Centre for New Industry

A Per Capita initiative

Australia's Science and Research Priorities: Conversation Starter

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FIGHTING INEQUALITY IN AUSTRALIA

About Per Capita

Per Capita is an independent public policy think tank. We work to build a new vision for Australia based on fairness, shared prosperity and social justice.

Our office is located on the stolen lands of the Wurundjeri people of the Kulin Nations, which were never ceded. We strongly support the Uluru Statement from the Heart and the call for a First Nations Voice to Parliament.

Per Capita's research and policy prescriptions are rigorous, evidence-based and long-term in outlook. All our publications and activities are intended to deepen political, social and economic democracy, and we are focused on challenges for the next generations rather than the next election cycle.

Our approach to public policy

Per Capita's approach to public policy challenges the dominant narrative that disadvantage arises from personal fault or failure by pointing out the policy choices that have deepened inequality and proposing alternative choices that will lessen it.

Our policy analysis and recommended solutions seek to recognise the challenges, and work within the complex economic, political and social conditions, of our age, such as:

- The impact of rapid climate change and extreme weather events;
- Growing economic inequality, with increasing returns to capital and a decline in returns to labour;
- The growing difficulty of accessing good jobs, adequate income support and secure housing; and
- The negative effects of privatisation and the deliberate shrinking of essential public services.

In doing so, we strive to incorporate new thinking in social science and economics, innovative ways of working with data, and effective evaluation tools to measure outcomes. We also engage actively with organisations across society, including the union movement, civil society, the community sector, academia, business, government and the public service, and social change movements.

In all our work, we seek to understand and highlight the experiences of those who bear the brunt of the effects of policy choices that exacerbate inequality, including underpaid and exploited workers, people who can't get a decent job, women, First Nations people, members of the LGBTQ+ community, people with disability and their carers, migrants and refugees, and others who are marginalised by our economic and social structures and denied their fair share of power and resources.

We live and work in hope and solidarity

The democracy Per Capita works for is one that shares its knowledge, wealth and power, to ensure all its citizens can live meaningful and fulfilling lives, able to take care of each other and of our shared planet.

About the Author

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Introduction

Australia depends on science and research to increase productivity, achieve sustainable economic growth, create jobs, and improve national well-being. Australian science also contributes to the global stock of knowledge across a broad range of areas. Like other countries, our capacity to support research is finite. With diverse investments in research across multiple agencies and many processes, we must ensure that we build our capacity to pursue research of particular importance to us as a nation.

A new set of national science priorities brings welcome attention to the issue of science and its value to society. But the content and scope of the underlying science policy debate – with its focus on budgets and breakthroughs – are narrow and limiting. Focusing on money masks legitimate and important questions about science and its role in our society and about the complicated nature of scientific progress by focusing on the latest isolated discovery. This conversation-starter consultation process brings welcome attention to science and its value to society. But these debates have tended to revolve tightly around a narrow set of concerns and then fade from view.

Science makes important contributions to economic prosperity through the generation of new knowledge, new technologies, new skills and new approaches to problems. This helps explain why governments invest significant public funds in it and why it can be more durable than others. But the policy consensus about science in innovation has masked two important issues:

- that our current understanding of the links between public support for science and the outcomes from that science remains quite limited; and
- that there is a clear and important role for government to take into account more than economics alone when making policy decisions about science.

This submission is focused on expanding the science policy debate to include a wider range of important issues related to the appropriate role of science in a healthy democracy. We aim to provide science policy decision-makers with principles and tools to help them better navigate these complex issues and work toward a more democratic, forward-thinking, and productive scientific enterprise. We argue that a renewed focus on science policy – related to but distinct from innovation policy – can improve the conduct of both science and policymaking and deliver enhanced economic, social and environmental benefits from the considerable public investment in science. We conclude that the Australian Government has a clear opportunity and role in encouraging innovation and expanding and improving its approach to science policy to realise these benefits.

A Legacy of Success

From William Farrer's 'Federation' wheat strain, to Howard Florey's work to make penicillin a practical medical treatment, to Graeme Clarke's development of the cochlear implant, Fiona Stanley's work in child health and the CSIRO's invention of Wi-Fi technology, Australian science has

changed lives around the world. Australia's dozen Nobel Prize winners in the sciences are a testament to the impact and quality of our science.

