ATSE 50 YEARS

REPORT

Boosting Australia's innovation

Practical steps for boosting Australia's innovation ecosystem

FEBRUARY 2025

Australian Academy of Technological Sciences & Engineering

Executive summary

Australia stands at a critical juncture in its journey to boost the national innovation ecosystem.

Institutional reform, targeted investment, increased collaboration and improved evaluation will create an innovation sector that can commercialise, iterate, experiment and develop the technologies to support better lives in Australia and around the world.

Strategies

Drawing on expert consultations, this report presents key insights and strategies for the government, research institutes, investors and businesses to revitalise the Australian innovation landscape.

Balancing the economic and public value of outcomes
Commercial outcomes are crucial for a sustainable ecosystem but not all research or innovation is destined for the marketplace. The ecosystem should recognise in its funding and strategic decision-making that the value of knowledge creation extends beyond immediate economic returns and that there are beneficial applications of knowledge without commercial outcomes.

Long-term policy horizons
Successful industrial policy implementation requires a long-term perspective beyond current political cycles. To achieve significant 'moonshots', the Government should support a combination of horizontal and vertical policy programs. These should be underpinned by stable, CPI-adjusted funding that promotes sustainable research and innovation pipelines over time.

A non-linear innovation pipeline
To truly drive innovation, we must embrace a non-linear approach, one that is not direct from research to market. It involves iterative discovery, development and application cycles, with frequent feedback loops. By fostering a culture of experimentation, embracing failure as a learning opportunity and prioritising agile methodologies, we can unlock the full potential of our innovation efforts.

Differing incentive structures
Obstacles to collaboration arise from differing incentives, bureaucratic hurdles, concerns over intellectual property ownership in joint projects and the absence of established frameworks to manage collaboration with different innovation actors. To foster a thriving innovation ecosystem, we must establish clear policy frameworks that address these obstacles hindering collaboration.

Fundamental discovery as a bedrock
Fundamental research forms the foundation for building current and future industries. While not immediately commercialised or translated, it leads to improved societal impacts that help inform the policy and practices essential for long-term innovation. To ensure long-term viability, consolidation of overlapping initiatives – wherever sensible – can streamline resources and maximise impact.

Support for varied organisational capacities
Universities, research organisations and NGOs possess varying levels of back-office expertise in governance, legal, risk and intellectual property management. Creating a centralised resource hub offering access to knowledge, advice and best practices on commercialisation, legal matters, and funding opportunities would ensure all players can navigate the innovation landscape effectively regardless of size.

Market-driven success
True innovation is driven by market needs. Successful scaling of commercial products is realised only when a specific challenge is solved in a market with willing customers. Innovation actors aligning their research efforts with market needs can drive tangible impact and maximise the return on our innovation investments.

Recommendations

With these strategies in mind, these broad recommendations are suggested to boost the innovation pipeline:

Recommendation for innovation-ready research institutions

- Ensure that university promotion criteria value research translation and commercialisation efforts equally with traditional academic metrics like publications and citations.
- Implement programs for intellectual property (IP) development and structured industry engagement targeted at innovators in research institutions.
- Integrate commercialisation awareness and pathways throughout the research process, while maintaining support for fundamental discovery.
- Introduce innovation concepts in early education and promote diversity in innovation activities to build a stronger foundation for future innovation.
- Reconsider how universities manage conflicts of interest where researchers have spun out a company.

Recommendation for improving collaboration

- Develop and implement programs to facilitate collaboration between SMEs and other innovation actors, including access to research infrastructure.
- Evaluate existing innovation programs and scale high-performing programs across government departments & jurisdictions to optimise innovation funding.

Recommendation for increasing innovation investment

- Develop a comprehensive strategy aimed at boosting total Australian R&D investment to 3% of GDP by focusing on strategies to boost industry investment in particular.
- Leverage the financial system to improve support for investors backing science, technology, engineering and mathematics (STEM) based start-ups, potentially through tax incentives.
- Use established procurement funds that support innovative domestic technologies addressing market and societal needs.

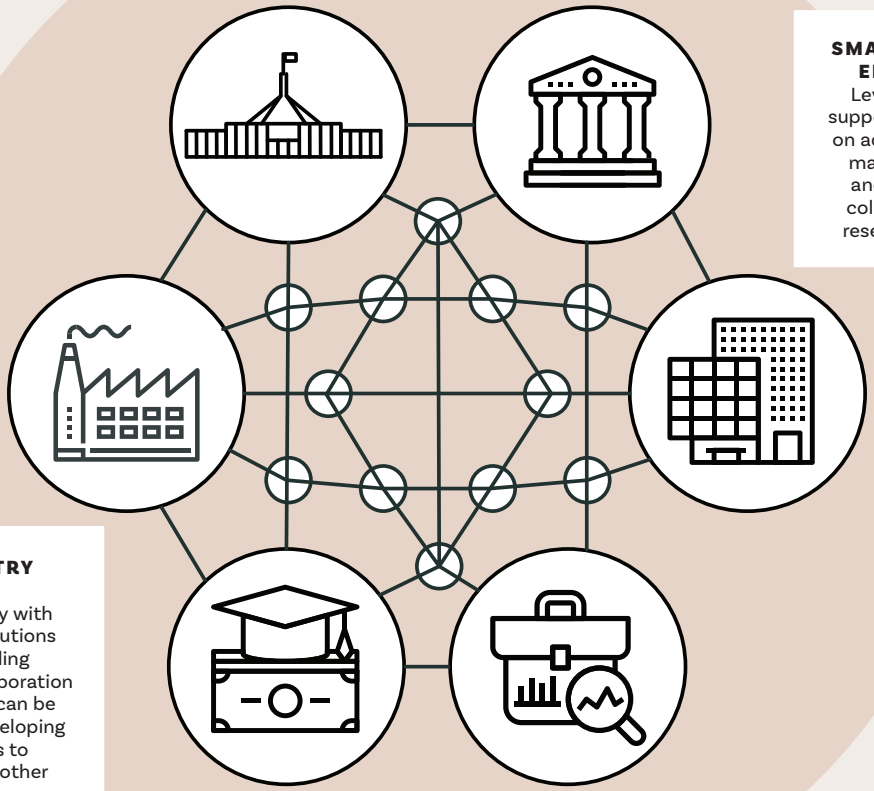
Recommendation to create better impact measurement and strategic focus

- Implement a robust innovation performance measurement framework as recommended in the Australian Government Innovation Metrics Review, enabling the evaluation of government policy initiatives and facilitating international comparisons.
- Focus on identifying and addressing global challenges as opportunities to position Australia as a competitive player in the international innovation landscape.

Stakeholders

Implementing these recommendations requires coordinated action from all stakeholders in the innovation ecosystem.

FEDERAL & STATE GOVERNMENTS
Lead with policy reform and language signalling that supports and encourages both fundamental research and market-driven innovation. Balancing both demand- and supply-side policy initiatives helps to create market conditions for different innovation actors to contribute effectively.



SMALL TO MEDIUM ENTERPRISES
Leverage available support systems, focus on addressing specific market challenges, and seek strategic collaborations with research partners.

LARGE INDUSTRY PLAYERS
Engage more deeply with both research institutions and SMEs, providing mentorship and collaboration opportunities. This can be helped by jointly developing clear approaches to collaboration with other innovation actors.

UNIVERSITIES & RESEARCH INSTITUTIONS
Streamline collaboration processes and timeframes, provide accessible knowledge transfer mechanisms, and incentivise researchers to engage in translation, application and commercialisation activities with other innovation actors such as SMEs and industry partners.

A successful and bright Australian innovation future requires a nuanced understanding of the innovation process, commitment to both fundamental and applied research and a willingness to embrace the non-linear nature of discovery and commercialisation. Australia can realise its potential as a world-leading innovation nation with concerted effort across all sectors and actors. Implementing long-term strategies that are combined with operational execution would create a more dynamic, collaborative and globally competitive innovation ecosystem. This approach will drive economic growth, advance fundamental knowledge and position the nation to address complex societal challenges through innovative solutions.

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About ATSE

An independent, non-government organisation and charity, ATSE is led by a diverse Fellowship of 900 leading Australian applied scientists, technologists and engineers.

We celebrate excellence in applied science, technology and engineering by appointing prestigious Fellows, awarding upcoming innovators and equipping the next generation with skills to build a better Australia and world.

We are an evidence-driven voice to decision-makers, and our world-class science, technology, engineering and mathematics (STEM) education and careers programs are shaping the knowledge-makers and innovators we need to tackle our most urgent challenges – now and in the future.

Our vision is for a sustainable and prosperous Australia where engineering and applied sciences protect our environment, nurture a skilled workforce, grow competitive industries and enable all Australians to reach their greatest potential.

Australian Academy of Technological Sciences & Engineering
1975-2025

Steering committee

The project steering committee shaped the report's direction and provided regular governance. The committee was co-chaired by Dr Dimity Dornan AO FTSE and Distinguished Professor Saeid Nahavandi FTSE, who guided the report team to carry out the scope of this project.

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About the report

Over the past six years, ATSE has undertaken a series of deep dives examining the technology readiness of different Australian economic sectors, using bespoke methodology developed, tested and refined in-house. This proven approach has involved surveys, interviews, roundtables and workshops with hundreds of leaders across the breadth of Australian research, development and economic activity underpinned by applied science, technology and engineering. The result has been 18 reports exploring Australia's readiness and identifying Australia's opportunity to transform the economy through the translation, application and commercialisation of research in the healthcare, transportation, renewable energy, minerals processing, artificial intelligence, quantum technologies, agriculture technologies, and waste management sectors, to name just a few.

Guided by the volume of insights gathered through these deep dives, ATSE in 2024 hosted three targeted roundtable discussions involving more than 150 senior representatives from industry, government, academia and peak bodies (see Appendix), distilling their feedback into actionable insights to improve Australia's efficiency, effectiveness, capability and achievement across the innovation landscape.

This report forms a go-to guide for enhancing Australia's science, technology and engineering-driven research innovation and commercialisation ecosystems. It articulates key insights from those in the know into the primary obstacles Australian innovators face, and – crucially – highlights the levers available to significantly enhance Australia's innovation pipeline.

