



**ATSE SUBMISSION**



JANUARY 2023

SUBMISSION TO THE TREASURY

# Pre-budget submission 2023-24

Australian Academy of Technological Sciences & Engineering

## The Australian Academy of Technological Sciences and Engineering (ATSE) is a Learned Academy of independent, non-political experts helping Australians understand and use technology to solve complex problems.

Bringing together Australia's leading thinkers in applied science, technology, and engineering, ATSE provides impartial, practical, and evidence-based advice on how to achieve sustainable solutions and advance prosperity. ATSE welcomes the opportunity to provide a submission to the 2023-24 Federal Budget.

Innovation is the fundamental source of economic and social progress and is an essential part of maintaining a strong and prosperous nation. Australia's STEM (science, technology, engineering, and mathematics) sector provides an essential basis for our nation's innovation. Supporting the STEM sector can help us tackle emerging health crises, engineer the food of the future, turn Australian resources into the energy of tomorrow and build a strong and stable economy. To be at the forefront of international innovation, Australia needs to build itself on a foundation of world-class science and technology.

In this submission, ATSE provides a series of recommendations that will help build Australia's ability to respond to the challenges and harness the opportunities our nation faces. Throughout, ATSE highlights opportunities to address the critical needs of the STEM sector right now, the needs of the sector for building a strong STEM ecosystem into the future, and how STEM can be deployed to help tackle the biggest challenge facing Australia, climate change.

Some of these recommendations require urgent action and should be implemented by the Australian Government immediately. To support Treasury's assessment of the urgency of these recommendations, ATSE has grouped recommendations into three categories, "High Priority", "Priority" and "Supporting". This is underpinned by a critical recommendation that is, in ATSE's view, the single most important recommendation the Australian Government could adopt to improve the state of science and technology in this country.



**CRITICAL RECOMMENDATION**



**HIGH PRIORITY RECOMMENDATION**



**PRIORITY RECOMMENDATION**



**SUPPORTING RECOMMENDATION**



### CRITICAL RECOMMENDATION

The Australian Government commits to conducting an independent review of Australia’s research sector, with a view to raising sector-wide funding to an internationally competitive level.



### HIGH PRIORITY RECOMMENDATIONS

The Australian Government establishes a National Engineering Council.

The Australian Government funds the full cost of teaching undergraduate and postgraduate STEM courses.

The Australian Government conducts a whole of workforce foresight study to identify emerging skills gaps and develop a national strategy for STEM.

The Australian Government develops and promotes a National Skills Taxonomy to align educators, government, and industry, with associated analysis and forecasting of skills supply and demand.

The Australian Government invests in near-term emissions reductions using proven technologies and strategically invests in emerging emissions reduction technologies to develop their economic viability.



### PRIORITY RECOMMENDATIONS

The Australian Government provides financial support for an Indigenous STEM Network.

The Australian Government supports the expansion of ATSE’s Diversity and Inclusion toolkit.

The Australian Government develops and funds a Regional, Rural and Remote Mathematics Community of Practice.

The Australian Government expands funding for the Elevate: Boosting Women in STEM scholarships.

The Australian Government provides funding to expand the IMNIS Ignite internship program.

The Australian Government implements the Australian Energy Research Plan developed by the Australian Council of Learned Academies.

The Australian Government invests in widespread electric vehicle charging infrastructure, supported by common standards and power supply infrastructure.



### SUPPORTING RECOMMENDATIONS

The Australian Government funds the development of a targeted, actionable, and achievable plan outlining immediate opportunities for Australia-Pacific STEM collaboration.

The Australian Government develops a paid internship scheme for undergraduate mathematics students to engage in teaching, with a particular focus on Regional, Rural and Remote areas.

The Australian Government develops a central hub for STEM teaching and careers resources.

## WHAT THE STEM SECTOR NEEDS RIGHT NOW

Australia's STEM research sector must be collaborative, linking academics with industry and Australia with our region. To achieve this, the STEM sector requires support and incentives to ensure that researchers can complete their work to a world-leading standard. This must include support across the research pipeline, from fundamental research through to research commercialisation. Right now, Australia risks falling behind its international peers and new investment is needed to remain internationally competitive.



### Funding for nation building research and development

No nation that seeks to be a leader in innovation, or have a strong economy, can do so without proper investment into research and development (R&D). The most recent available figures place Australia's total funding across the R&D sector equates to approximately 1.8% of Australia's GDP (OECD, 2022). This figure is well below the most recent OECD average of 2.67% of GDP and falls well below world leaders in research such as the United States, Germany and Japan who all spend more than 3% of their GDP on R&D (OECD, 2022). CSIRO has estimated that every dollar invested R&D provides a return to the Australian economy of \$3.50 (CSIRO, 2021). By failing to keep pace with comparable countries, Australia risks not only its strong reputation as a leader in high-quality, international research, but also risks a weaker economic outlook and falling competitiveness.