Since Federation, the Australian Government has had a central role in Australian science. Along with the states and territories, the Commonwealth has supported and encouraged the growth of a science ecosystem that includes world-famous publicly funded research agencies, internationally competitive universities, independent medical research institutes focused on improving the nation's health, and high-quality research infrastructure.

Over that time, Australia's science system has been transformed, and the government's investment has grown considerably. Science has also changed—becoming increasingly global, increasingly complex, and more directly touching people's everyday lives. More businesses are dependent on new knowledge and technologies than ever before, and there is a greater interest in science's practical applications and commercial possibilities. However, the critical role of science in modern society has not changed: contributing to building knowledge, solving problems and seizing opportunities, and improving the wellbeing of citizens.

The economy: an uncertain future?

Australia has enjoyed an enviable position over the last two decades, with demand for the nation's abundant resources leading to strong economic growth and rising standards of living.

Australian GDP grew at an annual rate of 3.3 per cent between 1992 and 2011, and per capita income grew by two-thirds over this period.[1]

The economy also displayed great resilience compared to other developed economies, weathering the 1997-98 Asian financial crisis, the 2000-01 'dotcom crash,' and the 2007-08 'global financial crisis' without a single year of economic contraction. While this resilience has its roots in Australia's market-oriented reforms of the 1980s, recent growth has been largely due to a global resources boom which caused commodity prices to rise rapidly on strong Asian demand.

The last decade saw significant growth in Australian exports of iron ore, coal and liquefied natural gas (LNG). The mining boom alone is estimated to have boosted real per capita disposable income by 13 per cent from 2000 to 2013.[2] This represents approximately 45 per cent of total real per capita disposable income growth over this period for a sector that contributes less than 10 per cent of Australian GDP.

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[1] Strutchbury, M. (2015), The rise, stall and threatened fall of Australia's great prosperity, 8 May 2015. Australian Financial Review.

[2] Downes, P. et al (2014), The Effect of the Mining Boom on the Australian Economy – Research Discussion Paper. Reserve Bank of Australia.

But this is changing. Commodity prices dropped significantly from their peak in 2011. The price of iron ore, Australia's largest export commodity, has fallen from US$180 per tonne to below US$65 per tonne.[3] The decline in commodity prices has led to a significant reduction in capital investment in the resources sector and declining terms of trade. For the foreseeable future, the resources sector alone is unlikely to continue to drive income growth to the extent it has over the last two decades.

In addition, global socioeconomic conditions are changing rapidly. The last two decades have seen unprecedented growth in global prosperity and a shift in the balance of economic power away from developed countries in North America and Europe and towards developing countries in Asia, Latin America, and Africa. This will continue, with global incomes expected to double and the number of people living in 'high-income' nations increasing from 1 billion to 3 billion by 2050.[4] This will continue to open up new markets for Australian exporters but also expose them to competition from relatively low-cost producers.

At the same time, new business models and disruptive technologies are transforming industries and threatening established businesses faster than ever before. This started with digital services and is quickly spreading into more traditional industries like agribusiness, medicine, manufacturing, minerals and energy. This will present enormous opportunities, but to capitalise on them, Australian companies need to quickly embrace transformational business models and disruptive technologies, or risk being left behind by faster-moving competitors.

The combination of these factors leaves Australia facing a number of questions about its economic future. With slowing growth in the resources sector and increasing competition from overseas, what will sustain future economic growth? In light of the rapid pace of technological change, how will Australia maintain competitiveness in existing industries and build comparative advantage in new and emerging industries? And what do we need to do today to ensure we are prepared to meet future opportunities and challenges?

Spending on Science, Research, and Innovation

The Global innovation index (GII) is an annual report providing statistical benchmarking of national innovation systems. The 2021 edition of the GII ranked Australia 25th of the 132 countries assessed and 24th of the 51 high-income countries.[5]

As in previous years, Australia ranks well (15th) on innovation inputs, including education and research, but less well (33rd) on innovation outputs, suggesting a weakness in translating research

[3] Ng, J. and Stringer, D. (2015) Bloomberg Business, Iron Ore Plummets Below $40 a Ton as Global Glut Hurts Outlook, 7 December 2015

[4] Hatfield-Dodds, S. et al (2015), Australian National Outlook 2015: Economic activity, resource use, environmental performance and living standards, 1970-2050. CSIRO, Canberra.

