By email: priorities@industry.gov.au

6 April 2023

Australian Academy of Science submission on Australia's science and research priorities

The Australian Academy of Science welcomes the opportunity to provide advice on Australia's Science and Research Priorities.

This submission focuses on **the strategic context and requirements of the National Science and Research Priorities**. Advice responding to this initial consultation has been prepared by the Academy's National Committees for Science based on discipline-specific sector analysis carried out by the committees. These submissions are provided as attachments.

Identifying science and research priorities is a crucial function of government. Australia is and remains a middle power in global science, and Australia does not have the capacity of larger economies for massive investment and deep focus across all areas. Our limited – and inadequate – support for research should not be spread too thinly.

What are the priorities for?

In recent years, the pandemic, geopolitics, and technological competition have made very clear the need for **strategic investment in Australia's scientific capability.** Indeed, a sovereign scientific capability is as critical to Australia's future as a sovereign industrial and defence capability.

To maintain and expand sovereign scientific capability, there are three areas that we should recognise as the basis of our national research effort:

- **Research on uniquely Australian matters** such as our environment and biodiversity, our agricultural capability, the needs of our geographic region and the specific needs of our population's health. Only we have the need, incentive and specialized talent to pursue this research.
- **Research on global matters** where Australian capacity and talent can contribute to international efforts, such as human health, energy, and climate change.
- **Research that builds intellectual capital** through the pursuit of the most basic understanding of the very nature of things. This includes fundamental research that can provide the knowledge we need for reasonable and sustainable futures, and it includes enabling research on science and research systems.

From this foundation, we must identify what, where and how we will focus our efforts.

We must consider where we have a **comparative advantage**, such as our skill sets, geographical space, regions encompassing multiple climatic and other conditions, and the terrestrial and marine environment. We must identify our **knowledge gaps** and areas for foundational, strategic, and exploratory research.

Research prioritisation would benefit from a deep understanding of the Australian research system. While the Academy's National Committees for Science provide a basis through decadal plans, a **whole-of-government review** to identify the optimal operation, funding arrangements and architecture of the Australian science and research system could inform and be informed by the science and research priorities.

What should the priorities include?

Priorities should be expansive and inclusive, recognising the multidisciplinary nature of Australia's challenges and allowing for innovation and exploration from multiple disciplinary perspectives. Mission-based priorities allow for this flexibility, providing clear targets for research without "closing out" research disciplines.

However, **some research disciplines will be fundamental to all priorities**, and this should be reflected in the priorities themselves. Data and information sciences are integral to all branches of research, and advances in these disciplines offer improvements across the sector.

While 'research priorities' usually focus on where we have needs that require solutions and existing talents, "metascience" analysis – research into the processes, practices and structures of science itself. Such studies can offer improvements in research practice, science communication and social licence, research ethics, equitable distribution of research benefits and other aspects of research – should be a constant thread continually in the national focus. It is the thread that will improve the efficiency and effectiveness of the research, amplifying the investment over the immediate to the long-term.

Indigenous knowledges

The priorities should look towards **deepening the intersections between contemporary science and research methods and traditional knowledge systems**. Traditional knowledges should not, per se, be siloed into an individual priority but should be an integral part of most priorities. This should build on the work done by IP Australia; the example of the methodology adopted to produce the 2021 State of the Environment Report; and work should adhere to the UNESCO Indigenous Declaration, UN Declaration on the Rights of Indigenous Peoples and the AIATSIS Code of Ethics for Aboriginal and Torres Strait Islander Research.

Efforts to deepen the intersection between Indigenous Knowledges can refer to:

a) science and research done with the participation of and co-design with indigenous peoples or addressing indigenous people's needs
b) science and research that benefits from the insights from traditional knowledges (such as science on the environment, biodiversity and sustainability)
c) building the capability of indigenous peoples – either to enter science as individuals, to work with scientists on country, or to preserve traditional knowledges

Scientific capability

The priorities should provide clear and unambiguous support for research leading to knowledge and separately for the translation of that knowledge.

To apply (or use) knowledge, you must first have the knowledge.

Fundamental research is the step that provides the knowledge that can be applied; it is the first step in the pipeline – it cannot be separated (or its importance diminished) from applied and commercial research and national innovation capacity.

The example of climate science is illustrative. Whilst some have argued that we know all there is to know about climate systems, this is remarkably myopic.

Scientists have identified foundational questions for climate science which are in the national interest for Australia to help answer:

- Where does the carbon go?
- What are the implications of the tipping points?
- How does the weather change with climate?
- How does climate influence the habitability of the Earth and its regions?

In this one area alone, all include the full spectrum from the need for the most basic of understanding to the application of that knowledge for reasonable survival – and to get change adopted, it needs the talents of

researchers in the humanities and social sciences to be integrated with those of the natural and physical sciences.

Key challenges

The Academy's National Committees have identified some major challenges, namely:

- Climate and its impacts on food systems, liveability and health
- Digital technologies and our capability to negotiate drastic changes in our daily lives and prepare for the future
- Neurosciences, and the understanding of the brain, can contribute to national needs in mental health, education (esp. early childhood), ageing and computer science.
- Material innovation and its role in assisting with decarbonisation, critical minerals processing, energy systems, biotechnology and telecommunications

Greater details can be found in the Attached submissions.

