21st Century Weather, Atmospheric Composition and Chemistry Observations and Modelling community, Australian Accounting Standards Board, Australian Antarctic Science Program, Australian Climate Service, BOM, CORDEX, DCCEEW, Defence, DISR, Geoscience Australia, IMOS and partners, INCOIS, industry climate reporters, IOC, IPCC, JAMSTEC, MNF, NCI, NESP, NIWA, NOAA, state EPAs, Terrestrial Ecosystem Research Network, WMO.

# Climate intelligence and advice

PROBLEM STATEMENT: Our weather and climate are changing and will continue to change, impacting many aspects of Australian life. To plan, prepare and adapt, every sector needs Australia-relevant, authoritative information and advice, delivered at the scale and locations of their interest. How do we meet this growing demand, while maintaining the quality of information and advancing the science that underpins it?

## SOLUTIONS

- Leverage our state-of-the-art monitoring systems to develop sophisticated Earth system models, including AI analogues, to inform future climate risks associated with the long-lived effects of greenhouse gas emissions.
- Pioneer developments related to climate changes and climate phenomena affecting our region, via the development of climate models and other lines of evidence.
- Develop tools to improve and independently verify national greenhouse gas accounting, to maximise Australia's carbon sequestration opportunities.
- Develop deep understanding of how Australia's weather and climate are changing and how they will change in the future through modelling, observations and climate process understanding.
- Identify critical locations subject to climate and weather pressures (drought, flood, bushfires, heatwaves, cyclone, sea level rise and coastal extremes).

- Clearly communicate authoritative and relevant information and advice that allows the nation to anticipate future climate associated risks and opportunities.
- Create climate knowledge and tools that are easy to use and understand, and designed with stakeholders to address their decisions and support their risk frameworks and risk disclosure reporting.
- Provide science-based guidance, expert elicitation and advice in adaptation planning to support effective outcomes within Australia and our neighbouring region.

## IMPACT

By 2050, Australia will have anticipated the changing climate and related hazards and have implemented adaptation and mitigation strategies to minimise the impact and identify potential opportunities in the emerging climate on Australia's environment, economy and people.

**Social:** Climate-resilient communities will be better prepared for climate disasters, with loss, damage and disruption to communities minimised.

**Environmental:** Resilience of the natural environment will be enhanced and ecosystem function maintained through better responses to weather and climate disasters.

**Economic:** The costs of climate change impacts, adaptation and mitigation solutions will be reduced, with climate risks understood and disclosed, informing climate-resilient investment.

## CURRENT COLLABORATORS

AAD, AAPP, ABS, ACCESS-NRI, ACS, AFAC, ARC Centres of Excellence for 21st Century Weather, Bluelink, BOM, Bush Heritage, Climate Change Authority, DAFF, DCCEEW, Defence, DFAT, DISR, Geoscience Australia, Global Carbon Project, INCOIS, IOC, IPCC, JAMSTEC, MIT, MLA, National partners, NCI, NCRIS, NEMA, NESP, NIES (Japan), NIWA (New Zealand), NOAA, SPC, SPREP, Standards Australia, Treasury, WMO, WPRC.

# Environmental prediction

PROBLEM STATEMENT: Natural and human-driven environmental hazards cost Australia approximately $40 billion per year and are increasing yearly. We need to continually improve our predictive capability and information delivery for better management of present and emerging hazards.

## SOLUTIONS

- Prediction of past (hindcast), present (nowcast) and future (forecast) environmental conditions.
- Evaluate the accuracy of environmental models and combine them with real-world observations to ensure predictions are reliable and can be applied with confidence.
- Model environmental management strategies and predict the impact of interventions.
- Develop integrated multidisciplinary modelling systems.
- Use climate projections and environmental models to future-proof and refine local or regional level management strategies.
- Create transformational digital tools to deliver complex environmental predictions to environmental, economic and health decision-makers.

## IMPACT

Robust environmental predictions delivered to decision-makers will improve environmental, economic and health outcomes.

**Social:** Safer, more resilient communities will be better prepared for natural disasters, with informed solutions for future environmental challenges and better human health through improved air and water quality.

**Environmental:** The resilience of the natural environment will be enhanced, ecosystem function maintained through better responses to natural disasters, and species threatened by environmental events will be managed using robust predictions.

**Economic:** Risks of climate extremes will be captured in investment and management decisions, with reduced cost of disasters.

## CURRENT COLLABORATORS

ABS, AFAC, Asthma Australia, Australia Maritime Safety Authority, DCCEEW, DFAT, European Space Agency, Fisheries Research and Development Corporation, Great Barrier Reef Foundation, James Cook University, NASA, NCRIS, NEMA, Southern Cross University, state and territory governments, University of Queensland, University of Tasmania, University of WA.

# Managing sustainability transitions

PROBLEM STATEMENT: The intersecting social and economic changes required to achieve Australia's net zero, climate adaptation and resilience, circular economy and nature-positive commitments are complex, uncertain and contested. How do we navigate these challenges to ensure change is purposeful and guided?

## SOLUTIONS

- Identify feasible economic and social transition pathways across net zero emissions and disaster resilience.
- Increase circularity and reduce the material footprint of society.
- Mainstream new or disruptive technology and industry solutions in socially responsible ways.
- Enable investment, governance and practice to drive resilience and sustainability transitions.
- Establish metrics, governance and learnings to reduce risk and enhance benefits during and beyond the transition.

## IMPACT

Transitioning to net zero, circular, nature-positive economies will enable Australians to reduce our material footprint and build climate-resilient, prosperous and biodiverse regions, cities and infrastructure. Co-designing this transition with diverse stakeholders will empower communities through benefits shared from new industries and technologies and incorporation of Traditional Knowledges of Aboriginal and Torres Strait Islander peoples.*

Successful sustainability transitions will enable inclusive and adaptive governance, foster resilient communities and, ultimately, support the broad economic participation and just and equitable societies that allow all Australians to thrive.

## CURRENT COLLABORATORS

Celestino, Cleanaway, Commonwealth Bank, DCCEEW, Department of Home Affairs, NEMA, regional collaborations, state governments, Treasury.

*INDIGENOUS SCIENCE

# Transformational analytics for recovery and resilience

PROBLEM STATEMENT: How can Australia be at the leading edge of recovery and resilience efforts across sectors such as infrastructure, emergency management, agriculture, energy, health and water through the effective implementation of cutting-edge AI, scalable data-driven analytics and insights gleaned from a plethora of sources?

## SOLUTIONS

- Develop secure and trustworthy digital platforms that integrate real-world data from sensors and satellites, combined with advanced big data analytics, AI and predictive modelling, to tailor insights for resilient decision-making and recovery.
- Model acute risks (e.g. floods, wildfires) and their consequences (e.g. ability for people to evacuate quickly, infrastructure planning).
- Model and analyse chronic risks (e.g. sea level rise, high temperatures) and their consequences (e.g. reduced agricultural productivity, variability in renewable energy generation).
- Tailor impact and risk outputs for specific sectors by integrating sector-specific data (e.g. infrastructure, climate, soil, energy use).
- Translate modelling outputs for diverse decision-making contexts, such as regulatory and strategic asset management.
- Develop scenario planning platforms to anticipate conditions, manage productivity, and evaluate adaptation strategies.

## IMPACT

We will drive the human-centred development of innovative, scalable digital platforms to enable the large-scale adoption of geospatial AI and analytics solutions for scientific advancement and data-driven insights for resilience building across sectors for Australia and for our overseas partners especially in the Indo–Pacific. This unified platform will support both scientific development and the delivery of AI-powered geospatial solutions, fostering a seamless and efficient ecosystem for research, innovation and real-world impact. Informed decision-making empowers communities, reduces vulnerability and creates jobs. Prevention and management of long-term risks will preserve resources, promote sustainability and improve productivity, allowing investment in, and development of, infrastructure by keeping environmental impact at the forefront.

## CURRENT COLLABORATORS

ACS, AFAC, Asia Development Bank, Bappenas Indonesia, BOM, Cardiff University, Copernicus Program EU, DAFF, Data Analytics for Resources and Environments (DARE) Centre (8 participating Australian universities), DCCEEW, DFAT, DOST Philippines, Grains Research Development Corporation, IBM, Monash University, NASA, state and local government areas, Turing Institute UK, UK Met Office, UNDP, University of Melbourne, World Bank.

# Valuing and restoring biodiversity and healthy ecosystems

PROBLEM STATEMENT: How can we transform the way Australia and its neighbours value and restore terrestrial and marine ecosystems to improve ecosystem extent and condition at scale by 2035?

## SOLUTIONS

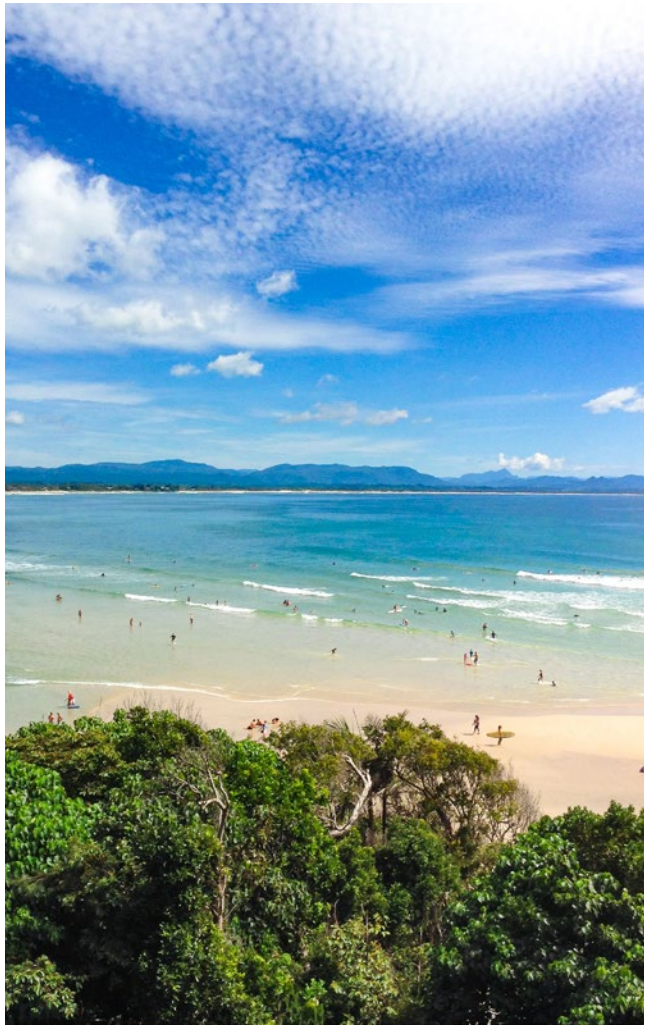
- Transition business models to embed nature into business practices and develop methods to track nature across supply chains.
- Value ecosystem services and Indigenous and cultural values flowing from nature and develop methods for transparently reporting these services.*
- Improve biodiversity outcomes through improved assessment of current and future biodiversity impacts and drivers.
- Design digital technologies to assess and track changes in our biodiversity, carbon and water footprints across land and seascapes.
- Identify techniques to build system resilience and recovery that enable ecosystem management and restoration at scale.
- Develop catchment-to-coast solutions that improve restoration outcomes.

## IMPACT

A growing global focus on nature-positive outcomes positions CSIRO as a leader in integrated approaches for valuing biodiversity and ecosystem health, with consistency across scales, spanning private and public sector needs and a diversity of societal objectives. Uptake of our innovations and technologies will revolutionise the ways ecosystems are valued, managed and restored across business, government, Indigenous communities and broader society.

## CURRENT COLLABORATORS

CRCs, environmental NGOs, Commonwealth and state government, industry (mining, forestry, agriculture, construction), R&D corporations, standards setters, universities.



*INDIGENOUS SCIENCE

# Pollution and waste

PROBLEM STATEMENT: How do we prevent and remove Australia's pollution and waste legacy and build a sustainable industry sector that preserves and protects the natural environment?

## SOLUTIONS

- Coordinate national detection, risk forecasting and response to wastes, contaminants and biologicals of concern.
- Develop innovative remediation, management, storage and disposal solutions for problematic chemical, biological radioactive and nuclear wastes.
- Promote chemical, biological and engineering processes that build the reduce–reuse–recycle technology chain in Australia.

## IMPACT

**Social:** The social licence for government and industry will be strengthened, with CSIRO seen as a trusted advisor for safe waste solutions, protecting the health of Australia's citizens, predicting pollutant threats and enhancing resource recovery.

**Economic:** Clean-up and management costs will be reduced while building a new era of industrial sustainability through technologies that enable new waste-based markets, cost-saving, low-impact industrial operations, and a nature-positive production economy.

**Environmental:** The resilience of Australia's ecosystems will be protected and enhanced through removal of the nation's waste legacy, minimising ongoing pollution and building global leadership in environmental protection.

## CURRENT COLLABORATORS

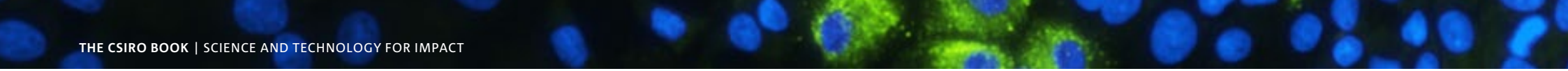
AECOM, ANU, ANSTO, ARPANSA, Australian Radioactive Waste Agency, Australian Submarine Agency, ASNO, BHP, BP, Charles Sturt University, Chevron, DEECCW, Department of Defence, Green Stormwater Infrastructure, Jacobs, Murdoch University, state EPAs, Texas Tech, University of Adelaide, University of California Los Angeles, University of Newcastle, University of Queensland, University of WA, US Department of Defence, Veolia.


# One Health

**Challenge to humanity:** One Health recognises the deep connectedness of health in people, animals and ecosystems. That intrinsic connectedness is an enabler for health in our biosphere but is being threatened as never before by existential threats that are complex, growing and synergistic. They include climate change; increasingly intense use and degradation of land, air and water resources; and globalisation, with its exponential growth in the global movement of people, animals and goods. This is driving increased spread and increased incidence of diseases; direct and indirect impacts on human health; and incursions of exotic and invasive species.

**Australia's aspiration:** Australia aims to leverage its biodiversity and elevate Indigenous knowledge to address climate change, invasive species and emerging diseases. By integrating cross-sector data and Indigenous knowledge, Australia seeks to predict and mitigate impacts on community and environmental health, enhancing overall wellbeing across the One Health system.

**CSIRO ambitions:** At CSIRO, we envision a future in which cross-sector collaboration and data-driven policies ensure the resilience of our precious biosphere; prevent health crises; and ensure equitable healthcare access and outcomes for all. One Health is the key to a resilient nation, protecting global ecosystems and working to eliminate health disparities, recognising the wellbeing of all species and the planet as integral to our collective future.



The fate of our health as a species is inextricably linked with the fate of wild and domesticated plants and animals, and of the environment that sustains us all. In seeking solutions to our health and wellbeing challenges – indeed, for us collectively to flourish – we must consider solutions, innovations and technologies that support human, animal and environmental health. This is the essence of One Health. Equally, it recognises that the broader determinants of health sit largely outside the health sector and include environmental, social, geopolitical, economic and commercial drivers and the human–animal interface with its implications for health security and pandemic potential.

CSIRO's ambitions prioritise: (1) strengthening capability for high-consequence infectious diseases, (2) catalysing Australia's biosecurity, (3) One Health digital transformation and (4) One Health at scale.

## Strengthening capability for high-consequence infectious diseases

As the threat level of infectious diseases grows globally, Australia requires a system that addresses the existing disease burden and mitigates the potentially catastrophic consequences of new, emerging and re-emerging animal and zoonotic diseases, including those with pandemic potential. CSIRO collaborates with international partners to proactively detect, prevent, manage and mitigate threats to human, animal and ecosystem health. CSIRO is working to create a robust prevention, surveillance and response capability that will minimise the social, environmental and economic impacts of disease. Our connections, capability and infrastructure ensure that we are uniquely placed to respond to natural, accidental and intentional biothreats.

These efforts are underpinned by the development and adoption of diagnostics, surveillance and early warning systems that are exemplary on a global scale; predictive epidemic modelling; and human and animal vaccines. Integral to these efforts is a deep understanding of pathogen characteristics and evolution, transmission dynamics, host responses, and environmental and anthropogenic drivers. CSIRO's efforts deliver to national and international action plans, such as the Coalition for Epidemic Preparedness 2.0 100 Day Mission and the Quadripartite (FAO, WHO, WOAH, UNEP) One Health joint plan of action.

CSIRO's strong global partnerships, operational capabilities, fundamental role in translational research, and engagement with policy makers across the animal, human and health sectors place us in a unique position with both the capability and responsibility to be the driver of cross-sector preparedness, mitigation and responses for infectious disease. Taking a proactive leadership approach to the science, data management and coordination efforts required, we will significantly reduce the risk and impact of outbreaks and pandemics and reduce the burden of zoonotic diseases.

Here's what we currently aim to achieve:

- Mitigating the impacts of infectious disease threats.
- Detecting dangerous emerging infectious diseases to protect Australia's livestock and people.

## Catalysing Australia's biosecurity

We're using new biological detection and control technologies to protect Australian agricultural and environmental systems. This will protect industries from invasive, exotic and endemic pest and disease threats and support the unique flora and fauna of the Australian landscape, in turn supporting livelihoods, the economy and community wellbeing. By developing rapid and effective response capabilities, we will ensure agility and timeliness in addressing the rapidly changing and complex threat landscape, mitigating impacts and optimising investments.