While the Australian Government is the largest single funder of R&D nationally, it currently spends less than 0.6% of national GDP on R&D (Australian Parliamentary Library, 2022). It is ATSE's position that an increase in investment into R&D is necessary, and such investment must be strategically targeted. To better understand where to target this investment, an independent review of the entire R&D sector needs to happen, one that spans all areas of research and includes government, industry, university, and not-for-profit sector research. Such a review should not consider just direct government spending through the core funding bodies, but also support for research and data sharing infrastructure, and corporate incentives (such as additional R&D tax incentives) to determine the most effective ways to increase sector-wide funding for R&D to internationally competitive levels of around 3% of GDP.

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## Enhancing research collaboration, translation, and commercialisation

A whole-of-sector approach is required to sustain the highest quality research across the nation. The research sector must be supported to collaborate by developing networks that bringing together experts from across the country and region. Given ATSE's role within the Australian STEM community as a body that interfaces government, research, industry, and education, ATSE would be well-placed to provide administrative support to build opportunities for collaboration, identify experts to work with these organisations and develop collaboration plans.

In particular, the development of a National Engineering Council would enhance our nation's ability to identify, respond to and influence emerging workforce trends within the engineering sector, a sector with critical workforce shortages (Engineers Australia, 2022). Addressing these workforce shortages will be necessary to tackle Australia's current and future challenges. Professional networks could also be established to help to ensure that STEM fields are representative of the communities their research affects, build a culture of Australian STEM and ensure a coordinated approach to challenges.

Aboriginal and Torres Strait Islander STEM professionals are underrepresented across the sector (Office of the Chief Scientist, 2020). The [National Indigenous STEM Professional Network](#) helps to support and retain current researchers and works to combine Traditional Knowledge with modern research techniques. These kinds of networks should be supported by tools to help organisations and workplaces conducting research to encourage diversity and inclusion. ATSE recently developed the [Diversity and Inclusion Toolkit](#) (Australian Academy of Technological Sciences and Engineering, 2022a) in response to the [Women in STEM Decadal Plan](#) (Australian Academy of Science & Australian Academy of Technological Sciences & Engineering, 2019), designed to provide small and medium-sized enterprises with the tools necessary for improving inclusion and diversity in their workplace.



Internationally, Australia should identify ways of using our expert STEM sector to engage with and contribute to our region, working in partnership with communities in the Pacific Island nations. Global challenges such as the impacts of climate change and extreme weather are particularly urgent issues for many of our Pacific Island neighbours, as they are for Australia. Working with our regional partners on co-designed, needs-driven STEM-based solutions to these urgent challenges will deliver tangible benefits for Pacific Island communities and help demonstrate Australia's

commitment to the region. A targeted, actionable, and achievable plan for Australia-Pacific STEM collaboration should be developed to identify opportunities for Australian researchers to work with Pacific Island partners to address common and urgent challenges.



### HIGH PRIORITY RECOMMENDATION

The Australian Government establishes a National Engineering Council.



### PRIORITY RECOMMENDATIONS

The Australian Government provides financial support for an Indigenous STEM Network.

The Australian Government supports the expansion of ATSE's Diversity and Inclusion toolkit.



