Australian Government

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THE NATION'S SCORECARD ON SCIENCE AND FUTURE SCENARIOS TO 2025

AUSTRALIAN-ISRAEL CHAMBER OF COMMERCE

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Part One Why Australia needs science.

Good evening and thank you for inviting me to speak tonight.

It's a pleasure to be here this evening to take a moment, in your company, to think about where Australia's science and technology future is headed. Beyond this, to think about why Australia's scientific future matters for our economy.

Since the industrial revolution, the growth of economies throughout the world has been driven largely by the pursuit of scientific understanding, the application of engineering solutions, and continual technological innovation. Some studies have shown that in the US, as much of 85% of growth in per capita income was due to technological change, even before the information-technology revolution[1].

It is easy to see why. Much of our everyday lives in Australia are the product of investments in research and in the education of scientists and engineers. We enjoy and rely on world travel, inexpensive and nutritious food, easy digital access to entertainment, instant communication, laptop computers, even knee and hip replacements… no jokes about my age here please.

From the mighty to the mundane, innovation, especially in science and technology, is at the crux of economic development.

But to most of you I'm sure, this is nothing new. A survey by GE found that 86% of Australian business leaders agree that innovation is the main lever to create a more competitive economy. Almost the same proportion (85%) felt innovation investment was the best way to create jobs[2]. In fact, a recent OECD report estimated that innovation influenced as much as 50% of economic growth in developed nations[3].

The U.S. Department of Labour has estimated that scientific innovation has produced roughly half of all U.S. economic growth in the last 50 years.[4] The science, technology, engineering and mathematics (STEM) fields and those who work in them are critical engines of innovation and growth: according to one recent estimate, while only about five percent of the U.S. workforce is employed in STEM fields, the STEM workforce accounts for more than fifty percent of the nation's sustained economic growth.[5]

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1 Committee on Science, Engineering and Public Policy. 2007. Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. *National Academies Press.* http://www.nap.edu/openbook.php?record_id=11463&page=1#p20012ecb8960001001

2 GE Innovation Barometer. http://www.ge.com/au/innovation_barometer.html

3 Australian Chamber of Commerce and Industry. http://www.acci.asn.au/Our-Agenda/The-Economy/Innovation

4 US Department of Labor, 2006. National Science and Technology Foundation, Science and Engineering Indicators : Review and Appraisal of the Federal Investment in STEM Education Research, as cited in *The STEM workforce challenge: the role of the public workforce system in a National solution for a competitive STEM workforce.*. http://www.doleta.gov/youth_services/pdf/STEM_Report_4%2007.pdf

5 U.S. Department of Labor, 2006. *The STEM workforce challenge: the role of the public workforce system in a National solution for a competitive STEM workforce*. http://www.doleta.gov/youth_services/pdf/STEM_Report_4%2007.pdf

And there is a global perception that a workforce with a substantial proportion educated in Mathematics, Engineering and Science (MES) is essential to future prosperity. Just one example, Europe.

The Rocard Report reviewing science education in Europe states the availability of highly qualified science and technology professionals is a key factor for the establishment, import and success of high-tech industry in the European Union. Europe should be in a position to anticipate rather than follow demand as it moves towards a knowledge based economy. Furthermore the link between the local availability of a highly skilled workforce and investment decisions as regards, for example, the location of R&D facilities is very apparent in global economic terms. It includes the recommendation, because Europe's future is at stake decision-makers must demand action on improving science education from the bodies responsible for implementing change at local, regional, national and European Union level.[6]

The good news for us is that as a developed country, we punch well above our weight. With 0.3% of the population, we produce around 3% of the world's scientific publications. But as the developing world begins to enter the fold, this may not always be the case.

So the bad news is, it is clear that our production in graduates in The sciences, technology, engineering and mathematics (STEM) is not what it could be- or needs to be.

And perhaps our economy is already beginning to show the signs. In Australia, our rank on the global competitiveness index has been steadily falling for the past decade – last year we were ranked 20th overall. In 2001 we were 5th[7].

Israel on the other hand has been stable in the low 20s, (though 15th in 2006), was 22nd overall in 2011 and ranked 6th in innovation.