1. Introduction

Innovation is the key long-term driver of productivity growth and a key enabler of adaptability and progress across all sectors of society. The innovation pipeline is not a linear journey from research to commercialisation.

Fundamental discovery is the bedrock upon which current and future industries are built and societies become healthier and more resilient. While commercial outcomes are essential for a sustainable research ecosystem, it's crucial to recognise that not all research or innovation is destined for the marketplace. Experts in our consultations underscored the importance of understanding that successfully scaling commercial products is only realised for any innovation when a specific challenge is being solved in a market, with customers willing to pay for that solution.

Fostering a culture and system that values problem-oriented fundamental research and applied innovation can create a more robust and resilient innovation ecosystem. Australia has a deep history of impactful research that has helped improve basic understanding of problems and has been translated into commercial products. Research, development, testing and scaling innovation for sustainable impact cannot be undertaken by any one actor working in isolation. The support of a wide range of actors (including technical, financial and political support from local, national and sometimes international entities) across the value chain is typically required to progress any innovation successfully.

The Australian innovation ecosystem has numerous actors and organisations (Figure 1) contributing to research commercialisation.

> The Australian Council of Learned Academies (ACOLA) defines research translation as a process through which knowledge is used or applied to achieve outcomes.[1]

In roundtables hosted by ATSE, participants communicated that leveraging relevant, high-quality research at low risk and low friction is instrumental in realising a viable commercial enterprise with the potential for scale. This can only be achieved when all the components of the innovation framework (Figure 1) are oriented strategically.

FIGURE 1 — Innovation Ecosystem

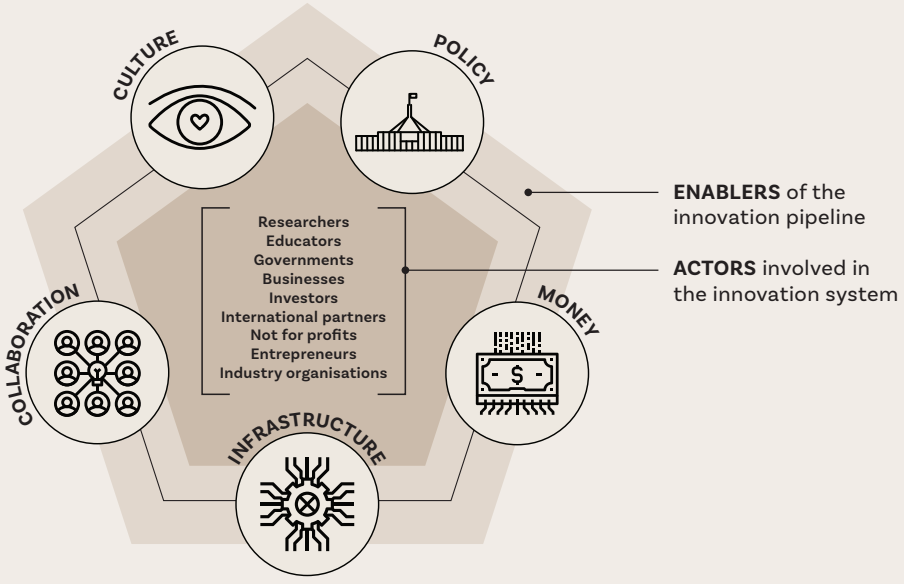


FIGURE 2 — Global Innovation Index: rankings. Data Source: (WIPO 2023)

Rank	Country	Global Innovation Index
1	Switzerland	67.6
2	Sweden	64.2
3	United States	63.5
4	United Kingdom	62.4
5	Singaprore	61.5
6	Finland	61.2
7	Netherlands	60.4
8	Germany	58.8
9	Denmark	58.7
10	South Korea	58.6
24	**Australia**	**49.7**

Despite Australia's history of impactful innovations (like Wi-Fi, solar cell technology, human papillomavirus vaccines, vanadium batteries, cochlear implants and many others), the country has lacked a systematic approach to supporting research commercialisation. This has resulted in declining performances in the Global Innovation Index (Figure 2). Australia ranks 24th out of 132 countries in 2023, down from 12th in 2017 (WIPO 2023)[2].

Sydney and Melbourne, the country's primary start-up hubs, respectively rank 27th and 36th globally(Engineers Australia 2022; Startup Genome 2022).

Experts in ATSE's roundtable discussions and technology readiness reports highlighted the importance of improving Australia's economic complexity (a measure of a region or country's productive capacity based on the quantity and complexity of the products successfully exported) to improve Australia's innovation ecosystem. For example, Australia's tech exports are worth around $9.3 billion per year – a third of Sweden's and half of Denmark's (Burton 2023). Both countries are significantly smaller than Australia (for example Sweden's population is 40% of Australia's). The prominence of resource-focused exports in Australia has led to a decline in manufacturing and increased import penetration in key areas like information technology. This, coupled with global counterparts' highly competitive manufacturing position, has led to a fall in Australian deep technology-focused innovations.

In ATSE consultations, participants identified the lack of cohesion and coordination between innovation policies at the state and federal levels. This dilutes resources, reduces competition, delays market paths for innovative products and decreases the likelihood of commercial success. While the lack of coordination between state and federal innovation policies is a major concern, the underutilisation of research infrastructure further exacerbates the challenges faced by innovators. Stakeholders described the innovation ecosystem in Australia as having limited and inefficient pathways for research collaboration (ATSE 2019, 2020a, 2020b). The current policies have resulted in world-leading innovators from Australia looking overseas to commercialise their research innovations.

Effective innovation policy demands alignment and cooperation among all stakeholders in today's highly competitive landscape. Globally, countries have different approaches to industry policy that help support their innovation ecosystem.

As globally influential economist Professor Joseph Stiglitz noted,

> "Every country has an industry policy. The question is whether it is explicit, whether it is implicit, whether it is coherent, whether it is incoherent."[3]

Recent global trends in industry policy highlight various approaches to supporting key industries and driving economic growth. For example, the United States Inflation Reduction Act details investment to help solve national goals by directing investment at scale in sectors addressing climate change and clean energy, and emerging industries such as AI and quantum. The *Future Made in Australia* policy announced in 2024 is the latest Australian policy that aims to achieve similar results by investing in emerging industries supporting national objectives and building economic resilience. The size of the two policies is commensurate with the size of the respective economies and share similar policy ambitions.

Fully realising Australia's potential in the global innovation landscape requires a concerted effort to mobilise private sector investment and foster a united front for innovation. The government can encourage teamwork at every level by emphasising supporting organisations and institutes that promote a unified approach to innovation.

There is an opportunity for policy frameworks to leverage the domestic research and industry ecosystem to solve national goals (Australian Government 2024a). This would result in a more dynamic relationship focused on public value. There is an obvious need for well-framed long-term strategies that define clear outcomes with adequate resourcing, frequent evaluation, and responsiveness to industrial trend changes.

2. The interconnected ecosystem

We live in an interdependent world, connected by global flows of goods, services, capital, people, data and ideas.

Global value chains have been built on these flows, and this can also be seen in Australia's highly interconnected research and innovation landscape. The innovation ecosystem also has unintended side effects because of global and domestic trends.

Experts have told ATSE about how different innovation actors can leverage the domestic and global interconnected innovation ecosystems to improve domestic innovation performance, highlighting that innovation policies and programs, at all levels of government, should seek to engage industry and other innovation actors.

TABLE 1 — Examples of interconnected innovation functions[4]

Functions	State and Federal Government	Academia	Entrepreneurial ecosystems
Agenda setting	Funding R&D, setting national research priorities, and investing in technological innovation	Conducting fundamental research, generating new knowledge, and technological breakthroughs	Knowledge generation within firms and research organisations; collaborative R&D efforts
Knowledge diffusion	Facilitating knowledge diffusion through policies, grants and public programs; supporting industry partnerships	Dissemination of research through publications, conferences, and collaborations; providing expertise and training	Access to knowledge networks, support services (mentoring, incubation, accelerators), and building absorptive capacity
Capability formation	Investing in education, training programs and skills development initiatives at national and state levels	Educating and training the future workforce; providing advanced degrees and specialised skills development	Talent development, workforce training, entrepreneurial experience, and capability building within firms
Finance and investment	Providing grants, subsidies, tax incentives and risk capital through public investment programs	Securing research funding from government grants, industry partnerships, international student fees, philanthropy and international collaborations	Access to risk capital from the financial sector and previously successful entrepreneurs/founders, make investment in innovation – both product and process, scaling, production capacity
Market creation	Establishing regulatory frameworks, policies and public procurement strategies to stimulate innovation	Collaborating with industry to align research with market needs and societal challenges; technology transfer offices facilitating commercialisation	Strategic innovation to shape market demand, create new markets, and enter existing ones
Governance	Setting policies, regulations and governance frameworks; promoting culture, trust and risk management	Setting research agendas and ethical standards; leading in governance frameworks and innovation policies	Corporate governance, leadership and institutional culture that influence innovation-driven growth and risk tolerance
Market dynamics	Supporting entrepreneurship through public policies, funding programs and business development services	Supporting spin-offs, startups, and commercialisation of research through university incubators and accelerators	Intrapreneurship, entry into new markets, technologies; fostering SME growth and adaptation in large firms

Academia

Universities and research institutes are central to the innovation ecosystem. They produce research that expands our basic understanding of science and technology. This allows further research to be focused on solving specific problems that can be turned into a commercial product. In 2019-20, universities performed 45.3% of all applied research and 90% of pure basic research in Australia (Universities Australia 2022).

The current academic promotion and research ranking systems hinder commercialisation efforts by prioritising publication over practical innovation outcomes. The "publish or perish" model discourages researchers from engaging in intellectual property (IP) development and commercialisation activities. There is a need for career structures that recognise and reward contributions to research translation, such as allowing sabbaticals for IP development. University promotion criteria that place more weight on research translation would help ensure that academics are not disincentivised from focusing on their research's practical application and commercialisation.