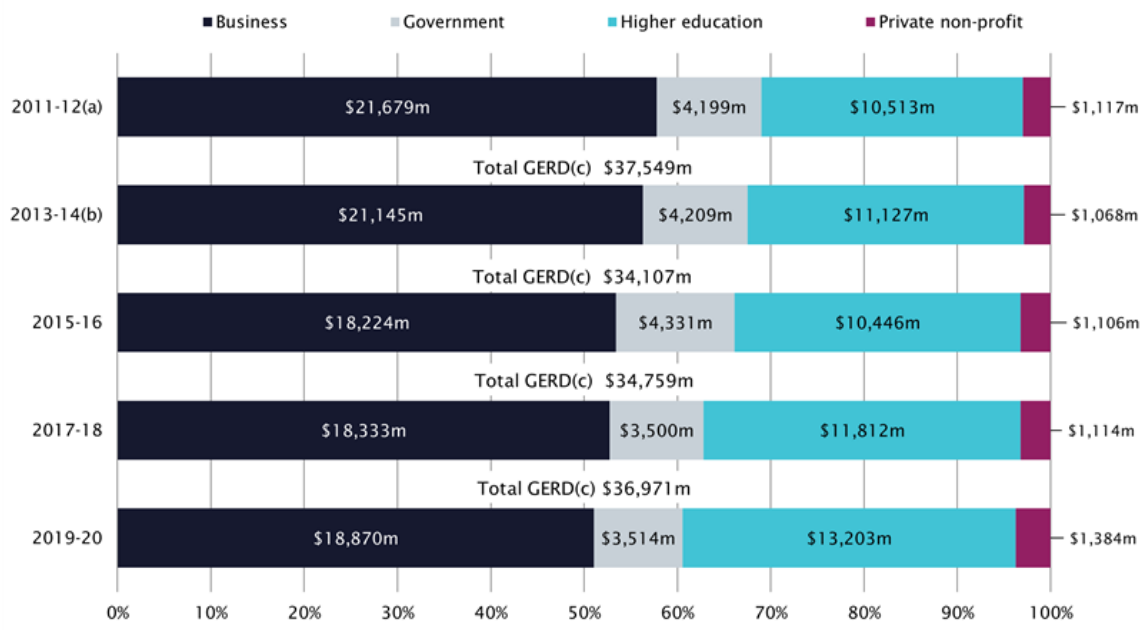
[5] OECD, Main Science and Technology Indicators database.

into commercial outcomes. Further analysis of the performance of Australia's innovation system relative to other countries can be found in the Australian Innovation System Monitor.

In 2019–20, Australian gross expenditure on research and development (GERD), which includes research spending by business, government, higher education and the non-profit sector, was $35.6 billion. This amounts to 1.79% of GDP, placing Australia 20th among 132 countries for this metric (Figure 2). GERD as a proportion of GDP has been falling since 2008. In 2019, business expenditure on research and development (BERD) in Australia was 0.92% of GDP, which is approximately half the OECD average (1.81%; Figure 2). The ALP has committed to increasing investment in research and innovation to levels closer to 3% of GDP (p. 7).

Figure 1 shows spending on R&D since 2011–12 converted to 2021 prices. Although total spending remained relatively steady (in 2021 prices), business and government spending dropped, and higher education spending rose over this period.

Figure 1
Gross expenditure on research and development (GERD) by sector (in 2021 prices)[6]