How should the priorities be implemented?

A common criticism of the current science and research priorities is that they have had little material effect: without a clear implementation framework or policy support, they are perceived as little more than a box-ticking exercise. Reporting has been minimal.

The priorities should be guided by a robust implementation strategy to connect Australian research to strategic policy outcomes and global partnerships. The priorities should inform, and be informed by, national strategies such as the National Reconstruction Fund.

The priorities should ideally guide targeted investment programs rather than divert funding from investigator-led ARC and NHMRC programs. The research system will not pursue "priorities" that do not come with funding and support – but sacrificing existing grants will damage Australia's research and innovation capacity.

As part of the strategy, **the priorities should inform recruitment, education and training of students** in priority research areas. Meeting the priorities will require attracting and supporting a diverse cohort of students in priority areas. In so doing, it will need to address sector diversity issues, including but not limited to gender diversity in the physical sciences and the need to provide appropriate support for Indigenous and Torres Strait Islander students in priority fields (and in the STEM sector generally).

Across the priorities, there should be **consideration of the impact of research on diverse populations,** especially those historically overlooked or marginalised by Australian research. Research should address the needs of Australia's diverse community and ensure equitable distribution of the benefits of research.

Identification of priorities carries a risk of Australia's research becoming limited by current perspectives and today's priorities. Ideally, they should take a 2050 horizon view on the grand challenges science needs to address. **The implementation plan should include processes for review, responsiveness, and renewal.** There should be capacity for the priorities to be advanced and refocussed as they progress. Formal, ongoing consultation with the research, industry and commercial sectors, as well as the general public, will ensure Australia's science and research priorities remain focused on Australia's needs.

To discuss or clarify any aspect of this submission, please contact Mr Chris Anderson, Director Science Policy at chris.anderson@science.org.au

NATIONAL COMMITTEE FOR ASTRONOMY

Australian Academy of Science

By email: nca@aph.gov.au

30 March 2023

National Committee for Astronomy submission on
Australia's science and research priorities: conversation starter

The National Committee for Astronomy welcomes the opportunity to comment on *Australia's science and research priorities: conversation starter*.

The committee:

- Stresses that nationally strong science education and outreach at all levels is key
- Supports Indigenous peoples and values being integral to decisions related to astronomy and the future use of Australian skies
- Notes the importance of continued support of fundamental science research in areas of excellence
- Highlights the opportunities for international connections through major facilities projects, including collaborations that harness the power of big data.

Skills, knowledge, and funding to enable fundamental scientific research will build future research translation and scientific literacy in our communities. A strong basis in mathematics, and an understanding of the world and Universe in which we live is important as Australia navigates the challenges of climate change, the requirements to reduce carbon emissions, and increased requirements for a true circular economy. Education and training need to include fundamental and practical elements and recognise the importance of cross-disciplinary research. There is a persistent gender gap in many fields of science and engineering. Continued action is required not only to address the gender gap, but to ensure education and job opportunities for other traditionally underrepresented groups.

Australia's strength in astronomy and physical science is underpinned by continued support for fundamental research, and investment in national and international facilities. The 2018 ERA assessment found 14 of the 16 universities assessed in code 0201 (Astronomical and Space Sciences) were rated at ERA 5 – Well above world standard. This excellence results in global impact, bringing value back to Australia in the form of attracting international talent to work with researchers and facilities.

First Nations scientists have fundamental knowledge of Australia's land and skies which represents the culmination of 65,000 years of celestial cycles and transient events, biodiversity fluctuations and climate changes. As a result, Aboriginal and Torres Strait Islander peoples are some of the most informed on the planet when it comes to human impact and the environment. The planet is facing a future where the sky could become inaccessible to humans due to the increase of satellites in Earth's orbit and the ever-increasing risk from light pollution. Using the skies and future technologies in ways that are consistent with Indigenous knowledges and values, alongside Indigenous communities, can help ensure Australia remains at the forefront of astronomical research.

Large fundamental science projects provide opportunities for Australia to engage internationally, providing peaceful and meaningful collaboration across nations and positioning Australia to be globally influential. The decadal plan for Australian Astronomy 2016-2025 *Australia in the era of global Astronomy,* recognising the transition from domestic facilities to global facilities. Australia has attracted the Square Kilometre Array Low telescope, leading to both international investment, and industry spin-out projects ranging from computing and manufacturing to space and defence outcomes already.

Australia's strategic partnership with the European Southern Observatory and future full membership provides a similar opportunity, particularly in the sensor and optical and data sciences, and connections with Australia's emerging space sector. Australia is well situated and placed to host one of (likely) three major 'third generation' gravitational wave observatories in the coming decades with ensuing industry spin-out projects in precision and quantum sensing. Large science projects can harness machine learning and AI as a research enabler and skill that is translatable across all research disciplines.

For more information refer to the Decadal plan for Australian astronomy (2016-2025). To discuss or clarify any aspect of this submission, please contact Mr Chris Anderson, Director Science Policy at Chris.Anderson@science.org.au.

NATIONAL COMMITTEE FOR
AGRICULTURE,
FISHERIES AND FOOD

Australian Academy of Science

6 April 2023

National Committee for Agriculture, Fisheries and Food submission on
Australia's science and research priorities: conversation starter

The National Committee for Agriculture, Fisheries and Food welcomes the opportunity to comment on *Australia's science and research priorities: conversation starter*.

