



Dr Alan Finkel Australia's Chief Scientist

An overview of activities

January 2016 – December 2020

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This publication is available online at: www.chiefscientist.gov.au.

Suggested citation

Office of the Chief Scientist, 2020, Australia's Chief Scientist: An overview of activities 2016-2020, Australian Government, Canberra



Foreword

As I reflect on five years as Australia's Chief Scientist, I am somewhat surprised by how much was accomplished. Only a tiny fraction would have been achieved if it were not for a number of key players.

First, the Prime Ministers and Ministers who trusted me to lead a large number of reviews. They have noted the recommendations in those reviews and to a large degree they have accepted them. There is no obligation on Prime Ministers and Ministers to act on what appears to be a solitary source of advice, so I am pleased with the responses afforded by them. I attribute the positive reception of these reviews to the fact that they were in fact based on wide consultation across all relevant communities, and also with the Ministers themselves. Being independent does not mean that you don't take input from all quarters; it means that the Chair and the Panel Members process the information and draw the best conclusions that they can, based on the facts before them and their relevant experience.

Second, the Commonwealth Departments who established the taskforces that supported these reviews. The Secretaries made sure that there was executive support. The taskforce leaders were chosen for their relevant skills and leadership. The taskforce team members were recruited by calls for expressions of interest to ensure that the membership had the necessary skills and enthusiasm. Most importantly, the key members including the taskforce leaders had their day jobs backfilled so that they could concentrate 100% on the task at hand. In my transmittal letter for my final report to Government – the national contact tracing review – I wrote:

"One standout factor that has made my work possible has been the invisible work of public servants. When the task is huge, the time is short and the public good is calling, they work as hard and as astutely as the teams I used to lead when I ran a company in Silicon Valley."

I cannot sing their praises any more strongly.



There are many other projects that were self initiated during these five years. For all of them, I have been supported by my Chief of Staff and a dedicated team of about a dozen members of the Office of the Chief Scientist. They amplified my personal endeavours a thousandfold and I am deeply indebted to them.

When there was a need for specialised or overflow support from time to time, the Department of Industry, Science, Energy and Resources always obliged, for which I am very grateful. And outside the office, my wife, Elizabeth, was a constant source of encouragement and wise advice, while other members of my family and colleagues were always stalwart supporters.

I've had the opportunity to brief or quiz the Governor General, Prime Ministers, Ministers, Premiers, leaders of the Commonwealth, State and Territory public services, academic leaders, research leaders and captains of industry. I am grateful to all of them.

It's been fun and a privilege.

There is nothing more important to one's self assessment of the role than the calibre of one's successor. I have respected Dr Cathy Foley as a professional colleague for a long time and I am thoroughly delighted by her appointment. Cathy will carve her own path and I wish her good fortune for the journey.

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Alan Finkel PhD AO Australia's Chief Scientist January 2016 – December 2020

Introduction

The role of Australia's Chief Scientist is to be an advisor to the Australian Government and a champion for science in the community.

As an advisor, Australia's Chief Scientist provides high-level independent advice to the Prime Minister, the Minister for Science and other Ministers on matters relating to science, technology and innovation.

A key element of the role of Australia's Chief Scientist is to advocate for science and to increase the understanding of its importance in our everyday lives. Linked with that is promoting the work of Australian scientists nationally and internationally.

Dr Alan Finkel's appointment as Australia's Chief Scientist was announced in October 2015. This document provides a snapshot of his work and that of the Office of the Chief Scientist over his tenure from January 2016 to December 2020.



Photo: Office of the Chief Scientist



National Science and Technology Council

The National Science and Technology Council (the Council) brings leading Australian scientists together with the highest levels of Government to discuss how science and technology can improve the lives of Australians and create a stronger economy.

The Council is chaired by the Prime Minister, with the Minister for Industry, Science and Technology, serving as the Deputy Chair. Council members include six scientific experts, the CEO of CSIRO, and Australia's Chief Scientist, who serves as the Executive Officer as part of the Chief Scientist role.

Council discussions over its eight meetings to date have covered a range of issues, including the contribution of science, research and innovation to Australia, engaging students and the community in STEM, artificial intelligence, lifelong learning and most recently, Australia's COVID-19 response.

An important part of work of the Council has been commissioning Horizon Scanning reports from the Australian Council of Learned Academies on emerging science and technology issues, to support decision makers through the decade ahead. These multidisciplinary reports have provided insights into the opportunities for Australia through the internet of things, agricultural technologies, artificial intelligence, synthetic biology, precision medicine and energy storage.

Forum of Australian Chief Scientists

The Forum of Australian Chief Scientists (FACS) meets twice a year and brings together Chief or Lead Scientists, and other representatives, from each state and territory in Australia.

Australia's Chief Scientist, as Chair of FACS, facilitates a national focus on key science, technology and innovation challenges. FACS provides an avenue to share information and insights, and work together on common issues.

Recent discussions have covered a broad range of issues, including women in STEM, citizen science, frontier technologies, education, research infrastructure, hydrogen, Indigenous research, COVID-19 and space.

The Forum has welcomed the attendance of international guests including Professor Juliet Gerrard, the New Zealand Prime Minister's Chief Science Advisor and Professor Teatulohi (Lohi) Matainaho, former Chief Scientist of the Papua New Guinea Government.

Science, research and innovation policy

Providing advice to the Australian Government on science, research and innovation policy has been a focus throughout Dr Finkel's tenure as Australia's Chief Scientist.

In 2016, Dr Finkel was appointed as co-chair with Mr Bill Ferris, Chair of Innovation Science Australia (ISA), and Mr John Fraser, Secretary of the Treasury, to conduct a review of the R&D Tax Incentive program.

As Deputy Chair of ISA, Dr Finkel contributed significantly to its performance review of the innovation, science and research system, and to the <u>Australia 2030: Prosperity through</u> <u>Innovation</u> plan delivered to government in late 2017 (p7).

The Australian Research Council's reviews of the use of the Australian Government's 2015 National Science and Research Priorities in its funding programs and of the Excellence in Research for Australia (ERA) and the Engagement and Impact Assessment (EI) evaluation programs all drew on Dr Finkel's contribution as an expert advisor.

