

FOCUS

WHERE IS AUSTRALIAN AGRIBUSINESS HEADING?

LEVERAGING
TECHNOLOGY AND
INNOVATION TO
MEET THE MANY
CHALLENGES



Clunies Ross Awards

2016 Sydney

The Awards are an initiative of The Australian Academy of Technology and Engineering (ATSE). They are the only Australian headline awards for science and technology which highlight the hard work, extraordinary risks and long-term commitment needed to achieve, through commercialisation, the practical marketplace impact on applied science and technology.

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The Academy congratulates
the 2016 ATSE Clunies Ross
Awards winners

ENTREPRENEUR OF THE YEAR AWARD

Dr Elaine Saunders

CEO, Blamey Saunders hears

KNOWLEDGE COMMERCIALISATION AWARD

Professor Maree Smith FTSE

Executive Director, Centre for Integrated Preclinical
Drug Development, University of Queensland

INNOVATION AWARD

Professor Peter Murphy

Professor in the Energy and Advanced Manufacturing
strand of the Future Industries Institute,
University of South Australia

AUSTRALIAN ACADEMY OF
TECHNOLOGY AND ENGINEERING

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Front cover photo: Technology is the future of Australian agriculture.



ATSE *Focus* is produced to stimulate discussion and public policy initiatives on key topics of interest to the Academy and the nation. Many articles are contributed by ATSE Fellows with expertise in these areas. Opinion articles will be considered for publication. Items between 800 and 1400 words are preferred. Please address comments, suggested topics and article for publication to editor@atse.org.au.

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BATTERHAM MEDAL

FOR ENGINEERING EXCELLENCE



One of Australia's most innovative young engineers will win the 2016 Batterham Medal.

NOMINATIONS CLOSE ON 14 AUGUST.

The Batterham Medal is an early career award for a graduate engineer who has achieved substantial peer/industry recognition for his/her work in the past five years. The Academy administers the award on behalf of the Group of Eight Deans of Engineering and Associates and the Medal will be awarded at ATSE's Oration Dinner on 25 November 2016 in Melbourne.

The winner will receive the Batterham Medal and a cash prize of \$5000.

THE WINNER WILL BE AN ENGINEERING GRADUATE OF AN AUSTRALIAN UNIVERSITY, UNDER 40 AT 1 JANUARY 2016 AND WILL:

1. have demonstrated excellence, innovation and impact in a field of engineering;
2. be clearly acknowledged by peers for a signature contribution to engineering in the five years prior to his/her nomination; and
3. have advanced the standing of the engineering profession.

The Batterham Medal recognises **Professor Robin Batterham AO FEng FAA FTSE**, an Australian science and technology leader who was Chief Scientist of Australia from 1999 to 2006, President of the Academy from 2007 to 2012 and is Kernot Professor of Engineering at the University of Melbourne.

THE BATTERHAM MEDAL GUIDELINES AND NOMINATION FORM ARE AVAILABLE AT www.atse.org.au/batterham-medal

NOMINATE AN INNOVATIVE YOUNG ENGINEER TODAY.



BY TONY GREGSON
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The future of farming.

A big opportunity – that won't be easy

AUSTRALIAN AGRIBUSINESS Australia must act now to ensure a profitable, sustainable and secure agribusiness sector in the face of global challenges.

In the years leading up to 2030 a focus on emerging markets and their growing middle classes provides the Australian agribusiness sector with significant opportunities.

Balanced with this is the changing landscape of consumer expectations in the domestic market, and the varying expectations of the 'clean and green' credentials of Australian produce, in both domestic and overseas markets.

Consistent and clear information across the supply chain will be essential for consumers, industry players and investors to confidently participate in the market.

While technology improvements won't solve all the challenges the agriculture sector faces, the adoption of available and emerging technologies presents many potential benefits. The Australian agricultural sector will need to embrace new science as it becomes available, including biotechnology and robotics, to remain globally relevant, competitive and to maximise profitability.

To achieve this, our workforce will need to be digitally competent with appropriate business skills.

Investment will be necessary to advance the desired changes in this capital-intensive industry and to generate profits for investors, processors and producers.

As well, we cannot ignore the major issues of climate change, biosecurity, the role of foreign investment and food security – they will all be pivotal in shaping Australia's agricultural future.

FARMING THE FUTURE

Technology developments have the potential to provide significant benefits to the agribusiness sector including reducing uncertainty, boosting productivity, lowering input and production costs, and reducing

environmental impacts.

Automation will bring costs of production down around the world and will change agribusiness business models. Physical changes to work practices through the introduction of robotic and drone technology are already part of Australian agricultural practices with precision agriculture and driverless machinery. This will increase.

Robots, drones, satellites (GPS technology) and fixed sensors are already improving land and water resource management and determining the location and health of livestock or crops. Infrastructure that facilitates the capture, sharing and extraction of this data is essential. The market for data analysis, via brokers or experts in specific fields, will probably lead to a proliferation of service providers.

This article reflects the discussion at the recent ATSE National Technology Challenges Dialogue Agribusiness 2030 (see page 28). Dr Tony Gregson chaired the Dialogue Committee. Other theme articles in this edition of *Focus* have been written by lead presenters at the Dialogue.

THE KEYS

We need to grasp the future and work to ensure that Australia:

- has strong government leadership;
- provides opportunities for investment;
- encourages and even forces cross-sectoral collaboration;
- insists on information sharing;
- achieves public awareness of agricultural technology;
- turns climate change adaptation into commercial opportunities;
- ensures that future generations of agribusiness professionals have the right mix of skills and experience; and
- develops an integrated plan for Australia's farming and food future.

Some producers are already embracing these changes, as many innovative and potentially revolutionary technologies are commercially available and more are in the research pipeline. But so far adoption is limited to a small proportion of the agribusiness sector – by scale, access to capital and – in some cases – inertia.

Broad-scale change in the agricultural sector is likely to be generational and will be heavily reliant on what are being understood as STEM skills (science, technology, engineering and maths) to drive the necessary innovation. Fast, sustainable internet access will increasingly be a key business requirement to enable producers to operate efficiently.

Access to infrastructure, capital and tailored programs to assist smaller-scale producers will assist with the facilitation of sector-wide innovation.

But we face some key issues.

BIOTECHNOLOGY

The development of advanced precision gene-editing technologies has potentially revolutionary prospects in agriculture.

Conventional breeding has been used to introduce useful traits into plants and animals for centuries. Gene editing now allows us to specifically alter gene segments with high precision. This allows us to introduce desired genetic variants (or suppress undesirable ones) and has the potential to improve drought and disease resistance, decrease the use of fertilisers, herbicides and pesticides, and increase nutritional profiles.

A balanced and adaptable policy and regulatory framework will be necessary to enable Australia to reap the benefits of agricultural biotechnology while respecting the concerns and values of the public. A regulatory approach that considers the product rather than the technology (that is, the characteristics of a novel crop rather than the specific technology used to create it) would be desirable.

CLIMATE CHANGE

The climate is a major factor in all aspects of agricultural production and climate change poses very real threats for agricultural producers including rising global temperatures and sea levels, increased frequency of extreme weather events, and land use changes.

Australia is already seeing a reduction in crop yield growth, which can be attributed to the impacts of climate change (increased temperature and decreased rainfall). However, Australian agribusiness has the opportunity to turn climate change adaptation into a competitive advantage. By proactively addressing the agricultural challenges that are predicted from climate change, Australia can help to secure local production and export this knowledge internationally.

The development of new technology solutions for the challenges of climate change will be essential to support producers' adaptation responses.

Improved meteorological forecasting and communication will equip Australia's producers with the best climate outlook information available to support their decision-making. This will be supported by new services, underpinned by technology improvements including advanced modelling on supercomputer systems. Big data, remote sensors and internet connectivity have the potential to increase the accuracy of meteorological modelling, and provide real-time information and insights.

COLLABORATION

Developments in digital technology have enabled new ways of collaborating and sharing information. This presents a range of opportunities in improving research engagement, sharing data, streamlining regulatory processes and developing new business models. It also presents many challenges, with issues of data ownership and security, and interoperability and quality of data.

A sustainable agribusiness sector will link agribusinesses, researchers, service and technology providers, consumers, investors, and government.


CONSUMERS

Understanding what drives consumers is subject to a complex values system, based on factors such as ethics, environment, financial status, cultural background and health – which in turn determines what goods they purchase and from where.

How the agriculture sector attempts to respond to consumer needs will be driven by which market they are targeting. For example, the concept of 'clean and green' may have different meanings for consumers in China and India compared with Australia and how these messages are framed will be pivotal.

There is a big divide between food and agriculture's role in nutrition and what that means for consumers. Health information around diseases such as diabetes and obesity is often provided in a different context to food purchasing decisions and consumption – representing a significant disconnect. Better links need to be made between what is produced and what is consumed and the relationships to health factors.

Households are also increasingly seeking information relating to the provenance of the food purchased. There will be opportunities to use digital technologies to track the provenance, processing and transportation of food products and to provide this information at the point of purchase. This in turn will provide invaluable data to the agribusiness sector.

To maintain its social licence, the agribusiness sector (along with the scientific community and decision-makers) must listen to and understand broader community views and values and then consider how to use new technologies in food production in ways that are socially and environmentally responsible. 

Dr Tony Gregson AM FTSE is immediate past Chairman, Plant Health Australia, and former Chair, Board of Trustees, Bioversity International. Dr Gregson is a grain grower from Victoria's Wimmera region with an extensive science and corporate research management background. He is Chairman of the Victorian Committee of the Crawford Fund and a board member of the Crawford Fund; Chairman of the University of Melbourne School of Botany Foundation; and a Director of Rural Industries Skills Training. He is a former Chairman of two CRCs, an inaugural member of the CSIRO and GRDC boards and a former member of the CIMMYT, ANSTO and Rural Finance Corporation of Victoria boards.



BY JOHN MANNERS
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Almost 100 per cent of Australia's cotton incorporates GM traits.

Technology and vibrant innovation are the keys

AUSTRALIAN AGRIBUSINESS Digital technologies have transformed the travel, retail and finance industries but are in their infancy in the agriculture and food industry.

A

Australian agriculture faces opportunities and challenges. The major economic opportunity is the rapidly growing middle

class in Asia driving increased demand for diverse, high-quality, safe, healthy, and ethically and sustainably produced food products from Australia.

The overarching challenge is for Australia to play a significant role in developing and applying technologies that will help meet the food-security needs of a growing global population where net production is under stress from climate change and diminishing resources.

Technological developments, in combination with vibrant innovation systems, will be needed for Australia to be successful in these endeavours. No single technology or approach will provide a silver bullet solution and it is the integration of multiple approaches into an improved food-production value chain and export system that will be the key to success.

DIGITAL AGRICULTURE.

Technology-driven changes, particularly from ICT, have had significant impacts across the global economy in the past 15 years. For instance, in the US, digital service companies have replaced manufacturing and finance entities as the most valuable major corporations. This transformation and disruption will continue in the next decade, including agriculture and food systems.

The catalysts for this change are

- new proximal sensors (aerial, vehicular and fixed) and remote satellite sensing technologies capturing farm data;
- big data analytics integrated with advanced modelling that can predict options for cost efficiency and profitability; and
- the development of robotics and automated systems that can deliver precise interventions

on-farm at high levels of precision.

These technological advances have led to the rise of new digital agricultural service providers. For example, The Climate Corporation, a Monsanto-owned company founded on detailed weather and climate data analysis and prediction, has recently entered the market in the US corn-belt, providing systems that guide input decisions at precise spatial resolution.

In Australia, Accenture, an established digital service provider in other sectors, is working with the National Farmers' Federation to launch digital agricultural services for selected primary industries in Australia.

These precise, personalised, decision-support systems enable enterprises, consultants and growers to make informed management decisions that weigh risks and

This article was prepared with input from CSIRO Agriculture and Food's Deputy Director Dr Michael Robertson, Research Director Dr Dan Walker, Principal Research Scientist Dr Dave Henry and Research Director Mr Mike Grundy, and CSIRO Health and Biosecurity's Science Director Dr Gary Fitt FTSE.



Clunies Ross Awards

2017 NOMINATIONS NEW FORMAT AND CATEGORIES CALL FOR NOMINATIONS

Nominations for the 2017 Clunies Ross Awards open Tuesday 16 August 2016 and close Friday 28 October 2016

The new format and specific categories introduced in 2016 will be continued in 2017.

Over the past quarter of a century the Awards have recognised contributions by dedicated individuals to the application of technology for the benefit of Australia, highlighting ATSE's commitment to fostering innovation and commercialisation and acclaiming the work of those taking the nation's leading technologies to the marketplace.

Winners of the 2017 Clunies Ross Awards will be announced at the **2017 Innovation Dinner**.

IF YOU WISH TO NOMINATE A 2017 AWARD CANDIDATE GO TO THE ATSE WEBSITE, www.atse.org.au/cluniesrossawards

CATEGORIES

The three award categories are:

Clunies Ross Entrepreneur of the Year Award

For those who have been responsible for the creation of a product or service with a financially successful outcome, in either an early stage or mature company environment with demonstrated impact for Australia.

Clunies Ross Knowledge Commercialisation Award

For those who have been responsible for a technology which has been commercialised, most likely by licensing, with a financially successful outcome.

Clunies Ross Innovation Award

For those who have been responsible for the adoption of a technology, at a stage where the financial outcomes are yet to be realised and/or the benefits are of a measurable broad community nature.

CRITERIA

The award criteria are:

1. The award winner has made an identifiably significant contribution to the advancement of industry and/or the community through the application of science and technology for the economic, social and environmental benefit of Australia;
2. The award winner is able to demonstrate the impact or potential impact of the technology-based innovation; and
3. The award winner has advanced the promotion of innovators and community awareness of technological innovation.

benefits around growing environments, inputs, costs and potential profits.

The development of digital agricultural services in the Australian context raises several challenges.

The **first** is the ownership and control of data on farm performance. Data management will require the development of a code of conduct about how on-farm data is collected and used, either by regulation or industry consensus. The US and New Zealand already have such codes in place and these systems reduce level of anxiety about access to, and use of, data collected by farmers.

Coordinated data storage will facilitate the provision of platforms that allow farmers to store, access, re-use and even market their own data with appropriate protections for ownership and privacy and also allow better interoperability between datasets collected by different proprietary systems.

A **second** issue is the availability of fast broadband access and connectivity to the internet in remote rural regions of Australia. It is possible that private fast broadband networks may arise for rural areas, similar to systems in development in other countries (like R4BN in the UK). Large-scale precision farming also requires local wireless connectivity. Innovative new options for local wireless networks exist – such as CSIRO's Ngara technology, the use of unsold 700 MHz spectrum or for longer range (over 30 kilometres) use of VHF frequencies, which are typically utilised in Australia for digital TV transmission in metropolitan areas.

Innovations in these systems will allow farmers to harness the 'internet of things' and use decision aids in the paddocks, control autonomous machinery, and monitor crops and livestock from the homestead.

There is also scope for improvement in the quality and density of soil and weather grids for Australian rural areas that are necessary for many robust digital agricultural services. Australia lags behind what is available in the US, although progress has been made with the national soil grid that

provides information on soil systems at a 90-metre x 90m resolution.

New technologies can achieve higher resolution in targeted areas to collect the same effective underpinning data that exists in the US. Similarly, there is an opportunity to deliver improved localised weather information that builds on the core services of the Bureau of Meteorology to support farm decision-making.

Ultimately, the combination of more detailed soil and weather data with on-farm data streams captured in real time using a variety of sensor systems, can be coupled with predictive models, such as Australia's APSIM platform, in a process known as data-model fusion and be used to provide precise predictions and decision-support systems to assist farm efficiency and profitability.

BETTER OUTCOMES

More optimal fertiliser and water inputs, pesticide applications, harvest scheduling and product quality for markets would be expected outcomes from these applications.

Most of the digital agricultural services that are being applied in the US are initially focused on the large-scale corn and soybean field-cropping systems. These services may be able to be readily adapted to Australian broadacre cropping, particularly grains.

However, livestock production – either in extensive grazing systems or in mixed farming operations – is a key feature of the Australian agricultural landscape. Livestock carrying GPS-enabled sensors and devices as collars, implants or ear tags can allow the monitoring of location, activity and health. A current example of livestock applications is virtual fencing, where animals are taught by stimuli to remain within predetermined GPS boundaries without physical fencing.

Digital technologies have been highly disruptive to value chains in other industries and allow the direct communication between all elements of the chain and allow direct connection with consumers. This process that has transformed the travel, retail and finance industries is in its infancy in the agriculture

and food industry. However, efficiencies in food and agriculture delivery have already been obtained by the analysis of supply-chain data, with the analysis of northern Australian cattle transport systems using the Transit program being one example.

Finally, scarce and expensive labour in rural areas will also drive the move towards the automation of farm tasks, with collateral benefits for safety and efficiency. New options in farming equipment are also under development with smaller flexible 'swarms' of automated machines likely to compete with the increasingly larger planting and harvesting machines produced by established companies.

Some generic 'autonomous farm bot' vehicular platforms have already been developed in Australia and overseas with capacity for multiple sensors, cameras and tools attached to complete diverse tasks, such as tailored and precise delivery of fertiliser and pesticide inputs at a single plant level.

GENETIC AND BIOLOGICAL INTERVENTIONS

Traditionally, plant and animal breeding has contributed greatly to increased yields in the cropping, horticulture, livestock, dairy and aquaculture industries of Australia. The first genetically modified (GM) organisms (cotton varieties) were released in 1996 and now almost 100 per cent of Australia's cotton incorporates GM traits, such as herbicide and insect pest resistance. This has resulted in a better than 80 per cent reduction in insecticide use in the industry and has provided social licence to continue to operate. Since 2008 GM canola crops incorporating herbicide resistance have also been grown in Australia.

The commercialisation of GM crop varieties has been influenced by moratoria introduced by some state and territory governments. Internationally, GM traits have been rapidly adopted in many countries, mainly in broadacre crops (corn, soybeans, cotton and canola), and are now thought to occupy more than 180 million hectares globally.

**CONTRIBUTIONS
ARE WELCOME**
FOCUS



Opinion pieces on technology related topics, preferably between 600 and 1400 words, will be considered for publication. They must list the full name of the author, if a Fellow of the Academy. Other contributors should provide their full name, title/role and organisation (if relevant) and email address. Please address to editor@atse.org.au



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Regulatory costs, consumer concerns about the technology and market uncertainty have reduced the momentum of uptake of GM traits and GM crops in Australia. Nonetheless there are some exciting GM products that are in the pipeline and the commercialisation of GM canola containing oils enriched in long-chain fatty acids is likely to occur within a five-year timeframe.

Omega-3 oils are produced by algae and accumulate in fish oil. A canola crop source of omega-3 oils would have markets in aquafeed and healthier food products and reduce dependency on wild-catch fish as a feed and food source of omega-3 oil, enhancing sustainability in threatened global fisheries.

