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ATSE

# FOCUS

# INFRASTRUCTURE FOR A BETTER AUSTRALIA

## WE NEED NEW INITIATIVES TO OPTIMISE OUR INFRASTRUCTURE

AUSTRALIAN ACADEMY OF TECHNOLOGY AND ENGINEERING

# CluniesRossAwards

## 2017 NOMINATIONS
## NEW FORMAT AND CATEGORIES
## CALL FOR NOMINATIONS

### Nominations for the 2017 Clunies Ross Awards close Friday 28 October 2016

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

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

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

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

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### CATEGORIES

The three award categories are:

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

**Clunies Ross Knowledge Commercialisation Award**
For those who have been responsible for a technology which has been commercialised, most likely by licensing, with a financially successful outcome.

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

### CRITERIA

The award criteria are:

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

AUSTRALIAN ACADEMY OF
TECHNOLOGY AND ENGINEERING

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**Front cover photo: We need new initiatives (Photo: iStock).**

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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API

The Australian Power Institute

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

## What is the API?

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

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

## Value Proposition

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

The key objectives of API are to achieve the following:

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

## Further Information

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BY DAVID SINGLETON
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# We need better decisions and long-term planning

**INFRASTRUCTURE FOR A BETTER AUSTRALIA** Australia's lack of transparency in infrastructure decision-making has often led to inefficiency and community distrust – and constrained informed debate.

The pace at which urban development is happening across the world in the 21st century is intense.

Highly concentrated demographic growth in cities is one of the greatest challenges that leaders face as they look to protect the future of their nations in the face of the global sustainability challenge.

There are few easy answers to the question 'What does it take to make cities better?', but many of the possible pathways to better cities are intrinsically linked to infrastructure provision.

Cities that make wise infrastructure investments have proven success at meeting future economic, environmental and social needs.

Improved understanding of the interactions between infrastructure provision, the needs and aspirations of the population served, and technology and sustainability both now and into the future are essential for our nation's prosperity.

In an Australian context, the combined population of Australia's capital cities will grow by nearly 16 million by 2061, and the proportion of Australians living in a capital city will significantly increase – from 66 per cent in 2011 to 69.3 per cent in 2031, and 73.4 per cent in 2061.

These 'medium' projections suggest that the population of Melbourne will grow to 8.6 million by 2061, Sydney to 8.5 million, Perth to 5.5 million and Brisbane to 4.8 million (see Figure 1).

The implications of this population growth for urban infrastructure needs will be significant.

As a consequence, Australia faces several difficult decades and must come to grips with a backlog of infrastructure investment that has been – and will continue to be – exacerbated by population growth, by increasing demand and by the impacts of climate change.

Australia's lack of transparency in infrastructure decision-making has often led to inefficiency and community distrust, and has constrained informed debate about the implied trade-offs: which projects, service outcomes, priorities, funding, and so on.

To get the greatest value from future infrastructure investments, leaders must think more strategically about how to plan, fund and implement these projects.

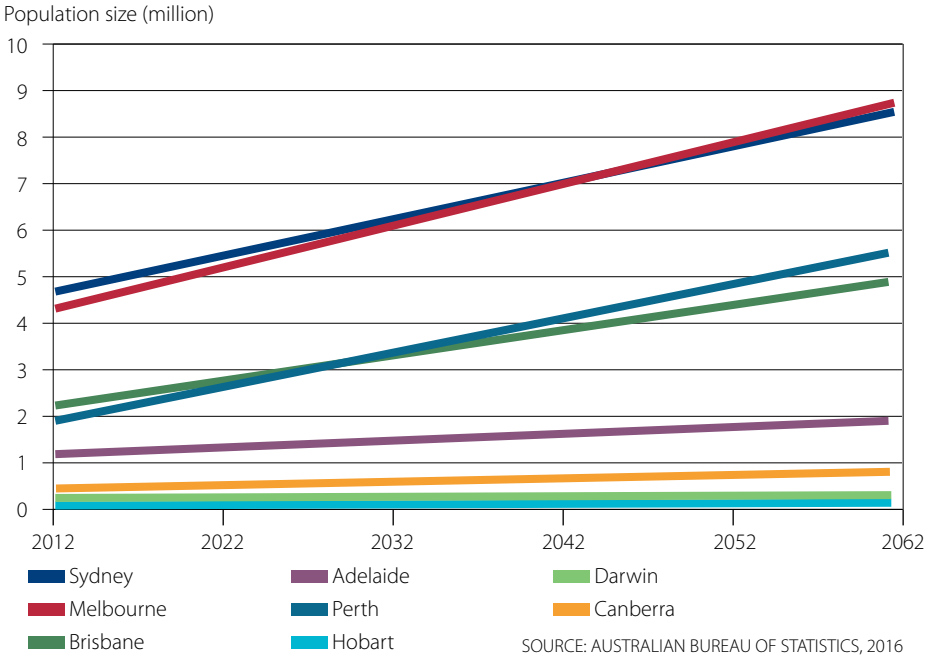
This could include:

- creating platforms to engage the public in discussions about investment decisions;
- creating greater transparency around spending;
- incorporating environmental and social issues into decision-making; and
- partnering with the private sector to find new sources of funding and design ideas.

Robust infrastructure planning would allow industry to develop effective delivery plans and better workforce management, particularly in engineering.

Economic, social and environmental benefits, such as jobs growth and creation, reduced demand through efficiency, equity of public and economic assets and reduced

**Figure 1 Population projections of Australia's capital cities**




SOURCE: AUSTRALIAN BUREAU OF STATISTICS, 2016

## WHAT IS A CITIZEN JURY?

The Victorian Department of Sustainability and Environment says:

"Citizen juries involve the wider community in the decision-making process. Participants are engaged as citizens with no formal alignments or allegiances rather than experts. Citizen juries use a representative sample of citizens (usually selected in a random or stratified manner) who are briefed in detail on the background and current thinking relating to a particular issue, and asked to discuss possible approaches, sometimes in a televised group.

"Citizen juries are intended to complement other forms of consultation rather than replace them. Citizens are asked to become jurors and make a judgement in the form of a report, as they would in legal juries. The issue they are asked to consider will be one that has an effect across the community and where a representative and democratic decision-making process is required.

"Citizen juries can be used to broker a conflict, or to provide a transparent and non-aligned viewpoint. Citizen jurors bring with them an intrinsic worth in the good sense and wisdom born of their own knowledge and personal experience. Citizen juries provide the opportunity to add to that knowledge and to exchange ideas with their fellow citizens."

greenhouse gas emissions, will accrue as a result of the development of sustainable long-term infrastructure.

Cooperation with communities and collaboration across sectors will result in speedier delivery of more successful high-quality infrastructure that accounts for the needs of all affected parties.

Governments will develop a citizen-jury approach for consulting with people, so that sound infrastructure decisions can be made.

When leaders take the time to learn from each other's successes and failures, infrastructure challenges can be overcome.

Achieving this will involve continuing to take advantage of the financial resources and innovation brought to the table by the private sector, as well as integrating community feedback into operations through ongoing engagement and stakeholder management.

Together, these strategies will help leaders to transition our nation for the future and will ensure that our cities can attract the investment and global talent that can enable their economies to grow. ⊙

*Mr David Singleton FTSE is a board chairman and non-executive director, a respected thought leader and expert adviser to governments and global businesses on resilient leadership and practice, specialising in infrastructure, business sustainability and climate change resilience. He 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 (2001–11 and was responsible for the strategic leadership of Arup globally. He chairs ATSE's Infrastructure Forum.*

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# Infrastructure for a warmer planet

**INFRASTRUCTURE FOR A BETTER AUSTRALIA** Australian governments should face the reality of the challenge and work with research institutes and professional bodies to implement a framework for design for a changing climate.