The committee notes:

- Australian agriculture safeguards our national sovereignty by providing abundant, safe, affordable and healthy food and fibre for our society and other nations. Agriculture is a major industry for Australia, worth well over $60 billion in 2021-22 and made up about equally of plant and livestock production (ABARES 2023).
- Australian agriculture production faces many challenges, including a highly variable and often harsh climate, and ancient and infertile soils. Australia is particularly vulnerable to climate change, which threatens the viability of rural production.
- Australia's world-leading capability in the development and application of low-input agriculture technologies was driven by strong science, a dynamic farming community willing to adopt new technologies and low government subsidies.

These three points emphasise the strength and need for maintaining agricultural research as a high priority for Australia.

Preserving sovereign capacity

The agriculture sector is vital to meeting the Australia's needs. Australian agricultural production is closely tied with our economy and environment, and will play an essential role in the National Reconstruction Fund. Agriculture today accounts for 2.4% of our GDP, 2.5% of employment and 11.6% of goods and services exports (DAFF 2023). Agriculture accounts for 24% of water extraction and occupies over 50% of the land area. Research, innovation, technological development and research translation are the foundation of this agricultural industry and to the management of our land.

Facing big challenges: climate change, societal changes and consumer demand

Australia needs a strong research base to address its specific agricultural challenges. Farming in Australia has been adaptive and resilient, allowing it to address the difficult production environment and low subsidies relative to most other developed economies. However, several existing challenges are intensifying and new challenges are emerging. Our vulnerability to climate change is likely to have a wide range of impacts, such as increasingly variable weather patterns, rising costs and reduced availability of fertilisers, and changes in pest and disease distribution. In addition, livestock industries must decrease methane emissions if Australia is to reach net zero greenhouse gas emissions.

Australia also needs to maintain a scientific skill base to capture overseas innovations. Global investment in agricultural research and development from both the public and private sector was estimated at about US$70 billion annually (Pardey et al, 2016). Australia accounts for only about 1% of this investment but has been an active partner in research both nationally and internationally (Langridge et al, 2014). Pardey et al, (2016) commented: *"Decades of decline in the real price of food and a sense that food provision was a solved problem may have fostered complacency among policy-makers and politicians in those countries that had a leading role in AgR&D throughout most of the twentieth century — including the United States, the United Kingdom and Australia. Meanwhile, some middle-income countries have been ramping up their spending to feed their*

increasingly wealthy populations (in the case of China and India), or to push into export markets (Brazil).” International collaboration is important for Australia to maintain research capacity.

Opportunities to bolster strengths

Australia has built a reputation as a reliable supplier of high-quality agricultural produce evidenced by the value of our exports. Success in low-input farming has been enabled by a strong research base and a farming community willing to adopt new technologies.

The impact of climate change and the pressure to reduce inputs are now challenging agricultural production in many countries, particularly in our region, and researchers are turning to us for advice and support. Our expertise in low-input agriculture has made our researchers valued partners in international collaborations and encouraged students from many countries to come to Australia to study. Building on these research strengths has multiple benefits, such as early access to scientific advances, and access to technologies and capabilities not available in Australia. This helps establish the critical mass to tackle difficult challenges, and builds diplomatic links to countries in our region.

To discuss or clarify any aspect of this submission, please contact Mr Chris Anderson, Director of Science Policy, at Chris.Anderson@science.org.au .

References:

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NATIONAL COMMITTEE FOR BRAIN AND MIND

Australian Academy of Science

6 April 2023

National Committee for Brain and Mind submission on
Australia's science and research priorities: conversation starter

The National Committee for Brain and Mind welcomes the opportunity to comment on *Australia's science and research priorities: conversation starter*.

The committee notes:

- Fundamental research is critical for addressing national challenges and opportunities, and leads to transformative breakthroughs. A transformative research system requires synergy between basic and applied research, and the research priorities should reflect this requirement.
- Large national multidisciplinary initiatives can address the big questions in brain science. Such initiatives can advise government on priorities and policy frameworks, catalyse collaborations with industry and develop local manufacturing capability (an example is the proposed Australian Brain Initiative, supported by the Australian Brain Alliance).
- Research priorities should be agile, flexible, and responsive to Australia's needs, with input from government, science and the public. Research priorities should be integrated with research practice, so that research outcomes can guide research prioritisation.

Understanding the function of the brain and mind contributes to Australia's prosperity and the quality of life of its people. Fundamental research in psychological and brain science underpins improvements in mental and cognitive health for Australians and new technologies that improve quality of life for those affected by disorders of the brain and mind. Advancements in psychological and brain science have far-reaching outcomes in fields such as mental health, medicine, education and defence.

Psychological and brain science aims to explain mechanisms through which the brain and nervous system regulate cognition, behaviour, and sensory and motor processes. Australia has existing competitive advantage in these sciences. Research priorities and associated funding mechanisms can maintain this advantage.

A significant opportunity in brain science is the development of a comprehensive whole-of-brain model. While there have been significant advances within different areas of focus, from molecules and cells through to circuits and systems, there is relatively little understanding of how insights from this work can be applied across levels to achieve a unified account of brain function. A whole-of-brain model would provide a mechanistic insight into how the brain regulates sensory processes, motor processes, cognition and behaviour, leveraging existing knowledge and providing a framework for future strategic research.