In recent years new technologies for making targeted modifications in the genome of organisms have emerged, which are collectively termed 'gene editing'. This enables targeted deoxyribonucleic acid (DNA) deletions or additions at precise locations in the genome. The precision of gene editing overcomes many of the concerns that have been raised about GM technology where there is little control over where an inserted transgene inserts in the genome.

Examples of projects that are currently exploring gene editing as a tool include:

- making a single amino acid change in a wheat cell wall polysaccharide-synthesising enzyme that can make wheat grain fibre adopt the cholesterol-lowering properties of oat grain fibre; and
- eliminating disease susceptibility genes from wheat, making disease-resistant crops.

The targeted change of single DNA bases can create a mutation in a gene that blocks or changes its function. The end result is identical to outcomes more conventionally achieved by mutation that occurs via natural copying errors or is induced by chemical or radiation treatments. Currently, induced mutations are not regulated and are commonly used in breeding programs to generate genetic variation.

Preliminary rulings from the US Department of Agriculture suggest that organisms subjected to gene editing resulting in DNA deletions or single base changes will not be subject to the same regulation as GM organisms in the US because the outcomes are equivalent to what can be achieved, and is accepted, in mutation-breeding.

These decisions, if adopted outside the US, potentially open the way for this

technology to be utilised in plant and animal breeding without the regulatory costs associated with deregulating GM organisms – but more communication with consumers will be necessary.

Gene-editing-related technologies also offer new and highly targeted options for management of pest organisms in agriculture and the wider environment. In particular 'gene-drive' technologies offer the capacity to force specific genetic changes into pest populations to influence survival patterns, reproductive success or other traits in ways that either lead to a major decline in the pest population or a reduction in their damaging potential.

Gene-drive technology uses endonuclease enzymes also used in gene editing to disrupt essential genes within populations of pest species to provide a stable and cost-effective mechanism for controlling these species. By targeting sites in the sex chromosomes these 'homing endonucleases' are able to spread engineered genes throughout target populations much more quickly than would be possible via simple genetic inheritance.

RAPID ADVANCES

The past decade has seen rapid advances in the development and use of this technology, which can provide innovative options for sustainable management of agricultural pests. Gene-drive applications will challenge current regulatory frameworks and community concerns. Unlike the gene-editing technology described previously for crop improvement, gene drive is a GM technology and so would be subject to current GM regulatory oversight. Gene-drive technology is best considered as the GM equivalent of classical biological control.

Finally, the high cost of meeting regulatory requirements and public concerns, for both pesticides and GM technologies are also spurring the investigation of alternative interventions that can positively influence productivity and profitability in the farming sector.

One class of interventions is generically termed 'biologicals' and includes either biologically based agents or living organisms that can be applied ectopically to plants and animals. An example of a biologically based agent is exogenously applied RNAi molecules that are able to enter cells and silence the expression of specific targeted genes.

Monsanto has filed a patent application that uses this technique to silence genes that provide herbicide tolerance in weeds, making these weeds again susceptible to herbicide treatments.

The application of microorganisms to plants has been used for decades in the biological control of diseases. What is new is that metagenomic analysis of the microorganism population (microbiome) that associates with plant roots and the surrounding soil has indicated that plants appear to support a distinct profile of microbes. These plant-associated microbes, or consortia of microbes, offer the potential for the generation of novel biological interventions that may stimulate plant performance, influence resource use efficiency or even product composition and quality.

Multinational companies have responded to this by acquisitions or alliances with smaller companies specialising in microbial discovery and also several new companies have been formed to pursue such new biological agricultural products. The expectation is that these biologically based products will have a clearer path to market.

These are examples of the many new technologies that will become available to boost Australian agriculture and the value of its exported products.

Given the relatively small size of the Australian market for new agricultural products, private incentives for investment and adoption may be insufficient to effect rapid change and public-sector funds will be needed to appropriately create valuable public goods that drive national innovation.

Public investment could play an enabling role in adoption of digital technologies through fostering leadership, technological foundations and public infrastructure in addition to the underpinning science. ☺

Dr John Manners is the Director of CSIRO Agriculture and Food, which coordinates and integrates all of CSIRO's research on plant and animal improvement including aquaculture species, food science, farming systems, science for sustainable production and international research aimed at improving food security globally. He was formerly Chief of CSIRO Plant Industry. Recent significant positions include: Deputy CEO, CRC for Tropical Plant Protection, Honorary Professor in Biochemistry and Molecular Biology at The University of Queensland, Board Director of the International Society for Plant Molecular Biology, and Member of the Gene Technology Technical Advisory Committee of the Australian Government's Office of the Gene Technology Regulator (OGTR).



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BY ALISON WATKINS
alison.watkins@ccamatil.com

We have a strong hand but we're not alone

PHOTO: CSIRO

An idyllic farm – but the market's much tougher.

AUSTRALIAN AGRIBUSINESS It would be a privilege rather than a right for Australia to be the preferred supplier of high-quality, safe and premium food for our region.

I've spent most of my life in and around agricultural, food and beverage businesses. I grew up on our family farm, learning all I could from my father, and more recently have had the privilege of leading the ASX-listed Graincorp and now Coca-Cola Amatil, one of the largest food and beverage manufacturers in the country.

I've always been enthusiastic about our sector and my optimism today regarding the future of agribusiness has never been stronger.

Last year, I was fortunate to chair the Business Council of Australia's (BCA) Agriculture and Food Manufacturing Steering Committee. I was joined by other passionate agribusiness leaders, including from Allens, ANZ, Coles, Incitec Pivot, JBS, Lion, Murray Goulburn, Telstra and Woolworths.

We developed an extensive report titled *Building Australia's Comparative Advantages: A 21st Century Agrifood Sector*.

My vision – drawn from our BCA work – is for Australia to be the preferred supplier of high-quality, safe and premium food for our region.

This vision is inspired by the strength of the hand of cards Australia holds today. We know global food demand will increase by more than 40 per cent by 2030, and 77 per cent by 2050.

Approximately 70 per cent of this demand will happen across Asia in countries like China, India and Indonesia, which cannot be self-sufficient, and where Australia has a geographic advantage and strong reputation.

However, we are not the only country to consider Asia a huge growth driver, nor are we the only country with the credentials required to supply premium, safe, quality products.

The US, Canada, Brazil, Argentina and

New Zealand are absolutely in the mix. In fact, New Zealand aims to double primary exports by 2025 and lift exports as a share of GDP from 30 to 40 per cent.

Australia does not have an entitlement to feed the growing Asian middle class. It would be a privilege rather than a right for Australia to be the preferred supplier of high-quality, safe and premium food for our region.

With that in mind, there are some important things Australia needs to do in order to take advantage of the demand in our region.

INVESTMENT

Australia is a relatively small country with large capital needs. ANZ's 'Greener Pastures' paper of 2012 estimated \$1 trillion in capital would be required by 2050, of which \$600 billion was needed just for liquidity.

A summary of the address to the 2016 ATSE Agribusiness 2030 Dialogue in Sydney by Ms Alison Watkins, Group Managing Director Coca-Cola Amatil.



Our vision is to create sustainability and excellence in Australia's power engineering.

What is the API?

The Australian Power Institute (API) is a not for profit national organisation established by the Australian power industry to boost the quality and numbers of power engineering graduates with the skills and motivation for a career in the energy industry which encompasses:

- Generation, transmission and distribution utilities
- Manufacturers and suppliers to the industry
- Consultants to the industry
- End users of electricity in their operations.

Value Proposition

To deliver a sustainable supply of highly skilled power engineering professionals working effectively to meet the challenges of creating Australia's new energy future, and underpin the technical and commercial success of member companies in the energy sector.

The key objectives of API are to achieve the following:

- Provide a sustainable supply of quality power engineering graduates to industry
- University power engineering teaching and learning provides relevant industry skills
- Value added continuing professional development programs
- A respected organisation leading the national development of power engineering skills.

Further Information

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Infrastructure needs to be low cost. We have a vast country and much of our grain rail infrastructure is inefficient, leading to road 'work arounds', which is not much better. Value-adding will require investment to modernise facilities, similar to what Coca-Cola Amatil is doing with SPC in the Goulburn Valley.

The difference between a top and bottom quartile farmer, in terms of productivity, is enormous and is often related to scale and infrastructure, as well as skill set.

In agribusiness, exchange rates and market volatility create risk that requires patient equity, not debt. Australian investors are cautious about investing in our own agribusiness sector. We must be open to foreign investment in order to grow.

History shows our major trading partners are the logical source of equity, but we are very cautious when it comes to investment from our current major trading partner – China. There is no doubting the importance of robust scrutiny when it comes to opening up strategic resources for such investment. What we do know is that outbound Chinese investment is multiplying and presents a huge wave of opportunity globally and that is what we should try to harness in order to avoid missing out on the opportunities before us.

To become more comfortable with the need for foreign investment, we need to define more broadly how and where future investment will be coming from and our priority areas for investment.

COMMODITIES PLUS

Australia already feeds approximately 60 million people and there are expectations that this number will double by 2030. If we can reach 100 million people, or thereabouts, by 2030, that will still be only three per cent of the three-billion-strong middle class population expected to live on Australia's doorstep by that time.

In order to maximise value for Australia we should focus on the most discerning among them, those most concerned about food safety and quality. Japanese consumers demand,

and will pay for, the very best cherries and strawberries. Chinese parents demand, and will pay for, the very best infant formula.

I would like to think of Australia as the boutique delicatessen offering the best of everything and operating at scale, rather than a small supermarket selling the same product as everyone else.

The Food and Agribusiness Growth Centres, recently established by the Federal Government, provide great opportunity to ensure that we understand and remove the roadblocks that might prevent Australia from capitalising on these, and many more valuable opportunities.

CONSUMER FOCUS

Ultimately, it all comes down to Australian agribusiness understanding and delivering for the consumers in our destination markets in a way that is well beyond what we have ever done before. We need to get to know our end-consumers really, really well.

Personalisation, segment of one, partnering via local supply chains to reach the consumer, providing complete traceability – these are all examples of the importance of marketplace insight, which is critical to success in Asia, or anywhere for that matter.

Securing long-term relationships with the right partners and obtaining relevant 'on the ground insight' will ensure the products continue to adapt to changing consumer preferences. It is for this reason that agribusiness must reconsider its slow-changing 'lift and shift' view. Shipping excess stock to other markets, particularly Asian markets, won't work today and certainly won't work in 2030.

THRIVING INNOVATION

Of all the points raised there is no doubt that continued innovation is the most critical when it comes to the future for agribusiness. Not just product innovation, but innovation in what we do and how we do it.

Technology is paramount across all aspects of the supply chain. Innovation across

the supply chain will be critical to the way we do business and will create efficiencies that will only further advance our position as the preferred supplier of high-quality, safe and premium food for our region.

One of the big challenges in agribusiness has been labour. People have not found agribusiness to be an attractive career. Graduates across the agricultural sector continue to decline in Australia, while in New Zealand there has been a recent increase. Attracting skilled labour will take an innovative approach, while technology may be required to fill the gap and to make farmer's jobs easier as they continue to age – the median age for a farmer in Australia was 53 years of age in 2011.

Innovation and technology are also key when it comes to 'adding value' and providing a true point of difference. It's very clear to me that if we want to compete on premium, from a high- labour-cost country, we need great technology and innovation – directed at productivity, food safety and quality.

So, for Australia to become the preferred supplier of high-quality, safe and premium food for our region – my vision – there needs to be continued focus across several key areas that will be critical to our success.

I am an optimist. We are blessed with natural advantages. We have demonstrated our ability to innovate and adapt.

Our agribusiness sector is unrecognisably better from the one my father showed to me all those years ago, but we must all appreciate that much more change is required, if we are to realise our exciting vision to the fullest. ☺

Ms Alison Watkins has been Group Managing Director, Coca-Cola Amatil since March 2014. She is also a non-executive director of The Centre for Independent Studies and the Business Council of Australia. Her previous roles include Chief Executive Officer of GrainCorp Limited and of Berri Limited, the market leader in Australian juice, and Managing Director of Regional Banking at ANZ. She spent 10 years at McKinsey & Company from 1989-1999 and became a partner of the firm in 1996 before moving to ANZ as Group General Manager Strategy. She has been a non-executive director of Australia and New Zealand Banking Group Limited, Woolworths Limited and Just Group Limited.





BY SALAH SUKKARIEH
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We're bipolar about robotics but growers are going for it

AUSTRALIAN AGRIBUSINESS Robotics requires an overarching discussion across the whole food-production process, including STEM education, ethics, the economic reality of food production and how to introduce robotic technology.

Society has a somewhat 'bipolar' view of robotics in agriculture. Outside of agriculture the application of robotics has an uncomfortable feel to it. Concerns are raised about the potential for turning food production into a soulless, mechanical activity; or that the technology will cause the loss of jobs; or that the process of automation will support the further commoditisation of food.

Growers however have a different perspective. Whether in developed or in developing countries, growers are inundated with many constraints: lack of labour and increasing labour costs; the need to grow more food, cheaply; to use less chemicals and to reduce food and water waste; and dealing with climate and supply chain uncertainty. For

growers, robotic technologies could provide a means to addressing these constraints.

Dealing with this dichotomy requires an overarching discussion across the whole food-production process, including STEM education, ethics, the economic reality of food production, and the application of current and future robotic technology.

For now, Australian growers are quickly turning to the use of these technologies to support on-farm activities.

Some of the key capabilities that robotics will provide include the following.

■ **Measuring crop and/or animal attributes at high spatial, spectral and temporal levels.**

The ability to move a robot (air or ground) anywhere on the farm, at whatever time, under whatever weather conditions, with

a collection of sensors, is changing our understanding of plant growth and animal behaviour and our understanding of food production.

■ **Undertaking laborious tasks 24/7 and tasks with precision using automated tools.**

Robotics will provide growers with the capability to advance their operations such as selective harvesting, herbicide-free weeding, precision water and fertiliser use and repetitive automated crop manipulation, such as thinning and pruning.

■ **Delivering whole-of-farm and supply-chain optimisation.**

As robotics and intelligent software become deeply integrated we will see powerful, automated decision-support systems that will aid growers in managing crop variability, animal health, pest outbreaks, business decisions and supply-chain constraints, and do so under the uncertainties of food production.

Robotics will also have a significant impact on the agricultural sciences. Unprecedented opportunities exist to measure precise information about crops and animals – under actual operational conditions, with high precision and various spectral frequencies – continuously. This will see the use of data analytics over large data sets and will challenge many assumptions and models that are being used currently in agricultural science.

The future will hold a combination of models built from our understanding of biophysical phenomenon with large data sets, and will present challenges on how this knowledge will change farming practices.



SwagBot, used for managing grazing livestock, goes through its paces on difficult terrain.

TREE CROPS

Tree crops pose an interesting challenge to robotics. The wide ranging tree architectures (2D and 3D structures), the different pruning techniques that growers implement and the environmental effects on tree growth mean there is no uniformity in the environment.

Engineers prefer a uniform environment because it simplifies the hardware and software systems needed. The greater the environmental entropy, the more complex the robotic platform has to be, and the more complex the perception algorithms (sensing, data fusion, machine learning) and control algorithms are. This has cost implications and makes the system more fragile when working at the edge of its operating envelope.

Over the past five years we have been looking at effective ways of implementing autonomous perception systems for future robotic systems in the tree crop industry. If the perception problem can be solved or, more-so, if an underlying systems theoretic approach to tree crop perception systems can be obtained, then it will dramatically ease the introduction of robotics into the tree crop industry.

The focus of our work is on developing algorithms that can undertake detailed mapping and segmentation of the terrain and vegetation in a range of horticulture tree crop settings. The algorithms being developed can autonomously identify individual trees as well as the fruit/nut and flowers on those trees.

A series of trials were conducted and successfully demonstrated the use of these algorithms in apple, almond, avocado, lychee, mango and bananas.

VEGETABLES

The vegetable industry has a more structured environment than the tree crop industry, making the application of robotics and intelligent software systems easier, but the profit margins in vegetables are much lower than in speciality tree crops. Hence the focus is on developing technologies that are low-cost, robust and that can operate continuously to monitor crops (the production cycle in vegetables is significantly shorter (weeks) compared to annual tree crops), and deal with pests routinely.

Our work has focused on the development and demonstration of ground robots with supporting intelligent software with the capability of conducting autonomous farm operations for different



The Shrimp robot working an almond orchard.

vegetable crop varieties. The robotic systems developed are lightweight, solar-electric and omni-directional – and use intelligent perception for conducting surveillance (mapping, classification, detection), as well as providing information for future research into high-level tasks such as crop health monitoring and yield estimation.

The robotic systems also have various manipulator arms to conduct autonomous and calculated (time, date, velocity, volume, temperature, space, etc.) delivery of insecticide, herbicide, fertiliser or other fluids and particulates to targets such as the crop, weeds and other pests.

Recently we conducted a trial with one of the robots (RIPPA), which ran for 22 hours continuously before shutting down in the middle of the paddock at 3am, and then starting up again once charged at 10am to resume operation.

GRAZING LIVESTOCK

The grazing livestock industry poses the most significant challenge to agricultural robotics, yet it is the industry that would most benefit from the introduction of this technology. Large undulating areas require more adept robotic systems with increased perception capabilities to identify obstacles and difficult terrain.

The focus of these robotic platforms will be to support growers in providing a greater understanding of their animals, which in turn means the capability of simultaneously

monitoring 'moving obstacles'. These robotic platforms will be able to evaluate biomass, support greater environmental sustainability by moving animals to appropriate grazing locations, and reduce the impact of weeds.

Probably the greatest benefit that this technology will provide is the ability to monitor the health of animals in real time (using thermal and vision sensors, for example) and relaying this information back to the grower.

Recently we demonstrated the SwagBot (a robotic swagman) on a cattle station under remote control conditions. The objective of the trial was to demonstrate the capability of the robot to operate under extreme terrain conditions and to understand cattle behaviour around the robot. The trial was successful and over the next two years we will be looking at increasing its autonomy and defining useful tasks.

SECURITY AND ETHICS

We know nations need to ensure nutritional security. What is not immediately apparent is what role robotics has in supporting this and the impact of this technology under the general banner of food ethics. This is an unexplored area that will probably rise to importance very quickly as we have greater discussions on the role and impact of robotics on society in general.

However, some points that maybe worth considering are the following.

■ Environmental sustainability – robotics will

provide the capability to reduce chemical inputs in the environment and minimise waste in general, and more broadly will support management decisions on the sustainable use of the land.

- Land productivity – robotics will help increase land productivity and reduce food variability.
- Animal welfare – robotics will support the better monitoring of animals, and potentially improve their condition.
- Food prices – robotics will reduce the cost of food production to a base level, meaning that globally the cost will be similar for producing any specific food item, reducing any competitiveness, and also potentially commoditising food further.
- Global demand – almost all nations are currently exploring the use of robotics (and emerging technologies more generally) in the agriculture sector. This trend has implications for export aspirations.
- Employment – robotics and intelligent systems will reduce labour requirements on the farm, but this will have an

impact on regional centres in terms of employment and secondary services.