As we look ahead to developing infrastructure in Australia and in our Asia–Pacific region, we are faced with a challenge never before laid out so obviously to engineers, planners and scientists. While even the earliest of development-orientated civil servants recognised that designs needed to take account of climate variability, no era of development has laid out the challenge – that we 'know' that the planet's climate will be trending one way or the other in different regions.

How should and will governments, designers and those that set standards and regulations respond?

Pioneering infrastructure developers in Australia knew that climate variability meant both dry times and flood. Attempts were made to build dams that could cover the extremes of dry and to build townships on high enough ground to escape extremes of flood. Faced with little knowledge of the range of climate variability, not all such attempts were perfect.

In response though, over a couple of hundred years, collective wisdom of scientists and engineers developed knowledge of the range of extremes one might encounter and hence we developed design 'rules' associated with climate variability.

Flood analyses consider such aspects as 'the 100-year event' (more accurately described as the one per cent chance event every year) and bridge designers ensure such infrastructure is safely designed for more extreme events, such as the one-in-10,000-year event.

But these considerations flow to less dramatic but still important infrastructure and

*Infrastructure under pressure.*

ATSE

# Enhancing Australia's prosperity through technology and innovation

## The Australian Academy of Technology and Engineering (ATSE)

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

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

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

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

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*The reality is that climate loadings on infrastructure are changing and will change over the lifetime of infrastructure built today.*

climate interactions. Local council regulations will likely require drainage capacities to cater for a once-in-two-year event and coastal infrastructure may be designed to tolerate occasional inundation of combined tide level, storm set-up and rainfall occurrences.

These may cause inconvenience but, like the infrastructure itself, communities can tolerate an occasional inconvenience for the sake of economical design. However, if the warming planet exhibits a climate trend over the life of new coastal infrastructure of even slightly higher sea levels and slightly more severe storm events, occasional inconvenience will quickly become regular inundation and community frustration.

Hence we face the challenge not faced before. Knowing that the warming planet will be exhibiting a trend towards a different 'average' climate over the life of infrastructure built today or tomorrow, what should be the response?

- Design and build for the climate at the end of its lifetime but of course incur greater costs for the 'over design' in all earlier years?
- Design and build for some intermediate stage – on average – such that the risk of failure or inconvenience is the same over its lifetime?
- Or perhaps design now for an incremental build that can readily cater for upgrades in future stages as the planet warms over the lifetime of the infrastructure?

This is the challenge not before faced – and not currently being faced very well, in my opinion.

The response to date in Australia has been a mixture of accidental and inadvertent applications of the options.

Some authorities have set guidelines for sea-level rise based on an end-of-lifetime scenario, but not applied commensurate guidance on other climatic loadings. Most authorities have left it to designers (and therefore often the courts) to determine an appropriate response.

Meanwhile currently built infrastructure is likely to suffer from the warming climate and, without the planning and design for incremental build under the third option above, communities will be faced with increased inconvenience or risk or costs of remediation.

## LITTLE TAKE-UP

Some research institutions and professional bodies have outlined adaptation frameworks but as yet there appears little take-up at the state or national level for a holistic approach to this reality – the reality that the climate loadings on infrastructure are changing and will change over the lifetime of infrastructure built today.

All countries have this challenge but Australia and the Asia–Pacific region face it more acutely because of the massive coastline lengths, island states and high population densities in coastal regions.

With sometimes fragile infrastructure in developing countries, disaster risk management is particularly important and requires climate change considerations. If Australia can develop and implement a sound and positive response to the challenge, its professional service providers will be well placed to lead such work in the wider region.

What could or should be done? Governments at the state and national level should face the reality of the challenge and work with the various parties, such as the research institutes and professional bodies that have been working in this area of adaptation, to propose and then implement a framework for design for a changing climate.

The construction of such a guidance framework could use the body of knowledge developed to date by those parties and fairly quickly proposed a consultation draft. This would give reality to the issue and challenge and change an attitude in designers nationwide – from perhaps one of comfortable awareness of the warming planet and the institutes and other parties 'doing their thing' to perhaps one of striving to understand the climate and economic reality and ensuring that the national 'rules' of implementation are appropriate to the circumstances.

Personally, I'd be happy to see and accept whatever came from such a process. I have previously proposed a possible framework which might be one of many suitable approaches. It could include four phases of assessment.

**1 Determining environmental loadings over the design life of the infrastructure**

The major environmental loadings affecting most infrastructure will include water level (sea level and its response to storm factors – and flood level), wind, rainfall and waves. Individual designers should not be expected to make predictions but the body of knowledge is now well developed and with care and consideration updated sets of predictions could be made available by a suitable authority.

**2 Risk assessment in response to those changing loadings**

In most circumstances, design will not remove completely the likelihood of a performance failure. 'Failure' in this context could vary from the overflowing of a drain designed for a once-in-two-year event to collapse of a bridge in an extremely rare event. The consequence determines the risks. The objective is to select a design performance standard such that the exceedance probability over the project's life in the changing climate is as acceptable as it would be if the climate stayed the same. For some infrastructure, such as bridges, one may adopt a design standard such that it always meets the current design standard throughout its project life (a more conservative approach); whereas for projects of less risk, one may select a design standard

such that the design meets the current standard on average over its project life.

**3 Adaptation options development**

Perhaps considering such options as (a) build now for predicted scenario (b) planned adaptation measures (c) progressive *ad hoc* modification or (d) build to repair. The first and fourth options are reasonably straightforward: respectively, designing now for the predicted lifetime conditions or ignoring, after analysis and choice, the impacts of climate change on design. The latter case will come about when consequences and costs of repair are acceptable and lead to a lower whole of life cost. The former case will deliver a more resilient design for climate change and will be most appropriate when retrofitting adds substantially to present worth calculations of whole of life costs. Options (b) and (c) are only subtly different from each other and involve careful, and probably innovative, considerations of modifications that can occur to the design during its lifetime. The former 'bites the bullet' in determining what the upgrade program will be and designs now for that program, perhaps including some changes known to be required later. The latter is less defined but the analysis will have explored various design modifications possible and without committing to any one of them accepts that solutions will be possible and feasible at the time. One expects that the second option will be favoured over the third when it is apparent that any likely upgrade will necessitate some major and costly retrofitting exercise and could better be accommodated in the initial construction.

**4 Options assessment and decision by owners and stakeholders for the agreed adaptation approach**

Inputs and decision points within each phase would allow the risk-based approach to be tailored to the specific project and the specific location. Examples of these specific input factors are the time span of the design life, chosen climate change scenarios, the desired risk profile and cost analysis of outcomes of various adaptation methods. It is likely that innovation will play a role in developing preferred design approaches.

This approach shows the designing infrastructure for a warming planet can be disciplined but provide substantial scope for innovation.

In the current regulatory vacuum, the reality is not being faced and wasted opportunities will return to bite us in the form of costly and disruptive retrofits in future.

If governments were to adopt a more positive and progressive approach now, not only would it be an opportunity for Australia but we would demonstrate a service offering vital for the Asia–Pacific region. ⊙

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# We need to recognise the water-energy nexus

**INFRASTRUCTURE FOR A BETTER AUSTRALIA** The vulnerability of water and energy resources in an era of increasing demand, uncertainty and cost represents a critical business, security and environmental issue.

In Australian cities, water management directly and indirectly uses 13 per cent of Australia's electricity and 18 per cent of its natural gas, and collectively accounted for eight per cent of the country's primary energy use in 2007.

In Australia, and also globally, more than of 95 per cent of global energy production is dependent on the availability of fresh water. The many uses of water in energy production include cooling of thermoelectric plants, hydropower generation, fuel extraction and production, and fuel refining and processing.

The broad water-energy nexus is generally well established. Put simply, water is used to produce energy and energy is used to provide water-related services. The International Energy Agency (IEA) in 2012 reported water consumption ranging from 250 to 1400 litres per megawatt hour of electricity produced from fossil power plants. The volume of water utilised and returned, in an elevated temperature state, is much higher, at between 75,000 and 450,000 litres per MWh for the associated once-through cooling system of these power plants.