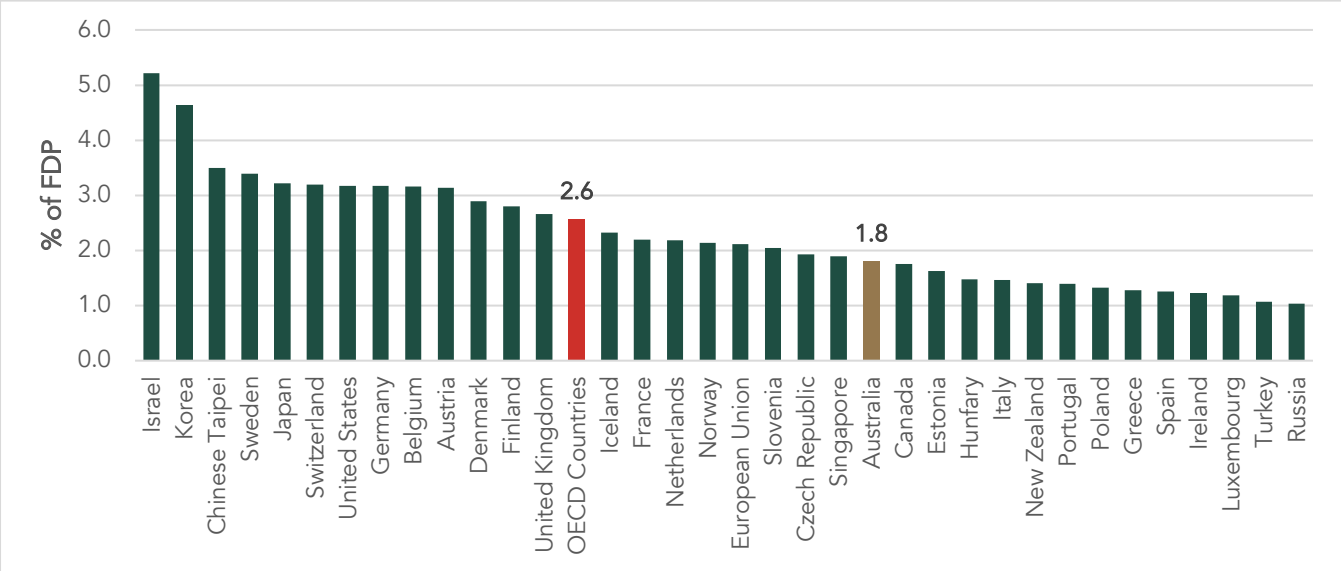
[6] (a) Higher education estimates modelled in 2011–12.
(b) From 2013–14 Government, Private non-profit and Higher education estimates have been modelled.
(c) Where figures have been rounded, discrepancies may occur between the sum of the component items and totals.
Source: Australian Bureau of Statistics (ABS), Research and Experimental Development, Businesses, Australia, 2019–20 Financial Year, (Canberra: ABS, 2021). All figures have been converted to June 2021 prices using Parliamentary Library calculations.

The declining level of business expenditure on research is largely due to changes in Australia's industry mix, including a decline in manufacturing and a transition in the mining sector from exploration and development to operations.

Australian Government investment in 2021–22 comprised:

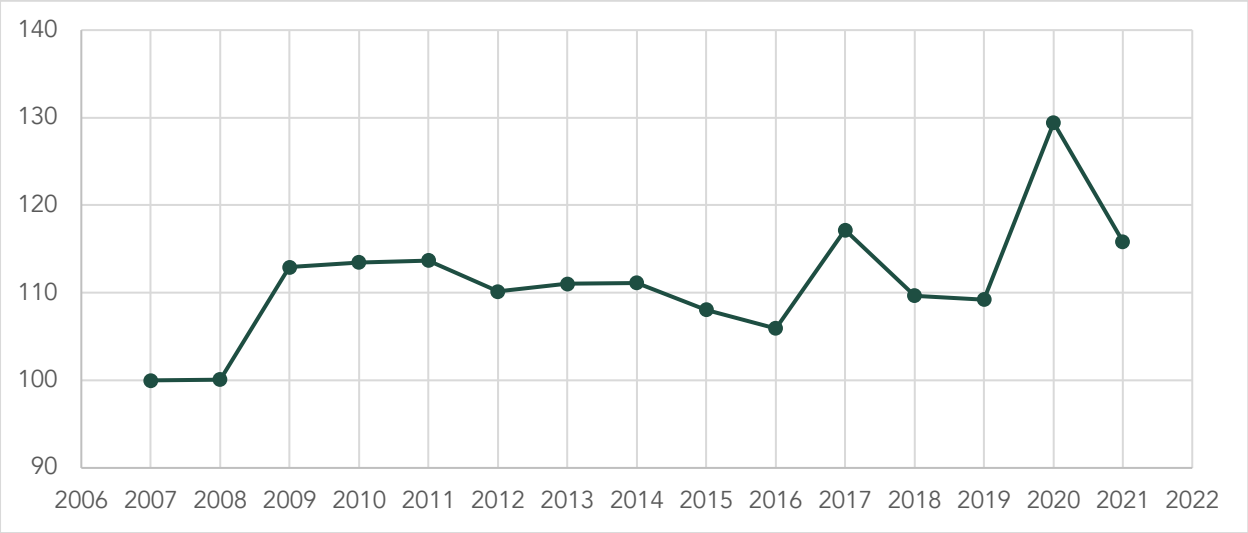
- Australian Government research activities: $2.3 billion, including CSIRO, Defence Science and Technology Group, and other government R&D
- business enterprise sector: $2.9 billion, almost all of which is spent on the R&D Tax Incentive, which provides a tax offset for businesses to undertake R&D activities.
- higher education sector: $3.7 billion, including the research block grants, Australian Research Council grants, and NHMRC grants to universities.
- multisector: $2.8 billion, including NHMRC's non-university spending, Cooperative Research Centres, Rural R&D Corporations, other health R&D, and energy and environment R&D.