While no single nation will achieve this alone, Australia can make an important contribution to this effort and reap the flow-on benefits for health and innovation. This requires a shift from prioritising and funding single-purpose, single-geography, single-industry or infrastructure grants. Coordinated multi-purpose, multi-geography and multi-industry/infrastructure missions are needed to accelerate research and support international collaboration.

Effectively addressing the big questions in brain science requires large multidisciplinary initiatives to coordinate, provide oversight and governance, and facilitate collaboration across clinical, academic and industry research. These initiatives would engage with and advise government on priorities and policy frameworks and catalyse collaborations with industry. An example is the proposed Australian Brain Initiative, supported by the Australian Brain Alliance. This initiative has previously been proposed to the Federal Government, by the Australian Brain Alliance, and this continues to be an urgent priority. We have provided strong evidence that investment in an Australian Brain Initiative would bring many major benefits to Australia, including health, social and economic benefits.

Brain research is underfunded in Australia relative to our OECD partners. Given Australian's geographic isolation, it is important to ensure Australia's brain science capacity keeps pace with – or exceeds – that available overseas. This includes ensuring cutting edge neuroscience techniques – such as neuroimaging facilities, neurointervention techniques, and optogenetic and pharmacogenetics capacities – are available and easy to access to incentivise leading experts and organisations to invest in Australian brain research.

A major challenge experienced in brain science is attracting and retaining talented scientists, especially those at the early stages of their careers. A priority should be to grow local talent and keep those individuals in Australia. Greater investment in research fellowships can help build capacity and attract world-class international scientists to Australia.

Transformative breakthroughs in psychological and brain science can only be achieved through the synergy of basic and applied research. While research priorities and funding increasingly emphasise industry and applied aspects, equal weighting should be given to each phase of the research pipeline (e.g., fundamental/basic, translational, clinical/applied). The national science and research priorities should consider the whole research pipeline.

The national science and research principles

The national science and research priorities principles are appropriate, but should highlight that fundamental research is the critical foundation to enable science and researchers to address national challenges and opportunities. Many of the targeted funding calls in Australia tend to overlook the importance of fundamental research. Without fundamental research, we have nothing to apply and translate to health, education and defence.

To discuss or clarify any aspect of this submission, please contact Mr Chris Anderson, Director Science Policy at Chris.Anderson@science.org.au.

NATIONAL COMMITTEE FOR CHEMISTRY

Australian Academy of Science

6 April 2023

National Committee for Chemistry submission on
Australia's science and research priorities: conversation starter

The National Committee for Chemistry welcomes the opportunity to comment on *Australia's science and research priorities: conversation starter*.

The committee:

- Notes the deep and unmistakable importance of chemistry to the entire science sector.
- Emphasises the increasing contribution of research in chemistry to solving the problems of a changing world. Renewable energy, climate change, pollution, agriculture, medicine, critical minerals, and nuclear capabilities are all challenges the fundamental chemical sciences address.
- Stresses that sovereign chemical industry and manufacturing will mitigate the shocks of global conflict, supply chain issues, and future pandemics.

At the frontier of the world's largest challenges

Fundamental research in chemistry is essential for addressing international challenges, namely providing innovative solutions to the climate change crisis and improving the well-being and health of our citizens. The electrification of our energy systems demands efficient energy capture, transformation, and storage. Green chemistry underpins these processes. Safeguarding Australia's health through sustainable food production, nuclear medicine, and the biologics revolution all rely on chemistry.

Chemistry subdisciplines are among the most crucial for our sustainable future and hold the key to understanding and solving pressing societal challenges. Advancements in nuclear chemistry, for example, will transform healthcare, energy systems and national security. Fostering chemistry as a foundation will encourage these new and emerging subdisciplines to flourish long into the future.

Chemistry can contribute significantly to Australia's ability to address the United Nations Sustainable Development Goals. The committee has identified at least eight Goals across climate, environment and health that the chemical sciences will work to solve. We can be confident that the questions the world faces in decades time will be answered by chemistry.

Education pipeline

For chemistry to meet the needs of our changing world, it requires a stable supply of skilled individuals. We must maintain a strong focus on high-quality chemistry education. Students and graduates of all ages must be encouraged in their curiosity and enabled in their passions.

Proactively understanding the needs of our future generations highlights the need for continued, innovative approaches to education. However, foundational knowledge of chemistry is among the key skills of enquiry we will always require of young scientists.

Industrial security

A strong scientific research capability that encourages blue-sky research must be supplemented by world-leading skills in research translation and application. However, Australia's susceptibility to global supply chain shocks, like those caused by the COVID-19 pandemic and war in Ukraine, has demonstrated a need for greater sovereign industry capability, multiple supply chains and science capability.

However, we will require additional research training opportunities and infrastructure in key areas (e.g. nuclear power, battery technology, critical minerals extraction and recycling, biologics) in order to build the capacity required to solve these and other challenges. When developed domestically, these capabilities will ensure prosperity for our nation and cement us as a leader in our region.

NATIONAL COMMITTEE FOR
DATA IN SCIENCE

Australian Academy of Science

5 April 2023

National Committee for Data in Science submission on
Australia's science and research priorities: conversation starter

The National Committee for Data in Science welcomes the opportunity to comment on *Australia's science and research priorities: conversation starter*.

