



FOCUS

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AUSTRALIA'S ENERGY OPPORTUNITIES

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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 similar 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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Front cover:
The now-iconic
low-energy light bulb.

PHOTO: ISTOCKPHOTO



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FOCUS

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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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.

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By Bruce Godfrey
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Increased use of public transport is a solution.

Tackling Australia's energy productivity challenge

The combination of poor energy productivity and high energy prices means increasing competitive disadvantage for Australian businesses and falling affordability for consumers.

Doubling Australia's energy productivity by 2030 will deliver a range of benefits for Australia and Australians. It will:

- **Boost industry competitiveness** – lifting energy productivity will enhance industry competitiveness, profitability and productivity while reducing costs for operation, maintenance and environmental compliance.
- **Reduce costs** – end-use energy cost is high in Australia, accounting for more than 10 per cent of Australian companies' earnings before interest, taxes, depreciation and amortisation. Improving energy productivity in Australia will reduce the cost of energy use in businesses and households and can defer capital expenditure.

- **Drive economic growth** – enhanced energy productivity will lift economic growth and underpin energy security.

- **Improve health and wellbeing** – energy efficiency and conservation measures will deliver benefits in improved health and wellbeing, particularly for low-income and vulnerable parts of society.

- **Deliver environmental benefits** – lifting energy productivity is a cost-effective option to meet emissions reduction targets.

At their Brisbane Summit in November 2014 the leaders of the G20 stated in their Communiqué: "Improving energy efficiency is a cost-effective way to help address the rising demands of sustainable growth and development, as well as

energy access and security. It reduces costs for businesses and households." Unfortunately, these benefits are often not known or simply overlooked by those who could reap the rewards.

Lifting productivity is a key priority to underpin prosperity, societal wellbeing and industry competitiveness. Energy productivity – the amount of economic output per unit of energy input – aims to take into account the economic, environmental and social dividends derived from the effective application of energy resources through efficiency and conservation.

Enhancing energy productivity therefore is an important element of any national productivity improvement strategy – and it is being

pursued in major economies such as China, Europe and the US.

For some two decades, Australia has ranked at or below the OECD average for energy productivity. Furthermore, Australia's electricity prices have almost doubled in the past seven years and gas prices are now increasing rapidly. The combination of poor energy productivity and high energy prices means increasing competitive disadvantage for Australian businesses and falling affordability for consumers.

Significantly and rapidly lifting Australia's energy productivity is a strategic tool to deliver a range of benefits that are currently under-recognised.

Some key barriers remain to realising the potential, especially the deployment of existing and new technologies.

A 2014 report by the International Energy Agency (IEA) cautioned that as much as two-thirds of energy efficiency potential will remain unrealised unless policies are changed due to the scale of inertia and to the barriers to implementation.

Formidable obstacles must be overcome to realise the potential, requiring major public and private support for:

- strengthening of energy-efficiency codes for commercial and residential building stocks;
- energy efficiency retrofits in buildings – for example, co- and tri-generation, heat recovery and lighting;

- enhanced minimum energy performance standards for commercial and residential appliances; and
- stringent fuel economy standards for vehicles and increased use of public transport.

Effective measures include product labelling, efficiency regulation, changes in tax policy, and educating and informing designers, builders, operations personnel and customers about the benefits of energy efficiency.

Special attention must be paid to policies surrounding long-lived products, from buildings and automobiles to refrigerators and air conditioners. Energy-inefficient performance at purchase may be locked in for decades and incentives are required to enable more efficient products to be chosen.

Achieving improvements in energy productivity requires raising awareness amongst residential and commercial consumers of the benefits of enhanced energy efficiency and a long-term, non-partisan and business-led approach.

It also requires sustained and strategic investment in research, development and demonstration of energy efficiency and demand management technologies in Australia to ensure appropriate technologies are available for Australian conditions – and that Australia has the capacity to deploy them effectively. Becoming a leader in technology for which there is growing demand in Asia

and worldwide would be an added benefit.

Creating a market and regulatory environment that encourages domestic and foreign investment in the uptake of high energy-productivity equipment and practices, and in their innovation, is crucial for Australia – and a clear role for Australian governments in conjunction with suppliers and users.

Strategically the following actions are key to doubling Australia's energy productivity level by 2030:

- **Develop a comprehensive roadmap** within the next 12 months to more than double Australia's energy productivity by 2030, including concrete intermediate targets. (This roadmap would be an important Australian contribution to the G20 Leaders' Action Plan for Voluntary Collaboration on Energy Efficiency).
- **Introduce stronger minimum energy performance standards and regulations** to drive improvements in the energy efficiency of existing and new buildings, appliances, industrial processes and vehicles.
- **Better assess and communicate the potential benefits** to be realised from energy efficiency measures in Australia overall and particularly in the transport, power generation, industrial processing and building sectors. (Such assessment and communication requires the establishment and regular tracking of national performance metrics, economy-wide and by individual sectors).
- **Support Australian innovation** in energy efficiency and demand management technologies that are suitable to be deployed under Australian conditions, through strategic investment in research, development and demonstration.

ATSE calls for energy productivity boost

Doubling the current level of national energy productivity by 2030 is a key measure for Australia's continuing international economic and environmental competitiveness.

This is a key platform in the Academy's **Energy Action Statement**, which is delivered to readers with this edition of *Focus*.

It says doubling energy productivity is achievable using currently available energy efficiency technologies and practices, and improvements continue to be developed and demonstrated. But without effective deployment of such technologies, the benefits of improved energy productivity will not be fully realised.

Sustained and strategic investment in research, development and demonstration of energy efficiency and demand management technologies in Australia also is crucial to ensure that technologies are available which are appropriate for Australian conditions, it says, adding that Australia has the capacity to deploy them effectively.

There could also be added benefits of becoming a leader in technology for which there is growing demand in South-East Asia and worldwide, the Action Statement says.

The Action Statement is available online at ATSE>About>Policy

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By Chris Greig
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PHOTO: PACIFIC HYDRO

The now familiar wind farm.

We need to get our energy policy right

Implementing policies that transition Australia to a low-emissions energy future – while maintaining adequate, reliable, secure and competitive energy supplies – is our key challenge.

Energy is essential to Australia's economy. Its availability, affordability and efficient use are key drivers of business productivity and social wellbeing.

Importantly, Australia is a net energy-exporting nation, with considerable national wealth derived from our exports of energy resources, including coal, uranium and liquefied natural gas. Our energy strategy and policies therefore have a critical bearing on productivity and prosperity.

Australia has for many years enjoyed

comparative advantage through the wide availability of large, low-cost energy sources, particularly for electricity generation. With national and international efforts and agreements to reduce emissions, natural gas increasingly linked to international prices and coal production costs rising, this advantage has all but disappeared.

Retail electricity prices now are comparatively high compared to our competitor nations and retail gas prices are following. Fossil fuels dominate global energy supplies and this is likely to continue for many more years.

Unfortunately, one of the consequences of using these fossil fuels – climate change – is a critical risk facing society.

While this is obviously a global challenge, Australians have a collective obligation to work towards increasing energy productivity and reducing national carbon emissions in order to contribute to the worldwide pursuit of reducing climate change risk.

Developing and implementing policies that will deliver a transition to a low-emissions energy future while maintaining adequate, reliable, secure and

**CONTRIBUTIONS
ARE WELCOME**

Opinion pieces on technological science and 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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competitive energy supplies is Australia's – and the world's – key challenge.

The failure of Australian energy policy to meet this challenge exposes us to the real geopolitical and economic risks that Australia may find itself out of step with international thinking around greenhouse gas (GHG) emissions and climate change and possible future international moves to limit and/or price carbon emissions.

Large investments

Large investments are required if Australia is to transition to low-emissions energy production. These investments are very long-lived (several decades) and often preceded by significant lead times and costs to complete feasibility studies, financing and development.

Investment decisions are driven by an investor's view of risks (including sovereign risk) and how each can be managed or mitigated to meet their required return on that investment.

Policy instability, such as a lack of bipartisan political agreement on the vision for Australia's energy sector, has meant investment uncertainty. An investment environment that encourages the replacement of old assets with new, low-emissions technologies is essential.

Policies should be more supportive of innovation and investment in more efficient, less emission-intensive technologies, including both renewables and nuclear energy, so that it is easier to write down and replace older, inefficient and emissions-intensive fossil-fuel-fired plant and equipment.

Australia also needs to invest in characterising its geological storage resources to better understand the potential of carbon capture and storage (CCS) as a carbon mitigation option.

The resilience of our energy economy is critical so that we are able to cope with inevitable uncertainties – and even shocks – in the broader world economy impacting on, for example, energy demand, resource security and prices, and carbon pricing or restrictions.

Australia must have a national energy policy that is:

- balanced – between the sometimes conflicting objectives of security, affordability and emissions reduction);

PHOTO: CSIRO



The massive Newcastle solar array.

- coordinated – between innovation, industry, climate change and investment policies; and
- stable – to attract the large investments required to transition the economy to a lower-emissions future.

Going forward, we need a robust and transparent approach for effective strategy formation, implementation, resourcing and oversight.

The approach should involve key stakeholders in a more participatory engagement process and allow for regular review and revision given the rapidly changing economic, environmental and social landscape.

Importantly, we must improve community engagement – which rests on increased community trust in both industry and government.

Near-term actions

1 The present cost/price/value relationship for electricity is not effective. Australia must modify tariff structures and broaden tariff choices to better align retail electricity prices with time-of-day cost and service value.

2 Australia must address the issues that are preventing resolution of current restrictions on coal seam gas (CSG) exploration and/or hydraulic fracturing in NSW and Victoria and provide incentives to attract and accelerate investment in exploration and development of onshore, unconventional gas resources.

3 We must support amendments to the *Australian Radiation and Nuclear Safety Act* and the *Environment Protection and Biodiversity Conservation (EPBC) Act* which would allow construction

LAND WANTED – TO HOUSE RADIOACTIVE WASTE

The Australian Government will begin a nationwide voluntary site nomination process for a radioactive waste management facility by calling for expressions of interest in March from landowners to nominate land for a facility under the *National Radioactive Waste Management Act 2012*.

The Department of Industry will establish technical and public interest stakeholder panels to assist in developing a framework to shortlist potentially suitable volunteered sites. Sites will be assessed against technical, economic, social and environmental factors.

The site, construction and operation of

the facility will be subject to assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* and the *Australian Radiation Protection and Nuclear Safety Act 1998*.

This multi-stage process will involve extensive community consultation and ensure safety and the protection of human health and the environment.

Australia has 4000 cubic metres of low-level and 550m³ of medium-level waste in temporary storage, which are byproducts of Australia's world-leading medical and industrial processes.

PHOTO: GLADSTONE PORTS CORPORATION



Fossil fuel dominance will continue for many years.

solar power, large-scale energy storage, intelligent networks, carbon storage resource characterisation, improving productivity of gas extraction and low-emissions liquid fuels technologies particularly for aviation, maritime and heavy logistics.

7 We must support such strategic investments in RD&D with a robust and independent techno-economic evaluation process.

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and operation of nuclear power plants if the markets and communities accept them and plant owners/funders choose to use nuclear power.

4 There should be a rigorous risk assessment of Australia's energy security in respect of transport fuels, including consideration of the potential contribution of electric vehicles associated

with low-emissions electricity supplies.

5 We must improve education and training with initiatives to increase the RD&D talent base by developing home-grown talent, attracting international expertise and fostering international connections of researchers and industry.

6 Australia needs increased strategic RD&D investments in large-scale

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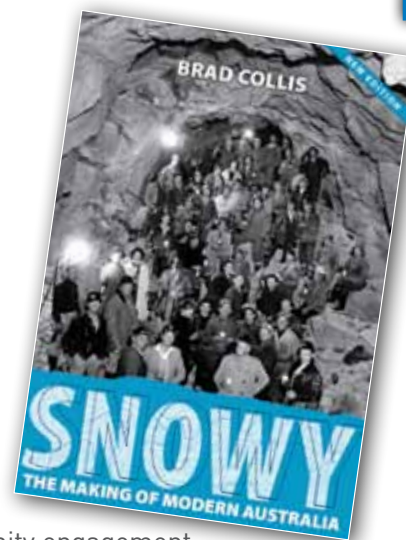
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By Susan Pond
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Getting from A to B without emitting C

Australia needs a strategy to benefit optimally from transformation from old to new transportation technologies and systems.

The global system for moving people and freight by road, rail, air and sea has expanded exponentially since the invention of the internal combustion engine in the mid-1800s and Henry Ford's motorcar for the mass market in the early 1900s.

This phenomenal transition in mobility required the parallel increase in production of gasoline, diesel and kerosene to power our machines. These liquid fuels fulfill the important characteristics of high energy content per unit volume, low cost and relatively easy onboard energy storage.

Global transport consumes more than 50 per cent of total oil production each year. But it contributes more than 20 per cent of global anthropogenic CO₂ emissions.

Transport is also a major contributor to air pollution in urban settings. Exhaust emissions of carbon monoxide, particulate matter (PM₁₀ and PM_{2.5}), nitrogen and sulfur oxides, lead and volatile organic compounds have well-demonstrated adverse

We cannot solve our problems with the same thinking we used when we created them.

— ALBERT EINSTEIN

effects on human health, including death.

Although Australia is a net exporter of energy, in the form of coal, uranium and gas, it is a net importer of crude oil and refined petroleum products, some 2200 petajoules (PJ). Our transport sector is 90 per cent dependent on imported fuels and accounts for more than a third of final national energy use in the form of more than 250 million barrels of oil a year.

Overall, transport contributes about 15 per cent of Australia's net greenhouse gas emissions. Passenger cars dominate transport energy use (75 per cent) and contribute more than 50 per cent of the sector's CO₂ emissions.

Accelerated demand

Population and income growth globally and here in Australia continue to accelerate demand for transport energy. The ATSE *Low Emissions Fuels for*

Transport Action Statement makes the case for clean energy choices for all forms of transportation in Australia, rather than a business-as-usual demand for more and more petroleum. Three reasons dominate: reduce emissions, reduce dependence on imported oil, and positive benefits for society and the economy.

The Action Statement also points out that Australia's high dependence on imported vehicles means that overseas markets will largely dictate the technological paths and the rate at which we re-power our transport.

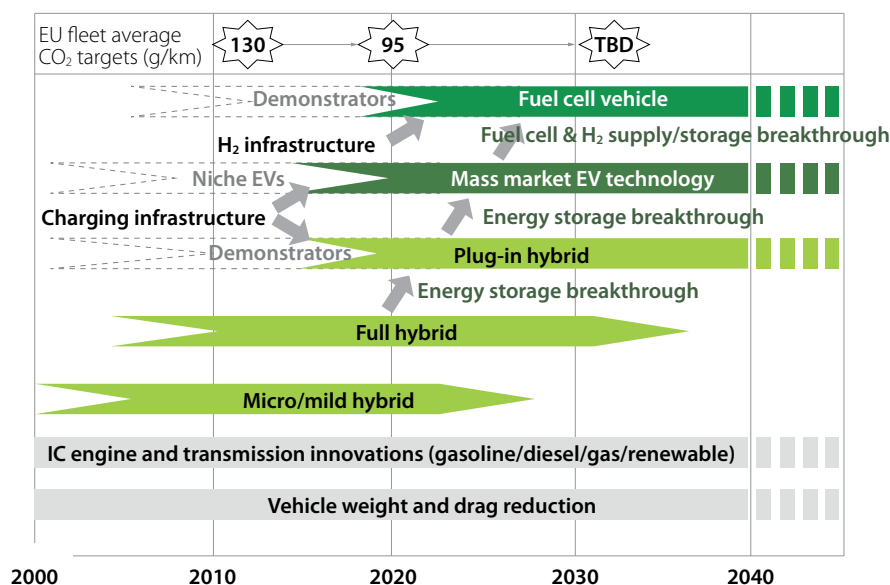
We are already seeing radical changes in mobility systems in many leading countries and companies.

Putting the spotlight on transportation technology and design, the UK Automotive Council recently published 11 roadmaps to illustrate projected advances in automotive technology in the next decades. The Passenger Car Low Carbon Roadmap represents "a shared vision of manufacturers and suppliers in the UK" of the rate of development of more fuel-efficient vehicles, greener fuels and new infrastructure.

At the recent Fuel Choices Summit in Israel, German auto manufacturer BMW outlined its corporate strategy in a new world of sustainable mobility. Concepts include electric cars, sitting alongside BMW Services that will make charging and/or parking convenient and easy, or even provide car sharing, thus obviating the need for individual car ownership.

Electric vehicle strategies are dependent on many key success factors including lower costs, usage convenience, energy saving and emissions reduction, partnerships between the transport and electric power industries and innovative government policy and regulation.

Passenger Car Low Carbon Technology Roadmap



SOURCE: UK AUTOMOTIVE COUNCIL

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Alternatives

At the same conference, Toyota showed the exponential growth in hybrids since their introduction in 1997 and its plans for further energy diversification. Fuel cell vehicles (FCV) are now selling in Japan in four cities that have built hydrogen infrastructure. FCVs will be sold in Europe and the US from mid-2015.

Through its Fuel Choices Initiative, established in 2011 and headed by the Prime Minister's office, Israel aims to reduce the share of oil consumption by its transportation sector by 60 per cent by 2025 while supporting green growth. Many innovations, such as the development of methanol blends, liquid fuels from CO₂, advanced biofuels and air batteries for electric cars, are at pilot or demonstration stage.

The innovators participating in the associated smart mobility exhibition, EcoMotion, demonstrated many varieties of electric bicycles and scooters. Some were stackable and dispensed for short-term rental from vending machines that also served as charging stations.

Innovations probing the future of urban mobility are rolling out of laboratories in the US, accelerated by programs such as the US Defense Advanced Research Projects Agency (DARPA) Challenge on autonomous vehicle and Google's self-driving car.

California recently made the decision to issue drivers licences to self-driving cars. This raises many interesting questions such as who is at fault if something goes wrong? This year, the UK will allow driverless cars onto its roads and Singapore will potentially also host a publicly accessible fleet of self-driving cars.

The Internet of Things (IoT) is presenting a host of opportunities to reduce traffic congestion and costs through better traffic management, parking and transit systems.

Motorists driving around looking for parking cause a large percentage



Stackable electric bicycles and vending machine.

of urban traffic and emissions. Sensor technologies that enable motorists and empty parking spots to link up are well advanced. Citizen-driver services originating from US companies Uber and Lyft, also taking advantage of mobile data, are blurring the distinction between public and private transport.