From the perspective of an academic, superannuation is a significant barrier to achieving these outcomes. Many academics who are tenured, are enrolled in defined benefit superannuation plans, which offer guaranteed retirement benefits. Transitioning to an accumulation account, as required for temporary industry placements, can be a significant disincentive. This is especially true when considering the potential loss of long-term financial security and the uncertainty associated with returning to a defined benefit plan after a sabbatical. Initiatives such as MTPConnect's "REDI Fellowship" have demonstrated the possibility for formal support in this area. Expanding on proven initiatives such as these would incentivise academics to translate their innovation (MTPConnect n.d.).

Roundtable participants have noted that the lack of coordination within academic research results in fragmented efforts that do not align with a cohesive strategic direction, hindering innovation potential.

Grants play a vital role in facilitating collaborative research. Roundtable participants agreed that aligning grant-funded research with market needs is essential to support research outcomes' relevance and commercial viability. Incorporating industry representation in grant review panels and tying funding to industry collaboration, while continuing to provide ongoing grant programs for basic research, can enhance the alignment of research with market demands.

Furthermore, the strategic allocation of funds that align with national research priorities remains a challenge, often leading to certain areas being underfunded or overlooked. This funding instability is exacerbated by the slow and cumbersome processes for obtaining grants, such as the ARC Linkage grants, which are often outpaced by rapid technological advancements in industry.

Leveraging grants to improve domestic innovation

The Australian Research Council (ARC) and National Health and Medical Research Council (NHMRC) are two of the major bodies responsible for allocating research funding in Australia. Cooperative Research Centres (CRC) grants also provide funding for medium to long-term, industry-led research collaborations. These grants can be used strategically to help establish emerging domestic science and technology industries.

By realigning funding priorities with dedicated long-term support for innovation, Australia can leverage research on emerging technologies to both solve national goals and create a competitive domestic industry. For example, AI has transformative potential across various sectors, including healthcare, agriculture, manufacturing and finance. It offers solutions to complex problems, drives efficiency and fosters innovation.

From 2014 to 2024, the ARC allocated $337 million in research funding for 655 projects directed towards Information and Computing Sciences, which are critical for the research, development and deployment of a domestic AI industry (Australian Government n.d.-a). This funding could be strategically deployed in developing fundamental research and research into commercial applications to address critical national goals such as using artificial intelligence and machine learning applications to improve healthcare outcomes, ensure food security and enhance industrial productivity. Also important is grant funding for research in social science and other disciplines that help better understand and develop the future business models and improve better legal frameworks for these emerging technologies.

By strategically aligning research funding in this way, Australia can optimise its resources and remain competitive in technological innovation and domestic industry development.

Industry

Business innovation, which encompasses the development of new products, processes and organisational methods, is crucial for industrial development. Businesses are most active in the experimental development phase of research, comprising 84.3% of all money invested in this phase of research nationally in 2019-20 (Universities Australia 2022).

FIGURE 3 — Ranked Barriers to Innovation[5], by type of barrier, two years ended 30 June 2023.
Source: (Australian Bureau of Statistics 2024a)

The barriers to innovation include capital constraints, uncertainty regarding business conditions, and skills (as seen in Figure 3). When businesses are uncertain regarding future trading conditions, their capacity and appetite for change and risk are lower. In the two years ended 30 June 2023, under half of all businesses (46%) reported being innovation-active (Australian Bureau of Statistics 2024a). ATSE's consultations and reports published in the last five years noted that Australian businesses have a great focus on process innovation, which enhances productivity by improving existing technologies and practices. This type of innovation is prevalent across all industries. It is particularly common in sectors where product differentiation is challenging, such as mining and utilities (sectors that are big contributors to Australia's current innovation metrics). While larger businesses tend to engage more in product innovation, process innovation is more accessible for SMEs due to lower overheads.

Effective collaboration between researchers and industry is crucial for innovation, as exemplified by the successful partnership between Boeing and CSIRO (CSIRO n.d.). However, ATSE experts in our consultations highlighted that differing incentive structures are often a barrier to forming such collaborations between these sectors. Bridging this gap requires strategic initiatives to incentivise business spending on R&D and establishing programs that allow the flow of talent from academia into industry and vice versa – with a strong focus on research commercialisation. A tech voucher system, for instance, can effectively leverage academic assets for industry and SMEs (Australian Government 2024b).

Issue	Current challenge	Solutions discussed
Asymmetry and alignment	A significant disconnect exists between the research agendas of the higher education sector and the private sector in Australia.	• Establishing mechanisms to identify and prioritise shared research goals that address both academic interests and industry needs. • Encourage academic researchers to work directly with or within companies to align research efforts, promote practical applications, and ensure mutual benefit. Create formal programs and incentives for collaborative projects.

ATSE Roundtable discussion on improving academia-industry collaboration

Small and Medium-Sized Enterprises (SMEs)

98% of Australian businesses can be categorised as small businesses (Australian Small Business and Family Enterprise Ombudsman 2024). In the past two decades, the number of Australian SMEs that hold patents has increased at the rate of 5, a pattern not observed for large firms (IP Australia 2024). SMEs are an integral component of the innovation pipeline in Australia. While they contribute to innovation, their smaller size often limits their appetite and ability for cutting-edge research. SMEs are motivated to engage with other innovation actors to access new knowledge, advanced technologies and innovation capabilities that can significantly enhance their competitive advantage. However, multiple barriers hinder these collaborations. Key obstacles include substantial differences in incentives, bureaucratic hurdles and concerns over intellectual property rights sharing. Additionally, the lack of prior experience and established relationships with innovation actors poses a substantial hurdle for SMEs.

Facilitators in innovation across universities, big industry players and government support play pivotal roles in bridging gaps between the innovation actors. Strategies to promote innovation among SMEs include providing incentives through targeted support programs. Roundtable discussions highlighted that SMEs need better access to the research base for knowledge transfer. State-level technology vouchers[6], co-location through SME incubators, and scaling up successful programs in states and territories to a federal level are potential solutions to enhance collaboration. Additionally, creating innovation labs strategically co-located with other innovation actors and organisations can provide environments conducive to collaboration and innovation.

Government & Not-for-profits

Governments invest directly in research through universities, government and hybrid research agencies (such as CSIRO, Rural R&D Corporations or the Defence Science and Technology Group), including via competitive research grant schemes (such as those distributed through the Australian Research Council and the National Health and Medical Research Council). These organisations conduct long-term research in areas of critical need and opportunity for Australia and the world. They have enduring international relationships and support research domestically, including through their role as hosts for large-scale research infrastructure facilities and scientific collections.

Collaboration models can be developed for upcoming innovators to use the research infrastructure in state and federal research facilities (Butler 2024). This can lead to significant productivity gains for startups. ATSE's experts note that existing frameworks could be further leveraged to foster a culture incentivised to prioritise performance and effectiveness, ultimately leading to improved public service delivery.

Not-for-profits and industry associations also play a strong role in sharing best practices and insights from member experiences. Non-profit institutions are participants in all sectors of the innovation ecosystem. They can be either market or non-market producers[7], including both performers and funders of R&D (OECD 2015).

Non-profit institutions or industry organisations form collaborations with universities, research institutes and government agencies to tackle complex challenges that require a multidisciplinary approach. According to Nonprofits Source, 90% of corporations in the US say they gain trust when partnering with reputable nonprofit organisations, and 89% believe such partnerships enhance their ability to drive societal impact (Nonprofits Source 2020; Simpson and Varley 2022). These organisations have an important role in supporting communities to adapt to technological change and iterate with innovators about the products according to community feedback. These collaborations can result in public-private partnerships that leverage the strengths of each sector.

Enhancing Australia's innovation performance through infrastructure investment

Investing in research and development and other innovation infrastructure is essential for Australia to improve its innovation performance and ensure that the benefits of technological advancements are shared domestically. Australia has witnessed a trend in recent years, with many innovative tech companies being acquired by foreign entities. This phenomenon is primarily driven by the challenges associated with scaling in the Australian market. Despite producing a wealth of talented individuals and high-impact research, Australian companies often struggle to secure the necessary growth funding to expand their operations.

Unlike other developed economies, Australia has a smaller domestic market and lacks the scale and infrastructure to support large-scale manufacturing and assembly operations (Original Equipment Manufacturers – OEMs or Digital Public Infrastructure - DPIs).

Establishing such domestic capability would allow Australia to not only help domestic innovators with translating their research, but create capability to produce key components for the global supply chain. For example, as many parts of a laptop computer are manufactured by different entities, having a domestic OEM capability would allow some parts, such as the processor or memory module, to be produced domestically. Without such domestic facilities, Australian companies frequently find themselves constrained to selling their businesses to foreign buyers in order to realise returns for their investors.

To address this challenge, experts have emphasised the importance of developing OEMs as a missing component of Australia's innovation system. By fostering the growth of OEMs, the country can create a more supportive environment for emerging industries and companies. Public investment in innovation infrastructure like OEMs DPIs can significantly enhance innovation ecosystems and incentives innovation, and create a level playing field for small businesses, to compete with larger firms.

Improving collaboration

The literature highlights that collaboration in innovation can take various forms, including contractual partnerships and equity-based joint ventures. It allows firms to share the burden of R&D costs, mitigate risks, and benefit from each other's expertise. This approach is particularly valuable in industries where the development of foundational knowledge is costly and time-consuming (WIPO 2011). Collaboration with producers of complementary goods can facilitate the development of interoperable products, which is essential in sectors such as technology and pharmaceuticals. By coordinating their efforts, firms can ensure that their innovations are compatible with other products, enhancing their market potential and reducing the risk of failure.

Australia can leverage the more than 100 innovation precincts and industry clusters in the country more strategically and collaboratively (Australian Government 2019). Institutions have dedicated entities to manage technology transfer and industry engagement. These entities build portfolios of industry relationships, manage intellectual property (IP), and seek business development opportunities. They include dedicated Technology Transfer Offices (TTOs) within academic institutions or incubators, accelerators in private entities, and state government research organisations. Federal government programs, such as the Industry Growth Program, provide advisory services for startups and SMEs undertaking innovative commercialisation and growth projects within the Australian Government's National Reconstruction Fund (NRF) priority areas. However, existing organisational structures often operate reactively rather than proactively, lacking the resources and strategic foresight necessary for effective innovation. This limits their ability to support the commercialisation of research outputs. ATSE roundtable discussions highlighted a strong desire for more effective collaboration among those in the sector. To achieve this, evaluating successful programs and leveraging existing networks may be beneficial (Figure 4).