We will transform our biosecurity systems and approaches by developing and deploying novel and robust methods and technologies to monitor and detect pest and disease threats internationally, prevent their entry to Australia and prepare for them, thereby reducing the impacts of any incursions. In prevention, early detection and control, we will apply One Health principles to ensure that complex decision-making processes take account of the trade-offs and take a holistic view of the biosecurity ecosystem.

Close international collaboration will be critical to maximising the potential innovations and system transformations for local, national, regional and global impact. CSIRO's efforts will be aligned with the Commonwealth Biosecurity 2030 Roadmap and National Biosecurity Strategy.

Here's what we currently aim to achieve:

- Transforming biosecurity systems and approaches.
- Protecting agricultural, environmental and cultural systems from high-consequence native and introduced biological threats.

## One Health digital transformation

CSIRO has deep expertise in digital health that drives solutions for better health outcomes for Australians. By supporting the widespread adoption of digital health standards, we are enabling connected care and patient engagement across our health system. By collaboratively developing and facilitating the widespread adoption of digital health standards we are enabling a fully connected and patient-centric health system. This includes quality models of virtual care for primary care, acute care, aged care, disability care and Indigenous health programs. We are also bringing AI to healthcare and health research – driving precision healthcare. This foundational transformation allows all Australians to access healthcare wherever they are and enables clinicians to make informed decisions.

Our research is transforming the way health data is captured and shared and is leveraging and embedding technologies such as AI and genomics into the health sector. With this we can improve patient engagement, clinician support, surveillance, modelling, prediction and deep data analytics that human health systems require for impact, quality, safety and efficiency. Beyond precision healthcare, this data transformation will establish a foundation for more effective prevention, with an objective to understand how we can prevent diseases occurring and delivery healthy years of life for the population.

The technologies driving the transformation of our health system have applications across One Health domains. Looking ahead, these technologies can be readily applied to create ecosystem level solutions under a One Health at scale approach, a complementary Ambition. Applying our approaches across One Health domains makes manifest the relationships, causal pathways and interconnections to inform threat management and enable of positive impacts across sectors. The outcomes are improved patient outcomes and a sustainable healthcare system.

Here's what we currently aim to achieve:

- Accelerating connected and informed healthcare.
- Artificial intelligence transforming healthcare and health research.

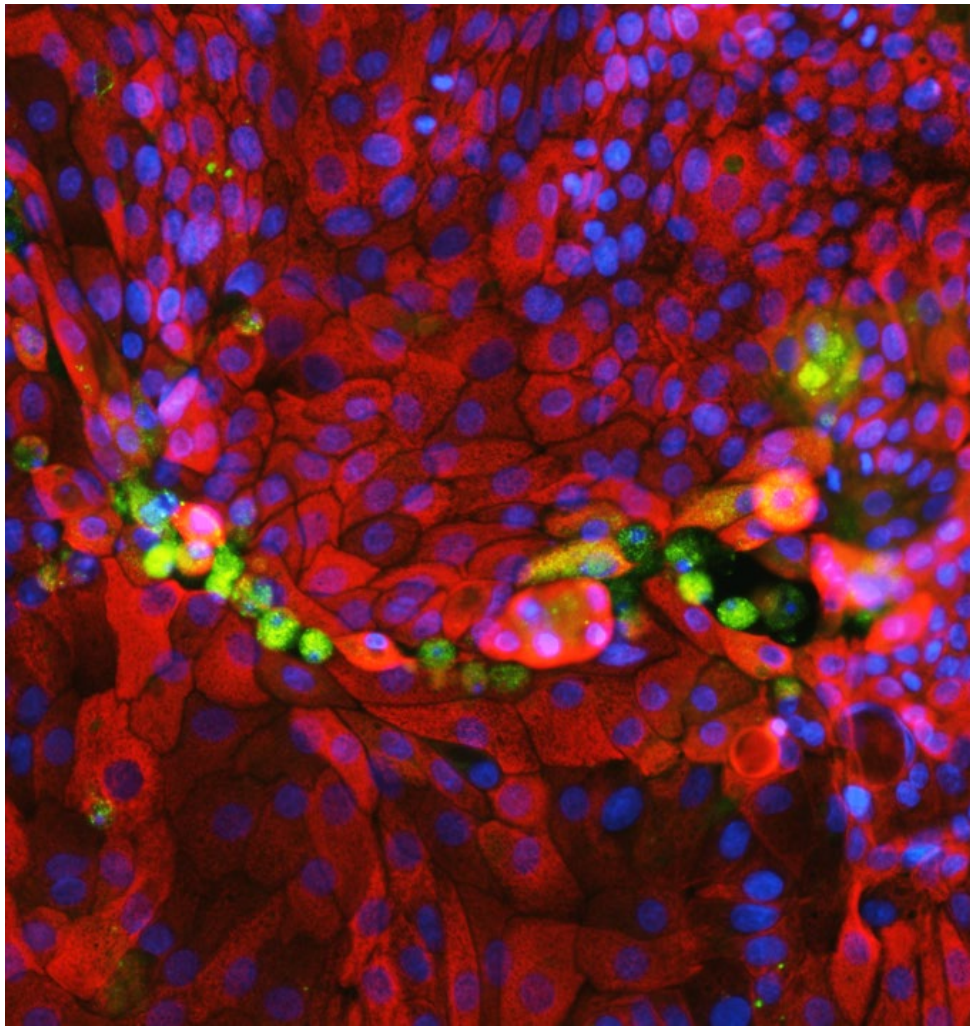
## One Health at scale

Our expertise in the diverse drivers of individual and community health, animal health and environmental health will be harnessed to deliver and evaluate large-scale interventions, targeted to geographical or demographic areas of vulnerability and potential impact. The Murray–Darling basin, with its profound dependencies across the environment, animal and human populations, is one example of where a One Health approach should be scaled and evaluated. While holistic water management has been highlighted for this region, there are already substantial challenges related to invasive animals and plants and an ecosystem vulnerable to climate change with all its myriad consequences. The region has seen Japanese encephalitis virus emerge as an endemic threat and is characterised by rural populations with challenges in accessing healthcare. Addressing broader determinants of health and prioritising prevention in this region is of critical importance – and as a region of high economic, agricultural and tourism value, there is undeniable value in protecting this unique ecosystem and applying lessons nationally and internationally. Equally, regions such as Far North Queensland, Arnhem Land, the Wheatbelt of WA and others could all be addressed through a One Health approach to the challenges they face.

Such One Health interventions, insights and impacts are underpinned by the development of a robust, at-scale community, biosecurity and environmental health intervention architecture. This includes a comprehensive, connected set of data indicators for direct and indirect health determinants and outcomes; all appropriately tailored for community context, deeply cognisant of current and emergent inequities, and available in real time.

Here's what we currently aim to achieve:

- Increasing healthy years of life for Australians.



Close up of rabbit liver organoid cells, showing the virus proteins in green, cell nuclei in blue and liver cells in red. © Dr Egi Kardia.

# Mitigating the impacts of infectious disease threats

PROBLEM STATEMENT: Australia is under constant threat from high-consequence pathogens impacting human and animal health and our economy. How do we mitigate the impacts of the most significant current and future threats of high-consequence pathogens in our region?

## SOLUTIONS

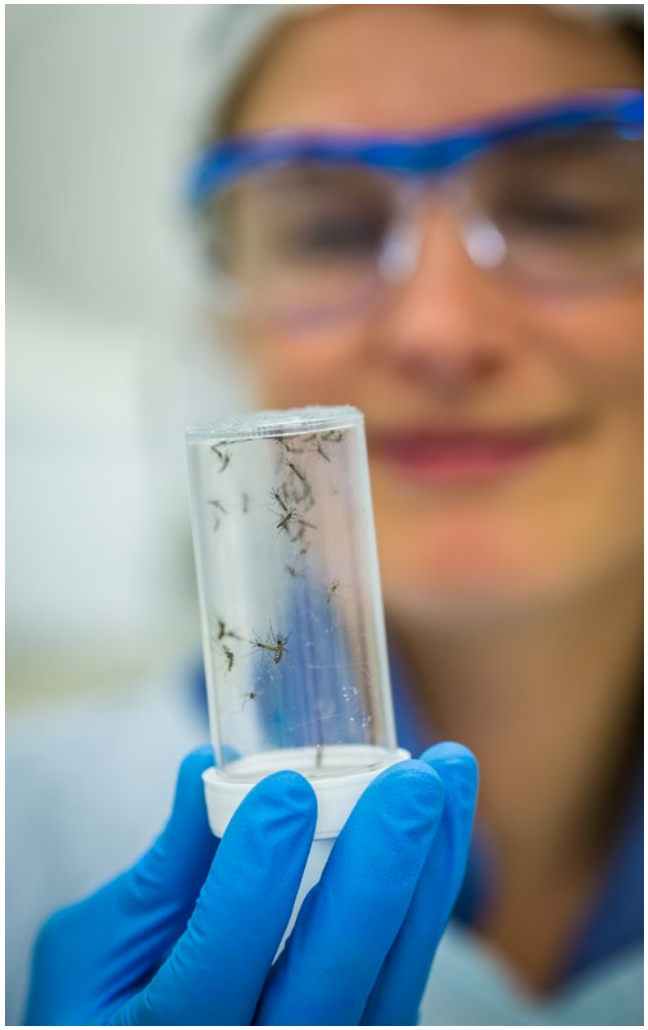
- Enhance early and accurate prediction and detection through new animal diagnostics, predictive models and disease surveillance, leveraging advances in data integration, AI and statistical analysis.
- Identify the epidemiological drivers of infectious disease emergence including transmission at the wildlife–livestock–human interface for vector-borne and zoonotic disease.
- Develop new interventions and risk modification approaches that can prevent disease outbreaks or mitigate their impact: vaccine platforms and delivery systems, genome engineering for disease resilience, vector control, behavioural and environment interventions, antimicrobial stewardship.
- Establish new animal and 'advanced cell models' designed to better understand the virulence and evolution of pathogens as well as host–pathogen interactions.

## IMPACT

Improved health and wellbeing for humans and animals will results from the reduction in the spread of infectious disease, with improved quality of life, protection of the livestock industry and increased economic productivity.

## CURRENT COLLABORATORS:

AgriFutures, Australian Centre for Disease Control, Australian Eggs, Bio properties, BOM, Charles Sturt University, Coalition for Epidemic Preparedness Innovation, DAFF, Dairy Australia, Department of Health and Aged Care, DFAT, DISR, Fisheries Research Development Corporation, Gates Foundation, James Cook University, MBF Therapeutics, Monash University Deakin University, MTP Connect, Oxitec Australia, Poultry Hub Australia, state governments (health, agriculture, primary industry and environment portfolios), University of Melbourne, University of Queensland, US Department of Agriculture, USA Food and Drug Administration, USA National Institutes of Health.



# Detecting dangerous emerging infectious diseases to protect Australia's livestock and people

PROBLEM STATEMENT: Australia's multibillion dollar animal industries and wildlife are under constant threat from exotic and emergency animal diseases. How do we diagnose dangerous emerging, zoonotic and exotic infectious diseases in Australia and the region?

## SOLUTIONS

- Continuously validate priority animal and zoonotic disease diagnostic tests and bioinformatics pipelines against regionally significant strains and variants (e.g. H5N1 highly pathogenic avian influenza).
- Deliver approximately 50,000 validated diagnostic tests for surveillance, quarantine, exclusion and innocuity per year for over 200 animal diseases for government and industry, including the National Avian Influenza Wild Bird Surveillance Program.
- Provide technical advice to outbreak response committees such as Australia's National Animal Health Committee and working groups such as the Public Health Laboratory Network Review Panel on Zoonotic Flavivirus Diagnostics.
- Design, conduct and participate in disease outbreak or biothreat simulations such as Exercise Waterhole 2023 and Exercise Volare 2024 to test and improve response plans.
- Develop and conduct adventitious agent 'innocuity' testing for biopharmaceutical companies to enable the safe import and export of biological products
- Develop training materials and deliver capability development programs for biosafety, quality assurance and priority disease diagnostic tests that are suitable for audiences across the Asia–Pacific region.
- Coordinate laboratory networks and provide proficiency testing services for over 100 globally positioned diagnostic laboratories.

## IMPACT

These solutions will result in the early detection of diseases impacting Australia's animal industries and people. National and international partners can subsequently respond more effectively to biosecurity incidents, mitigating onward spread to Australia and enhancing food and health security. Response agencies are further supported to implement efficient and effective outbreak control strategies informed by sound science following the initial detection, mitigating the health and market access impacts.


## CURRENT COLLABORATORS

Australian animal industry associations, biopharmaceutical companies, US FAO, Commonwealth and state governments, international high-containment laboratories, livestock product importers and exporters, research and development corporations, WOAH, WHO.

# Transforming biosecurity systems and approaches

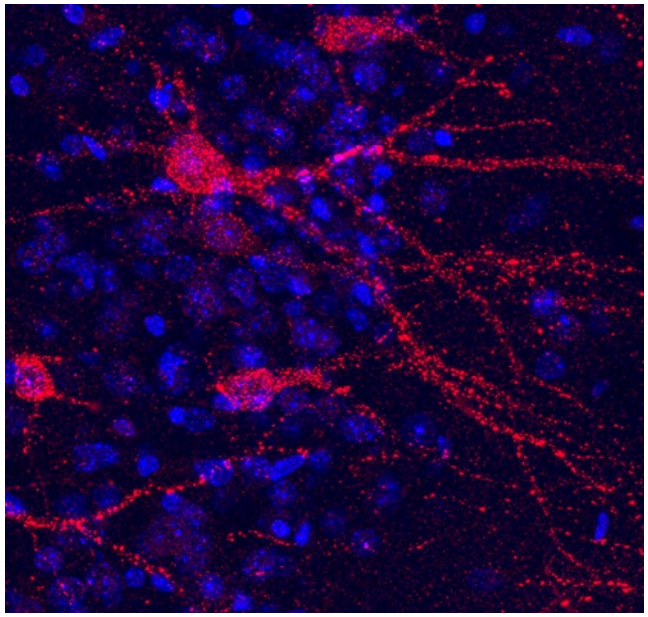
PROBLEM STATEMENT: In the face of increasing global risks from exotic, high-impact biological threats, Australia's biosecurity system requires technological transformation to maintain agricultural productivity and secure market access, while also protecting our environment. How do we sustainably prevent, prepare for, detect and respond to biosecurity threats through developing and deploying next-generation genomic and digital decision-support systems?

## SOLUTIONS

- Develop and deploy data systems and workflows to enable real-time data integration along the value chain for decision support and demonstration of biosecurity credentials, and embed commodity/pest-specific risk management tools in partnership with industry.
- Identify diagnostic biomarkers for plant and animal biosecurity to deploy into industrial settings, and build biosecurity alliances to enhance regional (Asia–Pacific) research and capability uplift.
- Develop and deploy genomic, internet and remote sensing data capture/analytic systems for threat surveillance to manage introduction pathways.
- Consolidate and connect existing modelling platforms for prevention, preparedness and emergency response and further develop state-of-the-art platform infrastructure to complete the gaps in preparedness and emergency response decision-making in animal and plant biosecurity.
- Apply human-centred co-design and responsible innovation approaches to technology and digital system co-design, co-development with Aboriginal and Torres Strait Islander communities and other public sector contexts.*
- Create and support platform infrastructure to house federated biosecurity data respecting Indigenous cultural and intellectual property.*

## IMPACT

Partnering with government and industry, we will develop next-generation genomic and digital decision-support systems to prevent, prepare for, detect and respond to high-impact biological threats. Under a technologically enabled biosecurity system, our agriculture will continue to maintain pest/disease-free productivity and secure market access, while also protecting our environment.



## CURRENT COLLABORATORS

ACIAR, Agri Futures, DAFF, DCCEEW, Department of Education NCRIS, DFAT, ExoFlare, Genics, GP Graders, Grains Research and Development Corporation, Horticulture Innovation Australia, Indigenous land management agencies and Ranger groups, Meat & Livestock Australia, state and territory governments, ThermoFisher, US Department of Agriculture, University of Melbourne.

*INDIGENOUS SCIENCE

# Protecting agricultural, environmental and cultural systems from high-consequence native and introduced biological threats

PROBLEM STATEMENT: Vertebrate and invertebrate pests, weeds and diseases have major impacts on the resilience and sustainability of our agricultural, environmental and cultural systems at a conservatively estimated annual cost exceeding $20B. How do we reduce the impact of biological threats by developing and deploying targeted, cost-effective mitigation tools and technologies?

## SOLUTIONS

- Identify novel genetic intervention targets in the field of genomics and genetic control to develop proofs of concept for 'omics-enabled' management technologies such as gene-drives and RNA interference, develop tools to build genetic resistance to novel pathogens in native and agricultural species and deploy regulation-guided interventions for landscape-scale management of invasive alien species.*
- Generate biological, ecological, evolutionary, genetic and biogeographic insights to guide biosecurity and bio protection across landscapes through classical biological control, biopesticides, culling/baiting and integrated management.*
- Build federated integrated data capture and analysis for real-time decision support biosecurity for impact mitigation interventions, build *in silico* tools and technologies for genetic intervention technologies, automate platforms for remote sensing and management, and co-design landscape-based digital tools to inform pest control risk decisions and direct coordinated action.*
- Co-design and develop socioeconomic tools for multiple co-benefits (e.g. asset protection, Indigenous businesses, nature-positive conservation outcomes, carbon emissions, landscape-scale insect and disease management).*

## IMPACT

Through partnerships providing biological, genetic and digital solutions, as a leader and trusted regional (Asia–Pacific) biosecurity and integrated management advisor we will enable the sustainable safeguarding of Australia's and our region's agricultural systems/commodities, environmental and cultural assets from high-consequence native and introduced biological threats.