The vulnerability of water and energy resources in an era of increasing demand, increasing uncertainty in the reliability and cost of utilising the traditional sources of energy and water represents a critical business, security and environmental issue.

But the interconnection or cause-effect relationship between water and energy continues not to receive the public and policy attention that it should. This is largely due to our inability to provide a clear picture of this nexus at a range scales, from regional to the household, to enable appropriate policies and actions for sustainable and resilience outcomes.

Water and energy, and related cycles such as carbon and nutrients, are interconnected and therefore a change in one can cause a change in the other. Too often though, management of water resources and energy production continues as if they are separate and unrelated entities.

The urban water-energy nexus can be considered at three scales:

- the regional scale, where water is needed to produce energy and energy is needed to deliver water services;
- the consumer scale, at the nexus of water efficient and energy efficient appliances, and energy input in household hot water services; and
- the precinct scale, where opportunities exist for the use of district-scale energy generation, utilisation of waste heat for water disinfection and production of hot water, and energy production from biosolids from wastewater treatment plants.

## REGIONAL SCALE

At a regional scale, we will need to examine the emerging trends in the vulnerability of cities to 'limits on growth' scenarios for water resources and energy production. A recent IEA report notes that water is used in: power generation, primarily for cooling thermal power plants; in the extraction, transport and processing of fuels; and, increasingly, in irrigation to grow biomass feedstock crops.

The IEA's *World Energy Outlook 2012* found: *"that the scale of water use for energy production is tremendous. Some 580 billion cubic metres of freshwater are withdrawn for energy production every year. At about 15 per cent of the world's total water withdrawal, the figure is second only to agriculture. The vast majority of water used in the energy sector is for cooling at thermal power plants, as water is the most effective medium for carrying away its huge quantities of waste heat. Though the amount used for biofuels and fossil fuels may appear minor on a global level, this must be viewed in the context of local water resources and potential risks posed to water quality. Water withdrawal by the energy sector is expected to rise by one-fifth through 2035, while the amount consumed (not returned directly to the environment) increases by a more dramatic 85 per cent."*

As part of the climate mitigation discussion, the notion of 'cleaner' energy production associated with nuclear power plants has been put forward. This will further increase water consumption per MWh of electricity production by 30 to 40 per cent and increase risk of water contamination.

Regardless of the mode of electricity generation, power production in future will be increasingly vulnerable to climate change impact on water resources. New regional power plants previously located in close proximity to energy sources for production (for example, coal fields) may need to be sited in areas of greater abundance of water or use dry cooling, which cuts water consumption sharply but reduces plant efficiency.

Hydropower development, where water resources directly produce energy, must be increasingly cognisant of water constraints that occur naturally (through droughts, heatwaves or shifting weather

patterns), or are human-induced as a result of growing competition among hydropower's multiple operational objectives (irrigation supply, flood and drought management) or regulations that limit access to water.

On the other side of the nexus at the regional scale, energy is needed to deliver water services to consumers – water extraction and production, water treatment, water supply and distribution, and water recycling.

In Australia, less than 10 per cent of water-related energy consumption is at the utility, while in excess of 90 per cent is related to water used in homes, business and government.

Energy costs are typically the second largest operating cost (after labour) in western countries. Across Asia, energy costs can account for up to 70 per cent of the annual operating cost of water utilities. In most countries energy use and costs for water are anticipated to increase significantly as we shift to more energy-intensive water sources to accommodate expected increases in demand attributed to population growth. The impact of growth in the use of energy will be exacerbated by anticipated increases in the electricity prices. CSIRO forecast a growth of some 500 per cent in the energy costs of Australian urban water between 2010 and 2030.

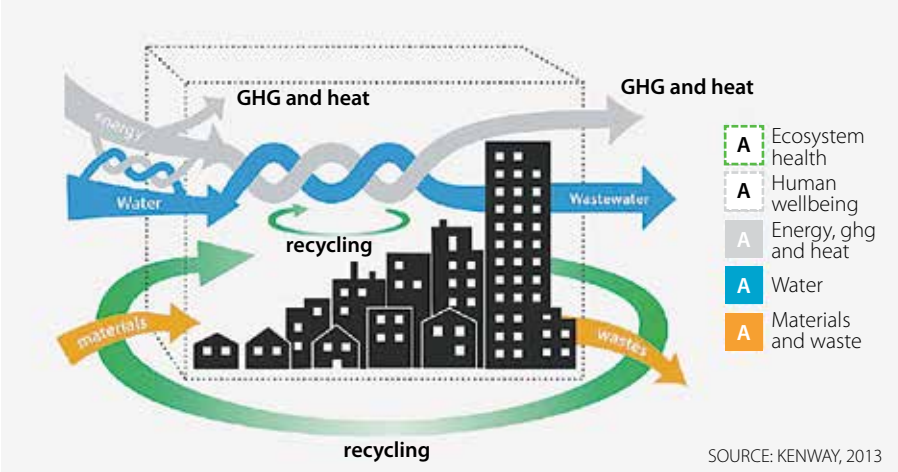
Many Australian utilities are working on a range of strategies such as replacement of inefficient assets, optimising water treatment and system management processes and generation of power from biosolids produced at wastewater treatment plants.

But a bigger gain in water and energy conservation is available at the point of end-use – in households, commercial and industrial enterprises. Most water-conservation initiatives reduce energy use.

Other water-related services with associated energy usage include flood protection and environmental clean-up associated with water pollution. An emerging approach to conceptualising the water and energy fluxes through a city is the use of an urban metabolism lens.

Simple accounting of water, energy and material inputs and outputs within a three-dimensional boundary helps city and infrastructure planners visualise the interconnections and interplay, and the energy implications of water management.

**Figure 1 The future paradigm: a framework for coordinated and more efficient urban performance management**




SOURCE: KENWAY, 2013

## CONSUMER SCALE

More than 90 per cent of water-related energy use in cities is at the consumer end of the water supply chain. Heating, cooling, pressurising and steaming water are all energy-intensive operations. At the residential level in particular, modeling by CRC for Water Sensitive Cities researchers has shown that water-related energy can account for more than half of household energy use (excluding transport) and one-third of household greenhouse gas (GHG) emissions.

Water use in showers, clothes-washer and bath sub-systems – and losses from hot water systems and pipes – comprised the major share of water-related energy use. The clothes-washer, dishwasher and electric kettle comprised the bulk of water-related GHG emissions. Production of hot water is typically the greatest household water-related energy consumption.

Consumer awareness and innovation in appliances hold the key to achieving greater energy conservation through consumer choices and behaviours linked to water conservation.

Scenario analysis suggests that occupant behaviour has a greater potential effect than technology changes, potentially accounting for between 47 to 72 per cent of water-related GHG emissions, comparable to the effect of installing a solar hot-water system.

## PRECINCT SCALE

District-level (or precinct-scale) water recycling, open space strategies for urban cooling, district-level power generation and precinct-scale integration of urban water services present significant opportunities to manage better key water-energy nexus issues.

A recent discussion paper issued by the CRC for Water Sensitive Cities noted that precinct-scale developments (in the case of this paper, the regeneration of Fishermans Bend in Melbourne) provide opportunities for "innovation in the design of the built environment, yet significant enough to materially reduce demands and reliance on currently stressed centralised energy, water and sewerage infrastructure systems."

Increased urban density often provides the financial business case for investment in innovation in urban water and energy services. These investments can come in many forms, ranging from architectural design for more water and energy-sensitive buildings, to open space design for urban heat mitigation,

to reuse of locally treated wastewater.

Each of these has direct and indirect positive impacts on both water and energy conservation and GHG emissions.

Many European cities have implemented district-level power generation to (a) meet greenhouse gas emissions goals and (b) accommodate increasing urban densities. These systems capture the waste heat from district-level electricity generation and pipe hot water to households. This also reduces the corresponding energy cost of hot water reticulation, owing to increased density of such precinct-scale urban development projects.

