Australian Academy of Science

PRE-BUDGET SUBMISSION TO THE

2022–23 FEDERAL BUDGET

AUSTRALIAN ACADEMY OF SCIENCE / JANUARY 2022

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The Australian Academy of Science (the Academy) welcomes the opportunity to make recommendations for consideration in the Commonwealth budget for 2022–23.

Science and technology continue to offer the only exit strategy from the pandemic for Australia and the world. Our nation was well served by policymakers being able to access scientific evidence. Mechanisms that now bring science to the heart of government should not be lost during or after our recovery and must be an important part of our future preparedness.

"Science and technology continue to offer the only exit strategy from the pandemic for Australia and the world."

Australia must sustain excellence in fundamental research; foster a scientific workforce more diverse in race, gender, and geography; and support high-quality science and mathematics education. Additionally, we must foster closer ties between academia and industry, keep borders open to promote international partnerships, and promote ethical research practices.

Australia has opportunities to benefit from a renewed focus on science, innovation, and creative entrepreneurialism. Through support for the new ideas and discoveries that underpin innovations and products, we can improve the lives and livelihoods of all Australians. These ideas and discoveries form intellectual capital that can be developed and applied within Australia and globally.

> *"Pure research was merely that research which has not yet been applied"*
> – George Porter, Chemist and Nobel Prize winner

Providing sustainable support across the research pipeline will require streamlining and reducing bureaucracy in the Australian research grants system, increasing connection and collaboration between industry and academia, and supporting international collaborations on projects and research infrastructure facilities.

The 2022–23 budget provides an opportunity for the Australian Government to:

- secure the scientific base by developing a ten-year science and technology investment strategy that includes whole-of-government alignment of science and innovation priorities and has a focus on underlying support for fundamental research. The strategy should include:
  - a plan to grow real funding for science, including increasing investment in R&D competitive with our peer nations
  - continuity and long-term funding to national research infrastructure facilities, including growth in funding levels beyond 2028–29, workforce development and advisory mechanisms
  - a new international science engagement and diplomacy strategy to enhance our international research collaboration and secure Australia's ability to participate and benefit from global science.
  - Ensure that the long-term investment strategy secures the scientific knowledge and discovery needed to underpin future technologies and commercial opportunities
- create a cohesive, national approach to secure new jobs and industries through science and technologies.
  - institute a national Small Business Innovation Research (SBIR) program to de-risk investment across all three stages of proof of concept, scale-up and commercialisation.

  - An independent knowledge brokering organisation should be considered to connect business and academia and better support for Higher Degree by Research students to engage in industry–research collaborations through internships and fellowships.
  - establish a science translation fund for university and science agency research in the physical sciences and technology (e.g., materials science, mathematical sciences, physics, quantum technologies, emissions reduction technology). This fund should operate according to accepted modes of governance, including transparency, peer review and clear priorities, and be managed at arm's length from government. The fund should build on the model of the Medical Research Future Fund (MRFF) and support interdependencies between and across disciplines which is where most new discoveries are expected to emerge.
- establish robust and permanent mechanisms for independent science advice to inform policy across all of government.
- commence a national whole of government review of the science and research system, including an urgent review of existing competitive grant funding schemes to reduce the bureaucratic burden, institute timely decisions, double the existing success rate of research funding proposals, and protect the independence of expert's decisions on individual projects.