The California-based electric car company Tesla is creating transformational changes in design, manufacturing and materials, as well as charging infrastructure. The company is now selling in Australia, generating the recent announcement of plans to launch supercharger stations between Melbourne and Brisbane.

The Norwegian Government policy to exempt electric cars from urban toll payments, fees and taxes has incentivised uptake by the public. EVs have accounted for more than 10 per cent of Norway's new car sales since the beginning of 2014 – far ahead of the rest of the world.

Obstacles

There are many obstacles in Australia, as there are in other countries, to widespread adoption of any of these new technologies, fuels and systems.

Our streets need to remain safe and become safer. Redundancies need to be introduced to account for failure in any one component in a vehicle, of any new fuel, in the fuel supply infrastructure or in digital security. Decarbonisation of the grid is a critical enabler.

Australia needs a strategy to benefit optimally from this chaotic environment of transformation from old to new transportation technologies and systems. Beginning the process by bringing together industry, government, academia and the community to work through the recommendations in ATSE's *Low Emissions Fuels for Transport* Action Statement is a good place to start.

Further reading

Towards Sustainable Road Transport, 1st Edition.

Ronald M Dell, Patrick J. Moseley & David A Rand. Academic Press. 2014. http://store.elsevier.com/Towards-Sustainable-Road-Transport/Ronald-M_-Dell/isbn-9780124046160/

Transport Fuels from Australia's Gas Resources.

Edited by Robert Clark and Mark Thomson. UNSW Press. 2014 <https://www.newsouthbooks.com.au/books/transport-fuels-australias-gas-resources/>

DR SUSAN POND AM FTSE is Adjunct Professor in Sustainability and Leader of the alternative transport fuels initiative at the United States Studies Centre at the University of Sydney. Her interests include accelerating the transition to alternative fuels by sectors with critical needs such as aviation, mining, defence and shipping. Dr Pond has previously held senior leadership and executive roles in business and academia, including Chairman and Managing Director of Johnson & Johnson Research Pty Ltd. She is Vice President of ATSE and Board Member of Innovation Australia, Engineering Sydney and Biotron Ltd.

**LETTERS
TO THE
EDITOR**

ATSE Focus welcomes letters from readers in response to published article or on technological science and related topics.

PLEASE KEEP LETTERS BRIEF. LONGER LETTERS MAY BE RUN AS CONTRIBUTED ARTICLES.

Please address to editor@atse.org.au

By John Söderbaum

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Rooftop solar panels are changing our electricity networks.



PHOTO: ISTOCKPHOTO

Can intelligent networks solve Australia's energy challenge?

We are changing from a one-way network sending electricity from large generators to consumers to a two-way network where electricity is exchanged between various participants.

Australia has for many years enjoyed the comparative advantage of relatively low cost electricity generation, but that advantage has declined in recent years.

Reasons include investments made in transmission and distribution networks that were needed to meet growing peak demand and natural gas prices increasing towards parity with the international price of gas as LNG exports from the east coast commenced.

In addition, the introduction of a range of policies designed to reduce emissions have put upwards pressure on the price of electricity.

The latter issue highlights a major challenge facing countries around the world, including Australia, as they seek to

reduce their emissions – how to develop and implement policies that will deliver a transition to a low-emissions energy future while maintaining an adequate, reliable and competitive energy supply.

Most would agree that market forces and enabling regulatory regimes should be the main mechanisms for driving Australia's transition to a lower-carbon electricity system.

However, policies, programs and regulatory mechanisms that support the development and deployment of new technologies will also be crucial. Ensuring that those new technologies can be integrated into existing supply chains in a way that minimises disruption is a particularly difficult challenge.

ATSE's May 2014 Position Statement

A Sustainable Energy Future for Australia identified four themes that, it argued, could collectively provide an integrated approach to effective government policy.

One of those themes called for supply systems and market measures that deliver reliable, competitive, low-emissions electricity. In particular, the Position Statement called for the reform of Australia's electricity markets to support investment in low-emissions electricity supply capacity appropriate to meeting the reliability, economic, environmental and social needs of consumers, suppliers and governments.

Australia is currently experiencing a gradual transition from a limited number of large power generation plants to a system that has a larger number of smaller, more technologically diverse electricity generators.

This change is driving a gradual evolution of the electricity grid from a network that catered for one-way flows of electricity from large generators to consumers to one that allows for the two-way exchange of electricity between various participants.

This shift towards distributed generation is also enabling consumers to change from being passive takers of electricity from the grid to become increasingly important contributors to the electricity system, through self-generation and demand management activities.

There is no doubt that the emerging electricity system will be more complex. Managing the interactions between the increasing number and diversity of participants and facilities, maintaining the reliability of electricity supply and minimising electricity costs will be a real challenge.

In an Energy Action Statement, *Intelligent Electricity Networks for the Future*, released in October 2014, the Academy argued that intelligent electricity

networks supported by enabling policy frameworks would help to ensure that future electricity supply systems could provide efficient, affordable and low-emission energy to the Australian economy.

So what would an intelligent electricity network look like?

It is likely to have many elements. The most obvious is, perhaps, the widespread use of smart meters, however there is much more to an intelligent network. Other elements are likely to include the means to acquire, store and analyse large sets of data in order to model this more complex network and predict its operation, and to do so increasingly in real time.

It is also likely that storage will be an increasingly important element of an intelligent network.

In the current network structure energy 'storage' is effectively provided by having continuously fuelled electricity generation plants that are ready to rapidly respond to changes in demand. However, as generation becomes progressively

more distributed, more conventional electricity storage capacity becomes an increasingly important consideration.

Certainly, access to affordable and reliable electricity storage would offer significant benefits to Australia's electricity system. Storage could help reduce price volatility, protect against loss of power, enable us to design the electricity generation system more towards meeting average, rather than peak, demand and help to defer the costs associated with upgrading the existing electricity grid.

Furthermore, affordable and reliable storage will facilitate the widespread integration of electricity generated from intermittent renewable energy sources. Currently these are largely solar and wind, but in future it could include renewable resources such as geothermal or ocean energy. Storage would allow these resources to provide a reliable contribution to Australia's base-load power demand.

In addition, the availability of storage technologies will increase both

UNSW solar researchers set world record

University of NSW solar researchers have converted into electricity more than 40 per cent of the sunlight hitting a solar system, the highest efficiency ever reported.

The goal was achieved in outdoor tests in Sydney, before being independently confirmed by the National Renewable Energy Laboratory (NREL) at its outdoor test facility in the US. The work was funded by the Australian Renewable Energy Agency (ARENA) and supported by the Australia-US Institute for Advanced Photovoltaics (AUSIAPV).

"This is the highest efficiency ever reported for sunlight conversion into electricity," said UNSW Scientia Professor and Director of the Australian Centre for Advanced Photovoltaics (ACAP) Professor Martin Green AM FRS FAA FTSE.

The 40 per cent efficiency milestone is the latest in a long line of achievements by UNSW solar researchers spanning four decades. These include the first photovoltaic system to convert sunlight to electricity with more than 20 per cent efficiency in 1989.

"The new results are based on the use of focused sunlight, and are particularly relevant to photovoltaic power towers being developed in Australia," Professor Green said.

Power towers are being developed by Australian company, RayGen Resources, which provided design and technical support for the high-efficiency prototype. Another partner in the research was Spectrolab, a US-based company that provided some of the cells used in the project.

A key part of the prototype's design is the use of a custom

optical bandpass filter to capture sunlight that is normally wasted by commercial solar cells on towers and convert it to electricity at a higher efficiency than the solar cells themselves ever could. Such filters reflect particular wavelengths of light while transmitting others.

Known as the 'Father of photovoltaics', Professor Green is the author of six books on solar cells and numerous papers in the area of semiconductors, microelectronics, optoelectronics and solar cells. International awards include the 1999 Australia Prize, the 2002 Right Livelihood Award (also known as the alternative Nobel Prize), the 2004 World Technology Award for Energy and the 2007 SolarWorld Einstein Award.

He was formerly a Director of CSG Solar, a company formed specifically to commercialise UNSW's thin-film, polycrystalline-silicon-on-glass solar cell. His group's contributions to photovoltaics are well known, including the development of the world's highest efficiency silicon solar cells and the successes of several spin-off companies.

Martin Green



the opportunities for effective demand management in the electricity network. This includes the possible use of the electricity storage capacity available in electric vehicles to increase the productivity of the electricity network.

Finally, as the costs of electricity storage technologies decline we are likely to see an acceleration of the existing shift towards distributed generation. This shift would probably initially be particularly evident among households, but businesses are also likely to seek to benefit from access to affordable and reliable storage technology over time.

This change from a highly centralised generation system to one that is much more distributed will create many challenges, not the least of which will be the impact on the business models of the incumbent players in the electricity system. Careful thought and analysis will be needed to ensure that any transition occurs in a way that is properly managed and ensures the ongoing reliability of the electricity supply.

The Academy's Statement provided

three recommendations to Australian governments and industry to facilitate the transition towards the use of intelligent electricity networks in the future:

1 Develop a strategic blueprint for the transition to future intelligent networks

Government, working with industry, should develop a strategic blueprint for the evolution of existing electricity networks and operations to one that incorporates intelligent networks. That strategic blueprint should include an assessment of the economic impact of future network developments.

2 Review market rules and regulatory processes to address barriers to intelligent networks

Governments should establish a review of market rules and regulatory processes to ensure that any barriers to providing appropriate market signals for participants in the construction, operation and use of an electricity supply system that includes intelligent networks and the interactions between participants are addressed.

3 Establish a strategic policy agenda

Industry and governments should jointly establish a strategic policy agenda that supports the evolution of the current electricity system to one that incorporates intelligent network configurations, including the development of a policy framework that allows a combination of technologies and tariffs to ensure net benefits are efficiently captured.

ATSE's Position Statement *A Sustainable Energy Future for Australia* and Energy Action Statement *Intelligent Electricity Networks for the Future* are on the ATSE website at About>Policy.

DR JOHN SÖDERBAUM FTSE is the Director Science and Technology for one of Australia's largest private economics, policy and strategy consulting firms, ACIL Allen Consulting. In a career spanning some 35 years he has provided advice on policy, programs and strategy to governments, the private sector and international organisations such as the World Bank and the International Energy Agency. He is Vice Chair of the ATSE Energy Forum.

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THE UNIVERSITY OF
WESTERN AUSTRALIA



By Erica Smyth
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An experimental nuclear reactor

The nuclear energy debate needs to be on our table

Australia is the third-largest uranium producer after Kazakhstan and Canada but we have not moved to maximise its use for our own economic benefit.



PHOTO: ISTOCKPHOTO

I am a Baby Boomer who remembers the global anti-nuclear sentiments of the 1970s but, 40 years on, many Baby Boomers retain questionable passions that make it difficult to even hold an intelligent discussion about nuclear options for power supply in Australia!

In a country still 72.5 per cent dependent on coal for its electricity (in 2013), we should heed the potential negative impacts of a CO₂-induced change in climate. Consequently, we need to look at *all* methods to reduce our carbon footprint – optimally, combining nuclear base-load power generation with renewables such as ocean, solar and wind.

There is no perfect safety solution in generating electricity. Industrial deaths around the world in coal mines, on petroleum production and refining facilities, and from hydro dam failures far exceed deaths from nuclear power accidents (43 at Chernobyl) but these statistics get little attention.

Yes Chernobyl in 1986 was a disaster waiting to happen – poorly designed, operated and regulated – but what has evolved since is a strong International

Atomic Energy Agency, better international monitoring and the development of passive, failsafe safety systems in all new plants.

We learnt from Fukushima (a tsunami-induced mishap) that all nuclear power generation nations need to stand back and look at even the most unlikely weather, seismic and human intervention scenarios and test old and new plants against these risks. Japan's immediate evacuation from around Fukushima (a learning from Chernobyl) and the significant safety review of that country's whole fleet of reactors (now being brought back on-line), are reminders of the need for strong independent regulation and safety authorities in all forms of nuclear electricity generation and operation.

The (Eastern Australian) National Electricity Market has 81 coal-fired generation units at 22 sites, ranging in size from 33 to 700 MW, with most located in clusters. Thirteen sites contain four or more generation units.

Scattered from Queensland to South Australia, 20 per cent of these plants can be down for maintenance at any one time – but in a scheduled and cooperative

manner that doesn't unbalance the extended power grid. Many of these coal plants will reach the end of their lives in 20 to 30 years and we need to start planning *now* for their replacement.

Australia's coal generation capacity is based on our huge coal resources but we also have reasonably assured resources of uranium recoverable at costs of less than US\$130 per kilogram uranium concentrate – 34 per cent of world resources in this category. Australia is the third-largest uranium producer after Kazakhstan and Canada but we have not moved to maximise its use for our own economic benefit.

If Australia were now to make a strategic decision to move to Generation 3 nuclear power plants, we could, in theory, purchase 'off the shelf' 1100 MW units. But the sheer size of these units, compared with our grid demand, adds a complexity in supply control. We would need to manage such big units in a synchronised manner across the whole grid. Downtimes for fuel changes would need to be managed carefully and cooperation between the states would be crucial.

In my mind, there is a different nuclear

opportunity that is almost available – one more suited to our demand distribution – the Small Modular Reactor (SMR). This design offers Australia a real opportunity to leapfrog into modern nuclear technology by becoming a fast follower.

SMRs are nuclear fission reactors generally of less than 300 MW capacity. The only operating nuclear power plants of this size are old and do not have the modern, passive safety features the world has come to expect. All the recent development effort has been injected into large reactor design but now the world realises there is a growing need for smaller reactors.

In most cases, the intended use of SMRs is for generation of electricity, but some could be used for process heat, or providing direct power for targeted industrial purposes such as sea-water desalination or minerals processing to metals.

Specifically, SMRs address deployment needs for smaller electrical grids and lower rates of increase in demand. They are modular and quicker to build than conventional nuclear power plants.

There is now considerable development work on SMRs, to increase their safety, security, non-proliferation, waste management, resource utilisation, design,

siting, fuel cycle options and economics.

Most SMR design concepts come under one of four categories: light water reactors (LWR), fast reactors, high-temperature gas-cooled reactors or molten-salt reactors.

The key focus now is on advancing the LWR designs – moderated and cooled by ordinary water – as they have the lowest technological risk, particularly due to their similarities to conventional nuclear power plants. The LWR variety of SMRs is expected to have fewer regulatory barriers prior to licensing, and is expected to be deployed between now and 2025.

Several countries are pursuing different LWR designs – Argentina, China, Korea and several options in the US, the latter backed by five-year funding of about \$450 million from the US Department of Energy.

Australia should adopt this SMR technology once it has been more fully developed and units are operating. Australia needs to encourage young people to work in the international nuclear power space and to bring those skills home as we look to adopt this technology.

But first we need to start and sustain an intelligent conversation with the Australian community. The Australian Parliament needs to strengthen and

adapt our nuclear regulation and safety regimes so that SMR technology can be included in our generation capability. We are already world leaders in some aspects of nuclear regulation.

Nuclear energy offers near-zero greenhouse gas emissions for base-load power supply. Levelised cost of energy modelling by the Bureau of Resource and Energy Economics suggests that nuclear power, in the 2030 to 2050 timeframe, is economically competitive with a broad range of other low- or zero-emission base-load technologies.

On economic, social and environmental considerations in an international carbon-constrained policy environment, nuclear power should be included as an option for base-load power supply in Australia.

Australia should proceed towards adoption of nuclear power within the International Atomic Energy Agency's (IAEA) full scope safeguards. The management of interim and long-term storage of nuclear waste will also need to be based on established international best practice.

But for Australia to keep its SMR options open for our climate, demographic and industrial needs, we need a bipartisan vision and a 20-year timeframe – is this is too much to ask of 'modern' Australia?

ENERGY SECURITY FOR AUSTRALIA REPORT

Engineers Australia's *Energy Security for Australia* report draws attention to Australia's current energy security flaws and maps out a pathway to a stronger energy future.

"Now more than ever it is important to acknowledge our current energy security policy settings are insufficient and open the discussion up to a whole-of-society, whole-of-government perspective," said Mr Neil Greet, co-author of *Energy Security for Australia* and former Australian Defence Force engineer.

"Australia's energy future is one of uncertainty and risk. We need to ensure resilience is built into our national energy strategy.

"By broadening the energy security discussion and subsequent policy development beyond the standard economic view to encompass other areas – such as defence, welfare and food security – we would put Australia on a path toward more resilient energy security settings. For example, recent discussion around fuel shipping routes to Australia becoming a potential target for terrorist attacks highlights our inadequate fuel reserves. Australia's liquid fuel security is non-existent.

"There is a need to shift government perceptions of energy from just a market-based economic viewpoint to broader thinking, which encompasses wider risks of energy policy aligned with national security issues."



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ATSE IN ACTION

200 at 2014 Oration Dinner in Melbourne

Some 200 Fellows and guests attended the Academy's 2014 Oration Dinner at the Langham Hotel in Melbourne in November to hear the 2014 Academy Orator, Ms Kathryn Fagg FTSE, and welcome new Fellows.

Ms Fagg's Oration, 'Competing for the Future', was an inspiring and thought-provoking speech, loudly applauded by the 200 attendees. Ms Fagg, a Reserve Bank Board Member and public advocate for women in leadership in engineering organisations, was recently named as one of Australia's 100 Women of Influence.

The President, Dr Alan Finkel AO FTSE, presented Fellowship certificates to most of the 26 new Fellows at the dinner, supported by retiring Director and Vice President Professor Mike Miller AO FTSE.

Dr Finkel also presented a sponsorship certificate to Mr Gavin Jackman, Executive Global Head Corporate Affairs & Social Responsibility at Orica, to mark the fact that Orica has been a backer of ATSE's STELR program in schools since its inception, making its first grant of \$150,000 to STELR in 2009, followed by further grants of \$150,000 for the calendar years 2011 to 2014.

Dr Finkel noted that these grants had been used to provide \$3000 subsidies to schools for the purchase of STELR classroom equipment packs, as well as staffing, development, implementation and training support.

Dr Finkel was also able to advise that Orica had committed to supporting the STELR program for a further three years and that Orica's support had been instrumental in enabling STELR's expansion into New Zealand – where there are now six schools benefiting from the program – and over the next three years would support the STELR program extending into New Guinea, Indonesia, Malaysia and the Philippines.