Figure 2
Gross expenditure on R&D (GERD) as a percentage of GDP, OECD+ countries, 2019 or latest available (Australia 2019)[7]



[7] OECD, Main Science and Technology Indicators database.

Figure 3
Australia's gross domestic expenditures on R&D by performing sector
Index 2007 = 100 (constant USD PPPs)[8]



National challenges

Health

Australia's health needs must be addressed at both the individual and population level, and must recognise that health or "wellness" is not simply the absence of disease or infirmity. Good health requires the development of treatments, solutions and preventative strategies to improve physical and mental well-being. Research will be essential to building healthy and resilient communities throughout Australia. It will capitalise on Australia's strengths in science and technology to generate wider economic benefits through improved knowledge translation and commercialisation, and partnerships with industry.

Departments and agencies should give priority to research that will lead to:

- better models of health care and services that improve outcomes, reduce disparities for disadvantaged and vulnerable groups, increase efficiency and provide greater value for a given expenditure.
- improved prediction, identification, tracking, prevention and management of emerging local and regional health threats.
- better health outcomes for Indigenous people, with strategies for both urban and regional communities.
- effective technologies for individuals to manage their health care, such as mobile apps, remote monitoring and online access to therapies.

[8] Ibid.

Environment

There are many factors that influence the environment. They range from global climate change to the environmental consequences of local actions; all are significant. These factors affect Australia's terrestrial, marine, rural and urban systems and within our region. While continuing to study environmental and climate science in Australia and connecting to global research, we must learn to mitigate and adapt to local and regional effects. Research will build Australia's capacity to respond to environmental change. It will require the integration of research outcomes from biological, physical, social and economic systems.

Australia has abundant energy resources, but we need to improve the efficiency of use, reduce emissions and integrate energy from any source into the electricity grid. A desirable energy future is one with a diversity of sources and suppliers that progressively reduces carbon emissions and is economically attractive for consumers and other stakeholders. Research will lead to the development of reliable, low-cost, sustainable energy supplies that are resilient to sudden shocks, decadal trends in demand and climate, and technologies that use energy more efficiently.

Departments and agencies should give priority to research that will lead to:

- improved accuracy and precision in predicting and measuring the impact of environmental changes caused by climate and local factors.
- resilient urban, rural and regional infrastructure.
- options for responding and adapting to the impacts of environmental change on biological systems, urban and rural communities, and industry.
- new clean energy sources and storage technologies that are efficient, cost-effective and reliable.
- Australian electricity grids that can readily integrate and more efficiently transmit energy from all sources, including low- and zero-carbon sources.

Cybersecurity

Australia's cyber infrastructure underpins the entire knowledge economy, including government, business, defence, police, and emergency services. But our cyber infrastructure is vulnerable to exploitation by malicious actors and is subject to damage caused by non-malicious events such as natural disasters, equipment failure, human error and other accidents. It is essential that the security and resilience of this key infrastructure is assured.

Research in cyber security, including quantum technologies will position Australia as a leader in fast-moving and emerging areas such as distributed network management, machine learning, and intelligent and secure data management and retention.

Departments and agencies should give priority to research that will lead to:

- highly secure and resilient communications and data acquisition, storage, retention and analysis for government, defence, business, transport systems, emergency and health

services. secure, trustworthy and fault-tolerant technologies for software applications, mobile devices, cloud computing and critical infrastructure.
- new technologies and approaches to support the nation's cybersecurity: discovery and understanding of vulnerabilities, threats and their impacts, enabling improved risk-based decision-making, resilience and effective responses to cyber intrusions and attacks.
- understanding the scale of the cyber security challenge for Australia, including the social factors informing individual, organisational, and national attitudes towards cyber security.

Resources

Australia's resource sector is a significant contributor to the economy. By prioritising the sustainable extraction of our resources and by adding value where we have a competitive advantage, we will optimise long-term economic, social and environmental benefitto the community.