In this submission, 'data in science' represents the use of data in science by all scientists, including their acquisition, digital analysis and modelling techniques.

Sophisticated national data capability is required in every field of research; no area of science is untouched by the fundamental transformation of digital technology. Without digital data, none of the priorities will deliver what is needed for contemporary science or society.

Data and advanced analytics are essential for humankind to find sustainable pathways to better health, secure food, reliable water and soil, smarter cities and transport, cheap and reliable energy, efficient resource extraction, secure information technologies, climate action, and indeed all the World Health Organization Sustainable Development Goals.

Data in science is not an exclusive or competitive priority—it is a shared priority approach across all of science. The Australian Government has identified the Australian Data Strategy and Digital Economy as cross-cutting societal concerns. The OECD[1] and UNESCO[2] reflect this at the international level. Australia's Learned Academies recently called for a systemic priority for data and digital in the future of science.[3]

The National Committee for Data in Science therefore recommends that data in science be recognised as fundamental to each of the science and research priorities identified by the Chief Scientist.

The committee also supports the call for emerging digital technologies to be recognised as a priority field of science in their own right (see the separate submission of our sister committee, the National Committee for Information and Communication Science).

To discuss or clarify any aspect of this submission, please contact Mr Chris Anderson, Director of Science Policy at Chris.Anderson@science.org.au

NATIONAL COMMITTEE FOR
HISTORY AND PHILOSOPHY
OF SCIENCE

Australian Academy of Science

6 April 2023

National Committee for History and Philosophy of Science submission on
Australia's science and research priorities: conversation starter

The National Committee for History and Philosophy of Science welcomes the opportunity to comment on *Australia's science and research priorities: conversation starter*.

The committee:

- Identifies that great challenges require integrative engagement between STEMM and HASS scholars, notably those studying science and its practices
- Recommends the creation of robust science and research priorities that explicitly include research approaches from History and Philosophy of Science (HPS) and Science and Technology Studies (STS).

Understanding science

The effectiveness of the National Science and Research Priorities in addressing Australia's challenges will require deep understanding of the mechanisms by which science permeates social, political and economic spaces. For this reason, STEMM and HASS scholarship should be explicitly recognised as a component of each National Science and Research Priority.

Some of the most significant barriers to successful innovation and application of scientific research are not technological, but are associated with the human, social and cultural aspects of science. These include communicating science to the public, consideration of the implications of science beyond the academic environment and alignment of science with societal benefits and expectations. Research along these interfaces is valuable to diverse professionals across the nation and informs scientific practices to improve their efficiency and their translation.

Disciplines such as HPS, STS and science communication enable researchers, policymakers and the public to better understand the nature and limits of scientific inquiry, evaluate the reliability and validity of scientific findings, shape ethical and policy debates and enhance interdisciplinary collaboration. These types of insights make significant contributions to the development of more effective and innovative research, particularly in collaboration with those in STEMM fields. In this way, HPS and STS cut across all science disciplines and should be cultivated through explicit incorporation into Australia's national research priorities.

Australian HPS/STS scholars actively partner with leading international scholars in the US, UK, EU and elsewhere to produce outstanding research with direct impacts for science practice and policy in Australia. Australia has long been a recognised global leader in HPS/STS, performing well beyond expectations given the relatively small number of researchers in the country. For instance, the current presidents of two major international organisations in these fields are Australian (Professor Emma Kowal for the Society for Social Studies of Science [4S] and Professor Rachel Ankeny for the International Society for the History, Philosophy, and Social Studies of Biology [ISHPSSB]).

Notable HPS/STS projects include:

- The University of Melbourne's repliCATS (Collaborative Assessment for Trustworthy Science) Project has shown that an alternative to traditional peer review (aggregative expert judgements) can predict the replicability of research and could offer a productive approach for assessing the reliability of research.

- *The Living Archive: Extinction Stories from Oceania* is a multimedia space that explores the social impacts of extinction by inviting people to tell their own stories about what extinction means and how it matters in their lives.
- The National Centre for Indigenous Genomics creates and curates Indigenous genomic data resources for use by researchers, subject to appropriate access mechanisms, for a wide range of Indigenous-focused genomic health and medical research. It allows researchers to develop national frameworks for biospecimen handling and genomics training programs for Indigenous people, and to study the cultural implications of genomics in Aboriginal and Torres Strait Islander communities against the backdrop of legacies of colonisation and unethical research practices.
- The University of New South Wales Vitalities Lab explores how digital, medical, and other technologies can produce benefits for certain individuals and social groups, and how marginalised groups be given a voice and better agency as these technologies continue to develop and permeate most aspects of our lives.

To discuss or clarify any aspect of this submission, please contact Mr Chris Anderson, Director of Science Policy, at Chris.Anderson@science.org.au .

NATIONAL COMMITTEE FOR INFORMATION AND COMMUNICATION SCIENCES

Submission on *Australia's science and research priorities: Conversation starter*

6 April 2023

The National Committee for Information and Communication Sciences of the Australian Academy of Science and the Digital Futures Forum of the Australian Academy of Technological Sciences and Engineering welcome the opportunity to comment on *Australia's science and research priorities: conversation starter*.