Earlier in the day 70 Fellows attended the 2014 Annual General Meeting, which confirmed the election of new Directors Dr Hugh Bradlow and Professor Karen



New Fellow and Chief Scientist Ian Chubb with Kathryn Fagg at the Oration Dinner.



Academy President Alan Finkel presents a certificate of appreciation to Orica's Gavin Jackman as Peter Pentland looks on.

Consisting of the Chairs and representatives of each of ATSE's State and Territory Divisions, along with the Chairs of the ATSE Topic Forums, the Assembly is the Academy's strategic advisory body.

Reynolds and the re-election of Dr Paul Greenfield and Professor Tanya Monro.

The meeting heard reports from the President, the Chair of the Audit and Risk Committee, Dr Susan Pond, Professor Miller and the Acting CEO Mr Bill Mackey.

Following the AGM most of the new Fellows described their aspirations and work in a series of captivating presentations during the New Fellows Seminar, which was well attended.

The previous day, preceding the AGM events, the Academy held Assembly 13 and a Joint Chairs meeting, where Division and



ATSE Director David Cook and University of Melbourne Provost Margaret Sheil at the Oration Dinner.

Forum Chairs discussed operational issues relating to the activities of their respective groups. The agenda for Assembly 13 included updates from the Topic Forums on recent and planned work, encompassing delivery of ATSE's Strategic Plan and National Technology Challenges.

Other items discussed included progress on industry and fellowship engagement, including gender equity, and overviews of activity within the ATSE office and the relevant government policy landscape.

There was a brisk discussion on ATSE's proposed new measures for research impact and current and future programs, including proposals to replace the Clunies Ross Awards dinner with a national innovation conference from 2016, to hold an international conference on unconventional gas in 2015 and to support a proposal to engage in a national industry/research mentoring network.

ATSE IN ACTION

Orator sees a “zeitgeist moment” for innovation

Australia is at a “zeitgeist moment” for innovation, says Academy 2014 Orator and Reserve Bank Director Ms Kathryn Fagg FTSE.

This is not just because more people are talking about it – beyond those who are deeply involved with the topic – but because innovation is becoming part of a much broader conversation in the community and more people are willing to become involved with the goal of building momentum for change.

Delivering the Academy Oration – ‘Competing for the Future’ – at the AGM Dinner in Melbourne, Ms Fagg said that there were many indicators that Australia was not as effective on the innovation front as it was in research.

“Perhaps most famously, we are at the bottom of the OECD league ladder in terms of the level of collaboration between our universities and large businesses,” she said.

“And our firms are not where they should be. McKinsey recently completed a study for the Business Council of Australia which concluded that Australian companies are behind on technology uptake, external orientation, innovation and learning, and an ability to implement and sustain change.

“We have much work to do.”

Ms Fagg noted that 100 years ago, like today, Australians enjoyed being among the wealthiest people in the world.

The agricultural sector dominated,

contributing about 25 per cent of GDP – now down to about two per cent of the economy. Over the same period the economy transitioned successfully from agriculture to manufacturing – which peaked at about 30 per cent of GDP in the 1950s – to the current focus on the services sector.

“Australia has enjoyed an extraordinary period of sustained economic strength, with 23 straight years of economic growth, which is almost unprecedented on the international stage,” she said.

Since the depths of our last recession in 1991, the highlights included:

- adding four million jobs;
- enjoying the strongest growth in real GDP per capita of most developed countries;
- weathering the Global Financial Crisis as well as any developed country;
- benefiting from the strong growth of our trading partners;
- improving productivity – with our labour productivity now having grown faster over the past three years than it did on average over most of the 2000s;
- seeing our terms of trade peak in 2011 at the highest level since federation; and
- seeing mining and resources sector growth double to 10 per cent of our economy in 2011.

She noted that we were now moving from the investment phase to production phase, accompanied by a reduction in jobs – and as the level of investment in mining and

resources declined the nation needed other investments.

Tectonic shifts

This transition in Australia’s economy was occurring simultaneously with tectonic shifts in the longer-term world economic outlook:

- the shift in economic activity towards emerging markets;
- the impact of digital technologies; and
- ageing populations.

“As Australians, we are fortunate to be geographically well positioned to participate in the shift of economic activity towards emerging markets – which in 2009 became the primary growth driver for the world economy.

“Not only are we close to these markets and enjoy a similar time zone, but we also have the advantage of strong family and education links as well.

“Already we have seen the power of the demand for our raw materials to support the development of infrastructure; but as the emerging economies shift more towards more consumption, there will be opportunities for many sectors – especially given that the middle class in the emerging economies is expected to increase from around half a billion in 2009 to over three billion in 2030.

“But with technology and innovation, Australia is not as well positioned.

“The question of understanding what Australia needs to do to improve its adaptability and level of innovation is at the heart of ATSE’s mission.”

The Academy’s new Industry and Innovation Forum was applying a “market lens” to the challenge of strengthening our innovation system with the priorities being:

- influencing government to have stable, long-term assistance programs;
- supporting the rebalancing of incentives for university researchers to recognise and reward industry collaboration and engagement and mobility;
- fostering stronger linkages between industry and research institutions;

ATSE A KEY PLAYER AT MINISTERIAL ROUNDTABLE

ATSE played an important role in a Ministerial Roundtable at Parliament House, Canberra, in November – one of a number the Australian Government is holding in relation to its Industry and Competitiveness Statement.

ATSE was one of 38 invited participants in the roundtable, hosted by Industry Minister Ian Macfarlane and Small Business Minister Bruce Billson, which focused on fostering innovation and entrepreneurship.

ATSE, represented by Senior Adviser Dr John Bell FTSE, urged the Government to accelerate promised action on employee share schemes and crowd-sourced equity funding.

ATSE’s proposal for an impact and engagement measure to sit alongside the ERA attracted support from several participants and an Australian version of the US Small Business Innovation Research (SBIR) scheme, advocated by ATSE, was acknowledged by Minister Macfarlane as a measure he wants to implement.

ATSE IN ACTION



Kathryn Fagg delivers the 2014 Oration.

- increasing ease of mobility between public and private sector research entities; and
- supporting the development of entrepreneurship, and business and innovation management in STEM programs

Women in leadership

Increasing the number of women in the workforce and in leadership roles was important from an economic perspective, Ms Fagg said.

"When I look at what businesses and other organisations are doing to increase the number of women in leadership roles, there are neither silver bullets nor much that is new. We've actually understood the underlying issues and what needs to be done for a long time.

"But it is having the right people taking the lead and making the changes that is important.

"And this has only happened by key institutions stepping up – such as the ASX and the Australian Institute of Company Directors – and groups working together – such as Chief Executive Women and the Male Champions of Change.

"Now, we have a very long way to go with improving workforce participation by women and their representation in leadership roles but, nonetheless, there is progress."

The rate of appointment of women to ASX200 boards had gone from eight per cent of appointments in 2008 to 30 per cent currently, Ms Fagg said.

"This is very similar the profile for ATSE in terms of the Fellows being appointed – of which ATSE can be proud.

"Building on this experience on working to increase the number of women in leadership roles, I see that one of the greatest strengths of ATSE is that we, as Fellows, represent the different sectors that do need to come together to make a difference in Australia's innovation capacity – education, research, government and business – and that we can work collaboratively to influence both community attitudes and political priorities."

Monash legacy

Ms Fagg said she drew inspiration from the legacy of General Sir John Monash, the acclaimed Australian World War I battlefield leader who was knighted on the battlefield by King George V, the first time that had happened in more than 200 years.

"Monash's genius and great innovation was to integrate all elements of the forces available in a planned attack – using infantry, artillery, aircraft and tanks in a coordinated way.

"But Monash did not just focus on how best to use the new technology. He was also very aware of, and committed to, the safety and wellbeing of his troops. Famously, he was able to get hot food to the troops on the frontline even in battle.

"One hundred years later, I find Sir John Monash an inspiring example of leadership – and of using technology very effectively while

drawing on the strengths of people – to have the greatest impact."

She said she was inspired by Monash's leadership, innovation and concern for people's wellbeing as a military commander and we could learn much from his approach – 100 years ago – in tackling our economic issues.

Monash's influence had been recognised by the Reserve Bank, which chose his image for the \$100 note and commented: "Articulate and supremely organised, he approached warfare as a series of challenges comparable to those of engineering."

The Reserve Bank had also been an example of tenacity and foresight in taking an innovative approach to redeveloping Australia's currency into a polymer banknote world leader, now used in more than 30 countries around the world.

Australia's polymer banknote emerged in response to a market need – protection from counterfeiting of Australia's new decimal currency notes introduced in 1966. It took 20 years of development – from 1968 to 1988 – before the launch of the polymer 'Monash' \$100 note.

"The timeframe gives an indication of the complexity of the innovation and commercialisation process. It was far from linear – and started with a market need rather than with a discovery."

Transition

Ms Fagg noted that as Australia transitioned from an extraordinary period of investment in mining and resources, its economy must shift form.

"Almost inevitably, with increasing digitisation and globalisation of industries, this will require Australian companies to be more innovative than ever before if they are to compete successfully, particularly internationally, and for us to sustain our prosperity and wellbeing.

"As a group of technology leaders – from across the different sectors (academia, research, business and government) – we have the opportunity to combine our skills and knowledge in concert with our ability to influence – to have an impact on the innovation landscape in this country.

"We look forward to working with all our ATSE Fellows to have the greatest impact we possibly can, in this zeitgeist moment."

ATSE IN ACTION

CRCs need backing and boosting

The Cooperative Research Centres (CRC) Program must be maintained and its level of funding doubled from current reduced levels, according to the Academy.

Over more than 20 years the CRC Program has encouraged research excellence, fostered effective collaboration, created new educational opportunities and translated research outputs into economic, social and environmental benefits to Australia, ATSE says.

In its submission to the current CRC Program Review, ATSE says past reviews have demonstrated that the Program's economic return on taxpayer funds has been impressive, generating a net benefit to the economy of \$7.5 billion since its inception and increasing gross domestic product, with widespread benefits to the environment and the community, and spill-overs to nearly every industry and sector.

The Academy says reduced funding to the Program jeopardises these benefits and suggests a number of actions to help to strengthen and improve the CRC Program.

ATSE says that, in light of the Government's strategy for lifting Australia's

competitiveness and innovation by increasing collaboration between researchers and business, the CRC Program has been highly successful in supporting research partnerships and providing economic returns.

"CRCs are one of the most important mechanisms for fostering collaboration and building industry–research networks in Australia, and are a means to build critical mass in well-defined areas," the submission says.

"It is important to note that funding for CRCs constitutes a relatively small proportion of overall government investment in research and innovation (only 1.6 per cent in 2014-15), so criticising CRCs for failing to solve Australia's poor rates of collaboration between business and industry is unfair," ATSE says, noting the benefits to small and medium enterprises (SMEs).

"This has particularly been the case where a large firm has been the customer for technologies developed by SMEs, offering a test platform to trial new technologies with relative financial security."

ATSE also recommends a simpler, cheaper and quicker process for processing CRC proposals, which would reduce the resources

allocated to the bid process and encourage the involvement of organisations (especially in industry) currently deterred from becoming involved by the onerous application requirements.

Ideally, the time from private sector companies submitting a signed declaration of their proposed cash contribution to a final decision should be less than one month, ATSE says – noting that the application process for CRC funding can be seen as complex and burdensome by some potential participants due to the requirements for multiple participants, an education program, a long-term commitment and at least two interrelated research programs.

"These applications can cost well over \$100,000 to prepare, and often require the hiring of consultants and lawyers, adding to compliance costs for applications."

Reporting and administrative requirements should be streamlined to the minimum required to ensure accountability for use of public money, ATSE says.

"While a mid-term review should

Australia must produce more food with less

Strong and stable support for science and R&D, translated to economic impact through various extension mechanisms, holds the key to the competitiveness of Australia's agriculture and food sectors.

To meet future challenges while building the capabilities to seize emerging opportunities requires a long-term strategic vision and national plan, with buy-in from State and Commonwealth governments and producer associations.

In its submission to the Government's Agricultural Competitiveness Green Paper ATSE made these key points and also said an agriculture strategy must take into account four key factors:

- increasing agricultural and food industry productivity – particularly the rate of productivity improvement pre-farmgate;

- managing responsibly natural resources and ecosystems;
- targeting high-value, high-quality products and value-add opportunities for emerging international markets; and
- maintaining Australia's strong biosecurity system.

The submission noted that agriculture played an important role in Australia's economic and social fabric, and was a key pillar of the Australian economy. Enhanced agricultural production and development would ensure strong, vigorous and competitive Australian agriculture and food sectors.

This would require increasing both output volume and value, through better value-adding of primary products and transformation of waste streams, targeting emerging markets for premium products, particularly in Asia, and

emphasising our reputation for high-quality, clean, safe and sustainable produce.

"Australia is a major international trader of agricultural commodities and one of only a few net exporting nations. While the volume of Australia's agricultural and food exports will never feed the world, the growing issue of global food security requires continued, robust international trade of food through agricultural commodities and products," it said.

"Australia's agricultural sector will continue to have an important role to play in this regard.

"Increasing output and seizing emerging market opportunities means sustainably adding value, effectively producing 'more food with less'. Key to this is the simultaneous increase of overall productivity and responsible natural resource and ecosystem management. The successful development of sustainably

ATSE IN ACTION

be retained, the primary accountability measures should be a comprehensive annual report and the imposition of technical/commercial audits on Centres identified as underperforming, with auditors able to recommend variations to the funding agreement (including closure).

"Oversight by the Commonwealth should be kept to a minimum and limited to approval of a qualified Board and monitoring of periodic reporting.

"Current CRC governance requirements in terms of structures and Board composition have served the program well, but more power should be given to the CRC Boards and management to act on the outcomes of the annual report and

mid-term review and reduce the amount of control exercised by the government"

ATSE says the CRC Program should be broadened and supplemented by additional funding to allow for the creation of new types of Centres that are essentially smaller and simpler CRCs.

"This would assist technology companies (usually SMEs) to undertake a specific research program or collaborative project operating under the CRC Program but with a lower level of funding, a shorter timeframe and less complex application, establishment, administrative and reporting requirements.

Australia should extract the most value it can from government funding of research, ATSE says.

"No OECD country relies on a single measure to bring research users and performers together and nor should Australia. There are situations where a much more agile approach is needed, and the UK and US both have such arrangements."

Intellectual property (IP) management arrangements for CRCs need to be flexible, as requirements differ widely, ATSE says. All aspects of IP management must be agreed when the CRC is set up so that issues do not arise if and when the CRC is to be wound up.

The CRC Program Review submission is on the ATSE website at [Publications>Submissions](#).



The faces of the CRC program – CRC for Polymers researchers, including Professor David Solomon (left) famous for the polymer banknote.



PHOTO: SIOBHAN DUFFY, CSIRO

intensified production and processing systems in Australia will require innovative approaches arising from targeted R&D and the strong participation and ingenuity of agriculturalists and agribusiness investors underpinned by a cohesive policy framework.

"Through ecologically responsible intensification married with a strategy targeting high-quality and high-value outputs, innovative agrifood businesses will reap the rewards from increasing global market opportunities while building resilience for future challenges," the submission said.

The Agricultural Competitiveness submission is on the ATSE website at [Publications>Submissions](#).

Research is driving increased wheat yields.

ATSE IN ACTION

Economic benefits must come from research

The effective translation of research into economic benefits will be at the core of Australia's future competitiveness and prosperity.

This bold statement was a key element of the Academy's submission in response to an issues paper circulated by the Federal Government.

ATSE noted that Australia undertook

world-class scientific research through universities and other publicly funded research organisations, such as CSIRO, ANSTO and AIMS, and that improving the commercial returns from research should not come at the expense of fundamental scientific research.

"The 'Boosting the commercial returns from research' issues paper correctly identifies many of the concerning issues that are adversely

affecting Australia's ability to capitalise on our strengths in research," ATSE said.

"One of the most important of these is the poor collaboration between industry and publicly funded researchers. This may be attributed in part to current disincentives for university-based researchers to engage with businesses, as an unintended consequence of the Excellence in Research in Australia initiative (ERA)," ATSE said.

It noted that a major problem related to commercialisation support programs identified in the issues paper was that of scale.

"Insufficient scale reduces the overall effectiveness of a whole range of initiatives designed to support research, innovation and commercialisation. However, the solution proposed of consolidating existing collaboration support programs to increase scale may be counterproductive.

"Programs must be sufficiently diverse to offer a range of appropriate niches for people seeking assistance to collaborate. Over-consolidation may end up making collaboration more difficult as options for seeking support become limited.

"Ideally there should be a full spectrum of programs available from the Commonwealth and state governments that range from discrete researcher-led grants to full, multiple-programme, multiple-partner, user-driven research centres, such as CRCs."

Appropriate levels of funding should be made available to achieve sufficient scale in these programs and overall funding levels and adequacy of scale should be assessed regularly through careful analysis and consultation with participants.

Without consistent, ongoing and adequate funding, programs designed to support collaboration and commercialisation of research would not reach their potential. The constantly changing landscape of these programs was a real impediment to researchers and industry.

The full submission, including the Academy's detailed recommendations, is on the ATSE website at Publications/Submissions.

EXCELLENCE IN RESEARCH IN AUSTRALIA (ERA)

The ERA exercise encourages university researchers to publish quality research, based on metrics such as citation rates, and rewards this behaviour by moderating allocation of approximately \$65 million per annum based on ERA outcomes. The behaviours that ERA drives in our university sector are even greater than might be anticipated from this scale of funding, demonstrating that a metrics-based approach can achieve important behavioural change. While research excellence is desirable in its own right, it is only one dimension of the research endeavour. The current system's weighting towards research excellence is often at the expense of other important activities such as university–industry collaborations, entrepreneurial behaviour and knowledge transfer.

In August 2014, ATSE proposed an initiative – termed 'Impact and Engagement for Australia' (IEA) – designed to encourage increased collaboration between Australia's publicly funded researchers and business. IEA proposed using data already reported through ERA, including income received by universities from commercial and industry sources, patents and licensing, to create a metric of industry engagement.