### SUPPORTING RECOMMENDATION

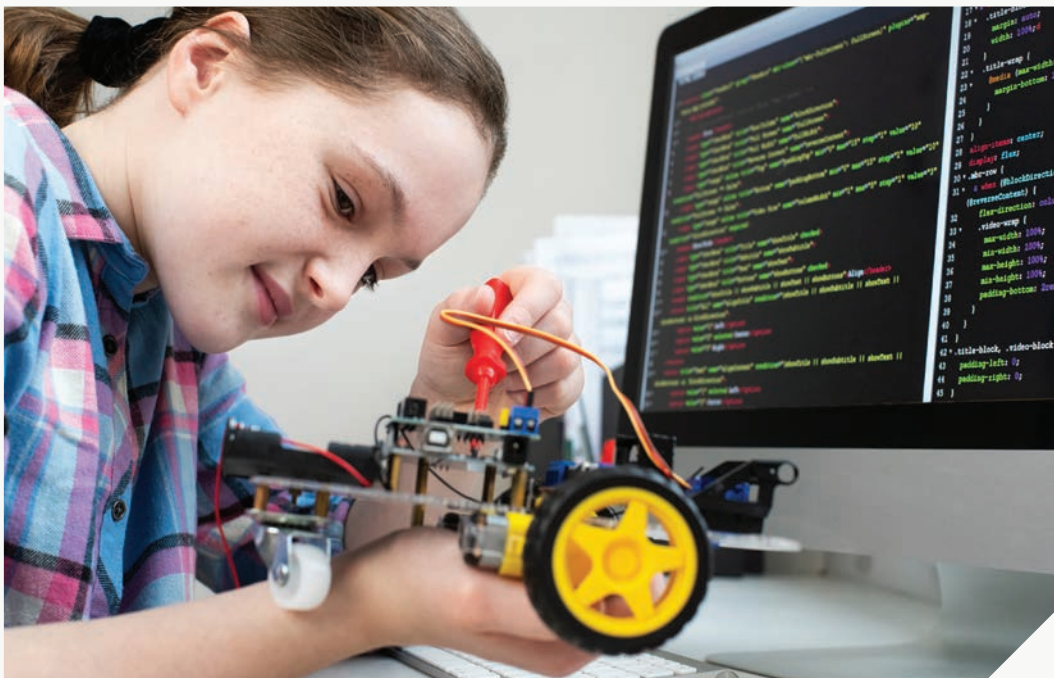
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## BUILDING THE STEM SECTOR OF THE FUTURE

For Australian innovation to thrive over the coming generations, we need to ensure that we have enough high-skilled workers who can rise to meet our future challenges. This must start early, in classrooms, to ensure our young people have access to the highest quality education possible. We must ensure that they are engaged and motivated to continue to learn and develop the skills necessary for success in our changing world. Building the next generation of STEM-skilled professionals will enable Australia to remain a world leader in innovation.

### Exciting and educating young people in STEM

Education is a transformative force for both individuals and their communities and builds a skilled workforce to face our nation's future challenges. It is crucial that every school student has an in-field teacher for STEM subjects and that teachers are supported to undertake professional development to continually improve their teaching practices and stay up to date with current issues and practices in STEM. However, less than a quarter of year seven to ten students have an in-field mathematics teacher, and 76% of Australian teachers describe their workload as unmanageable (Heffernan et al., 2019). It is essential the Australian Government supports and retains current teachers, while also working to boost the numbers of in-field teachers by incentivising more STEM students to consider teaching.



It is particularly important to support those teachers in regional, rural, and remote areas. The recent announcement of a National Teacher Workforce Action Plan and student loan reductions for teachers with four years of service in very remote locations is an important step in the right direction. Further incentives and supports are needed to ensure regional, rural, and remote teachers are resourced to deliver high-quality STEM education. Regional, rural, and remote students often have differing needs to their urban counterparts, and in-discipline teachers are often the sole teacher for that discipline at their school. Developing Communities of Practice between STEM teachers (particularly those in mathematics), community leaders and subject matter experts will enable connection between geographically isolated teachers, enabling the sharing and identification of the most effective strategies to improve pedagogy and provide additional opportunities for regional, rural, and remote students to engage with STEM.



Furthermore, while there are many resources available for teachers, they are often spread across different systems or are otherwise difficult to find and utilise. A single, one-stop-shop should be developed that brings together and builds various STEM teaching tools, to consolidate support resources into an easy to find and use system.

However, supporting current teachers will not resolve the shortage of in-field teachers. The Australian Government needs to do more to encourage those studying or holding STEM qualifications to consider careers in teaching, as well as increasing uptake of STEM education at a tertiary level. Universities must be incentivised to offer more STEM-based places to students. The Job-ready Graduates Program, implemented by the previous government, reduced student fees for STEM places to incentivise students to take these courses. However, the reduced revenue generated from these courses under the package creates a perverse incentive for universities to direct students away from critical STEM courses and into those that yield higher tuition fees (Norton, 2022). The commencement of the Australian Universities Accord process is a step towards resolving these misaligned incentives and cross-subsidisation from more profitable courses. ATSE looks forward to engaging constructively with the review. As part of this process, it is critical that the Australian Government fully funds the costs associated with teaching STEM courses.

Increasing the number of STEM places at university will both help to build the STEM skills sector and provide a greater pool for the recruitment of in-field teachers. Additionally, internship programs for teaching fields with shortages of in-field teachers, like mathematics, could help to encourage a greater number of talented people to enter the teaching profession by exposing undergraduate STEM students to teaching experiences.

**HIGH PRIORITY RECOMMENDATION**

The Australian Government funds the full cost of teaching undergraduate and postgraduate STEM courses.