This removes the need for hot water (and air heating) within individual households and also greatly reduces the emission of waste heat to the environment. Probably the most obvious opportunity for harnessing the water-energy nexus relates to recent advancements in highly efficient heat-exchangers.

The importance of system design for sustainability and resilience that incorporates the water-energy nexus at a range of scales cannot be overstated.

As concluded in a March 2011 World Policy Institute paper: *"Competition for water among municipalities, farmers, industrial and power suppliers is already evident … In a world where water scarcity is a major and growing challenge, meeting future energy needs depends on water availability – and meeting water needs depends on wise energy policy decisions."*

The Australian Prime Minister's Science Engineering and Innovation Council drew a similar conclusion in 2010 noting that: "Resilient pathways will simultaneously reduce GHG emissions, lower overall water demand, maintain overall environmental quality and allow living standards to continue to improve". Strategies that achieve this will also improve productivity, efficiency and competitiveness of Australian systems.

The challenges associated with the vulnerability of water and energy, particularly in cities, can be addressed. They need proper consideration of the water-energy nexus and a socio-technical approach to solutions.

Finding solutions to the water-energy nexus will be increasingly relevant at the level of the Australian economy, as nations are globally benchmarked regarding their gross national product per unit of consumption of water and energy and greenhouse gas emissions.

Precinct-scale urban design and infrastructure planning present the potential 'sweet spot' for innovation, which exploits local-scale opportunities for harnessing the water-energy nexus. ⊙

*Professor Tony Wong FTSE is CEO of the Cooperative Research Centre for Water Sensitive Cities, which has research hubs in Brisbane, Melbourne, Perth and Singapore. He is internationally recognised for his research and practice in sustainable urban water management, particularly water-sensitive urban design. His expertise has been gained through national and international consulting, research, and academia. He has led a large number of award-winning urban design projects. He received the prestigious Sir John Holland Award as Australia's Civil Engineer of the Year in 2010, cited as having defined "a new paradigm for design of urban environments that blends creativity with technical and scientific rigour".*

*Dr Bruce Godfrey FTSE is CEO of Australian Scientific Instruments Pty Ltd and a Director of Wyld Group Pty Ltd. His career has focused on the advancement and commercialisation of technologies (particularly new energy technologies), investment readiness of products and companies, and innovation policy and programs. He has served on a number of AusIndustry and other government agency innovation funding and advisory committees, including as Chair of the Australian Renewable Energy Agency's Advisory Panel until mid-2014. He is a Member of AusIndustry's R&D Tax Incentive Committee. He is an ATSE Director and chairs its Energy Forum and is a Member of the Academy's Audit & Risk Committee.*

*Dr Steven Kenway is Research Group Leader, Water-Energy-Carbon at the University of Queensland. He is an Australian and Fulbright Research Fellow and International Water Association taskforce leader for the water-energy nexus and Steering Committee member for Future Cities. He has worked for CSIRO (Team Leader, Future Cities), Brisbane Water (Manager, Environment and Risk), Kellogg Brown and Root (Principal Environmental Scientist) and Sydney Water (Environmental Scientist). Steven's work focuses on the urban water cycle and related environmental management. His research areas include energy and greenhouse gas emissions, urban metabolism, and sustainability analysis, management and reporting. Dr Kenway has led diverse, national and international multidisciplinary and multi-agency research projects. These include conceptualising and leading an energy use analysis for urban water in Australia and New Zealand and modelling the water and energy futures for Melbourne.*

## ATSE NAMES KEY ASPECTS FOR INFRASTRUCTURE ROADMAP

ATSE has recommended to the Federal Government that the 2016 National Research Infrastructure Capability Roadmap should focus on: alignment with national research priorities; emphasising collaboration; capabilities rather than disciplines; and dealing with data.

ATSE made these recommendations in its submission to the 2016 National Research Infrastructure Capability Issues Paper, saying they would help ensure the capability areas were the right ones and that the areas for future development were appropriate.

ATSE said that funded projects should be complementary, rather than supplementary, to existing research infrastructure programs with strategic consideration of investment by government:

- in those areas where it was necessary in the context of national priorities, under specific programs and in the national strategic interest;
- where it could enhance collaborative research and development opportunities by Australian researchers and commerce;
- in areas where Australia was, or potentially could be, world-class in research and provided international leadership in research opportunities that would otherwise be too large or too complex for individual institutions to fund; and
- where there was a multidisciplinary context and national/international relevance.

To ensure the success of these projects ATSE highlighted that the establishment of access arrangements for a range of stakeholders was essential for each facility, noting that infrastructure must be accessible by all categories of researchers, including meritorious, commercial and international users, terms of access should be transparent, and the cost of access should not be prohibitive.

Critically, ongoing funding for operational expenses must be factored in to ensure operational stability and to remove barriers to access, it said.

ATSE also noted that pivotal to the 2016 Roadmap was the positioning of data access, storage and management.

BY HUGH BRADLOW
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PHOTO: ISTOCK

# What will cars be in 2030? What roads will we need?

**INFRASTRUCTURE FOR A BETTER AUSTRALIA** We should aim for a situation where, by 2030, no human is allowed to touch the controls of a vehicle on a public road in Australia.

The motor vehicles we drive today will be as foreign to our children as a horse and buggy look to us. They are being hit by a perfect storm of three different developments that will change their nature dramatically.

First, the mobile internet has spurred the notion of the vehicle as a shared, as opposed to exclusive, asset. Uber, GoGet, Car Next Door and Sidecar, for instance, are already encouraging people to change from owning a car to purchasing the service of a car.

Second, huge investment in battery technology will result in a rapidly declining price for electric drivetrain vehicles. It is anticipated that by 2022 electric vehicles will be cheaper than those powered by internal combustion engines.

Electric motors are easier to build and maintain than internal combustion engines as they have far fewer moving parts. The improved manufacturing and technology of batteries will make electric cars increasingly competitive from both a cost and range perspective.

It can be readily envisaged that by the end of the next decade no one will purchase new internal combustion motor vehicles (if they purchase a vehicle at all).

Third, autonomous vehicle technology is developing at a rapid pace.

We should aim for a situation where, by 2030, no human is allowed to touch the controls of a vehicle on a public road in Australia.

## THIS IS A GOOD IDEA FOR SEVERAL REASONS

### First and foremost it will save lives.

Every year approximately 1200 people die on Australia's roads. It is well known that about 94 per cent of road accidents are due to human error. If we (conservatively) assume that a fully automated road fleet would avoid 90 per cent of today's accidents, that is about 1000 needless deaths we could avoid each year.

### It will reduce hospital admissions.

In addition to the lives lost on the roads, every year road accidents cause approximately 50,000 people to suffer injuries serious enough to require hospitalisation. That figure represents almost 10 per cent of all hospitalisations due to injury. Again, making the conservative assumption of 90 per cent accident avoidance through full autonomy, we would prevent 45,000 hospitalisations injuries currently burdening our health system each year.

Some people dispute that 90 per cent of accidents will be avoided by a fully autonomous

Australian Government
Department of Industry, Innovation and Science

**Business**
Business Research and Innovation Initiative


# Business Research and Innovation Initiative

## *Inviting business proposals*

A new programme to provide small and medium sized businesses with up to $1 million to develop innovative solutions to policy and service delivery challenges is now open.

The **Business Research and Innovation Initiative** aims to increase SME participation in government procurement and to stimulate the commercialisation of new products and services.

SMEs are invited to submit proposals to address five specific challenges. The selected businesses will receive grants of up to $100,000 to complete a feasibility study of their proposed solution within three months.

Businesses that successfully complete a feasibility study are then eligible to apply for a further grant of up to $1 million to develop a proof of concept within 18 months.

Businesses will keep IP rights to their solutions for future worldwide sales.