Other work has included chairing the Forum of Australian Chief Scientists (p5), and leading the expert working group for the 2016 National Research Infrastructure Roadmap (p7).

In the second half of his term, Dr Finkel advocated for improving the integrity and quality of research, to go from good to great. "People respond to incentives. Change will come only when grants and promotions are contingent on best practice."¹

He has organised workshops on research integrity and the publications process – bringing together publishers, heads of research funding agencies, leaders of research institutions, and experts in the field of publications. He has further explored these principles in <u>domestic</u> and <u>international</u> speeches. In 2019, Dr Finkel outlined his findings in an <u>article</u> for Nature.

ISA: Australia 2030: Prosperity through innovation and the Innovation Metrics Review

In 2016, ISA published Australia 2030: Prosperity through innovation, to assist Australia to thrive in the global innovation race. The plan included 30 recommendations under five strategic policy imperatives: education, industry, government, research and development and culture and ambition. Evaluation of the impacts of the plan's recommendations was seen as integral to its success. The plan recommended the development of a suite of innovation metrics and methodologies to fully capture innovation and link it to economic, social and environmental benefits.

In 2019, Dr Finkel and Mark Cully (then Chief Economist, Department of Industry, Innovation and Science) co-chaired the subsequent Innovation Metrics Review. The review aimed to improve existing innovation metrics and data sources, identify and fill measurement gaps, including to capture hidden innovation, and design an innovation scorecard to guide evidence-based decision making.

"It is a task for Australia, but at the same time we aim for this to be a project for the world: our measures have to be comprehensible, credible and comparable to our global partners."²

2016 National Research Infrastructure Roadmap

Dr Finkel chaired the expert working group that developed the 2016 National Research Infrastructure Roadmap. The Roadmap outlined the national research infrastructure required over the coming decade so that Australia's world class research system continues to improve productivity, create jobs, lift economic growth and support a healthy environment. The Australian Government responded in the 2018 Budget with its Research Infrastructure Investment Plan, developed with further advice from a small panel of experts led by Dr Finkel, with an investment of \$1.9 billion under the National Collaborative Research Infrastructure Strategy. Combined with previously announced funding, including \$140 million for High Performance Computing infrastructure and \$119 million for the strategic partnership with the European Southern Observatory, \$2.2 billion of funding was identified in line with the Roadmap over 12 years.

The Australian Government also committed to new roadmaps being developed every five years and investment plans every two years, to reaffirm and update investment activities. The latest investment plan was released as part of the October 2020 budget.

Artificial Intelligence and data

"We must all endeavour, with determination, to harness the power of scientific progress for the benefit of our society, while safeguarding the ideals of our society."

Throughout his term Dr Finkel has explored the ethical and human rights issues relating to the rapid development of artificial intelligence and advancing data management.

Revolving around the central question "What kind of society do we want to be?" the dual issues of ethics and regulation relating to this fast-moving area were discussed in a number of national and international fora.

"No matter how fast the pace of AI innovation, it must never surpass the primacy of human rights."³

Central to his argument has been the establishment of strong standards for ethical artificial intelligence development, such as a trust certification tentatively referred to as a 'Turing Certificate', similar to the Fairtrade mark on coffee or chocolate, or the CE mark on manufactured goods. Standards Australia included

this as one of its recommendations within its Artificial Intelligence Standards Roadmap: Making Australia's Voice Heard report, published in March 2020.

Dr Finkel has actively contributed to the Human Rights Commission's three year project into Human Rights and Technology as a member of the expert reference group. He has also served as a member of the National Data Advisory Council since its formation in 2019, advising the National Data Commissioner on ethical data use, community expectations, technical best practice, and industry and international developments.

Commissioned by NSTC, the Australian



Image: Wes Mountain

Council of Learned Academies delivered a Horizon Scanning Report on the opportunities, challenges and prospects that artificial intelligence technologies present for Australia.

Across this work, Dr Finkel has continued to push for thoughtful leadership and national discussion to decide how we can best integrate artificial intelligence into our society.

"We must all endeavour, with determination, to harness the power of scientific progress for the benefit of our society, while safeguarding the ideals of our society."⁴

Climate change

"Climate change is Nature's reaction to our actions. It is real, and it is already happening with a rapidity that is deeply affecting our way of life."⁵

The issue of climate change has been a constant and pressing thread throughout the five years of Dr Finkel's tenure. As Australia's Chief Scientist he has been involved in a number of climate-related advisory bodies providing regular advice to government on a range of scientific issues. Each of these bodies has a strong commitment to consulting broadly with the community, bringing a range of diverse views for consideration.

Throughout his term, Dr Finkel was a member of the board of the Australian Government's <u>Climate Change Authority</u>. It provides independent, expert advice on climate change policy. He was also a member of the <u>National</u> <u>Climate Science Advisory Committee</u>, which provided strategic direction for Australian climate science research through the national strategy it delivered for the Australian Government: <u>Climate science for Australia's</u> <u>future</u>. The impacts of climate change were felt by many during the devastating 2019-20 bushfire season. Dr Finkel led the Expert Advisory Panel that supported CSIRO in developing its <u>Climate and Disaster Resilience</u> report, which was requested by the Prime Minister in January 2020 (p10).

"We can do this. Time and again we have demonstrated that no challenge to humanity is beyond humanity. But we cannot be naïve about the scale of the task ahead nor can we afford to discard any of the tools at our disposal."

Dr Finkel made <u>a landmark speech</u> to the National Press Club in February 2020, where he reiterated the scale and importance of addressing the climate challenge that we are facing not just in Australia, but globally. He outlined his views on the impact of climate change, the need to commit to low emissions energy supplies and systems, and to adopt a combination of technologies to provide safe, reliable, cost effective energy for the Australian community.

