ATSE

SUBMISSION TO THE

Vision for a Science Nation Consultation Paper

JULY 2015

AUSTRALIAN ACADEMY OF TECHNOLOGICAL SCIENCES AND ENGINEERING (ATSE)

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ATSE Submission
to the
Consultation Paper: Vision for a Science Nation – responding to *Science, Technology, Engineering, Mathematics: Australia's Future*

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The Academy appreciates the opportunity to provide comments and input on the *Vision for a Science Nation* Consultation Paper.

Strong economic growth was a key objective adopted by all G20 members at their recent Brisbane meeting. To achieve this in Australia we can no longer rely on an appetite for our resources overseas and urgent attention must be given to fostering other sources of growth, including major improvements in productivity in existing industries and innovation to develop new products and services. The *Vision for a Science Nation* Consultation Paper correctly identifies the need for improved competitiveness underpinned by improved STEM education, research and international engagement.

While ATSE in general supports the sentiments expressed in the Paper, the Academy also suggests stronger recognition of the integral part STEM plays in growth, and more robust measures for improvement. ATSE recognises that there are budget constraints, but these will persist until there is improved economic growth. Resources applied to STEM initiatives need to be regarded as an investment in future growth, not just recurrent expenditure.

Just as enhanced engagement and collaboration between researchers and industry will boost innovation, better collaboration across Australia's science, research and innovation systems and players, at all levels of government, institutions and enterprise, will boost capability and capacity for sustained science and technology-driven productivity.

Enhanced innovation-driven productivity linked to clear industry sector roadmaps for diversification and growth will directly lead to profitable companies, global competiveness and economic wellbeing accompanied by enhanced social and environmental benefits for Australia.

As such, ATSE very much welcomes the Government's intention to develop its final response as a whole-of-government integrated policy in consultation with the Commonwealth Science Council. The Academy stresses that these plans and strategies must be backed by a commitment to increased investment in STEM, both by the public and private sectors, to achieve maximum impact.

While ATSE has provided some specific comments on the Consultation Paper below, the Academy is conducting ongoing work on how Australia's science, research, innovation and industry strategy can best be integrated and coordinated. This work will build on ATSE's 2013 Science & Technology Policy Statement, which called for a national science & technology strategy. ATSE is pleased to see this recommendation being adopted by Government, and notes that much of our current work addresses the overarching policy framework and engagement strategies alluded to in the Consultation Paper, including a practical approach to achieving overarching linkage across the main aspects of our science, research, innovation and industry system.

It is vital to better connect our science and research system; our innovation systems (including incentive programs) and industry development and trade policies. Without this connectivity and overarching vision, silos of policy initiatives will not be able to realise the full potential of efforts or investment. ATSE looks forward to seeing the Government policy developed from the Consultation Paper and hopes that this will provide the much needed linkages between the four areas discussed in the Paper. ATSE remains committed to helping embed science, technology and innovation as crucial components in improving Australia's prosperity and looks forward to continue to work with the Government on this important endeavour.

Dr Margaret Hartley FTSE
Chief Executive Officer

1. Australian competitiveness

STEM: Australia's Future recommends that the Government

- *Establish an Australian Innovation Board to draw together existing Australian programmes and target research and innovation effort.*
- *Support the translation and commercialisation of STEM discoveries*
- *Accelerate the integration of STEM experts into industry, business and public sectors*
- *Promote an entrepreneurial culture*

Government Response

The Government states that it aims to make our industries more innovative and internationally competitive by embedding STEM in all levels of the Australian economy. To this effect it correctly identifies the need to improve:

- performance on key global measures of competitiveness, entrepreneurship and innovation;
- the proportion of Australia's STEM experts that work in industry, business and the public sector outside of universities;
- the ability of Australian businesses to produce new-to-market innovations on a larger scale as a result of working with STEM experts; and
- business pathways to global supply chains.

ATSE agrees with the identified priority tasks and notes the related activities already underway to place science at the centre of industry policy including:

- **National Science and Research Priorities**
- **Industry Innovation and Competitiveness Agenda**
- **Industry Growth Centres Initiative** – 5 Industry Growth areas – identifying knowledge priorities & articulate the kind of research and innovation each sector needs
- **Entrepreneurs' Programme**
- **Prime Minister's Prize** for the commercial application of science from 2015.
- **Export Market Development Grants Scheme (**SMEs)
- **Significant Investment Visa** and new **Premium Investor Visa** arrangements
- **National Survey of Research Commercialisation** measuring commercialisation activity in Australian publicly funded research organisations.

However, the Academy stresses that each of these activities alone cannot generate the step change Australia needs to return its industry sectors to one of high profitability and competitiveness, creating jobs and wealth for Australia.

Further, while highly supportive of the Growth Centres being a "catalyst" to bring industry together to build bold visions for growth and new markets (both domestic and global), the challenge will be in creating a common vision of the future pathways, as many industries have a diverse set of possibly competing players who are often siloed or narrowly focussed. There are good examples where pre-competitive cooperation has seen some industry sectors (e.g. agricultural sectors such as grains and beef) develop strong markets internationally with world class reputations for reliable and quality product. The successful industries invariably have had strong research and development focuses, used innovation to drive growth, used Australia's regulatory system as a marketing advantage, and de-risked commercialisation through co-operative development of supply chains and manufacturing and marketing, both with Australian and overseas partners. This model needs to be expanded and well supported.

The National Science and Research Priorities are to be commended and ATSE supports the establishment and ongoing use of such a priority framework to guide investment in research in the public sector. ATSE believes that the nine priorities are too wide for simultaneous high level priority action on commercialisation, and that, like the Industry Growth Centres, a smaller number of areas should be identified for intensive research translation and

commercialisation efforts. As such, ATSE supports the first set of highest priority areas being reflected in the research and development needs of the five industries with Growth Centres.

ATSE welcomes the intention to review the role of the **Innovation Australia Board** (IAB).

This is a vital and timely reform. The IAB**,** as an independent statutory authority, would provide a whole of Government overview of the translation of science and research towards technology and innovation led industry applications and new products and processes.