A metric like IEA is intended as a counterbalancing measure to ERA to ensure that collaboration is appropriately recognised and rewarded alongside excellence, in line with the Government's Industry Innovation and Competitiveness Agenda. It is likely that this will increase the return on the public investment in research in science, technology, engineering and maths (STEM) and humanities and social sciences (HASS). It is important to note that an IEA-like metric is proposed to work in parallel with ERA and does not imply a loss of value of basic, curiosity-driven research. The Group of Eight's recently published Group of Eight: Research Impact Benefiting Society illustrates the fundamental importance of basic research to ongoing innovation and research commercialisation.

The concept of a metric to measure collaboration and engagement has received wide support from government, universities and other stakeholders. Importantly, the Forum of Australian Chief Scientists has endorsed the proposal, and the Queensland and South Australian governments have expressed interest in their universities participating in a trial. ATSE is undertaking a project to develop detailed inputs, appropriate definitions for the assessment bands and the methodology to be used to process the inputs into these bands. This work will demonstrate the feasibility of using these metrics to capture and reward the level of collaboration and knowledge transfer occurring in the Australian university research sector.



PHOTO: CSIRO

Turning research into products.

Telescope wins innovation award

CSIRO's world-leading astronomical telescope built in the Australian outback scooped the field to win the 2014 the Australian Innovation Challenge and a cash prize of \$30,000.

The Australian Innovation Challenge awards are run by *The Australian* in association with Shell and supported by the Department of Industry.

Judges, led by innovation policy expert Dr Terry Cutler FTSE FAHA, said the project was "one of those advances that keeps Australia on the global innovation map". Other winners included Chris Wilkins, who won the \$10,000 Backyard Innovation prize for his PodPlants invention, a novel aeroponic system for growing plants by suspending them in nutrient-laden mist. PodPlants has attracted interest worldwide as a way of growing vertical gardens in office blocks.

Queensland teenager Taj Pabari won the Young Innovators prize for his development of the ImaginTech Tablet Kit, a do-it-yourself kit enabling children to assemble their own Android tablets. He has clinched a deal with a retailer in South Africa to stock the kits, and expects a major retailer in Australia to start selling them soon.

The Minerals and Energy prize was won by Julian Malnic for a new method of processing ores of nickel, which has potential to boost steel production. Roger Dyhrberg won the Environment, Agriculture and Food category for the Enviocart, which cleans ship hulls underwater.

Technology called Pepster that encourages children with cystic fibrosis to do their breathing exercises won Elliot Smith and his colleagues the award for Community Services.

Rustom Kanga won the ICT award for leading the development of an automated system that cuts the response time of emergency services personnel to accidents. It uses intelligent CCTV cameras and the GPS coordinates of the smart phones of emergency services staff to identify the most appropriate officer to act as the first responder and dispatch them to the scene. Dr Marlene Kanga FTSE, a new Fellow of the Academy and former President of Engineers Australia, represented her husband at the awards ceremony in Canberra in November.

SCIENCE COUNCIL SETS ITS AGENDA

The Commonwealth Science Council held its first meeting in November, bringing together eminent scientists and business people, including Academy Fellows, to provide advice on boosting Australia's prosperity and competitiveness.

Council members from the science and research sector are Professor Timothy Davis, Professor Ian Frazer AC FAA FTSE, Professor Tanya Monro FAA FTSE, Mr Michael Chaney AO FTSE, Mr David Knox FTSE, Ms Catherine Livingstone AO FTSE and Chief Scientist Professor Ian Chubb AC FTSE.

The Council also includes the Ministers for Industry, Education and Health and is one of the foundation initiatives of the Commonwealth Government's Industry Innovation and Competitiveness Agenda.

The Council agreed a forward work program, with key items for further consideration to include:

- advice on science and research priorities and underpinning challenges;
- policy recommendations and actions on bringing strategic alignment, focus and scale to STEM in Australia;

- the outcome of consultation processes currently underway on the 'Industry Innovation and Competitiveness Agenda' and the 'Boosting the Commercial Returns from Research' discussion paper; and
 - actions to promote industry links and commercial returns from research.
- The Council will next meet in the first half of 2015.

UA CALLS FOR NATIONAL RESEARCH PLAN

Universities Australia has called for a long-term plan to promote national research priorities, support for researchers and deep university-industry collaboration.

UA says the plan is needed to ignite cultural change and lift Australia's research and innovation performance in the face of intensifying global competition.

The 60-page report, *University Research: policy considerations to drive Australia's competitiveness*, which draws on published ATSE and ACOLA material, warns Australia should adopt such a strategy to remain a high-wage, high-growth economy. The report echoes many of the Academy's calls for enhanced levels of research-industry collaboration.

"In view of accelerating investment in research and innovation by our Asian neighbours and traditional competitors, Australia could be close to the proverbial 'tipping point' whereby we are not able to achieve our goal of a high-wage, high-growth economy," the report states.

AUSSIE TAILS ON LIGHTNING JET

The first vertical tails manufactured by Australian company Marand have been installed on the F-35 Lightning II in Lockheed Martin's manufacturing plant in Fort Worth, Texas.

The installation of these first major air frame components marks an important production milestone for Marand, BAE Systems and Australia, demonstrating the significant benefits the F-35 program brings to the growing Australian aerospace industry. The work on the F-35 vertical tails is subcontracted to Marand by BAE Systems and is one of the largest planned manufacturing projects for the F-35 in Australia, with 722 ship sets planned.

The F-35 Lightning II aircraft will provide the Royal Australian Air Force with a transformational fifth-generation fighter capability and provides significant benefits to the Australian aerospace industry, with more than US\$412 million of work already contracted.

Melbourne-based Marand designs and manufactures complex and innovative equipment for the aerospace, defence, automotive, rail

and renewable energy industries, including Lockheed Martin, BAE Systems, Boeing, BHP Billiton and Rio Tinto.

Marand is the largest Australian supplier on the F-35 Lightning II Joint Strike Fighter program.



The Marand Lightning tail assembly.

WOMEN IN TSE



Role models launch 50:50

A new program to inspire young women to pursue degrees and careers in science and technology – led by UNSW's Scientia Professor Veena Sahajwalla FTSE – has been launched in Canberra.

The Science 50:50 initiative has a simple premise – since half of the population is female, why not half the scientists and technologists?

The program, which will provide internships, scholarships and mentoring to girls so they can succeed in an innovation-driven future, is supported by Professor Sahajwalla's Australian Research Council Georgina Sweet Laureate Fellowship and the University of NSW, along with scientific and industry partners.

Girls are under-represented in the STEM subjects – science, technology, engineering and mathematics. The number of female high school students taking advanced maths, for example, is half that of boys and only 1.5 per cent of Year 12 girls study the STEM trio of advanced maths, physics and chemistry.

Science 50:50 was launched in January at the National Youth Science Forum in Canberra – a gathering of Year 12 students who are interested in science – where Professor Sahajwalla highlighted the exciting and varied opportunities provided by scientific careers.

Speakers included Vice President and COO of Lockheed Martin Australia, Ms Laura Frank, and Chief Executive Corporate Affairs at Arrium, Ms Gillian Burrows.

Professor Sahajwalla was awarded a prestigious Laureate Fellowship, worth \$2.37 million over six years in 2014, to undertake her research on transforming toxic electronic waste into high value-added metals and alloys. It includes additional funding to help promote female participation in science.

Science 50:50 aims to:

- create internship opportunities for girls to get an experience of scientific careers;
- launch a New Innovators Competition offering university scholarships to the girls who submit the most original and innovative ideas for solving real world problems;

- provide an engaging video series on extraordinary women in research, industry and other areas;
- engage girls with science and technology through school visits; and
- build a network of interested people to help link girls with mentors.

ARMY NAMED AS A TOP EMPLOYER OF WOMEN

The Australian Army has been named one of the top 50 leading employers for women in a report published by the Asia-Pacific Economic Cooperation (APEC) organisation.

The Army was one of three Australian organisations recognised for best practice efforts in increasing opportunities for women.

The Chief of Army, Lieutenant General David Morrison AO, said the result was a positive reflection on the work the Army had done to increase the participation of women.

"For our Army to be recognised as a best-practice Australian employer in the attraction and retention of female soldiers and officers is indicative of our continuing progress to be a truly inclusive organisation," Lieutenant General Morrison said.

"This report recognises and validates the hard work undertaken by the thousands of men and women in our Army to increase the representation of women in our organisation.

GIRLS IN ENGINEERING PROGRAM AT UWA

Rio Tinto and The University of Western Australia's Faculty of Engineering, Computing and Mathematics have launched a Girls in Engineering program.

Part of Rio Tinto's and UWA's long-term education partnerships program, it aims to engage secondary school girls in the world of science and engineering and inspire them to consider engineering as a career path.

The Girls in Engineering program provides hands-on outreach activities and resources to girls in Years 7 to 10 through school visits, on-campus workshops and mentors. Participants will meet successful female industry engineers and students and explore the opportunities a career in engineering can offer.

The scheme also includes a Women in Engineering mentoring arrangement, matching female engineering students with female Rio Tinto engineers.

Rio Tinto's program lead Hannah Golding, a mechatronics engineer, said that programs such as Girls in Engineering played a key role in addressing the gender imbalance within the engineering industry.

"Less than 12 per cent of the engineering workforce is composed of women," Ms Golding said.

"This gender imbalance means the industry is significantly underutilising a key part of the workforce, which is detrimental to economic productivity and growth.

"Girls in Engineering aligns with Rio Tinto's diversity strategy and focuses on creating excitement about engineering, highlighting opportunities for girls in this multi-faceted engineering profession. It also aims to show how creative and collaborative engineering truly is. Through this program we hope to increase participation of girls and young women in training and employment in engineering."

WOMEN IN TSE

Women prominent in science awards

Women were successful in winning a number of science awards made by the Academy of Science recently.



Michelle Simmons

Professor Michelle Simmons FAA, from the ARC Centre for Excellence for Quantum Computation and Communication Technology, University of NSW, won the 2015 Thomas Ranken Lyle Medal for research in mathematics or physics.

Professor Simmons has pioneered a radical new technology for creating atomic-scale devices, producing the first ever electronic devices in silicon where individual atoms are placed with atomic precision and shown to dictate device behaviour. Her ground-breaking achievements have opened a new frontier of research in computing and electronics globally. They have provided a platform for redesigning conventional transistors at the atomic-scale and for developing a silicon-based quantum computer: a powerful new form of computing with the potential to transform information processing.

The 2015 Christopher Heyde Medal for research in pure mathematics was won by **Associate Professor Catherine Greenhill**, School of Mathematics and Statistics, UNSW.

Associate Professor Greenhill is internationally recognised as a leading expert in asymptotic, probabilistic and algorithmic combinatorics, undertaking research at the interface between combinatorics, probability and theoretical computer science. By studying fundamental combinatorial objects, such as graphs, she tackles problems of major significance to pure mathematics. Her highly cited research achievements include new formulae and algorithms that have found broad application in many areas, from statistics to computer science, physics and cryptography.

The 2015 Dorothy Hill Award for female researchers in the earth sciences was won by **Dr Nerilie Abram**, Research School of Earth Sciences, Australian National University.



Nerilie Abram

Dr Abram's pioneering research addresses the past behaviour of the Earth's climate system and has implications for anthropogenic climate change. Her outstanding research portfolio has generated unique new records of past climate and environmental impacts from regions spanning the tropics to Antarctica, and assessing these alongside state-of-the-art



Catherine Greenhill

climate models. Her high-impact work has led to ground-breaking advances in understanding how climate change is impacting Southern Ocean winds, Antarctic temperatures and Australian rainfall patterns.

The 2015 Moran Medal for research in statistics went to **Associate Professor Yee Hwa Yang**, School of Mathematics and Statistics, University of Sydney.

Associate Professor Yang is an applied statistician who has made significant contributions to the development of statistical methodology for analysing molecular data arising in contemporary biomedical research. Her work on removing extraneous variability for microarray data has been incorporated in major software packages

used worldwide to identify gene expression patterns. She has also developed novel methods for integrating molecular and clinical data and has already made an impact on melanoma research by identifying potential genes that help with predicting survival outcome.

The 2015 Nancy Millis Medal for Women in Science, named for long-time ATSE Fellow, the late Professor Nancy Millis AC MBE FAA FTSE, was awarded to **Associate Professor**



Tamara Davis

Tamara Davis, School of Mathematics and Physics, University of Queensland.

Associate Professor Davis uses astrophysics to test our fundamental laws of physics and study the nature of dark energy and dark matter. She is one of the most highly cited astrophysicists in the world. Her contributions include testing advanced theories of gravity, measuring time-dilation of distant supernovae, using galaxies to measure the mass of the lightest massive particle in nature (the neutrino), and discovering that active galaxies fuelled by black holes can be used as standard candles.

Dr Naomi McClure-Griffiths, Australia Telescope National Facility, CSIRO Astronomy and Space Science, won the 2015 Pawsey Medal for research in physics.

Dr McClure-Griffiths is an internationally recognised radio astronomer, who has used 'The Dish' at Parkes and other Australian telescopes to make stunning new discoveries about our home galaxy, the Milky Way. Her research has provided unprecedented insights into how the Milky Way is structured, lives its life and interacts with its neighbours. She has unravelled the complicated pinwheel-like structure of our home galaxy and has helped explain how the Milky Way keeps finding fresh gas to make new stars.



Yee Hwa Yang



Naomi McClure-Griffiths

WOMEN IN TSE

Research shows gender divide in tech industries

A new report by the US-based Catalyst organisation shines a light on the male-dominated culture of STEM companies and provides specific steps organisations can take to better attract and retain talented women across both its technological and business sectors.

High Potentials in Tech-Intensive Industries: The Gender Divide in Business Roles presents research it says is the first to study women and men in business roles in technology-intensive industries such as high tech and telecommunications, oil and gas, and automotive manufacturing.

Among high-potential MBA graduates who participated in the research, 75 per cent had a technical background, but:

- only 36 per cent return to tech-intensive industries for their first job post-MBA, while the majority of those who possess the required dual skillset took their talents elsewhere; and
- of high-potential MBA graduates with non-technical backgrounds, only 14 per cent opted for a first post-MBA job in a tech-intensive industry.

The findings in this report were based on responses to Catalyst surveys in 2007, 2010, 2011 and 2014 from 5916 MBA graduates working in business roles across industries in the US, Canada, Europe and Asia. Among this sample, 37 per cent received a bachelor's degree prior to their MBA in computer science, engineering or maths and 63 per cent received a bachelor's degree outside these areas.

They showed a gender gap in pay due to women starting in lower-level positions and noted that:

- women were less likely than men to enter tech-intensive industries in business roles for their first post-MBA job (18 per cent versus 24 per cent);
- women were also less likely than men to migrate to tech-intensive industries from other industries; and
- men leave tech-intensive industries for greater opportunities elsewhere, while women leave for personal reasons.

It noted that these highly educated women were not opting out of the workforce, but opting out of tech-intensive industries, where they lacked role models.

The report is available at www.catalyst.org

MGSM BACKS WOMEN IN MBA PROGRAM

The Macquarie Graduate School of Management (MGSM) will make the largest investment by any Australian business school into the postgraduate business education of women.

Powered by a \$4 million investment from MGSM, with a matching \$4 million from corporate and government partners, the Women in MBA program sets out to overcome the global gender imbalance in MBA programs. The total \$8 million investment goes directly to eliminating or reducing the fee women pay to complete MBA study.

Based on research conducted by MGSM, which found that time and

cost are the primary barriers for women to MBA study, the first initiative of the Women in MBA program is a scholarship program whereby women are financially supported through the MBA by both MGSM and their employer, or sponsor, who provide a matching percentage contribution to either reduce or eliminate the fees to the women to study an MBA.

Significantly, as part of the program, the employer or sponsor must also pair their nominated student with a mentor for the duration of the MBA, as well as provide logistical and practical support to help them reach their study goals.

Six foundation partners include CPA Australia, Echo Entertainment, Johnson & Johnson Family of Companies, Philips, Qantas and the Royal Australian Navy.

"MBA programs are the breeding ground for tomorrow's leaders. They are the finishing school for middle managers gunning for senior leadership positions. They are also the place where the national stock of leadership capital is being developed," said Professor Alex Frino, Dean of MGSM.

"In Australia today, 20,000 students are currently passing through the 65 MBA programs delivered by Australian universities and other educational institutions, but less than one-third of this pool of aspiring leaders are female.

"To put this into perspective, there are 13,500 men but only 6500 women enrolled in MBA programs at the moment," he said.

STUDENT ENTREPRENEUR LANDS AMP GRANT

A start-up founded by UNSW student entrepreneur Lily Wu that puts Australian students into Chinese internships has won a \$10,000 innovation grant from AMP's Tomorrow Fund.

Ms Wu, a 20-year-old commerce undergraduate, established Austern International to broker better cultural understanding between Australian and Chinese business people.

The AMP grants are offered to people "who have a talent or a passion for something that will ultimately benefit Australia", according to AMP, which received more than 3000 entries for this year's competition.

Wu said the grant "means a lot" and will aid Austern International's growth and expansion, including setting up offices in Australia and overseas and employing operations staff. Austern's first internship program was held in 2014 and introduced 35 students to businesses in China.

Austern International has previously been recognised in the UNSW



Young Entrepreneurs project and has also received support from the Student Entrepreneur Development program run by NSW's commercialisation company, NewSouth Innovations (NSi).

Austern International founder Lily Wu.

WOMEN IN TSE

ATSE backs new gender diversity initiatives

The Academy is a key supporter of a new report published in Australia promoting gender diversity in engineering, science and technology-related professions.

Titled *A strategy for inclusiveness, well-being and diversity in engineering workplaces*, and edited by Academy Fellow and former Engineers Australia President Dr Marlene Kanga AM FTSE, the document is described by Sex Discrimination Commissioner Elizabeth Broderick as "a roadmap which I hope will be a game changer for the recruitment and retention of women in science, engineering and technology".

ATSE joins the Australian Government's Workplace Gender Equality Agency, Consult Australia, Engineers Australia, Chief Executive Women, the Federation of Engineering Institutions of Asian and the Pacific, the International Network for Women Engineers and Scientists and the World Federation of Engineering Organisations in supporting the initiative.

Ms Broderick says: "Although increasingly employers are investing in a wide range of programs to support gender diversity, the change has been slow. As a result, there are still far too few role models of women engineers who have had successful life-long careers, raised families and achieved positions of leadership.

"It's not surprising that the percentage of women studying engineering has remained low for decades. Concerningly, even fewer women remain in the profession, many not returning after bearing their children.