Dr Finkel has driven a number of important reports in the energy area with a strong focus on emissions reduction (p11), complementing work on climate change. In June 2017, the <u>National Electricity Market Review</u> was delivered to the Australian Government (p11). Dr Finkel then led the development of the 2019 briefing paper Hydrogen for Australia's Future and chaired the development of the <u>National Hydrogen Strategy</u> (p12). Most recently, Dr Finkel chaired the Ministerial Reference Panel for the <u>Low Emissions</u> <u>Technology Statement</u>, released by the Minister for Energy and Emissions Reduction, the Hon Angus Taylor, in September 2020 (p12).



Bushfire and climate resilience

Following the devastation of the 2019-20 black summer bushfire season, CSIRO was tasked by the Prime Minister to report on practical measures for Australian governments to improve Australia's climate and disaster resilience. A key focus of the CSIRO report was on "building back better", to protect homes, Australia's environment, industries and infrastructure.

CSIRO was asked to work in close partnership with an Expert Advisory Panel, chaired by Dr Finkel. Dr Finkel consulted widely with Premiers, Chief Ministers and other key stakeholders from all states and territories to understand the key concerns for each jurisdiction. A sobering highlight was joining the National Bushfire Recovery Agency for virtual tours of Nambucca Valley Council and Kempsey Shire Council, both located on the NSW mid-north coast and heavily impacted by the bushfires. Hearing on-the-ground experiences offered the Panel an understanding of the tangible impacts of the bushfires and the support needed by these communities to aid in recovery and preparation.

CSIRO's final report, <u>Climate and Disaster</u> <u>Resilience</u>, considered the increasing challenges climate change is presenting, focusing on acute disasters including bushfires, floods, extreme hailstorms and cyclones. The report recommended nationally consistent bushfire modelling, more sophisticated satellite and aircraft-mounted observation technology, domestic production of fire-fighting foams, gels and retardants, more research into hazard reduction, improved building standards for new properties, and supporting the mental health of first responders and community members.

CSIRO's report significantly informed the recommendations of the Royal Commission into National Natural Disaster Arrangements. The Royal Commission's report was presented to National Cabinet in November 2020 and the Australian Government announced a package of Commonwealth measures to enhance and strengthen Australia's emergency response and recovery capacity in its response: <u>A national</u> <u>approach to national disasters</u>.

Energy and resources

Dr Finkel has delivered significant pieces of work that have helped to inform the Australian Government's policies in energy and emissions reduction. From the Review of the National Electricity Market, to the development of Australia's <u>National</u> <u>Hydrogen Strategy</u>, and chairing the advisory panel for the <u>Low Emissions Technology</u> <u>Statement</u>, these tasks have considered the central energy-related and emissionsrelated structural issues facing the Australian economy.

Each of these projects involved working with governments at multiple levels, consulting widely and collaborating with stakeholders to produce outcomes that are delivering real change. He also led an audit of the National Offshore Petroleum Safety and Environmental Management Authority's consideration of exploration in the Great Australian Bight in 2019.

National Electricity Market Review

In October 2016, in response to rising fuel prices, increasing electricity demands, and an unprecedented statewide blackout in South Australia, the Council of Australian Government (COAG) energy ministers agreed to an independent Review of the National Electricity Market (NEM). The Hon Josh Frydenberg MP, Minister for Energy, asked Dr Finkel to lead the review to assess the current security and reliability of the NEM and to provide advice to governments on a coordinated plan for national reform. In June 2017, Dr Finkel unveiled a blueprint to optimise Australia's National Electricity Market as a world-class electricity system capable of serving the needs of today and rising to the challenges of tomorrow.

The <u>Independent Review into the Future</u> <u>Security of the National Electricity Market:</u> <u>Blueprint for the Future</u> focused on four key features of the electricity system – future reliability; increased security; rewarding consumers; and lower emissions. The Review drew on an extensive public consultation process, with more than 390 public written submissions received, more than 100 meetings with stakeholders and around 450 attendees at public consultation sessions held in five capital cities in early 2017.

Among other significant changes, the Review led to the establishment of the Energy Security Board, which reports annually on the status of the recommendations in the review. The Integrated System Plan is another outcome from the review, and is enabling the rapid introduction of large scale solar and wind electricity generation into the NEM.

In 2020, the Energy Security Board <u>reported</u> that the transformation of the national electricity market has "progressed at a remarkable pace and scale" towards renewable energy generation, with increased affordability for customers.



National Hydrogen Strategy

During consultation for the Review of the National Electricity Market, stakeholders urged Dr Finkel to consider how hydrogen could be developed as an energy carrier, offering a potentially zero-emissions fuel source. Dr Finkel subsequently presented a briefing paper to the COAG Energy Council, called Hydrogen for Australia's Future.

At COAG Energy Council's request, Dr Finkel chaired a working group to develop Australia's National Hydrogen Strategy, which was unanimously adopted in November 2019. The Strategy outlines how Australia can establish itself as a producer of hydrogen to enhance energy security, create Australian jobs and build an export industry valued in the billions.

Hydrogen can be used to reduce emissions in transport, heating and industrial processes, and provides a way for Australia to export renewable energy, literally 'shipping sunshine'.

"We truly are at the dawn of a new industry that can contribute to jobs, export income, energy storage, and, vitally, global emissions reduction." To support the strategy, CSIRO developed <u>Hydrogen Research, Development and</u> <u>Demonstration: Priorities and Opportunities</u> <u>for Australia</u>. This report identified several areas across the hydrogen supply chain where research, development and demonstration will be needed to drive down costs.

Following the release of the Strategy, governments at the state and federal level have committed more than \$400 million to date in funding to boost the sector and allow Australia to realise its potential as a global leader in the supply of hydrogen.

Low emissions technology statement

In February 2020, the Hon Angus Taylor MP, Minister for Energy and Emissions Reduction announced Dr Finkel as Chair of the inaugural Ministerial Reference Panel to support the development of the first *Low Emissions Technology Statement*.