ATSE strongly supports the proposal that the Government amends the responsibilities and membership of the IAB to address and lead on Australia's science and innovation priorities.

ATSE recommends that the principal roles of the IAB should be to identify impediments companies face when they attempt to innovate and to administer programs developed to provide support for innovation. Together with the Commonwealth Science Council (CSC) and the National Science, Technology and Research Committee (NSTRC) the IAB has a role in ensuring the Government's strategy and priorities for research and innovation are coherent and mutually reinforcing, and to suggest ways to connect national challenges and priorities with innovative ideas from industry.

ATSE suggests that to enhance the whole of policy framework and monitoring of industry research translation and innovation and productivity, consideration should be given for the key independent expert advisors that constitute the CSC to meet with the IAB and the Industry Growth Centres Advisory Committee (IGCAC), ideally twice per year (and/or the Chairs meeting quarterly). This would provide a mechanism for key independent stakeholder advisers to Government to "take readings on" the effectiveness of the suite of policies and related programs against set performance measures/targets, noting the need for long term policy frameworks and program funding.

ATSE sees this enhanced engagement between CSC, IAB and IGCAC experts as important to link the policy strands that relate to connecting science, research, innovation and technology with industry, jobs and skills, as well as national business operational frameworks (such as tax, noting the government reviews underway at present; workplace relations; and regulation) and internationally (exports and trade). It will be important that these bodies include members with the detailed industry or technical experience required for high quality evaluation and management of the programs.

Engagement & collaboration

Small business solving national challenges - Growing innovation skills in Australia's small and medium enterprises (SMEs) is a key initiative, as is ensuring our larger companies are also committed to innovation.

ATSE agrees that Australia should foster growth in SMEs by encouraging them to innovate.

Currently some 80 per cent of industry in Australia is SME-based, but this sector only accounts for about 20 per cent of the use of the R&D Tax Incentive program. Therefore programs to enhance innovation of SMEs need to be targeted to those who seek to grow, particularly in priority industry sectors.

ATSE agrees that programs to enhance SME innovation are important and encourages the measures to this end discussed in the Paper. Many studies have shown that Australia is poor at researcher-industry engagement, and this is particularly true of SME-researcher engagement. A notable exception to this has been the CRC Programme, which in its 25 years of operation has seen over 1000 SMEs become engaged in research and its uptake. The lesson learned from the experience with CRCs is that measures to enhance innovation in SMEs need to be tailored to specific industry requirements and are often best managed by intermediaries with specialist skills rather than researchers themselves. There are also a number of international program initiatives that have boosted researcher-industry engagement, research translation and innovation that could be adopted in Australia.

A successful program funded by the Australian Government, in partnership with the European Commission, is the CAESIE (Connecting Australian Europe Science and Innovation Excellence) system of priming grants. ATSE administers these small grants, which are designed to support potential SME-researcher partnerships in exploring the viability of an intended research and development (R&D) collaboration or technology solution. The priming grants stimulate the intensification of joint researcher-SME engagement and innovation by reducing the financial risk of each partner entering a collaboration proposal. CAESIE priming grants are innovative in that they are modest in cost, flexible, have minimal amounts of red-tape and simple reporting requirements.

ATSE encourages the Government to develop approaches and similar programs, especially those that that pick up from current successful program examples nationally (e.g. industry-researcher engagement (voucher) programs) as well as exploring proven models from overseas. A key feature of success in many overseas programs is consistent funding over relatively long periods of time.

ATSE has developed a metric for measuring researcher-industry engagement, Research Engagement for Australia (REA), which can be implemented alongside many of the Government's planned reforms (see Section 3 below).

The Australian Council of Learned Academies (ACOLA) has completed a suite of research reports relating to these topics, including *The Role of Science, Research and Technology in Lifting Australia's Productivity* (2014), and will publish further report findings later in 2015 on a range of international best policy and practice models to drive researcher-industry engagement, research translation and commercialisation, entrepreneurial skills, and business innovation skills.

Intellectual property (IP) reforms are noted, and simplified processes within a modernised scheme will be welcome. With respect to universities and IP, there is much anecdotal evidence that viewing IP instruments as endpoints in themselves is perhaps preventing a greater outcome – that of strong and ongoing university-industry engagement with improved research translation and commercialisation outcomes. There are many examples internationally where universities have secured significant ongoing industry support funding in the absence of restrictive IP agreements.

2 Education and Training

STEM: Australia's Future recommends that the Government:

- Support the national interest by maintaining the pipeline of STEM graduates, and increase the recognition of STEM education and careers as a public good
- Lift the number of qualified STEM teachers
- Provide all pre-service and in-service STEM teachers with training and professional development opportunities to deliver contemporary science using contemporary pedagogy, with a focus on creativity and inquiry-based learning — more like science is practised
- Ensure active scientists, technologists, engineers and mathematicians are involved in the delivery of content in pre-service STEM teacher education courses at university
- Develop science literacy in schools
- Use curricula and assessment criteria, from primary to tertiary levels, to promote the development of long-lasting skills — including quantitative skills, critical thinking, creativity, and behavioural and social skills — in parallel with disciplinary knowledge
- Ensure that changes to the Australian Curriculum do not diminish the place of STEM
- Ensure that the skills of STEM graduates are aligned with workforce needs
- Increase the uptake of STEM across the workforce
- Facilitate community engagement with STEM
- Increase communication between STEM practitioners and the community

ATSE supports the recommendations and notes the Government's response to enhance science and maths literacy in the community, the quality of STEM teaching and the quality of science and maths teacher training in particular, through a range of initiatives.

ATSE has identified the following priority set of actions

1. Governments should commit to increasing the amount of time spent teaching quality STEM subjects in our schools.
2. Governments should commit to a national goal for the elimination of out-of-field teaching in STEM in Australian secondary schools.
3 The university sector must improve secondary science and technology teacher education, and provide broader attribute training in undergraduate and post graduate STEM courses across Australia.