## CURRENT COLLABORATORS

AgriFutures, ANU, Bayer, Beef and Lamb NZ, Centre for Invasive Species Solutions, Cotton Seed Distributors, DAFF, DCCEEW, Department of Health and Aged Care, DFAT, Grains Research and Development Corporation, Horticulture Innovation Australia, Indigenous land management agencies and Ranger groups, James Cook University, Macquarie University, Meat & Livestock Australia, NuFarm, Rural Development Administration of the Republic of Korea, state and territory governments, US Department of Agriculture, University of Adelaide, University of Queensland, University of WA.

*INDIGENOUS SCIENCE

# Accelerating connected and informed healthcare

PROBLEM STATEMENT: Patients receive healthcare in many different settings, but often their data is distributed across siloed systems and care is not available to them in the home or community. How do we safely capture and exchange patient data across the healthcare system and develop services that enable patients to be treated wherever they are?

## SOLUTIONS

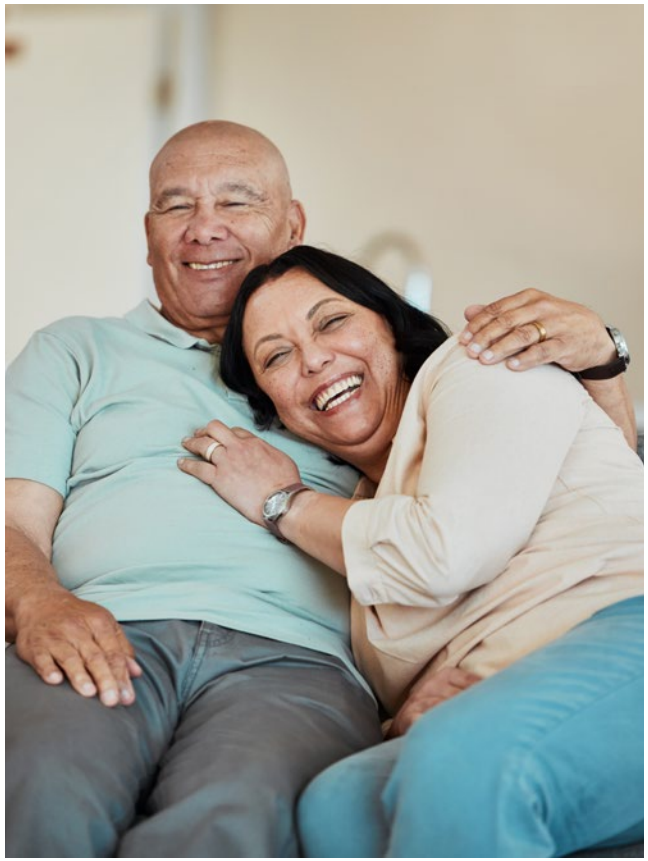
- Enable the capture of health data using standardised vocabularies in electronic medical records around the world, delivering the National Clinical Terminology Service for Australia with our digital technologies used globally.
- Lead community-based initiatives on how health data is shared in Australia, underpinning the implementation of AI tools in Australia's electronic health records and mobile health apps.
- Develop new ways of delivering healthcare using mobile phones, sensors and other digital technology with health, aged care and disability providers; over 10,000 women have used our 'MoTHer' gestational diabetes mobile phone-based tool for health monitoring during pregnancy.
- Work with Indigenous health providers and the Department of Health and Aged Care to reduce the gap in Indigenous health outcomes via digital technology.*
- Identify blockers to implementation and evaluate the effectiveness of many of our connected care interventions.

## IMPACT

Optimised healthcare delivery and patient outcomes will be enabled by connecting healthcare and data. This will be achieved through costs saved via reduced duplicate tests, delivery of real-time data for improved decision-making, and reuse of data. Virtual healthcare and higher-quality healthcare will also lead to reduction in use of healthcare services, impacting environmental factors from emissions to the use of plastics.

## CURRENT COLLABORATORS

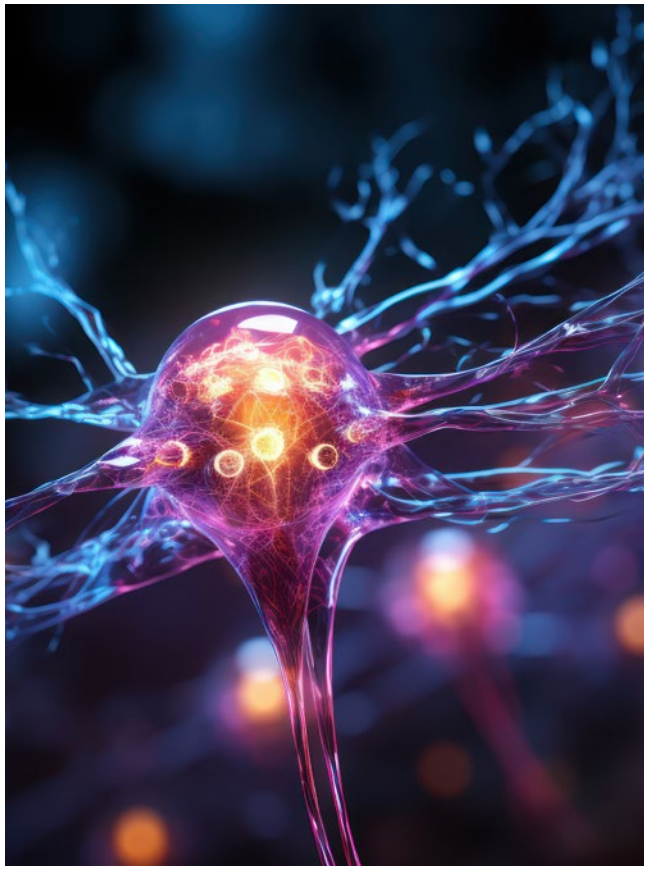
Amazon Web Services, Department of Health and Aged Care, Australian Digital Health Agency, Dedalus, DFAT, Fiji Department of Health, Google, HL7 Australia, HL7 International, Indonesian Department of Health, Monash Health, Philippines Department of Health, Queensland Health, Royal Brisbane and Women's Hospital, SMILE Digital Health, SNOMED International, Telstra Health, UK Biobank, WHO.



*INDIGENOUS SCIENCE

# Artificial intelligence transforming healthcare and health research

PROBLEM STATEMENT: Fully harnessing the benefits of AI for healthcare requires expertise in patient data, care pathways and healthcare systems, as well as new digital tools developed in line with ethical implementation frameworks and emerging regulatory requirements. How do we best use AI to transform health systems, accelerate clinical research and bring new digital tools to clinical care?



## SOLUTIONS

- Develop new precision health treatments, accelerating the adoption of new AI and digital tools in areas such as gene therapy, emergency medicine and even space medicine.
- Leverage new AI medical imaging and genomics technologies to accelerate research outcomes from national and international cohort studies for diseases such as Alzheimer's disease, cerebral palsy and motor neuron disease.
- Develop digital tools to support optimised clinical decision-making, from general practitioners using tools for chronic diseases, antimicrobial resistance and more to clinicians diagnosing childhood cancers and treating Alzheimer's diseases and cancers.
- Establish surveillance tools for disease control, surveillance of genomic variations in pathogens and One Health surveillance with partners across CSIRO and Australia.
- Develop forecasting technologies, including digital twins, that enable health services to manage service delivery efficiently.
- Deliver new tools that use new technologies such as AI and cloud computing that – where required – meet Software as a Medical Device regulations.

## IMPACT

CSIRO's research will advance clinical trials to bring medical interventions to market and tackle Australia's major health issues. Improving early diagnosis of diseases such as cerebral palsy and Alzheimer's disease will greatly reduce healthcare costs over a lifetime, while improving the efficiency of health systems will free up resources to provide higher-quality care. Higher-quality healthcare will also lead to reduction in use of healthcare services, impacting environmental factors from emissions to use of plastics.

## CURRENT COLLABORATORS

AdvanCell, Australia Dementia Network, Department of Health and Aged Care, Australian Imaging Biomarker Lifestyle study of Aging (Florey Institute, Edith Cowan University, Austin Health and others), Cerebral Palsy Network, Children's Health Queensland, state health departments (VIC, QLD, SA, NT), Peter MacCallum Cancer Centre, Siemens Healthineers, UK Biobank, US FDA.

# Increasing healthy years of life for Australians

PROBLEM STATEMENT: Chronic diseases arising from a complex interplay of genetic, physiological, environmental, sociodemographic and behavioural factors are the leading cause of preventable deaths and loss of healthy years of life in the Australian community. How do we reduce the impact and better manage chronic disease progression in our population through targeted, scalable and sustainable preventive health interventions targeting lifestyle, genetic and environmental factors?

## SOLUTIONS

- Understand the drivers of individual/population-level health behaviour and decision-making to build evidence-based interventions.
- Identify the biological determinants of chronic disease and translation of insights into individual and community disease prevention.
- Develop national health, behaviour and wellbeing indicators, tools and evaluation frameworks to inform national policy and programs.
- Promote the CSIRO Total Wellbeing Diet – personalised dietary and lifestyle programs developed for at-risk cohorts and diet preferences to support healthy living.
- Deliver the Australian Health Biobank, providing national research infrastructure linked to Australia's National Health Survey inclusive of genomic data.*
- Understand genetic/epigenetic influences on chronic disease predisposition and markers of risk for self and active management.
- Explore the impact of climate change on health determinants, adaptability and resilience through scenario analysis.

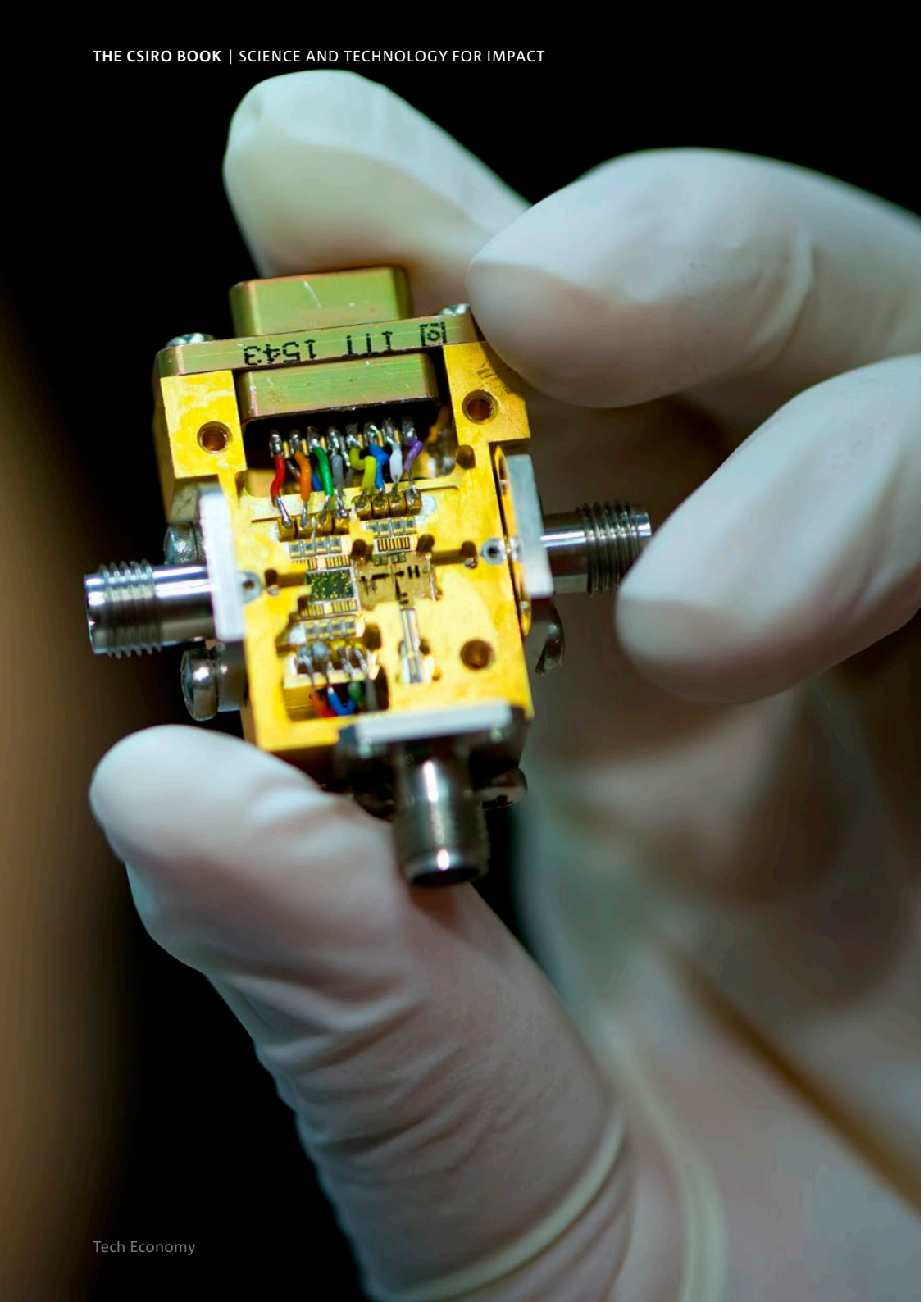
## IMPACT

Improved health and wellbeing will result in better quality of life, reduced healthcare costs, and increased economic productivity, community cohesion and resilience to climate change.

## CURRENT COLLABORATORS

ABS, Department of Health and Aged Care, Digital Wellness, Hort Innovation, local health districts, medical research institutes, Preventive Health SA, primary health networks.

*INDIGENOUS SCIENCE



# Tech Economy

**Challenge to humanity:** Technology continues to influence every aspect of our lives, shaping our workforce and creating opportunities for economic growth. It will also challenge us in new ways, so we need to ensure it's used in an ethical, responsible and trusted manner. We need to anticipate these challenges and innovate at the forefront of science to capitalise on these technological advancements for the benefit of Australia. Our economy currently ranks poorly in our ability to produce a wide range of high-value goods and services and achieve productivity growth from technological innovation. This will increasingly impact Australia's economic resilience and sovereign capability.

**Australia's aspiration:** Australia ranks highly in underpinning science areas driving the tech economy. Combining this with strong natural resources and innovative industries creates an immense opportunity within the next decade to build a tech economy that advances Australian prosperity, sovereign capability and economic performance. To build a strong tech economy Australia will need to remain at the forefront by developing industry capabilities to rapidly translate this science into business growth.

**CSIRO ambitions:** At CSIRO, our focus is at the interface of emerging technology, industry needs and societal benefits. Our ambition sees Australia ranked among leading global economies for (a) utilisation of powerful technologies of AI, robotics, quantum and high-tech manufacturing in our industries and sectors, (b) export of novel science and technology and (c) trusted and ethical development and use of technology. Together with our collaborators we are working towards this ambition in selected areas of technology that have high potential to accelerate, disrupt and challenge Australian science, industry and society.

We will focus on technologies including AI, robotics, quantum and high-tech manufacturing. These technologies utilise distinctive strengths of CSIRO and cut across many industry sectors. They reach national scale in potential economic impact, and they bring both benefits and risks that need to be managed to ensure trust in new technologies. CSIRO engagement with sector-specific technologies is detailed in the relevant sections elsewhere in this book.

### Building artificial intelligence for national challenges

Digital technologies, including AI, could contribute $315 billion to Australia's GDP by 2030 and generative AI alone could bring sweeping changes to the economy, with a 1.5% increase in productivity growth annually over the next decade. AI will also disrupt almost every aspect of Australian life, fundamentally changing the way we work and function as a society. AI, partnered with trusted data and human guidance, could also help us discover highly novel solutions to science questions and complex national challenges such as bushfire response, conservation or climate-resilient agriculture.

We consider 2 areas of AI focus for CSIRO:

- **Scientific discovery from human-AI collaboration** – How can AI accelerate and disrupt the process of scientific discovery? Could it amplify creativity in science through rapid synthesis of vast areas of existing knowledge?
- **Next-generation AI and decision-making** – Fundamental research to grow sovereign capabilities in the next wave of AI technology. For example, how can AI go beyond current approaches based on large-scale statistical pattern matching to more sophisticated forms of intelligence and decision-making.

### Advancing robotics capability and adoption

Robotics and related technologies could contribute a further $170–600 billion per year to GDP by 2030. Australia's robotics industry is growing fast, with homegrown innovations revolutionising agriculture, advanced manufacturing and mining automation. Australia is already a global leader in field robotics research, consistently ranking among the top 10 worldwide.

As part of our **Productive industries with human-robot teams** program of research, we consider 3 key focus areas for CSIRO robotics:

- Field robotics in extreme environments, specifically targeting underground, remote and space environments, founded on advanced 3D mapping, localisation and navigation.
- Safe and effective human–robot teaming – although research in this area is still nascent with many unsolved challenges, CSIRO's advancements in human–robot teaming could unlock substantial productivity and safety gains for Australia's economy through automation of more diverse and complex tasks.
- Next-generation robotics and AI, a field in which we aim to develop fundamentally new robotics approaches with generative AI, moving from task-specific programming to general-purpose intelligence .

### Building cross-sector quantum technology platforms

Quantum technologies are poised to profoundly impact industry and society across the globe. Australia's internationally recognised quantum research provides a unique opportunity to create a burgeoning commercial sector built on quantum technologies. CSIRO estimates that quantum technologies could be worth $6 billion to the Australian economy by 2045.