The statement was released by the Minister in September 2020 and presents the vision for Australia to be recognised as a global low emissions technology leader. The Statement identified five priorities for government investment; hydrogen, electricity storage (batteries, pumped hydro and thermal), low emissions steel and aluminium, carbon capture and storage, and soil carbon measurement. Each of these priority technologies has an economic stretch goal, such as 'H2 under 2' – clean hydrogen produced at or under \$2 per kilogram. These are ambitious but realistic goals to bring priority low emissions technologies to economic parity with existing, high emissions technologies.

The Statement was accompanied by nearly \$2 billion in Australian Government investment to deliver on its goals with an expected \$18 billion Government investment this decade. The Minister announced that Dr Finkel would be appointed to chair the expanded Technology Investment Advisory Council to advise on future Low Emissions Technology Statements.





Dr Finkel has been actively involved in Australia's response to the COVID-19 pandemic in a number of ways. Throughout 2020, he has worked with Commonwealth and state governments, and made contributions to national and international forums, to help shape Australia's evidence-based responses.

COVID-19

National efforts include working with the Department of Industry, Science, Energy and Resources' ventilator taskforce to secure the supply of ventilators, his leadership in establishing and Chairing the Rapid Research Information Forum (RRIF), and his membership as Chief Scientist of the Government's COVID-19 Vaccines and Treatments for Australia – Science and Industry Technical Advisory Group. Dr Finkel also steered a national cross-jurisdiction review on contact tracing, testing and outbreak management.

Rapid Research Information Forum

As the impact of the COVID-19 pandemic was emerging in Australia, Dr Finkel convened the <u>Rapid Research Information Forum</u> (RRIF). The RRIF was initiated to rapidly bring together relevant research expertise to address pressing questions about Australia's response to COVID-19. It is operationally led by the Australian Academy of Science, and brings together multiple organisations from across the science and research sector.

The RRIF enables timely responses to be provided to governments based on the best available evidence. It also informs the Chief Scientist's interactions and collaboration with other national chief scientific advisers. It demonstrates the critical value of research and innovation addressing national challenges, now and into the future.

Responses prepared by the RRIF have covered topics across health, education, technology and workforce, including the most promising vaccines and therapeutics, the impact of the pandemic on the research workforce and women in STEM, and the differences in learning outcomes for online versus in-class education. They have been referenced by governments across Australia, supporting them in their decision-making during this national crisis.

Engagement with International Chief Scientific Advisors

Chief Scientific Advisors from countries around the world came together to discuss how the science and research sector could maximise its contribution to the global response to COVID-19. The group was convened by the Director of the White House Office of Science and Technology Policy, Dr Kelvin Droegemeier. Its work highlighted the essential role of global collaboration in tackling COVID-19, with information shared almost in real-time about development of vaccines and therapeutic agents, serological testing, and clinical trials being conducted around the world. The group also championed increased open access to COVID-19 publications and data worldwide.

Tapping into the wide-ranging networks of scientific and technical experience available to the Chief Scientist, Dr Finkel consulted with experts from around the country to support the international discussions and his advice to government.

Ventilators for Australia's COVID response

In response to the worsening COVID-19 initial outbreak in Australia, Dr Finkel worked with the ventilator taskforce based in the Department of Industry, Science, Energy and Resources to ensure sufficient ventilators would be available. The taskforce was instrumental in identifying existing ventilator stock and securing additional ventilator supplies through negotiations with Australian ventilator manufacturers.

The <u>ventilator specifications document</u> developed by Dr Finkel in consultation with ICU specialists also assisted in supporting Australia's advanced manufacturing sector as it moved to manufacture additional ventilators. As a result of this work, the Government achieved its goal of making <u>7,500 ventilators</u> available for the Australian health system.

Contact tracing, testing and outbreak management

At the height of Victoria's second wave of COVID-19 infection, Dr Finkel was asked to assist with improving the efficiency of the state's test, trace, and isolate processes, particularly the adoption of new ICT solutions. This work then led to National Cabinet commissioning a review of the systems and operations in all jurisdictions used for COVID-19 testing, contact tracing and outbreak management, and to exchange case and outbreak management data between jurisdictions to enhance the management of outbreaks nationally.

Supported by a small taskforce, Dr Finkel and his fellow panel members, Tarun Weeramanthri, president of the Public Health Association of Australia, and Leigh Jasper, co-founder of Aconex, visited each Australian state and territory to learn about their systems for managing the pandemic and assess the nation's state of readiness for reopening borders and the economy.

On 13 November 2020, National Cabinet agreed unanimously to the <u>report and</u> <u>its recommendations</u>, which set out the characteristics of an optimal system for testing, contact tracing and managing COVID-19 outbreaks, which Australian states and territories can use to evaluate and refine their own measures.

Image: Department of Health and Human Services, Victoria



During his term, Dr Finkel has championed the importance of education and skills development as core elements for a forward thinking Australia. This has included leading several national education policy initiatives and activities with direct relevance to science, technology, engineering and mathematics (STEM).

Advocating for content-rich curricula and deep discipline knowledge, highlighting the need for school students to gain the necessary fundamental knowledge to thrive in the world of work has been a key objective. Students who choose to pursue STEM careers should have learned the deep content knowledge required to be successful and adaptable members of the STEM workforce. Dr Finkel has led reviews, contributed to strategic education policy activities and worked to bring education and industry together in a range of fora. Working with colleagues, he and the Office of Chief Scientist have contributed significant original research on STEM education and STEM qualified populations in Australia.



STEM Partnerships Forum

The STEM Partnerships Forum was established to bring together schools and industry to develop the engagement, aspiration, capability and attainment of students in STEM. The STEM Partnerships Forum was chaired by Dr Finkel, and included members from the schooling, vocational education and higher education sectors, as well as industry leaders. The Forum met with stakeholders across Australia to seek their views and inform the report's recommendations.

The work of the Forum culminated in the <u>Optimising STEM Industry-School Partnerships:</u> <u>Inspiring Australia's Next Generation</u> report, published in April 2018. The ten recommendations from the report, along with those from other major national reviews, informed the development of the National School Reform Agreement between the Australian Government and all states and territories. The <u>National STEM School Education</u> <u>Resources Toolkit</u> – a key recommendation of the STEM Partnerships Forum – was released in September 2020. It aims to help teachers, school leaders, industry partners and other providers to deliver high quality STEM initiatives in schools. The toolkit was commissioned by the Australian Government Department of Education and provides information on the elements of successful partnerships, the important role of intermediaries, and advice to support schools and industry in designing, implementing and evaluating partnerships.