ATSE has eight years of practical experience in developing and implementing a national program of STEM teaching that aims to make teaching of physical sciences, chemistry and maths easy and relevant and thus fun and meaningful to learn. An outline of the ATSE Science & Technology Education Leveraging Relevance (STELR) Program is provided in Attachment 1. The STELR program specifically addresses the negative student perceptions of science and maths, assists teachers (especially those teaching out-of-field) to enhance their science and maths teaching, and focusses on enquiry-based learning with robust, world-class resources, especially in poorly resourced, disadvantaged, rural and remote, and indigenous schools. STELR is a national program in over 460 schools, with 17 topic learning modules across years 6 to 10, covering physical, earth, space and chemical sciences and maths with over 160 lessons that are fully compliant with the Australian Curriculum and are

endorsed by all State and Territory education departments. Some 150,000 students per year experience STELR.

ATSE notes that many of the proposed policy and program approaches flagged in the Consultation Paper remain extracurricular in nature and call for more engagement of already busy teachers (often outside of regular class teaching). ATSE urges caution in this approach. It is critical that these initiatives be seen as secondary to a general improved approach to teaching and learning science and maths at schools, as part of the regular curriculum.

ATSE urges a more systemic solution that focuses on enhanced science and maths teacher quality through better teacher training, relevant and authentic learning through enquiry-based problem solving approaches to teaching students, and providing enhanced career information on science and technology based industries. These fundamentals must be in place to fully capitalise on other programs such as mentoring and scientists in schools. Of particular importance are initiatives focussed on improving the quality of new teachers entering the profession.

3. Research

STEM: Australia's Future recommends that the Government:

- Adopt a long term plan for science and research
- Develop and implement strategic research priorities
- Support research careers, including collaboration with industry and business
- Enhance dissemination of Australian STEM research by expanding open access policies and improving the supporting infrastructure
- Provide support to encourage and enable quality research to respond to problems identified by industry

ATSE welcomes the Government's aim to build a strong STEM research enterprise that adds to our understanding of the world and to our competitiveness as a country. It will build a framework under which existing and new programs will operate. ATSE agrees that this will involve:

- long-term stable investment in science and research, including infrastructure;
- national science and research priorities, and identified pockets of research excellence outside these priorities, being backed by appropriate resources ;
- increased number of people using research in business and the community beyond academia; and
- rankings for quality of research output and collaboration that compare favourably with the highest performing countries.

Connecting industry to research solutions

ATSE notes that:

- Nine Science and Research Priorities have been established (see comments on section 1), which will be reviewed every 2 years;
- the review of research infrastructure is due to report shortly;
- the CRC Programme has been continued and refocussed, post the Miles Review;
- the ARC Industrial Transformation Research Program funds research hubs and training centres & supports higher degree student placements in industry; and
- ACOLA has been commissioned to conduct a review of the Research Training System.

ATSE strongly supports the Government developing a 10 year national science and research vision. A 10 year outlook for research and research infrastructure is perhaps the central platform on which all other proposals and ideas of the *Vision for a Science Nation* Consultation Paper will sit, and will indeed ensure the success of the research, innovation

and commercialisation policy framework.

ATSE supports an ongoing **Future Fellowships scheme** that supports mid-career researchers, particularly in STEM fields.

Medical Research Future Fund – ATSE agrees with the Government that future discoveries in medical research will contribute to improving the health and wellbeing of all Australians. ATSE also believes that such discoveries in medical research require translation into medical services, technologies and devices. This may be achieved through established or start-up firms that will gain commercial benefits, grow the sector, create jobs and ultimately strengthen the economy.

The MRFF is an opportunity to consider specific investment in multidisciplinary, project-driven research. Today's healthcare system is technology dependent, and many of the future advances will depend not only on medical expertise but on collaborative contributions from engineers, computer scientists, physicists and chemists. Such research has high capacity for translation of research and innovation into end use products and processes.

Funding should support the commercialisation of medical technologies from medical research institutes, universities and start-up firms.

The key to maximising economic benefit from medical research is to ensure the MRFF harnesses all of Australia's medical research expertise and that clinical and market based outcomes are specifically pursued. To achieve this, MRFF funding allocations will need to be competitive, assessed by expert review and merit based.

ATSE suggests that **at least 50 per cent** of the MRFF funds allocated to research be allocated for translational clinical trials and for project-driven multidisciplinary research (e.g. development of a bionic eye, limb prosthetics and other medical devices). This will ensure the Fund promotes not only improved health outcomes for all Australians but will also foster enhanced researcher-industry engagement, a highly skilled and innovative workforce, and profitable and competitive companies in the biomedical, medical technology and devices sectors.

Research Careers – ATSE welcomes all efforts to ensure our world class research workforce remains well trained, innovation-ready and – importantly – "industry-ready". The enhanced engagement between publicly funded researchers and Australian industry is critical to see more translation of knowledge, more application of innovation within Australian businesses and enhanced science and research skills within businesses.

Incentives for recognising or gaining industry relevant experience are an important and much needed advance. The first step is to supplement the quality system that research academics are currently valued against, Excellence in Research Australia (ERA).

ATSE acknowledges the value of the ERA as a robust quality measure of research excellence but sees it as important that the Australian Government, and the community more broadly, receive a measurable return on investment in research beyond just the research itself. It must be translated into community and commercial benefit.

ATSE believes it is vital to reward activities by researchers directed at innovation and has spearheaded an approach to change the way Australia values research.

There is growing acknowledgement in government and industry that the ERA model – currently the only accepted measure of research 'quality' – cannot adequately encourage research commercialisation or other translation into community benefit.

ATSE REA Model

To drive policy thinking towards a more balanced approach, ATSE has produced a major

report, *Research Engagement for Australia (REA)*, which proposes to reward research *engagement***,** under the REA banner, alongside research *excellence*, via ERA.

The key principle is to use the amount of income from industry and other research end-users as a measure of research engagement. ATSE believes that use of the REA metrics will help to increase the return on the public investment in research in science, technology, engineering and maths (STEM) and humanities and social sciences (HASS) alike. Importantly, the metrics are calculated for disciplines within universities (by Field of Research code), so that comparisons are made between universities, not between disciplines.

REA will foster collaboration and knowledge exchange – and encourage research translation and impact.

Initial trials show that the resulting REA metric is a simple, robust measure of research engagement, based on data already collected by the university sector, which can be applied within the various research disciplines.