The Committee and the Forum would like to make a case for Elevating "Emerging Digital Technologies" as a National Science and Research Priority[1].

- Digital technologies will be the enabler to unlocking progress and productivity growth across sectors such as advanced manufacturing, agriculture, water management, healthcare, infrastructure and others. Emerging digital technologies will play an increasingly fundamental role in Australia's way of life, but we risk falling behind as a technologically driven nation unless we recognise emerging digital technology as a central and independent science and research priority.
- With the rapid advancement of emerging digital technologies, science priorities should not be limited to specific application areas or unduly focused on today's demands, as this limits the possibility for innovation that could otherwise create totally new industries and jobs.
- It is important also to not single out a particular area such as Artificial Intelligence (AI), blockchain, or quantum computing, as it will take innovation across all areas of emerging digital technologies to demonstrate Australia's digital leadership.

Emerging digital technologies include artificial intelligence (AI), cybersecurity and blockchain, augmented and virtual reality, quantum computing and quantum engineering systems, 5G, the Internet of Things (IoT), new computing infrastructures and processing units, machine learning, and data science. These digital technologies are considered 'emerging' as they are not yet at a stage where they can be considered commoditised; they are instead undergoing rapid innovation and active research and transforming traditional industries such as manufacturing, agriculture, resources, transport, finance, and health.

The digital revolution is well underway, and many countries and sectors have signalled that digital futures should be a critical priority for investment, skill and capacity-building, and economic growth. Many of Australia's international peers, including the USA, UK, France and Canada, are prioritising digital technologies as a strategy to bolster competitiveness in the emerging 'digital economy'. Australia is lagging its global peers, with digital innovation accounting for only 7.4 per cent of Australia's GDP compared to the 11.2 per cent average across the OECD[2].

With the wave of the global digital revolution building, Australia has a critical opportunity to institute a strategic national approach, supporting fundamental research and engineering to drive innovation in emerging digital technologies. We have strengths in emerging digital technology research and development, but opportunities for sector growth and sovereign capability are nascent and require coordinated and strategic support. We need a vision for innovation and research in areas of national strength and strategic priority—one that is matched by a globally competitive level of commitment and investment.

Information and Communication Sciences has a long history of international collaborative research and development activities, resulting in a deep equity in global knowledge systems. Elevating emerging digital technologies to a national science priority ensures the protection and growth of local expertise and

opportunity for homegrown talent and companies, to allow Australia to adequately tackle the asymmetry created by the dominance of big tech in US and China.

Australia must also strive to address the digital divide to ensure equity of access to the benefits delivered by digital technologies, and to meet the skill requirements for a future digital workforce. We recommend mission-oriented implementation frameworks for the National Science and Research Priorities that provide incentives and pathways for cross-disciplinary research between information and communication scientists and engineers with social scientists, application domain experts and education leaders.

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2. McKinsey and Company. *Australia's automation opportunity: Reigniting productivity and inclusive income growth*. https://www.mckinsey.com/featured-insights/future-of-work/australias-automation-opportunity-reigniting-productivity-and-inclusive-income-growth (2019).

NATIONAL COMMITTEE FOR
MATERIALS SCIENCE
AND ENGINEERING

Australian Academy of Science

27 March 2023

National Committee for Materials Science and Engineering submission on
Australia's science and research priorities: conversation starter

The National Committee for Materials Science and Engineering welcomes the opportunity to comment on *Australia's science and research priorities: conversation starter*.

The committee:

- Notes the national need for advanced materials for energy storage and transmission, critical for accelerating Australia's trajectory as a net energy exporter both in our region and globally
- Stresses sovereign materials, engineering and manufacturing capabilities will safeguard the Australian economy and people from future shocks caused by global uncertainty
- Further notes future developments in energy efficiency, health and clean environment will be advanced by solutions to fundamental science and engineering problems.

Solutions to the problems of today and tomorrow

Australia needs advanced material innovation and high-value technology production for a circular, sustainable and electrified economy. Fundamental basic research has accelerated the nation's development and will be invaluable to our future. Australian innovation is driven by this exploration. While some research is rapidly commercialised, some requires a supportive science system that encourages innovation and advancement.

Australia's abundant resources and critical minerals are deeply valuable on the domestic and international markets and Australia must maintain a sovereign value chain for sustainable energy supply. As the world is rapidly transitioning to renewable energy technologies, we should develop value-added products that can be manufactured within Australia for global energy supply. Research should focus on low-cost, high-performance and sustainable energy conversion and storage technologies that can reduce carbon emission with long durability.

Australia's recognition of the urgent need to address the climate change must be accompanied by action that is accelerated and empowered by research in emerging material innovation. Research priorities should reflect our national need for new carbon capture, storage and conversion systems, renewable energy supply, and more sustainable use of lands and the critical materials underpinning these technologies.

Materials innovation also underpins much of the work to mitigate some of the world's largest health problems, especially in remote communities. Cutting-edge biomedical and biotechnology research will require collaboration and intersection from nanomaterials, laser and radiation tech and other new technologies. Developments in health for example are being increasingly connected with radiation, such as radiotherapies for cancer. The life-saving medical technologies of tomorrow require investment in materials science and innovation.

New technologies, materials and manufacturing processes will also be necessary for the Government's National Battery, Electric Vehicle and Critical Mineral Strategies and the National Reconstruction Fund.