OPTIMISING STEM INDUSTRY-SCHOOL PARTNERSHIPS: INSPIRING AUSTRALIA'S NEXT GENERATION

FINAL REPORT APRIL 2018 STEM Partnerships Forum





Informed Choices

Promoting understanding of the importance of fundamental secondary school subjects, such as mathematics, science, English, languages, and history has been an active aspect of Dr Finkel's work in the education space. He considers they offer essential grounding for students so they can achieve at university, complete vocational training or effectively navigate the changing workforce.

"Build a solid foundation to keep the doors of opportunity open. This means building your expertise in two fundamental subjects: English and mathematics. Neither can be picked up easily later in life. They are best learned layer upon layer, from prep school through to Year 12. Mathematics is the language of science and commerce. I can't over emphasise that for many tertiary study fields you must have a strong knowledge of mathematics."⁶

Over the last 20 years, fewer secondary school students have been choosing to study intermediate and higher mathematics and science subjects. At the same time, there has been a decline in Australia's international student assessment scores in mathematics, literacy and science and an increasing tendency for students to select Year 11 and 12 subjects with the aim of maximising their ATAR scores rather than preparing them well for university studies.

Working with university vice-chancellors, Dr Finkel has developed a plan known as 'Australian Informed Choices', to help increase participation in core secondary school subjects. The plan proposes the creation of a common set of authoritative, understandable and widely promoted resources with information and advice that sends a clear message to Australian students that they are more likely to succeed at university if they have completed studies in relevant, fundamental school subjects – at the level that allows them to achieve to the best of their ability.

The Office of the Chief Scientist released <u>two papers</u> related to this topic, an Informed Choices position paper, and a joint paper with the Australian Mathematical Sciences Institute titled Mapping University Prerequisites in Australia. Both papers provide valuable insight into university prerequisite requirements at the end of 2019 and the messages that they send to students and schools across the country.



Australia's STEM Workforce Report

The <u>STEM Workforce Report</u> is one of the Office of the Chief Scientist's key publications over the past five years, and has bookended Dr Finkel's tenure as Australia's Chief Scientist. Initiated by his predecessor, Professor Ian Chubb, the STEM Workforce Report uses data from the Australian Census to explore the demographics and employment statistics of people with STEM qualifications in Australia.

The report details how many people in Australia have STEM qualifications, their age, earnings

and the industries in which they are employed. These insights are valuable for government and policymakers, who use the analyses to inform skills and workforce strategies. Career advisors, young people and their parents and carers also access the information in the report to learn where a STEM qualification could take them.

The first edition was released in 2016 and drew from 2011 Census data. The second edition of the report, released in July 2020, presents 2016 census data and explores the diversity of the STEM workforce in more detail, comparing it to the diversity of the Australian population. The latest report also includes comprehensive analysis of three key groups; women with STEM qualifications, young people with STEM qualifications, and the large cohort of people with engineering qualifications.

The STEM Workforce Report is the most cited publication from the Office of the Chief Scientist. Data from the report has been used to inform key documents such as the <u>Women in STEM</u> <u>Decadal Plan</u>, <u>The Defence Industry Skilling and</u> <u>STEM Strategy</u>, and <u>The State of Mathematical</u> <u>Sciences 2020</u>.



PHOTO: Convergence Science Network

significant analysis of the STEM workforce by gender, including a chapter that examined how many women have STEM qualifications, what jobs and industries these women work in, and how their employment is affected by having children, by being from a culturally diverse background, or in nearing retirement.

Following the release of this report, Dr Finkel co-authored an <u>article</u> with Australia's Women in STEM Ambassador, Professor Lisa Harvey-Smith, which examined how gains made in female representation in STEM are under threat from the workforce upheaval due to COVID-19. This issue was also the subject of a Rapid Research Information Forum response to a question posed by the Hon Karen Andrews, Minister for Industry, Science and Technology.

Women in STEM

Advocating for systemic change to improve the representation of women in STEM education, in STEM occupations, and in management and executive roles has been a key element of Dr Finkel's tenure. Through his membership of the Male Champions of Change STEM group, and his support of the Science in Australia Gender Equity (SAGE) program, Dr Finkel has supported the national conversation about ways to remove barriers to more women participating and excelling in STEM.

Under Dr Finkel's leadership, the Office of the Chief Scientist has delivered bodies of evidence to inform women in STEM policy. The Occasional Paper <u>Busting Myths about</u> <u>Women in STEM</u> investigated women's underrepresentation and community myths about why that underrepresentation exists. The <u>2020 STEM Workforce Report</u> included



Australian Science Policy Fellowships Program

The <u>Australian Science Policy Fellowship</u> <u>program</u>, an initiative of the Office of the Chief Scientist during Dr Finkel's tenure, provides a pathway for early-career and mid-career scientists to become skilled policy practitioners. Fellows are employed as policy officers by participating Commonwealth Government host departments for 12 months.

The program is designed to strengthen the science-policy interface and expand the diversity of expertise held by the Australian Public Service (APS) workforce. It was launched in July 2018 and has placed 34 science policy fellows across eleven Commonwealth Government departments and agencies over the three years since launch. Each year, participation has grown both in numbers of fellows placed, and in the number of host departments participating, and the vast

majority of fellows have subsequently moved into permanent positions within the APS.

"I can easily see a career pathway that would be filled with interesting work and challenges over the next few years and I'm keen to keep on the journey that I have started."

- 2018-19 Science Policy Fellow

A recent evaluation found that the program is providing significant value to both fellows and host departments. Fellows reported that they had grown to better understand the workings of government and how policy is developed. Hosts highlighted that fellows brought a different perspective, along with high-quality data, research, analysis and writing skills that were very beneficial to their teams' policy work. "We found a very capable person to join our team who brings valuable professional experience from outside government and who wants to succeed in this new career."