ATSE would be pleased to work with the Government to introduce an REA metric, and believes the exercise of determining such a metric would modify behaviour within the university sector and encourage research collaboration and uptake by industry and other end users.

ATSE Research PhD-Industry Mentoring

ATSE is now piloting a program of industry mentoring for science and technology PhD students. The Industry Mentoring Network in STEM (IMNIS) is a national mentoring program, directed at linking PhD level (2nd year and above) students to individual industry based mentors, who can provide advice and role models for industry based STEM careers.

IMNIS will raise awareness of the value of research-industry engagement and collaboration, whether participants opt for a career in research/academia or in industry. Both outcomes will contribute positively to the need for Australia to enhance industry engagement and collaboration and the commercialisation of research to boost productivity and prosperity.

Two pilots are running in 2015, each for duration of at least six months. The purpose of the pilot stage is to allow development of all aspects of the IMNIS program on a small, controllable scale. Experience gained in the pilots, along with the outcomes as measured by surveys of students, mentors, coordinators and champions, will facilitate the next stage of IMNIS development.

ATSE is using its extensive industry networks to source mentors and universities to pilot the program for students. It is the Academy's experience that there is a real demand for such programs. Further information on IMNIS is provided in Attachment 2.

4 International Engagement

STEM: Australia's Future recommends that the Government:

- Adopt an international strategy for science, research and education
- Establish a fund for strong government-to-government linkages as a basis for international collaboration
- Unlock flows of knowledge and research talent
- Leverage STEM in international diplomacy

ATSE strongly supports the Government's key aims in addressing this recommendation – namely to leverage international STEM engagements to Australia's advantage. This means Australia needs to:

- engage in a highly targeted manner in bilateral and multilateral partnerships to address shared priorities and challenges;
- provide significant resources to these partnerships in order to gain real benefits for Australia; and
- as a result, increase the strategic participation of our researchers from both the public and private sectors in international collaborative networks and projects.

ATSE notes and welcomes the activities already underway:

- developing a **National Strategy for International Education** to be finalised in the second half of 2015
- the **New Colombo Plan** (NCP) deepening Australia's relationships in the Asia Pacific region and enhancing both institutional and personal links between Australia and Asia, leading to generational change in these relationships. However, it is noted that while the NCP includes science and technology activities, that is not its focus.
- **intergovernmental Science and Technology relationships** with selected countries fostering collaboration (researcher to researcher; institution to institution, and importantly researcher to industry). Only three specific **bilateral funds** exist, namely:
    - Australia China Science and Research Fund
    - Australia India Strategic Research Fund
    - Connecting Australian and European Science and Innovation Excellence.

This leaves some major gaps, of which Australia's limited relationship with the European Union is particularly conspicuous. The EU Framework Programs have supported a large number of major projects where appropriately supported Australian participation would have provided significant benefits for Australian researchers in business and in the public sector. Without adequate means to support such activity, Australia is left to catch up with other countries. The current bilateral funds are inadequate if Australia is to truly realise the innovation dividend from its investment in science, research and innovation.

National Policy Framework

ATSE has identified the follow key issues:

- International science, research and innovation engagement is a long-term investment that needs to be culturally sensitive and developed at the personal, institutional and diplomatic levels.
- The effectiveness and efficiency of international cooperation is enhanced when programs are aligned with national priorities (e.g. the National Science and Research Priorities).
- Australian engagement needs to be global in scope, but it also needs targeted activities to strengthen ties with Asia where economies and technological innovation capabilities are growing rapidly.
- Government needs to utilise long-standing bilateral science and technology relationships through sustained funding of strategic collaborations.

In the past, the Australian Government had a long-term commitment to global engagement through bilateral and multilateral agreements, targeted dialogue with other countries and actively funding effective science and technology activities and research collaboration. This global network of science, research and technology collaboration has been shown to return value to Australia of at least 6-to-7 fold. While the ARC and NHMRC have increased the scope for international engagement in their grants, there is no evidence that this is resulting in targeted engagement with priority countries and the benefits to Australian industry are likely to be minimal. Foreign co-authorship of research papers is a growing phenomenon around the world, including in Australia. However, in relation to ARC and NHMRC-supported work, the extent to which this reflects real and significant research collaboration has not been demonstrated, to our knowledge.

The closure of the majority of global linkages programs in mid-2011 left only China and India as dedicated Australian science collaboration funds. Encouragingly, innovative programs

aimed at engagement between SMEs and researchers have seen a successful CAESIE program be developed and implemented with significant returns.

Australia needs to now establish wider world class international engagement in education, science and technology, and industry with specific focus on research-business-industry linkages, research-research linkages and alignment with Government policy priorities, such as maximising the benefits of recent Free Trade Agreements (FTAs). Business (including SME) engagement into these FTA specific markets is a vital step in creating and benefiting from science and technology-led innovation opportunities.

ATSE notes that the strength of our science, research and innovation depends in great part upon the effectiveness of our international engagement, which leads to:

- *assurance of international best-practice and enhanced quality: e*ngagement with overseas peers provides a significant level of assurance that our activities are well aligned with international standards;
- *building on national investment:* effective collaboration with overseas peers underpins a much larger effort and output than from an isolated national activity;
- *enhancement of international leadership:* Australian contributors to international activities have influence in global forums, influence that allows Australia to help set the international agenda for science, research and innovation and ensures that the international agenda includes issues of importance to Australia; and,
- *reduction in risk exposure to commercialisation and application of new technology:* partnerships with large overseas companies allow Australian businesses (including SMEs) to overcome the challenges of commercialisation in the global market.

These benefits apply to all aspects of science and technology activity, from research and development to marketing. Innovation and product development in Australia needs to be aimed at global markets more than ever before.

A Global Plan for a Global Economy

ATSE supports the vision for a long-term global strategy for science, technology and industry engagement. The Plan needs to identify the country partnerships that will assure Australia's global position and the new partnerships that will afford Australian research and business new opportunities in the future. A strategy can identify targeted actions aligned with Government priorities.