FIGURE 4 — Recommendations from ATSE's roundtable discussions to improve collaboration between different innovation actors

Leveraging already established innovation networks

Review initiatives and programs, and scale one that are successful

Improving the efficiency and resource allocation within these dedicated collaboration entities is essential to foster innovation for commercialisation. Other solutions discussed by roundtable participants included:

- **Valuing diverse experience** — To bridge the gap between research and commercialisation, the different innovation actors must value and leverage diverse experiences (such as past academic and industry experience). Expanding academic evaluation and performance criteria to include contributions to industry, government and non-profits would incentivise meaningful engagement. Professionals with diverse backgrounds would help bring practical insights crucial for translating research into applications, yet their experience is often undervalued in promotions and grants in the current system.
- **Addressing operational differences** — Academic-industry partnerships in Australia face challenges due to differing priorities, language, and timeframes. While academia focuses on long-term research, industry seeks immediate practical outcomes. Building trust, especially around IP and knowledge sharing, is key to overcoming these differences. Bureaucratic hurdles such as grant applications, IP agreements and regulatory requirements complicate academic-industry collaboration (ATSE 2024). Streamlining these processes, and building shared understanding and a shared commitment to overcoming hurdles, are essential for fostering effective partnerships.

Simplifying processes and maintaining consistent innovation policies will help the innovation actors and organisations focus on value creation.

Denmark's collaborative innovation model

Building on its successful innovation ecosystem of high-tech firms and university spin-offs, Denmark is an innovation leader in domains such as sustainable energy solutions and wind energy. The country's success in fostering a risk-taking, high-reward innovation culture is attributed to several factors (Berg et al. 2023; Nejabat and Van Geenhuizen 2019):

1. Networks
- Danish firms form deep-rooted partnerships with universities (such as a long-standing Industrial PhD program to foster academic-industry collaboration), large corporations, suppliers, customers and financial investors.
- These networks provide a support system for navigating market challenges, accessing resources and mitigating risks associated with technology commercialisation.
- Collaboration facilities are not only co-located but also help the exchange of ideas, expertise and best practice among partners.

2. Structured collaboration
- Formal agreements outline governance structures, workflows and conflict resolution processes.
- Steering committees involving both public and private entities ensure aligned goals and efficient decision-making.
- Contractors and suppliers are integrated into the design process, leading to optimised outcomes and reduced risks.

3. Risk management
- The strategic partnership framework includes a six-step conflict resolution process, starting from project management-level discussions and escalating to legal arbitration if necessary.
- Substantial investments from both the government and private sector provide firms with the financial resources to scale up their innovations and overcome initial market hurdles.
- Careful consideration of market introduction risks, especially those driven by pressure to recoup investments quickly, ensures a sustainable approach.

4. Strategy
- Danish firms prioritise the application of research to address tangible problems and meet market needs.
- Founding teams often possess practical business skills that contribute to successful commercialisation.
- Collaborative efforts align partners' objectives and methodologies, ensuring effective knowledge transfer and innovation implementation.
- The development of procurement schemes are used in three distinct phases: experimentation, definition and replication.

Above: Wind turbines on Middelgrunden a few kilometers outside Copenhagen, Denmark

Denmark's collaborative innovation model provides valuable insights for other regions seeking to foster innovation and drive economic growth. By emphasising collaboration, risk management, a practical mindset and innovative procurement practices, Denmark has created a thriving ecosystem that is well-positioned to address global challenges and seize emerging opportunities.

Building structural enablers for university-industry collaboration is essential. Initiatives such as Australia's Trailblazer Universities Program are a step in the right direction, although they require expansion and long-term commitment to make meaningful change. The UK's Catapult Network and Germany's Fraunhofer Institutes can provide valuable insights on actions that improve structural support for collaboration.

For example, the Catapult Network focuses on areas of strategic importance to the UK where there is also significant market potential. The Network groups receive primary government funding but also receive industry and grant contributions. As private, non-profit entities, they operate with autonomy while adhering to government guidelines for governance, planning and performance. Each Catapult Network group continuously measures its long-term impact on its sector, which is important given the extended development cycles common in deep tech fields (Department for Business and Department for Science 2021). Australia can learn from the UK Catapult Network model, which succeeds due to its strategic focus, stakeholder aggregation, long-term support and targeted approach.

Elevating Aboriginal and Torres Strait Islander Knowledge systems through collaboration

The Australian innovation ecosystem is rich with potential, and one particularly promising avenue lies in deep collaboration between Western science and Traditional Knowledge. As noted in the National Science and Research Priorities, to maximise the benefits of science and research, Australia must deeply integrate Aboriginal and Torres Strait Islander Knowledge into its practices (Australian Government 2024a). This needs to be done through collaborative research that respects and protects Traditional Knowledge, language and cultural property, and respects Traditional Owners and their communities. By respectfully and appropriately incorporating Indigenous Knowledge into critical technologies and addressing challenges like climate change, Australia can foster a more inclusive and sustainable future, with Aboriginal and Torres Strait Islander communities leading the way in shaping research priorities and outcomes (IP Australia n.d.-a).

An example of such a collaboration can be seen in the example set by 2023 ATSE Traditional Knowledge Innovation award winners John Dadigar Watson, a Nyikina Mangala man from the Jarlmadangah Burru Aboriginal Community of the Kimberley & Professor Ron Quinn AM FTSE.

Above: John Watson's finger was bitten off by a crocodile and he used bark from the Mudjala mangrove tree for pain relief. A partnership eventuated between the Nyikina Mangala people and Griffith University seeking to identify what compounds could be present in the bark.

In 1986, John Watson's finger was bitten off by a crocodile. He turned to the bark of the Mudjala mangrove tree seeking pain relief. He chewed on a strip of bark and applied it as a dressing to his wound. When Professor Ron Quinn from Griffith University heard of John's ordeal, and his use of the Mudjala bark, he was intrigued.

An enduring partnership eventuated between the Nyikina Mangala people and Griffith University under the leadership of John and Ron, seeking to identify what active compounds could be present in the bark. Combining thousands of years of Traditional Knowledge with western science has revealed a novel, natural remedy for the treatment of severe pain. The bark contains two classes of compound: one is effective for inflammatory pain and the other mitigates sciatic nerve injury. The resulting product – a possible topical gel – will be based on the complex mixtures present within the bark paste. John and Ron hope that this gel could be supplied to athletes at the 2032 Brisbane Olympics (ATSE 2023).

Balancing collaboration with competition

Despite the benefits, to build genuine success, collaboration in innovation must be balanced with competition. The interplay between competition and collaboration within the innovation pipeline is a crucial dynamic in fostering sustainable innovation and economic growth. The relationship between these two forces involves multiple factors that influence how firms innovate, and how these innovations impact market structures.

The role of policymakers supporting collaborative/competitive success is to create an environment where collaboration can thrive without compromising the competitive integrity of the market. Competition can catalyse innovation by pushing firms to differentiate themselves from competitors through the development of new products or improvements to existing ones (WIPO 2011).

This is particularly evident in contestable markets where companies can gain a competitive edge through innovation (OECD 2023a). Competition can lead to incremental innovations that improve existing products and processes and breakthrough innovations that create an entirely new market (OECD 2023b).

Overemphasis on competition can stifle collaboration, leading to duplicated efforts and inefficient use of resources. Conversely, excessive collaboration without competitive pressure can reduce the incentives for firms to innovate (OECD 2023a). An optimal innovation ecosystem requires a careful balance between these two forces, where competition drives firms to innovate, and collaboration enables them to leverage shared knowledge and resources to achieve more significant breakthroughs.

Understanding the different needs of different innovations

Innovation involves developing or refining products, services, or techniques to enhance value. Different types of innovations—such as product, process, disruptive, continuous, sustaining, business and radical—require distinct approaches, resources and strategies to succeed (Stanford University n.d.-a).

For example, deep tech companies differ significantly from Software as a Service (SaaS) and other tech businesses in their journey from conception to commercialisation. The complexities of starting and scaling deep technology companies, which produce IP-intensive, science-based innovations aimed at solving some of the world's most pressing challenges, such as sustainable agriculture and energy security, require specialised infrastructure, significant capital, and long-term investment strategies that differ markedly from those of SaaS or other tech businesses.

Different types of innovations have unique needs that must be addressed to achieve success. Understanding these diverse needs is crucial for the different innovation actors – like innovators, investors and businesses as they navigate the complex landscape of bringing new ideas to market. The right resources, strategies and support structures can make the difference between an idea that falters and one that transforms industries.

3. Building Support Systems

Research infrastructure comprises the assets, facilities and services that support research across the innovation system and maintain the capacity of researchers to undertake excellent research and deliver innovative outcomes. By investing in world-class facilities and supporting IP protection, we can empower researchers to tackle complex challenges and develop solutions that benefit society. Australian innovation infrastructure has several high-performing assets located in universities, government, industrial organisations, not-for-profits, small and medium businesses, and startups (Australian Government 2019).

Intellectual property support

Issues related to intellectual property (IP) rights and use, particularly in collaborations between different innovation actors, present significant barriers to innovation. Regarding IP, the incentive structures between the different innovation actors are differently aligned. While research institutions focus on IP ownership for knowledge protection and future research, industry actors require clear and secure IP rights for commercialisation, investment attraction and strategic partnerships. This incentive divergence creates challenges in translating research into market-ready products and services (IP Australia n.d.-b).

Research shows that Australian firms granted patents are more likely to form collaborations in the form of joint R&D and joint commercialisation arrangements than firms without granted patents (IP Australia 2024). IP Australia provides recognised models that protect and incentivise collaborative innovations (Australian Government 2023a). SMEs are increasingly contributing to innovation – there is a growing trend of startups developing early-stage technologies, while larger firms commercialise these innovations through acquisition or collaboration. The IP Australia 2024 review revealed that over the past two decades, the number of SMEs in Australia that hold patents has increased at five times the rate of the number of SMEs in the economy, a pattern not observed for large firms (IP Australia 2024).