- Department of Finance

Champion of science in the community

A key element of the role of Australia's Chief Scientist is to advocate for science and to increase the understanding of its importance in our everyday lives. Linked with that is promoting the work of Australian scientists nationally and internationally.

Using a range of communication tools, primarily speeches, presentations and opinion pieces, Dr Finkel has reached out to a variety of audiences across a broad range of topics; everything from research priorities, the electricity reforms, encouraging secondary school students to choose fundamental subjects, and the ethical issues around the development of artificial intelligence. Each public event allowed the opportunity to engage with the audience on key messages: the value of science in our everyday lives, the importance of investing in research and development, the role of scientific evidence in contributing to policy development, and the amazing success of Australian science and



Photo: Mark Graham

research. Dr Finkel has promoted Australian science and the fantastic work being undertaken by our research and development community.

Over the five years of his tenure, about 100 speeches were delivered; and more than 600 presentations, on the various activities, reports, developments and issues on which Dr Finkel, the Office of the Chief Scientist, and taskforce members, have worked.

High profile speeches include 'The Prerequisite for success', exhorting students to commit themselves to learning foundational subjects of English and mathematics; 'What kind of society do we want to be?', about the march of artificial intelligence and data privacy, which also won a <u>Cicero speechwriting award</u>; and 'Evidence and integrity', about the challenges of finding the right balance when providing scientific evidence into policy development.

A selection of Dr Finkel's speeches has been compiled in a specific publication titled <u>The Finkel Files</u>. Videos of his speeches and presentations are available on the Australia's Chief Scientist <u>YouTube channel</u>.

School and university visits

Throughout his tenure Dr Finkel has given many presentations to and engaged with students of all ages. From roaming the ACT's National Science Week event wearing a Dr Who scarf and avoiding daleks, to presenting to high school students in the Latrobe valley in Victoria, or sitting on the mat with primary school students in Launceston, Tasmania for the launch of National Science Week 2019, Dr Finkel has recognised the importance of engaging with budding young scientists of all ages.

"We must [cultivate] the natural curiosity and capabilities of children. By stimulating a love of learning and expertly guiding their enthusiasm for exploration. By igniting their imaginations to a world of possibilities and challenging them to pursue new ideas and help solve real-world problems through the application of deep knowledge.

Equipped with the disciplinary knowledge and learning skills they need, they will be bold and ambitious in their goals. With ambition, I am confident our children will achieve their, and our nation's, future aspirations."⁷



STARportal

STARportal

How do parents, students and teachers find information about Australian science or STEM outreach programs?

The <u>STARportal</u> is Australia's national public web platform connecting students, parents and teachers with their local and online STEM programs and events, and its development has been an initiative of Dr Finkel, the Office of the Chief Scientist and Engineers Australia during his tenure.

The website consolidates details of hundreds of extra-curricular and co-curricular STEM programs into an accessible, searchable online tool. Providers of STEM programs, events and prizes maintain a profile in the database which they can be viewed by prospective participants.

The development of the STARportal followed a project by the Ai Group, Professor Ian Chubb and the Office of the Chief Scientist in 2015-16 to consolidate national and state-based extra-curricular STEM programs into a printed index (STEM Programme Index 2016).

Moving the information to a web-based platform, the STARportal was officially launched by Senator the Hon Arthur Sinodinos AO, Minister for Industry, Innovation and Science, in August 2017.

"Science doesn't start and stop at the classroom door – it's everywhere. But if families and teachers don't know about these programs, our students miss out."⁸

The development of the STARportal was a collaboration between the Office of the Chief Scientist, Engineers Australia, Telstra, AMSI, BHP Billiton and the Commonwealth Bank, in consultation with the Department of Education. Since the launch, over 1,600 individual activities have been added to the STARportal and to date has had more than 150,000 unique users.

The STARportal saw a rapid increase in demand as a result of the COVID-19 pandemic and increase of at-home learning for many students, and has continued to be a useful tool for parents, teachers, and students to connect and engage with STEM activities.

"The STARportal aims to spark the curiosity of students and encourage deeper engagement with skills that are so vital to give humans a competitive edge in a technology-driven world."9



Prime Minister's Prizes for Science

The Prime Minister's Prizes for Science are Australia's most prestigious awards for outstanding achievements in scientific research, research-based innovation and excellence in science teaching. Run by the Department of Industry, Science, Energy and Resources, the prizes recognise the achievements and success of Australian scientists and innovators, as well as science educators, who play a critical role in inspiring and encouraging students to take an interest in science at school. The awards recognise achievements across diverse disciplines and career stages.

"Over the years, the Prime Minister's Prizes for Science have showcased many successes made possible by a diverse scientific workforce. I've been associated with the Prizes for about 10 years, and I find it's impossible to overstate their importance for Australian science. The Prizes are how we support and encourage our fantastic cohort of brilliant scientists.⁷⁷⁰

The awards are presented annually by the Prime Minister and the Minister for Science. As Australia's Chief Scientist, Dr Finkel is chair of the Prime Minister's Prizes for Science Selection Committee. 2019 marked 20 years of the prizes. "As Chair of the science prizes selection committee, it was a pleasure to see the incredible depth and breadth of Australian science through the lens of the many outstanding nominations received."¹¹

Throughout his tenure, Dr Finkel supported the work of the Department of Industry, Science, Energy and Resources to increase the number of women nominated and ensure the nomination and selection processes reduced implicit bias and subjectivity.

Chief Scientist's Storytime Pledge

Without childhood literacy, there can be no future scientists. Dr Finkel has championed childhood literacy with the <u>Storytime Pledge</u> campaign, calling on all Australians to read a book to a child.

Coordinated by the Office of the Chief Scientist, the pledge is publicly taken up by leading members of Australia's science community, across a wide range of disciplines.

Participants recommend a favourite book, with pledges promoted across the Office of the Chief Scientist's social media channels and website, and those of other science stakeholders. The Australian Libraries and Information Association has also supported each campaign of the Storytime Pledge.



viewpoint-25

INCURABLE ENGINEER ALAN FINKEL is an electrical engineer, a neuroscientist and the Chief Scientist of Australia.