As you drill down deeper, there are even more troubling figures. In the latest report, we rank 27th on capacity for innovation. On availability of scientists and engineers, we ranked 60th, out of 142, just scraping into the top half. On the availability of scientists and engineers, Israel ranked 10th.

Science is a fickle beast, ignore it for one minute and you will spend years trying to catch up. Australia should fear the abruptness with which a lead in science and technology can be lost—and the difficulty of recovering the social and commercial benefits once that lead is lost. Why? Because there are certain areas that Australia is struggling in, and we *must* do better.

The fact of the matter is, that without the knowledge-intensive enterprises that lead to discovery and new technology, our economy would suffer and our people would face a lower standard of living[8]. Australian business leaders have a responsibility to our

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6 Rochard M et al, 2007. *Science Education Now: a renewed education for the future of Europe*, Directorate-General for Research, European Commission.

http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf

7 World Economic Forum Global Competitiveness Index 2011
http://www.weforum.org/issues/global-competitiveness

8Committee on Science, Engineering and Public Policy. 2007. Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. *National Academies Press.*

economy. The World Economic Forum reports that in the long run, standards of living can be enhanced only by technological innovation[9].

Part Two **- Scorecard on science**

In my office we are coming to the end of a six month long exploration into the health of Australian science – where we are doing well and where our vulnerabilities lie. The report is yet to be published but we are starting to get a very good idea about how we are faring. Two areas of particular concern are agriculture and engineering. They're also particularly relevant in this forum, since Israel and Australia are quite similar. Both Australia (6%) and Israel (18%)[10] have a small percentage of arable land and face harsh weather conditions but in spite of, or perhaps because of this, both perform above what might be expected given our population size in agricultural technologies.

Israel, with 0.1% of the global population, produces about 0.5% of the world's agricultural science publications and Australia produces about 4% of global publications, with 89% growth in outputs from 2002-2010[11]. In a population of only 20 million, but with 400 million people reliant to some degree on our agricultural science, it is important that our agricultural production and our innovation in agriculture, continues to be strong.

But in Australia, only *half of one percent* of university students take agriculture. In 2010 we had only 743 graduates in agricultural science. That same year, approximately 4500 agricultural science jobs were advertised[12]. They are some scary figures.

At the beginning of the 20th century, 38% of the labour force was used for farm work. Developments in plant and animal genetics, husbandry and machinery have reduced that figure to 3%[13]. And for the economy, modern agriculture has exceptionally high returns on investment for public funding - for member countries of the OECD it is estimated at 45%.[14] But despite a smaller workforce and greater returns, the Australian agricultural industry is becoming more and more vulnerable as student enrolment numbers continue to fall.

In engineering the story is similar.

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http://www.nap.edu/openbook.php?record_id=11463&page=1#p20012ecb8960001001

9 World Economic Forum, The Global Competitiveness Index 2010–2011: Looking Beyond the Global Economic Crisis. Chapter 1. https://members.weforum.org/pdf/GCR10/Report/Part1/Chapter%201.1_The%20Global%20Competitiveness%20Index%202010-2011.pdf

10 CIA World Factbook, https://www.cia.gov/library/publications/the-world-factbook/fields/2097.html

11 *InCites*TM Global Comparisons, Thomson Reuters. http://sciencewatch.com/dr/sci/10/dec26-10_1/ (Israel) http://sciencewatch.com/dr/sci/11/sep18-11_2/ (Australia)

12 Chief Scientist, Senate Enquiry into Agriculture. http://www.chiefscientist.gov.au/2012/02/senate-enquiry-submission-agriculture/

13 National Research Council. *Frontiers in Agricultural Research: Food, Health, Environment, and Communities*. Washington, DC: The National Academies Press, 2003. In: http://www.nap.edu/openbook.php?record_id=11463&page=42#p20012ecb8960042001

14 R. E. Evenson. 2001. Economic Impacts of Agricultural Research and Extension. In B. L. Gardner and G. C. Rausser, eds. *Handbook of Agricultural Economics Vol. 1.* Rotterdam: Elsevier. Pp. 573-628.