- Digital divide – tech-savvy growers will benefit from robotics solutions earlier, potentially causing greater consolidation of farm and food production.

These are all elements of a much wider discussion on the role of food and of food production, given global population growth and dwindling resources. However, what is immediately apparent is that we need to provide a systematic approach on how technology, education and employment come together in the food-production process.

This could include:

- improving STEM education in rural communities – both in schools and grower re-training – especially in the role of robotics, automation and ICT in agriculture;
- supporting developing countries in the adoption of these technologies, which cater for their needs, in order to remove pressure on their food-production systems, as well as the global food supply chain;
- shrinking the food supply chain by looking

at individualised growing areas closer to city areas as well as urban agriculture; and

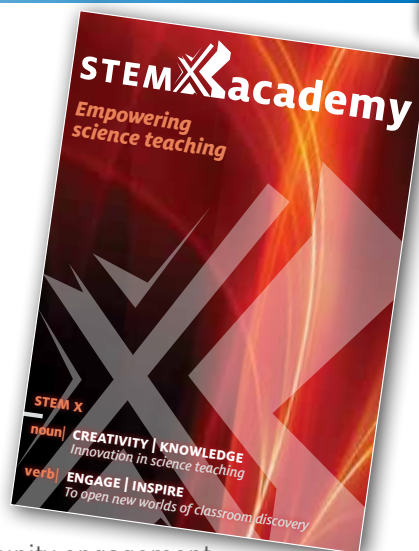
- generating an innovative research-to-commercialisation technology pipeline that is concerned less with economic return, and more with delivering beneficial technological solutions for sustainable food production.

While this discussion will – and should – continue, it is already abundantly clear that the potential for agricultural robotic technologies to improve food security, quality and affordability on a global scale is significant. ☺

Professor Salah Sukkarieh FTSE is Professor of Robotics and Intelligent Systems, School of Aerospace Mechanical and Mechatronic Engineering, University of Sydney, and Director of Research and Innovation at the Australian Centre for Field Robotics. He is a pioneer in the research, development and application of robotics and intelligent systems. He has worked with a range of companies and government organisations to apply these technologies in industrial and civilian applications for Australian and international benefit. He is a world leader in autonomous navigation and mapping for robotic aircraft and in the application of this technology to operational systems in aerospace, biosecurity and agriculture.

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BY CRAIG CORMICK
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Emotion clouds our views on technology

AUSTRALIAN AGRIBUSINESS Arguing about the validity of the science is about as effective in changing attitudes as taunting name-calling.

A

At last – a significant, credible report has come out and stated definitely that genetically modified (GM) crops present no

more substantial risk to human health than conventionally bred crops.

The almost-400-page report, by the US National Academies of Sciences, Engineering and Medicine, analysed more than 1000 studies on the use of GM crops, since they emerged in the 1980s, to make this determination.

Among the many caveats and nuances, the report even stated that there is some evidence that GM crops have some benefits to human health.

So we can now anticipate no more debates or discussions or discourse over the safety of GM foods, yes? Game over, done and dusted! Well – probably not.

Why? Because when it comes to debates on GM foods, arguing about the validity of the science is about as effective in changing attitudes as taunting name-calling.

And that's because our values, or worldviews, filter our receptiveness to messages and govern our attitudes – and this report is likely to have very little impact on anyone who already believes that GM foods are not safe.

When we are presented with information that is complex we tend to make emotionally based judgements, driven by our values rather than on the information presented to us. So we tend to reject or dismiss messages that don't align with our values or worldviews.

It is already well shown that pro-science and technology values are a strong indicator of support for GM foods and tendencies towards

conspiracy theories are strong predictors for anti-GM positions. That is not to say they are the only drivers of such attitudes, of course, but they are positions that correlate closely.

Studies of how our worldviews and beliefs translate into attitudes towards GM foods have been undertaken by the Department of Industry and Science and the Office of the Gene Technology Regulator. These studies have found there are four key values-based segments of the population that are better predictors of people's attitudes to GM foods than age, gender or other standard demographics.

And a good understanding of these value segments can help us understand what drives support or opposition to technologies in the food chain, such as GM foods.

THE FOUR VALUES SEGMENTS ARE:

Segment 1 (about 20 per cent of the population) – the concerned and disengaged

Segment 1 is the least enthusiastic about the benefits of science and technology. These people have the highest agreement that "the pace of technological change is too fast to keep up with" and are the most likely to agree that "science and technology creates more problems than it solves", that "scientific advances tend to benefit the rich more than the poor", and that "we rely too much on science and not enough on faith".

Segment 2 (23 per cent) – the risk-averse

This segment tends to be less positive towards the benefits of science and



People trust others whose values mirror their own.

technology generally, and biotechnology specifically. These people are also more concerned with related risks. But in contrast to Segment 1, they have relatively high awareness of the term "biotechnology" and various biotechnological applications. They are least likely to agree that "human activities have a significant impact on the planet" and least likely to agree that "not vaccinating children puts others at risk".

Segment 3 (28 per cent) – the cautiously keen

Segment 3 has relatively high interest in



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science, and agrees that “the benefits of science are greater than any harmful effects”. In relation to GM, this segment is the second most positive, yet while awareness of biotechnology is relatively high these people can be very risk-averse. They also have the highest agreement that “children should be protected from all risks”.

Segment 4 (23 per cent) – the science fans

This group is the most positive towards science and technology. These people express greater agreement that “science is such a big part of our lives that we should all take an interest”, that “new technologies excite me more than they concern me” and that “the benefits of science are greater than any harmful effects”. They also strongly disagree that “science and technology creates more problems than it solves” and that “we depend too much on science and not enough on faith”.

When asked if they supported modifying the genes of plants to produce food by introducing the genes of a plant of a different species, the results by segments were stark (Table 1).

Similar values segmentation has been found in relation to climate change and attitudes to science and technology, and they can provide an insight into how to engage

with different audiences.

It's rarely about needing to debate the quality of the science of genetic modification, as the US National Academies of Sciences, Engineering and Medicine report has done. For many people it more about ensuring children are safe from the effects of unknown technologies, or about feeling unsettled by the pace of technological change.

And if you are not addressing these issues you are not addressing or changing their concerns.

If you seek to communicate with the public about a contentious technology, some key points to remember include the following.

- 1** When information is complex, people make decisions based on their values and beliefs.
- 2** People seek affirmation of their attitudes (or beliefs) – no matter how fringe – and will reject any information or facts that are counter to their attitudes (or beliefs).
- 3** Attitudes that were not formed by logic are not influenced by logical arguments.
- 4** Public concerns about contentious science or technologies are almost never about the science – and scientific information therefore does little to influence those concerns.
- 5** People most trust those people whose values mirror their own.

TABLE 1 CONSUMER SUPPORT FOR GENETIC MODIFICATION OF PLANTS BY TWO DIFFERENT MEANS.

Segment	By introducing genes of a plant of the same species	By introducing genes of a plant of a different species
1	49 per cent	29 per cent
2	44 per cent	25 per cent
3	61 per cent	37 per cent
4	81 per cent	59 per cent

When turning this knowledge into action you need to:

- address people's Values of Concern as well as their Attitudes of Concern; and
- identify people's values and then frame a message to align with those values,

Recognising that people are receptive to messages that align with their values gives you a much higher chance of your message being accepted. ☺

Dr Craig Cormick is a science communicator and author and a former Manager of Public Awareness and Community Engagement for the Department of Innovation, Industry and Science. He has also worked for CSIRO and Qwestacon. He has published a dozen papers on public acceptance of contentious science and technologies in peer-reviewed journals and given dozens of conference presentations on similar topics globally. He has represented Australia at agricultural biotechnology workshops in Asia, Europe, South Africa and the Americas, including APEC and OECD forms.

NOVEMBER PRESENTATION FOR 2016 BATTERHAM MEDAL

One of Australia's best young engineers will win the 2016 Batterham Medal, which the Academy will present at ATSE's Oration Dinner on 25 November 2016, in Melbourne.

Nominations will close on 14 August and the award will be more accessible to women engineers this year.

The Batterham Medal is an early career award for a graduate engineer who has achieved substantial peer/industry recognition for his/her work in the past five years. ATSE administers the award on behalf of the Group of Eight Deans of Engineering and Associates.

The award consists of a medal (The Batterham Medal) and a cash prize of \$5000. The winner will be an engineering graduate of an Australian university, under 40 at 1 January 2016 and will:

- have demonstrated excellence, innovation and impact in a field of engineering;
- be clearly acknowledged by his/her peers for a signature contribution to engineering in the five years prior to his/her nomination; and
- have advanced the standing of the engineering profession.

Applicants who have taken career breaks for family or carer responsibilities are eligible for an extension to the age criterion, for the period equivalent to the break.

The Batterham Medal recognises Professor Robin Batterham AO

FREng FAA FTSE, an Australian science and technology leader who was Chief Scientist of Australia from 1999 to 2006, President of the Academy from 2007–12 and is Kernot Professor of Engineering at the University of Melbourne.

The 2016 Batterham Medal Selection committee is: Mr Richard Kell AM FTSE; Professor Elanor Huntington, Dean of Engineering and Computer Science, Australian National University; Emeritus Professor Robin King FTSE; Mr Clive Weeks AO FTSE; Air Vice Marshal (Retd) Julie Hammer AM CSC FTSE; Professor Karen Reynolds FTSE; and Ms Denise Goldsworthy FTSE.

The Batterham Medal Guidelines and Nomination form are available at www.atse.org.au ABOUT>BATTERHAM MEDAL

Canberra engineer Lachlan Blackhall receives the inaugural 2015 medal from Robin Batterham.

Dr Blackhall is founder and Chief Technology Officer of Reposit Power, a technology company designing advanced control systems for grid-deployed energy storage.





BY MARK HOWDEN, PETER HAYMAN AND SCOTT CHAPMAN

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Climate and other changes that reduce agricultural productivity

AUSTRALIAN AGRIBUSINESS If Australia is to compete in a world with rapid climate and other changes, we need to boost, not reduce, our knowledge base and its use.

Palaeo evidence, such as the declines of civilisations, and the recent historical record both demonstrate the pervasive and profound

effects that climate averages and climate variability have on agriculture across the globe.

Climate has impacts on, amongst other things: choice of production systems, preferred soil types, areas planted, production potential and variability, product quality, management systems and technologies, input costs and levels, product prices, natural resource management including water, human physical and mental health, social fabric of rural communities, business along value chains, regional economies and local to global trade.

This widespread biophysical and social impact is evident in Australian history from the recent Millennium Drought (2002–09), the Federation Drought and the El Niño-related drought in 1791–93, which affected the initial penal settlement.

There is also much experimental evidence of the impacts that elevating carbon dioxide (CO₂) has on plants – broadly increasing their water, nitrogen and light-use efficiencies.

So it follows logically that if climate and CO₂ concentrations occur, then agriculture will be impacted – sometimes a little and sometimes a lot, sometimes for the better and sometimes for the worse.

The evidence of change in climate and CO₂ is incontrovertible. Human activities have raised atmospheric CO₂ concentrations from about 280 ppm in pre-industrial times to above 400 ppm now. Concentrations of other greenhouse gases such as methane and nitrous oxide have also risen. The relationship

between the concentrations of these gases and increased atmospheric heat-trapping has been known for more than a century, so it is unsurprising that the global temperature has also increased.

Since the 1950s, each decade has been warmer than the previous one. The highest ever annual global temperature measured was experienced in 2015, with a combined land and ocean temperature 0.9°C above the 20th century average. Importantly, the temperature over land where agriculture is practised, was 1.33°C above the long-term average.

This trend continues into 2016, with the year-to-date land temperature being 1.85°C above the 20th century average, beating the previous record set in 2015 by an astounding 0.45°C.

SIGNIFICANT IMPACTS

Even though these temperature increases sound small, they can have significant agricultural impacts: various analyses show a reduction of about six per cent of global grain yields for every 1°C increase in temperature. Importantly, the frequency of extremely high temperatures is increasing and hot extremes (which particularly negatively affect crop and livestock production) are coming earlier in the season.

For example, in the wheat-growing regions of Queensland, the first days with temperatures greater than 35°C are coming three weeks earlier in the year.

Rainfall is also changing with mid to high-latitude zones generally receiving more rainfall and equatorial, subtropical and Mediterranean zones receiving less. In many water-limited, rain-fed agricultural

systems, such as most of those in Australia, productivity is directly related to rainfall. Importantly, rainfall intensity is also increasing, with implications for increased erosive potential and reduced water quality.

In aggregate, these and other changes appear to already be reducing agricultural productivity.

The Intergovernmental Panel on Climate Change synthesised studies on this and found that for the three major food crops (wheat, rice and maize) the growth in crop yields over the past half century was reduced by climate change by about two per cent per decade below where it would have otherwise been.

The potential future changes to climate and agriculture are much greater than the past changes covered above. For example, average temperature in Australia could increase by 3°C to 6°C by the end of this century if we continue to emit high levels of greenhouse gases.

This will, in a sense, bring the temperatures of Roma (Queensland) to Melbourne. Even an increase of 2.7°C will result in effectively every day becoming a heat-stress day for northern Australia – impacting negatively on humans, crops and livestock.

There are also major possible reductions in rainfall with consequent impacts on water availability, with median reductions in runoff of 10 per cent to 25 per cent per degree Celsius warming in south-east and south-west Australia respectively.

To reflect on the likelihood of and concern about these major changes in water resources and hence irrigation, consider what has already happened to Perth's catchments:

historical annual average streamflow of 338 gegalitres has reduced to 50 GL at least in part due to climate changes – and last year streamflow was only 11.4 GL.

Unsurprisingly, both crop and livestock-based agriculture in Australia and similar nations located in the monsoonal to Mediterranean zones will become increasingly challenging. But on the positive side, commodity prices are likely, on average, to increase due to supply-demand imbalances. These relate particularly to increases in consumption, driven by population growth, and changes in consumption patterns – particularly increased protein intake in countries like China.

Importantly, there will also be adaptations to the changing risk imposed by alteration of climate and CO₂ conditions.

Climate adaptations can be on-farm, such as changing crop varieties or sowing time,

cultivation techniques, irrigation systems, using seasonal climate forecasts or alteration of the crop–livestock mix. Adaptations can also be off-farm along the value chain such as flexible product-sourcing strategies, or changes in storage or processing, or changes in supportive institutional arrangements.

They can be incremental, such as altering livestock feed strategies, or transformational – such as relocation of enterprises or changing to a completely new production system such as becoming energy or carbon farmers.

OPPORTUNITIES

There are also opportunities to use big data to accelerate crop and livestock breeding and management. For example:

- using high-resolution satellite and drone imagery for rapid field-based assessment of plant response to climate – linked to simulation models of molecular breeding

strategies to develop super-fast-growing, heat and drought-resistant, CO₂-responsive crops; or

- harnessing this imagery for the next generation of precision agriculture.

Importantly, effective adaptation to climate changes will require much more effective strategic decision-making. The ability of a country to adapt agriculture to climate changes is likely to become an increasingly important aspect of comparative advantage.

Australian agriculture has had global leadership in many of these areas, resulting in a competitive edge. This expertise, plus the similarities of many of our agricultural systems to those in developing countries, means that we have a major opportunity to transfer our climate-adaptation strategies, meeting both trade and aid objectives.

However, to do this on an ongoing basis we need to continue to invest in agricultural research and

development here in Australia. After the effects of climate were removed, the total factor productivity (essentially a measure of the knowledge and technology based improvements in productivity) of Australian agriculture averaged about 1.95 per cent before the year 2000. This has dropped to 0.4 per cent since, with reductions in research and development apparently major contributors to this fall.

If Australia is to compete in a world with rapid climate and other changes, we need to boost, not reduce, our knowledge base and its use.

We can, if we are smart, reframe climate adaptation to be a source of competitive advantage, driving innovative, information-rich, sustainable agricultural systems. ☉

Professor Mark Howden is Director of the Climate Change Institute at the Australian National University. His work has focused on climate impacts and adaptation for systems we value: agriculture and food security, the natural resource base, ecosystems and biodiversity, energy, water and urban systems. He helped develop the national and international greenhouse gas inventories and has assessed sustainable ways to reduce emissions. Professor Howden has partnered with many industry, community and policy groups via both research and science-policy roles and has produced 400 publications. He has been a major contributor to the IPCC since 1991, now being a Vice Chair of IPCC Working Group 2.

Dr Peter Hayman is a Principal Scientist in Climate Applications at the South Australian Research and Development Institute (SARDI), a position he has held since May 2004. Prior to moving to Adelaide he was coordinator of climate applications for NSW Agriculture. He is an agricultural scientist with an interest in applying climate information to dryland and irrigated farming systems, with a recent focus on impacts and adaptation to climate change in the irrigated wine grape industry and low-rainfall grains industry. He was part of the leadership team of the Primary Industries Adaptation Research Network and the Australasian representative on the WMO Expert Team on Software Resources for Operational Applications in Agro-meteorology.

Dr Scott Chapman is a Senior Principal Research Scientist with CSIRO Agriculture and Adjunct Professor at the Queensland Alliance for Agriculture and Food Innovation (QAAFI), University of Queensland. He is a Fulbright Scholar and for the past 17 years has worked with researchers and breeders around the world on multiple crops including sunflower, sorghum, sugarcane, maize (corn) and wheat. He focuses on innovative ways of linking climate, field data and genetics with simulation models to increase the speed and effectiveness of crop breeding programs. With a focus on dryland crops subject to drought and heat, he aims to determine how to select crops with the best growth characteristics efficiently using light, water and nutrients.

Adapting to climate change through soil moisture and nutrient monitoring at the Silalatshani irrigation scheme in Zimbabwe, an ANU/ICRISAT project funded by ACIAR.



PHOTO: JAMIE PITTOCK, ANU



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The Defence Science and Technology Group (DST) is part of the Department of Defence. Its role is to provide Government with scientific advice and innovative technology solutions to meet Australia's Defence and national security needs.

As the country's second largest public-funded research organisation, DST employs 2100 scientists, engineers and researchers with in-depth knowledge and experience in many science disciplines.

Whether it is improving personal protection armour and ration packs for the Army, designing missile decoys to protect Navy ships, putting wings on bombs to increase the Air Force's missile range or building the world's largest over-the-horizon radar network to keep a watch on our borders, DST scientists continually come up with clever science solutions that work.

It was a defence scientist who invented the black box flight recorder in the 1950s. Among other innovations, today's DST scientists are developing equipment to protect Australian soldiers from improvised explosive devices and extending the safe service life of fighter aircraft beyond their use-by date.