**PRIORITY RECOMMENDATION**

The Australian Government develops and funds a Regional, Rural and Remote Mathematics Community of Practice.

**SUPPORTING RECOMMENDATIONS**

The Australian Government develops a paid internship scheme for undergraduate mathematics students to engage in teaching, with a particular focus on Regional, Rural and Remote areas.

The Australian Government develops a central hub for STEM teaching and careers resources.



### Developing a skilled STEM workforce

For Australia to be ready to face the nation's current and future challenges, it must have a highly skilled workforce that is targeted towards meeting the nation's demands and long-term requirements. Australia must be able to identify critical skills gaps and develop policy interventions accordingly. A single shared language around skills will help to facilitate this process and enable individuals and employers to articulate the skills they have and need, and support individuals to seek career transitions (Australian Academy of Technological Sciences and Engineering, 2022b). A single skills taxonomy could be led by Jobs and Skills Australia to ensure national coordination. Combining this taxonomy with a whole of workforce foresight study would enable key areas of skills shortages to be detected and addressed.

Reducing the underrepresentation of women in STEM (Office of the Chief Scientist, 2020) is one mechanism to address STEM skills shortages. In 2022, ATSE's Elevate scholarship program provided 50 scholarships, each worth up to \$82,000, to women commencing undergraduate and postgraduate studies in STEM, supported by the Australian Government. There were over 700 eligible applications for the 15 scholarships available for undergraduate students, indicating huge demand for the support for women entering STEM degrees. Expanding the availability of these undergraduate scholarships will help more young women and non-binary people who might not typically study STEM, particularly Aboriginal and Torres Strait Islander women, to begin a STEM career.

Once students have begun their STEM journeys we must continue to engage and excite students to continue their careers in STEM. For postgraduate research students, ATSE's IMNIS Ignite internships provide paid 3-month or 6-month placements for the next generation of STEM leaders with industry partners, creating career pathways and providing practical experience. This program not only benefits the students, but also helps to develop and consolidate connections between researchers and industry, benefitting both. Supporting and expanding this internship program will help retain students in STEM by exciting them individually and building Australia's national research and innovation capacity.

#### **HIGH PRIORITY RECOMMENDATIONS**

The Australian Government conducts a whole of workforce foresight study to identify emerging skills gaps and develop a national strategy for STEM.

The Australian Government develops and promotes a National Skills Taxonomy to align educators, government, and industry, with associated analysis and forecasting of skills supply and demand.

#### **PRIORITY RECOMMENDATIONS**

The Australian Government expands funding for Elevate: Boosting women in STEM scholarships.

The Australian Government provides funding to expand the IMNIS Ignite internship program.



## USING STEM TO SOLVE OUR NATION'S BIGGEST CHALLENGES

Having a strong STEM sector and workforce is needed not for its own sake but so that Australia can develop solutions to the nation's biggest challenges. Nowhere is this more evident than in addressing the increasing impacts of our changing climate. By utilising Australian technology and innovation, the nation can achieve the reductions in carbon emissions required to meet and exceed our international obligations.

### Climate change mitigation and adaptation

Australia needs rapid uptake of mature low-emissions energy generation technologies to make immediate deep cuts to greenhouse gas emissions and to reach or exceed the 43% target by 2030. Australia is well placed for the deployment of large-scale wind and solar energy generators, providing the most viable path to meeting the nation's emissions reduction target. This investment in energy generation needs to be coupled with investment in electricity distribution and energy storage (e.g. battery farms or pumped hydro). It is predicted that more than 10,000 kilometres of transmission lines will be required by 2050 to deliver firmed renewable energy to main grids (Australian Energy Market Operator, 2022).

In addition to prioritising near-term emissions reductions using proven technologies, the Australian Government should invest in research that supports the development of Australia's growing green energy industry. The [Australian Energy Transition Research Plan](#) released by the Australian Council of Learned Academies provides the Australian Government with a roadmap for the research required to best support Australia through the transition to a green energy economy (Australian Council of Learned Academies, 2021). Supporting the implementation of this research plan will focus Australia's researchers on addressing the nation's key challenges in the transition to a green energy future.

With a growing green energy sector, the electrification of passenger and commercial vehicles is a key opportunity to reduce ongoing carbon emissions across Australia. The reliability and maintenance of the supporting electric vehicle infrastructure will be crucial in determining the pace and extent of electric vehicle uptake. Investment is needed to expand Australia's network of charging stations, particularly in regional Australia to ensure uptake is not limited to city-based drivers. Crucially, this investment in electric vehicle infrastructure needs to be supported by common charging standards, to ensure the widespread useability of charging stations, and power generation, storage, and transmission infrastructure to support the growing demand on the electricity network (Australian Academy of Technological Sciences and Engineering, 2022c).