CSIRO has the multidisciplinary expertise to develop complex quantum technologies that will impact a range of sectors including healthcare, defence, energy, transport and communications. Our research is focused on superconductors, NV-diamond and 2D materials, precision fabrication, theoretical modelling and the development of field-ready quantum sensing platforms. For example, our LANDTEM technology has helped discover more than $10 billion of ore deposits and our biocompatible sensors are being developed for medical diagnostics and chemical detection.

We consider 3 key focus areas for CSIRO **Quantum Technology**:

- Software and algorithms that will underpin effective quantum computing applications and facilitate safe access to quantum platforms.
- Quantum sensors and quantum communications, developing engineered quantum devices and systems that can offer significant advantages for highly sensitive measurement and monitoring as well as enabling quantum-secured information sharing.
- Early-stage research in disruptive technologies such a quantum batteries and materials.

### Thriving Australian high-tech manufacturing

Australia's capacity to build, scale and grow new industries for the future rests on a thriving manufacturing ecosystem. It requires innovation-intensive manufacturers with an ability to produce a wide range of high-value, specialised components and devices. These must be competitive in global markets. Harnessing and developing critical technologies and innovation is crucial for growth in Australia's manufacturing self-sufficiency and sovereign capability.

CSIRO currently has 4 key focus areas:

- **A thriving biotech industry and advanced materials and processing for clean tech** – Develop industry partnerships and provide expertise in materials science and engineering, particularly in polymers, metals, composites, metals additive manufacturing, thin film technologies, process engineering, and device engineering, as well as biomanufacturing, particularly in therapeutics and vaccine development and manufacture.
- **Materials and systems for aerospace and defence** – Identify, harness and develop novel platform technologies to boost existing industry sectors and apply them to emerging industries.
- Optimise the design and development of advanced materials, complex products, manufacturing processes and components using digital technologies and specialist materials characterisation expertise and facilities.
- **Bioengineering for a sustainable economy** – Use our expertise to work with industry and academia to bridge the gap between bench-scale and commercial-scale manufacturing with capabilities and facilities that will enable their ability to bring sophisticated manufactured products to market.

### Trust in new technologies

Any new technology brings potential benefits but also risks. In some cases, these risks can be significant and hinder its adoption and the realisation of its benefits. New technologies are often not well understood, and it can take time to assess the ways in which the technology may shape society. As our national science agency, CSIRO has a duty to systematically and scientifically assess the risks, benefits and uncertainties associated with emerging science and technology, and to develop responsible ways of applying these technologies, removing barriers to adoption and accelerating development to achieve a positive impact.

CSIRO seeks to harness and develop new technologies in a responsible, safe and secure manner. The Tech Economy research area specifically considers the trust aspects of cross-cutting technologies.

CSIRO currently has 2 key focus areas within its **Digital Trust** program of research:

- Responsible AI – CSIRO will focus on research that advances techniques to develop and deploy AI technology efficiently and responsibly.
- Cybersecurity – CSIRO will pursue advanced research on how to prevent cyberattacks in an increasingly complex geopolitical environment. A particular focus will be the threats that new technologies bring. For example, while AI is a useful weapon in the fight against cyber-criminals, it can also introduce new vulnerabilities.

# Scientific discovery from human–AI collaboration

PROBLEM STATEMENT: AI is the most consequential general-purpose technology of the current era, and the AI community is undergoing a step-change of productive applications of AI to science and industry. How can AI transform scientific discovery and enhance the productivity and creativity of our scientists? How can AI help scientists to problem solve for industry and society?

## SOLUTIONS

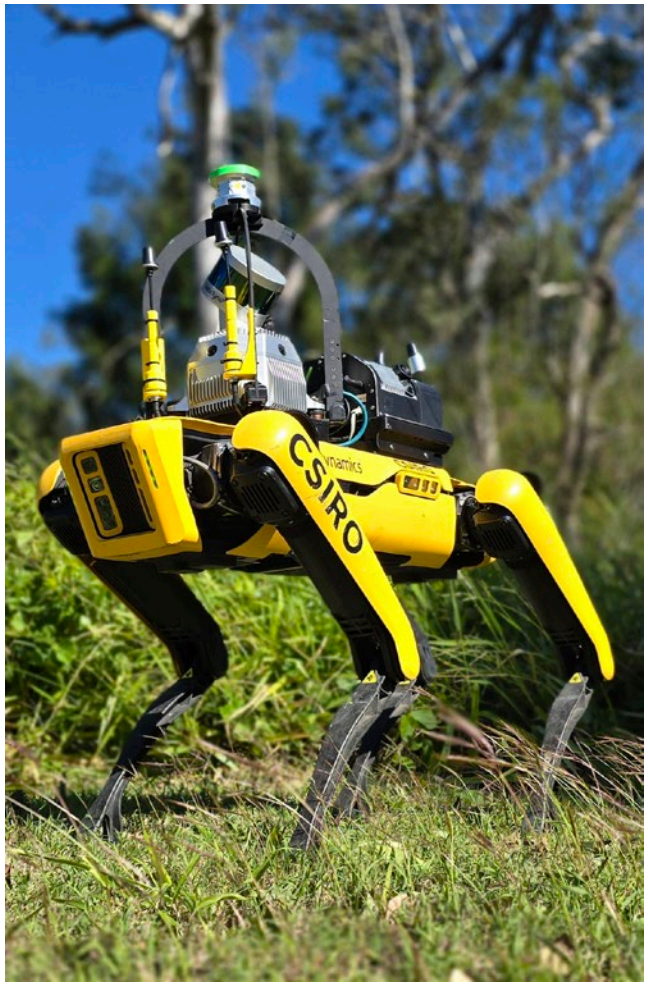
- Develop and deploy AI assistants (agents) for scientists, enhancing their efficiency, productivity, creativity, and impact of their work. This will empower scientists to produce scientific breakthroughs that would otherwise be decades away or entirely out of reach.
- Deliver an AI-powered competitive advantage to Australian industry, advancing AI to manufacturing design for new devices, components and processes.
- Enhance scientific decision-making by combining human intelligence and AI, ensuring trusted decisions that consider complex data inputs and multiple forms of uncertainty, and developing best practice on how individual scientists and science organisations use AI systems.
- Develop automated scientific experimentation platforms integrating AI and machine learning, computational modelling, real-world sensing, metrology and intelligent control.

## IMPACT

Coupled with scientific advances, AI will find solutions to difficult environmental problems including waste, carbon emissions, biodiversity loss and coral reef destruction. Cutting-edge AI technologies will improve the efficiency, safety, speed and quality of scientific research, knowledge discovery and innovation in Australia. This will achieve productivity gains and improved sovereign capability across all industry sectors. It will involve using AI in novel, science-driven solutions for critical national challenges previously beyond reach, thereby boosting jobs growth, GDP growth and quality of life.

## CURRENT COLLABORATORS

Boeing, Curtin University, Google, Monash University, Queensland University of Technology, Turing Institute UK, University of Melbourne, University of NSW, University of Sydney.




A Boston Dynamics quadruped outfitted with CSIRO's NavStack and Wildcat technology.

# Digital trust

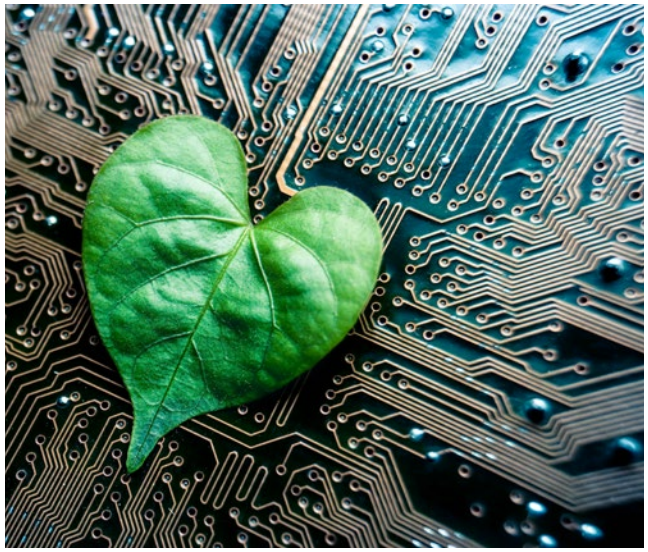
PROBLEM STATEMENT: Higher trustworthiness in emerging digital technologies accelerates their safe adoption by Australian organisations and communities. How can the technical factors and underlying mechanisms that determine the security, safety and trustworthiness of emerging digital technologies for Australian organisations and communities be enhanced through systematic engineering design and system-wide risk management?

## SOLUTIONS

- Responsible and safe AI engineering: develop system-level AI and agent safety mechanisms and best practices.
- Explainable and human-centred AI engineering: develop methods to measure human–AI trust and ensure the explainability of AI outputs.
- AI for processes and supply chains: leverage AI to create trustworthy, compliant, and adaptable business processes and supply chain systems.
- Privacy and security for AI/data: study privacy/security threats in AI/data ecosystems, and design trust-enhancing techniques to assess and mitigate them through sovereign/private AI, secure federated learning, and data privacy.
- AI for cybersecurity: develop AI-driven techniques and human–AI collaborative frameworks to identify, protect against, respond to and recover from cyberattacks, and protect against postquantum security threats.
- Synthetic content risk management: mitigate risks associated with synthetic content through the development of misinformation and deepfake detection, provenance and transparency mechanisms.
- Safe quantum machine learning and engineering: design safe and secure quantum algorithms and systems to harness the power of quantum computing.

## IMPACT

Increased trust in emerging digital technologies will accelerates their safe adoption by Australian organisations and communities, strengthening sovereign capabilities and national resilience. From a social perspective, this will help ensure AI systems behave in ways that align with human values, build trust and bolster defences against misuse and cyberattacks. Economically, it will drive productivity through the faster adoption of AI and quantum technologies. The system-wide designs and best practices from this research will enable further optimisations, supporting sustainable, lower-emission AI, quantum computing and digital supply chains.

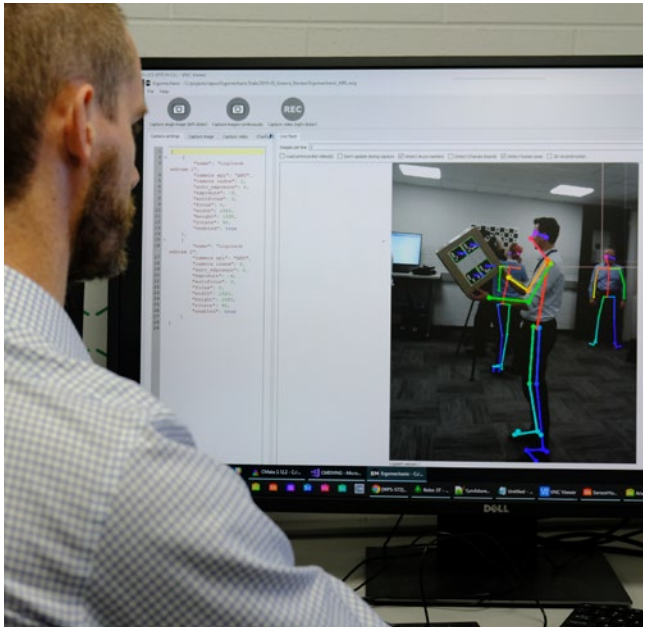


## CURRENT COLLABORATORS

Advanced Strategic Capabilities Accelerator, AI start-ups, Department of Home Affairs, Digital Finance CRC, Digital Transformation Agency, DISR, Google, international AI safety institutes, PenTen, State governments, Westpac.

# Next-generation AI and decision-making

PROBLEM STATEMENT: How do we build the next generation of AI and decision-support systems that are accurate, reliable, human-centric and provide actionable insights for Australia's highest value industrial, societal and environmental challenges?



Dr Simon Harrison Principal Research Scientist and Team Leader at Data61's Mixed Reality Lab located in Clayton which enables manufacturing and multiple other industries to create Digital Twins of real-world objects.

## SOLUTIONS

- Develop next-generation AI models and decision-making tools that harness complex datasets, quantify uncertainty, clarify causal relationships, and apply new data analytic approaches.
- Harness CSIRO's exemplary expertise in natural and physical sciences, combined with extensive datasets, advanced computation, world sensing, metrology and intelligent control capabilities, to power a new generation of AI models that directly integrate known physical laws and power a new generation of AI-driven intelligent digital twins.
- Provide advanced, rigorous, multiscale models that can predict and influence real-world outcomes through detailed quantification of intervention risk.
- Design new AI-driven paradigms in multidimensional information understanding combined with rigorous methods for establishing and measuring trust.
- Develop immersive and collaborative human–AI driven analytics, interfaces and visualisations.
- Apply advanced analytics and AI approaches to understand how to catalyse inclusive and equitable development of Australia's digital technology industries.
- Improve data use in policy and strategy foresight for better decisions.

## IMPACT

We will creating step-change improvements in Australia's capacity to anticipate, respond to and shape change in our future world for a resilient and prosperous nation. The creation of the next generation of AI and decision-making tools will empower Australia in tackling its most critical industrial, societal, and environmental challenges. The advancement and deep fusion of AI with CSIRO's unique domain expertise, deep scientific knowledge, advanced computation, and sociotechnical systems understanding will transform Australian industries – enhancing efficiency, driving innovation and strengthening Australia's economy and environmental resilience.

## CURRENT COLLABORATORS

Australian Sports Council, Boeing, Bradken, DAFF, DFAT, DISR, Foundation for the National Institutes of Health, Monash University, National Research Council Canada, Nippon Steel, Queensland University of Technology, Turing Institute UK, UNDP, University of Melbourne, University of NSW, University of Sydney.

# Productive industries with human–robot teams

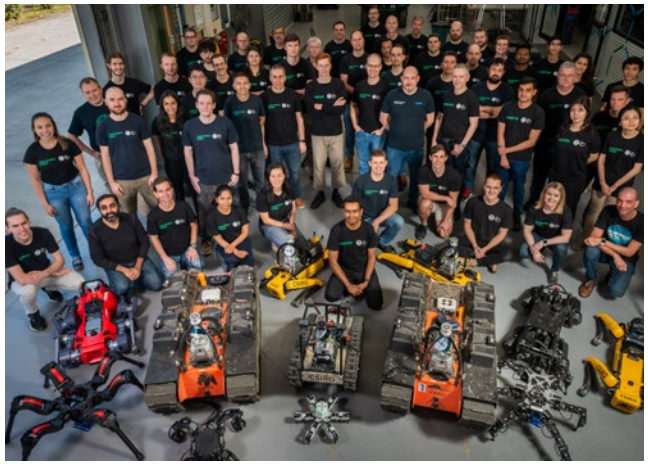
PROBLEM STATEMENT: Australia's growing labour gap demands smarter human–robot collaboration. Advancing robotics research will reduce the burden of excessive human supervision, drive innovation, and future-proof industries. How can Australia address its critical labour gap caused by an ageing workforce and rising demand for skilled labour, given that current human–robot collaboration still requires many human supervisors per robot due to technological and adoption limitations?

## SOLUTIONS

- Advance human–robot interaction and teaming with tiered autonomy for seamless task handovers between robots and humans.
- Develop dexterous mobile manipulation capability including soft grippers for robot-coworkers to safely assist humans.
- Advance robot perception and navigation capability to allow robots to operate with austere sensing and processing in challenging and remote environments.
- Develop foundation AI models for robotics leveraging continual collective learning, human demonstrations and feedback for adaptive skill acquisition.
- Create queryable representations of the world around us with advanced 3D computer vision and efficient AI models deployed on resource-constrained systems.

## IMPACT

By advancing sovereign research in robotic and autonomous systems, we will reverse the humans-to-robots ratio and enable safe and effective human–robot collaboration in industry sectors with complex, uncertain and data-limited environments. From co-located to remote operations, this innovation will revolutionise Australian industries, foster new sectors and ensure socially responsible, future-ready productivity. Human–robot teams will improve biodiversity cataloguing and environmental monitoring, informing improved ecosystem management. Australian society will begin to address skilled labour shortages, by lowering barriers to entry to use robots. Improvements in safety for humans working in hazardous industries will result in enhanced productivity, and creation of new sovereign capability and industries. This will also reduce our carbon footprint through advanced manufacturing, accelerating Australia's transition to net zero.



The Robotics and Autonomous Systems Group based at CSIRO's Queensland Centre for Advanced Technologies (QCAT).

## CURRENT COLLABORATORS

ANU, Australian Safeguard and Non-Proliferation Office, Automap, Automated Solutions Australia, Boeing, Defence Science and Technology Group, DLR (German Aerospace Centre), Emesent, International Atomic Energy Agency, Monash University, NASA, Navantia, Orica, Queensland University of Technology, University of NSW, University of Queensland, University of Sydney, University of Technology Sydney.

# Quantum technologies

PROBLEM STATEMENT: Technologies built on the principles of quantum science provide capabilities beyond those conceivable via conventional approaches, with Australia at the forefront of quantum research globally, but translating this research into real-world technologies and industries remains a challenge. How do we develop and deploy quantum technologies to empower Australian industries and government with unparalleled competitive advantage?

Rolando Dimaculangan characterising the surface chemistry of a quantum device using X-ray photoelectron spectroscopy.

## SOLUTIONS

- Develop quantum sensors to enable us to monitor our environment with exceptional precision, detect threats and revolutionise medical diagnostics.
- Research quantum communications systems – including single photon technologies, quantum key distribution, protocols and quantum-assured timing – as core technologies for securing our most sensitive information and providing the ability to navigate when GPS is unavailable.
- Apply quantum computing to deliver unprecedented outcomes in logistics, pharmaceuticals and novel materials.
- Enable the design, characterisation and fabrication of quantum batteries that can revolutionise energy storage through more efficient and faster charging.
- Provide hardware and software testbeds for prototyping and use-case demonstration to provide an open-access environment for researchers and industry to design, validate and optimise performance of quantum products.