**Applications close on 30 November 2016.**

For information on how to apply visit:

**business.gov.au/BRII**

fleet. In particular, the recent incident in which a Tesla in autopilot mode had a fatal accident is giving fuel to this fire. However, this argument is negated by a number of key points, the most important of which is that Tesla has already updated and corrected their autopilot software to prevent the same circumstances arising again. By contrast, human drivers have the same accidents over and over again.

### Road efficiency will be improved.

Autonomous vehicles will be able to occupy the road system much more efficiently because they can be coordinated through V2X (vehicle-to-vehicle, vehicle-to-infrastructure, vehicle-to-pedestrian) communications and the cars themselves react at machine speed. This will allow them to be packed more efficiently onto the roads.

Modelling road capacity requirements has shown that, despite a 2.5-fold increase in road demand between now and 2050, we would need no more road infrastructure in 2050 than we have today, due to a combination of technology developments including driverless cars.

Even more stark, the International Transport Forum of the OECD did a much more detailed model of Lisbon as an example of a typical mid-sized European city and found that a combination of shared autonomous vehicles (which they called 'taxibots') and mass transit would reduce road traffic at peak hour by more than 65 per cent.

### Capital requirements will decrease.

Besides road infrastructure, capital is also tied up in vehicles. The Lisbon study showed that their model of taxibot and mass transit would lead to a 10-fold reduction in vehicles on the road. In Australia, approximately a quarter of a trillion dollars is tied up in vehicle ownership, so a 90 per cent reduction would free up more than $200 billion of capital which could go into other areas of the economy.

### The environment will benefit.

A fully electric vehicle fleet will have an obvious impact on greenhouse gas emissions. In addition, environmental savings will also result from the fact that vehicles that don't crash can be built out of lighter and cheaper materials.

### Journeys will be delay-free and absolutely predictable, thereby saving additional 'buffer' time that is required to ensure arrival on time.

A world of fully autonomous vehicles will relegate congestion and stopping at intersections to the dustbowl of history. Furthermore it will open personalised transport options to individuals who are otherwise disadvantaged – the elderly, the disabled and children.

## IS IT POSSIBLE?

A fully autonomous vehicle fleet would have enormous beneficial impact on society. How soon is it possible? Is 2030 a realistic date? There are a number of reasons why it is achievable.

### Investment

Every major automotive manufacturer is investing in developing fully autonomous vehicles by early next decade. For instance, Ford has announced plans to release a fully driverless car without a steering wheel or pedals in the next five years.

In addition, the Silicon Valley giants (Google, Uber and possibly others) and a host of start-ups are investing in the technology for self-driving cars.

Industry sources estimate the venture capital and merger investment close to $1.5 billion over the past few years and dozens of deals have been done already.

While investment in itself is not a guarantee of an outcome it is usually an indication of the strength of belief of enough technologists that they can get the job done.

*The reasons for forbidding human drivers on public roads are compelling and the technology to make it possible is developing very rapidly.*

### Technology change

The technologies required to create an efficient vehicle are improving at an exponential rate. Essentially, four sets of technologies are required to create autonomous vehicles.

- sensors for situational awareness such as cameras with image recognition, radars, lidars and possibly microphones;
- augmented GPS and maps;
- vehicle-to-X communications; and
- machine learning and other algorithms.

To cite one example, the cost of lidars (which stands for 'light detection and ranging' and is a technology that measures distance by illuminating a target with a laser light) is falling dramatically. Lidars are an essential technology in that they enable accurate position and velocity detection for objects surrounding the autonomous vehicles.

A decade ago, lidars would have cost $80,000 apiece. In 2014, American company Velodyne (in which Ford has invested US$75 million) announced an $8000 lidar. However, even at that price lidars impose a hefty price impost on a vehicle, but a number of start-ups, including Quanergy and Sweep, have announced lidars in the $100 to $250 range. Recently Massachusetts Institute of Technology (MIT) reported that it had developed CMOS (complementary metal-oxide-semiconductor) lidar chips that it believes can be mass-produced for $10 per lidar.

Lidars will no longer be an expensive option for self-driving vehicles but a standard integral component.

The machine learning algorithms to drive the vehicles are also improving rapidly. As more data about driving behaviour is collected, the machine learning improves apace. For example, start-up Comma.ai has the novel idea of collecting driving behaviour data by providing incentives for human drivers to record their road activity on their smartphones. Comma.ai will use this data to train its algorithms.

### Existing vehicles

One reason why people believe it will take decades for all vehicles to become self-driving is because of the millions of existing vehicles that do not have the capability. The average age of cars in Australia is 10.1 years, which means that cars can hang around for about 20 years.

However, start-ups are already tackling

this problem because it represents a huge commercial opportunity. For example, Comma.ai claims it will have an after-market kit available at a cost of $1000 to convert existing vehicles to self-driving by the end of 2016. It claims its kit is compatible with any car that has electronic steering and electronic stability control. Another start-up, Cruise Automation, also developing after-market kits was acquired by General Motors in March 2016 for more than US$1 billion.

## Software versus human beings

There seems to be an almost mythical belief in the driving capabilities of human beings. For example, people assert "self-driving vehicles won't be able to execute the 40,000 lane changes that occur per hour on our freeways".

But the evidence indicates otherwise. Stanford University raced an autonomous car against a semi-professional human driver and beat him. Stanford believes that by 2030 self-driving cars will be capable of beating the best human Formula One drivers.

The reasons for forbidding human drivers on public roads are compelling.

The technology to make it possible is developing very rapidly and will most likely be ready in the first half of the 2020s.

Despite the significant disruption to their existing ways of doing business, Australian road authorities are embracing the change with enthusiasm. Their goal is to achieve a zero road toll and autonomous vehicles are the mechanism to achieve that goal.

They are already addressing the regulations required to manage the transition from today's world to tomorrow's driverless one. However, it needs to be recognised that human issues will be the main impediment to a fully autonomous road system.

A fully driverless world represents a massive disruption to vested interests – both of private individuals and substantial commercial entities.

Moving us to the new world as fast as possible represents a significant challenge politically.

*Professor Hugh Bradlow FTSE is Chief Scientist at Telstra Corporation in which capacity he acts as a 'forward scout', looking at the longer-term technology directions and technology disruption that will impact Telstra and its customers. He is also President Elect of ATSE. Before joining Telstra in September 1995, Professor Bradlow was Professor of Computer Engineering at the University of Wollongong in Australia and Professor of Electrical Engineering (Digital Systems) at the University of Cape Town. He is an Emeritus Professor of the University of Wollongong and a Professorial Fellow of the University of Melbourne and is globally recognised as a thought leader in telecommunications.*

# WLAN PIONEERS HONOURED AGAIN

Five 2010 Clunies Ross Award winners have been honoured again for their revolutionary 1992 CSIRO invention that led to the establishment of Wi-Fi.

Their invention has been chosen by the National Museum of Australia to be part of the *A History of the World in 100 Objects* exhibition, which opened in Canberra in September and runs until January 2017. The exhibition is a collaboration between the British Museum, the Western Australian Museum and the National Museum of Australia.

*A History of the World* in 100 Objects showcases items from around the globe to explore the past two million years of human history, sourcing the oldest objects from the British Museum's collection and incorporating those from the present day.

*CSIRO's WLAN team with the WLAN testbed (from left) Terry Percival, John Deane, Diet Ostry, Graham Daniels and John O'Sullivan.*

The National Museum chose to include a 101st object representing a globally recognised Australian innovation – the ground-breaking CSIRO wireless local area network (WLAN) test bed (the precursor to modern Wi-Fi).

In 1992, five researchers from CSIRO's then Radiophysics Division developed a technological breakthrough in advanced WLAN, which increased indoor wireless data transmission rates from 10 megabits per second to greater than 50 Mbits/s and prevented the distortion of the signal, as the radio waves bounced off walls and furniture.