IP Australia's report also noted that firms granted patents are more likely to form partnerships, including joint research and development and commercialisation agreements with other innovation actors (IP Australia 2024).

Participants in our roundtable discussions emphasised the persistent challenge of sharing IP ownership in research collaborations. Disagreements often arise due to differing incentives among innovation actors, hindering commercialisation. Different innovation actors have different needs in the patenting journey – delaying patent granting can benefit smaller firms by giving them more time to commercialise their innovations and foster follow-on innovation. Larger firms are less affected by patent timing (IP Australia 2024). Simplifying IP agreements and providing support for creating IP strategies for SMEs and universities are essential steps toward fostering a more innovative environment.

Several strategic interventions have been identified by ATSE's experts, noting there is no single solution for supporting efficient IP rights and use. They are:

Leveraging IP as a strategic asset

- By developing a clear IP strategy early on, innovation actors can gain a competitive edge and protect their IP during partnerships. Government agencies like IP Australia, as well as state-based innovation agencies specialising in IP, can equip SMEs with the tools and knowledge to develop robust IP strategies that can transform them into innovation powerhouses.
- Given the complex nature of IP law, such as patent drafting and filing, trademark registration and IP audits, SMEs often require specialised expertise and spend time and resources navigating through this. While this upfront investment in IP strategy may seem costly, it can significantly reduce risks and costs in the long run, contributing to medium and long-term company growth.
- Reforming the IP distribution model is another vital component of improving the ecosystem. Exploring alternative models that balance the interests of inventors, universities and investors is essential. Creating an Australian model that borrows from leading global approaches, such as Stanford University's Intellectual Property policies, can be the key to improving Australia's IP ecosystem (Stanford University n.d.-b).

Optimising IP support

- Providing targeted financial support through voucher programs can help innovators protect and commercialise their intellectual property.
- Investing in talent development programs that equip researchers and entrepreneurs with IP management skills can create a pipeline of IP-savvy professionals.
- Exploring alternative IP ownership models can create greater flexibility and incentivise innovation.
- Implementing clear performance metrics for commercialisation can drive a more entrepreneurial culture within research institutions (Australian Government and Australian Academy of Technological Sciences & Engineering 2022)

Stanford's intellectual property policies model: A way forward for collaborative IP policies in academia?

Stanford University's intellectual property (IP) policies provide a framework for the ownership, management, and commercialisation of inventions, fostering a culture of collaboration, entrepreneurship and technology transfer. One approach to building clear IP policies in Australia around academic institutions would be to leverage the model from Stanford.

Key policies in the Stanford model include (Stanford University n.d.-b, n.d.-c, n.d.-d):

1. **Inventorship and ownership**
   - Stanford claims ownership of all patentable inventions conceived or reduced to practice by its employees in the course of their University responsibilities.
   - In certain cases, inventors may retain ownership if their work was conducted outside the scope of their University duties or with minimal use of University resources.

2. **Patent income distribution**
   - Patent income is shared among the inventor, their department, school, and the Office of the Vice Provost for Research (VPDOR).
   - The distribution percentages vary based on the cumulative income generated by a single license.
   - Department and school royalties must be used for research or educational purposes.

3. **Signature authority**
   - The Office of Technology Licensing (OTL) has the authority to sign license agreements, material transfer agreements, and other IP-related contracts on behalf of the University.
   - Faculty and inventors are not authorised to sign such agreements independently.

4. **Sponsored research and licensing**
   - Sponsored research agreements and license agreements are distinct legal entities.
   - OTL strives to ensure that the University receives a fair return for licensed intellectual property.

5. **Government-funded inventions**
   - Stanford adheres to the Bayh-Dole Act, a US law from 1980 that enables universities, nonprofit research institutions and small businesses to own, patent and commercialise inventions developed under federally funded research programs within their organisations (Athanasia 2022).
   - The University must grant the U.S. government a non-exclusive, royalty-free license for government purposes.

6. **Conflict of interest**
   - Stanford has policies in place to address conflicts of interest and ensure transparency in research and commercialisation activities.

Streamlining IP processes

- Adopting user-friendly IP frameworks can reduce administrative burdens and accelerate research commercialisation.
- To reduce costs and help SMEs, ATSE's experts proposed a central hub, akin to New Zealand's Return on Science, to connect researchers, businesses and investors. This platform could offer early-stage commercialisation advice, identify potential partnerships, and facilitate access to relevant programs and expertise. While there are already facilities offering this in some states, creating a centralised source or assimilating these avenues in an accessible location for innovation actors could help facilitate collaboration.

By carefully considering the strengths and weaknesses of different IP ownership models, Australian universities, industries, SMEs and other innovation actors can optimise their strategies for commercialising research and creating higher economic impact.

Leveraging the financial system

One of the most consistent messages from STEM start-ups, hubs and innovation centres is the burgeoning financial sector in Australia compared to mature markets like the US and UK. Australia has one of the lowest levels of venture capital (VC) investment among OECD countries (Startup Genome 2022). According to the National Innovation System Theory (Rikap 2022; Yue et al. 2023), the government plays a crucial role in shaping innovation capabilities. As a significant policy instrument for government macro-control, tax policy can stimulate R&D investment, upgrade industrial structures, and optimise innovation through systematic and targeted financial measures. The taxation system can be a lever that reduces the cost of capital for companies, thereby stimulating R&D investment (Bloom et al. 2019; Mukherjee et al. 2017). While Australia does offer a 20% tax concession and capital gains concessions for investors in Early-Stage Innovation Companies (ESIC), roundtable participants noted that there is still potential to enhance support for STEM start-ups. Other jurisdictions, such as the UK and Singapore, have implemented additional measures that could further attract global capital flows to Australian innovations. By optimising the existing tax regime and exploring new strategies, Australia can continue to develop its innovative economy and improve productivity levels.

TABLE 2 — Examples of financial incentives to help support domestic innovation

United Kingdom	The UK has three venture capital schemes which offer tax relief to individuals to encourage them to invest in companies and social enterprises that are not listed on any recognised stock exchange. — **Seed Enterprise Investment Scheme (SEIS)** grants a tax credit worth 50% of the investment, gives exemptions on capital gains tax (CGT) on earnings from shares, and exempts profits realised within three years from CGT altogether if they are reinvested in a SEIS-qualifying start-up. It targets new start-ups seeking capital investment (UK Government 2023a). — **Enterprise Investment Scheme (EIS)** grants a tax credit worth 30% of the investment, defined as the amount paid for shares in the start-up. It targets existing start-ups to scale further and grow (UK Government 2023b). — **The Venture Capital Trust (VCT)** scheme offers substantial tax benefits to investors, including income tax relief of up to 30% on the initial investment, exemption from capital gains tax on any profits made when selling VCT shares, and tax-free dividends (UK Government 2024).
Singapore	The Venture Capital Fund Incentive (VCFI) and Fund Management Incentive for VCFI approved funds (FMI) schemes aim to encourage investments into Singapore-based businesses and startups. VCFI provides tax exemptions for income from funds that meet the scheme's requirement, while FMI offers fund management companies a 5% concessionary tax rate on income derived from managing VCFI approved funds (StartupSG n.d.). Other schemes include (PwC 2024): — **Enterprise Innovation Scheme**: Provides tax deductions or cash payouts for R&D, IP registration, acquisition, employee training and innovation projects. — **Intellectual Property Development Incentive**: Offers reduced tax rates for companies commercialising IP arising from R&D activities. — **Pioneer Tax Incentive**: Offers full tax exemption for 5-15 years for companies involved in high-tech manufacturing or qualifying services. — **Development and Expansion Incentive**: Provides reduced tax rates for companies undertaking new high-value projects or expanding their operations after the pioneer period.

Government support is vital for start-ups in the absence of a vibrant venture capital market. Several approaches can be taken (see examples of utilising the tax structure in Table 2) to help support the funding landscape. Australian initiatives such as tax benefits for investing in start-ups via Venture Capital Limited Partnerships (VCLPs) and benefits for angel investors to invest in early-stage innovation companies are positive steps towards fostering a supportive environment for new ventures (Australian Government 2024c, 2024d). However, roundtable participants noted that more could be done to support the innovation sector by allowing interested actors to help support domestic innovation financially, for example through existing training programs made available to qualified investors to help raise their understanding of early-stage investing (Angel Loop n.d.).

Understanding the intricate relationship between market dynamics and innovation is another crucial pillar for crafting effective innovation policy. Research suggests that macroeconomic conditions and monetary policy significantly impact a nation's innovative capacity, with long-term productivity and economic growth implications. Studies have shown that contractionary monetary policy can be associated with a decline in R&D spending (Moran and Queralto 2018), and hinder technology adoption (Amador 2022). This is often attributed to reduced demand, tighter credit conditions and lower perceived returns on innovation (Comin and Gertler 2006; Barlevy 2007). Conversely, expansionary monetary policies can stimulate innovation, though the effect of such policy will vary across firm sizes (Majeed et al. 2024). These findings underscore the need for policymakers to consider the broader economic context when designing innovation strategies, recognising that monetary policy can either complement or counteract innovation-focused initiatives. By carefully analysing these dynamics, Australia can optimise its innovation ecosystem and foster sustainable economic growth.

Human capital optimisation

Australia's skills flow is influenced by both domestic training initiatives and international migration. The country has implemented several visa programs to attract skilled workers from abroad, particularly in high-demand sectors. The Australian Government should maintain initiatives and support programs to attract skilled individuals and investors who can contribute to Australia's innovation landscape (Australian Government 2024e). Existing programs to improve STEM skills and the innovation ecosystem should focus on linking researchers with commercial partners rather than solely training them as entrepreneurs. Countries like Israel, Singapore and the US have successful models of supporting researchers within commercial teams. The movement of skilled migrant workers between firms helps transfer knowledge and spread innovation. There is an opportunity to leverage Australia's innovative capabilities to entice expats to repatriate and add to the domestic innovation ecosystem. Programs of the Department of Foreign Affairs and Trade to showcase active innovation in emerging technology areas can resonate with the interests and aspirations of returning citizens.