## IMPACT

Quantum technologies will provide significant performance advantages over conventional technologies and provide value-added exports to boost a thriving industry across multiple sectors such as computing, health, defence, communications and energy, contributing $6.1 billion to GDP by 2045. Sovereign quantum capability will strengthen Australia's global supply chain, security, and environmental resilience.

## CURRENT COLLABORATORS

Adelaide University, ARC Centres of Excellence, Crone Geophysics, Department of Defence, DISR, Phasor Quantum, PsiQuantum, Quantum Australia, QUBIC, state governments, Sydney Quantum Academy, University of Melbourne, University of NSW, University of Queensland, University of Sydney.

# Thriving biotech industry

PROBLEM STATEMENT: A thriving biotech industry will improve the economies of Australia and our regional partners. How do we enhance the biotech industry to increase benefit to the Australian economy and the surrounding region, and improve equitable access to human and animal health products?

## SOLUTIONS

- Identify, develop and implement high-tech R&D solutions to deliver biomedical innovations that address human and animal health threats of national, regional and global significance, including infectious diseases, cancer, antimicrobial resistance and rheumatic heart disease.*
- Develop enabling technologies and research capabilities that deliver all components and processes, pilot-scale manufacturing and tech transfer of innovative products to the biotech industry including new vaccines, therapeutics, small molecules and device-regulated manufacturing.*
- Build new and disruptive technologies and platforms allowing translation of novel biomedical innovations to commercial/clinical reality, including first-in-class biotherapeutics, next-generation drugs and advanced medical device technologies.
- Enhance sector understanding to further enable human and animal health interventions to be translated by providing research gap analysis to academia and industry for therapeutic development programs.
- Develop chemistry, manufacturing and controls strategies for process development and manufacture of new biotech, including biopharmaceuticals, small molecule drugs, medical devices and bioconjugates, and act as a key opinion leader for industry.
- Leverage our collective, multidisciplinary capabilities in small molecule drug design and manufacture, analytical and biological assay development, cell line development, biologics production, biomedical polymer synthesis, medical device translation and other areas.

Dr Patrick Shilling and Dr Carine Farenc purifying proteins at our biomedical manufacturing labs.

## IMPACT

A thriving biotech industry will improve the economies of Australia and our regional partners by enhancing sector understanding, building platform technologies, and supporting the co-implementation of high-tech R&D solutions. New medical interventions and novel medicines will become available from an increasing number of SMEs in the advanced high-tech biotech sector. The capability from research solutions being developed will impact across multiple sectors – health, pharmaceutical, biotech, medical technology, agricultural and sovereign security sectors. New and improved cost-effective manufacturing processes will drive a reduction in environmental footprint and increase access to essential medicines for remote communities in Australia and regional partners.

## CURRENT COLLABORATORS

Agri Vic, Bionics, CSL, DFAT, Griffith University, Mater, Monash University, Ochre Sun, QIMR Berghofer Medical Research Institute, Q-Sera, Secret Harvest, Tessara, Therapeutic Innovation Australia, TKI, University of Melbourne, University of Queensland, University of Sydney, University of Technology Sydney, Vaxxas, WEHI.

*INDIGENOUS SCIENCE

# Advanced materials and processing for cleantech

PROBLEM STATEMENT: How do we create advanced materials, processes and devices to transform Australia into a cleantech economy by 2040?

Dr Mei Gao with CSIRO's flexible solar technology which can be used for various applications across urban construction, space, defence, mining, emergency management, disaster relief, and wearables.

## SOLUTIONS

- Create low-cost, sustainable manufacturing processes required for sovereign capability and export markets, such as those using continuous flow chemistry, additive manufacturing, advanced pyrolysis and catalytic processes for key sectors including pharmaceutical, fine chemical, energy materials and plastic waste.
- Design and synthesise sustainable, high-performance materials and coatings (porous materials, polymers, membranes, nanofibers and bio-derived materials) for applications including the capture of noxious gases, hydrogen storage, water from air, packaging and contaminant removal.
- Develop all aspects of battery production, spanning precursor processing and validation, cell chemistry, prototyping, and battery management systems, to support the development of an Australian battery supply chain to enable domestic manufacturing.
- Design and develop revolutionary energy storage systems that offer 3- to 5-fold increases in energy and power density over conventional batteries and/or unlock novel pathways of storing different forms of energy (e.g. heat, biological) for emerging applications, such as waste heat recovery from computing centres or multiweek storage.
- Create next-generation flexible solar cells that can be manufactured using printing techniques, thereby increasing production rates and decreasing capital requirements.

## IMPACT

The transition to a cleantech economy will result in a healthier Australian public and environment due to reduced greenhouse gases and pollutant emissions, and more effective energy and materials utilisation.

Domestic adoption of cleantech production and utilisation will increase the size of SMEs, contributing to a potential economic benefit of $23 billion to Australia's GDP and reducing the risk of supply chain shock.

## CURRENT COLLABORATORS

Australian Centre for Advanced Photovoltaics, Australian Renewable Energy Agency, Boeing, Boron Molecular, DISR, Energy Renaissance, Monash, RMIT, Swinburne Universities, University of New South Wales.

# Materials and systems for aerospace and defence

PROBLEM STATEMENT: How do we address materials and technology gaps to grow an enabled sovereign aerospace and defence industry?

## SOLUTIONS

- Design and process advanced materials with extreme performance characteristics to protect defence personnel and first responders from hostile environments and enable long life for critical components for defence and aerospace.
- Advance critical manufacturing technologies to build new components essential for our maritime, aerospace and defence industries.
- Predict materials performance characteristics and optimise manufacturing parameters for high-value-added, complex products such as satellite, rocket, robotic, submarine and aerospace components.
- Develop new and enhanced sensing and measuring devices for advanced detection – for example, novel, high-frequency electronic technologies to enable next-generation satellite communication and 6G terrestrial telecoms.
- Design and deploy bespoke, high-performance, hyperspectral imagers to transform earth observation, and work in collaboration with application and launch partners to enable next-generation water quality and bushfire monitoring capability for Australia.
- Develop flexible solar cell technologies for extreme and hostile environments that are highly portable, radiation-resistant and damage-tolerant, allowing them to power space missions and critical services for defence personnel.
- Create high-energy density and robust battery systems that are incorporated into satellites and equipment in contested environments.

## IMPACT

We will diversify and transform Australia's industrial base by creating new materials, devices and processes to strengthen our space and defence industries. This will enhance our national security through increased supply chain and energy resilience and increased protection for defence personnel. CSIRO innovations will contribute to domestic industry and job creation across the supply chain, and increased exports in the defence and space sectors.

## CURRENT COLLABORATORS

Additive Manufacturing CRC, Australian Space Agency, Boeing, Defence Science and Technology Group, Department of Defence, Gilmour Space, Monash University, RMIT University, Titomic, Trailblazer Universities Program.

# Bioengineering for a sustainable economy

PROBLEM STATEMENT: How do we help build an industrial biomanufacturing sector in Australia that is exemplary on a global scale, which leverages the power of engineering biology to secure sovereign capability and that contributes to net zero goals, economic growth and regional jobs?

## SOLUTIONS

- Revolutionise molecular design using big data and AI through a predictive, next-generation framework for understanding and delivering new biological functions, organisms, processes and microbial communities.
- Transform the design, utility and efficiency of novel industrial biomanufacturing processes.
- Develop new, commercially viable bioprocesses through better biological machinery and bioengineering tools.
- Develop a deep understanding of societal risk and decision-making to navigate technological transitions.
- Ensure proactive, interdisciplinary integration of socioeconomic and biophysical sciences.
- Understand complex interactions between individuals, society, institutions and future innovations to facilitate implementation.

## IMPACT

As the world transitions from a fossil economy, industrial biomanufacturing will provide a major opportunity for Australia in hard-to-abate sectors such as fuels, chemicals and materials. Research and development will deliver new bioprocesses through AI and bioengineering that are efficient, safe and scalable with evidence-based paths to adoption by industry and society.

## CURRENT COLLABORATORS

Allozymes, Amazon Web Services, ARC Centre of Excellence for the Mathematical Analysis of Cellular Systems, ARC Centre of Excellence in Synthetic Biology, Australian National University, Azenta, Bioplatforms Australia, Delica Therapeutics, Food and Beverage Accelerator Trailblazer, Google, Griffith University, Illumina, Macquarie University, Mycena, Nanjing University, Nourish Ingredients, Ocean Oils, OECD, PacBio, Queensland University of Technology, University of California Berkeley, University of Adelaide, University of Cambridge, University of New South Wales, University of Queensland, University of Technology Sydney, University of WA, Western Sydney University, World Economic Forum.

# Research infrastructure

CSIRO is a steward of research infrastructure that delivers scientific impact across the innovation ecosystem, nationally and globally.

We invest in science, engineering, and technology development to provide research infrastructure for Australia's future. We develop and sustainably manage platforms and technologies that underpin current research priorities and will inspire future generations in conducting essential research.

Research infrastructure plays a critical role in scientific advancement, providing platforms and adapting new technologies to deliver on Australia's aspirations and CSIRO's ambitions as described in the first section of this publication. CSIRO develops and manages research infrastructure both for our own research portfolio and on behalf of the nation, ensuring that it remains sustainable, safe and fit for purpose. This infrastructure connects a broad network of scientists, government and industry partners, and communities, fostering collaboration and accelerating innovation.

CSIRO's research infrastructure underpins our ability to explore both the cosmos and the complexities of the world around us. It equips scientists with the tools and capabilities to investigate phenomena across all scales – from global systems to molecular detail. This infrastructure enables the pursuit of critical research, addressing immediate scientific and societal challenges while also providing the long-term observational capacity needed to understand and respond to a rapidly changing world.

## Our partnerships

CSIRO's stewardship of national research infrastructure is built on national and international partnerships. This includes leading 5 facilities supporting Australian and international science that receive National Collaborative Research Infrastructure Strategy (NCRIS) funding: the Atlas of Living Australia (ALA), Australian Centre for Disease Preparedness (ACDP), Australia Telescope National Facility (ATNF), Marine National Facility (MNF) and Pawsey Supercomputing Research Centre (Pawsey). We partner with Australia's higher education sector, government and industry to build, maintain and enhance other research infrastructure supported by NCRIS, such as the AuScope and the Terrestrial Ecosystem Research Network.

Our research infrastructure also plays a critical role as part of a broader international network, providing Australian researchers access to global data, infrastructure and expertise.

As the Australian node of the Global Biodiversity Information Facility, the ALA's global partnerships ensure Australian researchers can access the best global data to support biosecurity risk modelling.

Australia's contribution to developing the SKA project is an endeavour that will enable international research communities to make novel discoveries, engage industry and inspire future STEM students. The SKA telescopes are a world-first for astronomy and will revolutionise our understanding of the Universe and the fundamental laws of physics.

## The full spectrum of infrastructure

Our research infrastructure encompasses significant physical, biological and digital assets , along with the skilled individuals whose expertise ensures this infrastructure is prepared to address current and emerging scientific inquiries. The advancement of future-ready infrastructure is detailed among the research areas highlighted earlier in this publication.

This section of the book highlights major components of our research infrastructure, though it does not encompass the complete array of experts, equipment, data sets and facilities that underpin our research initiatives. Through these endeavours, we are cultivating platforms and technologies designed to inspire and equip future generations for essential research undertakings.

## Understanding our Universe

CSIRO enables humanity to understand our Universe, from Earth to the furthest frontiers. Our research infrastructure takes advantage of our unique view of the southern hemisphere sky and of our global partnerships to enable unparalleled discovery of our planet, the Solar System and beyond. This is underpinned by the following research infrastructure:

- Australia Telescope National Facility (ATNF)
- Earth observation
- SKA project
- Spacecraft tracking and communications

## Understanding our natural systems

Our ambition for a nature-positive future, in which Australia successfully navigates the threats of climate change, the biodiversity crisis and pollution impact, relies on foundational research infrastructure. Understanding and monitoring changes in Earth's natural systems – including the atmosphere and ocean coupling in the Southern Ocean, and Australia's unique biodiversity and ecosystems – requires long-term, large-scale research infrastructure.

CSIRO and our partnerships deliver national research infrastructure that enables innovative technologies to accelerate our understanding and monitoring of our natural systems. These infrastructures underpin research that informs biosecurity risk, natural disaster response, understanding of our marine domain, environmental assessment and planning, land management and natural capital accounting, and environmental service provision.

Our national infrastructure is connected to global infrastructure and partnerships and supports Australia's international commitments, such as the UN Sustainable Development Goals, the Global Climate Observing System and the Kunming–Montreal Global Biodiversity Framework. The research infrastructure that underpins this includes:

- Atlas of Living Australia
- Marine National Facility
- Marine Observing Systems
- National Research Collections Australia

## One Health approach to mitigating the impacts of disease

To protect humans and animals from the impacts of most dangerous emerging infectious diseases, Australia needs a laboratory that allows safe and secure research. The Australian Centre for Disease Preparedness (ACDP) is a high-biocontainment facility in Geelong, Victoria. Biological specimens from across the globe must be able to enter the facility to allow analysis while always maintaining the highest assurance of biocontainment, within a highly regulated environment. By facilitating this work to occur in Australia, our valuable livestock and aquaculture industries, and the community, are better protected from exotic and emerging infectious animal and zoonotic diseases.

## Characterising structure and function

CSIRO's collective characterisation infrastructure and expertise enables us to interrogate biological, chemical and physical phenomena from atomic to macroscopic scales. The CSIRO Characterisation Network integrates this research infrastructure across Australia into a single network – enabling studies of structure–function relationships in multiple domains, including health, energy, minerals, materials, aerospace and nature.

## Harnessing the power of compute to solve research challenges

Modern research relies heavily on high-performance computing to address complex issues in climate, health and the economy. Computing and data capabilities are essential for scientific inquiry, driving discoveries across various fields, from genomics to AI. CSIRO's management of Tier-1 and Tier-2 compute resources is vital for advancing the nation's research goals. Tier 1 facilities such as Pawsey Supercomputing Research Centre provide a national facility with significant performance for researchers across the innovation system, while Tier-2 systems support CSIRO projects with methodology development, data provenance, specialised workflows, software development and computational expertise. These include:

- CSIRO High Performance Computing
- Pawsey Supercomputing Research Centre

# National and international facilities

# Australia Telescope National Facility (ATNF)

UNIQUE PURPOSE: To enable researchers to answer the biggest questions about fundamental physics and the Universe.

**Research significance for Australia:** Australia is a recognised global leader in radio astronomy research and has been since the birth of the field in the 1940s. This is driven by the ATNF's long-term technical innovation and researchers' access to the ATNF's instruments and data archives, supported by our in-house astronomers. The ATNF also enables significant contributions to STEM education and community engagement with science.

Our ASKAP radio telescope – located at Inyarrimanha Ilgari Bundara, our Murchison Radio-astronomy Observatory on Wajarri Yamaji Country – is one of the instruments that makes up the Australia Telescope National Facility.

**National scale and utilisation:** In 2024–25, the ATNF provided astronomers from 29 countries with merit-based access to our instruments, and our team co-supervised 46 postgraduate students from 17 universities (12 domestic, 5 international). Almost 110,000 people attended our ATNF visitors' centres and approximately 200 senior school students completed our PULSE@Parkes education program.

## INFRASTRUCTURE DESCRIPTION

- ASKAP telescope (36 × 12 m antennas with phased array receivers at 1 GHz), Wajarri Country, Murchison, WA.
- Australia Telescope Compact Array (ATCA) (6 × 22 m antennas, 1–100 GHz), Gomeroi Country, Narrabri, NSW.
- Murriyang, our Parkes radio telescope (64 m antenna, 0.7–25 GHz), Wiradjuri Country, Parkes, NSW.
- Long Baseline Array, a network of CSIRO and non-CSIRO telescopes including ATCA and Murriyang.
- ATNF astronomy data archives (12 petabytes).
- Visitors' centres at our Parkes and Narrabri observatories.

## IMPACT

**Science:** Our instruments enable researchers to make fundamental contributions to understanding the Universe. For example, the discovery of fast radio bursts using archival data collected by Murriyang, has opened a new branch of astrophysics, an achievement for which members of the research team were awarded the 2023 Shaw Prize and 2024 Prime Minister's Prize for Science. By quickly turning ATCA to follow-up detections of short-lived and variable events, we've enabled new insights into the physics of extreme objects such as black holes and merging neutron stars. Researchers have also used our telescopes to test fundamental theories of gravity and map our Milky Way galaxy.

**Technology:** The ATNF provides platforms on which new instrumentation is developed and enables future radio astronomy such as the SKA telescopes.

**Global:** We have deep engagement with the international community for research collaboration and science diplomacy.

**Social:** Our infrastructure and radio astronomy research results inspire the community and Australia's future STEM workforce, and we partner with Indigenous communities on whose Country our telescopes are located.

## CURRENT COLLABORATORS

Department of Education, DISR, domestic and international universities, European Space Agency, Intuitive Machines, NASA, Pawsey Supercomputing Research Centre, SKA Observatory, SpaceX.

# Earth observation

UNIQUE PURPOSE: To secure and enhance satellite-derived data, quality assurance and processing capacity for CSIRO's and Australia's Earth observation science needs.