A strong skills pipeline

Australia's science and research priorities should leave no Australian behind. Our nation is proud of its ability to leverage the participation of its people to solve big challenges. This problem-solving capability requires diversity, inclusion and intersectionality to be explicitly mentioned as an underpinning guide to all the priorities. Research in materials and fabrication, and their development and commercialisation, will continue

to drive the technological advancement that will see our nation prosper, but requires an investment in people and their skills.

Early- and mid-career researchers (EMCRs) are the future of our advanced materials capability. They will carry the baton and solve the challenges that we are yet to face. However, the attractiveness of careers for skilled workers is waning. This starts from early education and is compounded throughout the education pipeline. Little available fellowship funding and limited R&D-focused industry positions in Australia drive our best and brightest to seek opportunities elsewhere.

Clear value in career pathways for EMCRs can only come about through sustained investment in this space. A nurturing science research system will minimise burnout and provide a stable base for the nation's most highly educated and skilled individuals.

To discuss or clarify any aspect of this submission, please contact Mr Chris Anderson, Director Science Policy at Chris.Anderson@science.org.au .

NATIONAL COMMITTEE FOR NUTRITION

Australian Academy of Science

6 April 2023

National Committee for Nutrition submission on
Australia's science and research priorities: conversation starter

The National Committee for Nutrition welcomes the opportunity to comment on *Australia's science and research priorities: conversation starter*.

The committee recommends as essential national priorities for developing Australia's sustainable future:

- A sovereign scientific capability to ensure a sustainable food system
- Ensuring scientific literacy to combat public misinformation, and empower Australians to make informed choices and encourage positive social and environmental outcomes
- Science priorities guiding investment in research infrastructure, fundamental research and rapid research translation are necessary to meet Australia's commitments to the World Health Organization's Sustainable Development Goals.

Sovereign capability

Australia requires an effective and sustainable food system, with integrated agriculture, food manufacturing and distribution. The current system is vulnerable and unsustainable. One in twenty Australians now have diabetes, demonstrating a need for cross-system reform and scientific capability across all of these sectors. To achieve real change, cooperation and partnerships between the food industry, government and NGOs are essential.

Scientific literacy

The ability for Australians to make informed decisions based on reliable, evidence-based information is essential for a functioning democracy, regardless of an individual's socio-economic background, culture or education level.

Equitable health and nutrition literacy is a critical component of a sustainable and secure food system. Improvements in diet quality and the promotion of healthy dietary patterns are crucial to reduce the burden of chronic disease, support biodiversity and enable people to maintain traditional food practices. This approach will significantly impact both individual health and broad social and environmental outcomes.

Access to accurate nutrition information allows Australians to make informed decisions about their health and wellbeing, including the ability to select health-promoting foods that are nutritious and affordable. This is particularly true of vulnerable populations, such as low-income families, Indigenous and Torres Strait Islander communities, and people with limited access to healthcare.

Nutrition literacy is also critical in combating public misinformation about food and health.

International obligations

Meeting the World Health Organization's Sustainable Development Goals of Zero Hunger (SDG 2) and Good Health and Well-being (SDG 3) will require specific priorities in Australian research, including nutrition and dietetic research, with rapid translation of research into practice.

The Australian dietetic research community has established these priorities via consensus processes.[1] These priorities require investment in fundamental research and infrastructure, including funding, training and collaboration to support the development and promotion of interdisciplinary research networks and foster partnerships between policymakers, researchers and practitioners across the entire research pipeline.

For more information on the NCN's research priorities, see Nourishing Australia: A decadal plan for the science of nutrition.

To discuss or clarify any aspect of this submission, please contact Mr Chris Anderson, Director Science Policy at Chris.Anderson@science.org.au

[1] Porter, J, Charlton, K, Tapsell, L, Truby, H. Using the Delphi process to identify priorities for Dietetic research in Australia 2020-2030. Nutr Diet. 2020; 77: 437– 443. https://doi.org/10.1111/1747-0080.12634

NATIONAL COMMITTEE FOR PHYSICS

Australian Academy of Science

6 April 2023

National Committee for Physics submission on
Australia's science and research priorities: conversation starter

The National Committee for Physics welcomes the opportunity to comment on *Australia's science and research priorities: conversation starter*.

Physics lies at the heart of science, crossing the boundaries of chemistry, biology, engineering and medicine, and providing an increasingly quantitative view of the world around us, allowing us to design solutions to outstanding problems and invent new ideas that are revolutionising our world. For Australia to remain a strong member of the world's physics community, and reap the associated intellectual, economic and social rewards, the committee recommends:

- Continued, increased investment in blue-sky research, an essential indicator of an intelligent country that can compete on the scientific world stage.
- Investing in and protecting Australia's skilled, educated and science-literate workforce.
- Supporting research and providing mechanisms that will allow Australian researchers to capitalise on existing international research infrastructure, that is often beyond the means of any single nation to build and maintain.

Fundamental research

The Committee commends the following sentiment expressed in the Conversation Starter document: *"The priorities will not identify all science and research that should be undertaken in Australia, nor preclude investment in other areas, particularly for basic or blue-sky research".*

'Blue-sky' research conducted by physicists has led to most of the modern technologies that underly our daily lives. Examples include electronics, computers, WiFi, x-ray and MRI imaging. Return on investment in research is important, but the lead time for the practical application of fundamental breakthroughs in research is often very long. For example, the electronics revolution in the 1960's had its origin in the formulation of quantum mechanics in the 1920's. At that time, nobody could have envisaged the impact of such understanding of nature on atomic and subatomic length scales on the global economy.