Secure the scientific base through a long-term investment strategy for science

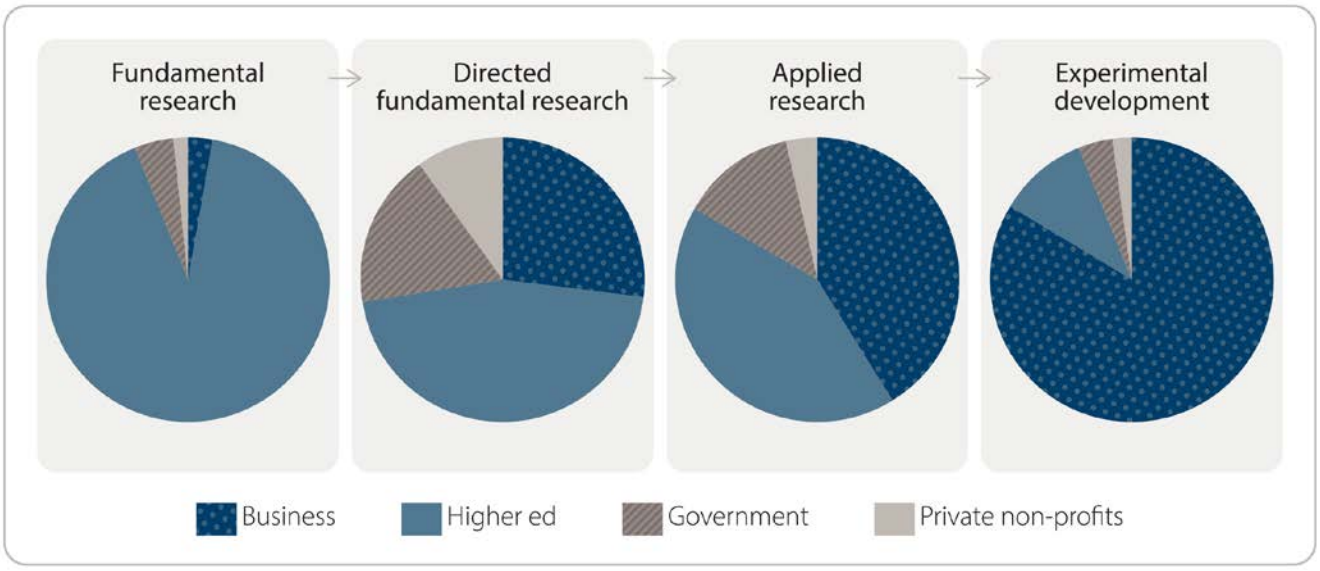
The primary purpose of fundamental research is to generate new knowledge and better understand our world, which generates 'scientific capital', a repository from which innovative applications can be drawn. Fundamental research has received a declining share of university and government support over the past 30 years.

New ventures drawing on fundamental science are emerging from our universities, from chemistry (green steel, zinc bromide battery technology) and physics (quantum computing and applications), to materials science (semiconductors, advanced materials) and geophysics (cost-effective below-surface critical-mineral exploration methods). From a scientific conception to a commercial product, the time can be measured in decades. Hence patient government support for science needs to be consistent at every stage of the research pipeline.

Australia has over 200 schemes and programs to support research and industry engagement across 13 portfolios. There remains a lack of a cohesive, patient, and national approach to research funding. By working towards common goals and priorities, such an approach would help enable an evolving and flourishing advanced manufacturing sector and collaboration and alignment between industry and research.

A translation fund mirroring the Medical Research Future Fund (MRFF) for sciences not currently eligible for the MRFF, such as the physical sciences, should be considered. Many emerging technologies outside medicine and health are based in the physical sciences. Support for translation of all research will be critical to maintain the knowledge pipeline for future Australian manufacturing opportunities and mitigate sovereign risk.

Figure 1—The research pipeline



Data sourced from the Australian Bureau of Statistics (ABS) on expenditure and human resources devoted to research and development by government and private non-profit organisations; higher education organisations; and businesses. Research and development activities in Australia are classified into four broad categories (names in parentheses are as defined by the ABS):

- **Fundamental (pure basic)**: experimental and theoretical work undertaken to acquire new knowledge without looking for long-term benefits other than the advancement of knowledge.
- **Directed fundamental (strategic basic)**: experimental and theoretical work undertaken to acquire new knowledge directed into specific broad areas in the expectation of practical discoveries.
- **Applied**: original work undertaken primarily to acquire new knowledge with a specific application in view. It is undertaken either to determine possible uses for the findings of fundamental research or to determine new ways of achieving some specific and predetermined objectives.
- **Experimental development**: systematic work, using existing knowledge gained from research or practical experience, which is directed to producing new materials, devices, policies, behaviours or outlooks; to installing new process, systems and services; or to improving substantially those already produced or installed.

International engagement and collaboration enriches Australian science and enhances our capacity. It allows us to leverage local knowledge, expertise, and capital into more expansive projects, amplifying our investment and providing a far greater contribution to global science than would be achieved operating independently.

Access to international science lifts our capacity, providing a broad evidence base to inform local decisions, develop local industries and mitigate sovereign risks. International science agreements can provide access to scale and collaboration opportunities, simultaneously growing our knowledge base and industrial base.