"These losses come at a significant cost to Australia and its economy. Some of the most pressing problems facing us today – such as energy, water and climate change – have science and engineering at the heart of the solution.

"We need the best talent, male and female, to bring diverse perspectives to address these challenges."

The document makes a case for increased diversity in engineering, analyses the deficit of women in technological workplace – particularly engineering – and sets out a strategic approach for inclusiveness, wellbeing and diversity in engineering workplaces.

Dr Kanga is one of Australia's leading women engineers and was the National President of Engineers Australia in 2013, only the second woman to hold this position in its 95-year history. She is a chartered chemical engineer and an expert in process safety and risk engineering for the chemical process industries. She was listed among the Top 100 most influential engineers in 2013 and 2014 and the Top 100 Women of Influence in 2013, and awarded the FEIAP Engineer of the Year Award in 2014, which recognised her contributions to engineering in the Asia-Pacific region.

She has held numerous leadership positions in Engineers Australia and is Chair of WEC 2019, the World Engineers Convention, which

will be held in November 2019 as part of the organisation's centenary celebrations and will bring the world's engineers to Melbourne.

The Academy is also a key participant in another initiative to challenge the Australian research sector to trial a gender equity program to address female under-representation and retention in science, technology, engineering and mathematics.

The Science in Gender Equity (SAGE) Forum, led by the Australian Academy of Science, has called for engagement from universities, medical research institutions and research agencies to 'beta test' a successful program that was originally developed in the UK.

The Athena SWAN Charter is an award system that rates research organisations based on their gender equity policies and requires them to develop and implement targeted action plans. Some UK research bodies now tie grant funding to participation in the program.

ATSE Director Dr Susan Pond AM FTSE is leading the Academy's involvement in the initiative, supported by the Office of the Chief Scientist, and co-chaired by Nobel Prize winner Professor Brian Schmidt and Australian Laureate Fellow in mathematics Professor Nalini Joshi.

CHERYL PRAEGER WINS CAREER AWARD

Professor Cheryl Praeger AM FAA, is the first woman to receive the Australian Mathematical Society (AustMS) career award, the George Szekeres Medal, awarded every second year.

This prize honours mathematicians who have made an outstanding contribution to the mathematical sciences over an extended period.

Professor Praeger, from the University of WA, is internationally renowned, collaborating with world-leading mathematicians and statisticians. She was the second woman to be appointed as a Professor of Mathematics in Australia.

She has had an exceptional research career in the mathematical disciplines of group theory and combinatorics, with more than 350 published journal articles and books, and has spent many years promoting the benefits of international collaboration and being an inspiring role model for women in mathematics.

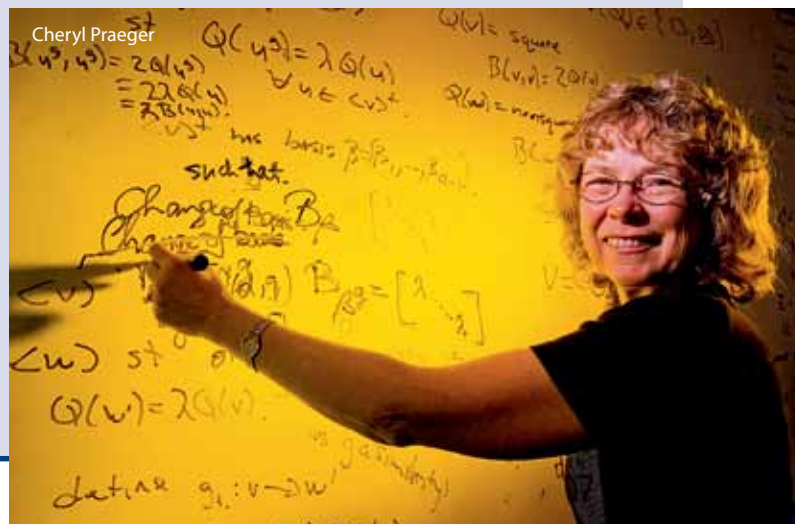
She is Foreign Secretary of the Australian Academy of Science, Vice President of the International Commission for Mathematical Instruction, an Honorary Life Member and former president of the AustMS, and this year was elected an Honorary Member of the London Mathematical Society, joining names such as Albert Einstein and Australian Fields Medallist Terry Tao.



Marlene Kanga



Susan Pond



BoM upgrades Climate Outlooks service

The Bureau of Meteorology has revamped its Climate Outlooks service – three-month outlook maps and analysis of what to expect on the climate front compared to the average – which has been operating for 25 years.

The new service enables users to tailor the outlook maps to their needs, getting specific information for any location, while still viewing the broader picture, and allows a user to view rainfall or temperature details and graphs anywhere in Australia.

An educational video explains how to get the most out of the Outlooks, and monthly Climate and Water Outlook videos discuss the key climate influences behind the current Outlook.

Using the monthly rainfall and temperature information, users can now get Bureau guidance on the likely climate conditions for separate months as well as for the three-month season.

The process of improving the Climate Outlooks service provided the perfect opportunity to better understand how people use climate outlook information.

Dr Andrew Watkins, Manager of Climate Prediction Services at the Bureau, says: "We heard from more than 900 users, many from the agricultural sector, and we learnt that while most users understood the Outlook maps, others needed assistance to interpret the information. In response, we produced short videos explaining the outlook probabilities for wetter or drier and cooler or warmer seasons, and the climate influences driving them."

UNDERSEA WAVES UNDER THE MICROSCOPE

The world has seen TV footage of surfers tackling massive surf at Margaret River, WA, or Oahu in Hawaii, where waves can tower to six metres and produce solid walls of water and long pipelines.

But few people know that undersea waves are even bigger, often as tall as skyscrapers, and play an important role in ocean mixing and the transport of sediments and nutrients.

An environmental engineer from The University of Western Australia is participating in an international study of undersea waves off the coast of Tasmania, potentially a global hotspot for deep tidal mixing.



Roger Revelle

Associate Professor Nicole Jones and her PhD student Tamara Schlosser will spend most of February on board the US research vessel *Roger Revelle* where they will work with scientists from the Scripps Institution of Oceanography, the University of California San Diego, Oregon State University and the University of Alaska.

They will study the tidal waves that are generated off New Zealand's south coast and break on the Tasmanian continental shelf. Some of the waves are up to 240 kilometres long and impact not only the ocean ecosystem but also the Earth's climate.

By better understanding these internal waves, the scientists hope to learn more about the effects of the deep-sea turbulence and to improve global climate models.

Associate Professor Jones, who has conducted similar studies off WA's North West Shelf, said there was still a lot more to be discovered about internal waves, which can affect the safe operation of the oil and gas industry and ecosystem management.

CRC AIMS TO MANAGE DEBRIS IN SPACE

International and Australian space researchers and companies will work together as part of a new collaboration to determine ways to monitor and potentially move space debris that put satellites at risk.

The Space Environment Management Cooperative Research Centre (CRC), based at Mt Stromlo Observatory near Canberra, will tackle the complex and commercially important issues of managing space debris and preserving the space environment.

The CRC's industry-led research will focus on tracking space debris, improving predictions of space debris orbits and predicting and monitoring potential collisions in space. As part of this focus it will develop ways to modify the orbits of space debris to help avert collisions.

Industry Minister Ian Macfarlane said \$19.8 million from the Australian Government would enable the CRC to bring together experts from around the world to look at ways to protect about 3000 operational satellites.

"This new CRC is an international collaboration and will harness the combined knowledge from a range of prominent science and research organisations and businesses," Mr Macfarlane said.

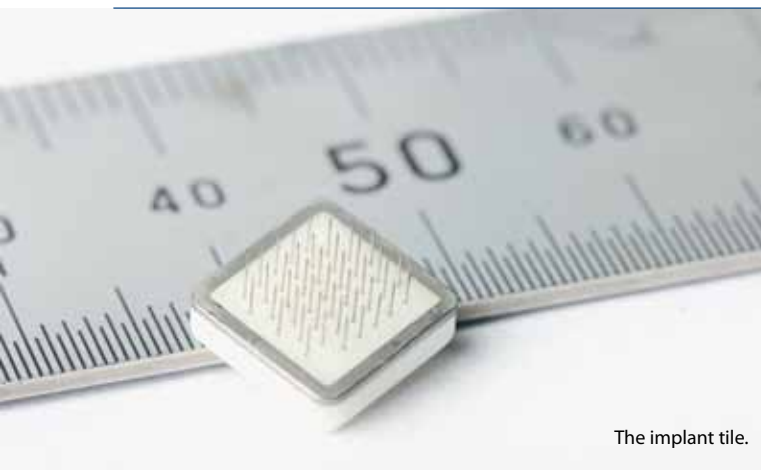
"This includes the NASA Ames Research Centre and Lockheed Martin from the US, the National Institute of Information and Communications Technology from Japan and our very own Optus and EOS Space Systems. They will also be joined by experts from both the Australian National University and RMIT University."

He said only 10 per cent of 300,000 major space debris objects were presently monitored and around one trillion dollars worth of space assets risked being transformed from valuable technology to floating space junk if a major collision occurred.

"International studies show that as the amount of space debris continues to rise, the satellite-reliant technologies that we depend upon every day are at risk of becoming unavailable.

"This project will research ways to enable affordable monitoring of all major space debris objects, through developing low-cost optical-tracking sensors and better management strategies.

"Australia is a world leader in optical space tracking, a key technology for protecting satellites, and has the existing infrastructure and data for effective research, making it the ideal country to host the CRC."



The implant tile.

Vision Group moves to human trials

The Monash Vision Group, headed by Professor Arthur Lowery FTSE, has moved a step closer to clinical trials of its Bionic Eye, thanks to donations from Melbourne business leaders Dr Marc Besen AO and Monash University Chancellor and ATSE President Dr Alan Finkel AO FTSE.

Each has donated \$1 million to the project through their respective foundations. With an additional commitment of \$1 million from Monash University, the philanthropic donations will cover critical development costs. The support keeps MVG on track through the next phase of the project, culminating in the first human trials next year.

More than 50,000 people in Australia are clinically blind and the number exceeds 160 million globally. The Bionic Eye offers hope of restored vision to humankind and has the potential to change many lives.

Called the Gennaris, the Bionic Eye combines state-of-the-art digital and biomedical technology with consumer-friendly glasses. A digital camera embedded in the glasses captures images from the user's environment. A vision processor extracts the most useful features from these images and a wireless transmitter presents this information to a series of tiles implanted at the back of the brain. Each tile, through hair-thin electrodes, then stimulates the brain's visual cortex to produce patterns of light. Over time, the user learns to interpret these patterns as visual images.

Dr Finkel said the Bionic Eye was a potential game-changer in treating vision impairment.

"I am familiar with many cutting-edge projects across our nation and none excites me more than this one. It has the potential to match and even exceed the success of the world's first cochlear implant – pioneered here in Melbourne in the 1970s. Three decades later, hundreds of thousands of people worldwide have benefited," Dr Finkel said. "I believe the Gennaris Bionic Eye offers Australia a further opportunity to demonstrate its reputation for science and innovation."

Leaders in engineering, physiology, neurosurgery, ophthalmology and industrial design are involved in the project. MVG partners are Monash University, Grey Innovation, Alfred Health and MiniFAB.

MVG Director Professor Arthur Lowery, a former winner of the Clunies Ross Award, said the funding came at a critical, yet pivotal stage. "We are incredibly grateful to Dr Besen and Dr Finkel for their investment and support. This enables us to move ever closer to clinically testing a technology that has the potential to improve the lives of millions across the globe for generations to come," he said.

ANSTO NUCLEAR MEDICINE FACILITY SHAPING UP

The first critical steps in the development of Australia's new nuclear medicine production facility are now complete, with the bulk of the excavation work finalised, more than 1700m³ of concrete poured and more than 200 tonnes of steel reinforcement in place.

The ANSTO Nuclear Medicine (ANM) project at ANSTO's Sydney headquarters represents a \$168.8 million investment by the Australian Government to secure continued supplies of nuclear medicines for the domestic market and the ability to contribute significantly to international demand.

ANSTO currently produces around 10,000 patient doses of nuclear medicines per week, which are distributed to more than 250 hospitals and medical practices across Australia, as well as shipped internationally.

Current world demand for Technetium-99m (Tc-99m), which is the decay product of Molybdenum-99 (Mo-99), is estimated to be approximately 40 million patient doses a year. Once fully operational, Australia's new Mo-99 manufacturing plant will enable ANSTO to supply up to 25 to 30 per cent of global demand.

Artist's impression of the ANSTO Nuclear Medicine facility.



RiAus LAUNCHES SCIENCE CHANNEL

Adelaide-based national science hub RiAus has launched what it says is Australia's first dedicated science TV channel, to deliver science-based content that will be available via desktops, tablets and smartphones through RiAus TV.

RiAus will broadcast high-quality science content from major Australian science-based organisations as well as exclusive interviews with leading scientists.

RiAus Director Dr Paul Willis said there was strong demand for high-quality Australian science-based content and a need to make science "an integral part of Australian pop culture. The future of our society depends on it – plain and simple.

"RiAus TV will provide a great opportunity to encourage conversations about science across Australia. With RiAus TV, students will have a direct connection to the great knowledge available here in our own backyard, and access to some of the greatest scientific minds both past and present. It truly is an inspirational project to be a part of."

The University of Adelaide, Flinders University, the University of South Australia, the University of Queensland, Queensland University of Technology and the Defence Science and Technology Organisation have already signed up as partners for RiAus TV.

The Crawford Fund: progressing and evolving

When the Crawford Fund was established in the late 1980s under the auspices of the Academy, its key activities were centred around public awareness and training. Its early public awareness efforts focused on two books written by the inaugural Director, Professor Derek Tribe AO OBE FTSE – who will be well-known to many Academy Fellows – *Doing Well by Doing Good* in 1991 and *Feeding and Greening the World* in 1994.

The Fund's public awareness program went on to maintain a focus on public events including the very successful annual Parliamentary conferences, training successes, coverage from journalist's visits to developing countries and attention around visits to Australia by leading food security specialists – all to highlight the benefits to developing countries and to Australia from international agricultural research.

These strategies have remained the Fund's core business to this day.

The extended specialist training program continues to fill a niche by offering practical, highly focused, non-degree instruction to individuals and

groups engaged in agricultural research, development and extension in developing countries. This training has involved more than 10,000 individuals since inception.

With growing concerns in early 2008 about rising food prices and their impact on global food security, the Fund brought together an eminent group of Australians with international experience in agriculture and development to form a national taskforce. The group addressed the causes and impacts of the crisis and identified policy options for Australian governments. Its work and recommendations attracted national attention and support following its launch at the National Press Club by taskforce head Mr James Ingram AO, former head of the UN World Food Program.

The exercise also raised the Fund's own awareness of the value of its tremendous network of Australian experts in identifying solutions to food security policy issues and using the Fund's public awareness program in bringing them to national attention.

The Crawford Fund has continued with this work with a series of research briefs on policy issues launched in 2011



Crawford Fund research battles many food enemies, including fruit fly.

and another taskforce report in 2013, which has been the basis of a sustained advocacy and events campaign throughout 2014 to highlight the benefits to Australia from international agricultural research.

More recently, the Fund is being invited to be part of a range of partnerships around policy, public awareness and training.

"As a small organisation, we are using our core asset – our network of committed Australians – to move into new areas of training and policy and using our public awareness strength to ensure word gets out and is supported," said Dr Denis Blight AO, Chief Executive of the Crawford Fund.

An interesting example of these collaborations was announced by The Hon Julie Bishop, Minister for Foreign Affairs, on World Food Day 2014, highlighting the Alliance for Agricultural R&D for Food Security.

CSIRO warns against biosecurity complacency

A human disease pandemic, European honey bee colonies wiped out and an invasion of a devastating wheat disease are just three potential biosecurity threats facing Australia, according to a new CSIRO report.

These three events alone could devastate Australia's agricultural industries, economy and environment, and could severely alter our way of life. But can we ensure that we see them coming and are we prepared to respond if they occur?

As an island nation Australia has largely been able to maintain an enviable biosecurity status. However, experts warn that the 12 biosecurity megashocks identified in a new report – *Australia's Biosecurity Future* – could turn into reality if we become complacent with our nation's biosecurity measures.

CSIRO Biosecurity Flagship Science Director Dr Gary Fitt FTSE said it was much better to pre-empt and avoid biosecurity issues than have to deal with the consequences.

"Dominating the news right now is the Ebola virus crisis, which is an obvious global health concern," Dr Fitt said. "Meanwhile farmers near Katherine, in the Northern Territory, are dealing with an outbreak of a new disease – cucumber green mottle mosaic virus – and, while not fatal to people like Ebola, this virus is devastating their crops, which has severe financial impacts."

"The new report outlines a systematic examination and assessment of where we're heading and what we need to do as a nation to protect our environment, industries, people and way of life over the next 20 to 30 years.

"If there was a significant decline in European honey bee populations across Australia in the future, for example, this would impact our economy with losses of around \$4 to \$6 billion," Dr Fitt said.

"Losing this free pollination service would severely impact production of several fruit and vegetables including avocados and almonds."

In addition to considering the 12 potential megashocks, the report identifies a number of global megatrends that highlight significant change

The Alliance links the Australian International Food Security Research Centre (AIFSRC) within the Australian Centre for International Agricultural Research (ACIAR), the Syngenta Foundation for Sustainable Agriculture (the philanthropic arm of the multinational Syngenta Seed Company) and the Crawford Fund.

Its first project is on demand-led research and is led by the University of Queensland's Global Change Institute. It is based on the knowledge that African agriculture is moving from subsistence to market-led systems, as small-scale producers seek to generate surpluses to sell in local, regional and even international markets. Central to this transformation is the need to overcome the low uptake of new varieties from breeding programs in Africa.

"There is less than 35 per cent uptake of new plant varieties in Africa compared to 60 per cent uptake in Asia and 80 per cent in South America," Dr Blight said.

"As a first step, the Alliance is working with senior educators across Africa to devise a new curriculum for postgraduate training and professional development of plant breeders in Africa to enable them to better build into their breeding programs characteristics that will meet demand from the whole value chain from farmers to consumers," he said.

Another example is the Australia–Africa Plant Biosecurity Partnership, which is led by Australia's Plant Biosecurity CRC



Students in a Crawford Fund workshop in Africa.