A skilled and motivated workforce is an essential prerequisite for the organisation to continue delivering outstanding scientific support to Defence. So, DST is committed to attracting talented people and offering a unique opportunity to pursue a rich and rewarding career in science while contributing to Australia's national security.

DST's drive to recruit the country's future top scientists and engineers is helped by the many and varied science career pathways on offer. These include cadetships and scholarships for students, a summer vacation placement program, an industry experience placement program, and a graduate program.

DST scientists also partner with teachers as part of the Science and Mathematics in Schools program, helping Australia develop a national science, technology, engineering and mathematics (STEM) capability to underpin the search for future scientists.

One only has to reflect on the amazing breadth and depth of scientific research undertaken by defence scientists to understand the great career opportunities DST can offer to present and future generations of Australians.

DST
GROUP

Science and Technology for Safeguarding Australia

WOMEN IN TECHNOLOGY

NERVO inspire women to study engineering

Eight universities – led by the University of New South Wales – have launched a song and music video by Australian twin-sister DJ duo NERVO to highlight engineering as an attractive career for young women.

NERVO, made up of 29-year-old singer-songwriters and sound engineers Miriam and Olivia Nervo, launched the video clip for 'People Grinnin' in July.

In the futuristic music clip, a group of female engineers create android versions of NERVO in a high-tech laboratory, using glass touchscreens and a range of other technologies that rely on engineering, highlighting how it is embedded in every facet of modern life.

The song and video clip are part of Made by Me, a national collaboration between UNSW, the University of Wollongong, the University of Western Australia, the University of Queensland, Monash University, the University of Melbourne, the Australian National University and the University of Adelaide, together with Engineers Australia.

It aims to challenge stereotypes, and shows how engineering is relevant to many aspects of our lives, in an effort to change the way young people, particularly girls, see engineering.

NERVO, the Melbourne-born electronic dance music duo, pack dance floors from Ibiza to India and, according to *Forbes* magazine, is one of the world's highest-earning acts in the



Twins Miriam and Olivia Nervo, the 29-year-old singer-songwriters and sound engineers.

male-dominated genre. They said the Made by Me project immediately appealed to them.

"When we did engineering, we were the only girls in the class. So when we were approached to get behind this project it just made sense," they said.

"We loved the chance to show the world that there is engineering in every aspect of our lives. We're sound engineers, but our whole show is only made possible through expert engineering. From the make-up we wear, to the lights and the stage we perform on. Engineering makes it all possible, including the music that we make," the duo added.

Made By Me includes online advertising across desktop and mobiles, a strong social media push, a website telling engineering stories behind the video, links to career sites, as well as the song and video, released globally by Sony.

"We needed to find a way to meet teenagers on home turf and surprise them with an insight into engineering that would open their minds to its possibilities," said Professor Mark Hoffman FTSE, UNSW's Dean of Engineering.

"This is what led to the idea of producing an interactive music video, sprinkled with gems of information to pique the audience's interest in engineering."

Professor Hoffman has set a goal to raise female representation among students, staff and researchers to 30 per cent by 2020. Currently, 23 per cent of UNSW engineering students are female (versus the Australian average of 17 per cent), which is up from 21 per cent in 2015. In industry, only about 13 per cent of engineers are female, a ratio that has been growing slowly for decades.

"Demand from industry has completely outstripped supply, and that demand doubled in the past decade," Professor Hoffman said.

"In a knowledge-driven economy, the best innovation comes from diverse teams who bring together different perspectives. This isn't just about plugging the chronic skills gap – it's also a social good to bring diversity to our technical workforce, which will help stimulate more innovation.

"We can't win at the innovation game if half of our potential engineers are not taking part in the race."

SYDNEY BACKS SPRINGBOARD

A fast-track program to support female entrepreneurs is being supported by the City of Sydney as part of its efforts to foster business and boost the local economy.

Springboard Enterprises Australia (SBE) has received \$35,000 in sponsorship for its 2016 Accelerator Program that includes an education and coaching course designed for women entrepreneurs in the early stages of their company's development.

Sydney Lord Mayor Ms Clover Moore said it was important to support women entrepreneurs, who are underrepresented in areas such as emerging and high-growth businesses.

"Too little investment in women-led, high-growth companies impedes our city's economic growth. So it's not only a women's issue, it's a broader economic issue," the Lord Mayor said.

The sponsorship falls under the city's 10-year economic development strategy that aims to enhance the skills of business people and increase their awareness of business opportunities.

Each year, SBE runs a 'bootcamp' for up to 10 companies, designed to accelerate their growth by providing skills and knowledge, coaching, mentorships and connections to local and international venture capitalists, angel and corporate investors.

Companies selected to take part must:

- have a woman in a senior position with a significant equity stake;
- demonstrate a qualified and profitable market opportunity;
- have a track record of milestone achievement;
- have a credible management team or ability to attract one; and
- be based in or have significant operations in Australia.

WOMEN IN TECHNOLOGY

SAGE holds first Symposium

Science and technology experts, business and policy leaders examined ways to enhance gender equity and create a more diversity and innovation in the STEM sector in Australia at the first annual SAGE Symposium in June in Sydney.

Former Sex Discrimination Commissioner and Male Champions of Change Founder – and chair of the SAGE Expert Working Group – Ms Elizabeth Broderick delivered the keynote address. Ms Ita Buttrose, 2013 Australian of the Year, and Mr David Ruebain, Chief Executive of Britain's Equality Challenge Unit and former Director of Legal Policy at the UK Equality and Human Rights Commission, also addressed the Symposium.

Other speakers include Australia's Chief Scientist Dr Alan Finkel AO FAA FTSE, NSW Chief Scientist and Engineer Professor Mary O'Kane AC FTSE, Former ATSE Director and gender equity campaigner Dr Susan Pond AM FTSE, ATSE Gender Equity Working Group Chair Dr Mark Toner FTSE and President of the Australian Academy of Science Professor Andrew Holmes FAA.

Dr Finkel discussed the involvement of the Office of the Chief Scientist in gender equity issues and Professor O'Kane closed the Symposium, discussing the future of the SAGE Pilot and Athena SWAN Australia.

Dr Pond described the SAGE Pilot of the Athena SWAN program, its difference from other gender equity programs and how it might boost productivity and outcomes in Australian. She

emphasised the importance



Alan Finkel



Mary O'Kane

of recognising and acting on the current gender imbalance in Australia.

"It matters because Australia's higher education and research sectors are failing to benefit from the additional range of perspectives and backgrounds [women] would bring to the table," she said.

"It matters also because gender equality is a moral imperative, and it matters because of this new and bright, shiny thing: the challenge of innovation."

Dr Toner explained what gender equity meant for ATSE and the work of its Gender Equity Working Group, as well as discussing why men in senior leadership positions sometimes found it challenging to lead on gender equity.

The SAGE symposium brought together each of the 40 organisations in the program for the first time since it was initiated in 2015.

The SAGE Pilot of the Athena SWAN Charter is a partnership of the Australian Academy of Science and ATSE. It promotes equity and inclusion through an evaluation and accreditation framework to

ELIZABETH BRODERICK TO ADVISE SAGE

Former Sex Discrimination Commissioner Ms Elizabeth Broderick has been named Chair of the Expert Advisory Group to the Science in Australia Gender Equity (SAGE) Initiative, in which ATSE and the Academy of Science are partners.

Ms Broderick's appointment was announced at the first national SAGE Symposium in Sydney in June.

Ms Broderick was Sex Discrimination Commissioner from 2007–15. She was also the Commissioner responsible for Age Discrimination from September 2007 until July 2011. During her term, she was committed to improving gender equality through her advocacy in preventing violence against women and sexual harassment,

improving lifetime economic security for women, balancing paid work and unpaid caring responsibilities, promoting women's representation in leadership and strengthening gender equality laws and agencies.

She has been a key advocate for Australia's national paid parental leave scheme and domestic violence reform. She has championed the changes to the ASX Corporate Governance Principles to increase the number of women at decision-making

level and has developed the Male Champions of Change strategy.

SAGE Executive Director, Dr Wafa El-

Adhami said Ms Broderick's appointment would bring a broader perspective to the Expert Advisory Group.

"Ms Broderick has an outstanding track record in addressing gender equity across a breadth of sectors, most particularly as Sex Discrimination Commissioner and as head of the Male Champions of Change program."



Elizabeth Broderick

WOMEN IN TECHNOLOGY

identify and address gender inequity in science organisations.

Institutions are graded by a panel of experts against this framework to determine areas that need to be addressed to improve gender equity and diversity in science, technology, engineering, mathematics and medicine (STEMM).

The pilot includes a two-year program of training and advice on how gender equity and diversity issues can be addressed, and successful organisations will be awarded an Athena SWAN Bronze award indicating they are well placed to improve gender equity and diversity across their academic and professional staff.

The SAGE Expert Advisory Group was reconstituted from members of the SAGE Steering Committee (the founding body of the SAGE Pilot) aiming to preserve the knowledge and enthusiasm of the Steering Committee members, with additional members with practical experience of the Athena SWAN program in the UK.

The Advisory Group's role is to champion the SAGE Program and provide strategic advice. Its members include Professor Caroline McMillen, Professor Doug Hilton AO FAA FTSE, Professor Ian Jacobs, Dr Marguerite Evans-Galea, Professor Nalini Joshi, Dr Roslyn Prinsley, Professor Sharon Bell, Dr Susan Pond AM FTSE and Professor Tim Wess.



Mark Toner and Susan Pond at the Symposium.

FEMALE-ONLY MATHS JOBS

The University of Melbourne has advertised jobs for female applicants only in an attempt to drive change in the male-dominated area of mathematic academia.

The university has advertised three positions in its School of Mathematics and Statistics for female applicants only – believed to be the first time it has limited applications to women only for permanent academic positions. The jobs, in pure mathematics, applied mathematics and statistics, range from lecturer through to senior lecturer and associate professor, depending on a candidate's experience.

The positions have been advertised using a special measure of the *Victorian Equal Opportunity Act*, which allows organisations to take actions to promote equality, according to discrimination lawyer Mr Rowan Skinner.

"The Act specifically permits an organisation to engage in what is overtly a discriminatory act, but for the purposes of ensuring that there is equal opportunity overall," Mr Skinner said.

Wafa El-Adhami



SAGE appoints Executive Director

Dr Wafa El-Adhami has been appointed Executive Director of SAGE.

With a research background in molecular biology and microbiology, Dr El-Adhami has held a number of senior management positions in the Australian Government, including in the Department of Health and Ageing, the Office of Chemical Safety and the Occupational Health and Safety Commission.

More recently she has worked internationally as a consultant specialising in health policy, regulation and clinical solutions.

Academy President Professor Peter Gray welcomed the appointment of Dr El-Adhami.

"She brings a wealth of highly relevant expertise to the implementation of the SAGE Pilot of Athena SWAN in Australia, including well-developed skills in policy and regulatory reform, data and performance management, stakeholder engagement and negotiation skills, and governance."

The SAGE initiative is a partnership between the two academies that aims to address gender equity in the science, technology, engineering, mathematics and medicine (STEMM) sectors.

Australia is the first nation beyond the UK and Ireland to pilot the Athena SWAN program, which is an evaluation and accreditation framework that addresses the improvement of gender equity policies and practices.

Athena SWAN has been operating for 10 years and has shown significant results in improving gender diversity and bolstering women's leadership roles within STEMM institutions. The Australian program will involve 40 universities, medical research institutions and government research agencies.



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ATSE IN ACTION

ATSE's REA initiative moves ahead

ATSE's REA initiative, which seeks to enhance measurement of the engagement between public and private researchers in Australia, has moved to its next stage with the support of the Australian Research Council and the Department of Education and Training (DET).

ATSE released a report titled *Research Engagement for Australia: Measuring research engagement between universities and end users* in March, which highlighted the outcomes of a pilot of the Research Engagement for Australia (REA) metrics conducted in collaboration with all South Australian and Queensland universities.

The REA metrics use external-income data already collected as part of the Excellence in Research Australia (ERA) exercise to generate measures of university engagement with research end-users.

DET has commissioned ATSE to further investigate the REA metrics to:

- inform the development of the national assessment of the engagement and impact of university research; and
- help universities prepare for the national assessment of the engagement and impact of university research by providing them with benchmarking information.

The ARC will undertake a pilot assessment of the engagement and impact assessment in 2017 and the first national assessment and reporting will take place in 2018 as a companion to ERA.

The initial stage of this project will examine the viability of collecting additional external-income data such as research extension income, industry income sourced through Rural Research and Development Corporations and consulting income, recorded within or separate from university financial systems.

ATSE will then amend the REA metrics accordingly and identify any further improvements to the methodology before generating a national set of REA metrics for all universities in each discipline.

The initiative has been advised to all Vice-Chancellors in a letter from ATSE Interim President Professor Peter Gray FTSE and senior executives of both DET and ARC.

ATSE has also responded to the Engagement and Impact Assessment

consultation paper issued by the ARC as part of the process announced under the National Innovation and Science Agenda (NISA) to develop measures of research engagement and impact.

The ATSE response highlights the difficulties in assessing research *impact*, as opposed to *engagement*. Attempting to measure the impact of university research presents a number of challenges, including the long time lags involved, the diversity of indicators of impact across disciplines, and the limited usefulness of using a lagging indicator such as impact as an indicator of current collaboration.

While it is only readily possible to 'assess' research impact, research engagement can be 'measured'. ATSE has strongly recommended that the proposed NISA process focus primarily on research engagement, not impact.

ATSE's REA initiative has attracted international attention.

In a recent issue of *Nature*, the history of the ATSE initiative (dating from 2014) was outlined, along with the underlying issue – Australia's good record in research and poor record in translating research into economic impact.

Nature said that "these are early days for the REA, but the momentum is strong", noting that in the NISA "the government singled out the need for a measure such as the REA to be part of a national assessment of university research performance".

Professor Gray put it simply in the *Nature* article: "Dollars are auditable and they are a good measure of collaboration," he said.

"It's a good independent measure of the degree of commitment by the end user to the collaborative research program."

SPEED DATING WITH PARLIAMENTARIANS

The SA Division held a successful Parliamentary briefing in June at the SA Parliament for parliamentarians and staff.

The topic, requested by parliamentarians, was 'Horticulture and Viticulture: Opportunities and Threats for Boosting the SA Economy', presented by Ms Di Davidson FTSE, Deputy Chancellor of University of Adelaide, a widely respected agricultural scientist and viticulturist and member of the Murray–Darling Basin Authority and CRC Plant Biosecurity Director.

Her presentation kick-started a 'speed dating' networking session, with those attending engaging in five-minute sessions with science experts at six 'stations':

1 Agribusiness Station – Mr Justin Ross, Director of Agriculture Food and Wine Division, PIRSA (Primary Industries and Regions SA).

2 Climate Change Station – Dr Peter Hayman, Program Leader Climate Applications Program, SARDI (SA Research and Development Institute).

3 Water Station – Dr Jim Cox, Program Leader Water Resources and Irrigated Crops Program, SARDI.

4 Soil Station – Dr Michael McCarthy, Principal Research Scientist for Viticulture, SARDI.

5 Viticulture Station – Dr Paul Petrie, joint Australian Wine Research Institute–SARDI appointment in Viticulture Research and Extension.

6 Plant Biotechnology Station – Professor Diane Mather, Professor of Plant Breeding and Genetics, University of Adelaide.

The SA Minister for Science, the Hon

Leesa Vlahos, and the Shadow Minister, Mr John Gardiner, welcomed participants and encouraged them to attend the next briefing to be held in October.



The 'speed dating' session.

ATSE IN ACTION

Looking at Australia's agribusiness future

A focus on agribusiness at the start of the fourth decade of the century was at the heart of ATSE's National Technology Challenges Dialogue 'Agribusiness 2030', held in Sydney in June and attended by some 150 industry experts and observers.

Many aspects of agribusiness were discussed, with key contributions from a broad array of speakers including: Australia's Chief Scientist Dr Alan Finkel AO FAA FTSE; Ms Alison Watkins, Group Managing Director, Coca-Cola Amatil; and Dr John Manners, Director, CSIRO Agriculture.

The Dialogue covered:

- Grasping Agricultural Biotechnology – which biotechnologies offer potential for better breeding, resistance to disease, drought and heat, and improved nutritional value?
- Winning Community Support – how can community acceptance of technology be achieved, such as for agricultural biotechnologies, finance and (foreign) investment?
- Profiting from the Technology Revolution – how can Australian agribusinesses make the most out of the technology revolution, and what barriers stand in the way?
- Farming the Future – what ambitions and visions for change will the next generation pursue? What barriers stand in their way, and how can we help them succeed?
- Working with Climate Change – what impacts can Australian agribusinesses expect to see from climate change over the next 15 years? How can technology help?

Ms Alison Watkins, Group Managing Director of Coca-Cola Amatil, said Australia should better target the premium end of the burgeoning middle-class market across the Asia-Pacific region by becoming a stronger, more innovative exporter.

Ms Watkins set the scene for the two-day event in the first session 'Scanning the 15-year horizon', noting that by 2030 the middle class across Asia-Pacific is expected to reach more than three billion people, delivering a step change in demand for food in our region.

"Australia's opportunity will be to target



The next generation tackles the topic: (from left) Anika Molesworth, 2015 Young Australian Farmer of the Year; Jane Bowen, CSIRO; Lee Hickey, UQ; Moshir Rahman, University of New England; and Tom Bull, GM, Lambpro.

those who demand the most premium, high-quality products by building on our strengths as a commodity exporter to become a stronger, more innovative 'value-add' exporter," she said.

"We should set our sights high and become the preferred source of high-quality, safe and premium food for our region."

Young, innovative people with entrepreneurial flair should be encouraged to disrupt the status quo in agriculture to find new pathways to innovate agribusiness and feed the world, said **Ms Anika Molesworth**, the 2015 Young Australian Farmer of the Year.

"My generation has been raised with a different perspective than previous generations. The youth who work in agriculture are driven, on a mission, impatient to make change and satisfy their values," said Anika, who presented the concerns of young farmers at the 2015 United Nations Conference on Climate Change.

"They do not accept doing something just because it has always been done that way.

"Agribusiness needs to welcome, embrace and promote young people in agriculture – we are technological masters of a digital age and philosophical thinkers without the grey beards. We come with a fresh take on the world's oldest industry. Mobiles, wi-fi, GPS and drones are all extensions to our bodies that enhance our skills and capabilities.

"With minds like complex circuit-boards and creative and critical perspectives, youth in agriculture make agribusinesses, and the industry as a whole, more competitive.

"We work not only to make money, but to make meaning," said Ms Molesworth, who splits her life between her family's sheep station in the semi-arid drylands of far-west NSW, the Riverina, and South-East Asia – where she works with some of the world's poorest farmers.

"We need more efficient and sustainable ways of producing food," said **Dr Lee Hickey**, who has played a pivotal role at The University of Queensland in developing 'speed breeding' – the rapid generation advance technology for spring wheat which, through traditional breeding, achieves an impressive six plant generations annually.