The proposed international engagement strategy needs to be underpinned by significant funding, in the order of $100 million. To attract high quality international researchers and business, such a Plan initially requires significant support from Government as this scale of investment will not come from industry alone. Further, while providing seed funding is an important first step, the availability of significant funds to support follow-up activity will be essential. Without the availability of such funding, the seed-funded projects will only raise expectations that cannot be fulfilled.

Building and maintaining government-to-government linkages

ATSE very much supports and welcomes the Government's commitment to build on existing linkage activities to **establish a global science and innovation collaboration program** to build international STEM collaboration with priority countries on shared interests. The program must align with the National Science and Research Priorities and the Industry Innovation and Competitiveness Agenda.

ATSE welcomes the innovation of shifting international collaboration programs towards more strategic researcher to business/industry engagement within priority areas. ATSE welcomes initiatives that:

- support Australian businesses and researchers to make international research connections with priority partner countries;

- provide voucher-style support for international exchanges for businesses, including SMEs, to work with researchers; and
- provide seed funding for Australian business research consortia to work globally.

These approaches would complement larger scale funding initiatives outlined above in the Global Plan and will enhance Australia's competiveness.

ATSE also supports the concept of **a science diplomacy strategy** that promotes international understanding of Australia's science, research and innovation capabilities. The strategy would complement Australia's international science engagement strategy and wider diplomatic efforts, including work to promote research and to promote Australia as a partner and destination of choice for education, training, and research. Initiatives under the strategy could include:

Bilateral agreements
Bilateral collaborations are a key mechanism for driving economic prosperity. Research-business partnerships will deliver better research, better technology and better business opportunities for Australia. These partnerships are very effective at the pre-competitive stages of research and innovation, where broad collaboration promotes the identification and solution of specific challenges. Enhancing bilateral arrangements is an important mechanism to attract investment into Australia. However, bilateral agreements serve no useful purpose unless they are backed with the necessary support to deliver significant outcomes that are beneficial to both parties.

Commercialisation
International partnerships provide an effective mechanism for enhancing research-industry collaboration leading to commercialisation and application, especially with countries that have FTAs with Australia.

Using the Learned Academies
ATSE and the Australian Academy of Science have cordial relations with their equivalent learned academies in most of the countries where mutually beneficial scientific collaboration could be established. These academies have networks behind them covering a very broad range of science and technology disciplines, far more extensive than would be readily accessed by government-to-government relationships. Furthermore these academies are essentially volunteer organisations, so supporting them as the platform for collaborative activities such as conferences, visits and exchanges is particularly cost effective. ATSE is aware that many of our sister academies around the world are keen to foster greater mutual initiatives and many have resources able to be devoted to these, however the Australian academies remain somewhat limited in the support received to participate in joint collaborative activities.

Education and career development
The New Colombo Plan continues to be enhanced with linkages to industry mentoring and engagement. A strategic international science engagement plan supported by bilateral agreements linked to the New Colombo Plan would provide a basis for developing young Australian global leaders through international workshops and exchanges. This would advance the capabilities of scientists and engineers throughout their careers ensuring that our future research and industry leaders have substantial research, and research translation, networks and/or business linkages across the globe.

Asian Area Research Zone
ATSE agrees that Australia must work to create an opportunity to cooperate within its region to address challenges facing both Australia and our near neighbours. The Government should look to establish partnerships with countries with which we have FTAs and/or existing strategic research funds (i.e. China, India, Japan, South Korea). Where possible, these partnerships should focus on shared priorities, such as those identified in the Paper.

Countries in our region have already established networks to promote cooperation between members and one option would be to seek, over time, to join these arrangements. However, to do this first requires investigation of potential mutual benefits. It is not clear to ATSE what the modus operandi of an Asian Area Research Zone would be. The European Research Area is designed to assist achieving the objectives of the Treaty of Rome and may therefore not be translatable to our region. The Government would need to clearly articulate, to Australian and regional stakeholders, the aims of seeking to establish a regional research zone. With that said, ATSE supports the broad objective of aiming to improve regional cooperation on research and innovation.

ATSE recognises the enormous value of the Australian education and science counsellors in the 10 locations across Asia and suggests they would play a key role in leveraging STEM in diplomatic efforts and assist in establishing the research zones.

Australian Academy of Technological Sciences and Engineering (ATSE)

Attachment 1

Science and Technology Education- Leveraging Relevance (STELR)

ATSE STEM Education Priorities

The ATSE STEM Education Action Statement: *Advancing STEM Education* **was released in September 2013.** It made 3 recommendations, two of which were relevant for secondary schooling:

- **Governments should commit to increasing the amount of time spent teaching quality STEM subjects in our schools.**
- **Governments should commit to eliminating of out-of-field teaching in STEM in Australian secondary schools.**

These recommendations are in response to four major challenges facing Australia.
Challenge 1

- Sustainable wealth creation now and in the future will be driven by science and technology.
- Demand for STEM skills is clear:
- 75% of the fastest growing occupations require significant STEM knowledge and skills
- STEM-based employment is projected to grow at twice the rate of other occupations
- But 41% of current employers struggle to recruit STEM graduates - and the problem is worsening!

Challenge 2
Quality STEM education is essential to supply a skilled workforce to Australia's research and innovation system and for existing and emerging industries.

- So we need more effective policies and much stronger and targeted initiatives to support STEM in schools, ATSE is calling for:
- More teaching time on STEM subjects
    - STEM qualifications for STEM teachers
    - Better STEM teacher education
    - Hands-on, inquiry-based learning for STEM.

Challenge 3
There is a need to address the current problem of STEM in secondary schools including:

- Negative student perceptions of science and maths
- Students think science has no relevance to their lives
- Need to assist teachers who are teaching 'out of field'
- Poorly resourced schools.

These factors result in the ongoing decline in Year 12 STEM participation rates and the decline in uptake of tertiary STEM courses.

Challenge 4
In Australia, there is a low level of science literacy and a general mistrust of science at a time when national and global megatrends and challenges (e.g. climate change, environmental sustainability, population and resource utilisation) depend on science and technology solutions

STEM enhancement programs are universally extracurricular in approach - and 'preach to the converted' - i.e. there is no long term impact from short term activities that focus on the science 'whiz kids'

STELR (Science & Technology Education Leveraging Relevance) is a national secondary science education program.