To optimise human capital and boost Australia's innovation ecosystem, it's also crucial to address gender disparities. Women face significant barriers to accessing capital, support networks and opportunities. For example, only 10% of female founders feel highly confident about raising venture capital, compared to 30% of men (Council of Small Business Organisations Australia and Future Female Entrepreneurs Program 2024; Folklore Ventures 2023). By empowering and boosting entrepreneurs from diverse backgrounds, Australia can add between $71 billion and $135 billion to the economy (Australian Government 2023b; Shalini Unnikrishnan and Cherie Blair 2019).

Addressing the STEM skills crisis

ATSE's 2022 report 'Our STEM skilled future – An education roadmap for an innovative workforce' emphasised the current skills crisis in Australia, particularly in STEM fields, highlighting the need for a more resilient and responsive workforce to meet the demands of a technology-driven future (ATSE 2022a). The report underscores the importance of collaboration between government, industry, education sectors and individuals in addressing the STEM skills gaps. Increasing diversity and inclusion in the STEM workforce is highlighted as crucial to addressing skills shortages and ensuring broad participation in the workforce. Five critical areas of focus were identified – mathematics, digital skills, agricultural technologies, engineering and entrepreneurship – each requiring targeted interventions. The document calls for urgent, decisive actions to prevent Australia from falling behind in global competitiveness due to STEM skills shortages.

FIGURE 5 — Key themes discussed during ATSE's roundtables to help foster a culture of innovation

The role of vocational education and TAFE

The Tertiary and Further Education (TAFE) sector has also developed a range of micro-credentials and micro-skills that are industry-relevant along with other innovation actors like universities and Government Departments, making it flexible and accessible. These courses are co-designed with industry partners to ensure alignment with current job market needs and are offered online, allowing individuals to learn at their own pace and convenience. TAFE provides pathways for students to transition into higher education, enabling them to gain qualifications that are recognised across sectors (e.g., digital technologies and construction and trades). However, TAFE has faced budget cuts from both Commonwealth and state/territory governments in recent years. This has led to campus and course closures, reduced resources, and increased workloads for staff (Australian Education Union 2020). To address Australia's skills shortages, it is imperative to invest in TAFEs, which offer critical retraining and alternative vocational education pathways.

4. Reforming policy and regulatory frameworks

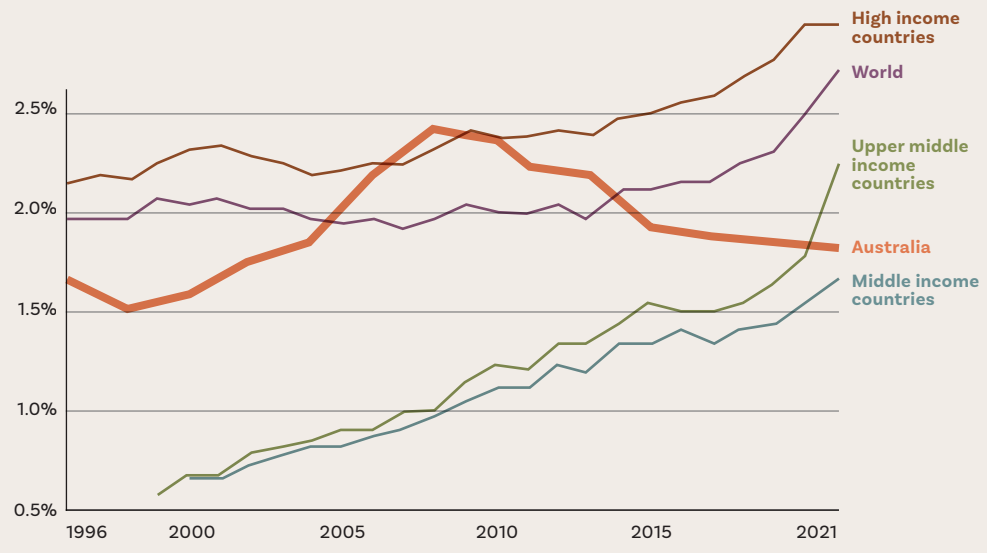
Modern industry policy demands dynamic relationships between government and the private sector, focusing on public value. Governments adopt learning-by-doing approaches, take calculated risks, and build market-shaping capacities. Industries collaborate with governments to maximise public and financial value.

The research sector struggles to accelerate innovation due to a complex interplay of cultural and systemic barriers. A risk-averse culture pervades the innovation ecosystem, creating an initial barrier to transformative work by prioritising incremental advancements, and at times prioritising technology adoption over potentially groundbreaking initiatives. This institutional caution is compounded by cumbersome regulatory frameworks that further impede progress. Stakeholders highlighted that the research ecosystem is caught between institutional caution and bureaucratic complexity. Frequent policy shifts that impact the funding strategies and allocations of the different innovation actors introduce additional uncertainty, making it difficult for researchers and organisations to plan and execute innovative strategies. To address these challenges, a multifaceted approach is crucial.

Optimising funding strategies

Investment is needed across the entire innovation pipeline, with funding gaps often leading to projects failing or being taken overseas for commercialisation. Australia's total investment in innovation (including government, business, university and philanthropic funding) equates to 1.68% of the nation's GDP, falling well below the OECD average (2.7% of GDP (OECD 2022). More critically, this investment has been falling as a percentage of GDP, after reaching a high of 2.25% in 2008 (OECD 2022).

FIGURE 6 — Research & development spending as a share of GDP. Source: World Bank 2024



This has put Australia's innovation capability on the back foot by comparison with increasing commitments to R&D investment internationally (OECD 2024–Figure 6). Lack of funding is the commonly reported barrier to innovation by businesses (Australian Bureau of Statistics 2024b). Roundtable participants also reported a lack of support for innovation in regional Australia, unavailability of investment for early-stage startups and SMEs, and difficulty attracting domestic and international investment as major funding-related barriers.

Crucially, government investment in innovation has recently been below the long-term average (Brennan et al. 2023). Federal Government funding in Australia is spread across multiple federal programs and government departments. The result is a lack of cohesion, efficiency and clarity for innovators, making it difficult for them to find and apply for opportunities, and for the government to meet innovation goals. Additionally, duplication in administration for all these programs leads to inefficiencies and poor use of limited government budgets. At the same time, Australia is over-reliant on government funding compared to other developed economies. 53% of R&D investment comes from industry in Australia (Australian Bureau of Statistics 2023), while industry accounts for 78% of R&D funding in the United States (National Center for Science and Engineering Statistics 2022). This disparity may be due in part to the U.S. developing its venture capital landscape much earlier, with the first VC organisation established in 1946. Australia's venture capital industry only began in the late 1990s to early 2000s, resulting in less experienced startup VC firms. If Australia invests now in growing and scaling its innovative companies, it can cultivate a stronger ecosystem providing R&D and innovation funding in the future. Government investment in R&D is usually measured by various funder-based or performer-based approaches. Table 3 showcases a summary of the different methods used to measure innovation funding.

TABLE 3 Current research & development funding metrics

Metric (measurement method)	Definition
BERD (performer-based)	Business enterprise R&D spending
GBARD (funder-based)	Government budget allocations for R&D
GERD (performer-based)	Total R&D expenditure within a country
GOVERD (performer-based)	Government expenditure on R&D
HERD (performer-based)	Higher education R&D spending
PNPERD (performer-based)	Private non-profit R&D spending

Australia lacks a national strategy to help boost innovation investment across the board – ideally to 3% of GDP to match top-performing competitors like the United States, Germany and Japan. A national strategy can help to consolidate and streamline existing innovation programs into a single easy-to-understand and access funding pathway. It can at the same time boost innovation funding to help meet the funding shortfalls and fill vital gaps in our innovation ecosystem.

Governments can lead the way by increasing investment and setting the national direction, and Australian policy settings can help attract investment, both domestically and internationally. They can provide incentives for both sophisticated individual investors and industry players to invest in the innovation ecosystem (explored in Leveraging the Financial System in the previous section). Currently, fewer than half of Australian businesses engage in research and innovation (Australian Bureau of Statistics 2024b).

For SMEs in particular, innovation can be a risky investment. Governments can therefore play a risk management role that supports investment and innovation from Australian businesses. Currently, Australian government research funding organisations like the ARC and NHMRC tend to be risk-averse, prioritising incremental research rather than opportunities with greater risks and rewards. Creating the frameworks for government agencies to engage appropriately in strategic and managed risks is essential for innovation. This should include decisions on investment, which is common behaviour among international competitors (European Innovation Council n.d.). Australia's innovation ecosystem also faces challenges. For example, universities fund their research through a combination of international student fees and short-term government funding. Having volatility in either aspect of these revenue sources would affect the performance and output of the university research sector. Establishing a long-term commitment to a government-sponsored research baseline as a fraction of GDP can ensure a sustainable investment profile.

Measuring success and impact

Australia's innovation ecosystem is marked by its complexity and lack of interconnectivity, which make comprehensive measurement a significant challenge. Combining the outcomes from the Innovation Metrics Review that ATSE worked on with the Australian Government in 2019 with our recent roundtable discussion, several critical challenges are clear:

Complex interdependencies — Innovation involves numerous interrelated processes and products that function across multiple levels of analysis. Participants noted that the way Australia measures the interaction of these elements —especially when they are inherently difficult to quantify—is a layer of complexity not adequately captured in the current evaluation process.