Alison Watkins addresses the Dialogue.

ATSE IN ACTION

"Farmers worldwide need clear breakthroughs in plant breeding and genetics to overcome the many challenges to producing food crops," he said

"In reality, we need 'all the tools in the shed' and integration of technologies, including traditional plant breeding methods, remote sensing and genetic engineering."

Australia is well placed to use real-time and high-quality data to supercharge research and provide a pathway to rapid commercialisation – and ubiquitous broadband connectivity is critical to enabling infrastructure to achieving this vision, according to **Ms Ros Harvey**, Founder and Managing Director of The Yield.

"The productivity challenge for agriculture has never been greater. We need to produce 70 per cent more food by 2050 with less arable land, less and more expensive inputs and the unprecedented impact of climate change," said Ms Harvey, who started her 'Internet of Things' (IoT) AgTech product company in 2014.

"Digital technology, and the broadband connectivity that enables it, are the keys to unlocking the next wave of improvements to sustainably increase production throughout the entire food value chain, and help feed the world without compromising the planet," she said.



Joanne Daly sums up.



Ros Harvey – broadband is critical.



John Manners looks at the future.

With Australia's farming future looking increasingly reliant on automated technologies, such as low-cost robotics, the industry's vision should include more support for agri-technology start-ups, retraining growers and agronomists for a digital age, and introducing rural kids to hands-on robotics, according to **Professor Salah Sukkarieh**, Professor of Robotics and Intelligent Systems at the University of Sydney and Director of Research and Innovation at the Australian Centre for Field Robotics.

"One of the biggest issues facing the agribusiness sector is how to support the industry with low-cost, automated

technologies, as well as the development of these technologies," he said.

Robots were already inspecting crops, counting yields, weeding and being new-age shepherds, with a new two-year trial starting to train a 'farmbot' to herd livestock, monitor their health and check they have enough pasture to graze on.

"Robotics and automation technology provide the grower with greater knowledge of their farm state and the capability for acting in real-time, thus increasing efficiency, reliability and productivity whilst minimising environmental impact."

■ Presentations by other speakers at Agribusiness 2030 are on the ATSE website.

ATSE BACKS AUTONOMOUS VEHICLE TECHNOLOGY

ATSE strongly endorses regulatory reform to enable the advancement of autonomous vehicle technology and implementation in Australia. The potential for economic growth, through advancements in research and development, collaboration with large multinationals, and commercialisation are immense if Australian governments embrace and pursue automated vehicles.

ATSE made these points in its recent submission to the National Transport Commission's issues paper on the Regulatory Options for Automated Vehicles.

Autonomous vehicle technology was already in existence and creating significant opportunities for companies and cities across the world, ATSE said. It was rapidly evolving and increasingly in demand by a range of industry sectors and consumers.

Australian governments must introduce flexible and adaptable legislative frameworks that could keep pace with the technology and ensure that Australia became a key competitive player in the global market of automated vehicles. Automated vehicle technology was a universal and generally shared technology and the regulatory and insurance hurdles that must be faced in Australia were the same internationally. ATSE strongly recommended that any regulatory and insurance changes should be aligned with overseas examples and draw on best practice from around the globe.



Creating change in cancer treatment

What happens when skin cancer treatment works well for a third of patients, but poorly for the other two-thirds? And what if that drug is the best – and sometimes the only one available?

For The University of Queensland Diamantina Institute (UQDI) researcher Dr Fiona Simpson, the answer is easy: find a better drug, or find a way to support that drug to make it more effective.

Dr Simpson lost her mother to cancer, and this experience, combined with advice from UQ's Professor Ian Frazer to 'do something translational' with her research, has led her to study how patients respond to targeted cancer therapy antibodies. Dr Simpson and her team aim to find out how to change patients from treatment non-responders into responders and ultimately to prevent cancer from recurring.

So far Dr Simpson and her team have discovered a connection between how tumour cells present signalling molecules on their surfaces and then how therapeutic antibodies bind to them, which in turn changes the level of immune cell activation, leading to tumour cell killing. They have found a way to use small molecule inhibitors to create 'good patterns' that force tumours to leave more receptors on cell surfaces. This provides more targets on which antibodies can

act, bringing the immune cells in to attack the tumour and hopefully reducing the recurrence of cancer in the future.

The collaboration between UQDI and the Princess Alexandra Hospital (PAH) has enabled the crucial access to clinicians, patients and tumour samples required for Dr Simpson's research, and clinical trials are currently underway at the PAH.

UQDI is part of the Translational Research Institute and is based at the PAH in Brisbane, enabling UQDI's strong clinical interactions. UQDI is an internationally recognised research facility and students of UQDI are given the chance to undertake research in an environment dedicated to the pursuit of excellence, where researchers challenge the frontiers of biomedical and translational science. For more information visit di.uq.edu.au

The Federal Government's 2015 Excellence in Research for Australia exercise confirmed The University of Queensland as one of the nation's top three universities, measured by the quality of its comprehensive range of specialised research fields. UQ's outstanding critical mass offers researchers significant interdisciplinary capability.

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ATSE IN ACTION

STELR wins teacher accolades

Teachers are often strong advocates for the STELR program, which is now in 500 Australian secondary schools. Teacher comments from a recent STELR evaluation survey included:

■ *[STELR is] an excellent resource that has proved to be very valuable in encouraging inquiry learning and engaging students.*

– Mark Butler, Gosford High School, NSW

■ *STELR is a challenging unit that gives students the opportunity to do hands-on investigating and critical thinking about scientific issues that are relevant to them. It has given our students access to equipment and activities that were very different to those they were used to.*

– Susan Edwards, Nowra Christian School, NSW

■ *The STELR module and equipment has become a valuable and integral tool for teaching energy transformations and renewable/sustainable energy topics.*

– Dave Elith, Taree Christian College, NSW

■ *The value is very high and it has had a very positive impact on the quality of STEM teaching that we can offer. The amount of kit that we have been given has allowed us to utilise them across whole year groups. Teaching and learning has been enhanced.*

– Kate Ashdown, Trinity College Lismore, NSW

■ *The STELR Module is an excellent resource and we have been recommending it to other schools in Tasmania.*

– Heather Omant, St Mary's College Tasmania

■ *The capacity of teachers to deliver physical sciences has definitely increased and they are now more confident in this area. The STELR unit ties in very well with the Australian Curriculum and we have used the practical investigation design template in a number of classes. This design process and knowledge of variables has been valuable.*

– Rod Stott, Belmont High School, Victoria

■ *This program is one that is easily accessed by new teachers to the field due to the excellent resources. The students have enjoyed the hands-on approach to learning and find the pictures clear enough to set up equipment themselves. The program, overall, has allowed students to direct their own learning successfully.*

– Donna Jackson, Clonard College, Victoria

■ *Teachers commented on how engaged their students were when doing the activities we used this year. Teachers liked the materials (equipment and curriculum materials) and we are planning to increase their use. As we are a new school, developing our programs with an inquiry-based focus, these materials will support our focus. The fact all teachers had the opportunity to experience the materials with Year 9 students, they now have a feel what is available. Thank you for producing this excellent resource.*

– Julie Weber, Byford Secondary College, WA

■ *The younger students end up with a clear understanding of concepts like series and parallel circuits. Many of our students go on to become engineers and they really need the hands-on skills of building something, testing it and then pulling it apart. STELR is perfect for this.*

– Darren Hamley, Willetton Senior High School, WA

SW SCIENCE COUNCIL HOLDS FIRST SYMPOSIUM

WA's South West Science Council, chaired by Professor Adrian Egan FTSE, tackled climate change in its first symposium in May, held at Edith Cowan University's Bunbury Campus. 'The Future of the South West in a Changing Climate' brought together a dozen experts to examine the topic, including WA Chief Scientist Professor Peter Klinken and top brass from academic and government bodies. Professor Egan called for greater STEM education to meet the ever-growing need for evidence-based problem-solving and better decision-making.



At the Symposium (from left) Dr Simon Carroll from Scitech, former WA Chief Scientist Professor Lyn Beazley AO FTSE and Professor Egan.

MEDICAL RESEARCH COULD PROVIDE BETTER RETURNS

Australia was missing out on a significant return from its investment in medical research, ATSE said in its recent submission to Australian Medical Research and Innovation Five Year Strategy, which will guide investment from the Medical Research Future Fund (MRFF).

Better returns could be delivered through patient benefits, creating skilled jobs, improving research–industry collaboration, attracting private and foreign investment of product development, and profiting from sales of patented products and services, and taxation revenue, ATSE said.

Currently, there was a lack of funding allocated for commercial translation of medical research in Australia and MRFF funding should support the commercialisation of medical technologies from medical research institutes, universities and start-up firms.

Investing in translational medical research would help overcome inefficiencies within the health system and blunt the rapidly growing costs of health care, ATSE said.

Additional funding would also help resolve issues in the current funding models and a lack of experts in some areas.

For Australia to become a major competitor in commercialised biomedicine and medical technology, and guarantee a sustainable long-term future for the nation's medical research, the Government must commit to a significant financial investment.

ATSE recommended that at least 50 per cent of the funding allocated by the MRFF be devoted to translational research.

Enhancing Australia's prosperity through technology and innovation

The Australian Academy of Technology and Engineering (ATSE)

ATSE is made up of some of Australia's leading thinkers in technology and engineering. One of Australia's four Learned Academies, it's an eclectic group, drawn from academia, government, industry and research, with a single objective in mind – to apply technology in smart, strategic ways for our social, environmental and economic benefit.

To achieve that goal, ATSE has formed a variety of expert, independent forums for discussion and action – platforms to move debate and public policy on issues concerning Australia's future. These focus on energy, water, health, education, built environment and innovation – and the international collaboration necessary to ensure that Australia is abreast of world trends.

It's an open, transparent approach – one that government, industry and community leaders can trust for technology-led solutions to national and global challenges. Each year, the Australian Government recognises the importance of the work we do by awarding the Academy an establishment grant to help with:

- Fostering research and scholarship in Australia's technological sciences and engineering;
- Providing and conducting administrative support, workshops, forums and events to enable the Academy and its Fellows to contribute on important national issues;
- Managing the development and execution of our programs; and
- Supporting relationships with international communities.

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AUSTRALIAN ACADEMY OF
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ATSE IN ACTION

Clunies Ross winners named at Innovation Dinner

A crowd of nearly 400 attended ATSE's inaugural 2016 Innovation Dinner in Sydney, in June, where Clunies Ross Awards winners in three new categories were recognised.

The dinner attracted some stellar guests including the Hon Niall Blair, NSW Minister for Primary Industries and Minister for Lands and Water, Australia's Chief Scientist Dr Alan Finkel AO FAA FTSE, NSW Chief Scientist and Engineer Professor Mary O'Kane AC FTSE (who delivered the keynote address) and three state Chief Scientists – Dr Geoff Garrett AO FTSE (Queensland), Dr Leonie Walsh FTSE (Victoria) and Dr Leanna Read FTSE (South Australia) – who presented the three Clunies Ross Awards for 2016.

Two women won awards.

Professor Maree Smith FTSE, from the University of Queensland, won the **2016 Clunies Ross Knowledge Commercialisation**

Award, presented by Dr Garrett.

Professor Smith is recognised internationally for her significant and sustained contributions to pain relief and pharmaceutical development through her pioneering breakthroughs in drug discovery and translation, highlighted by discovery of a first-in-class novel therapeutic (EMA401) to treat neuropathic pain and chronic inflammatory pain.

Ms Elaine Saunders, from Melbourne, won the **2016 Clunies Ross Entrepreneur of the Year Award**, presented by Dr Walsh.

Dr Saunders is an audiologist, innovator and entrepreneur who has worked over the past 20 years to successfully disrupt hearing service provision in Australia, through challenging current business and pricing models, and improving technology in partnership with inventor Professor Peter Blamey, who won a Clunies Ross Award in 2012.

Associate Professor Peter Murphy, from the University of South Australia, won the **2016 Clunies Ross Innovation Award**, presented by Dr Read.

Professor Murphy has led an industry-focused research team specialising in thin-film coating science to develop a world-first plastic automotive rear-view mirror. With more than 10 years' experience working in private industry, Professor Murphy has demonstrated outstanding research leadership across the industry/academia interface.

Dinner guests saw short video productions from each of the three states, presented by the state Chief Scientists, and longer videos illustrating the work and achievements of the Clunies Ross Award winners. The winners' videos can be viewed on ATSE's YouTube page, accessed through the Clunies Ross Awards story on our home page under 'Latest News'.

Guests included former Clunies Ross Award winners: Lifetime Achievement Award winners Dr John Boldeman, Dr John Nutt and Professor Jim Patrick; and Clunies Ross Award Winners Dr Alan Finkel (2005), Professor Peter Blamey (2012), Dr Simon Poole FTSE and Dr Paul Wood



Mary O'Kane delivers the Keynote Address.



Leanna Read and Peter Murphy.



Leonie Walsh and Elaine Saunders.



Geoff Garrett congratulates Maree Smith.

FTSE (2013), Professor Kevin Galvin FTSE (2014) and Dr Cathy Foley PSM FTSE (2015).

Mr Blair, a NSW Upper House Member since 2011, delivered the opening address, noting the contribution of innovation and technology to Australia's economic performance and its value to primary industries.

Professor O'Kane, one of Australia's science and technology stalwarts and a long-standing Fellow of ATSE, delivered an engaging keynote address.

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Parkes scope gets a 'hand' on space

Research with CSIRO's Parkes telescope has discovered the first molecule in space that has a key attribute associated with life – 'handedness' or chirality.

The breakthrough is expected to help scientists solve one of the greatest mysteries in biology – the origin of homochirality – and offer insights into what we can expect from life throughout the universe.

Like our two hands, many molecules can exist in forms that are mirror images of each other. But scientists know that molecules associated with life, such as amino acids, proteins, enzymes and sugars, are found in nature in only one form. For example, the amino acids that make up proteins only exist

in the left-handed form, while the sugars found in DNA are exclusively right-handed. This phenomenon is known as homochirality.

Chiral molecules are essential to biology on Earth, but until now they hadn't been known to exist outside our own solar system. Now for the first time a 'handed' molecule, propylene oxide, has been detected in space with the Parkes telescope and the Green Bank Telescope in the USA.

"This discovery gives us a window into how an incredibly important type of molecule is made in space, and gives us the chance to understand the impact that process may have on life in the universe," Director of Operations at CSIRO Astronomy and Space Science, Dr John Reynolds said.

Propylene oxide is a common compound used in making polyurethane plastics. The chemical was found in a region near the centre of our Milky Way galaxy in an interstellar cloud, Sagittarius B2, which is actively forming stars.

An Australian finding two decades ago



PHOTO: SHAUN AMY

'The dish' at Parkes.

suggested how the light from a forming star could 'bias' the molecules in space around it, leading to one of the handed forms being more common than the other.

ONE STEP CLOSER TO HYPERSONIC FLIGHT

PHOTO: DEPARTMENT OF DEFENCE

An Australian-US team has sent a rocket 278 kilometres into space in an experimental hypersonic flight at the Woomera Test Range, achieving the targeted speed of Mach 7.5 (7.5 times the speed of sound).

The experimental flight was undertaken as part of a joint research program, HIFiRE (Hypersonic International Flight Research Experimentation Program) being conducted by the Defence Science and Technology Group and the US Air Force Research Laboratory, with Boeing and the University of Queensland providing expert technical design and analysis.

The program is aimed at exploring the fundamental technologies critical to the realisation of sustained hypersonic flight, involving speeds of more than five times the speed of sound, which has the potential to provide immense social and economic benefits.

HIFiRE 5b rocket launches successfully at the Woomera Test Range in South Australia in May 2016.

"The success of this test launch takes us one step closer to the realisation of hypersonic flight," said Chief Defence Scientist Dr Alex Zelinsky FTSE. "It is a game-changing technology identified in the 2016 Defence White Paper and could revolutionise global air travel, providing cost-effective access to space."

The HIFiRE team has already achieved some significant milestones such as the design, assembly and pre-flight testing of the hypersonic vehicles and the design of complex avionics and flight systems. More test flights are scheduled in the next two years.

WILD WINDS SPIN ENERGY FOR SA

South Australia's wind turbines provided 83 per cent of the state's power needs in the 24 hours to 4pm on Monday 11 July, during the height of the wild winter weather across the south of Australia, according to the Clean Energy Council.

"South Australia is a national leader in renewable energy, and is blazing a trail for the rest of the country to follow," Policy Manager Alicia Webb said.

"The state now has 683 turbines, which have generated more than \$6 billion of investment and hundreds of jobs in regional communities – as well as lots of renewable energy. It is in the midst of a remarkable transformation, with more than 40 per cent of its power needs coming from renewable energy last year.

"New technologies such as battery storage are falling in price, and will act as a perfect complement to smooth out the supply of renewable energy in the future."



BY BRIAN SPIES AND GRAEME PEARMAN

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Can Australia meet the challenge of the Paris climate targets?

OPINION Besides adopting a more rapid reduction target, we need to improve our assessment of the risks associated with climate change at both the global and regional levels.

M

Meeting the Paris goal of limiting global warming to two degrees Celsius (2°C) or less will require a massive reduction in Australia's

greenhouse gas emissions and a much steeper emission-reduction trajectory than commonly assumed.

Much of Australia's fossil fuel resource – coal, oil and gas – will need to remain safely sequestered in the ground. Energy will become more expensive. Society will adapt by rapidly expanding renewables and becoming more energy efficient.

But as ATSE Past President Alan Finkel remarked in June 2016 *Focus*, "few people comprehend the challenge to reduce emissions".

The overwhelming scientific evidence that humans influence the climate system carries profound implications for all aspects of society, the economy, the environment and future generations.

Opinion on the causes and importance of climate change remains divisive across society. Whether or not a person accepts the science of climate change rarely depends on their educational level or reasoning capacity, but rather more likely reflects their constructed worldview and, often, their ideological preferences for either a free-market system or a regulated economy. Nevertheless, the scientific evidence is robust.

Scientific understanding of the drivers of the climate system has steadily advanced since the 1992 adoption of the United Nations Framework Convention on Climate Change (UNFCCC). Updates by the Intergovernmental Panel on Climate Change (IPCC) every four to five years provide ever more certain evidence that human

activity influences the world's climate.

The IPCC reviews and summarises the thousands of peer-reviewed scientific papers published every year on climate science. The summary reports are carefully reviewed and edited, and the final text must be approved by almost all the world's governments – a slow and painstaking but ultimately robust process.

The most recent (2013) IPCC report concludes: "It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century".

WHAT HAPPENED IN PARIS?

COP-21 (the 21st Conference of the Parties to the UNFCCC), in Paris in December 2015, was the most recent of a series of international meetings attempting to reach agreement on policies to limit the impact of human activities on climate change. The journey has been slow and disjointed as developed countries most able to reduce emissions jostled with developing countries with growing populations demanding financial assistance before taking action.