Research will lead to a fundamental understanding of the structure, composition, and processes governing Australia's formation and distribution of resources. This knowledge will support the exploration, the potential discovery of major new sources, production, and distribution of traditional resources such as strategic metals and minerals, coal and gas and those in increasing demand, such as rare earth elements and groundwater.

Departments and agencies should give priority to research that will lead to:
- a fundamental understanding of the physical state of the Australian crust, its resource endowment and recovery.
- knowledge of environmental issues associated with resource extraction.
- lowering the risk to sedimentary basins and marine environments due to resource extraction.
- technologies to optimise yield through effective and efficient resource extraction, processing and waste management.

Case Study: Semiconductor Supply Chains

Semiconductors are now used in everything from our phones to medical equipment. Even though critical national infrastructure relies on semiconductors, Australia is reliant on international supply chains to supply them.

Disruptions caused by the pandemic as well as other geopolitical developments have given us a glimpse into their fragility. Without a local semiconductor industry, Australia is at the whims of private companies and foreign governments and exposed to supply chain shocks. The Australian Strategic Policy Institute argues:

Having unfettered access to microchips is a matter of economic and national security, and, more generally, of Australia's day-to-day wellbeing as a nation. In an increasingly digitised world, policymakers must treat semiconductors as a vital public good, almost on par with other necessities such as food and water supplies and reliable electricity—a reality that would become immediately apparent in a time of international crisis resulting from, for example, wars or natural disasters.[9]

To go further, many of those already necessities like water and energy are reliant on supplies of cheap, low-grade semiconductors for things like smart grids and pipeline monitoring systems.

Developing and manufacturing semiconductors is a complex and expensive project. Building the capacity to manufacture semiconductors in Australia will require long term planning and investment.

The Commonwealth could adopt a "moonshot" industry strategy to build towards a domestic semiconductor industry, of the kind advocated by Mariana Mazzucato and domestically by the Australian Strategic Policy Institute and Dr Venkata Gutta.[10] A national moonshot agency could coordinate public and private investment across the entire supply chain, from minerals extraction and processing, and semiconductor design, fabrication and assembly, to developing advanced manufacturing sectors that domestically produced semiconductors could feed into.

Given the critical nature of this technology, this project should be led by the government and remain in public hands to ensure that all Australians benefit from this technological development.

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[9] Capri, Alex and Clark, Robert. Australia's semiconductor national moonshot. Canberra: Australian Strategic Policy Institute, 2022.

[10] Capri, Alex and Clark, Robert. Australia's semiconductor national moonshot. Canberra: Australian Strategic Policy Institute, 2022. and Gutta, Venkata. "Australia's place in the semiconductor world." Australian Manufacturing Forum. November 24, 2022.

Agriculture

Australian research and ingenuity have led to well-developed agricultural and fishery industries that contribute nutritious food to domestic and global markets. If Australia is to respond to increasing global demand for both plant and animal-based food, we will need to develop internationally competitive, sustainable, profitable, high intensity and high production capacity in new and existing food products and in new and existing regions of Australia. We will face constrained soil and water resources, shifts in climate, and changes in the environment, and the emergence of new pests and invasive species, that could lead to increased difficulties in meeting expectations.

Research will aim to optimise food and fibre production and processing, enhance food safety and minimise waste. Research will also be critical to preserving our hard-won reputation for clean, safe and sustainable production.

Departments and agencies should give priority to research that will lead to:

1. knowledge of global and domestic demand, supply chains and the identification of country-specific preferences for food Australia can produce
2. knowledge of the social, economic and other barriers to achieving access to healthy Australian foods. enhanced food production through:
    a. novel technologies, such as sensors, robotics, real-time data systems and traceability, all integrated into the full production chain.
    b. better management and use of waste and water; increased food quality, safety, stability and shelf life.
    c. protection of food sources through enhanced biosecurity.
    d. genetic composition of food sources appropriate for present and emerging Australian conditions.

Biodiversity

Australia's soil, vegetation, biodiversity and water along with its marine resources are national strategic assets that should be highly valued and effectively managed. These assets are fundamentally interconnected components of our ecosystems, but how they interact and respond to change remains poorly understood.

Research should therefore focus on aquifers and urban catchments and build capacity for improved accuracy and precision in predicting change. Research will lead to better decision-making strategies in the context of potentially conflicting demands between development, the environment and landscape management.