(PBCRC) and funded by the AIFSRC within ACIAR, CABI and the Australia Awards scholarship program. The program is being delivered by a consortium of PBCRC, ACIAR, CABI, CSIRO and the Fund.

"This project will develop a cadre of 'change champions' to improve plant biosecurity in around 10 east and southern African countries," Dr Blight said.

"Our first workshop in November involved plant biosecurity specialists in national plant protection organisations, and in trade and private sector organisations and identified plant biosecurity training needs for 10 African countries. Matched training in Australia will follow, with the resulting 'biosecurity change champions' working to improve regional biosecurity to impact farmer incomes, food security and safe regional trade of agricultural products," he explained.

"Those involved with the Crawford

Fund, including a number of Academy Fellows with agricultural and development expertise, share our vision of a better world realised through the dedicated efforts of agricultural scientists leading research, development and training in developing countries.

"The Fund achieves a lot with limited resources. We believe that we could do much more by drawing further on our growing network of former trainees and of Australian scientists motivated to assist in the vital business of global food security.

"The Fund is actively exploring new revenue streams for its work to supplement the core funding it receives from the Federal and State governments," he added.

More information on the Crawford Fund is at www.crawfordfund.org and Fellows can donate to its work through the website or by contacting the office.

and the growing complexity relating to our nation's biosecurity challenges.

"We have identified a number of important trends, such as the need to produce more food for a growing population while dealing with ongoing pressure on the key soil, water and biodiversity resources which sustain production," Dr Fitt said.

"These trends will produce new challenges for all our plant and animal industries, our environment and human health." "Understanding the biosecurity megatrends identified in the report will help Australia prepare for, and deal with the pests and diseases that threaten our farming sector, environment and people."

CSIRO partnered with Animal Health Australia, the Plant Biosecurity CRC and the Invasive Animals CRC and consulted with various industry, government and scientific organisations to deliver the report.

The 'megashocks'

The 12 megashocks in the report illustrate the challenges Australia may face and emphasise that we cannot be complacent in the face of growing biosecurity challenges.

The megashocks include:

- nationwide incursion of a new race of an exotic wheat stem rust more virulent than existing races of Ug99;
- nationwide loss of pollination services from feral European honey bees due to a multi-state varroa mite incursion;
- nationwide incursion of a new exotic fruit fly;
- nationwide outbreak of a variant strain of foot and mouth disease;
- bluetongue outbreak across Australia's sheep-producing regions;
- highly virulent rust spreads across multiple ecosystems;
- government 'walks away' from environmental biosecurity;
- successful establishment of black-striped mussel;
- outbreak of infectious salmon anaemia; and
- a nationwide zoonotic disease epidemic.



By Ian Rae
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Taking the polymer all the way to the bank

The authors, two of our Fellows, set out to give us a blow-by-blow account of the process that led to a commemorative \$10 polymer banknote in 1988, regular issues of all Australian banknotes from 1993, and a flourishing international business.

While there may be some secrets remaining undisclosed it would seem – on the face of it – that this is the whole story, the definitive version, although not quite a forger's handbook.

The project began in April 1968 when the Reserve Bank of Australia sought expert advice from scientists about ways to combat counterfeiters who had laid siege to the recently introduced dollar banknotes. By the end of the year the Bank had agreed to support CSIRO research on producing a more secure banknote.

The rest is history, and a complex history it is.

Running through the book there are at least two stories: one concerning the technological details and the other exploring the different cultures that pervaded the two institutions. The blame for dragging the project out for two decades is placed squarely on the Bank, while the brave scientists did their best, and more, to meet the ever-shifting and often poorly articulated requirements of the body entrusted with the production and security of our currency.

However, as I reflected after I had read the book and reviewed the arguments put forward by Solomon and Spurling, I wondered if we might see a Reserve Bank version of the story if we just wait a while.

Although security was the main reason that the Bank sought assistance, banknotes had to meet scientific, artistic and production criteria as well. On security, Class 1 features of a genuine note had to be such that they would be recognisable by the 'person in the street'; Class 2 identified at point of sale by a technical device; and Class 3 only at the central Bank.

Suggested security devices such as fancy

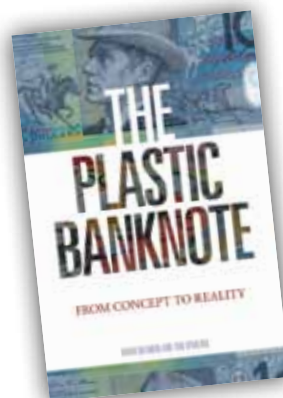
diffraction gratings and moiré patterns that were incremental advances on what was built into the paper banknotes, came to nothing. Instead the major security feature of the new notes was a clear panel that was only possible when the substrate was polymer.

Plastic – 'polymer' in more genteel usage – was unfamiliar to the Bank, whose officers expressed doubt that images could be printed on such material. Its staff seemed unaware that the food packing industry, as Solomon pointed out, was already printing quite high-quality text and images on a variety of plastic surfaces. This exchange was typical of many that revealed a lack of broad expertise in the Bank and a narrow focus on the printing process. Printing was important, of course, but the new banknotes, like the old, were printed with the intaglio process in which the ink was transferred onto the 'paper' from grooves in the printing plate.

When the Bank spruiked the new technology to sister organisations in the US, the UK and Canada without consulting the scientists, it was brought home to Solomon that "the Bank treated CSIRO as contractors rather than as collaborators".

This only began to change in the early 1980s when a new Governor of the Reserve Bank and a more technically oriented General Manager of the Note Printing Branch were appointed. They accepted the need for the Bank to employ technologists who could lead the project from within and establish production based on the inventions and ongoing advice of CSIRO.

It is probably the case that many of the Bank's objections, like those of traditional scientists to new theories, vanished as the proponents died or retired. There were changes in the CSIRO team, too, with Solomon one of the few to stay the distance and, in doing so, providing the backbone of the research effort. Of course it wasn't all smooth going on the CSIRO side, where



*The Plastic Banknote:
From concept to reality* by
David Solomon and Tom
Spurling. CSIRO Publishing,
2014, xv + 222 pp. \$39.95.

the arts of working in multidisciplinary teams and of commercialisation of its inventions were being developed, although hardly in a linear fashion, as the Bank project ground its way forward.

Both sides, but especially CSIRO, had some mavericks. They injected wild ideas but were senior enough to have them taken seriously, at least for a time.

The book has some photographs of historic interest but I'd urge the authors to change the caption of Figure 8.2 in the electronic version, at least, to make clear in the caption (and not just in the text) what was involved in the "feel test". The colour plates that come early in the volume add to its historicity and show trial banknotes in brilliant colours.

The effort to give credit to every contributor, however noble, makes for heavy reading at times. The inclusion of detailed lists of the attendees at meetings, and pages given up to biographies of some important contributors also detracts from readability. Both the latter would have been better placed in appendices.

At the end of 1987, with the basic work done, CSIRO sold its interest in the Currency Notes Research and Development project to the Bank for \$9 million. Solomon and Spurling estimate that the Bank "easily recovered" this sum by selling 850,000 souvenir commemorative \$10 notes at \$14 each – making money in at least two senses.

PROFESSOR IAN RAE FTSE, an Honorary Professorial Fellow at the University of Melbourne, is a former Technical Director of ATSE. He was President of the Royal Australian Chemical Institute (2006–08) and has served for more than a decade as a technical adviser to the UN Environment Program.



Knee injury led to robotics MOOCs

A broken knee was the genesis for Queensland University of Technology (QUT) launching the world's first massive open online courses (MOOCs) on robotics, designed for undergraduate engineers but suitable for anyone with a strong interest in robotics.

MOOCs are free, open-access courses delivered online to an unlimited number of participants worldwide. Very few robotics MOOCs have been offered by institutions globally in the past – and all were designed for postgraduate-level students undertaking science, technology, engineering and mathematics (STEM) related research.

QUT's two MOOCs are the first developed for people with undergraduate STEM knowledge, and they are the first robotics and vision MOOCs ever offered globally.

They are the brainchild of course creator Professor Peter Corke, world-renowned roboticist with QUT's Science and Engineering Faculty and the director of the ARC Centre of Excellence for Robotic Vision.

"A couple of years ago I broke my knee, just days before semester started," Professor Corke said. "I had to record my lectures at home and a colleague showed them to the class. At the end of semester I put them on YouTube. I was really surprised by the interest those lectures generated – more than 70,000 views, with one lecture alone viewed 32,000 times.

"That made me realise just how many people are genuinely interested in robotics and it got me thinking about how I might be able to deliver structured course content online. I've spent about 16 months working with QUT's eLearning Services team to develop the MOOCs.

"Once upon a time we needed a lecture theatre and a lab full of hardware to teach robotics but in this digital age we don't always need that resource-intensive, bricks-and-mortar model to deliver a strong robotics course. These days we can teach mechatronics with LEGO kits at home rather than labs, and I find that a truly exciting prospect," he added.

"While the MOOCs might attract some high school STEM stars and skilled armchair roboticists, I expect most of the students will be undergraduates, perhaps studying engineering or computer science at a university that doesn't itself have a strong robotics program," he said.

"It could also be helpful for STEM professionals looking to expand their skill set – with big players like Google, Apple and Boeing pouring hundreds of billions of dollars into robotics and automation, it's an industry that'll be screaming for workers into the near future."

Peter Corke and friends.

QUT's 'Introduction to Robotics' MOOC is designed to develop the fundamental mathematics and algorithm skills that underpin robotics, including representation of pose and motion, kinematics, dynamics and control. As an optional practical assignment, students with a LEGO Mindstorm kit can build a simple robot arm and write control software for it.

The 'Robotic Vision' MOOC takes that knowledge further, introducing students to the evolving field of computer vision, learning how images are formed and fundamental algorithms to process images in a computer to extract information such as the colour, size, shape and position of objects. As an optional practical assignment students can build an intelligent vision system that can recognise objects of different colours and shapes.

Students in the MOOCs are supported by online discussion forums for sharing information and asking questions of tutors and other students.

'Introduction to Robotics' runs for seven weeks from 15 February and 'Robotic Vision' runs for seven weeks from 12 April.

SIX STUDENTS ATTEND SC14

Six Australian high school students, from two specialist science schools, attended SC14, the annual International Supercomputing held in New Orleans, in November – one of the most significant events in the supercomputing calendar.

SC14 launched the HPCmatters campaign to demonstrate the contribution supercomputing makes to society through supporting environmental modelling to producing better products and movies.

The students were competitively selected from the John Monash Science School (JMSS) in Melbourne and the Queensland Academy of Science, Mathematics and Technology (QASMT) in Brisbane.

Professor David Abramson FTSE, from the University of Queensland, instigated the sponsorship originally for JMSS students in 2011 and extended it to QASMT when he moved from Monash University to UQ in 2013.

In 2014 both schools launched a joint project to monitor environmental parameters around their buildings. Even though the project only began a few months ago, they had managed to collect sufficient data to demonstrate a visualisation at the Australian booth on the conference show floor. The students gave a brief presentation to booth attendees and engaged in discussions with delegates from around the world.

The program is financially supported by the Faculty of Information Technology at Monash University, the Research Computing Centre at the University of Queensland, and the students themselves.



Australian students and teachers at SC14.

By John Dell and Peter Lilly
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Creative collaboration using the EZONE approach

It is often not part of academic educators' experience to see value in making space in the curriculum for multi- and inter-disciplinary training.

The most exciting advances in knowledge and developments of new technologies that have the greatest impact occur at the boundaries of disciplines. This understanding has seen the rise of new disciplines such as bioinformatics, informed modern climate science and underpinned the success of the CSIRO Flagships Program.

Industry also recognises this.

Solutions to complex challenges within industry sectors and within individual companies see teams from multiple disciplines brought together to work in an inter-disciplinary manner, using a whole-of-system approach.

Discipline depth is still needed, but it is increasingly rare that such challenges can be solved only by the thought processes and knowledge base of a single discipline.

To support this, university-level STEM (science, technology, engineering and mathematics) teaching, research and community engagement (which includes, of course, industry engagement) must be substantially underpinned by a culture of collaboration in which academics, students and community partners readily work across and with other disciplines.

Discipline depth is retained but cross-disciplinary collaboration is increased.

This is a far more challenging proposition

than might appear at first glance.

Reward for most academics in the form of promotion and peer recognition is more likely to come from working and publishing within narrow fields of mono-disciplinary activity. In addition, most academics without industry experience have not been exposed to training that includes a substantive multidisciplinary aspect.

By this we don't mean that an academic mining engineer, for example, has not studied mathematics, physics, chemistry and geoscience at an undergraduate level – rather that his or her higher-level engineering units are usually not of a genuinely multidisciplinary nature nor

New report benchmarks Australian STEM

Australia's Chief Scientist, Professor Ian Chubb AC FTSE, has released a new report, *Benchmarking Australian Science, Technology, Engineering and Mathematics*, following the tabling of the report at the inaugural meeting of the Commonwealth Science Council.

In his foreword to the report, Professor Chubb says: "In view of the central importance of STEM, we need to know how we perform. We need to get 'a fix' on our performance – not an easy one, against 'the world' – but a more challenging one, against nations that, like us, are essentially free-market economies with serious science engagement.

"... This report provides insights into where we are and will help us decide what we should do. As an analysis mostly at a high level – signposts in kilometres not metres, let alone centimetres – it is intended to highlight performance and trends that might warrant further investigation, prompt questions for government and contribute to discussion on the future shape and scale of Australian STEM.

"The report is about encouraging wise decisions, not about making them. Used well, it will help us improve and help us position Australia in a changing world."

This report builds on a previous report by the Office of the Chief Scientist, *Health of Australian Science*, which provided an assessment of the strengths and vulnerabilities of Australia's science capability. The new report extends, deepens and updates the analyses in *Health of Australian Science*. It takes guidance from similar international benchmarking reports produced in the US, Europe and elsewhere that

document indicators for the performance of national and international STEM.

Two groups of nations were identified for the purpose of benchmarking: countries at stages of development similar to that of Australia and with similar governance systems (the US, Canada and selected European nations) and selected countries in the Asia-Pacific region.

The 11 European nations chosen for comparison are Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Norway, Sweden, Switzerland and the UK. The comparator countries from the Asia-Pacific region, are China, India, Indonesia, Japan, Malaysia, the Philippines, Singapore, South Korea, Thailand, Vietnam and New Zealand.

Among the primary indicators used in this report are number, citation rates and international authorship of STEM research publications; funding for STEM R&D; researchers in the workforce; enrolments and completions in STEM in higher education institutions; school students' performance in standardised international tests in mathematics and science; and rates of high school students' participation in mathematics and science.

The report places emphasis on research publications, which are generated primarily by the higher education sector. This focus reflects higher education's pivotal role in Australia's contribution to the global stock of knowledge and as a major source of innovation. It notes that more than 60 per cent of Australia's researchers are employed in the higher education sector and less than 30 per cent are in business.

taught in an interdisciplinary manner.

As a result, it is often not part of academic educators' experience to see value in making space in the curriculum for multi- and inter-disciplinary training.

It is very common at universities that different disciplines are located within different buildings – or, if an entire faculty is located in a single large building, that the school/department/discipline structure drives the location of the staff. Additionally, quality spaces for substantive collaboration with one another, with students and with the community (industry) are rare.

The Faculty of Engineering, Computing and Mathematics (ECM) at The University of Western Australia is well placed within UWA to become a leader in creative interdisciplinary collaboration.

ECM includes the core disciplines of chemical, civil, electrical and electronic, environmental, mechanical, mining and software engineering, as well as computer science, mathematics and statistics. Additionally, it has outstanding research capacity in ocean and coastal engineering and petroleum process engineering. The Faculty also has excellent working relationships with key disciplines in other Faculties, particularly those in Business, Law, Medicine, Dentistry and Health Sciences, and Science.

Led by ECM, UWA is adopting a new approach to transform the teaching, research and community engagement paradigm which is embodied in the EZONE UWA (or Engineering Zone) initiative. EZONE UWA brings together three critical elements:

- space – creating modern places for people to study, work and interact;
- capability – attracting the best people who think across boundaries (including joint appointments with CSIRO) and equipping them to achieve excellence; and
- mindset – focusing on and developing systemic approaches to creative collaboration and community engagement.

ECM's buildings are not designed to facilitate the learning and research ethos that the Faculty is striving for. Figure 1, sourced from the UK Office of Government Commerce report *Working Beyond Walls*, shows how successful mindset change and space are inextricably linked.

EZONE UWA will transform much

Figure 1 The nexus between mindset and workspace.



SOURCE: *WORKING BEYOND WALLS*, UK OFFICE OF GOVERNMENT COMMERCE

of the western side of its Crawley Campus in three stages over a 10 to 15-year period.

Stage 1 will see the development of the Hub, estimated to cost up to \$200 million. Subject to funding, the Hub is planned for completion by late 2020. It will be the heart of EZONE UWA, where all ECM staff, PhD students and postgraduate coursework students – particularly those undertaking the Master of Professional Engineering degree – will interact and collaborate with one another and with industry.

The Hub will provide workspaces for both individual (that is, solitary) activities and team or group undertakings.

Augmentation of ECM's capabilities will occur through the appointment of three new Chairs and associated postdoctoral positions. In addition to academic excellence and research team leadership at the professorial level, the attributes sought in these senior appointees includes a strong focus on a record of collaborative behaviour, being able to influence others, working with and delivering successful outcomes to industry partners with an emphasis on impact, and leading and integrating significant multidisciplinary teams.

These "collaboranaughts", to use Harvard Professor Rosabeth Moss Kanter's evocative term, will support the good work being carried out by some of the extant leaders in the Faculty to maximise and systematise the changed way of thinking and working.

The vision for EZONE UWA is both exciting and challenging, and this vision has already attracted significant

financial and in-kind support from BHP Billiton, Woodside Energy and a number of individuals.

The proponents believe that EZONE UWA will empower staff and students to change the world for the better, focus STEM research activities on key economic, environmental and social challenges and advance the prosperity and welfare of people by creating knowledge and technologies previously unimagined.

PROFESSOR JOHN DELL is Dean of the Faculty of Engineering, Computing and Mathematics at UWA. He has 30 years' experience including more than 10 years in industry working in technology development in Europe and Australia. His current educational interests are in the use of intensive mode teaching and technology to facilitate engineering learning. His research interests are in sensors and sensing systems. He has more than 300 publications and has managed numerous industry and government research contracts and grants. He holds a number of patents, two of which are currently being pursued for commercialisation.