But progress on a global agreement is steadily being made, with Paris the first meeting where both of the world's largest emitters, the US and China, agreed to a course of action.

The main outcomes from the Paris Agreement were:

- establishment of a clear goal for containing global warming – reaffirming the goal of limiting global temperature increase to below 2°C, while urging efforts to limit the increase to 1.5°C;
- establishment of binding commitments by all parties to make "nationally determined

contributions" to emission reduction, and to pursue domestic measures aimed at achieving them;

- commitment of all countries to submit new contribution targets every five years, with the clear expectation that they will "represent a progression" beyond previous ones; and
- extension of the current goal of mobilising \$100 billion a year by 2020 through 2025 in support of developing countries responding to climate change, with a new, higher goal to be set for the period after 2025.

Australia, for its part, agreed to implement an economy-wide target to reduce greenhouse gas emissions by 26 to 28 per cent below 2005 levels by 2030.

HOW ARE WE TRACKING?

In order to keep global warming to 2°C or less, the atmospheric concentration of CO₂ (the direct effect of CO₂ plus a small additional impact of other gases, expressed as CO₂ equivalents) must be less than 425 parts per million by the end of this century.

To meet this goal (with an estimated 67 per cent probability) the atmosphere and its interacting reservoirs in the oceans and biosphere can only accept a total global budget of 1700 gigatonnes of CO₂ between 2000 and 2050. About 36 per cent of this has been used up between 2000 and 2012, leaving 1088 Gt CO₂ for between now and 2050.

This budget must be shared between all nations. Thus limiting global emissions to keep warming below 2°C is feasible only with immediate and strong international action, especially by the major emitting countries. According to a 2015 article in *Nature*, more

than 80 per cent of the world's coal, 50 per cent of gas and 30 per cent of oil reserves are "unburnable" and must remain in the ground under the goal to limit global warming to no more than 2°C.

Australia's contribution ("fair share") might reasonably be:

- a minimum target for 2020 of 15 per cent below 2000 levels, with carryover under the Kyoto Protocol, an effective target of 19 per cent (a budget of 4200 Mt CO₂ for 2013–20); and
- a trajectory range tracking to between 40 and 60 per cent below 2000 levels by 2030 (a budget for 2013–50 of 10,100 Mt CO₂).

The Australian Government's current reduction target for 2030 is 26 to 28 per cent – far short of that required to meet the 2°C goal if accepting this "fair share".

WHAT ELSE?

Besides adopting a more rapid reduction target, we need to improve our assessment of the risks associated with climate change at both the global and regional levels.

Much of this assessment will be done within the sectors of interest, such as coastal protection, agriculture and water resources, but some serious gaps in fundamental knowledge still exist, demanding further research. For example, the way ecosystems operate, involving the interaction of thousands of species, is so complex that in most cases we currently have little or no knowledge of how those dynamics will respond to future changes of climate, or even to the changes that have occurred thus far. In some sectors, potential exposure has yet to be identified as a risk.

Clearly a major component of our response to climate change has to do with both the generation and utilisation of energy. Active research and development is needed in energy efficiency and the wide range of potential alternative ways of sourcing and applying energy.

Knowledge is incomplete with regard to the technical capabilities of particular resource options, their respective cost both now and as time unfolds and their impacts on both the environment and societal structures. Given these combined uncertainties, investment is required in research and

development in a wide range of options but, in the meantime, new forms of energy production are needed to both serve existing and expanding energy needs.

At the same time contribution to the challenge of emission reduction is paramount. There is a need for acceptance that the role of fossil energy both in terms of our domestic usage and international sales must (and most likely will) change significantly through the next decade.

This demands policy that reflects a portfolio of options that is constantly reviewed in light of new knowledge and technologies and is unafraid of the fact that the energy world of tomorrow will be

in five years time, will be demanding of successive Australian governments. The greatest demand will be for visionary leadership, both at the corporate and government level. A de-carbonised world will be different from today and the transition presents large challenges and opportunities.

Leadership is required to ensure that continuing delays in decision-making do not compound the expensive and invasive nature of the changes, but rather encourage the capture of opportunities and entrepreneurialism that arise in this new world state of energy sourcing and usage.

It is hard to think of any area of the economy that will not require far-reaching

scientific and technological advances to meet the challenges posed by climate change such as: developing drought-resistant crops and water and energy-efficient cities; mosquito eradication and disease control; distributed renewable energy with low-cost storage; and building resilient infrastructure and transport systems.

The path to decarbonisation will be incredibly disruptive to the status quo and existing industries, but will open up immense

opportunities for innovation. ATSE

is well placed to help guide this technological revolution. ☉



Prime Minister Malcolm Turnbull at COP-21.

markedly different from today.

This will pose a challenge for energy marketers. Yet there are also opportunities. For example, energy utilities will develop new business models of retailing energy. For the electricity distribution system it is likely that the changes that have caused challenges related to the incorporation of intermittent renewable energy into the grid will continue to grow through the coming decades.

The impact of domestic and centralised energy storage and the growth of electric-drive vehicles could both facilitate and complicate the transition of our energy systems.

A myriad of sociological, economic and political barriers exist with respect to any change, particularly for one so disruptive and revolutionary. Individuals have strong behavioural practices and belief structures, but so too do institutions and companies, which are inherently conservative and often governed to protect vested interests – and sometimes aim to exploit the system through rent-seeking.

Meeting Australia's ambitious emission-reduction targets, and then revisiting them

Dr Brian Spies FTSE has held senior research and management roles in the mineral exploration, petroleum and environmental sectors in Australia and the US, including Chief Research Scientist at CSIRO and Director of Physics at ANSTO. His current research interests include the interface between water, energy, climate change and the Australian economy. He was lead author of the 2012 ATSE report Sustainable water management: Securing Australia's future in a green economy. He is Honorary Secretary of ATSE's NSW Division, serves on Assembly, and is active in organising NSW events and seminars, including the 2016 luncheon series 'Climate change and its consequences'

Dr Graeme Pearman AM FAA FTSE was CSIRO Chief of Atmospheric Research 1992 to 2002, contributing more than 200 scientific journal papers. He is now a consultant, Adjunct Senior Research Fellow (Monash University) and Professorial Fellow (University of Melbourne). Awards include the CSIRO Medal, a UN Environment Program Global 500 Award and Federation Medal. He is on the Board of the Climate Institute and recently served on the science advisory committees for the Singapore National Research Foundation and the German Council of Science and Humanities. Current interests include resilient energy futures, transport technologies, limitations/risks associated with biofuels and the role of science in modern societies.

DIGITAL AGRICULTURE

At QUT we believe the next agricultural revolution will be digital.

The ubiquitous application of digital technologies will transform agriculture over the coming years. Digital agriculture will integrate deep local knowledge and systems science with powerful digital technologies – from robots, autonomous systems and sensor networks to cognitive data analytics, economic modelling and artificial intelligence. It will enable farming and food enterprises to use precise agronomic, environmental and economic data to make better decisions and run their operations more efficiently, profitably and sustainably.

QUT is uniquely positioned to lead developments in digital agriculture. Our researchers are finding integrated solutions, in collaboration with industry, to key management problems. As well as developing new technologies and systems, we are studying the key aspects of adoption: regulation, ethics, business and economics, and human factors.

Our agricultural robotics researchers are developing enabling technologies that will transform farming practice, such as the farming robot prototypes AgBot II and Harvey, which have achieved exceptional results in fields trials in 2015 and 2016.

We are also working with industry on cognitive data analytics for incorporating growers' priorities, values and preferences into digital tools for situational awareness and decision making. This research brings together decision science, cognitive science and user interface design.

QUT also hosts the Queensland node of the ARC Centre of Excellence for Mathematical and Statistical Frontiers (ACEMS), which is exploring new methods of data analysis based on advanced mathematical and statistical techniques.

Professor Bronwyn Harch (left) is the Executive Director of the Institute for Future Environments, which is driving QUT's research in digital agriculture. Professor Tristan Perez, leader of QUT's Strategic Investment in Farm Robotics (SIFR) program, is investigating agricultural applications of 'IntelliSensing' – transformative methods of data collection, modelling, analytics and decision making. Dr Kate Devitt is an information ecology lecturer who is researching cognition and decision making in agriculture.



NEWS

Making mining less of a 'drag'

A new CSIRO technology that takes the energy-sapping 'drag' out of industrial pumping has been adopted by a major mining company, Glencore's Minara Resources, following a successful full-scale trial.

The drag-reduction technology can save mining companies energy and water use each year, while boosting productivity.

Minara has installed the technology to improve the feed ore slurry pumping capacity at its Murrin Murrin nickel operation in Western Australia.

Almost all mineral processing plants need to transport slurry – a semi-liquid mixture that can include water, ore and other material – through pumps at various process steps.

CSIRO senior engineer Dr Rueben Rajasingam said that reducing water content, power demand and pumping inefficiencies always results in significant operational and cost improvements.

"The thicker the material, the more friction or 'drag effect' you get, which makes it hard to pump and more energy and capital-intensive," Dr Rajasingam said. "Water is typically added to dilute the material before pumping, but only as a last resort because the more water you add the less throughput you achieve."

"Our technology combats both these challenges: it introduces a



CSIRO senior engineer Dr Rueben Rajasingam says that the drag-reduction technology offers a sustainable and cost-effective solution for industrial pumping.

thin, uniform and long-lasting ring of fluid between the slurry and the inside of the pipe so that thick material can be efficiently pumped without friction at a high throughput."

CSIRO's drag-reduction technology could be applied to a broader range of industrial processes where there is a dewatering aspect that results in a sludge, slurry or paste that needs to be transported, such as in construction, waste management, coating services and food processing.

SALT BATHS FOR BATTERIES

The next generation of rechargeable lithium batteries set to disrupt the electric vehicle industry may soon be here, thanks to the humble salt bath.

CSIRO scientists, in collaboration with RMIT University and Queensland University of Technology (QUT), have demonstrated that pre-treating a battery's lithium metal electrodes with an electrolyte salt solution extends battery life and increases performance and safety.

The simple method is set to accelerate the development of next-generation energy-storage solutions and overcome the issue of 'battery range anxiety', which is a current barrier in the electric car industry. The technology is claimed to have the potential to improve electric vehicle drive range and battery charge to a point where electric vehicles will soon be competitive with traditional petrol vehicles.

CSIRO battery researcher Dr Adam Best said the pre-treated lithium metal electrodes could potentially

outperform other batteries currently on the market.

"Our research has shown by pre-treating lithium metal electrodes, we can create batteries with charge efficiency that greatly exceeds standard lithium batteries," Dr Best said.

The pre-treatment process involves the immersion of lithium metal electrodes in an electrolyte bath containing a mixture of ionic liquids and lithium salts, prior to the battery being assembled.

Ionic liquids, or room-temperature molten salts, are a unique class

of materials that are clear, colourless, odourless solutions and are non-flammable. When used in batteries, these materials can prevent the risk of fire and explosion, a known rechargeable battery issue.

The salt-bath pre-treatment adds a protective film onto the surface of the electrode that helps stabilise the battery when in operation.

"The pre-treatment reduces the breakdown of electrolytes during operation, which is what determines the battery's increased performance and lifetime," Dr Best said.



CSIRO, RMIT and QUT are developing a 'salt bath' to increase battery life and performance.

NEWS



Doarama's online interactive 3D maps: changing the way we experience sport.

Data61 puts us on the bike

Sports fans saw the Tour de France in a whole new way this year and are taking a new look at the Rio 2016 Olympics thanks to Doarama, a start-up out of CSIRO's Data61 group.

This year, spectators through doarama.com were able to access customised 3D interactive map visualisations of Tour de France stage

routes – able to interact with the maps by controlling how they view the route in a 3D virtual world. They have the same options to preview selected routes for the Olympics.

CSIRO's Data61 Software Engineer and head of Doarama, Pete Field, said the 3D maps are changing how we experience endurance events, either as a spectator or an athlete.

"Until now we've 'made do' with a 2D overhead map and a separate terrain profile," Mr Field said. "3D fly-through maps were only available to large media broadcasters and, even then, these maps were limited to a single point of view, and only made available for the largest races.

"With Doarama, sport routes can be made available online, and it is completely interactive. The viewer can move around inside the 3D world while the route is laid out before them. For athletes, sports enthusiasts and event organisers, Doarama gives you an edge when preparing for that big event."

The tool for the Olympics demonstrates the versatility of Doarama – the platform is able to accommodate various types of events that cover large areas. "Paragliders and ultramarathon races in Italy, France and California and the RedBull XAlps Competition have been early adopters," Mr Field said.

Doarama is free, works on desktop and mobile devices, and gives people the opportunity to experience a walk, run, hike, rock climb, paraglide, cycle or ski route using its GPS route visualisations.

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NEWS

XPrize & IBM Watson offer \$5M AI challenge

XPrize, the international prize competition organiser, is running the US\$5 million (A\$6.7 million) IBM Watson AI XPrize, a four-year global competition challenging teams to develop and demonstrate how humans can collaborate with powerful artificial intelligence (AI) technologies to tackle the world's greatest challenges.

The AI competition is XPrize's first open challenge where teams will define their own goals and create AI applications that solve some of humanity's most pressing challenges in areas such as health care, education, energy and environment, global development and exploration. First-round registrations close 1 December 2016.

"The IBM Watson AI XPrize is intended to promote and progress the notion of 'AI for impact' among the global bold innovator crowd, both the established community of practitioners, as well as encourage newcomers to experiment and ultimately demonstrate how AI can be used as a tool for good," said Mr Marcus Shingles, CEO of XPrize.

Teams have until 1 December to register via the XPrize website for the four-year competition, and then until 1 March 2017 to submit a detailed development and testing plan for their proposed solution. There will be three subsequent rounds of selection each year when a panel of judges will choose the top 10 teams, which will advance to compete at IBM Watson-sponsored events where they can receive Milestone Prizes.

The competition culminates in three finalists participating in the Grand Prize competition on the TED2020 stage in front of in-person and online audiences. Teams will be judged based on the standards they set in their plans, as well as the performance and scalability of their AI application, with the heaviest weight placed on the potential for solutions to achieve an exponential impact.

"Cognitive solutions can understand the world's data, reason with purpose, learn at scale, and interact with humans naturally, holding the key to solving some of society's greatest challenges," said Mr Stephen Gold, Vice President, IBM Watson.

"The IBM Watson AI XPrize will stir innovation and empower a global group of developers, entrepreneurs and organisations to push



IBM Watson researchers at work.

IBM WATSON

IBM Watson positions itself as representing a new era in computing called cognitive computing, where systems understand the world the way humans do: through senses, learning and experience. Watson continuously learns from previous interactions, gaining in value and knowledge over time.

To advance Watson, IBM has three dedicated business units:

- Watson, established for the development of cloud-delivered cognitive computing technologies that represent the commercialisation of AI across a variety of industries;
- Watson Health, dedicated to helping doctors, researchers, and insurers and other related health organisations to surface new insights from data to deliver personalised healthcare; and
- Watson IoT, focused on making sense of data from the more than nine billion connected devices operating in the world today.

the boundaries of human-machine collaboration, forever changing for the better the way in which we live and work."

■ US-based XPrize positions itself as "the global leader in designing and implementing innovative competition models to solve the world's grandest challenges". Its competitions include the \$30 million Google Lunar XPrize, the \$20 million NRG COSIA Carbon XPrize, the \$7 million Shell Ocean Discovery XPrize and the \$7 million Adult Literacy XPrize.

AUSSIE STUDENTS DO WELL AT INTEL ISEF

Nine BHP Billiton Science and Engineering Award finalists were selected to attend the Intel International Science and Engineering Fair (Intel ISEF) in the US and six returned home with a prize.

Hannah Sutton from Tasmania won an Intel ISEF Grand Award for her work, supported by the Menzies Institute, investigating how a peptide from the skin glands of the Australian tree frog could be used as a possible treatment for Alzheimer's disease.

CSIRO Chief Executive Dr Larry Marshall congratulated the returning students, saying their innovation highlighted the importance of STEM education to the future of Australia.

The students attending Intel ISEF were finalists of the BHP Billiton Science and Engineering Awards, a partnership between BHP Billiton, CSIRO and the Australian Science Teachers Association. The awards reward young people who have undertaken practical research projects

that demonstrate innovative approaches and thorough scientific or engineering procedures.



Australian students at Intel ISEF (back row, from left) Terence Johnson, Lachlan Wilson, Hugh McKay, (front row, from left) Madeleine Maloof, Hannah Sutton and Hayden Goodwin.



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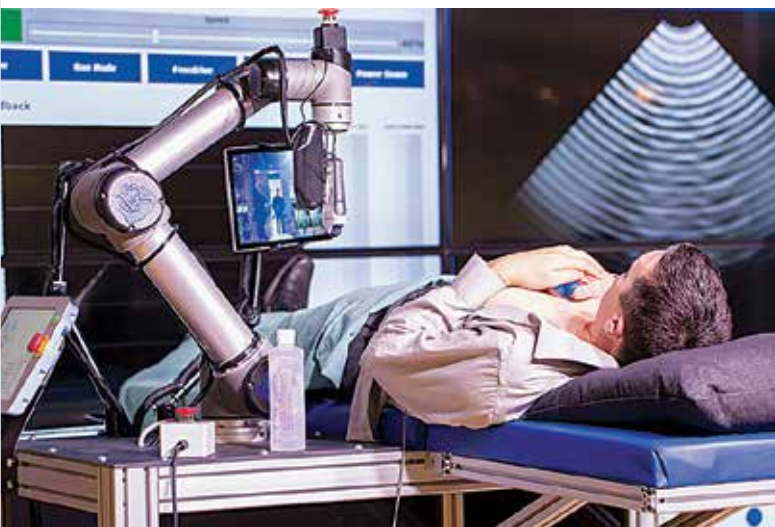
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Long-range robotic ultrasound technology.

Deakin & Telstra driving remote ultrasound diagnostics

Australians may soon be able to undergo ultrasound diagnostics from remote locations, thanks to world-first robotics technology developed by Deakin University, in partnership with Telstra.

The haptics-enabled technology means a patient will no longer need to be in the same room as the sonographer – the medical professional could be as far as 1000 kilometres away from the ultrasound unit.

The HER (haptically enabled robotics) remote ultrasound technology was developed by Deakin University's Institute for

Intelligent Systems Research and Innovation (IISRI), with funding and technical support from Telstra as part of its Research Partner Program.

With the addition of patient feedback technology, the sonographer can remotely monitor patient discomfort in relation to the applied probe force. This information can be used to assess the tenderness of the examined area and compared with historical data on the patient.

IISRI Director Professor Saeid Nahavandi said Deakin and Telstra had collaborated on a world-first trial of the technology, which has so far been successfully tested using data links between Melbourne and several regional and rural cities within Australia.