**Research significance for Australia:** Australia is one of the largest users worldwide of Earth observation (EO) data for land and ocean monitoring, including our Antarctic territory. Over 150 government programs depend on access to satellite data, with several CSIRO groups evaluating new satellite EO technologies and developing new data applications to address national needs, including environmental monitoring, resource mapping, biodiversity monitoring, agricultural applications, land use mapping and monitoring, water monitoring, carbon accounting, and disaster monitoring and mitigation. Satellite calibration and validation infrastructure provides reciprocal capabilities in support of international partnerships and EO data access arrangements, in addition to quality assurance of EO data for CSIRO researchers.

**National scale and utilisation:** Our EO infrastructure, capabilities and services include a 10% capacity share of the NovaSAR-1 satellite (Australia's only ability to directly task an EO satellite for the benefit of the national research community and international collaborators, and the only national capability CSIRO hosts that can be tasked for flood monitoring); unique southern hemisphere satellite calibration and validation facilities that benefit CSIRO researchers and international partner satellite operators; the world-leading EASI data analytics platform, which supports large-scale data processing to significantly enhance the utilisation of EO data by CSIRO researchers, and Australian and international commercial users; and operational, technical and policy expertise required to maintain EO capabilities and support EO users and critical international relationships.

## INFRASTRUCTURE DESCRIPTION

- NovaSAR-1 National Facility (10% capacity share).
- Earth Analytics Science and Innovation (EASI) data platform.
- CSIRO contribution to national EO satellite calibration and validation capabilities (sensors, sites, expertise).
- Representation on behalf of Australia in international EO forums (e.g. CSIRO will co-chair the Committee for Earth Observation Satellites in 2026).

## IMPACT

Increased production, productivity and efficiency of other industry sectors (e.g. agriculture) due to uptake of new EO technologies and products.

Greater protection of ecosystems and biodiversity on Earth through improved natural resource management through EO.

Improvement of aquatic environments and land quality due to new EO technologies and capabilities.

A Sentinel-2A Earth observation satellite image showing where the Herbert River in Queensland meets the Pacific Ocean. Credit: Sentinel-2A MSI/ESA/EUMETSAT.

Improved national and regional security and stability through increased uptake of EO services for various applications (e.g. climate innovation, food and water security, disaster monitoring).

## CURRENT COLLABORATORS

Amazon Web Services, Australian Space Agency, BOM, Centre for Appropriate Technology, Committee on Earth Observation Satellites, DCCEEW, Geoscience Australia, international space and government agencies.

# SKA project

UNIQUE PURPOSE: Collaborate to deliver the global SKA project, which is building 2 radio telescopes that will revolutionise our understanding of the Universe, develop cutting-edge technology and make broader positive impacts.

**Research significance for Australia:** Australia is a member and host country of the SKA Observatory (SKAO), the intergovernmental organisation bringing together 16 member and partner countries building the SKA telescopes. The SKAO is partnering with CSIRO to build and operate the SKA-Low telescope at Inyarrimanha Ilgari Bundara, our Murchison Radio-astronomy Observatory on Wajarri Yamaji Country in Western Australia.

**The SKA Observatory's SKA-Low telescope is under construction at Inyarrimanha Ilgari Bundara, our Murchison Radio-astronomy Observatory, on Wajarri Yamaji Country. Credit: SKAO.**

**National scale and utilisation:** Our involvement in this international collaboration enables Australian researchers to continue to make discoveries that explore fundamental questions in astronomy and physics, ensuring continuation of our leadership in this field.

## INFRASTRUCTURE DESCRIPTION

- Two SKA telescopes are currently under construction by the SKAO: the SKA-Mid telescope in South Africa and SKA-Low in Australia. The SKA-Low telescope is a next-generation, software-defined telescope that will produce vast quantities of data. It comprises 131,072 two-metre-tall antennas grouped in 512 stations of 256 antennas, alongside significant on-site computing and processing infrastructure.
- We manage the observatory site and Australia's obligations as an SKAO host country on behalf of the Australian Government. The SKAO-CSIRO collaboration establishes a combined team in Australia to construct and operate SKA-Low.
- We are contracted by the SKAO for significant construction activities including technology and software development, project management and support.
- We assess and advise on radio frequency interference to manage the Radio Quiet Zone surrounding our observatory.
- The site has the first solar-hybrid power station powering a large remote astronomical observatory.

## IMPACT

**Science:** We will map the structure of the Universe in its first billion years, the Cosmic Dawn, which is not possible with any other instrument.

**Social:** The Indigenous Land Use Agreement with the Wajarri Yamaji People, Traditional Owners and Native Title Holders of the observatory site, brings significant multigenerational benefits and opportunities for the Wajarri community, including co-design of the SKA-Low telescope layout with the SKAO and Wajarri Yamaji ensuring significant sites and the telescope can coexist. We capitalise on the greater than 50-year project lifespan to increase the diversity of our STEM workforce and inspire generations of scientists and engineers.

**Economic:** We leverage the $691 million investment by the Commonwealth in the SKA project to increase employment and contracting opportunities across many sectors and develop widely applicable new technologies and industries.

**Environment:** With Wajarri Yamaji, we comanage the observatory land's transition from pastoral station to research infrastructure, and the SKA-Low telescope has been designed for low impact on the land.

## CURRENT COLLABORATORS

Australian Communications and Media Authority, Australian SKA Regional Centre, Curtin University, DISR, International Centre for Radio Astronomy Research, Pawsey Supercomputing Research Centre, Southern Yamatji, University of WA, WA Government, Wajarri Enterprises Limited, Wajarri Holdings, Wajarri Yamaji Aboriginal Corporation, Wajarri Yamaji People, Whadjuk Noongar.

# Spacecraft tracking and communications

UNIQUE PURPOSE: Provision of dedicated deep space robotic vehicle tracking, spacecraft tracking and human spaceflight support on behalf of NASA and the European Space Agency, and several missions conducted by various international space agencies (Japan, India and South Korea, among others).

**Research significance for Australia:** Host country utilisation of NASA infrastructure to support Australian-led astronomy and bistatic radar opportunities in the southern hemisphere (near-Earth asteroid and space situational awareness).

**National scale and utilisation:** All NASA and European Space Agency assets are fully utilised for the tracking of dozens of space science and exploration missions under cross-support arrangements.

## INFRASTRUCTURE DESCRIPTION

- We operate 2 deep space communication ground station sites on behalf of international partners, NASA and the European Space Agency.
- NASA's Canberra Deep Space Communication Complex comprises 1 × 70m parabolic antenna (DSS43) and 3 × 34 m parabolic antennas (DSS34/35/36) with a fourth 34 m antenna (DSS33) under construction.
- The European Space Agency's New Norcia station comprises 1 × 35 m parabolic antenna (NN01) and 1 × 4.5 m parabolic antenna (NN02), with a second 35 m antenna under construction (NN03).

## IMPACT

Through robotic and human exploration, we provide an increased understanding of the Universe, from Earth to the furthest reaches of the cosmos. We provide societal benefit through scientific collaboration with space agencies, research institutions and international organisations. We bring economic benefit to Australia by leveraging our advantageous geographical location and deep technical expertise in space tracking operations.

## CURRENT COLLABORATORS

Australian Space Agency, DFAT, European Space Agency, Geoscience Australia, Japan Aerospace Exploration Agency, NASA Jet Propulsion Laboratory, Swedish Space Corporation, University of NSW.

We manage the Canberra Deep Space Communication Complex for NASA, which includes a 70-m antenna. The station is one of three in NASA's Deep Space Network supporting interplanetary spacecraft missions exploring the Solar System and beyond.

# Atlas of Living Australia (ALA)

UNIQUE PURPOSE: Delivering trusted biodiversity data for Australia, supporting science and decision-making.

**Research significance for Australia:** Australia is a mega-biodiverse continent with many species found nowhere else, and only 30% of our biodiversity has been identified and described. Trusted, national biodiversity data supports science and major biodiversity conservation and reporting programs.

**National scale and utilisation:** National biodiversity data infrastructure and associated products and services to support biodiversity data mobilisation and analysis, as well as the Australian node of the Global Biodiversity Information Facility, with over 120,000 registered users nationally and internationally.

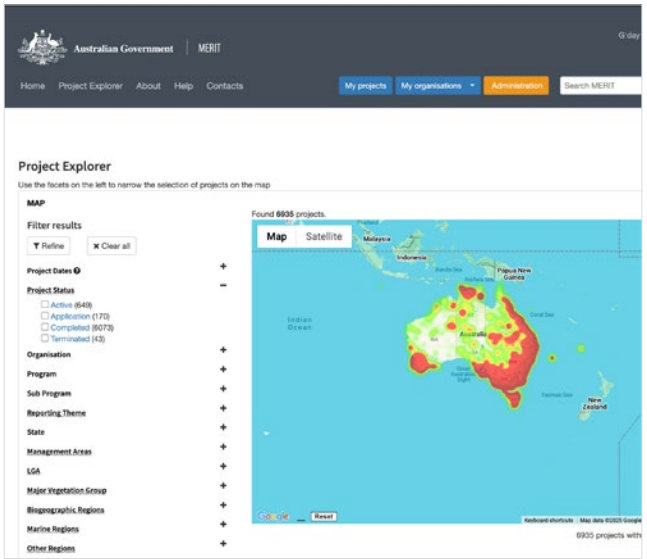
## INFRASTRUCTURE DESCRIPTION

- Over 146 million records of Australia's flora and fauna come from biological collections, field observations, citizen science, government, and research programs.
- Images, species descriptions, sound recordings, genetic data, literature, and Aboriginal and Torres Strait Islander peoples and communities' ecological knowledge.
- Over 400 spatial layers allow users to examine the connections between species distribution and factors such as rainfall, temperature, soil moisture, regional boundaries, fire and vegetation.
- A suite of powerful, open-source data analytics and mapping tools that allow users to explore and analyse data in new ways.
- Stand-alone software products and platforms to support Australia's biodiversity information sector to capture, manage and deliver trusted biodiversity data.

## IMPACT

**Social:** Protect Australia's natural environment for the recreational enjoyment of Australians now and into the future; support Aboriginal and Torres Strait Islander cultures through greater appreciation of Traditional Knowledge relating to biodiversity.

**Environment:** A sustainable natural environment facilitated through the maintenance of Australia's biodiversity.




**Economic:** Growth through improved productivity enabled by efficiencies in information management and the delivery of services; robust national biosecurity system.

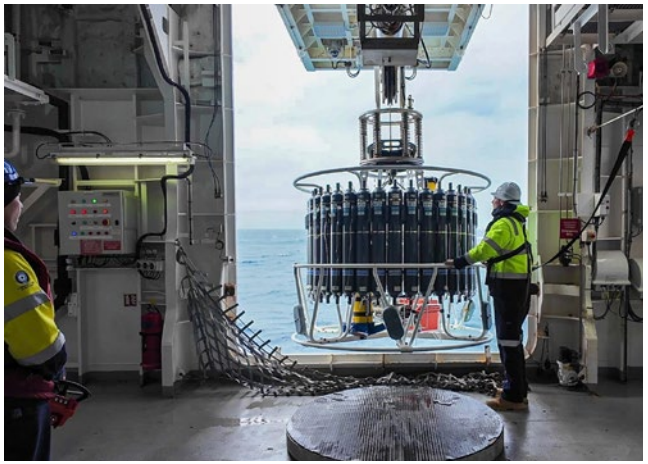
## CURRENT COLLABORATORS

Australian Biological Resource Study, Australian Museum and state museums, DAFF, DCCEEW, Department of Education, Environment Institute of Australia and New Zealand, Global Biodiversity Information Facility, IDigBio, Parks Australia.

# Marine National Facility (MNF)

UNIQUE PURPOSE: RV *Investigator* is Australia's dedicated, multipurpose and critical blue-water research vessel, with dedicated capabilities supporting oceanographic, biological, geoscientific and atmospheric research. The MNF enhances the long-term prosperity of Australia's marine environment, industries and community by providing information that supports evidence-based decision-making by government, industry and our community.

**Research significance for Australia:** From ice edge to equator, RV *Investigator* enables world-leading research to increase our understanding of Australia's vast and valuable marine environment. Monitoring changes in our oceans and atmosphere delivers key understanding into the long-term impacts of anthropogenic change. RV *Investigator* activities provide a unique opportunity for engagement with Traditional Owners of Sea Country and identification of their submerged landscapes.



**National scale and utilisation:** RV *Investigator* is Australia's only dedicated blue-water research vessel and mobile atmospheric platform and includes scientific equipment and large-scale datasets that contribute to continental-scale observations. The MNF is available to all Australian researchers and their international collaborators through an openly competitive, rigorously peer-reviewed and over-subscribed application process.

## INFRASTRUCTURE DESCRIPTION

- RV *Investigator*: 94 m ocean-class research vessel that supports crew of 20 and up to 40 researchers and technical staff. Has an 'at-sea' endurance of 60 days and 10,000 nautical miles without the need for resupply.
- RV *Investigator*'s scientific infrastructure covers geoscience (seabed mapping, and seafloor and sub-bottom studies), oceanography (physical and biogeochemical studies down to 6000 m), biology (fisheries and ecosystems studies), and atmospheric science (aerosol composition, ocean–atmosphere interactions and climate data). It is equipped for robust underway data collection, including atmospheric sampling, geophysical surveys and mapping, and seawater analysis.
- 40 years of marine data collected by RV *Investigator* and its predecessors is freely available for use by government, industry, scientific community and the public.
- The MNF also provides leading expertise in vessel, technical and voyage management systems.

## IMPACT

**Social:** Integrated marine management for sustainable use of the oceans and resources; recognition and respect for Traditional Owners' rights and interests in Sea Country.

**Economic:** Sustainable use of ocean resources for economic growth, enhanced livelihoods and job creation, while preserving the health of the marine ecosystem.

**Environmental:** Climate modelling, biodiversity and ecosystem management drive informed policy initiatives; climate mitigation technologies assist Australia's transition to net zero.

## CURRENT COLLABORATORS

AAF, Australian Fisheries Management Authority, Australian Hydrographic Service, BOM, DCCEEW, Department of Defence, Fisheries Research and Development Corporation, Geoscience Australia, Integrated Marine Observing System, international research community (as external reviewers of merit access), Parks Australia.

# National Research Collections Australia (NRCA)

UNIQUE PURPOSE: To provide a national repository of Australia's biodiversity to support research on species discovery and characterisation, understanding ecosystem dynamics and related traditional cultural significance, and to enhance conservation management, biosecurity and bioprospecting opportunities by CSIRO and its collaborators.

**Research significance for Australia:** Australia's biodiversity is globally unique and is our most valuable renewable resource. The differentiated value of Australia's innovation sector is based on the continental scale, temporal depth and taxonomic breadth of its biodiversity collections, and its long association with Aboriginal and Torres Strait Islander custodians who hold enduring traditional ecological knowledge.

**National scale and utilisation:** CSIRO's biological collections are the national biological collections, with a continent-wide remit, and strong domestic and international connections.

## INFRASTRUCTURE DESCRIPTION

- Over 15 million specimens of preserved vertebrates, invertebrates, plants, algae and fungi from Australia's land and sea since 1770.
- Two living collections of algae and tree seeds.
- Preserved tissues, DNA samples and environmental DNA.
- Curatorial and research facilities with state-of-the-art archival storage, labs, digitisation suites and data systems.
- Taxonomic, geographic, environmental data, genomic reference library and digital media assets.
- Expertise in field operations, biological specimen curation, data management and digital imagery.
- Expertise in collection-driven fundamental and applied research.

## IMPACT

**Social:** Broader community awareness of significance and importance of biodiversity, new and existing Indigenous partnerships that can grow two-way value and knowledge; enhanced human health and wellbeing; protection of Australia's natural environment for the recreational enjoyment by Australians, now and into future.

**Economic:** Provision of key environmental services (e.g. clean water, air); enhancement of Australian agricultural and natural resource-based industries; economic growth through improved productivity driven by better biosecurity to minimise economic loss.

**Environmental:** A sustainable natural environment facilitated through the maintenance of Australia's rich and largely unique biodiversity in the face of climate change; improved readiness and recovery of ecosystems to natural disasters.

## CURRENT COLLABORATORS

ALA, Centre for Biodiversity Analysis, DAFF, DCCEEW, DFAT, Global Biodiversity Information Facility, state governments (NT, QLD), international and domestic museums/herbaria.

# Australian Centre for Disease Preparedness (ACDP)

UNIQUE PURPOSE: A purpose-built biosecurity facility providing the highest level of biocontainment to protect Australia's animals and people from the most dangerous emerging infectious diseases.

**Research significance for Australia:** As Australia's leading biocontainment laboratory with extensive biosecure laboratories, ACDP enables diagnostics and research on dangerous pathogens and is pivotal in safeguarding Australia from exotic, emerging and zoonotic animal diseases.

**National scale and utilisation:** As Australia's national reference laboratory, ACDP's work protects Australia's valuable livestock and aquaculture industries, and the community, from exotic and emerging infectious animal and zoonotic diseases.

## INFRASTRUCTURE DESCRIPTION

The ACDP facility in Geelong, Victoria, spans 76,000 sqm over several levels. It features a 'box in a box' design for physical containment, with high-containment labs on Level 3, air filtration above and water handling below. The building uses over 1000 high-efficiency particulate air filters and has its own water treatment facility. There are at least 3 levels of plant to support laboratories and up to 4 in some areas. The high-containment lab spaces total 3,225 sqm, with 90% at PC3 standard and 10% at PC4.

## IMPACT

We enable world-renowned science that will further our understanding, preparedness and management of infectious diseases to protect a healthy, productive and prosperous future for Australia's animals and people.