It is hands-on and inquiry-based.
It provides purpose-built equipment and comprehensive teacher resources to schools.
Relevant contexts such as renewable energy and sustainable housing engage students and teachers.
It addresses major challenges in STEM education:

- Demand outstripping supply for STEM graduates
- Teacher training and resourcing of STEM subjects
- Low student enrolments in STEM subjects
- Low level of science literacy in the population.

iSME - inspiring Science and Mathematics Education

iSME is a federally funded program that is a part of the Australian Maths and Science partnerships Program.

iSME partners are Southern Cross University, the University of Wollongong, Charles Darwin University, ATSE and Stile Education.

The aim is to develop at least five new modules based on the STELR model. At the end of the two year program, the new modules will become part of the STELR offerings. The program aims to boost the numbers of students taking science and mathematics subjects at senior secondary level.

The new modules will use the cutting-edge research of the university science and engineering faculties and schools of education will ensure the latest pedagogies are utilised.

Each university has recruited four pilot schools each that will first employ the STELR Renewable Energy program and then trial the new modules.

iSME involves an evaluation of the new modules as trialled in the pilot schools and the setting up of a longitudinal evaluation to track the outcomes of the students that have experienced STELR modules.

The new modules will be classified as core and extension. They will have a careers element. They will be delivered to schools in digital format (word documents) and using the Stile web-based delivery and student management platform.

iSME will develop maths activities, activities adapted for indigenous students and activities for schools in southeast Asia. The sustainable housing module will be developed with input from the Indonesian QITEP (Quality Improvement of Teachers and Education Personnel) for Science and it will be translated into Indonesian.

ATSE manages the iSME partnership and the delivery of the new modules into schools.

ATSE approach – basis of STELR and iSME

STELR is designed to:

- Address STEM teaching and learning now Years 6-10
- Produce better trained and qualified STEM teachers
- Be taught within the curriculum and not be an extra-curriculum activity - in this way all students benefit from having quality STEM learning

- Make the ‘hard’ sciences (physics, chemistry, maths) easier to teach and fun to learn through real and relevant contexts, inquiry-based learning with hands-on activities
- Accommodate traditional and digital delivery - iSTELR is the web-based version of the STELR program delivered using the excellent STILE platform
- Emphasise relevant STEM careers

STELR aims to:

- Improve the level of science literacy and understanding in the community
- Improve the quality of science classroom teaching practice
- Prepare students to engage with science ideas and be knowledgeable about the way science and scientists work
- Provide a quality STEM experience for all (gender equity, indigenous, social equality, rural, remote or urban)
- Increase the numbers of students studying Maths and Sciences at Years 11 and 12
- Increase the number of students choosing science and engineering careers to address the shortage of science and engineering graduates
- Raise awareness of opportunities in technology-related careers

STELR philosophy:

- Cover the national curriculum for science and mathematics while still supporting individual curricula of local jurisdictions
- Use real-life contexts that are relevant and exciting for students such as global warming, renewable energy, sustainable housing and health and safety
- Provide purpose-built, Australian-designed and manufactured equipment to support the hands-on activities
- Cover areas of greatest need – for example physics chemistry and mathematics
- Curriculum content is modularised with core and extension activities/lessons
- Modules cover years 6-10, (once students have chosen to study STEM subjects in years 11 and 12 the courses are determined by the state authorities)
- Support teachers teaching out of field in years 6 - 10
    - Professional learning workshops
    - Teacher resources and manuals supporting the modules
    - Mentor support by local recently retired teacher experts
    - On-line pre and post testing
    - Prepared lessons in student books or online downloads
- Provide career profiles and have these embedded into each topic to provide a pull for students to study science and maths at year 11 and 12.

STELR history

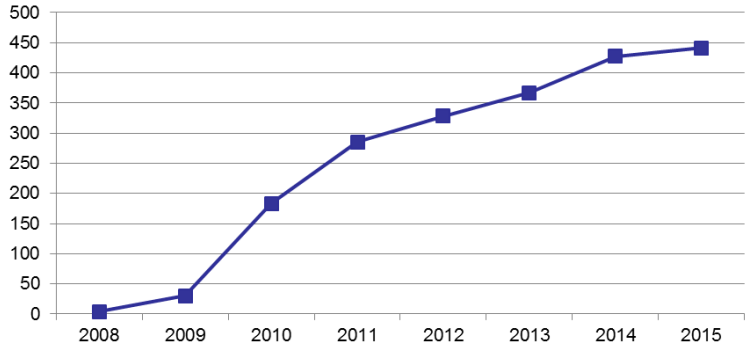
2007 - STELR was devised

2008 – Proof-of-concept phase with four schools in Victoria

2009 - Pilot program with 30 schools in QLD, VIC, TAS, SA and WA

2010 - 187 schools involved with funding from the federal government ($2M), corporate sponsors, philanthropic foundations and private donors – schools in all states and territories

2011 - Present There are now over 450 schools in Australia and New Zealand; funding is derived from corporate sponsors, universities, philanthropic foundations and private donations.



The number of schools running the STELR Renewable Energy program up to March 2015

State/Country	Number of schools (as at Mar 2015)
ACT	10
NSW	102
NT	20
QLD	91
SA	40
TAS	25
VIC	117
WA	30
NZ	6
Total	441

Students that have undertaken the program to March 2015

Year	STELR students per year	Cumulative total students participation
2008	400	400
2009	3000	3400
2010	18,300	21,700
2011	25,600	47,300
2012	29,500	76,800
2013	33,000	109,800
2014	38,500	148,300
2015 (estimate)	43,500	191,800
2016 (estimate)	48,500	240,300