A LETTER TO A YEAR 10 STUDENT

DEAR JULIE,

You lamented that you are anxious about your subject choices for Years 11 and 12. You're not alone! These are important decisions and there's lots of confusing advice around.

In my career I've been an academic researcher, a businessman, a university chancellor and now a government adviser. Based on this experience, some warm advice...

For starters, build a solid foundation to keep the doors of opportunity open. This means building your expertise in the two fundamental subjects: English and mathematics. Neither can be picked up easily later in life. They are best learned layer upon layer, from prep school through to Year 12.

Mastery of language is crucial to succeeding in whatever you do – whether it's writing a report to advise the government on electricity markets or a job application. Your ability to "win friends and influence people" will only be as good as your language skills. The best way to hone them is to read a lot, and read some more. Novels, histories, science-fiction – it doesn't matter, just read!

Mathematics is the language of science and commerce. I can't overemphasise that for many tertiary study fields you must have strong knowledge of mathematics. These include medicine, science, engineering, economics and commerce. If you like, you can look at it from a fundamentalist point of view: in the beginning, there was mathematics, and mathematics begat physics, and physics begat chemistry, and chemistry begat biology, and biology begat commerce.

With the basics in place, next choose subjects that will stretch you. Why is breadth a good thing? In my case, I studied sciences and mathematics right through but I also picked up Year 12 Economics, which helped me in business and policy development. You'll find it easier if you choose subjects you like, although my own experience is that nearly all subjects (even economics) are interesting once you knuckle down and get past the initial barriers.

What's left? We're not just intellectual robots. We are a complex fusion of mind, body and emotion. Besides English and mathematics, there are two other fields that you should keep up as long as you can, even if you don't do them as formal subjects. These are music, the language of the emotions, and sport, the language of the body. Music and sport complete us as human beings, and like English and mathematics they are incredibly difficult to pick up later in life.

I don't know why, but some wellmeaning advisors will suggest that you pick easy subjects so that you will achieve a higher raw score. Don't do that! You won't be doing yourself a favour, you'll be diminishing your long-term prospects. Instead, choose the enabling subjects, the ones that will keep the doors of opportunity open. Every time you drop an enabling subject – bang! a door of opportunity slams shut.

You'll hear lots of talk about "21st Century skills", such as resilience, clear thinking and collaboration. These are important, but truth is, these were 20th Century skills, too. I learned them, a long time ago. They are important, but they are useless unless you study demanding subjects through which you can practise these skills. It's like playing basketball – you need to know the rules and on-court behaviour – but unless you practise you won't make the team.

There is no substitute for raw knowledge, even in the age of internet search. After all, there is no use learning to collaborate if you don't have anything distinctive to contribute. Another way to build these 21st

Another way to build these 21st Century skills is by volunteering to do some community service or taking a casual job, perhaps at McDonald's or a local cafe.

To finish, two comments about careers. First, be aware that employers look for

"T-Shaped" individuals, where the vertical pole of the T represents deep disciplinespecific knowledge and the horizontal bar of the T represents 21st Century skills. Restrict your focus to one or the other and you will be limiting your employment options.

Second, the era in which your tertiary studies determine your lifelong career is over. You might do science but pivot into business. You might do engineering but pivot into politics. You might do accounting but pivot into a job that hasn't been invented yet. The critical thing is to do your initial tertiary studies really well – that's how you hone your skills – then after that, in the workforce, it will be easy to pivot from one career to another.

There is, of course, much more to a fulfilling life than these suggestions, but I trust that they will help.

With warm regards, The Incurable Engineer **(**

Responding to community inquiries

Australia's Chief Scientist receives a large number of enquiries from the public each year on a wide range of topics, from hydrogen to horticulture, climate change to immunisation. Dr Finkel and the Office of the Chief Scientist respond to each enquiry, directing those seeking science advice to trusted outlets, linking people with other scientific and government organisations, and providing further elaboration for those seeking a deeper insight into the Chief Scientist's views.

Televised public engagements, such as a speech at the National Press Club, generate targeted questions and comments, while topics such as climate change, hydrogen and energy, and STEM education remain popular topics of enquiry each year.





One of the many hats of Australia's Chief Scientist is as a champion of Australian science internationally leading delegations, hosting international visitors and travelling to a number of countries to inform specific policy work. As an incurable engineer, Dr Finkel has enjoyed the opportunity to see world leading international science and innovation in action. More importantly, these trips are key to building strong working relationships with government and scientific peers across the globe.

Dr Finkel has travelled to New Zealand twice, to build relationships and to discuss scientific collaboration with our nearest neighbour. In 2016, Dr Finkel met with the NZ Prime Minister, the NZ Science Minister and Science Advisor, and Professor Peter Gluckman in Auckland, while in 2019 he travelled to Wellington to have meetings with NZ Minister Dr Megan Woods and the NZ Prime Minister's Chief Science Advisor, Professor Juliet Gerrard. In 2016, Dr Finkel travelled to Italy and Belgium to strengthen Australia's international engagement in science, research and nuclear science. Dr Finkel spoke at the International Atomic Energy Agency Scientific Forum and the second meeting of the International Network for Government Science Advice. A highlight was visiting the VIRGO Gravitational Wave Detector, particularly relevant and exciting given the first observation of gravitational waves had been reported earlier that year.

In 2019, Dr Finkel gave a plenary speech and held a number of side meetings with experts in research integrity at the 6th World Conference on Research Integrity, in Hong Kong. Dr Finkel also tied this visit in with his role leading the development of Australia's National Hydrogen Strategy, visiting Shenzhen to tour the world's largest electric car manufacturer, BYD, and to visit the UNSW-Kohodo Hydrogen Energy Laboratory, a pilot hydrogen production facility.

APEC Chief Science Advisors and equivalents

In 2018, Dr Alan Finkel and Professor Lohi Matainaho, Chief Scientist for the Papua New Guinea Government, co-hosted the Asia-Pacific Economic Cooperation (APEC) Chief Science Advisors and Equivalents (CSAE) in Brisbane.