## CURRENT COLLABORATORS

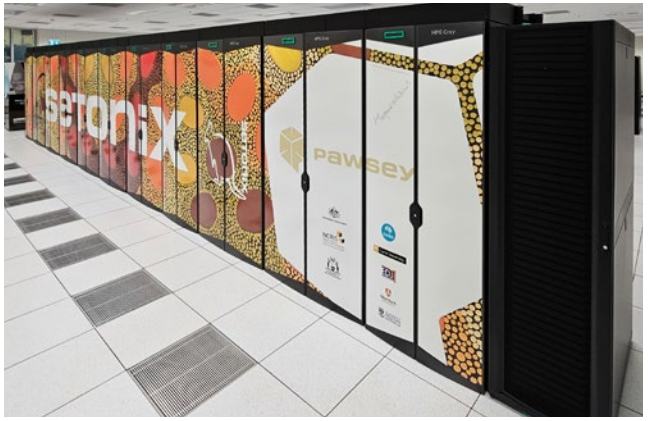
5RD Biodefence Network, AgriFutures, Australian/NZ Biosafety Association, DAFF, Dairy Australia, Defence Science and Technology Group, Department of Education, Department of Health and Aged Care, DFAT, European Viral Archive Global, Fisheries Research Development Corporation, NCRIS, international biosafety organisations, Victorian Biosafety Network, WHO, WOAH.

# Pawsey Supercomputing Research Centre

UNIQUE PURPOSE: To provide Tier-1 high-performance computing (HPC) infrastructure and supporting services for Australian researchers.

**Research significance for Australia:** Sovereign Tier-1 HPC infrastructure, services, and capabilities to accelerate the science of 2500 Australian scientists.

**National scale and utilisation**: Setonix, at the Pawsey Supercomputing Research Centre (Pawsey), is the most powerful supercomputer in the southern hemisphere and debuted as the world's fourth greenest supercomputer on the Green500 list. It is used by researchers (universities, industry, government, SMEs) from a wide range of domains and organisations from around Australia. In 2024, Pawsey provided approximately 80% of compute capability to Australian researchers under the National Computational Merit Allocation Scheme. Setonix provides essential compute support to operate our ASKAP radio telescope.




## INFRASTRUCTURE DESCRIPTION

Setonix Supercomputer:

- EX Supercomputer by HPE Cray
- computing power: 50 petaflops double precision
- 1592 dual 2.45GHz AMD EPYC 7763 'Milan' 64-core CPU nodes with 256GB RAM 217,088 CPU cores
- 8 dual 2.45GHz AMD EPYC 7763 'Milan' 64-core CPU nodes with 1TB RAM power consumption 17.5 kW/PF
- 154 single AMD EPYC 7A53 'Trento' 64-Core GPU nodes with 8 AMD Instinct MI250X GPUs and 256GB RAM
- 38 single AMD EPYC 7A53 'Trento' 64-core GPU Nodes with 8 AMD Instinct MI250X GPUs and 512GB RAM
- 11 data mover nodes, 31 visualisation nodes and 9 login nodes
- lustre filesystems
- over 75PB usable warm tier object storage and 70PB mirrored cold tier tape storage
- visualisation systems and services.

## IMPACT

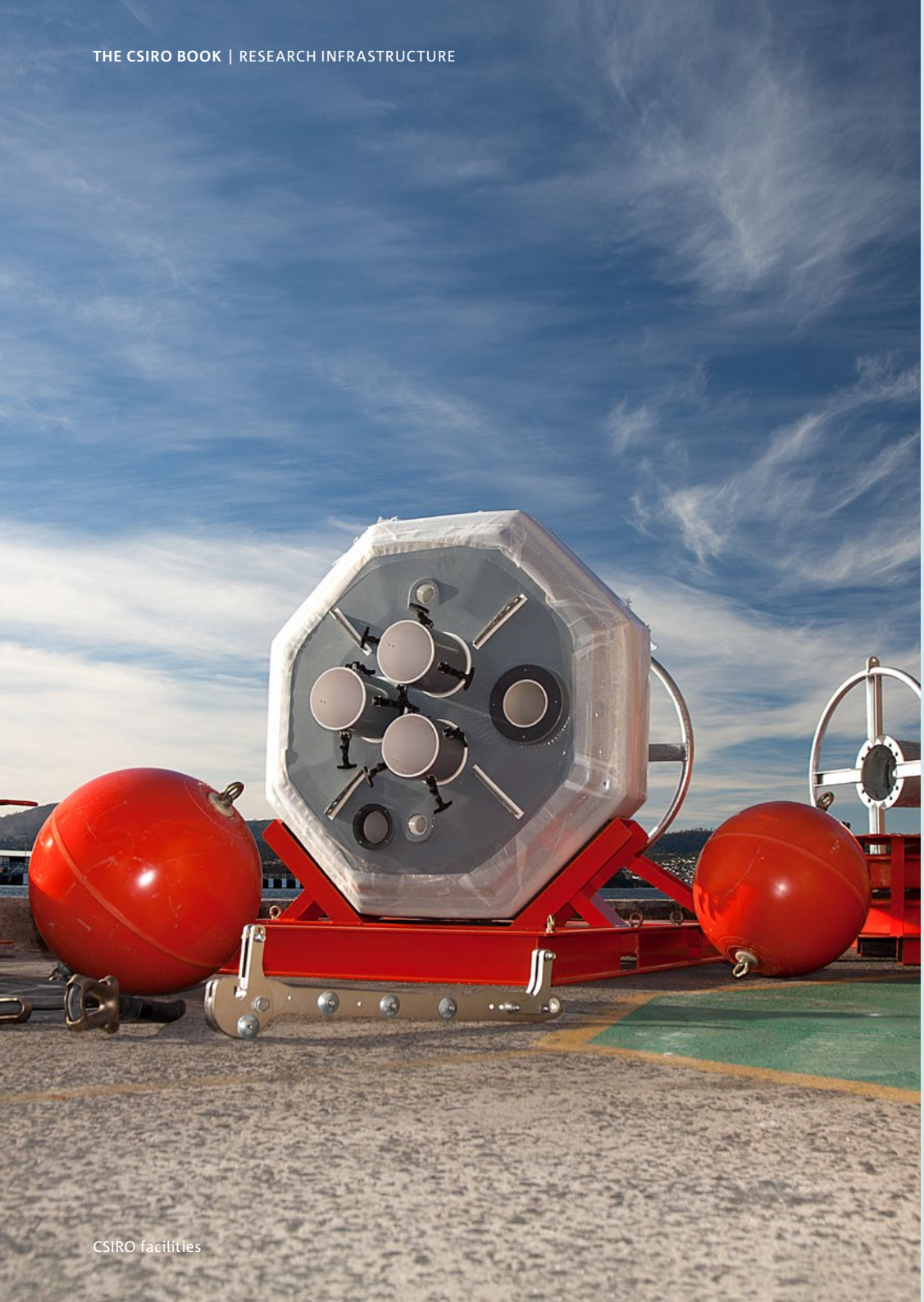
**Social:** Next-generation pipeline of skilled Australians developed because of Pawsey's training and STEM offering.

**Economic:** Increased employment and talent attraction to Australia; research outputs of projects involving Pawsey help place Australia in a globally competitive position; funding and other opportunities are attracted to Australia because of the HPC infrastructure and expertise based here (e.g. radio astronomy, including the SKA project and the SKA Observatory's SKA-Low telescope).

**Environmental:** Green credentials of Australia are enhanced through support of a leading and internationally benchmarked energy-efficient supercomputing facility.

## CURRENT COLLABORATORS

Australian Research Data Commons, Australian SKA Regional Centre, BioPlatforms Australia, Curtin University, Edith Cowan University, International Centre for Radio Astronomy Research, Murdoch University, NCI, NCRIS, SKAO, University of Western Australia, WA Government.



# CSIRO facilities

# Marine observing systems

UNIQUE PURPOSE: To deliver holistic and vertically integrated marine observational research capability, operating across coastal and blue-water marine environments to the polar edge, within a range of science domains including essential climate variables, physical and biogeochemical oceanography, biodiversity and habitat observation, geoscience and fisheries science.

**Research significance for Australia:** Australia has the third largest ocean territory in the world and our observation platforms and data infrastructure underpin key Programs of Research within the Nature and Minerals and Energy research areas, while long-term datasets are critical to state of the environment reporting and understanding the impacts of ocean interventions (climate change, food security, net zero initiatives).

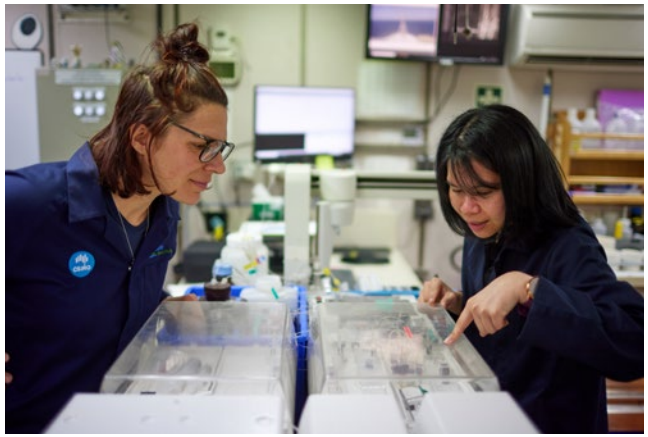
**National scale and utilisation:** CSIRO brings together multiple disciplines at scale and partnerships with national institutions including the maximise our scale of operation and the utilisation of our platforms. Our infrastructure increasingly delivers real-time, quality-controlled information to decision-makers for immediate use.

## INFRASTRUCTURE DESCRIPTION

- Shore facilities including Hobart Wharf, marine engineering and development hub (advanced fabrication capabilities), NATA-accredited marine instrumentation calibration, carbon laboratory, deepwater pressure test facility, autonomous vehicle lab, hydrochemistry laboratories, acoustic calibration facility, Argo lab, and Lucinda Jetty.
- Vehicle capabilities including underwater sea gliders (open ocean and coastal), emerging autonomous surface vehicle capabilities, RV *Linnaeus* coastal vessel, Ships of Opportunity capabilities.
- In-water platforms including Argo floats, marine science instrumentation pool, coastal and deepwater moorings hardware, towed platforms and cabled observatory infrastructure.

## IMPACT

**Social:** Enabling continued human enjoyment of the natural world; safer use of the oceans and other environments.



**Economic:** Sustained economic benefit from marine industries (e.g. fisheries, aquaculture, offshore wind energy) through cost-effective, informed management.

**Environmental:** Climate modelling and impact assessments drive informed climate adaptation initiatives; climate mitigation technologies assist Australia's transition to net zero.

## CURRENT COLLABORATORS

AAD, AIMS, Alfred Wegener Institute for Polar and Marine Research, ANSTO, Australian Antarctic Division, Australian Hydrographic Service, Blue Economy CRC, BOM, Curtin University, Geoscience Australia, IMOS, JAMSTEC, MNF, Monterey Bay Aquarium Research Institute, NIWA, NOAA, Southern Coastal Research Vessel Fleet, University of Tasmania, University of WA, Woods Hole Oceanographic Institution.

# CSIRO characterisation network

UNIQUE PURPOSE: Dedicated, multipurpose, integrated and coordinated characterisation research infrastructure and expertise across CSIRO.

**Research significance for Australia:** Enabling science impact by leveraging breadth of technology and depth of expertise to explore the structure–function relationships that underpin many of our ambitions.

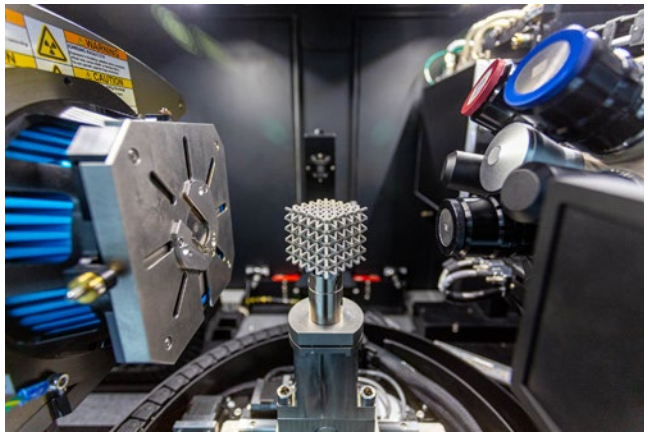
**National scale and utilisation:** CSIRO characterisation network comprises approximately $100 million of scientific infrastructure and 80 characterisation experts co-located in 8 nationally distributed nodes. The network delivers to hundreds of projects across CSIRO in Research Areas including Tech Economy, Nature, One Health, Energy and Minerals, Food and Fibre, and Connecting Science and Innovation to Society.

## INFRASTRUCTURE DESCRIPTION

Extensive range of specialised instruments (some unique in Australia) and expertise combining analytical science and domain specific applications to analyse:

- bulk chemistry and structure of minerals, materials and solutions
- 2D and 3D microscopy of material morphology and chemistry
- biomolecular structure
- biophysical properties and interactions
- multi-omics
- complex mixtures
- mechanical and thermochemical properties
- material evolution in real time under controlled conditions (*in situ* monitoring)
- surface properties.

Instrumentation is supported by dedicated sample preparation, data management, and multimodal interpretation using commercial and bespoke software.



## IMPACT

Our broad technical expertise and extensive characterisation infrastructure allow CSIRO to probe the multiscale structure and environmental interactions of materials, enabling the innovation critical for breakthroughs in energy, healthcare, defence, and environmental technology.

## CURRENT COLLABORATORS

ANSTO Australian Synchrotron, Australian National Fabrication Facility, JEOL Ltd, Thermo Scientific Inc, WA universities consortium.

# CSIRO high-performance computing

UNIQUE PURPOSE: Enabling research across CSIRO science by providing robust internal HPC ecosystem and expert support.


**Research significance for Australia:** CSIRO's HPC delivers a range of services covering researchers' compute, data, visualisation, and workflow needs and supports specialised collaboration projects to bring research applications beyond the desktop onto advanced computational facilities. Our internal HPC capabilities are critical for delivering computational power, storage, and expert support that facilitate impactful research outcomes and ensure CSIRO remains globally competitive.

**National scale and utilisation:** CSIRO's HPC capabilities are highly utilised across the organisation, addressing research problems across multiple research areas.

## INFRASTRUCTURE DESCRIPTION

- HPC hardware including the Petrichor and Virga clusters, with over 34,000 CPU cores and 480+ advanced GPUs for AI and machine learning workloads.
- Modular data centres (e.g. Clayton and Pullenvale) optimised for supercomputing and virtual workloads.
- Storage infrastructure: high-performance storage supporting petabytes of research data.
- Energy-efficient cooling with $CO_2$ chillers to enhance sustainability in data centre operations (Pullenvale).
- Expert support teams providing HPC user support and sys administration, science-specific expertise in optimisation, data analytics, visualisation, workflow and software engineering.

## IMPACT

Providing in-house access to HPC hardware and expertise enables researchers to tackle national challenges in biosecurity, climate resilience, and health. This capability meets current needs and adapts to emerging computational requirements, supporting CSIRO's ability to maintain a research edge in this capability for Australia.

## CURRENT COLLABORATORS

Australian eResearch organisations, Australian Research Data Commons, CDC Data Centres, DataDirect Networks, Defence Science and Technology Group, Dell, NCI, NetApp, NVIDIA, Oper8 Global, Pawsey Supercomputing Research Centre.

# Connecting science and innovation to society

The pace of scientific discovery and technological advances is remarkable and accelerating. Globally, the recognition and application of Indigenous peoples' knowledge is growing, offering wisdom and new insight.

**Challenge to humanity:** How do we effectively harness and translate the extraordinary potential of knowledge, research and innovation to transform economies and societies and solve the world's most complex challenges?

**Australia's aspiration:** Australia aspires to create future sustainable prosperity and quality of life for all Australians by embedding knowledge, research and innovation into the fabric of our nation's economy, industries and society.

**CSIRO ambition:** CSIRO aims to inspire, support and drive a shift to a knowledge-intensive economy that mobilises science, technology, creativity and entrepreneurship to fulfil national aspirations in a globally connected world. In addition to delivering great science and national scale research infrastructure, CSIRO will play a key role in supporting and strengthening the innovation system.

CSIRO will do this by focusing on delivering programs to place science at the heart of Australian industry, developing Australia's STEM workforce and providing services to underpin the formation of new industries and facilitate innovations achieving real-world impact. CSIRO will embrace Indigenous science and knowledge throughout the delivery of these programs.

### Indigenous science

For over 65,000 years, Aboriginal and Torres Strait Islander peoples have been Australia's first scientists, observing, experimenting and innovating to thrive, prosper and care for Country. These Traditional Knowledges and practices offer unique insights that enable new ways to approach innovative solutions and technologies for the benefit of all Australians. By embracing Indigenous science, we acknowledge the historical and ongoing contributions of Aboriginal and Torres Strait Islander people and tap into a rich source of creativity and problem solving.

Through respectful collaborations with Aboriginal and Torres Strait Islander peoples, CSIRO fosters impactful innovations through knowledge sharing, ethical practices and sustainable partnerships. These partnerships ensure that our research is informed by and responsive to the needs of Indigenous communities as well as building capability within our organisation.

Our commitment to Indigenous science and engagement aligns with government priorities, the National Science and Research Priorities and the National Agreement on Closing the Gap, as well as our own Reconciliation Action Plan and complementary strategies that give voice to Indigenous leadership and respects Indigenous knowledge systems.

Together, we are forging a brighter future for Australia and contributing to a more innovative research sector.