Departments and agencies should give priority to research that will lead to:

- new and integrated national observing systems, technologies and modelling frameworks across the soil-atmosphere-water-marine systems.

- a better understanding of sustainable limits for productive use of soil, freshwater, river flows and water rights, terrestrial and marine ecosystems.
- minimising damage to, and developing solutions for restoration and remediation of, soil, fresh and potable water, urban catchments and marine systems.

Advanced Manufacturing

Advanced manufacturing is a key industry for Australia, but challenges include global competition, automation, and supply chain disruptions. Science can help to address these challenges through research into new manufacturing processes and technologies, as well as the development of new business models and supply chain strategies.

Australian competitiveness needs innovative industries that are focused, agile, high value-add, transformative and fully integrated into global supply chains. In the competitive global market, Australia should aim to dominate in selected product categories where we have a particular advantage. Research will be critical in developing and supporting existing industries while enabling the development of a new and advanced manufacturing sector.

Departments and agencies should give priority to research that will lead to:

- knowledge of Australia's comparative advantages, constraints and capacity to meet current and emerging global and domestic demand.
- cross-cutting technologies that will de-risk, scale up, and add value to Australian manufactured products.
- specialised, high value-add areas such as high-performance materials, composites, alloys and polymers.

Case Study: Space Exploration

Over fifty years ago, Australia entered the space age. On 29 November 1967, we launched our first satellite at Woomera, South Australia. The Weapons Research Establishment Satellite, known as WRESAT, had an orbiting life of 42 days, and circumnavigated the globe 642 times before it ran out of battery. Its purpose was to provide scientific data on upper atmosphere physics. Planned, built and launched in just eleven months, WRESAT was a landmark in Australian science, and an early high point of the Australian space industry. Australia became the seventh nation to send a satellite into orbit and the third nation to both design and launch an orbiting satellite from its own territory. Videos of the design and construction of WRESAT are still available online.

The furthest satellite from Earth is a NASA mission, Voyager 1; it is 23.816 billion km away. In 1977, Voyager was launched from Cape Canaveral, Florida, and 11 years ago, it left our solar system and entered interstellar space. In case it's ever encountered by extra-terrestrials, Voyager is carrying photos of life on Earth, greetings in 55 languages and a collection of music ranging from Gregorian chants to Chuck Berry. including "Dark Was The Night, Cold Was The Ground" by '20s bluesman Blind Willie Johnson, whose stepmother blinded him when he was seven by throwing lye in his eyes after his father had beat her for being with another man. He died, penniless, of pneumonia, after sleeping bundled in wet newspapers in the ruins of his house that had burned down, but his music is at the very edge of the universe as we know it.[11]

Accomplishments such as these do not have a direct economic return, and yet they align with public values. They spark curiosity, drive children to learn about science and inspire us all to look at the stars as Galileo did.

Principal Recommendations for Science Policy

This submission seeks to highlight some common misconceptions about the role of science in society and the role of government in science, and to suggest some useful ways of approaching problems and enhancing science policy into the future. We recognise that implementing science policy based on these ideas is far more complicated than simply discussing them in the abstract. To begin this final section, we present six broad principles for science policy, distilled from the ideas and examples presented above:

1. **Serve public values.** Science policy is innovation policy and economic policy, but it is also social policy. Science plays a crucial role in fulfilling a wide variety of societal and governmental needs, from national wellbeing and security to environmental regulation to international diplomacy. Public values will change over time, but we need to be able to

[11] Smith, B.A., Soderblom, L., Beebe, R., Boyce, J., Briggs, G., Bunker, A., Collins, S.A., Hansen, C.J., Johnson, T.V., Mitchell, J.L. and Terrile, R.J., 1981. Encounter with Saturn: Voyager 1 imaging science results. *Science*, *212*(4491), pp.163-191.

articulate the ways in which we structure science policy decisions and science institutions in response to them and then also evaluate accordingly. In addition, public values and the ethical, legal, and social implications of science and technology should be considered explicitly, both as a part of internal science policy decision-making and as a part of efforts to engage the public on science issues.

2. Recognise diversity. There is no single best way to fund and manage science with public money, nor is there a single best way to monitor and evaluate those investments. Beware of universal standards (e.g., net present valuation, journal citations) and funding models (e.g., peer review) for science, and instead consider whether the institutional structures in place are appropriate for the circumstances. Just as we expect some failure as a part of scientific experimentation, we should expect that some science policy models will work better than others and seek innovations and improvements over time. There are new tools and frameworks that can help in planning and evaluating different approaches to science policy.