#### **HIGH PRIORITY RECOMMENDATION**

The Australian Government invests in near-term emissions reductions using proven technologies and strategically invests in emerging emissions reduction technologies to develop their economic viability.

#### **PRIORITY RECOMMENDATIONS**

The Australian Government implements the Australian Energy Research Plan developed by the Australian Council of Learned Academies.

The Australian Government invests in widespread electric vehicle charging infrastructure, supported by common standards and power supply infrastructure.

## REFERENCES

- Australian Academy of Science, & Australian Academy of Technological Sciences & Engineering. (2019). Women in STEM decadal plan. [www.science.org.au/womeninSTEMplan](http://www.science.org.au/womeninSTEMplan)
- Australian Academy of Technological Sciences and Engineering. (2022a). Diversity and Inclusion Toolkit. <https://www.atse.org.au/research-and-policy/publications/publication/diversity-and-inclusion-toolkit/>
- Australian Academy of Technological Sciences and Engineering. (2022b). Our STEM skilled future An education roadmap for an innovative workforce. <https://www.atse.org.au/research-and-policy/publications/publication/our-stem-skilled-future-an-education-roadmap-for-an-innovative-workforce/>
- Australian Academy of Technological Sciences and Engineering. (2022c). ATSE submission on National Electric Vehicle Strategy. <https://www.atse.org.au/research-and-policy/publications/publication/atse-submission-on-national-electric-vehicle-strategy/>
- Australian Council of Learned Academies. (2021). Australian Energy Transition Research Plan. <https://acola.org/wp-content/uploads/2021/06/acola-2021-australian-energy-transition-plan.pdf>
- Australian Energy Market Operator. (2022). 2022 Integrated System Plan for the National Electricity Market. <https://aemo.com.au/-/media/files/major-publications/isp/2022/2022-documents/2022-integrated-system-plan-isp.pdf?la=en&hash=D9C31A16AD6BF3FB2293C49AA97FE1EA>
- Australian Parliamentary Library. (2022). Budget Review April 2022-23. [https://www.aph.gov.au/About\\_Parliament/Parliamentary\\_departments/Parliamentary\\_Library/pubs/rp/BudgetReview202223](https://www.aph.gov.au/About_Parliament/Parliamentary_departments/Parliamentary_Library/pubs/rp/BudgetReview202223)
- CSIRO. (2021). Quantifying Australia's returns to innovation. <https://www.csiro.au/en/work-with-us/services/consultancy-strategic-advice-services/CSIRO-futures/Innovation-Business-Growth/Quantifying-Australias-returns-to-innovation>
- Engineers Australia. (2022). Strengthening the engineering workforce in Australia. <https://www.engineersaustralia.org.au/publications/strengthening-engineering-workforce-australia>
- Heffernan, A., Longmuir, F., Bright, D., & Kim, M. (2019). Perceptions of Teachers and Teaching in Australia. <https://www.monash.edu/perceptions-of-teaching/docs/Perceptions-of-Teachers-and-Teaching-in-Australia-report-Nov-2019.pdf>
- Norton, A. (2022, June 6). The inequity of Job-ready Graduates for students must be brought to a quick end. Here's how. The Conversation. <https://theconversation.com/the-inequity-of-job-ready-graduates-for-students-must-be-brought-to-a-quick-end-heres-how-183808>
- OECD. (2022). Main Science and Technology Indicators, Volume 2022 Issue 1. <https://doi.org/https://doi.org/10.1787/4db08ff0-en>
- Office of the Chief Scientist. (2020). Australia's STEM Workforce. [https://www.chiefscientist.gov.au/sites/default/files/2020-07/australias\\_stem\\_workforce\\_-\\_final.pdf](https://www.chiefscientist.gov.au/sites/default/files/2020-07/australias_stem_workforce_-_final.pdf)

# Australian Academy of Technological Sciences & Engineering (ATSE)

**ATSE is Australia's foremost impact network for leading applied scientists, technologists and engineers.**

Our Academy celebrates excellence in science, technology, engineering and mathematics (STEM) by appointing prestigious Fellows, awarding upcoming innovators and equipping the next generation with skills to build a better Australia and world.

We are an authoritative and independent voice to government and our world-class STEM career programs demonstrate how to tackle our most urgent challenges. Delivering frank, fearless and evidence-based policy advice to government and industry we help drive a technology-powered, human-driven future.

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