### Coordination and collaboration

Australia has struggled to realise the full potential of the knowledge, science and innovation it produces. Our ambition is to support and enable industry–research collaboration and remove barriers that have impeded this in the past. We strive to help create a system in which the 'missing middle' or 'valley of death' in research is bridged, and Australian innovations are readily scaled and absorbed into industry. Realising these ambitions would maximise the returns on investment in science and research and make long-term finance available to drive Australian-based investments in technology-enabled, priority growth areas of the Australian economy.

CSIRO delivers programs and services to drive coordination across the innovation system. We support cross-disciplinary, cross-organisational and cross-jurisdictional collaboration, facilitating risk sharing and mobility among scientists, researchers and entrepreneurs. Through international collaboration and solving shared problems, Australia and its regional partners are at the forefront of new scientific discoveries and emerging technologies. CSIRO is a key liaison between Australia and other countries in matters connected with scientific research.

## Science and technology at the heart of Australian industry

CSIRO is dedicated to helping Australia use science and innovation to create new sources of productivity growth and comparative advantage, creating a diversified and resilient industrial base, with new strengths in its domestic and export sectors. We work to ensure that science and technology inform government policy development to drive domestic and global interests – ultimately with legislation, regulations, and standards supporting the adoption of innovation.

CSIRO's science underpins reports, information, and advice that:

- Drive economic growth by showing how science, technology and innovation can boost competitiveness and activate new markets.
- Improve policymaking by providing evidence-based insights on technology-based solutions to national challenges.
- Coordinate Australia's R&D and innovation investment to support national priorities.

Through independent testing and certification, CSIRO provides product, system and infrastructure assurance, underpinning regulatory and customer confidence and creating pathways to market for innovative products. CSIRO facilitates the adoption of science through the delivery of high-quality programs for industry, research, education and government stakeholders, uplifting the effectiveness and industry impact of Australia's innovation system.

## Strengthen the innovation system with a skilled workforce and community trust

To realise the potential of our science, technology and innovation Australia must develop the strong and diverse pipeline of STEM-capable workers needed for a prosperous future, reversing Australia's downward trend in OECD-benchmarked educational performance in maths and science. A skilled workforce enables the translation of scientific advances into new products and services. Companies will need to invest in new apprenticeships, re-skilling employees, improving in-job mobility and collaboration with research and educational institutions

Impact from science, technology and innovation is underpinned by trust. Public trust in science is bolstered through responsible technology development and collaboration to counter misinformation and disinformation. We need to work to ensure that the Australian public can confidently trust science and willingly respects and listens to scientific advice.

Our aspiration is for science leadership in Australia to be diverse and foster new opportunities for collaboration. Aboriginal and Torres Strait Islander peoples, communities and scientists are recognised and respected for their valuable contribution to STEM, and we elevate and invest in their knowledge systems.

CSIRO uses evidence and works with stakeholders, including Indigenous communities, to design and deliver programs that create opportunities, build capability and motivate students to pursue a STEM career. Out goals are for young Australians and their communities to see a future for themselves in STEM and for STEM graduates to be supported through STEM career pathways in which their training and skills are used and enhanced.

CSIRO publishes, disseminates and communicates Australian science both locally and internationally, advancing science, empowering decision-making and increasing trust and capability in science.

# A strong and diverse science, technology, engineering and maths talent pipeline for Australia

PROBLEM STATEMENT: How do we ensure Australia has the strong and diverse pipeline of STEM-capable workers needed for the future?

## SOLUTIONS

- Design and deliver programs that connect education with industry, bring real-world, emerging science and technology into classrooms, strengthen the relevance of STEM education, and build the capabilities of students who are traditionally underrepresented in STEM.*
- In partnership with industry, understand and build Australia's STEM workforce to meet current and future need.
- Lead the generation, use and sharing of evidence-based practices in STEM education through thorough testing and support the widespread adoption of proven methods to enhance students' STEM skills.

## IMPACT

Successful programs will lift engagement, participation and performance in STEM for Australian students, reverse the downward trends in OECD performance and help build a future-ready workforce capable of supporting economic prosperity. Enhanced scientific literacy will empower Australians to better understand and protect their natural environment, foster understanding and trust in science and enable society to realise the potential of research and innovation to solve complex challenges.

## CURRENT COLLABORATORS

Aviation Aerospace Australia, Bechtel, BHP Foundation, Chevron, CSL, Department of Defence, Department of Education, NIAA, NSW Department of Climate Change, Energy, the Environment and Water, state education departments (QLD, NSW, SA).

*INDIGENOUS SCIENCE

# Indigenous science

PROBLEM STATEMENT: The body of knowledge that enabled Aboriginal and Torres Strait Islander peoples to live and thrive in Australia for 65,000 years was formed with science using experimentation and observation. How do we partner with Indigenous Australia to deliver innovative, sustainable, holistic solutions that meet our greatest national challenges?

## SOLUTIONS

- Develop and support an Indigenous STEM workforce.
- Support Indigenous leadership, governance and accountability through the Indigenous Advisory Group, Indigenous Research Grants and Board representation.
- Embed Aboriginal and Torres Strait Islander voices and views into research.
- Facilitate Indigenous-led projects to support the health and wellbeing of Aboriginal and Torres Strait Islander people.
- Utilise Traditional Knowledge of biodiversity, plants and Country for health and wellbeing.
- Use our Stretch Reconciliation Action Plan to build CSIRO's capability to respond to the priorities of Indigenous Australia.
- Protect Indigenous cultural and intellectual property.
- Unlock new markets and economies for Indigenous businesses to benefit from their Indigenous knowledge.
- Design and implement policies and practices across the data life cycle to respond ethically to Indigenous data rights and interests.

Living STEM, our teaching support program, sponsored by Chevron Australia, is co-led with local Elders. It highlights the value of Indigenous ecological knowledge and relevance to contemporary challenges by opening the school gates and connecting Country to classroom.

## IMPACT

CSIRO support for Indigenous science and knowledge systems will enable new ways to approach innovative solutions and technologies that incorporate human- and Country-centred design for the benefit of all Australians.

## CURRENT COLLABORATORS

Aboriginal and Torres Strait Islander students, Australian Institute of Aboriginal and Torres Strait Islander Studies, Australian Research Data Commons, community organisations/networks, DCCEEW, Indigenous Land and Sea Corporation, Indigenous peak bodies, Indigenous recruiting agencies, Indigenous-owned enterprises, IP Australia, Lowitja Institute, NIAA, National Native Title Council, NESP, Prescribed Body Corporates, Reconciliation Australia, Traditional Owners, universities.

# Better science and technology decision-making

PROBLEM STATEMENT: How do we ensure that Australian policymakers and senior executives can access a credible, independent evidence base to make informed decisions related to science and technology policy, strategy, and investments?

## SOLUTIONS

- Provide clear, concise, evidence-based analysis that shows how science and technology can contribute to national-scale opportunities and challenges.
- Outline opportunities to boost productivity and economic growth through investment in science and technology.
- Improve policymaking by providing evidence-based insights on science and technology.
- Coordinate Australia's R&D investment to support national priorities.
- Develop national-scale technology and industry roadmaps that provide clear guidance on technology-based industry growth opportunities.
- Produce bespoke advisory work that supports public policy, corporate strategy, and/or technology investments.

## IMPACT

Improved policymaking and more efficient allocation of technology-related investments will lead to higher standards of living via stronger economic growth and better environmental outcomes. Public trust in science will improve as a result of transparent, evidence-based, public reports.

## CURRENT COLLABORATORS

Australian and multinational corporations, Australian universities, Commonwealth departments, industry peak bodies, partners/sponsors, publicly funded research agencies, state governments.

# Safety and assurance of national infrastructure

PROBLEM STATEMENT: How can we provide assurance regarding the safety and performance of Australia's critical built environment and transport infrastructure including reliable and trusted paths to market for innovative products?

## SOLUTIONS

- Develop testing, verification and certification services for products and systems that produce trusted outputs (reports, certificates) to underpin confidence in better and safer products for customers, builders, building owners and occupants.
- Deliver recognised, trusted and accredited certification of products and systems to address a wide range of regulatory drivers affecting national infrastructure including the building and construction, energy, and transport (road, rail and maritime) sectors.
- Introduce certification of products and systems within industries and market sectors aligned to many of CSIRO's impact areas.
- Support CSIRO research projects to meet external goals that include regulatory acceptance aspects and provision of a flexible quality assurance system that supports the accredited testing activities of a wide range of laboratories within other CSIRO Research Units.
- Represent CSIRO's experience and judgement on committees and boards that shape industry and related regulation and standards.

## IMPACT

Facilitating the commercialisation of new products and systems, whether locally manufactured or distributed, will drive economic growth. Pathways will be established for products and systems that adapt to changing environmental and climatic conditions and meet regulated levels of safety and amenity for the community.

## CURRENT COLLABORATORS

Australian Building Codes Board, Building Research Association of New Zealand, Danish Institute of Fire and Security Technology, industry, International Organization for Standardization, National Association of Testing Authorities, US National Fire Protection Association, US Society of Fire Protection Engineers, Standards Australia, state governments, technical associations, UL Solutions, universities, WSP New Zealand.

# Innovation programs

PROBLEM STATEMENT: How do we embed innovation into our nation's economy by overcoming barriers to industry–research collaboration, accelerating research and technology translation, and building our industrial STEM talent pipeline?


## SOLUTIONS

- Design and deliver programs, and provide facilitation services to build the capability of SMEs and researchers to effectively collaborate.
- Provide researchers with the skills, industry connections and financial resources to commercialise their research through formation of deep tech start-ups, attraction of investment capital, technology licensing and other research translation pathways.
- Develop job-ready STEM professionals able and willing to work in industry, ready to translate research into commercial outcomes and entrepreneurially skilled to boost innovation in emerging technology fields.
- Support Australian start-ups and SMEs working on innovative technology to expand overseas.
- Build Indo-Pacific regional innovation capability and preparedness, including delivery of strategic DFAT initiatives.
- Operate at the intersection of research, industry, education and government, including delivery or support of national-scale initiatives such as Australia's Economic Accelerator, Trailblazer, Industry PhD, ON, and Main Sequence Ventures.

## IMPACT

By uplifting the effectiveness and industry impact of Australia's national innovation system, Australian research and innovation will be efficiently harnessed to solve global challenges and strengthen Australia's industries including SMEs. This will drive economic growth, skilled employment and increases in living standards and sustainability for all Australians.

## CURRENT COLLABORATORS

Department of Education, DFAT, DISR, industry associations and companies, SMEs, state governments, universities.

# Publishing trusted science

PROBLEM STATEMENT: The credibility and usability of science and technology is underpinned by research that is accessible, peer-reviewed and well-communicated. Australian research and science outcomes are not complete until they are reviewed, published, disseminated, and communicated so that other researchers can build upon their results to solve research challenges.


**Oliver Berry, Clare Holleley and Simon Jarman, with their book *Applied Environmental Genomics*.**

## SOLUTIONS

- Publish and disseminate high-quality scientific research and information in well-respected, peer-reviewed journals, scientific and technical reports, books, periodicals and other publications.*
- Build and sustain international connections through journal-based research communities.
- Contribute to efforts to support open research and the development of policies and initiatives both locally and globally for the benefit of the advancement of science.
- Serve as a unique voice and aggregator of Australian science, research and outreach for local and global audiences.
- Operate as a commercially sustainable publishing enterprise that embraces digital innovation to scale impact.

## IMPACT

A commercially sustainable publishing enterprise forms the foundation for all outcomes and will foster growth through science-enabled innovation both domestically and internationally. Decision-making informed by scientific research will bolster Australia's economic growth and enhance CSIRO's research stewardship. The creation of academic communities around our journals will engage scientists worldwide, facilitating a global exchange of ideas based on submitted research and editorial contributions. This collective effort will support trust in science, contribute to informed public debate and decision-making and drive progress across multiple dimensions.

## CURRENT COLLABORATORS

Association of Learned and Professional Society Publishers, Australian Academy of Science, Australian Publishers Association, Chinese Academy of Science, Learned Societies in Australia and beyond, Council of Australasian University Librarians, International Association of Scientific, Research4Life, ResearchGate, research institutions and libraries globally, SDG Publishers Compact, Silverchair, Society of Scholarly Publishing, Technical and Medical Publishers, Committee on Publication Ethics, universities.

*INDIGENOUS SCIENCE

# Abbreviations

2D: Two-dimensional

3D: Three-dimensional

4D: Four-dimensional

AAD: Australian Antarctic Division

AAPP: Australian Antarctic Program Partnership

ABS: Australian Bureau of Statistics

ACCESS-NRI: Australian Community Climate and Earth Simulator National Research Infrastructure

ACDP: Australian Centre for Disease Preparedness

ACIAR: Australian Centre for International Agricultural Research

ACS: Australian Climate Service

AFAC: National Council for Fire and Emergency

AI: Artificial Intelligence

AIMS: Australian Institute of Marine Science

AIRAH: Australian Institute of Refrigeration Air Conditioning and Heating

ANU: Australian National University

ALA: Atlas of Living Australia

ANSTO: Australian Nuclear Science and Technology Organisation

ARC: Australian Research Council

AREA: Australian Renewable Energy Agency

ASKAP: Australian SKA Pathfinder

ATCA: Australia Telescope Compact Array

ATNF: Australia Telescope National Facility

BOM: Bureau of Meteorology

CCS: Carbon capture and storage

$CO_2$: Carbon dioxide

CPU: Central processing unit

CRC: Cooperative Research Centre

CSIRO: Commonwealth Scientific and Industrial Research Organisation

DAFF: Department of Agriculture, Fisheries and Forestry

DCCEEW: Department of Climate change, Energy, the Environment and Water

DFAT: Department of Foreign Affairs and Trade

DIRDCA: Department of Infrastructure, Regional Development, Communication and the Arts

DISR: Department of Industry, Science and Resources

EASI: Earth Analytics Science and Innovation

EO: Earth observation

EPA: Environment Protection Authority

FAO: Food and Agriculture Organisation

FDA: Federal Drug Administration

FMiA: Future Made in Australia

GDP: Gross domestic product

GPU: Graphics processing unit

HPC: High-performance computing

IMOS: Integrated Marine Observing System

INCOIS: Indian National Centre for Ocean Information Services

IOC: Intergovernmental Oceanographic Commission

IPCC: Intergovernmental Panel on Climate Change

JAMSTEC: Japan Agency for Marine Earth Science and Technology

LLM: Large language model

MNF: Marine National Facility

mRNA: Messenger ribonucleic acid

NASA: National Aeronautics and Space Administration

NATA: National Association of Testing Authorities

NCI: National Computational Infrastructure

NCRIS: National Collaborative Research Infrastructure Strategy

NEMA: National Emergency Management Agency

NESP: National Environmental Science Program

NGO: Nongovernment organisation

NIAA: National Indigenous Australians Agency

NIWA: National Institute of Water and Atmospheric Research

NOAA: National Oceanic and Atmospheric Administration

NRF: National Reconstruction Fund

NSRP: National Science and Research Priorities

NSW: New South Wales

NT: Northern Territory

NZ: New Zealand

OECD: Organisation for Economic Co-operation and Development

QLD: Queensland

RAM: Random-access memory

Pawsey: Pawsey Supercomputing Research Centre

RV: Research Vessel

SKA: Square Kilometre Array

SKAO: Square Kilometre Array Observatory

SME: Small to medium-sized enterprise

SPC: South Pacific Community

STEM: Science, technology, engineering and mathematics

TU: Technical University

UNDP: United Nations Development Programme

UNEP: United Nations Environment Programme

VIC: Victoria

WA: Western Australia

WEHI: (formerly) Walter and Eliza Hall Institute

WHO: World Health Organization

WMO: World Meteorological Organization

WOAH: World Organisation for Animal Health

# Glossary

**Bioconjugate:** A molecule created by chemically linking 2 or more molecules at least one of which is a biomolecule, such as a protein or an antibody.

**Biologics:** Medications that are produced from living organisms, such as proteins and genes.

**Digital twin:** A digital model of an intended or actual real-world physical product, system, or process that serves as a digital counterpart for purposes such as simulation, integration, testing, monitoring, and maintenance.

**Epigenetic:** Caused by or relating to changes in gene expression that occur without altering (mutating) the DNA sequence itself.

**Indigenous:** Respectfully includes both Aboriginal peoples and/or Torres Strait Islander peoples.

**In silico:** Of an experiment or study, performed on a computer or by using a computer simulation.

**Metrology:** The scientific study of measurement. It establishes a common understanding of units, crucial in linking human activities.

**Physical Containment Level 3 (PC3):** Laboratories rated at the second highest level of containment and biosecurity level.

**Physical Containment Level 4 (PC4)**: Laboratories rated at the highest level of containment and the highest designated biosecurity level for working with highly transmissible diseases and viruses for which there are no vaccines or effective treatment.

**Omics:** Collectively, the branches of biological science (genomics, proteomics, metagenomics etc.) involved in studying sets of biological molecules and how they translate into the structure and functioning of organisms.

**Pyrolysis:** the process of applying heat to transform organic materials into their molecular components.

**Quantum technology:** Technology that capitalises on the laws of quantum mechanics.

**Zoonotic:** Of a disease, capable of being transmitted from animals to humans or vice versa.

# Units

B: billion

GB: gigabyte

GHz: gigahertz

GW: gigawatt

GWh: gigawatt hour

kg: kilogram

kW: kilowatt

M: million

m: metre

mt: metric tonne

PB: petabyte

sqm: square metre

TB: terabyte

6G: sixth-generation wireless

As Australia's national science agency, CSIRO delivers the science Australians need for the nation they want – productive, sustainable, healthy and secure.

CSIRO. Improving the life of every Australian.

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