3. Think ahead. We know that government decisions about and investments in science now will lead to a wide range of outputs and outcomes – both positive and negative – well into the future. This is not a process that we must just surrender to. Human institutions shape the development and use of science, and a range of techniques and tools exist to help us steer towards more positive and less negative consequences. There is a clear role for the government to set a framework for these techniques and for enhancing preparedness.

4. Engage outside the science community. A more equitable, forward-thinking and productive science policy requires improved public engagement. This is partly because the public deserves a voice in advancing knowledge's many ethical, legal and social implications, and partly because doing useful and beneficial science requires input from lay communities. There are a variety of mechanisms that can aid with this goal, but they are rarely used. To meet its goals, the government should encourage science organisations to explore ways to promote and embed these activities in their core operations to increase democratic involvement in publicly funded science.

5. Promote evaluation and organisational learning. We don't always know what knowledge will be most useful in efforts to solve problems, nor the best way to pursue that knowledge. But organisations that learn from experience, and apply that knowledge to future decisions and investments, are more likely to make significant progress than those that proceed blindly. There is a need to learn from the past and for experimentation and new thinking in science policy.

6. Remember the rest of the world. Australia represents a tiny fraction of world science, which is already global and continuing to globalise. Science policy debates in traditional 'superpowers' such as the US, Europe and Japan will be different from those here. Science-policy decision-making needs to be cognizant of this – linked into international best practices and efforts and clearer about balancing Australia's unique national needs and values and international objectives and imperatives. 'International' issues and considerations are not a separate sub-set but should be a part of all science policy decisions.

An obvious issue in promoting and implementing enhanced science policy across the Australian Government is the need for greater whole-of-government coordination. To constructively engage the range of other departments and agencies involved in science and science policy, DIISR has an opportunity to lead the updating of the Australian Government science policy framework informed by both theory and practice.

Practical suggestions are provided below of areas where engagement could commence across government to improve science policy, informed by the six principles outlined above.

1. Examine the **evidence base** across government for making better science policy decisions and lead work to improve this (as part of existing work on innovation metrics).
2. Lead an initiative to look at the **use of science** in policy across government and ways to improve this, contributing to a more sophisticated understanding of 'evidence-based policy'.
3. Set out **principles for science priority-setting** on behalf of the nation that are more inclusive and forward-looking.
4. Foster networks and a community of practice across existing boundaries to enable the **sharing and improved coordination of techniques and tools** used in Australia to improve science policy.
5. Examine the potential of using a small portion of existing government funding for science to **support science policy research**, with researchers encouraged to undertake activities directly relevant to government needs. This could also include related training and education.

Conclusion

The policy focus on innovation and economic productivity has helped demonstrate part of science's significant contribution to Australia. But a renewed focus on science policy – and the complexity of science in society – is needed to develop this into a more coherent and coordinated picture. We believe that science will struggle to gather increased public funding and support until it can engage with these issues.

Our argument in this submission has been that the commonplace focus on science budgets and breakthroughs has hindered the development of a more holistic science policy.

In taking science policy forward, we do not intend to recommend to government-specific 'answers' to science policy questions. We do not propose an appropriate balance between basic and applied research, we do not suggest new national priorities, we do not propose specific changes to some institutions over others, and we do not emphasise quality over impact or vice versa.

In truth, all of these things are important questions for science policy, but there are no permanent 'right' answers to them. They will and should be addressed openly by a dynamic and democratic process linked to the public values that form the rationale for public science, recognising that these values will change over time.

Our focus is the deeper question – what institutions and processes does the Australian Government put in place to ensure we can keep addressing these important questions and learning from previous experience for better policy and science?

The principles set out above aim to provide a practical framework to improve the linkages between science policy decisions and the social, economic, and environmental outcomes that flow from the science they support.

This will be an ongoing project, and it is, of course, not a new one. In 1979, Dr Herbert Cole 'Nugget' Coombs wrote a short paper entitled Science and Technology: for what purpose? which was later taken up by the Commission for the Future, established at that time within the Department of Science of the Australian Government.

In that paper, Coombs argued that science was of critical importance but that it "needed to reconsider its objective, reorient to some degree its directions, and, particularly, examine its impact upon the human and social aspects society".

More than 40 years later, those imperatives are just as important, and they relate to science policy just as they do to science itself.