"A principal advantage of this system is the ability to translate the sense of touch to the operator. Haptic feedback allows an operator to feel and experience the remote environment, through the robotic system, as though they were interacting with it directly.

"The addition of stereovision can improve operator situational awareness by giving the operator depth perception, which also contributes to the accuracy and efficiency of the ultrasound."

Mr Kannan Alagappan, Director of Technology, Technology Strategy at Telstra, said that Telstra was the perfect partner for the project, bringing network expertise and capabilities, along with commercial experience. "Early stage testing has extended the trial beyond initial expectations by proving the technology on Telstra's 4G wireless network," Mr Alagappan said. "It's now portable and expandable enough to cover more than 97 per cent of Australia's population."

Deakin University clinician and Epworth Geelong Chair in Surgery, Professor Glenn Guest, said the ability to perform a remote ultrasound procedure using robotic technology would enable skilled surgeons, doctors and radiologists to make diagnoses from their preferred location.

Telstra and Deakin are seeking partners and paths to bring the technology to market, through global health technology companies, and health networks across Australia.

DIAMONDS AND RUBIES MAY BE NANOMATERIALS OF CHOICE

A new study has shown that miniscule diamonds and rubies could be the nanomaterials of choice for researchers aiming to explore cellular and molecular processes inside the living body.

The ruby and diamond particles, more than 1000 times smaller than the diameter of a hair, were tested alongside other nanoparticles for use in biological imaging, and were shown to have a high degree of stability, critical to achieving imaging success.

"Fluorescing nanoparticles can be used as 'tiny lamps' that when placed in the body, are able to light up cells and their internal processes," explained Dr Philipp Reineck, RMIT University lead scientist on the study and researcher at the ARC Centre of Excellence for Nanoscale BioPhotonics (CNBP).

"We shine light at the biological sample of interest in a very controlled way and the

nanomaterials send light back, helping us to see very specifically what is happening, right down to a molecule and protein level. This is the area we're focused on, exploring how the 'very small' can help us in answering some of the very big questions in biology."

In the study, Dr Reineck and his team compared seven types of fluorescent nanomaterials: organic dyes, semiconductor quantum dots, fluorescent beads, carbon dots and gold nanoclusters, as well as the nano-sized diamonds and rubies. Characteristics tested for included levels of fluorescence brightness and photostability (resistance to change under the influence of light), as well as how efficiently these new materials can be imaged with standard microscopes used in biology.

"What our study clearly shows is that nanodiamonds and nanorubies are excellent

materials for long-term biological imaging.

These two materials provide acceptable levels of brightness and the best photostability by far, when compared to the other materials that were tested."

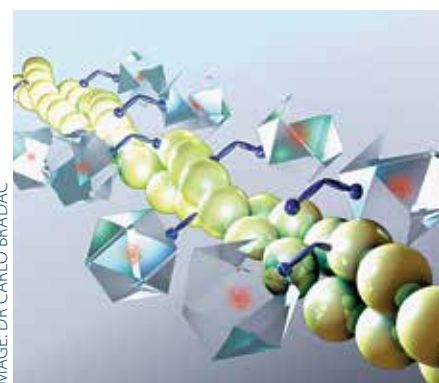


IMAGE: DR CARLO BRADAC

A representation of nanodiamonds being used to light up and image a protein chain.

NEWS

Moving mining to renewable energy



The DeGrussa panels.

A big off-grid, renewable energy-powered mining project has been successfully completed in remote WA demonstrating a confluence between established and emerging Australian industries.

More than 34,000 solar photovoltaic (PV) panels have been installed at the DeGrussa copper–gold mine alongside 6 megawatts (1.8 megawatt hours) of new battery storage. The DeGrussa mine, near Meekatharra, is operated by Sandfire Resources.

The DeGrussa Solar Power Project is owned by leading French renewable energy firm Neoen, with juwi Renewable Energy responsible for project development, engineering procurement and construction, and operations and maintenance. The plant was constructed by national surveying and infrastructure construction company OTOC Ltd.

The Australian Renewable Energy Agency (ARENA) is supporting the \$40 million project with \$20.9 million recoupable grant funding and the Clean Energy Finance Corporation (CEFC) has committed \$15 million in debt finance.

ARENA CEO Mr Ivor Frischknecht said the successful commissioning marked a turning point for the use of renewable energy in off-grid industries.

"This is a clear example of renewables providing substantial, reliable results for one of Australia's largest industries," Mr Frischknecht said. "The project has achieved a series of firsts. It's the largest off-grid solar PV system in the world and one of the largest solar plants providing peak power load to a mining operation."

"The project was constructed in 10 months and delivered on budget, despite being located in remote Australia. Cutting-edge technology is being demonstrated at the site, with advanced lithium-ion batteries storing solar power and sun-tracking solar PV panels maximising plant output. Smart control systems are linking these components with the existing diesel plant to maximise the amount of renewable energy delivered."

"Mine owner Sandfire Resources is benefiting from more predictable power costs and is anticipating potential cost savings through reduced reliance on trucked-in diesel."

"The mining industry has been watching the progress at DeGrussa. Sandfire has already fielded enquiries from other miners looking to take advantage of renewable energy and tap into Sandfire's experience."

HYDRO TASMANIA TO FUEL COOBER PEDY

Hydro Tasmania will help transform Coober Pedy, in remote SA, into a mostly renewable energy township, allowing the mining town of about 3500 people to draw, on average, 70 per cent of its energy from solar and wind. When conditions allow, the town will be 100 per cent renewably powered.

The Coober Pedy project will use the technologies developed and proven by Hydro Tasmania in its King Island Renewable Energy Integration Project (KIREIP), which has reduced the Bass Strait island's annual diesel consumption by, on average, 60 per cent.

Hydro Tasmania has been engaged by project developer Energy Developments Ltd (EDL) to provide renewable power under grant funding to EDL of up to \$18.4 million by the Australian Renewable Energy Agency.

EDL supplies power to Coober Pedy via a 3.9 megawatt diesel power station. Under the contract, Hydro will supply EDL with its proprietary enabling technology – control, load management and storage systems. The project offers significant benefits as diesel generation is intrinsically expensive and emissions intensive. Hydro Tasmania expects to deliver its technology in mid-2017.

The CEO of Hydro Tasmania, Steve Davy, said the Coober Pedy project demonstrated the success of KIREIP and growing commercial interest in this technology within Australia and overseas.

ARENA CEO Ivor Frischknecht said Hydro Tasmania had joined a growing list of companies that have commercialised early-stage renewable energy technologies with ARENA support.

"Combining wind, solar, battery storage and smart control systems could provide a blueprint for off-grid communities to access cleaner and cheaper power and achieve energy independence by greatly reducing their reliance on trucked-in diesel," he said.

Hydro Tasmania's Manager Off-Grid Solutions Simon Gamble said it was the company's biggest external supply contract to date.

"The enabling technology successfully pioneered on King Island will be deployed to Coober Pedy in our new scalable 'containerised' format. Each unit is a purpose-built shipping-style container utilised for easier transport and installation and designed for long-term, on-site operation, providing a very flexible and efficient logistical solution."



Hydro Tasmania's containerised solution.

NEWS

UNSW engineers boost solar cell efficiency, again

A new solar cell configuration developed by engineers at the University of New South Wales has pushed sunlight-to-electricity conversion efficiency to 34.5 per cent – establishing a new world record for unfocused sunlight and nudging closer to the theoretical limits for such a device.

The record was set by Dr Mark Keevers and Professor Martin Green AM FRS FAA FTSE, Senior Research Fellow and Director, respectively, of UNSW's Australian Centre for Advanced Photovoltaics.

They used a 28cm², four-junction mini-module – embedded in a prism – that extracts the maximum energy from sunlight by splitting the incoming rays into four bands, using a hybrid four-junction receiver to squeeze even more electricity from each beam of sunlight.

The new UNSW result, confirmed by the US National Renewable Energy Laboratory, is almost 44 per cent better than the previous record – made by Alta Devices of the US, which reached 24 per cent efficiency, but over a larger surface area of 800cm².

The result was obtained by the same UNSW team that set a world record in 2014, achieving an electricity conversion rate of more than 40 per cent by using mirrors to concentrate the light – a technique known as CPV (concentrator photovoltaics) – and then similarly splitting out various wavelengths. However, the new result was achieved using normal sunlight with no concentrators.

"This encouraging result shows that there are still advances to come in photovoltaics research to make solar cells even more efficient," Dr Keevers said. "Extracting more energy from every beam of sunlight is critical to reducing the cost of electricity generated by solar cells as it lowers the investment needed and delivers payback faster."



Dr Mark Keevers and Professor Martin Green of UNSW's Australian Centre for Advanced Photovoltaics.

"What's remarkable is that this level of efficiency had not been expected for many years," said Professor Green, a pioneer who has led the field for much of his 40 years at UNSW.

"So things are moving faster in solar-cell efficiency than many experts expected, and that's good news for solar energy," he added.

"But we must maintain the pace of photovoltaic research in Australia to ensure that we not only build on such tremendous results, but continue to bring benefits back to Australia."

Australia's research in photovoltaics had already generated flow-on benefits of more than \$8 billion to the country, Professor Green said.

Gains in efficiency alone, made possible by UNSW's Passivated Emitter Rear Cell (PERC) cells, are forecast to save \$750 million in domestic electricity generation in the next decade. PERC cells are now becoming the commercial standard globally.

The 34.5 per cent result with the 28cm² mini-module is already a world record, but scaling it up to a larger 800cm² is well within reach. "There'll be some marginal loss from interconnection in the scale-up, but we are so far ahead that it's entirely feasible," Dr Keevers said.

The research is supported by \$1.4 million grant funding from the Australian Renewable Energy Agency (ARENA). Other partners are another ARENA-supported company, RayGen, Trina Solar, a PV module manufacturer, and the US National Renewable Energy Laboratory.

CLIMATE COUNCIL LAUDS SA, ACT

A Climate Council report on the renewable energy progress of Australia's states and territories says South Australia and the ACT are leading the charge.

NSW received the worst grade due to its low and falling percentage of renewable energy, no renewable energy target and low levels of rooftop solar.

The report, *Game On: Australia's Renewable Energy Race Heats Up*, grades the states on their renewable energy policy settings and performance across a range of indicators including rooftop solar penetration, large-scale capacity per capita and percentage of renewable electricity.

It finds that policy support for renewable energy amongst the states continues to increase. It says all states, except Victoria and NSW, have increased the proportion of

renewable energy in their electricity supply since the Climate Council's last state update in 2014.

The report also said that:

- South Australia (A) scored the highest grade followed by Tasmania (B), then Queensland (C), Western Australia (C) and Victoria (C), then NSW (D);
- ACT was singled out for its strong leadership on renewable energy, while NT "performs poorly on a range of indicators and has no policies or targets related to renewable energy";
- of the states, SA had achieved the greatest increase in its share of renewable energy – going from 26 per cent renewable electricity in 2013 to 40 per cent in 2014;
- in NSW, Queensland and Victoria, fossil fuels such as coal and gas still accounted

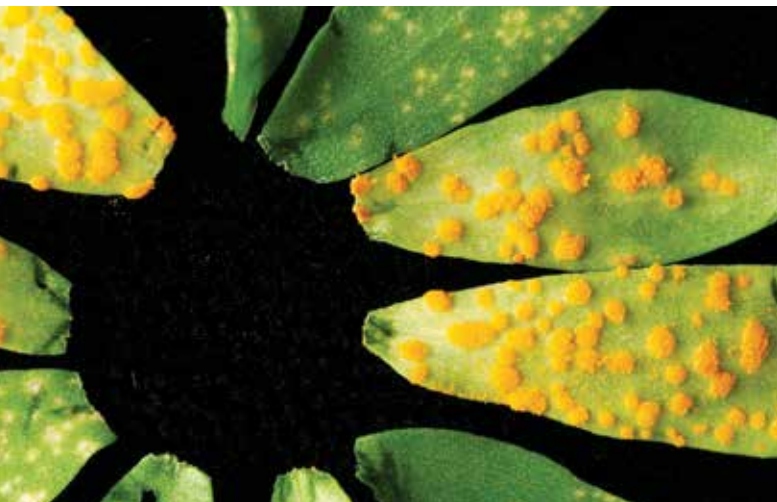
for 90 per cent or more of total power supply; and

- both Queensland (29.8 per cent) and SA (28.8 per cent) were approaching almost one-third of homes with solar and were far ahead of the other states (WA was in third place on 22.5 per cent).

The Climate Council was established with a crowd-funded campaign following the closure in 2013 of the Government's Climate Commission.

The Council website says it exists "to provide independent, authoritative climate change information to the Australian public because our response to climate change should be based on the best science available". Professor Tim Flannery is the Chief Councillor and Professor Veena Sahajwalla FTSE is a Councillor.

NEWS



Rusts are a common fungal disease of plants, including many of Australia's cereal and horticultural crops.

Robust management helps keep out invaders

New CSIRO research into the global impacts of invasive species has found that the chances of invasive species entering Australia are relatively high, but the overall threat to agriculture is lessened due to our robust management practices.

The research found that Sub-Saharan African countries are most at risk, while China and the US pose the greatest threat.

The research examines the worldwide distribution of nearly 1300 invasive pests and pathogens, international trade flows, and each country's main agricultural production crops, to determine potential invasion risks and impact.

This is the first analysis of invasive species' threat to global crop production on a country-by-country basis, calculating the total potential cost of these species invading each of the 124 countries.

Senior researcher Dr Dean Paini said the research found that the most vulnerable countries were located in Sub-Saharan Africa.

"These countries generally do not have diverse economies making them disproportionately more dependent on agriculture," Dr Paini said. "As a result, any threat from invasive species can potentially have a greater relative impact on these countries."

The study also determined which countries presented the greatest threat to the rest of the world, given the scale of agricultural export and the invasive species already established.

The US and China posed the greatest threat as a source of invasive species – not surprising given the high number of pests already present, the scale of their agriculture export industries and their role as regional food hubs with an extensive network of trade partners.



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- Provisional Patents
- International Applications
- IP Valuation
- Trade Marks
- Enforcement



Keeping them working – and barking
– with snake bite protection.

PHOTO: CSIRO, CARL DAVIES

Anti-venom to keep dogs barking

CSIRO scientists have worked with Padula Serums Pty Ltd, a small biotech company in regional Victoria, to produce an anti-venom to treat bites from Australian Eastern Brown and Tiger snakes, which are among the 10 most venomous snakes in the world.

Dr Andrew Padula of Padula Serums said working with CSIRO helped turn his idea into a reality. "I've been working on anti-venom serums for dogs and cats for a while now but I really needed the expert equipment and skills of CSIRO to make the best product possible."

Professor George Lovrecz from CSIRO's manufacturing team said the new process created an anti-venom more effective than those currently on the market because it was distilled and concentrated to create a pure, fully tested and ready-to-be-injected product.

Once final testing has been completed and the anti-venom has been given approval for sale it will be available to be stocked by veterinarians around the country.

The new treatment could have application in treating humans for snake bite or the toxins of paralysing ticks. CSIRO is also investigating the possibility of using a similar approach to viruses such as Ebola.

BLOOD TEST PREDICTS PREMATURE BIRTH

A blood test developed by a team of scientists, including UWA researchers, can identify women who are at risk of giving birth prematurely, but not displaying symptoms, as early as 18 weeks into their pregnancy. The test is the most accurate to date and provides the earliest detection of premature birth, with a 86 per cent accuracy in determining mothers at risk of early delivery.

The research, carried out by scientists from UWA and the universities of Toronto, Alberta and Calgary, was made possible by a \$5 million grant from Alberta Innovates-Health Solutions, a provincial government program that aims to improve health and well-being through research and innovation.

Premature birth is the main cause of death and disability of babies globally. About eight per cent of Australian babies (26,000) are born prematurely. Aside from infant death, premature birth can result in lifelong physical ailments from organs that are insufficiently developed before birth.

CLUNIES ROSS WINNER TAKES ANOTHER PRIZE

A scientist from The University of Western Australia, who won a 2010 Clunies Ross Award, has scored a prestigious new international award for his outstanding contribution to the management of and improvement in quality of life for patients with red blood cell disorders.

Professor Tim St Pierre, from UWA's School of Physics, has been awarded the inaugural Panos Englezos Prize, jointly presented by the University of Nicosia Medical School and the Thalassaemia International Federation, based in Nicosia.

Professor St Pierre has spent more than 30 years researching

the magnetic properties of iron in biology and medicine and is also chief scientific officer of Resonance Health Ltd, an Australian healthcare company spun out from UWA that specialises in the development and delivery of non-invasive medical imaging software and services.

He and his team developed the non-invasive liver iron measurement technology, FerriScan, which has already been used in more than 30,000



Tim St Pierre

patients around the world.

Resonance Health was named Western Australia's 2014 Innovator of the Year for its development of HepaFat-Scan, a non-invasive technology to enable MRI technology to measure the concentration of fat in the human liver.

DAIRY DIP IS CONCERNING

A CSIRO/University of Adelaide study has found that one in six adult Australians are choosing to avoid milk and dairy foods, the majority without a medical diagnosis, leading to public health concerns for women in particular.

The survey found that 74 per cent of dairy avoiders are making this choice to relieve adverse gastrointestinal symptoms such as cramps, bloating or wind. Others cited not liking the taste or concern about weight gain.

The study also revealed that the decision to avoid some or all dairy foods is influenced by a range of sources from outside medical practice such as the internet, media, friends or alternative practitioners.

"The scale of people restricting their diet without a medical reason is very concerning in terms of the public health implications, especially for women," said behavioural scientist Ms Bella Yantcheva, from CSIRO.

"It means there is potential for nutritional deficiencies or imbalances, or the risk that an underlying health condition could be going untreated," she said.

Dairy foods are important for all of us, but especially for women owing to the calcium content, and foods from the dairy and alternatives group are important throughout life to reduce the risk of osteoporosis.

ATSE PEOPLE

Hugh Bradlow is President Elect

Professor Hugh Bradlow FTSE, Telstra's Chief Scientist, has been elected President of the Academy.

Professor Bradlow will take up the presidency in October. Until then, ATSE's Interim President Professor Peter Gray FTSE, will continue to lead the Academy.

The President's role became vacant when Dr Alan Finkel AO FAA FTSE resigned last December to take up his appointment as Australia's Chief Scientist.

Professor Bradlow, a Fellow since 1991 and an ATSE director, holds a bachelor's degree in electrical engineering from the University of Cape Town and a doctorate in experimental nuclear physics from the University of Oxford.

Before becoming Telstra's Chief Scientist he was Telstra's Chief Technology Officer and Head of Innovation.

Prior to joining Telstra, in September 1995, he was Professor of Computer Engineering at the University of Wollongong and Professor of Electrical Engineering (Digital Systems) at the University of Cape Town.