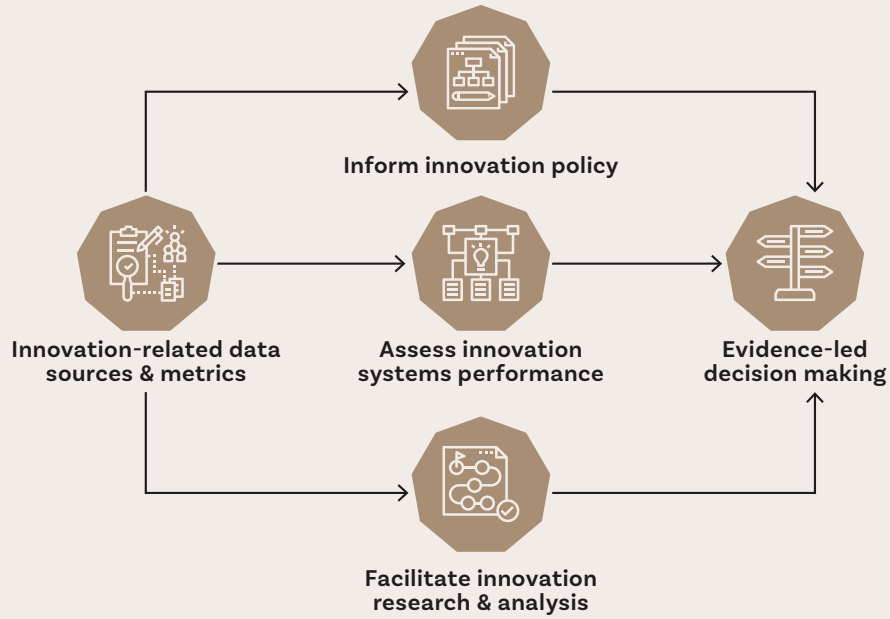
Selection of metrics — The process of selecting appropriate metrics and frameworks requires ongoing attention and a deep understanding of the innovation system's intricacies. Existing approaches, such as composite indices, detailed dashboards and scorecards, while useful, are often limited in providing clear policy insights due to gaps in underlying data.

Standardisation issues — Another significant challenge is a lack of standardisation in the metrics used to assess the success of investment in innovation. Roundtable participants noted that this inconsistency across investments hampers the ability to compare and assess the effectiveness of the different innovation initiatives.

Transparency deficiencies — There is insufficient transparency in reporting the outputs and outcomes of innovation and collaboration efforts. This lack of clear and accessible data also hinders our ability to assess the true impact of innovation activities. Initiatives such as the Australian Taxation Office (ATO) publishing data reports on Research and Development Tax Incentive entities are a step toward greater openness and accountability in the administration of innovation policies (Australian Government 2024f).

The accurate and comprehensive measurement of innovation performance is crucial for guiding effective policymaking and enhancing Australia's economic outcomes (Figure 7). The roundtable discussion yielded several crucial recommendations for enhancing Australia's approach to measuring and fostering innovation. These recommendations aligned with the central recommendation of the Innovation Metrics Review of developing a comprehensive yet accessible scorecard, aligning innovation measurements with broader economic outcomes, and ensuring the consistent application and analysis of the resulting data (Australian Government and Australian Academy of Technological Sciences & Engineering 2022).

FIGURE 7 — How innovation-related data sources support evidence-based decision making



The scorecard design must be inclusive, resonating with a diverse array of stakeholders ranging from policymakers and industry leaders, to academics and the general public. This broad appeal would enhance its utility as both an analytical tool and a means of communication. It was also noted that innovation flow-on effects need to be captured and the scorecard should focus on a carefully curated set of pivotal indicators that directly align with national priorities. To maintain its relevance and responsiveness to the evolving economic landscape, annual reporting to the government could be instituted, complemented by periodic reviews of the scorecard's structure and content.

The roundtable emphasised that innovation measurements should not be pursued in isolation. Instead, they should be intrinsically linked to wider economic objectives, particularly those centred on enhancing productivity and elevating living standards. This connection will serve to illustrate the tangible impact of innovation on productivity enhancement, economic expansion and societal prosperity, providing a clear narrative of how innovation efforts translate into real-world benefits for Australia. Furthermore, ensuring transparency and accessibility of innovation data and insights to the public is crucial. This openness will promote broader engagement, stimulate open discussion and encourage collaborative problem-solving in the innovation space.

Strategic direction

Governments play a proactive role in steering economic development. Multiple roundtable participants voiced the need for more directional and integrated approaches to policymaking. ATSE has asserted the importance of viewing the innovation system as a means to understand ourselves and the world, contributing to societal and economic development. This fundamental purpose should guide policy decisions.

Past ATSE technology readiness reports supported this argument and roundtable participants wanted to see more focus on strategic directionality (ATSE 2019, 2020a, 2020b). Directionality refers to the government's role in setting clear, strategic priorities for economic development (Parks 2022). This involves identifying key sectors or goals, such as decarbonisation or next-generation computing, and aligning resources and policies to support these priorities (examples of such directionality can be seen in Table 4). The roundtable discussions emphasised that successful directionality is required through high-level political and fiscal commitment, signalling clear and consistent support to industry actors. The table below highlights examples from other countries that are implementing policy frameworks. It is important to note that strategic direction in innovation is also swayed by geo-political forces. However, the approaches taken by international counterparts provide valuable lessons for Australia and the way other nations change their innovation policy would impact the market dynamics of Australia's own strategic direction choice.

TABLE 4 — Examples of strategic directionality in policy taken by different countries.

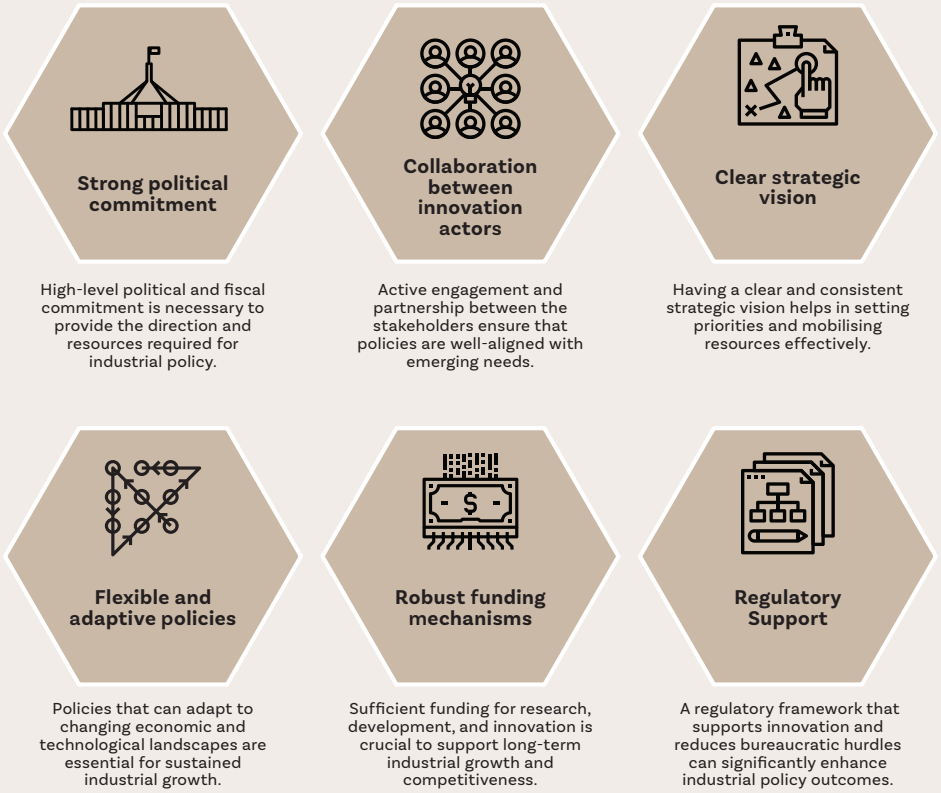
United States	The US employs a strategic approach to industry policy with initiatives like the Inflation Reduction Act, CHIPS and Science Act, and the Bipartisan Infrastructure law which aims to spur investment in clean energy, address climate change and enable emerging manufacturing industries like advanced semiconductors through subsidies, grants, loans, tax credits and other funding support mechanisms (U.S. Government 2022a, 2022b, 2024).
China	China's "Made in China 2025" policy is another example of strategic directionality. It aims to transform the country into a leader in high-tech industries such as AI and electric vehicles. The policy includes substantial government support and strategic planning to achieve these goals (Institute for Security & Development Policy 2018).
European Union	The EU's approach includes a combination of strategic planning and regulatory support. EU updated the European Industrial Strategy in May 2021, with a focus on the resilience of the EU single market, the EU's dependencies in key strategic areas and support for small and medium-sized enterprises (SMEs) and start-ups, as well as on accelerating the green and digital transitions (European Commission 2021). It has been using the Horizon Europe program, providing substantial funding for research and innovation, with a focus on addressing societal challenges and promoting sustainability (European Commission n.d.).
Australia	The Future Made in Australia Act signals the explicit aim to capitalise on Australia's advantages in resources necessary for the clean energy transition (Australian Government 2024g). The policy seeks to encourage investment in industries supporting the net-zero transformation and economic security. This has been complemented by the National Science Priorities and the National Reconstruction Fund Priorities signalling a strategic national direction (Australian Government 2023c, 2024a).

Successful policy implementation requires a long-term perspective, akin to the 25-year horizons adopted by countries in Table 4. Australia requires a combination of horizontal and vertical policy programs, which is crucial for achieving the priorities identified for innovation.

This involves deploying a range of policy tools, including financial incentives, regulatory reforms and direct support for research and development. The roundtable participants agreed that a multifaceted approach is necessary to create an environment conducive to innovation, the scale-up of firms and long-term industrial growth. Some of the themes discussed in the roundtable are summarised in Figure 8.

Each sector has distinct roles and requires tailored support. Effective governance structures are also essential for coordinating the various elements of industry policy across all levels of government. ATSE advocates for high-level coordination across government departments and active engagement with stakeholders in the different innovation actors. This ensures that policies are coherent, well-aligned with industry needs, and capable of driving systemic changes.

FIGURE 8 — Identified themes discussed to create a strategic direction in ATSE's roundtable sessions



The strategic direction should be clear in its support for both curiosity-driven and applied research, and existing funding bodies like the Australian Research Council and National Health and Medical Research Council should be expanded for this purpose. Applied research funding should be aligned with specific national goals, and long-term missions with clear objectives should be established. Expert-based boards can oversee mission-based funding and investment, while agile bottom-up supports can enable individual researchers to pursue innovative ideas. Additionally, the strategic directionality for the innovation ecosystem should have provisions to ensure that private investment is not hindered.