We currently face a similar revolution via research into quantum science and technology, in which Australia is a world leader as a result of far-sighted research investment and more possibly forthcoming.

Skilled Australian workforce

Securing the job market in Australia is of great importance, and will enable development of Australian industries. Students trained in physics are highly valued by employers in government and industry for their skills in problem solving, critical thinking and data analysis.

It is also essential to provide continuous work-force training to capture new areas of technology and science. An example of is quantum technology, where most of our highly trained early career researchers are currently in high demand. This is a great success for Australia, but also demonstrates the danger of 'brain drain' negatively impacting our sovereign capability.

Many new technologies are the result of research outside Australia, and the successful local uptake and application of these technologies depends on a scientifically trained workforce globally. For this reason, it is vital that Australia invests in science education – from primary schools through to universities and technical

colleges cultivating a generation of world leading innovators. This will lead to higher availability of skilled graduates for the higher education and research sector, industry, business and government.

Science as an international endeavour

Science is global; physics is global. The past decade has seen Australian physicists play prominent roles in large international collaborations working at the forefront of modern science. An example is the discovery of gravitational waves, and confirmation of their origin, by the Laser Interferometer Gravitational-Wave Observatory (LIGO) collaboration. Further examples of international engagement include Australian involvement in the ITER nuclear fusion project, the discovery of the Higgs boson at the Large Hadron Collider, and the development of an Australian-based dark matter detection program. Connections have been fostered with organisations in our region, such as the Asia Pacific Centre for Theoretical Physics (APCTP), and other key international links have been strengthened, such as that with the European Organization for Nuclear Research (CERN).

The Australian physics community's ability to positively contribute to international debate and policy in a rational and scientific-evidence-based way is based on maintaining a standard of physics education from primary school to postgraduate level, that does not fall behind that of the larger international community. It relies on mechanisms to establish and maintain research relationships with leading research organisations and nations, and to build and expand relationships with emerging nations.

Current priorities in Australian physics

Overall research priorities in physics today are wide-ranging, including:

- Soft condensed matter physics
- Medical physics
- Atomic and Molecular physics
- Quantum science and technology
- Nuclear and particle physics
- Biophysics

They all feed either directly or indirectly into the present science and priority areas in Australia, which are broadly defined as:

- Food
- Transport
- Energy
- Advances manufacturing
- Health
- Soil and water
- Cybersecurity
- Resources
- Environmental change

For more information please refer to the Physics decadal plan 2012-2021: building on excellence in physics, underpinning Australia's future.

To discuss or clarify any aspect of this submission, please contact Mr Chris Anderson, Director Science Policy at Chris.Anderson@science.org.au

NATIONAL COMMITTEE FOR
SPACE AND RADIO SCIENCE

Australian Academy of Science

6 April 2023

National Committee for Space and Radio Science submission on
Australia's science and research priorities: conversation starter

The National Committee for Space and Radio Science welcomes the opportunity to comment on *Australia's science and research priorities: conversation starter*.

The committee believes that key challenges are:

- Sovereign scientific capability to assure critical infrastructure
- Ensuring support for discovery and applications that advance knowledge and quality of life
- Ensuring STEM workforce capacity necessary for innovation and productivity growth

Narrative

Challenges also provide opportunities, especially to early responders. Australia's unique geography and scientific expertise are major assets. Partnerships in major international programs can leverage expertise and IP to national benefit.

Critical infrastructure underpins the economy and Australia's resilience to extreme events. Failure of elements of interlinked critical infrastructure can lead to failure of systems of systems. Much critical infrastructure depends on space activity. For example:

- The commerce, business, logistics and resources sectors increasingly rely on satellite-derived positioning, navigation, timing and communication services. Science underpins all these technologies and applications. Assured access to such capabilities in an increasingly fraught geopolitical environment requires sovereign scientific and technical expertise.
- All space assets and related services are at risk from extreme space weather and space debris. Space weather prediction must incorporate solar, interplanetary, global and local effects. This is not yet achievable with suitable fidelity, but is an area of strength in Australia.

Fundamental research enables breakthrough science and applications. These are essential for a sustainable future. For example:

- Understanding and managing our environments and resources under climate change requires enhanced science and modelling capability, largely based on international partnerships and critical observations from space.
- Australia's geography challenges terrestrial communications providers, but provides the ideal platform for space communications services. New developments in secure quantum and high bandwidth radio and optical technologies can be a game changer.
- Australia's planetary science expertise can contribute to international programs exploring the formation of planets and origins of life within the solar system.

Expansion of Australia's innovation and sovereign manufacturing capabilities requires a significant increase in STEM participation rates. Science must be seen to be engaging, relevant and rewarding, with diverse role models and mentors. Curriculum-integrated space activity is a demonstrated vector to STEM engagement.

For more information please refer to Australia in Space: a decadal plan for Australian space science 2021–2030.

To discuss or clarify any aspect of this submission, please contact Mr Chris Anderson, Director of Science Policy at Chris.Anderson@science.org.au