Australia produces less than half of its annual engineering workforce needs, with only around 6000 graduates annually. In the road sector alone, we will need an additional 4000 engineers over the next 8 years[15]. The peak body Engineers Australia has reported that there is a shortage of 20,000 engineers right now.[16]

So let's take a look at our system. Australia ranks 19th on the global competitiveness index for the quality of math and science education, and yet we have huge shortages in areas crucial to our sustainable future. The problem is not just confined to engineering and agriculture – mathematics and statistics are also vulnerable. In comparison, Israel ranks 79th for quality of math and science education, but from its rank of 10th in availability of scientists, we can assume they have very few shortages.

Something is going wrong. We have strong research outputs and quality education and yet our students are not interested in these degrees. At Prime Minister Gillard's request, in a week's time, I will be submitting recommendations on how to increase the number of students taking maths and science in high school and universities.

As part of my findings, I will be strongly advocating to engage industry and bring cadetships back to the forefront of university degrees. Students often disengage from mathematics and science because they cannot see real world applications of their studies. But cadetships give students the chance to see the relevance of their work, the potential they hold to improving the quality of life of Australians. So I encourage you all to consider the possibility of cadetships in your own organisations – whether scientific or not.

Part Three - **Future to 2025**

I said earlier that Israel and Australia were similar. In terms of arable land, climate and water supplies, this is true. But on the global scientific stage there are even more similarities.

On the global impact of our research, measured by citations, Australia and Israel share three of their top four fields: physics, pant & animal sciences and space sciences[17].

In terms of the percentage of papers produced relative to percentage of world population, the figure is exactly the same – 9.4 for both Australia and Israel[18].

On international collaboration, over 40% of both countries' papers have international co-authors[19].

And yet despite the similarities, Australia and Israel's international collaboration together is remarkably small. Less than 4% of Israel's international collaborations

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15 Engineers Australia, http://www.engineersaustralia.org.au/news/engineering-skills-shortage-taskforce-underway

16 Quote from Engineers Australia - http://www.adelaidenow.com.au/news/south-australia/education-to-tackle-shortage-of-20000-engineers-in-australia/story-e6frea83-1225907964866

17 InCites Global Comparisons, Thomas Reuters. http://sciencewatch.com/dr/sci/11/sep18-11_2/

18 UN data for populations #'s http://esa.un.org/unpd/wpp/index.htm

19 SciMago. 2007. "SciMago Journal & Country Rank." http://www.SciMagojr.com.

feature Australian co-authors, and only around 1% of Australia's papers feature Israeli co-authors[20].

While this Chamber might be working hard to build strong relations with Israeli business, we must also seek ways to engage more on scientific and innovative levels. If innovation drives business organization, then science, the innovation force, will have to be more closely integrated with business for the well being of both.

Because, according to the OECD, whose analysis essentially echoes our own common sense, knowledge is the main source of economic growth and improvement in the quality of our lives[21]. Nations which develop and manage effectively their knowledge assets perform better.

So looking to the future, how do we better manage our knowledge assets? According to the World Monetary Fund, Australia is becoming less competitive each year. To improve this, to turn this around by 2025, we need a sustained commitment to the education of more scientists and more engineers. We need a sustained commitment to international collaboration, not just those close to us geographically, but those close to us in science.

We must also, as businesses, foster innovation and seek new markets and new ways of achieving efficiency. The power of research is demonstrated not only by single innovations but by the ability to create entire new industries. Despite Australian scientists and engineers developing the breakthroughs in photovoltaic's, we all but missed the boat on these technologies. We must ensure that we are in a position to commercialise our research when it comes around. New industries in science and technology will be some of the nation's most powerful economic drivers. Nanotechnology for example is estimated to be worth $50 billion to the Australian economy by 2014[22].

Increasing the level of innovation in Australia is a complex task that has no simple solution. However, ensuring we have the graduates to do it and working with our developed nations to increase our knowledge are solid steps in the right direction. And industry has a large role to play.

Thank you.

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20 National Science Board, 2012. Science and Engineering Indicators 2012, National Science Foundation, Arlington VA.

21 OECD, 1996. *The OECD jobs strategy - technology, productivity and job creation*, Paris. http://www.science.org.au/reports/pmsec.html

22 Monash University, 2009. *Social and Economic Impacts of Nanotechnology: A literature review.* Prepared for DIISR. http://www.innovation.gov.au/Industry/Nanotechnology/NationalEnablingTechnologiesStrategy/Documents/SocialandEconomicImpacts_LiteratureReview.rtf