2017 (estimate)	53,500	293,800

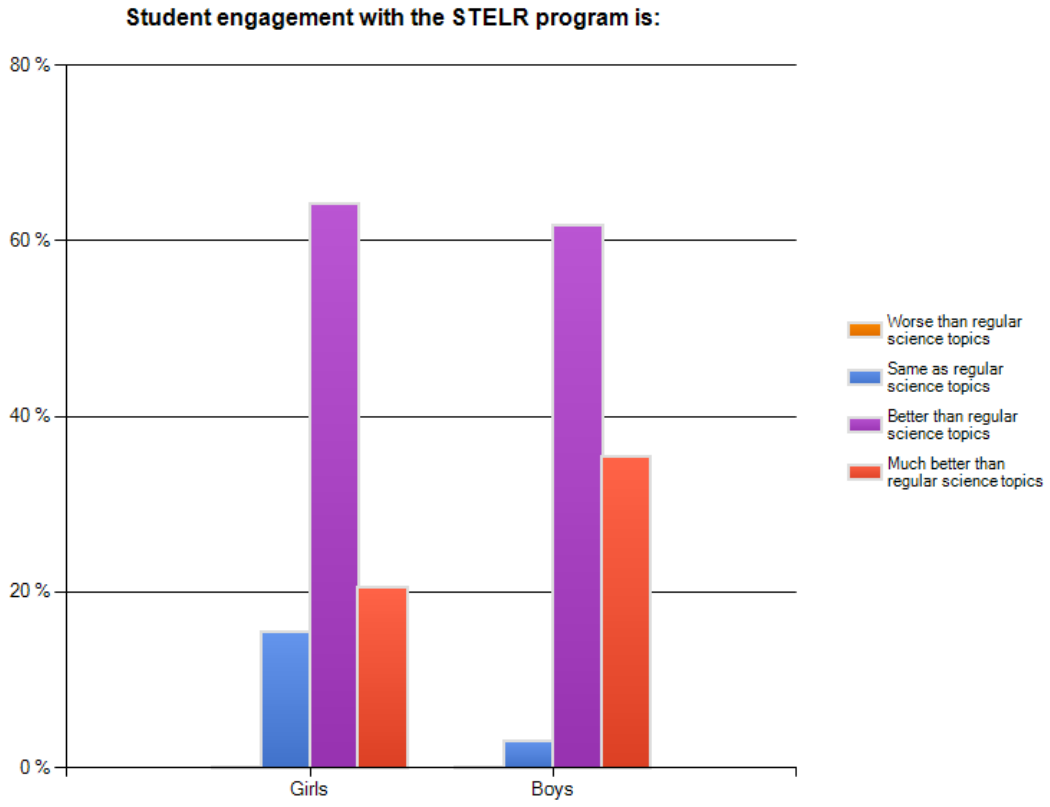
Funding

STELR has always been self-supporting.
Part of the corporate sponsorship is used to provide subsidies to schools (particularly disadvantaged, remote and rural and indigenous schools) to enable them to purchase class sets of STELR Renewable Energy Equipment.

STELR evaluation

Independent evaluation of the renewable energy package shows:

- Students are more engaged in STELR lessons compared with regular science lessons
- STELR teachers are more confident (PD training, mentors, teacher manual, step by step lessons)
- Increased enrolments in STEM at Year 11 in STELR schools
- STELR students more scientifically literate - even if not pursuing STEM in later years



iSTELR

iSTELR is the web-based delivery of STELR modules using the Stile Education platform.

- It encourages a 'flipped' classroom approach where students study theory at home and "unpack" knowledge at school.
- It operates on all systems – iPad, Android, PC etc.
- Teachers can fully edit module activities to suit the specific needs of their classes.
- Teachers are able to track student submissions, deliver tests and assignments and keep accurate student records. Students are able to upload videos, photos and whole multimedia projects.
-

Stile Education is also an authoring tool. Many STELR modules were developed using the Stile platform and then reverse engineered into word documents for schools that were unable to use the platform for all their classes.

Approximately 30% of STELR schools deliver the program using iSTELR.
Not all schools require students to bring their own devices

Australian Recognition

- All state education jurisdictions have provided funding to develop STELR curriculum packages.
- STELR has been promoted to schools by Catholic Education Offices and the Australian Council of Independent Schools. One Catholic Education Offices have purchased class sets of the STELR renewable energy equipment for all of its secondary schools.
- The NSW Education Department has purchased 11 wind energy kits to promote STEM education at a conference.
- ACARA has used STELR staff as consultants for the Design and Technologies curriculum.
- THE ACT Education Department subsidised schools to purchase
- ATSE is an Industry partner for the Deakin University ARC program *Using ICT to support teacher professional learning of digital pedagogies and inquiry science.* This program uses iSTELR as a major component of the research.
  Thirteen universities use STELR as an exemplar for training pre-service science teachers.

Future

New topics being developed in ATSE's curriculum class lessons include

- Sustainable housing (completed)
- Environmental geochemistry – water and food security
- Future health
- Mathematics (part completed)

The strength of the STELR modules is that they focus on areas of the science curriculum that teachers are least practiced on and where there is a lack of resources.

These are:

- Physical sciences (part of the Science Understanding strand)
- Science Inquiry Skills strand
- Science as a Human Endeavour strand

In addition the Australian Curriculum has three cross curriculum priorities:

- Aboriginal and Torres Strait Islander histories
- Asia and Australia's engagement with Asia
- Sustainability

And seven general capabilities:

- Literacy
- Numeracy
- Information and communication technology capabilities
- Critical and creative thinking
- Personal and social capability
- Ethical understanding
- Intercultural understanding

INDUSTRY MENTORING NETWORK IN STEM (IMNIS) AN OVERVIEW

THE CHALLENGE[1]

Collaboration between business and publicly funded research organisations (PFROs) is crucial to improving the translation of research into productivity. However, experience has shown that effective collaboration between business and PFROs can benefit from independent facilitation to build trust and to establish momentum between parties.

Further, OECD data shows that Australia consistently has one of the lowest levels of engagement between the academic and industry sectors despite the almost $9 billion investment by Government into the research, science and technology and innovation sectors. In addition for every $1 invested by Government in Australian public R&D, business invests $2 in business R&D.

In Australia only 30 per cent of PhD students take up work opportunities in either industry or government. In the USA, Europe and Asia this figure is generally over 70 per cent.

It is well recognised that a scientific education provides knowledge and skills that are valuable in many careers. Indeed studies have suggested how Australian universities can best prepare their STEM graduates to take up roles in the wider economy, as well as in academic research. This included activities that increased collaboration between industry/business, professional bodies and universities.