The CSAE is APEC's primary forum for synergies between science, public policy and international engagement across 21 economies in the Asia-Pacific region. The 2018 meeting focussed on how science can inform policy making to support open, inclusive and sustainable economic growth.

Dr Finkel participated in a program of events, including chairing a high-level Industry Roundtable and an Entrepreneurship Showcase reception. These events engaged the private sector to address a multistakeholder problem in the APEC region: how do we support vulnerable groups (women; indigenous; rural; young) to make full use of their STEM and entrepreneurship skills.

Leading an innovation delegation to Europe

In 2017, Dr Finkel led an innovation delegation to Europe to build international innovation engagement between Australia and key European nations. Across eight days, the delegation visited Germany, Switzerland and France and met with industry, government and research officials. Dr Finkel delivered a number of speeches in Europe and was pleased to work with other members of the delegation, including representatives from Australia's Industry Growth Centres and other peak bodies supporting innovation and science in Australia.





International energy and hydrogen trips

As part of the National Electricity Market Review in 2017, trips to Europe and North America allowed a better understanding of how comparable markets were transitioning away from fossil fuel sources. Dr Finkel met with government departments, energy providers, energy regulators, grid operators, research organisations and companies.

In developing and supporting Australia's National Hydrogen Strategy, international engagement during 2018 and 2019 included leading a delegation of Australian industry, government and research leaders to Japan in September 2018, Europe in February 2019 and the US and Canada in April 2019.

Following the release of the National Hydrogen Strategy, Dr Finkel returned to Japan, and the Republic of Korea in December 2019 to meet with government and industry and discuss the benefits of partnering with Australia as a hydrogen supplier.

Supporting Australia's Chief Scientist

During his tenure, Dr Finkel has had close and positive engagement with Prime Ministers, Ministers for Science and other Ministers and their offices, facilitating the delivery of important strategies, reports and reviews for Australia across a range of topics. In this work, Dr Finkel has been ably supported by the staff in his office, public servants, scientists, researchers and industry experts.

Support for reviews and activities chaired by Dr Finkel

National Contact Tracing Review (November 2020)

- Expert Advisory Panel
- Taskforce comprising staff from Department of Health, Department of Prime Minister and Cabinet and Office of Chief Scientist

Low Emissions Technology Statement development (September 2020)

- Ministerial Reference Panel
- Taskforce at the Department of Industry, Science, Energy and Resources

CSIRO Bushfire and Resilience Expert Advisory Panel (June 2020)

- Expert Advisory Panel
- Team at CSIRO

Innovation Metrics Review (March 2020)

- Co-Chair
- Taskforce members at Department of Industry, Science, Energy and Resources; and Australian Bureau of Statistics
- Steering committee and Expert Working Group, International Expert Panel, Intangibles Expert Working Group, ATSE Expert Working Group

Australia's National Hydrogen Strategy (November 2019)

- National Hydrogen Strategy Steering Committee
- National Hydrogen Strategy Taskforce comprising staff from the former Department of the Environment and Energy, the former Department of Industry, Innovation and Science and State and Territory Governments

Independent audit of the National Offshore Petroleum Safety and Environmental Management Authority's consideration of exploration in the Great Australian Bight (September 2019)

- Expert advisors
- Taskforce comprising staff from the former Department of Industry, Innovation and Science

Optimising STEM industry-school partnerships (April 2018)

- Members of the forum
- Staff at the former Department of Industry, Innovation and Science and the former Department of Education and Training

National Electricity Market Review (June 2017)

- Review panel members
- Review taskforce from the former Department of Environment and Energy

National Research Infrastructure Roadmap (May 2017)

- Expert working group
- Taskforce at the former Department of Education and Training

R&D Tax Incentive Review (April 2016)

- Co-Chairs
- Taskforce at the former former Department of Industry, Innovation and Science, and the Treasury Department



Office of the Chief Scientist

Members of the Office of the Chief Scientist work across a broad spectrum of projects and activities.

The key roles that support the Chief Scientist are:

Chief of Staff

As well as managing all the staff in the Office of the Chief Scientist, the Chief of Staff supports the Chief Scientist and is responsible for working with Ministers and their offices across government and linking the work of the Office of the Chief Scientist with the wider work of the APS.

Policy

The policy team works with colleagues in the APS, academia and industry to contribute to policy, conduct original research, manage projects and deliver programs.

Communications

The communications team supports the Chief Scientist in preparation for public engagements, including speeches, presentations and events. They also engage directly with the Australian and international media, and the community via traditional and social media with a strong focus on STEM and education outreach.

Administration

The administration team manages enquiries and correspondence to the Chief Scientist, provide secretariat support for meetings both large and small, and manage the Chief Scientist's diary and engagements.

Endnotes

- 1 To move research from quantity to quality, go beyond good intentions, Nature, 2019.
- 2 Introductory address to the Innovation Metrics Review International Workshop, 13 March 2019.
- 3 *AI on my device, not in the cloud,* an address to the Centre for Artificial Intelligence and Digital Ethics (CAIDE), 20 March 2020.
- 4 *Harnessing the power of artificial intelligence to benefit all,* Go8 Artificial Intelligence Collaboration and Commercialisation Summit, October 2019.
- 5 *The orderly transition to the electric planet*, National Press Club address, 12 February 2020.
- 6 A letter to a Year 10 Student, Cosmos, August 2019.
- 7 *Alan Finkel's 2020 Vision: 'We must cultivate the natural curiosity and capabilities of children',* The Guardian, 20 February 2020.
- 8 *Expanding STEM options for all Australian students,* Chief Scientist Media Release, 16 August 2017.
- 9 Find STEM Activities For Your Kids At This New Website, GISMODO, August 21 2017.
- 10 *Prime Minister's Prizes for Science Chief Scientist says get nominating!*, Video by Department of Industry, Innovation and Science, February 2019.
- 11 *Celebrating small science with big impact,* Media Release, 18 October 2017.

For further information, please visit www.chiefscientist.gov.au

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