Professor Bradlow is an Emeritus Professor



Hugh Bradlow

of the University of Wollongong, a Professorial Fellow of the University of Melbourne and a recipient of a Centenary Medal.

He is globally recognised as a thought leader in telecommunications and was elected as the joint 2009 Australian Telecommunications Ambassador of the Year, named by Global Telecom Business as one of the most 100 most influential telecommunications executives in the world and Smart Company designated him as one of the 12 most influential people in Australian ICT.

FOUR ATSE FELLOWS JOIN ACADEMY OF SCIENCE

Australia's Chief Scientist and former ATSE President Dr Alan Finkel AO FAA FTSE is among 21 scientists elected to the Australian Academy of Science.

The six women and 15 men elected also included Fellows Professor Benjamin Eggleton FAA FTSE, from the University of Sydney, Professor Simon Foote FAA FTSE, Australian National University, and Professor Geoffrey Fincher FAA FTSE, University of Adelaide.

The former Australian of the Year and mental health advocate Professor Patrick McGorry FAA was among those elected.

New AAS Fellows were admitted in a formal ceremony in Canberra in May,

and made presentations about their work at the AAS's annual flagship event, Science at the Shine Dome.

The AAS total fellowship is 511 scientists.



Geoffrey Fincher

In his speech to the AAS, Dr Finkel noted his ATSE presidency.

"I became Chancellor of Monash University, which was the most extraordinary opportunity to give back to the organisation that taught me – and provided more training for my current job.

"And I became the President of the Australian Academy of Technology and Engineering, known as ATSE. This was the cream on the cake in my training program.

"Through my presidency of ATSE I came to understand public policy, the common good, and the benefit to be accrued by working collaboratively with the Fellows of all of the learned academies."

BRONWYN HARCH HEADS QUT FUTURE INSTITUTE

Environmental statistician Professor Bronwyn Harch FTSE has been appointed Executive Director of the Institute for Future Environments (IFE) at Queensland University of Technology.

QUT says its IFE "is tackling the grand challenges facing humanity, from feeding the world's booming population to managing scarce natural resources and reducing our carbon footprint" – with a mission to find ways to make the world more sustainable, secure and resilient.

"Bronwyn brings to the role of Executive Director impressive research leadership experience at CSIRO and at QUT, as both a research director and a chief investigator," said QUT Vice-Chancellor Professor Peter Coaldrake.

"She is extremely well placed to lead QUT's Institute for Future Environments in its next, critical phase of development."

Since joining QUT in 2014, Professor Harch has served in the joint role of Deputy Director – Research in the IFE and Assistant Dean (Research) of the Science and Engineering Faculty.

Before that she was Chief of CSIRO's Division of Computational Informatics and Deputy Director of CSIRO's Sustainable Agriculture Flagship.

She took up her new role on 1 July.



Bronwyn Harch



Simon Foote

ATSE PEOPLE

Five Fellows in Queen's Birthday Honours

Five ATSE Fellows were recognised in the Queen's Birthday Honours, with two receiving the nation's highest honour.

PHOTO: STUART HAY



Brian Anderson

Professor Brian Anderson AC FRS FAA FTSE, from ANU, and Professor David Solomon AC FRS FAA FTSE, the 'father of the plastic banknote', were both appointed Commanders

of the Order of Australia.

CSL R&D Director and Chief Scientist Dr Andrew Cuthbertson AO FTSE, CSIRO agriculture legend Dr TJ Higgins AO FAA FTSE and WEHI Director Professor Doug Hilton AO FAA FTSE were all appointed Officers of the Order.

The late Professor Mike Raupach AO FAA FTSE was appointed an Officer posthumously.

This honour was also won by former Clunies Ross Award winner and IMNIS co-founder Dr Tony Radford AO.

Professor Anderson, from the Australian National University College of Engineering and Computer Science, was honoured "For eminent service to information and

communications technology, to engineering and to higher education, as an academic, researcher and author, to professional

scientific associations, and as a mentor of young scientists".



David Solomon

Professor Solomon, co-inventor of the plastic banknote first circulated in Australia in 1988, and since exported to 34 countries, was honoured

"For eminent service to science as an academic, researcher and author in the field of polymer chemistry and plastics, to the development and commercialisation of processes and materials, and to professional scientific institutions".

Dr Cuthbertson, a former molecular biology researcher and CSL R&D director since 2000, was honoured "For distinguished service to medical science, particularly through the development and delivery of innovative biotherapies to assist public health, and to professional research organisations".

Dr Higgins, a leading researcher in plant gene technology, was honoured "For distinguished service to agricultural

biotechnology as a biologist and researcher, particularly in the area of plant nutritional value and resistance to pests and disease, and to professional scientific organisations".



Andrew Cuthbertson

Professor Hilton, President of the Association of Australian Medical Research Institutes and one of 20 inaugural 'Male Champions of Change', was honoured

"For distinguished service to medical research and education, particularly in the field of haematology, as a molecular biologist and author, to gender equity, and as a mentor of young scientists".

The late Professor Raupach, an eminent climate scientist, was honoured "For distinguished service to science in Australia and internationally as a leader and researcher into climate change and land systems, and to professional organisations".

Dr Radford, a passionate advocate for improved public health through detection and prevention of tuberculosis, who shared the 2013 Clunies Ross Award with three colleagues, was honoured "For distinguished service to science and global public health through innovation, research and development of technology to diagnose tuberculosis".

ATSE was pleased to note the AO award to Professor Nalini Joshi AO FAA, a Georgina Sweet Australian Laureate Fellow in mathematics at the University of Sydney and a driving force behind the establishment of the SAGE program, who was honoured "For distinguished service to mathematical science and tertiary education as an academic, author and researcher, to professional societies, and as a role model and mentor of young mathematicians".

ATSE also acknowledges the AM award to Dr Elizabeth Finkel AM "For significant service to the print media as a science journalist and author, and as a supporter of a range of not-for-profit organisations".



Doug Hilton



TJ Higgins

LIVERIS TO HEAD MERGED DOWDUPONT

Dr Andrew Liveris AO FTSE, Chairman and Chief Executive officer of Dow Chemical, will become executive chairman of DowDuPont following the merger of Dow and DuPont.

His appointment will be effective on completion of the proposed merger transaction, which is expected to close in the second half of 2016, subject to satisfaction of customary closing conditions, including receipt of stockholder and regulatory approvals.

Dr Liveris is a 40-year veteran of Dow – a materials, polymers, chemicals and biological sciences enterprise. A recognised global business leader, his career has spanned roles in manufacturing, engineering, sales, marketing, and business and general management around the world. In addition to other duties, Dr Liveris will have responsibility for the Material Science business.

He sits on the Board of Directors of IBM, is Vice Chair of the US Business Roundtable, an Executive Committee Member and Past Chairman of the US Business Council, and a member of the US President's Export Council and the Australian Government's Industry Growth Centres Advisory Committee.

He serves on the Board of Trustees for the Herbert H. and Grace A. Dow Foundation, California Institute of Technology and the United States Council for International Business.

Mr Liveris attended the University of Queensland in Brisbane, graduating with a bachelor's degree (first-class honours) in chemical engineering.

PHOTO: GETTY IMAGES



Andrew Liveris

ATSE PEOPLE

Michelle Simmons wins Feynman Prize

Professor Michelle Simmons FAA FTSE has been awarded a prestigious Foresight Institute Feynman Prize in Nanotechnology for her world-leading research in the fabrication of atomic-scale devices for quantum computing.

Two international Feynman Prizes, in honour of the late Nobel-Prize-winning US physicist Richard Feynman, are awarded each year in the categories of theory and experiment to researchers whose work has most advanced Feynman's nanotechnology goal of molecular manufacturing.

Professor Simmons, Director of the ARC Centre of Excellence for Quantum Computing and Communication Technology (CQC2T) at the University of NSW, won the 2015 experimental prize from the Foresight Institute for her work in "the new field of atomic-electronics, which she created".



Michelle Simmons

As director of CQC2T, Professor Simmons heads a team of more than 180 researchers across six Australian universities, including UNSW. She has previously been awarded two Australian Research Council Federation Fellowships and currently holds a Laureate Fellowship.

She has won both the Pawsey Medal

(2005) and Thomas Ranken Lyle Medal (2015) for outstanding research in physics. She was named NSW Scientist of the Year in 2012, and in 2015 she was awarded the Eureka Prize for Leadership in Science. In 2014, she had the rare distinction for an Australian researcher of becoming an elected member of the American Academy of Arts and Sciences.

"By creating electronic devices atom by atom, we are gaining a very fundamental understanding of how the world behaves at the atomic scale, and it's phenomenally exciting," Professor Simmons says.

The Foresight Institute is a leading think tank and public interest organisation focused on transformative future technologies. Founded in 1986, its mission is to discover and promote the upsides, and help avoid the drawbacks, of nanotechnology, artificial intelligence, biotechnology and similar life-changing developments

VANESSA GUTHRIE NEW CHAIR OF MCA

Dr Vanessa Guthrie FTSE will chair the Minerals Council of Australia for the next two years.

Dr Guthrie is Chief Executive of Toro Energy, which is developing uranium operations in Western Australia. Dr Guthrie is the first woman to chair the mining industry representative body in its 40-year history.

Outgoing chair Mr Andrew Michelmore FTSE said Dr Guthrie had wide experience in the resources sector, deep knowledge of public policy and community engagement and would be an outstanding advocate for the sector.

Dr Guthrie paid tribute to the leadership provided by Mr Michelmore during a

period of sharply lower commodity prices.

"Andrew has led the MCA during an extremely volatile and challenging period. Like the sector it represents, the MCA has refocused its efforts on core priority issues and

delivered more with less.

"The reality is that a diversified mining industry is more important to the Australian economy than ever. The dividend of the mining investment boom is a much larger mining industry," Dr Guthrie said.

Dr Guthrie has qualifications in geology, environment, law and business management, including a PhD in Geology. She has substantial experience in the mining industry in diverse roles including operations, environment, community and indigenous affairs corporate development and sustainability.

She is a member of the Australian Institute of Company Directors and Chief Executive Women (CEW), and a Director of the WA Cricket Association. In 2015, she was appointed to the Australia-India Prime Ministers' CEO Forum, to help drive the bilateral economic relationship between Australia and India.

She won the winner 2013 Outstanding Professional Woman award from the WA Chamber of Minerals and Energy and was also recognised in 2013 in the world's Top 100 list of inspirational women in mining globally.

ROSS PILLING CALLS IT A DAY AT BASF

Mr Ross Pilling FTSE, a Board Member of the CRC for Polymers, is retiring as Chairman and Managing Director of BASF Australia and New Zealand.

He has more than 30 years' experience in highly regulated chemicals, manufacturing and services industries across Australia, Malaysia, Singapore and the UK.

Mr Pilling is a Board Member of the

Australian Plastics and Chemicals Industries Association, Deputy National President for the Australian Industry Group and a member of the Industry Advisory Committee of RMIT's School of Aerospace, Mechanical and Manufacturing Engineering.

For the past three years at BASF he has been leading

a major transformation program, aligning the business with key customer industries and the market.

He says his future focus is in business and "especially in the space between business, research and academia".



Ross Pilling

Vanessa Guthrie

ATSE PEOPLE

Colin Pearson was a pioneer conservator

One of Australia's pioneer heritage conservators, Emeritus Professor Colin Pearson AO CBE FTSE, was known as the 'father of the conservation profession in Australia' and was a friend and mentor to generations of conservators in Australia and internationally.

Professor Pearson studied at the University of Manchester from 1962–66, completing a bachelor's degree, a master's and PhD in corrosion science. In 1967 he commenced a three-year contract as a Research Scientist at the Materials Research Laboratories, Melbourne.

During this time he undertook the conservation of iron cannon and ballast jettisoned by Lieutenant James Cook from the *Endeavour* in 1770 and was made a Member of the Order of the British Empire (MBE) in 1970 for his contribution to corrosion science.

In 1971 he set up the Conservation Department of the Western Australian Museum in Fremantle, specialising in the treatment of maritime archaeological material



Colin Pearson

from Dutch and colonial shipwrecks on the West Australian coast.

He continued this internationally known

work for seven years, before joining the Canberra College of Advanced Education to establish a conservation training program. The first in Australia, the program offered courses at bachelor's, master's and PhD levels.

Professor Pearson stayed with the CCAE (later the University of Canberra) for 25 years and, in 1994, was appointed Professor of Cultural Heritage Conservation. In the same year he was made an Officer of the Order of Australia (AO) for contribution to heritage conservation.

He resigned from the University of Canberra in 2002 and was appointed Emeritus Professor.

Until his death, in Moruya, NSW, on 17 April 2016, aged 75, he was a heritage conservation consultant.

The Australian Institute for the Conservation of Cultural Materials (AICCM) noted he was the author of more than 120 papers and a number of major texts, including *Conservation of Marine Archaeological Objects*, and one-time executive member of both ICOM-CC (The International Council of Museums) and the IIC Council (the International Institute of the Conservation of Historic and Artistic Works).

In 1984 Professor Pearson was elected to the Council of the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), an intergovernmental organisation dedicated to the preservation of cultural heritage worldwide and raising awareness of the importance and fragility of cultural heritage. He served in an active capacity until 1995 and was a key actor in a critical period of ICCROM's program development from the 1980s to the 1990s.

He was honoured with the ICCROM Award in 2003 and praised as "clearly among the most versatile and capable conservators of his generation. His informal manner, his ability to motivate and inspire, have made him a mentor and colleague to so many of those practising conservation today."

Professor Pearson received the ICOM-CC medal in 2014 in recognition of his influential role within the field of conservation. In this same year, he established a grant attached to the AICCM Outstanding Research in the Field of Material Conservation Award.

RHEOLOGIST FELLOWS WIN RECOGNITION



David Boger



Roger Tanner

Two longstanding members of the Australian Society of Rheology, Professor David Boger FRS FAA FTSE and Professor Roger Tanner FRS FAA FTSE, have been made Fellows of the Society of Rheology (SoR).

Professor Boger has had an illustrious career spanning five decades. Some of his major works include the discovery of Boger fluids, and the demonstration of how basic surface chemistry can strongly determine yield stress and other properties of particulate fluids.

He has also worked extensively towards achieving an environmentally sustainable minerals industry, resulting in a considerable shift in the industry's approach to waste management.

He has been awarded several medals including the British Society of Rheology Gold Medal, the Walter Ahlstrom Environmental Prize by the Finnish Academies of Technology, the Medallion of the Australian Society of Rheology, the Flinders Medal of the Australian Academy of Science, the Chemeca Medal of the Institution of Chemical Engineers, the Clunies Ross Award, the Prime Minister's Prize for Science, the Centenary Medal, and the Victoria Prize.

Professor Tanner is a pioneer in the field of rheology with more than half a century of experience. Although he is best known for his book *Engineering Rheology*, his scholarly contributions to experimental and computational rheology are broad and include a further three books, 11 book chapters, 270 refereed journal papers and 88 conference manuscripts.

He is an Honorary Fellow of Engineers Australia and the American Society of Mechanical Engineer and has been awarded several medals including the Medallion from the Australian Society of Rheology (1993) and the Gold Medal from the British Society of Rheology (2000).



Calum Drummond wins RACI's HG Smith Medal

Professor Calum Drummond FTSE has been awarded with a national medal for his fundamental research in chemistry.

Professor Drummond, Deputy Vice-Chancellor Research and Innovation and Vice-President of RMIT University, has been awarded the HG Smith Memorial Medal from the Royal Australian Chemical Institute (RACI) for his ability to fundamentally advance a field of research in chemical science, as evidenced by the preceding 10 years of publications.

The annual medal is given to the person deemed to have contributed the most to a

particular field of chemistry in Australia.

He had previously won the Rennie Memorial Medal (1989), the Applied Research Award (2002), the Industrial Chemistry Division RK Murphy Medal (2004), the Green Chemistry Challenge Award (2005) and the Physical Chemistry Division Medal (2006).

As well as leading RMIT's Research and Innovation portfolio, Professor Drummond leads a research team of 10 scientists developing next-generation advanced materials, including improving the understanding of liquid and soft matter structure.

Since 2005, he has published 104 refereed

journal papers and three book chapters. He has also had nine patents granted or filed in this time, while his journal papers have been cited more than 4800 times.

"Calum is to be congratulated on his success and the RACI recognition is well deserved," said Professor Martin Bean CBE, RMIT Vice-Chancellor and President.

"The fundamental research and its translation to practice in the area of advanced materials, which underpin this recognition, has led to productivity gains of up to 100-fold in new materials discovery, as well as to allow a myriad of other applications in the world of chemical sciences to be advanced by the academic and industrial research community worldwide.

"This achievement is an indication of Calum's research being an inspiration to the internal and external research community and a catalyst for innovative solutions and a driver of impact."

RACI was founded in 1917 as both the qualifying body in Australia for professional chemists and a learned society promoting the science and practice of chemistry.

RACI has over 6000 members throughout Australia, working across all industrial sectors in food and hygiene, climate and environment, energy and resources, analytical and forensic, health and biotechnology, education and the public service.

EDWINA CORNISH RETIRING FROM MONASH

The Provost of Monash University, Professor Edwina Cornish AO FTSE, has decided to retire from Monash University at the end of this year.

Professor Cornish joined Monash University in 2004 and has spent more than 12 years in senior executive roles, beginning with her appointment as Deputy Vice-Chancellor (Research) and culminating in her appointment as inaugural Provost and Senior Vice-President in 2012.

"In every role she has held at Monash, Professor Cornish has made a significant contribution to the success of the institution and to Australian higher education," said Monash Vice-Chancellor Professor Margaret Gardner AO, announcing her retirement. Monash had accomplished an unprecedented standard of research excellence as a direct outcome of Professor Cornish's guidance, she said.

Professor Gardner said that, during her time as Provost, Professor Cornish had:

- led the reshaping of Monash's course architecture;
- championed its Better Teaching, Better Learning strategy;
- expanded its graduate offerings;
- actively sought to improve its teaching and learning infrastructure; and

- improved the quality of its coursework offerings and the overall student experience.

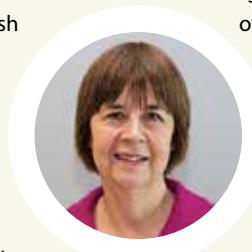
As Provost, Professor Cornish had provided crucial support for the continuing improvement in faculties, both academically and financially.

Through her active role in the recruitment and appointment of academic staff and by enhancing promotions and development frameworks she had helped to foster a culture of excellence.

A national and international search would be conducted for the position of Provost, she said.

Professor Cornish joined the Academy in 2000. She has a bachelor's degree with honours in biochemistry and a PhD in microbiology from the University of Melbourne.

Before joining Monash, Professor Cornish played a key role in building one of Australia's first biotechnology companies, Florigene Ltd. Under her leadership the company established global research and development and marketing operations and successfully commercialised the world's first genetically modified flowers.



Edwina Cornish

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