Demand-side initiatives

Australia currently has state and federal government policies and action plans designed to create market demand for innovation, particularly in priority areas crucial for economic growth and competitiveness. By aligning policies and initiatives across state and federal departments, particularly in areas such as the transition to a net-zero economy and the development of sovereign advanced manufacturing capabilities, the government can create a stronger market "pull" for innovative solutions.

To help support the strategic direction, demand-side innovation policies can act as strategic initiatives designed to stimulate innovation by influencing the demand for new technologies, products or services. Unlike traditional supply-side policies, which focus on supporting the generation of innovations (e.g., through R&D funding), demand-side policies aim to create or enhance market conditions that encourage the adoption and diffusion of innovations. In roundtable discussions, participants discussed the following key strategies:

Procurement

Innovation should be the cornerstone of all procurement decisions across the rapidly evolving technology sector. This approach not only benefits buyers by ensuring they have access to the most advanced solutions across various sectors, such as defence, health and agriculture, but also fosters a more compliant and transparent procurement process. For industry, innovation-driven procurement provides clearer opportunities, lowers barriers to entry and contributes to overall sector growth.

Roundtable discussions urged the need for setting up "first customer" funds to act as initial buyers for Australian inventions. Governments act as early adopters by purchasing innovative goods or services, creating a market and setting standards to drive broader private-sector adoption.

Regulation and standards

Implementing regulations or setting standards that require or encourage the use of innovative solutions is vital. Regulations ensure safe operation and performance, while standards can be voluntary unless mandated by regulations.

Australia is shaping global standards for critical technologies, by working with India, Japan and the United States of America to develop the Quad Principles on Critical and Emerging Technology Standards (Australian Government 2021). For example, the Australian Government's Tech Standards Knowledge program helps technical experts develop international standards for critical technologies (Australian Government n.d.-b). Integrating programs like this and the discussions on standards that are taking place between the different global standards agencies to the smaller innovation actors like SMEs can accelerate the diffusion of domestic innovations in overseas markets, helping Australian firms access global value chains more easily.

Incentives

As discussed in the section above, offering subsidies, tax incentives or other financial incentives to consumers or businesses can drive the adoption of innovative technologies, thereby creating demand that fuels further innovation. Additionally, identifying and fostering new markets through initiatives like competitive grants, challenges or prizes that reward innovative solutions to specific societal problems can stimulate targeted innovation efforts. Roundtable discussions also highlighted the potential of streamlining foreign investment approvals and eliminating tariffs as approaches for market creation.

Roundtable participants noted that incentive structures should be aligned with the level of innovation risk. It was suggested that proportional support should be extended in the form of providing targeted advice, connections and resources to de-risk opportunities with a higher innovation risk. Dedicated demand-side policies could help SMEs seeking to service growing export markets or transition internal markets with innovative new-to-market offerings.

Demand side innovation policy programs: Connecting the loop

Demand-side innovation programs, such as the Victorian Smart SMEs Market Validation Program (MVP) and the NSW Small Business Innovation & Research programs, are strategic initiatives by state governments in Australia to foster innovation within small and medium-sized enterprises (OECD 2011; Hammond 2011; NSW Government n.d.). These programs operate by identifying specific needs within government departments and inviting SMEs to propose innovative solutions.

The programs guide SMEs through three key stages:

- Feasibility and Concept Development — SMEs receive funding to explore the viability of their proposed solutions.
- Prototype Development and Testing — Successful concepts move to the prototype stage, with further funding and real-world testing within government departments.
- Procurement: Relevant Government agencies look to consider purchasing successful solutions.

These Australian programs are modelled after the U.S. Government's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. Administered by the U.S. Small Business Administration, the SBIR/STTR programs provide funding across various federal agencies, supporting a diverse portfolio of startups and small businesses (U.S. Small Business Administration n.d.). This approach stimulates technological innovation, meets Federal research and development needs, and enhances commercialisation efforts to transition R&D into impactful solutions.

While current Australian iterations effectively support SMEs in commercialising their innovations by providing real-world validation and feedback, these programs could benefit from:

- Greater collaboration across different state and federal agencies, to increase the reach and impact of these programs and allow for broader application and integration of innovative solutions.
- Expanding the scope of procurement for SMEs across various fields of research to further solidify the connection between innovation and practical implementation, ensuring that public sector challenges are met with cutting-edge solutions.

Policies should also promote collaboration between businesses of different sizes and types, encouraging the formation of diverse innovation networks. Specific initiatives should focus on integrating innovative SMEs into the supply chains of larger businesses and facilitating engagement with multinational corporations. These efforts will provide SMEs with de-risked scaling opportunities, access to established market demand, and pathways to international markets.

Previous ATSE reports have also recommended the development of programs to build strategic capabilities in areas such as identifying technological and market opportunities, improving technological awareness and adoption, attracting talent, and commercialising new products and services. Specific attention should be given to enhancing manufacturing, production and management capabilities in medium-sized firms, addressing the "scale-up problem" identified.

In Australia, demand-side policies have been employed to drive innovations in sectors such as automotive technologies and climate change, effectively linking innovation to broader public policy goals, like reducing emissions or enhancing public services. Roundtable discussions detailed support for these policies and participants agreed that they could be critical tools for fostering innovation ecosystems to be responsive to societal needs and challenges.

Appendix

Glossary of acronyms

ACOLA	Australian Council of Learned Academies
ARC	Australian Research Council
ATO	Australian Taxation Office
ATSE	Australian Academy of Technological Sciences and Engineering
BERD	Business expenditure on Research and Development
CRC	Cooperative Research Centres
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPI	Digital Public Infrastructure
EIS	United Kingdom Enterprise Investment Scheme
FMI	Singapore Fund Management Incentive
GBARD	Government budget allocations for Research and Development
GDP	Gross Domestic Product
GERD	Gross expenditure on Research and Development
GOVERD	Government Resources Devoted to Research and Experimental Development
HERD	Higher education expenditure on Research and Development
IP	Intellectual Property
NHMRC	National Health and Medical Research Council
NRF	National Reconstruction Fund
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
PNPERD	Private non-profit Research and Development spending
R&D	Research and Development
SaaS	Software as a Service
SBIR	United States Government's Small Business Innovation Research
SEIS	United Kingdom Seed Enterprise Investment Scheme
STEM	Science, Technology, Engineering, and Mathematics
STTR	United States Government's Small Business Technology Transfer
TAFE	Technical and Further Education
TTO	Technology Transfer Offices
VCFI	Singapore Venture Capital Fund Incentive
VCT	Singapore Venture Capital Trust
WIPO	World Intellectual Property Organization

Methodology

ATSE's Technology Readiness Assessment methodology aims to identify suitable measures for technology awareness, adoption and impact in Australia. It allows measurement of the progress of Australian businesses and governments against defined criteria, metrics and indicators (ATSE 2022b).

Using this methodology since 2018, ATSE has consulted hundreds of leaders across a vast array of Australian economic sectors and scientific, engineering and technological expertise, to produce 18 reports exploring Australia's readiness and identifying Australia's opportunity to transform the economy through the translation.

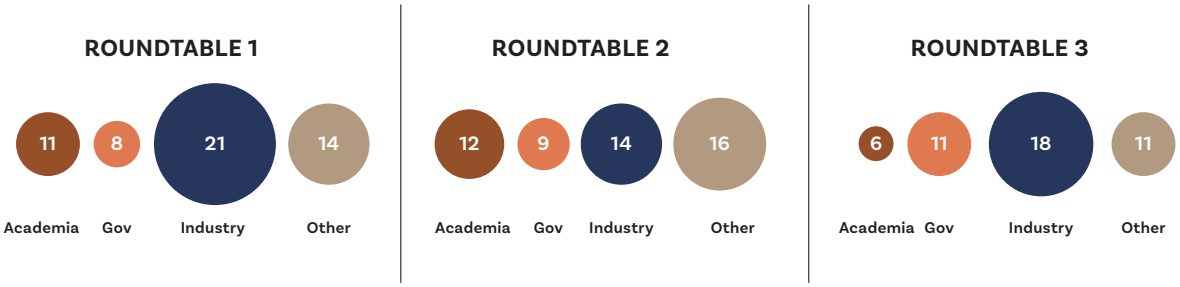
The three roundtables conducted during July 2024 were as follows:

ROUNDTABLE 1
Bridging the innovation gap: From research to reality.
Chaired by Dr Dimity Dornan AO FTSE

ROUNDTABLE 2
Breaking down cultural barriers: Building a culture of innovation.
Chaired by Distinguished Professor Saeid Nahavandi FTSE

ROUNDTABLE 3
Navigating the innovation pipeline: Collaboration.
Chaired by Dr Jack Steele FTSE

The roundtable registrations of experts that attended the above sessions by their sectors can be found in the graph below.



Endnotes

1. Australian Council of Learned Academies 2015
2. Australia ranks 23rd out of the 50 high-income economies listed and 6th out of the 16 economies in Southeast Asia, East Asia, and Oceania (Robyn Prior and Tim Brennan 2023)
3. Source: (Columbia University 2023)
4. The table draws on academic literature and provides an example of the major innovation system functions (Chaminade et al. 2018; Grønning and Fosstenløkken 2015; Eggink 2012; Mahroum and Al-Saleh 2013; Borrás and Edquist 2013; Hekkert et al. 2007; Hekkert and Negro 2009; Australian Government and Australian Academy of Technological Sciences & Engineering 2022)
5. Businesses could report more than one barrier.
6. For example, TechVouchers in NSW provide small to medium enterprises with matched funding to help them collaborate with a research partner from the Boosting Business Innovation Program. SMEs through this program have access to work on collaborative research projects with researchers from 13 public universities, with approved projects awarded 50% of the total eligible project costs in match-funding, up to a maximum of $50,000 (Australian Government 2024b)
7. Market producers record only market output and output for their final use. Non-market producers (which are recorded in sectors of general government and non-profit institutions serving households) record mainly non-market output (Eurostat n.d.).
8. Performer-based: Focuses on who performs the R&D (e.g., BERD, GOVERD, HERD, PNPERD). While, funder-based: Focuses on who provides the funding for R&D (e.g., GBARD).

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