IMNIS arose from the consideration of what type of activity, if sustained and replicated across Australia, might start to shift the culture of academic - industry interactions? IMNIS capitalises on the value of mentor relationships and the power of networks.

Having experienced individuals in translating research in STEM based Australian industries being willing to share their experiences with PhD students undertaking research studies in science and technology is seen as a mechanism to enhance research-industry engagement as well as expose bright research students to the existence of broader career options just as or more rewarding as one in academia.

While mentoring programs and other course related industry placement schemes exist already (see Appendix A for examples), they are usually course and institution specific. IMNIS aims to establish in the longer term a sustainable national industry mentoring network system to complement these existing activities.

[1] Source documents:

Science, Technology, Engineering and Mathematics in the National Interest: A Strategic Approach. A Position paper July 2013, Office of the Chief Scientist.
The Changing PhD. Group of Eight Discussion paper, March 2013.
STEM Education and the Workforce. Office of Chief Scientist Occasional Paper Series Issue 4 September 2012

Top Breakthrough Actions for Innovation. PMSEIC, December 2012

ATSE international Workshop Series report May 2011. Strengthening links between industry and Public sector Research organizations

The advantages of the IMNIS concept compared with existing programs, is that it will be:

- scalable across Australian universities and all STEM based industry sectors;
- capable of involving large numbers of PhD students;
- have a relatively low operational cost per student; and
- able to capture the goodwill of the significant numbers of industry professionals who wish to give back to the STEM community.

It is difficult to find definitive data on the number of STEM PhD students in Australia.

Further, definitive data on the number of STEM based PhD students are lacking. Best available data indicate that there are around 45,000 PhD students enrolled in AustralianUniversities and that we graduate 7,000 students per year. Even assuming the average PhD takes over 4 years and that not all students graduate it is hard to align these numbers - although a 40 per cent attrition rate for those students studying a higher degree by research has been reported[2].

It is not unreasonable to conclude that there is population of about 5,000 STEM based PhD students.

Target Groups

An ultimate target of recruiting 10 per cent (500 students) of STEM PhD students to be enrolled in IMNIS nationally is envisaged, with a matching 500 industry based mentors. Students should see the program as being highly prestigious, competitive and providing them with tangible benefits.

The mentors are recruited as individuals who have strong industry backgrounds and commercialisation knowledge. While companies may support/encourage individuals to be mentors, IMNIS is not an industry placement or recruitment program.

IMNIS will be developed via a staged process, with small scale Pilot studies being implemented in the first instance. The results of these pilot studies will be used to shape and refine as needed the ongoing IMNIS program.

A pre-condition for success of the program is enlisting the support of strong champions within the involved parties:

- **Identification of State Champions**. Using the ATSE Fellows and network the aim is to identify individuals who would be willing to help recruit Mentors within industry sectors at a State level.
- **Industry Sector Champions**. It will be important to engage with the key opinion leaders within industry sectors at both a National and State level. If these people are willing to get involved others will follow their lead. Industry professional associations will be another source for both support and coordination of activities.
- **Key Contacts at Individual Univer**sities. While we expect that universities who wish to be involved in the program will allocate resources within their Graduate Studies departments, we will still need support and advocacy from senior University personnel.

Governance

Steering Committee

ATSE has established an IMNIS Steering Committee that will provide program oversight and expert guidance to the IMNIS Project. The Steering Committee members will:

- use their networks and experience to assist the Project Team in identifying local IMNIS champions;

[2] Office of Chief Scientist (2012) *Health of Australian Science*. Australian Government Canberra.

- Assess the efficacy of IMNIS at its various stages from Pilot to full national scale program, including consideration of metrics of success;
- advise on the identification of IMNIS Mentor Champions in Universities and Industry;
- Post Pilot Program assessment ;
- Assess long term viability of expanding IMNIS into a national program covering a broad range of STEM fields of study.

The Project Team

The IMNIS project team are responsible for the development and delivery and administration of the various stages of the Project commencing with the Pilot activities in 2015. The Project Team (supported by ATSE and the Steering Committee) will in the first instance use a staged approach of Pilot studies to:

- undertake technical design and implementation of the mentor–mentee identification and matching processes;
- identify and utilise appropriate databases and software;
- develop guidelines for mentoring relationships and meetings;
- develop the business plan and budget, including key milestones for delivery;
- evaluate risk and incorporate stage gate exit points;
- identify funding sources and secure funding; and
- provide regular performance reports to the Steering Committee and the ATSE Board via the CEO.

The Project team will work with the Steering Committee to analyse performance results from the Pilot activities so as to evaluate the operation of the pilot mentoring program and its elements. Data and feedback will be used to develop IMNIS further.

APPENDIX *Some existing Australian Mentoring / Secondment programs, none of which focus specifically on mentoring of PhD students.*

- ***Griffith Industry Mentoring Program***. Its aim is to help students clarify their career options and facilitate their transition from study to work. The focus is mostly on undergraduate students and linking them to local industry leaders.
- ***Western Australian – InSpire program***: This involves collaboration between five WA universities and targets doctoral and masters students in a week-long intensive program with industry mentors. This group also plans to run iPREP WA – an Industry and PhD research engagement program focused on interdisciplinary teams conducting short-term projects.
- ***Molecule to Medicine*** run by Cancer Therapeutics CRC. This is a Victorian Government-sponsored intern program to provide practical on the job training and mentoring for postdoctoral researchers in technology transfer and commercialisation. This is an intensive program that graduates around 40 people each year.
- ***The Dairy Sage Mentoring program***. This program run by the Dairy Futures CRC offers future leaders the opportunity to interact with inspirational and experienced industry professionals to develop new skills and share knowledge. Currently there are 19 students involved in the program for an initial 12-month partnership.
- ***Swinburne University: Industry–Ready*** PhDs for the medical device industry. With support from the ARC and Victorian medical technology companies they aim to take a cohort of 10 PhD students through an intensive program with guidance from mentors from industry.
- ***Veski inspiring women industry internships***. This program targets female honours and masters students in STEM to partner with industry through short-term (four- month) focused research internships.