Shifts in the scale of facilities required to support the research into the future, such as the shift to exascale computing, may leave Australia unable to fund and host some facilities independently. In addition to access to international facilities, Australia should consider funding mechanisms within the National Collaborative Research Infrastructure program to host large-scale facilities in Australia to attract investment and participation from other nations. Hosting international facilities in Australia could benefit the local economy, our scientists and assist in attracting, training and retaining skilled workers.

Case study 1 – Foundational chemistry leads to green steel and new batteries

Australian scientists have harnessed foundational chemistry to invent and commercialise innovative solutions for the renewable energy transition and development of a circular economy. At the Academy's Science and the Public Good symposium in 2021, internationally recognised Australian chemists Professor Veena Sahajwalla and Professor Thomas Maschmeyer reflected on foundational chemistry's role in developing innovative technologies.

Professor Sahajwalla is best known for the invention of polymer injection technology, also known as 'green steel', for which she won the 2005 Eureka Prize. The technology allows recycled rubber tyres to be melted down and reformed to replace some of the non-renewable coke used in steel production. This process, as well as creating less waste, is cheaper for the industry. The invention and commercialisation of this process have diverted over two million rubber tyres from Australian landfills.

Professor Maschmeyer reflected on how his work in the fundamental area of catalysis (the process of accelerating a chemical reaction) has led to impactful innovations. For example, inspired by safety issues with current lithium-ion battery technology and the need for batteries in renewable energy transition, Professor Maschmeyer invented a new kind of battery. He invented a safe and recyclable zinc-bromide battery by reimagining zinc-bromide chemistry and using a stable gel. The battery can operate at temperatures up to 50 degrees and does not catch fire even when exposed to temperatures above 600 degrees. Recently, Gelion, a spin-out company of the University of Sydney, partnered with Battery Energy Power Solutions to make and distribute the batteries for the Australian market. The batteries will be produced in a factory in Western Sydney.

A cohesive, national approach to secure jobs through the translation of science to industry

To scale up innovative ideas, research and industry must be supported to interact and collaborate. Small and medium enterprises (SMEs) dominate Australia's economic structure, and therefore should be the focus of schemes that aim to bring research and industry closer together.

Globally the exemplar is the small business innovation research Small Business Innovation Research (SBIR) program. While Australia has had a Business Research and Innovation Initiative since 2016 and an SBIR for Defence program, these are small, bespoke and lack critical mass.

The pathway to engage with SMEs must also involve knowledge brokering, connecting organisations, industries, and researchers, and harmonising partnership enablers such as IP arrangements and early-stage investment options. Successful approaches such as Interface in Scotland can provide a model for an independent organisation that specialises in brokering relationships between businesses and academics.

With over half the research workforce in universities being Higher Degree by Research (HDR) students, they must be considered a necessary force in driving industry–research collaboration. Implementing and continuing to support programs that engage HDR students in industry collaboration, such as the successful APR Intern program, can help create a necessary shift in Australia's research culture. Such schemes can also grow our national capacity in entrepreneurial and translation expertise.

The Academy supports establishing an industry fellowships scheme, similar to the scheme by The Royal Society. The model provides a pathway for academic scientists who wish to work on a collaborative project with an industry organisation and for scientists in industry who wish to work on a collaborative project with an academic organisation. Such an approach offers more expansive collaboration with an industry partner than existing programs.

Establish robust and permanent mechanisms for independent science advice to inform policy across all of government

Australia's response to the pandemic, in part, has been informed by the integration of the latest evidence into policy deliberations. The experience of utilising rapid science and research advice to inform public policy should be carried forward into new challenges such as the decarbonisation and digitalisation of our economy and society.

In 2018 an OECD report called upon governments to develop national mechanisms to provide scientific advice in crises.3 It also called for the fostering of domestic capability in science policy and advice. Indeed, the routine provision of scientific evidence from independent, authoritative, and trusted sources to inform policymaking has been mostly absent in Australia. There are few permanent and structural mechanisms for the provision of independent scientific advice to government.

In 2020, the Rapid Research and Information Forum's (RRIF), chaired by the Chief Scientist, filled this gap. RRIF provided relevant, timely and accessible evidence informing policy to a non-specialist audience. Significantly, the reports are based on the nation's leading researchers' knowledge of the balance of the evidence, are multidisciplinary, and are not the views of one expert, opinion, or cherrypicked data.

This mechanism has now been replaced by Rapid Research Information Reports coordinated by the Office of the Chief Scientist and the National Science and Technology Council. This recognises the benefit to the Australian Government beyond the pandemic by providing evidence-based answers to questions to inform a range of policy challenges, from adaption to global warming, the challenge of a circular economy, and building sovereign capability in manufacturing.