DR PETER LILLY FTSE is Director EZONE UWA and Adjunct Professor of Mining Engineering. He has held senior leadership roles in mining, applied research and academia. He is Chairman of the Minerals Research Institute of Western Australia, Past President of The Australasian Institute of Mining & Metallurgy and Chairman of the Inductees Selection Committee of the Australian Prospectors & Miners Hall of Fame. He is also a member of CSIRO's Mineral Resources Sector Advisory Council, the Board of Trustees of the AIMM Education Endowment Fund and the Advisory Board of the Ian Wark Research Institute at the University of South Australia.

By Ian Rae
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New slant on educating our engineers

At the 2014 Academy AGM in Melbourne I attended the Education Forum workshop where Professor Sam Bucolo pointed to “a future education paradigm ... to equip students to address wicked problems and complex challenges”.

Within a single generation, changes in practice have affected engineering more than most professions and – as I listened to Sam’s and the other excellent presentations, augmented by spirited discussion – it was clear to me that engineering education was struggling to keep up and to demonstrate its relevance.

Two recently published books address this problem and they offer different solutions.

The first is James Trevelyan’s *Making of an Expert Engineer*, subtitled “How to have a wonderful career creating a better world and spending lots of money belonging to other people”.

Professor Trevelyan, who has been at The University of Western Australia since he graduated there in the early 1970s, is Winthrop Professor of Engineering. A specialist in robotics, he has contributed to the development of the Kreepy Krawly pool cleaners,

mine clearance technologies and robot shearing of sheep. Since the beginning of the new millenium he has been thinking and writing about engineering practice, reading what other researchers have found and publishing his 2013 book *Engineering Practice in a Global Context: Understanding the Technical and the Social*.

Now, writing in a very personal style, he addresses common misconceptions (17 of them) of engineering practice, and expands his prescription for the future in a series of practice concepts (85), quizzes, practice exercises (some accessible in the eBook), case studies and scenarios. In addition there are endnotes to all 15 chapters, 17 pages of references, a keyword index (16 pages), and a seven-page index of people and organisations. Summing it up after more than 500 pages, Professor Trevelyan reflects that while engineering education does moderately well on engineering, business and science, it is underweight in teaching about listening, reading and visual perception and does not develop tacit ingenuity. His analyses of numerous situations where an engineer might find herself (yes, he’s interested in improving gender balance in the profession) can help an engineer to garner

the benefits of successful engineering practice – client satisfaction, reputation and the satisfaction of achievement.

He does not expect his advice to influence undergraduate or postgraduate courses in engineering because there are “too many obstacles”, among which are the concentration of university staff on research publication and their separation from professional practice, “the supremacy of the written word in formal education” and simplistic student assessment procedures.

Instead he looks to senior engineers to draw on the book and mentor their younger colleagues while they learn on the job.

While Professor Trevelyan baulks at trying to change his university colleagues, Professors David Beanland FTSE (RMIT) and Roger Hadgraft (CQU) believe that the curriculum can be used to revivify the profession. Their work was commissioned by UNESCO following Professor Beanland’s commentary on an earlier UNESCO Report *Engineering Issues, Challenges and Opportunities for Development* (2010).

They address rising concerns in the engineering profession that many beginning students were turned off by first-year courses that were “boring and

FELLOWS BACK IPSWICH RAILYARDS RENEWAL

A group of ATSE Fellows are playing a leading role in an ambitious program to regenerate the historic North Ipswich railyards, near Brisbane, into a global destination by building around the existing iconic rail museum to create a knowledge centre of complementary facilities and infrastructure.

The vision for Ipswich North Precinct is to develop a location “that delivers transformational outcomes in the engineering and construction industry, helping firms innovate and compete locally, nationally and internationally”.

It says that by “utilising and investing in available infrastructure assets, Ipswich North Precinct will become a vibrant place that will inspire the next generation of highly skilled and creative professionals”.

The regeneration of the precinct into a centre of excellence in innovation and construction seeks to “integrate the past, present and



The historic bricks and mortar.

future to foster innovation and deliver transformational engineering and construction” by inspiring young people to pursue careers in engineering and construction.

hard work” and that courses in most universities were not preparing students for a profession that had changed dramatically. Present courses, they say, are just “technology added to a science core” and they propose instead that undergraduate education should comprise “engineering from the beginning”, with mathematics and science introduced where they are needed and mostly later in the course.

Most existing courses purportedly adhere to the Washington Accord and seek in their own ways to produce graduates with its knowledge and attribute profiles. The authors feel, however, that only lip service is paid to the Accord and that universities and the professional organisations responsible for the accreditation of engineering courses “have proven inadequate to achieve the transformation required”. Reaching for the language of the profession, they state that designing curriculum “is a multi-variable complex system engineering problem” that has no unique solution.

The curriculum they set out in the core of the book, Chapter 6, is couched in general terms, allowing for local development and implementation. It is built around principles that cover:

- the Accord;
- the development of the necessary capabilities in the young engineer;
- a first-year course that maximises student motivation;
- project-based and student-centred learning (less simple transmission of information equals fewer lectures); and

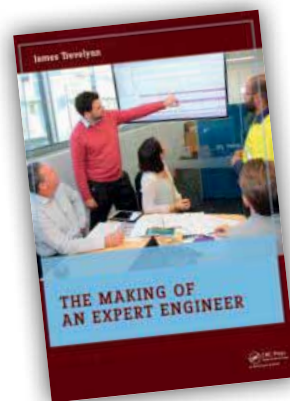
- extensive use of information and communication technology (ICT).

The authors have invited other experts, drawn from an international list, to contribute their views on the matters raised in the text, and these interludes take the form of pages-long text boxes. Some of these describe institutions where curriculum change, in the direction recommended by Beanland and Hadgraft, is already underway. James Trevelyan, who wrote one of these contributed pieces, calls for a move “From Graduates to Experts”, thus providing a point of intersection between the two books.

Beanland and Hadgraft share Tevelyan’s conclusion that an emphasis on practice should replace what now seems to be merely “engineering science” but there are differences between their prescriptions for change.

Trevelyan’s appeal is to the broader profession to take responsibility for the raw product of university education. I’m sure this has always happened to some extent but he would like to formalise a kind of graduate apprentice model.

Beanland and Hadgraft, on the other hand, recommend modification of the production system. They will almost certainly know that other professions are also struggling with recruitment and retention of new members, along with induction of recruits into the workforce. They look to courses that are “exciting, relevant and seen as socially responsible” – don’t we all?



The Making of an Expert Engineer by James P. Trevelyan. CRC Press, 2014. xxxix + 581 pages. ISBN 9781138026926. Also available as an eBook.

Engineering Education: Transformation and Innovation by David Beanland and Roger Hadgraft. RMIT Publishing, on behalf of UNESCO, 2014. xii + 196 pp. ISBN (paperback) 978-1-922016-09-6, eBook pdf 9781922016-10-2. Available from RMIT University Press, \$33.00; eBook available for download (free) from <http://search.informit.com.au>

My modest experience of curriculum reform suggests that if real change is to be achieved the wisdom and authority of senior members of the profession needs to be allied with the revolutionary zeal of younger people.

I look forward to learning that Team Engineer is on the job. – IAN RAE

The regeneration aims to:

- create a skills and training facility;
- expand engineering and construction skills;
- facilitate industry/university collaboration;
- provide smart infrastructure for R&D; and
- encourage commercialisation and entrepreneurship.

The plan is based on the 17.3-hectare historic railyards, home to the Ipswich Railway Museum.

To develop the vision, a group of industry leaders was established as an Advisory Board, which includes:

- Mr Martin Albrecht AC FTSE, Former CEO and Managing Director, Thiess;
- Professor Robin Batterham AO FREng FAA FTSE, former Chief Scientist of Australia and immediate Past President of ATSE;
- Dr Marlene Kanga AM FTSE, Former National President, Engineers Australia; and
- Mr Charlie Sartain FTSE, Former CEO of Xstrata Copper, and Chairman, UQ Sustainable Minerals Institute.

CATCHPOLE TAKES 2015 JOHN BOOKER MEDAL

Associate Professor Kylie Catchpole, from the ANU College of Engineering and Computer Science, has been awarded the 2015 John Booker Medal in Engineering Science, awarded by the Academy of Science.

Associate Professor Catchpole’s research focuses on using nanotechnology to make solar cells cheaper and more efficient.

Her major achievements include showing that the efficiency of thin solar cells can be improved using tiny metal particles, which act like antennas to direct light into the solar cell. This has opened up a range of new possibilities for reducing the cost of solar electricity.



Kylie Catchpole

ATSE IN FOCUS

Three Fellows among 2014 business leaders



Sam Walsh



Alan Joyce



Catherine Livingstone

Three Academy Fellows were named by the *Australian Financial Review* in December among "six leaders of Australian business" who had "made their mark" during the year and "led the debate over the future of the nation".

Boral CEO Mr Mike Kane was named as the AFR business Person of the Year 2014 and the newspaper's six business leaders included Business Council of Australia and Telstra Chair Dr Catherine Livingstone AO FAA FTSE, Qantas CEO Mr Alan Joyce FTSE and Rio Tinto CEO Dr Sam Walsh AO FTSE.

Ms Livingstone was recognised in an article headed 'Time to reset the future' for her focus on the need to change the economic and political debate to encourage a growth agenda.

Under a heading 'Qantas stirrer and shaker', Mr Joyce was acknowledged for having survived "bruising battles to get the national carrier back in the black".

Mr Walsh was credited with turning around Rio Tinto's fortunes and reviving the mining giant under the heading 'Reclaiming Rio Tinto's mojo'.

They were recognised in the AFR's 51st set of business leader awards.

Fellows past and present who have been named by AFR as its business Person of the

Year over time include Dr Peter Farrell AM FTSE, Mr John Grill AO FTSE, Sir Ian McLennan KCMG KBE FAA FTSE, Dr Brian McNamee AO FTSE and Sir Arvi Parbo AC Kt FTSE.

SA FELLOWS RIDE FOR CANCER CURE

Two Adelaide Fellows, Mr David Klingberg AO FTSE and Mr David Knox FTSE, were on the pedals in Adelaide's Ride for a Reason in January, raising funds for cancer research as part of the Tour Down Under cycling event.

Mr Klingberg, Cancer Council SA Business Patron, Chairman Centrex Metals and former SA Division Chair, was one of a high-flying team riding under the banner of the Chairman's 11 Team headed by former Governor Rear Admiral the Hon Kevin Scarce AC in the charity ride.

Mr Knox, Managing Director of Santos and a member of the Commonwealth Science Council, was also a keen participant, along with a host of notables led by SA Lieutenant

Governor Professor Brenda Wilson, Chief Executive Cancer Council SA, and coached by former international road racer Patrick Jonker.

AUSTRALIA-CHINA AWARD TO MAX LU

University of Queensland Provost Professor Max Lu FTSE has been named a winner in the inaugural Australia-China Achievement Awards, which showcase the leadership and creativity of Australian organisations and people in building stronger economic, cultural and education connections between Australia and China.

Professor Lu won the Education Category, awarded for exemplary leadership in advancing the research and education relationship between Australia and China.

Professor Lu's award was announced by the Prime Minister in November during Chinese President Xi Jinping's visit to Australia. The awards attracted significant interest from the Australian community with more than 80 nominations received.

The nominations were in three categories – Arts, Entrepreneurship and Education – and Professor Lu was the only individual winner. The others were the Sydney Symphony Orchestra (NSW) for showcasing Australian arts and creativity and

Bridestowe Estate (Tasmania) for promoting Tasmania as a destination for Chinese tourists.



Max Lu with Prime Minister Tony Abbott.



David Klingberg (second from left) and David Knox (third from right) preparing for Ride for a Reason.

PHOTO: COURTESY THE ADVERTISER

ATSE IN FOCUS

Jacques Miller Medal to Michael Cowley



Michael Cowley

The 2015 Inaugural Jacques Miller Medal for Experimental Biomedicine has been awarded to Professor Michael Cowley FTSE, an internationally recognised physiologist with a strong focus on developing drugs to treat obesity, diabetes and metabolic disorders.

Professor Cowley has discovered how the body informs the brain about how much body fat we have, and how much sugar there is in our blood. Through his understanding of these pathways in the brain he has devised new drugs to treat obesity, and he has recently discovered why obesity causes high blood pressure. He has received several awards for his research and now leads a global effort to find new diabetes drugs.

Professor Cowley returned to Australia in 2008 to take up the position of Director, Monash Obesity and Diabetes Institute (MODI), having received a 2008 Victorian Endowment for Science, Knowledge and Innovation (VESKI) Innovation Fellowship. In 2009 he won the Science Minister's Prize for Life Scientist of the Year.

Professor Cowley has more than 15 years' experience in research and biopharmaceutical drug development. Prior to joining MODI, Professor Cowley was the founder and Chief Scientific Officer of the biopharmaceutical firm Orexigen, which he took public in April 2007, raising US\$255 million to fund this drug development program.

NEW UWA CHAIR FOR MARK RANDOLPH

Western Australian Scientist of the Year for 2013, Professor Mark Randolph FRS FREng FAA FTSE, has been appointed Fugro Chair in Geotechnics at The University of Western Australia's Centre for Offshore Foundation Systems (COFS).

Professor Randolph has applied his geotechnical expertise to meet the scientific and engineering challenges of the offshore oil and gas industry over many years.

Professor Mark Cassidy FTSE, COFS Director, said Professor Randolph was an internationally regarded guru in offshore geotechnics.

"He is perfectly positioned to expose UWA to the world's most pressing geotechnical problems as faced by Fugro and their industry partners," he said.

"Together, UWA and Fugro will develop new solutions to building economic and safe platforms in our ocean environment."

An international company that specialises in the design of offshore foundations, Fugro will work with COFS to develop a sustainable research group, address key questions related to design and performance within the field of offshore geotechnics, and reduce risk and enhance engineering design within the offshore sector.

Professor Randolph's leadership has established Perth as an internationally recognised hub for excellence in geotechnical engineering and attracted many world-leading companies as well as academics. He has advanced the design of piled foundations, made important scientific advances through plasticity solutions and finite-element analysis of soil penetration problems, and developed novel techniques for offshore site investigation, including the difficult, little-studied and economically important foundation problems of calcareous materials off the Australian coast.



Mark Randolph

His work includes analysis, computations, experiments, the development of new software, and comparisons between results of these techniques and the observed behaviour of large offshore structures.

Professor Randolph founded the COFS in 1997. COFS is a major node of the Australian Research Council Centre of Excellence for Geotechnical Science and Engineering, of which Fugro is a Partner Organisation.

The Fugro partnership with UWA also provides funding for three PhD scholarships to facilitate the growth of high quality graduates in offshore geotechnics and engineering, with selected students offered the opportunity to work with Fugro.

VICTORIAN LEAD SCIENTIST GETS SWINBURN HONOUR

Swinburne University of Technology has awarded an honorary doctorate to Victorian Lead Scientist Ms Leonie Walsh FTSE, President of the Australasian Industrial Research Group.

Ms Walsh has extensive experience in management and commercialisation of research. Over a career spanning 25 years, she has worked both in Australia and internationally, building a reputation for driving strategic commercial improvements and innovation in the organisations in which she has worked.

Prior to her appointment to the Lead Scientist position, Ms Walsh worked for Visy Industries and South East Melbourne Water in Victoria, and internationally for Henkel and Dow Chemical.

She has led R&D groups with direct involvement in technical service, new product development, material sciences, characterisation and process research. She has also provided support to technology-based start-up companies.

Ms Walsh has a Bachelor of Science, a Graduate Diploma and a Master of Science in Applied Science from Swinburne. She was the keynote speaker at Swinburne's International Women's Day Breakfast in 2014.

"Ms Walsh is a prolific contributor to the public debate about the role of innovation and a passionate advocate for the role of women in science, technology and innovation," Swinburne Vice-Chancellor Professor Linda Kristjanson said.

ATSE IN FOCUS

Max Lay awarded EA's top medal

Engineers Australia has awarded Dr Max Lay AM FTSE its 2014 Peter Nicol Russell Medal, presented at the EA AGM in Melbourne in November.

The Peter Nicol Russell Memorial Medal – Career Achievement Award in Engineering



Max Lay

is the most prestigious award made by Engineers Australia. It is presented annually to an Honorary Fellow of Engineers Australia who has made a notable contribution to the science and/or practice of engineering in Australia.

The award perpetuates the memory of Sir Peter Nicol Russell, a Sydney industrialist during the latter half of the 19th century, who made major donations to the cause of engineering in Australia.

Dr Lay, Chair of the Infrastructure Forum, has been an ATSE Fellow since 1985. He is recognised world-wide as an expert in the fields of structural engineering, road and transport engineering and information technology.

His early career included positions with BHP, where he became an expert in the effects of welding on structural steel.

In 1975 Dr Lay was appointed the Executive Director of the Australian Road Research Board (ARRB) and over a 13-year period built the organisation into one of the world's leading road and traffic research organisations.

In 1988 he moved to VicRoads as Director of Quality and Technical Services and was responsible for the introduction of quality

management into the state's road authority as well as planning and design. In 1993 he was appointed Director of Major Projects, a role with responsibility for major road developments in Victoria, including the Eastern Freeway and the Western Ring Road.

Dr Lay joined consulting engineers SKM as the independent reviewer for the Melbourne City Link Project in 1996. This role had joint responsibilities to both the state and the City Link developer, Transurban, to provide advice and assurance on the design and construction of this massive privately financed and delivered public infrastructure project.

Dr Lay was Director of the Royal Automobile Club of Victoria and became Chairman in 1999. He is a past President of the Australian Automobile Association, Chairman of Intelematics Australia Pty Ltd and President of the Royal Society of Victoria (1995-96).

Dr Lay has been awarded many notable prizes including Engineers Australia's Transport Medal and Monash Prize, the Warren Medal and the Mossieff Medal of American Society of Civil Engineers. He served on the Victoria Division Committee of Engineers Australia for several years, including a term as Chairman, and was a National Councillor for some 15 years.

BRONWYN EVANS WINS EA PRESIDENT'S PRIZE

Dr Bronwyn Evans FTSE, CEO of Standards Australia, has been awarded the Engineers Australia 2014 President's Prize.

Dr Evans has more than 30 years' experience as an engineering executive in the areas of power generation, engineering education, Standards creation and medical devices. She was previously the Senior Vice President Quality, Clinical and Regulatory with Cochlear Ltd.