The WLAN team was Dr John O'Sullivan FAA FTSE, Mr Graham Daniels, Dr Terence Percival AM FTSE, Mr Diethelm Ostry and Mr John Deane – all of whom won a 2010 Clunies Ross Award for their work.

National Museum senior curator Dr Michael Pickering said the WLAN invention was a fitting 101st object in the exhibition because it had revolutionised the way people all over the world communicate.

"CSIRO's practical solution for high-speed data transmission was a commercial success and laid the foundation for Wi-Fi, which in turn led to today's laptop and liberated users from the desktop computer," Dr Pickering said.

"The scientific discovery of Wi-Fi is a perfect example of how research undertaken right here in Australia, by CSIRO, is having a significant positive impact across the globe," said Mr Brendan Dalton, Chief Information Officer, CSIRO.

In 2011, CSIRO donated the four main hardware components used in the original WLAN prototype test-bed to the National Museum.

# WOMEN IN TECHNOLOGY

## Mary O'Kane wins Ada Lovelace Medal

Professor Mary O'Kane AC FTSE, the NSW Chief Scientist and Engineer, has won the inaugural Ada Lovelace Medal for an Outstanding Woman Engineer, a new national award that recognises the contribution Australian women have made to the profession and to wider society.

"Mary O'Kane has made an outstanding and lasting contribution to Australia through her intellect, tenacity and commitment, and through numerous and diverse roles over the past 30 years," said Professor Mark Hoffman FTSE, Dean of Faculty of Engineering at the University of New South Wales, which created the award.

"She has been involved in many fields: from her original specialisation of speech recognition and artificial intelligence, to stimulating Australian innovation, national energy policy, higher education, international development, computing and the fostering of young women and early career researchers," he added.

"Her career shows what a vital contribution women can make to engineering, and to the nation, and we hope many more women will be inspired by her example."

Dr Richard Sheldrake AM FTSE, a former Director-General of the NSW Department of Primary Industries, ATSE NSW Division Chair and one of the Professor O'Kane's nominators, said her "contributions have not only benefited the people of Australia, but also people in communities throughout the world. She is a remarkable Australian, and a truly worthy recipient of the Ada Lovelace Medal for an Outstanding Woman Engineer."

The Ada Lovelace Medal is named for Augusta Ada Byron, later Countess Ada Lovelace, an English mathematician who worked on Charles Babbage's revolutionary mechanical general-purpose computer, the Analytical Engine. Her remarkable notes on the engine in the 1840s include what is recognised today as the first computer algorithm, making her the world's first computer programmer.

Professor O'Kane said she was honoured to be recognised. "In my role, I have the privilege to meet and work alongside many wonderful women engineers, and witness first-hand the contribution they make across a diverse range of disciplines.

"That is why I am particularly humbled to receive the inaugural Ada Lovelace Medal from UNSW – a university that has been an exemplar in appointing women engineers to senior leadership positions, and fostering the next generation of women engineers through its first-class courses," said Professor O'Kane.

UNSW's Faculty of Engineering describes itself as the "powerhouse of engineering research in Australia, comprising of nine schools, 21 research centres and participating or leading 10 Cooperative Research Centres".


*Mark Hoffman and Mary O'Kane.*

UNSW says it is ranked in the world's top 50 engineering faculties, and is home to Australia's largest cohort of engineering undergraduate, postgraduate, domestic and international students.

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

## FIRST FEMALE SURVEYOR GENERAL NAMED

Ms Narelle Underwood has been appointed NSW Surveyor General – becoming the first female Surveyor General in Australia.

Acting Principal Surveyor at NSW Roads and Maritime Services, she is NSW's 25th Surveyor General since Augustus Alt was appointed to the position in 1787 before his arrival with the First Fleet.

Ms Underwood has worked as an adviser to the Board of Surveying and Spatial Information and Chair of the Surveying Mapping and Industry Council.

While studying at the University of NSW, she won the Dean's Award twice and the University Medal on graduation. She also contributed to the Surveying Student Society, serving as both treasurer and president and is currently a member of the School of Civil and Environmental Engineering Industry Advisory Committee.

*Narelle Underwood.*

She has won a total of nine industry awards for her innovation and commitment to quality outputs, including the Asia–Pacific Spatial Excellence Awards Young Professional of the Year in 2011.

She is currently working with two professional bodies on the NSW Surveying Task Force to encourage more graduates to consider a career in surveying.

"There is a severe shortage of Registered Land Surveyors in Australia so we're working to lifting the profile of the profession," she said.

"With technology changing so rapidly, we really don't know what will be happening in five or 110 years, what people will need and how data and information will be used. It's an open book, which makes this profession extremely exciting."

# WOMEN IN TECHNOLOGY

## Fellows drive Women in STEM agenda

Two ATSE Fellows contributed to an online discussion on Women in STEM on the Science Meets Business website in September.

Dr Mark Toner FTSE, Gender Equity Working Group Chair, contributed a thinkpiece on why women leave STEM careers. ATSE Vice President Professor Tanya Monro FAA FTSE, Deputy Vice Chancellor of Research and Innovation at the University of South Australia, focused on the need to build STEM skills.

Dr Toner asked why the subject of women in STEM was so important right now?

"To answer this, it might be useful to analyse the issue on two levels – national and personal.

At the national level, Australia needed far more young people taking up careers in STEM, he said.

"According to our Prime Minister, 75 per cent of our fastest-growing industries require skills in STEM. But women are greatly under-represented in this sector. Hence the Australian Government's new Women in STEM and Entrepreneurship grant program, which commits $8 million to encourage women to choose and develop a STEM career."

He noted ATSE's STELR Project and the SAGE program, in which ATSE is a partner with the Academy of Science, as examples of national programs aiming to increase the numbers of women in STEM. He also noted that the engineering profession had been slow to promote the excitement and opportunities for men and women who choose engineering careers.

At the personal level – women were just as ambitious and competent as men in STEM, he said.

### UNDER REPRESENTATION

"Their under-representation in the sector has a number of causes. An obvious one is that too few girls choose science and maths subjects at school, thereby preventing them from later choosing a career in STEM. But the sector also suffers from too many women leaving STEM careers early."

Research showed multiple reasons:

- hostility in the workplace;

*Mark Toner*

*Tanya Monro*

- isolation associated with being the only woman in a team;
- difference in work styles between men and women;
- inflexible and long working hours;
- lack of career advancement; and
- lack of self-confidence.

A current topic in the gender space was unconscious bias, Dr Toner said. "This is a less obvious reason for too few women in STEM and women leaving STEM careers.

"There is no doubt that women in academia and business suffer from people with both unintentional (unconscious) and deliberate (conscious) gender bias, and the common misunderstanding that unconscious bias training eliminates this bias is unfortunate.

"The reality is that such training is useful, but is only the first step to managers and staff members making less biased decisions about their people."

### BUILDING STEM STUDENT NUMBERS

Professor Monro said there had been a lot of talk about the need to get more students studying STEM skills to equip them for the jobs of tomorrow and that for Australia to have the right mix of high value jobs and industries to maintain or improve our quality of life, it needed more people with the digital and data-related skills that these jobs require.

"A natural assumption would be that the reason we need to encourage students to study science and other STEM skills is to boost our research clout – the cohort of technically trained people within Australia's university and publicly funded research laboratories," she said.

"While of course Australia's research capabilities are a pivotal element of our innovation ecosystem, this misses the point.

"In my view, the areas where we desperately need more graduates with STEM skills include industry, government, politics and the entrepreneurial domain.

"The ability to use complex data to make evidence-based decisions has never been more critical for decision-making – whether that be in the corporate boardroom, the executive suite, or the cabinet room.

"Most of the global challenges we face – from climate change to cyber crime – require a sophisticated understanding of STEM and basic STEM skills.

"Technology offers solutions to many emerging problems. But experience from the nuclear debate to genetically modified crops tells us that when communities aren't equipped with a good understanding of the scientific process and complexities behind these issues, it is extraordinarily difficult to secure the societal licence required to introduce transformative technological solutions.