Australian government funding should be allocated to this advisory capability to secure and strengthen it. Funding would also allow the capability to grow to routinely service all government portfolios and to maximise coordination.

A national whole of government review of the science and research system

Providing adequate and consistent support across the research pipeline requires finding a funding system with a balance between mobilising science to address national priorities and providing researchers with the freedom to work on problems that may provide the fundamental basis of future industries or our response to crises.

The Government supports Australian science through competitive research grants and research block grants. In 2018, around 60 competitive grant programs were distributed across six different portfolios – a complex and inefficient system that creates a substantial burden on both researchers and universities.

Our sovereign scientific capabilities, and the extraordinary mobilisation of the science and research sector to address this global crisis, has helped Australia manage the COVID-19 pandemic.

The sector's capacity is no accident. Instead, it results from decades of investment in education, research (especially fundamental and discovery research), research

careers, research infrastructure, scientific agencies and international collaborations. This capacity has been demonstrated by the rapid, and unprecedented, development of a vaccine within twelve months of the publication of the genomic sequence by Australian scientist Professor Eddie Holmes FAA and Chinese scientist Professor Yong-Zhen Zhang.

However, defects in Australia's unsustainable approach to funding and organising research and development have been exposed. Despite the Australian Government's additional investments in the 2020–21 budget, the ongoing negative impact on the scientific enterprise of the pandemic are manifesting.

Australia's investment in research and development as a proportion of GDP was already falling before the pandemic. Australian universities' exposure and dependence on international education to fund Australian research is an urgent risk that will require further policy reform to be addressed.

The Academy has long sought an uplift in our national scientific ambition. This ambition requires broad agreement on how to focus any additional funding for science and research on societal challenges, particularly uniquely Australian challenges, such as the health of crucial economic and environmental assets like the Murray Darling Basin and the Great Barrier Reef.

Central to this is an appreciation that we cannot expect other nations to invest in strategic research impacting uniquely Australian issues , and the issues in our region. There are certain fields of knowledge and expertise where a sovereign science capability is of strategic national importance.

Case study 2 – Australia's opportunity to become a leader in RNA science and technology

In 2020, the race was on to create effective vaccines that could aid in ending the COVID-19 pandemic. Two of the first vaccines produced by Pfizer/BioNTech and Moderna used a promising 'new' technology – mRNA. These COVID-19 vaccines were the first mRNA vaccines approved for use across the globe and have received substantial public interest as a technology that might offer rapid reformulation to be used against future strains of the virus.

While this technology rapidly made its way into the public consciousness, it was only successful due to previous decades of patient investment in RNA sciences worldwide. Given the efficacy and flexibility of mRNA-based vaccines, Australia is now working towards developing a sovereign capability to deal with the ongoing COVID-19 crisis and future pandemics. Australia is well placed to do this, with many world-leading experts in RNA science, biomaterials and biotechnology located within our universities and research institutes.

Through the adoption of policies and strategic investments, opportunities exist to become a leader in RNA science and technology, from knowledge creation to translation and manufacturing. The example of mRNA vaccines demonstrates the importance of sustained programs of fundamental science, patient capital and a diverse manufacturing portfolio.

Urgent review of existing competitive grant funding schemes

Australia's existing grant environment may benefit from better aligned grant schemes based on national imperatives and sovereign advantages but should retain freedom for researchers to explore new paths and emerging fields of research. A new overarching body modelled on United Kingdom Research and Innovation is a promising model for adapting to the Australian context.

Competitive grant systems seek to identify, often through expert peer review, the best proposals for funding. However, international evidence suggests that such systems with incredibly low success rates and high numbers of applications don't necessarily fund the most innovative or leading-edge proposals if mired in unnecessary bureaucracy.

In Australia, despite spending months of time preparing applications for grant funding, success rates for grants are low, with typically only around 20% of applications being funded and often with less than the full amount requested by the investigators. In the 2021 NHMRC Ideas Grants round, less than 10% of applications were successful. After grants have been awarded, the management process for contracts is similarly burdensome.

Given the complex nature of research funding and the myriad of stakeholders involved, the Academy calls for a comprehensive review of the Australian system of research funding be undertaken to determine the most sustainable and effective way to support the research and development our nation so heavily relies on.