In 2013 she was named the Professional Engineer of the Year by the Sydney Division of Engineers Australia and in 2014 was recognised as one of Australia's 100 most influential engineers.

A passionate advocate for women in engineering, Dr Evans is chair of the advisory board for the Robogals schools program. She is also chair of EA's national board for the Centre for Engineering Leadership and Management and has overseen the creation of an Engineers Australia college – the College of Leadership and Management.

Dr Evans is also a director of the Warren Centre for Advanced Engineering and a member of the Dean's Industry Steering Committee at



Bronwyn Evans

the University of NSW. She has held positions as an independent non-executive director of John Holland, chair of the Medical Technology Association of Australia board and member of the University of Wollongong's School of Electrical, Computer and Telecommunications Engineering Advisory Board.

NEIL FOSTER JOINS EUROPEAN ACADEMY

Scientia Professor Neil Foster FTSE, from the University of NSW's School of Chemical Engineering, has been elected to the European Academy of Sciences and Arts. The European Academy of Sciences and Arts is a European

academic forum with 1500 members. It is a transnational, interdisciplinary body that works especially on European issues and tries to build solid bridges to unite Europe.

Among the academy's 1500 members are 29 Nobel Prize winners as well as Pope Benedict XVI. Professor Foster is one of only three Australians to be currently accorded this recognition.

Professor Foster has been invited to attend the Plenary Session where new members are inaugurated in March in Salzburg, Austria.



Neil Foster

ATSE IN FOCUS



Tam Sridhar

Tam Sridhar calls time

Professor Tam Sridhar AO FAA FTSE, Academic Vice-President (China and India) at Monash University and former Head of Chemical Engineering and Dean of Engineering, retired from the university at the end of last year.

Professor Sridhar, a Fellow for 20 years, was one of the university's longest-serving academics, first joining Monash to do his PhD in 1974.

After completing his PhD, Professor Sridhar took up a senior teaching fellowship at Monash for two years before joining the State University of New York at Buffalo, USA. He returned to Monash as a Senior Lecturer and was promoted to Reader five years later. In 1992 he was promoted to a professorial position within the Department of Chemical Engineering, and then became the Head of the Department.

He was Head for the next 11 years, a time of rapid development in research reputation and financial viability for the Department. His intense focus on recruiting the best students and staff became a hallmark of his leadership style. In 2003 Professor Sridhar was appointed Dean of the Faculty of Engineering and shortly after was awarded the title of Sir John Monash Distinguished Professor.

He also had the pivotal role in the establishment of the IITB–Monash Research Academy in Mumbai, which has now reached some 150 PhD students.

In 2013 Professor Sridhar accepted an offer of appointment to the role of Academic Vice-President (China and India) reflecting his leadership of the IITB–Monash Research Academy in India. He then led the establishment of the Joint Graduate School for Monash University in China.

Alongside his academic leadership, Professor Sridhar continued his distinguished academic career. He has an international reputation in the area of polymers/rheology.

He is an Honorary Fellow the Indian Institute of Chemical Engineers and was awarded its GP Kane Award. He won the ESSO Energy Award for his outstanding contribution to chemical engineering, is a Foreign Fellow of the Indian National Science Academy and in 2014 received the Medal of the Australian Society of Rheology and was also awarded the Chemeca Medal, the most prestigious award for Chemical Engineering in Australia and New Zealand.

"Through years of distinguished service in research, teaching, community service and leadership, he has contributed immensely to shaping the culture of excellence in both the Faculty of Engineering and the wider university," said Monash Vice-Chancellor Professor Margaret Gardner AO.

PETER COLEMAN TO CHAIR AKF

Mr Peter Coleman FTSE is the next Chair of the Australia–Korea Foundation, which encourages deeper people-to-people links between the two countries, including promoting the study of the Korean language by Australians and showcasing Australian excellence and innovation in Korea.

Perth-based, Mr Coleman is the Chief Executive Officer and Managing Director of Woodside – a company with long-term business links to Korea – an honorary Adjunct Professor in Corporate Strategy at the University of WA, an Ambassador for the WA Museum and a Commissioner of the WA Football Commission. He holds a MBA from Deakin University and a Bachelor of Engineering from Monash University.

He will serve in the role until 2019.

Announcing the appointment,

Foreign Affairs Minister Julie Bishop said the importance of the Australia–Korea relationship increased every year. Both countries were major regional players with strong economies, vibrant cultures and an enduring commitment to supporting peace and prosperity in our region.

The appointment came as the Korea–Australia Free Trade Agreement entered into force and New Colombo Plan students arrived in Korea, she said.

"Drawing on his extensive business links and impressive academic, sporting and cultural connections, Mr Coleman will promote opportunities for Australians in Korea, and continued engagement in the arts, sports, science and media in his new role," Minister Bishop said.

Professor Michael Manton FTSE, former ATSE Director and now Chair of the ATSE International Strategy Group, is an AKF Board member. He was Chief of the Bureau of Meteorology Research Centre from 1984 until his retirement in 2006 and is now a Professor in the School of Mathematical Sciences at Monash University.



Peter Coleman

ATSE IN FOCUS

MTAA awards Karen Reynolds

Professor Karen Reynolds FTSE, Director of the Medical Device Research Institute (MDRI) and Medical Device Partnering Program (MDPP) at Flinders University, Adelaide, has been awarded the 2014 Outstanding Achievement Award from the Medical Technology Association of Australia (MTAA).

The Award acknowledges an individual's significant and outstanding contribution to the Australian medical technology industry.

Professor Reynolds, Chair of ATSE's Health Technology Forum and an ATSE Director, is one of Australia's leading researchers in biomedical engineering. The award recognises her efforts to bridge the divide between research and industry, and the lead role she plays in the advancement of the medical technology industry within Australia.

"Her pragmatic and strategic leadership, her direct 'hands on' approach, and her openness and integrity have earned her great respect amongst the country's biomedical engineering and medical device community," according to MTAA.

In addition to her positions with Flinders University, Professor Reynolds is Chair of the College of Biomedical Engineers and a member of the Therapeutic Goods Administration's Advisory Committee on Medical Devices and the SA Premier's Science and Industry Council.

Professor Reynolds was named South Australian Scientist of the Year 2012 and awarded Australian Professional Engineer of the Year (2010). In 2013 and 2012 she was named one of Australia's 'Top 100 Most Influential Engineers' by Engineers Australia.

MEGAN CLARK LEAVES CSIRO TO JOIN RIO

Dr Megan Clark AC FTSE has joined the board of Rio Tinto as a non-executive director.

Dr Clark, the former CEO of CSIRO, who stepped down on 20 November, has had an extensive career in both the private and public sector in Australia, combining expertise in the metals and mining business with high-level experience in science, research and technology.

Dr Clark was awarded a BSc (Hons) in Economic Geology at the University of



Karen Reynolds

Western Australia in 1981 before earning a Doctorate in Economic Geology at Queen's University, Kingston, Ontario, in 1987.

She worked in an extensive range of roles for Western Mining Corporation, including mineral exploration, mine geology, research and development, and strategy, before joining NM Rothschild and Sons (Australia) as a director in venture capital and later joining BHP Billiton as Vice-President Technology in 2003. She was appointed Vice-President Health, Safety, Environment, Community and Sustainability with BHP Billiton in 2008.

Dr Clark is currently a member of the Australian advisory board to the Bank of America Merrill Lynch.

As head of CSIRO, Dr Clark has also held a number of influential advisory positions to the Government and the World Economic Forum on science, technology, innovation and research. She has been a member of the Australian Prime Minister's Science, Engineering and Innovation Council and the Prime Minister's Taskforce on Manufacturing. She is



Megan Clark

also a Commissioner on the International Commission on Sustainable Agriculture and Climate Change.

ANOTHER AWARD FOR MILTON HEARN

Professor Milton Hearn FTSE, from Monash University, has been selected as the American Chemical Society 2015 Awardee for the Alan S. Michaels Award, which will be conferred in Denver in March.

The Award recognises "outstanding research and practice contributions toward the advancement of science and technology for the recovery of biological products that has exceptionally significant impact".

He had earlier been named winner of the 2015 ACS Award in Chromatography.

The American Chemical Society (ACS), with more than 161,000 members, is the world's largest scientific society and one of the world's leading sources of authoritative scientific information. ACS has been at the forefront of the evolving worldwide chemical enterprise since 1876 and is now the premier professional society for chemists, chemical engineers and related professions around the globe.

Professor Hearn has previously received the Leighton Memorial Medal, the Green Chemistry Challenge Medal, the R.K. Murphy Medal, the Analytical Chemistry Medal, the Applied Research Medal and the H.G. Smith Medal, all from the Royal Australian Chemical Institute, as well as an Alexander von Humboldt Forschungspreis and numerous other national and international medals and awards for his pioneering work at the forefront of the separation sciences, analytical chemistry and biotechnology.

Professor Hearn is Professor of Chemistry, Associate Director – Green Chemical Futures – Industry, and Director of the Victorian Centre for Sustainable Chemical Manufacturing at Monash.



Milton Hearn

ATSE IN FOCUS

Graeme Clark shares Russ Prize in US



Graeme Clark

Australia's bionic ear pioneer, Laureate Professor Emeritus Graeme Clark AC FRS FAA FTSE, is a joint recipient of the prestigious 2015 Russ Prize, awarded by Ohio University and the US National Academy of Engineering.

The biennial Russ Prize recognises a bioengineering achievement in widespread use that significantly improves the human condition. The prize encourages collaboration between the engineering, medical and biological disciplines and professions.

Professor Clark is the first Australian to receive this prestigious award. It is further international recognition of the achievement of Professor Clark and his team at the University of Melbourne, which developed the first multi-channel cochlear implant in 1978.

The Russ Prize is the latest in a long list of awards Professor Clark has received over his distinguished career. In 2013 Professor Clark was awarded the Lasker De-Bakey Clinical Medical Research Award, in 2011 he was awarded the CSL Howard Florey Medal and in 2010 he received the Lister Medal.

Professor Clark shared the Russ Prize with four other cochlear pioneers – Blake

Wilson, Erwin Hochmair, Ingeborg Hochmair-Desoyer and Michael Merzenich.

Cochlear implants (CIs) are small electronic devices that provide a sense of sound to people with severe-to-profound sensorineural hearing loss. CIs comprise two parts: an externally worn audio processor, which picks up sound and codes it into signals, which are transmitted to the small, surgically implanted internal component. An electrode attached to the implant directly stimulates the auditory nerve and sends the signal to the brain where it is interpreted as sound. The CI is the most-used neural prosthesis developed to date. More than 320,000 hearing-impaired people have received CIs in one or both ears.

Professor Merzenich, a neuroscientist and professor of otolaryngology at the University of California at San Francisco (UCSF), established some of the neurophysiological underpinnings of present CI designs in 1971. Best known for his ground-breaking discoveries in multisite stimulation of CIs and neuroplasticity, Professor Merzenich, along with other CI contributors, paved the way to the Advanced Bionics cochlear prosthesis, which enabled greater access to and commercialisation of CIs.

Electrical engineers Ingeborg J. Hochmair-Desoyer and Erwin Hochmair, co-founders

of the leading global hearing implant manufacturer MED-EL Medical Electronics, GmbH, began their work on CIs as a team in the mid-1970s. Building on existing knowledge of the physiology of the auditory system, their engineering-based approach led to the world's first microelectronic multichannel CI, considered to be the prototype of modern CIs. The first two devices were implanted in December 1977 and March 1978. Open speech understanding without lip reading, via a small body-worn audio processor, was achieved in 1980. The Hochmairs went on to found MED-EL and have continued to bring cutting-edge hearing implant technologies to deaf and severely hearing-impaired people of all ages for the past 25 years.

At the same time, physician Graeme Clark, professor of otolaryngology at the University of Melbourne, was independently studying multi-site stimulation of the cochlea through the 'place coding' phenomenon, which routed particular speech sounds to different parts of the cochlea. Professor Clark was focused on designing an implant that would sit flawlessly against the cochlea to correctly stimulate nerve endings. He perfected his design in 1978 and not long after implanted his CI into a patient. This enabled him to discover how to select the best speech information for deaf adults and children, and later, in 1989, how bilateral implants could assist hearing speech in noise. He helped create global leader Cochlear Ltd, which has over 30 years provided implants to more than 250,000 patients.

In the late 1980s, engineer Blake Wilson, an adjunct professor at the Duke University departments of surgery, biomedical engineering and electrical and computer engineering, and co-director of the Duke Hearing Center, developed the 'continuous interleaved sampling' system. This model made it possible for CI recipients to understand words and sentences with greater clarity. His breakthrough provided the basis for sound-processing strategies used widely in today's CIs and resulted in a rapid expansion in the number of deaf and nearly deaf persons who have received a cochlear implant in one or both ears.

Professor Clark and his colleagues are the eighth recipients of the Russ Prize and will receive the award in Washington on 24 February.

ATSE IN FOCUS

David Singleton to head new EA College



David Singleton

Mr David Singleton FTSE, Deputy Chair of the ATSE Infrastructure Forum and former Arup director, has been appointed inaugural chair of Engineers Australia's newest college, the College of Leadership and Management.

The College is Engineers Australia's ninth, through which it will provide continuing professional development for members via regular conferences, publications and visiting speakers.

Mr Singleton is a member of the Swinburne University of Technology Board, a Director of Standards Australia Ltd and Chairman of the Infrastructure Sustainability Council of Australia. He worked with the global consultants Arup for 41 years, holding a series of global and regional leadership roles.

He was a Director of Arup Group Ltd, the global holding company, from 2001 to 2011 and was responsible for the strategic leadership of Arup globally.

"As a professional engineer whose career has morphed to a role in business leadership over the past 15 years, I am only too well aware of the need for the home that the new college will afford," Mr Singleton said.

"At present many professional engineers have found themselves to be disenfranchised and many have relinquished their membership of Engineers Australia. We hope to reconnect with many of these engineers during 2015."

With the addition of the College of Leadership and Management, the nine colleges broadly cover all areas of practice in engineering – biomedical, chemical, civil, electrical, environmental, ITEE, mechanical and structural.

Dr Bronwyn Evans FTSE, CEO of Standards

Australia and chair of the Centre for Engineering Leadership and Management (CELM), which has been working towards the establishment of the new college over the past two years, believes Mr Singleton will have a "significant impact" as chair of the college.

"David Singleton has extensive experience at the most senior level in industry, at the CEO and chairman level, and has been the chair of the Civil College, a national councillor of EA and is a member of the CELM board as well as the Transition Working Group," she said.

JOHN FRENEY KNOWN FOR SOIL RESEARCH

Dr John Freney FTSE, who died in Canberra in January, aged 85, was known nationally and internationally for his research into soil science.

A Fellow since 1986, he was a former Chief Research Scientist at the CSIRO Division of Plant Industry in Canberra and Senior Fellow at the University of Melbourne. After his retirement at 65 he continued his scientific work, mentoring scientists, editing books and presenting at international meetings – and was honoured with his Doctorate of Agricultural Science last August.

He was diagnosed with mesothelioma in October 2014.

Initially he researched the chemical nature and biological transformations of sulfur and nitrogen in soil, and the problems caused by too little sulfur in pasture soils. He then progressed to work on problems caused by too little nitrogen in agricultural soils or too much

nitrogen in the environment.

His research concentrated on the development of new techniques for assessing the transfer of gaseous nitrogen from fertiliser and animal excreta to the atmosphere, and on unravelling the fate of fertiliser nitrogen applied to bananas, cotton, maize, sunflowers, flooded rice, sugar cane and wheat in Australia, China, Indonesia, Malaysia, New Zealand and the Philippines.

This work included determining the factors controlling the emission of gaseous nitrogen compounds from plants, soils and water, and developing management practices to improve the efficiency of use of fertiliser nitrogen and reduce the deleterious effects of fertiliser on the environment.

Dr Freney was honoured by UNESCO's Scientific Committee on Problems of the Environment (SCOPE) when he was presented with a Lifetime Achievements Award at the presentation of the SCOPE–Zhongyu Environmental Awards for 2012, in Taiyuan, Shanxi Province, China.

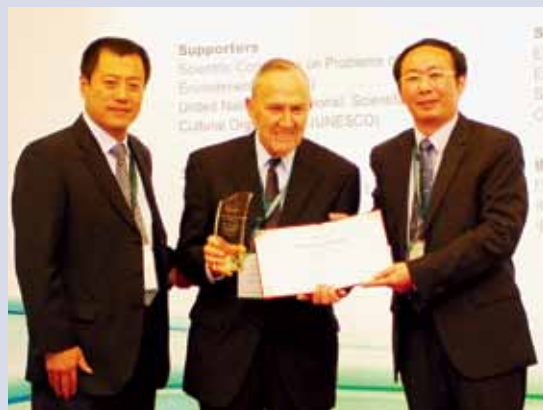
Dr Freney was honoured for his distinguished career as a research scientist and author of more than 240 authoritative scientific publications and, in particular, his pioneering work in developing our understanding of the role of agriculture in transforming the global nitrogen cycle, his decades-long active leadership in international science activities, and as an outstanding educator and academic leader.

The SCOPE–Zhongyu Environmental Awards recognise scientists who have made significant contributions and expert knowledge for regional and global syntheses, new research and policy approaches,

and solutions to emerging environmental problems.

Educated at the University of Queensland, Dr Freney spent more than 40 years with CSIRO and was a member of the International Soil Science Society, the Soil Science Society of America, the Australian Society of Soil Science, the Australian Society of Agronomy and the Australian Society of Sugar Cane Technologists.

He was awarded the Australian Society of Soil Science's Prescott Medal in 1985.



John Freney receives his 2012 award from (left) Mr Xiaochang Shan, President of Zhongyu Environmental Technology Corporation, and Dr Yonglong Lu, President of SCOPE.

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dream large



USING ALGAE TO FUEL THE WORLD

In the search for clean energy, microalgae may be one of our most important allies. Professor Ben Hankamer and his team from UQ's Institute for Molecular Bioscience are developing microalgae systems to produce renewable fuels for the future.

He has launched the Solar Bio-fuels Research Centre to test the most effective way of using green algae cells and photobioreactors to produce bio-fuels such as biodiesel, aviation fuels and hydrogen. If this process proves suitable to be replicated on a large-scale, it has the potential to help alleviate the world's constantly growing demand for fuel, food and clean water.

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