"There are some STEM fields where we need to focus serious effort on getting more girls to engage – in particular, IT and engineering. Both areas are so critical to Australia's future that we simply can't afford to be building on half our talent base," she said.

"We can't afford to wait for more girls to select these traditionally male-dominated careers.

"We need to be proactive in creating pathways and incentives for girls to enter these fields. We also need to provide much better systems and cultures to retain our capable women in STEM and research."

# WOMEN IN TECHNOLOGY

## Two Fellows honoured in UNSW awards

**The inaugural Judy Raper Award for Leadership, made by the University of NSW, has been won by Ms Athena Venios, Technical and Group Director at the engineering firm AECOM.**

Named for University of Wollongong Deputy Vice-Chancellor (Research) Professor Judy Raper FTSE, the award honours the achievements of Ms Venios, who has worked on major projects in water and transport, holding leadership roles in transport and infrastructure programs for major sporting events, including the Sydney and Athens Olympic Games, the Melbourne Commonwealth Games and the Melbourne Grand Prix.

She founded and chaired the KBR Women's Professional Engagement group and has been vice-chair of Engineers Australia's Women in Engineering Sydney Division. She holds a bachelor's degree in civil engineering from UNSW.

"Athena's passion for excellence in engineering not only ensures that she excels in her work, but that she inspires all who come into contact with her," said Dr Alexandra Bannigan, Manager of the UNSW Women in Engineering program.

*Maria Skyllas-Kazakos*

UNSW has also inaugurated the **Maria Skyllas-Kazakos Young Professional Award for Outstanding Achievement**, which has been won by Monique Alfris, co-founder and director of Pollinate Energy.

Pollinate Energy is an award-winning, not-for-profit social enterprise founded in 2012 that provides access to affordable clean energy to improve the lives of poor people living in India's urban slums. Previously she worked to develop micro-financing in several Asian countries, and in a number of green building consultancy roles in Africa and Australia.

She has a bachelor's degree in photovoltaics and solar energy engineering from UNSW.

"Monique's work at Pollinate Energy has improved the livelihood of almost 60,000 people through the distribution of technologies such as solar lights, cook-stoves and water filters," said Professor Darren Bagnall, Head of the School of Photovoltaic and Renewable Energy Engineering at UNSW, one of her nominators. "Her passion to make a positive difference is only matched by her passion for the profession of engineering."

*Judy Raper*

The award is named for Emeritus Professor Maria Skyllas-Kazakos AM FTSE who is known worldwide as the scientific researcher and pioneer who is credited with the invention of the Vanadium Redox Battery. A chemical engineer, she won the 1998 Chemeca Medal.

## DEFENCE RESEARCHER TAKES AWARD

*Kayla Johnson*

Defence researcher Kayla Johnson has won the Best Young Scientist Award at the International Conference on Traffic and Transport Psychology (ICTTP), recognising her lead-author role in the multi-author paper 'Early morning high-dose caffeine mitigates driving performance decrements during sleep deprivation'.

Kayla's team, led by Defence researcher Dr Eugene Aidman, has studied cognitive fatigue and drowsiness countermeasures for more than 10 years and she has been instrumental in developing the team's sharply focused collaborative research program investigating cognitive fitness, its assessment and enhancement through tailored training, operator functional state monitoring and cognitive augmentation technologies.

The program has rapidly grown into a multi-partner international engagement involving a score of university and R&D industry stakeholders.

Chief Defence Scientist Dr Alex Zelinsky FTSE congratulated Kayla.

# ATSE IN ACTION

## Elizabeth Broderick is 2016 Orator

*Elizabeth Broderick*

**Former Sex Discrimination Commissioner Ms Elizabeth Broderick AO will be the Academy's 2016 Orator and will address the 2016 Oration Dinner in Melbourne at the Intercontinental Hotel on Friday 25 November.**

Ms Broderick is Chair of the Expert Advisory Group of the Science in Australia Gender Equity (SAGE) Initiative, in which ATSE is partnering with the Academy of Science, that will Champion the SAGE initiative and provide expert strategic and gender equity advice to ensure a successful implementation and evaluation of the SAGE Pilot program.

Ms Broderick was Sex Discrimination Commissioner from 2007 to 2015. She was also the Commissioner responsible for Age Discrimination from September 2007 until July 2011.

During her term, she was committed to improving gender equality through her advocacy in preventing violence against women and sexual harassment, improving lifetime economic security for women, balancing paid work and unpaid caring responsibilities, promoting women's representation in leadership and strengthening gender equality laws and agencies.

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

The dinner will also see the formal induction of the 2016 Fellows and officially mark ATSE's 40 years of technology advice for Australia.

The new Fellows will earlier in the day share highlights of their work and careers in brief presentations to Fellows following the Annual General Meeting, at the same venue.

Prior to the AGM, two of ATSE's topic forums will present seminars on Health Technology and Mineral Resources.

## SEVEN RESEARCHERS TAKE NEXT STEPS

Seven Australian researchers have been selected by an ATSE expert panel to participate in the 2016 Next Steps Initiative, receiving funding to support travel to China.

This program offers small travel grants, of up to $3600, and is open to the Australian Young Scientist Exchange Program (YSEP) participants who visited China in November 2015, as well as those who hosted Chinese YSEP participants in 2015.

The Australian researchers are all from Australian universities and are visiting Chinese academic institutions.

Dr Amir Karton, from the University of Western Australia (Nanjing University), Dr Georgios Konstantinou, from the University of New South Wales (Beijing Jiaotong University, University of the Chinese Academy of Sciences) and Dr Gunther Paul, Queensland University of Technology (Sun-Yat-Sen-University) visited China in September.

Dr Shan He, from Flinders University (Academy of Agricultural Science), Dr Travis Beddoe, from La Trobe University (Zhejiang University, Shanghai Jiao Tong University) and Dr Yanhua Luo, from UNSW (Harbin Engineering University) will visit China in December.

Dr Ruslan Puscasu, from the University of Queensland (Beijing General Research Institute of Mining and Metallurgy, Yunnan Diqing Non-ferrous Metals Industry Co [Chinalco]) will travel in early 2017.

## SIX KOREANS VISIT AUSTRALIA

Six Korean scientists visited Australia in August in an exchange program between the two countries organised by ATSE as part of the Australia–Korea Emerging Research Leaders Exchange Program.

They were in Australia for two weeks as part of a scheme which is targeted at mid-career researchers of both countries who are emerging leaders in the science and technology community.

The participants were: Dr Jeewoo Ryu, Korea Institute of Information Communication Engineering; Associate Professor Miyoung Lee, Kookmin University; Associate Professor See Hoon Lee, Chonbuk National University; Associate Professor Jong Mo Seo, Seoul National University; Professor Hyu Yong Park, Chonbuk National University; and Associate Professor Hyo Lee, Sangmyung University.

The first Exchange Program occurred in August 2014 with ATSE organising a two-week program for six Korean participants visiting Australia. In May 2015, six Australian researchers travelled to Korea.

Their study focus included cloud computing, mobile office environments, energy conversion, eyesight research, ageing populations and sport and exercise psychology.

The program is supported by the Australian Government through the Australia–Korea Foundation, Department of Foreign Affairs and Trade, and the National Research Foundation of Korea.

# ATSE IN ACTION

## ATSE argues against funding cut proposal

**ATSE argued against two legislative proposals in a submission to the Senate Economics Legislation Committee' Inquiry into Budget Savings (Omnibus) Bill 2016.**

The Bill sought to realise the savings from the 2014-15 Budget related to cuts to the Australian Renewable Energy Agency (ARENA) – a $1.3 billion cut that ATSE says would essentially abolish ARENA in its current form, moving it from being a grant-awarding agency to a debt and equity investor (via the Clean Energy Finance Corporation).

ATSE strongly urged the Senate to reconsider this change, noting that the types of projects supported by ARENA were generally earlier stage demonstration projects that would be unlikely to attract commercial financial support on a debt and equity basis alone.

ARENA played a critical role in ensuring that the R&D required to enable increased use of renewable energy in Australia was supported, ATSE said, urging the Senate and the Government to ensure ARENA continued this role by not proceeding with the proposed savings.

Second, ATSE noted, the Bill proposed reductions to the tax offset rate claimable under the Research & Development Tax Incentive.

"A review of the Incentive has recently been completed by the Chair of Innovation & Science Australia, the Chief Scientist and the Secretary of the Treasury, which included consultation with the research and innovation sectors," ATSE said.

"Given that the recommendations of this review for improving the Incentive to increase Australian innovation have not yet been released, nor responded to by Government, it would seem premature to make changes such as that proposed in the Bill.

"The Incentive is a vital component of Australia's innovation system, and ATSE strongly encourages the Senate to postpone any changes until after the review has been released."

The amended Bill was passed by both chambers in September, with a cut of $500 million to the ARENA budget, and the review was also released for comment.

## BASFORD LEADS CAETS TEAM

*Kaye Basford and Max Lu in London.*

ATSE Director and chair of its International Collaboration Strategic Leadership Group, Professor Kaye Basford FTSE, led the ATSE delegation to the annual CAETS Symposium in London in September.

Executive Manager Policy and Projects Dr Matt Wenham and Senior International Relations and Policy Officer Dr Carolyn O'Brien also attended, as well as Professor Max Lu FTSE (Vice-Chancellor at the University of Surrey).

Dr Marlene Kanga AM FTSE also attended in her capacity as President-elect for the World Federation of Engineering Organisations (WFEO).

ATSE has also nominated two young Australian engineers, Angela Rozali and Judd Harris, to attend the Young Engineers Leadership Day on 12 September in London, hosted by the Royal Academy of Engineering.

## BATTERHAM MEDAL WINNER CHOSEN

The Batterham Medal Selection Committee has chosen the 2016 winner of the Award, which will be presented at ATSE's Oration Dinner on 25 November in Melbourne.

The Batterham Medal is an early career award for a graduate engineer who has achieved substantial peer/industry recognition for his/her work in the past five years.

The award was more accessible to women engineers this year, making allowance for applicants who had taken career breaks for family or carer responsibilities.

The 2016 Selectiopn Committee was:

- Mr Richard Kell AM FTSE, Senior Consultant at Cardno and President (2003-05) of the International Federation of Consulting Engineers (chair);
- Professor Elanor Huntington, Dean of Engineering and Computer Science, Australian National University;
- Emeritus Professor Robin King FTSE, Former Pro-Vice-Chancellor for the Division of Information Technology, Engineering and the Environment at the University of South Australia;
- Mr Clive Weeks AO FTSE, former CEO and Chair of engineering consultancy GHD;
- Air Vice Marshal (Retd) Julie Hammer AM CSC FTSE, former RAAF electronic engineer and the first women to command an RAAF operational unit;
- Professor Karen Reynolds FTSE, ATSE Director, Chair of the Academy's Health Technology Forum, Professor of Biomedical Engineering at Flinders University, SA Scientist of the Year 2012 and Australian Professional Engineer of the Year 2010; and
- Ms Denise Goldsworthy FTSE, Chair of the Academy's Mineral Resources Forum, Principal of Alternate Futures, Chair of ChemCentre WA and 2010 Telstra Australian Businesswomen of the Year.

# ATSE IN ACTION

## STELR takes STEM to Bogor

**STELR will conduct a five-day STEM workshop in Bogor, Indonesia, at the end of October, following on from its inaugural Bogor workshop last October.**

*Participants at the 2015 workshop.*

The 2016 workshop will be held at the SEAMEO BIOTROP Centre for Tropical Biology from 31 October to 4 November, with an anticipated 50 participants, up from 35 teachers and trainers from eight South-East Asian countries last year.

The workshop will be conducted by Peter Pentland and Pennie Stoyles, who run the STELR project from the ATSE Office, Dr Greg Smith, STELR school mentor and lecturer in science education at Charles Darwin University, and Barbara Jensen from Southern Cross University.

The program will cover the following topics:

- what is STELR;
- teaching energy concepts;
- wind and solar energy activities;
- technology activities;
- STEM and inquiry-based science learning;
- global warming and oceans;
- sustainable housing and sustainability;
- maths activities for housing and renewable energy;
- water for the 21st century;
- car safety; and
- STELR resources and curriculum planning.

The program is organised by the SEAMEO Regional Centre for Quality Improvement of Teachers and Education Personnel (QITEP) in Science and the workshop will be opened by Dr Didik Suhardi, Secretary General of the Indonesian Ministry Education and Culture.

Orica has recently donated class sets of STELR Renewable Energy equipment to three schools in Bontang, East Kalimantan, and will sponsor six teachers from these schools to attend the workshop.

The South-East Asian Ministers of Education Organisation (SEAMEO) was established in 1965 as a chartered international organisation with the purpose of establishing cooperation in education, science, and culture in the South-East Asian region.

The SEAMEO Regional Centre for QITEP in Science has the vision to be the centre of excellence in professional development of teachers and education personnel in science towards sustainable development in South-East Asia. Its mission is to provide relevant and quality programs in professional development for science teachers and education personnel.

The QITEP in Science has translated STELR Renewable Energy curriculum materials into Indonesian and uses STELR Renewable Energy and Sustainable Housing equipment sets in its teacher training workshops.

## SA SCHOOL SCIENCE TEACHING AWARD

Mrs Kate Morgante, of Gleeson College, Golden Grove, in Adelaide's outer north-east, has won the South Australian Division's prize for high school science teaching for 2016.

The Division annually sponsors the prize, which is presented at the SA Grand Challenge for the Science and Engineering Challenge, a nationwide STEM outreach program by the University of Newcastle.

*SA Divison Chair Dr Meera Verma presents the award to Kate Morgante.*

## CAS-AAS-ATSE ANNUAL SYMPOSIUM

Advanced materials were the focus of the CAS-AAS-ATSE 2016 Annual Symposium, organised by the Chinese Academy of Sciences, the Academy of Science and ATSE, in September in Ningbo, China.

The Symposium covered three themes:

- advanced materials fundamentals – material properties, characterisation, modelling, theory;
- advanced materials research – nanomaterials, biomaterials, materials design, composites; and
- advanced materials industrial applications – polymers, metal alloys, energy and environment, advanced fibre composites, electronics and photonics, aerospace.

ATSE was represented by Interim President Professor Peter Gray FTSE, who presented with AAS President Dr Andrew Holmes FAA FTSE on advanced materials in the physical and biological sciences in Australia.

Professor Xinhua Wu, Director of the ARC Centre of Excellence for Design in Light Metals at Monash University, also attended. Professor Murray Scott FTSE (Chairman, Advanced Composite Structures Australia and former CEO, CRC for Advanced Composite Structures) was ATSE's representative on the planning committee for the Symposium.

# ATSE IN ACTION

## ATSE finalises REA report

**ATSE has completed its report for the Department of Education and Training (DET) on research engagement – the latest step in its campaign for better assessment of research impact and engagement.**

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

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

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

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

The report aims to help inform the Engagement and Impact Assessment development groups being run by DET and the Australian Research Council (ARC).

All 41 Australian universities participated, and ATSE used their ERA 2015 data, supplied by the ARC, to calculate the REA metrics for all universities across all disciplines.

ATSE also received additional data from 21 universities on their research extension and consulting income, which was used to conduct an assessment of the feasibility and impact of collecting this data on a wider scale.

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

## TRANSFORMING TOWARDS ZERO EMISSIONS

There is a race to the bottom that every advanced economy wants to win – the race to the zero-emissions world – according to Australia's Chief Scientist, Dr Alan Finkel AO FAA FTSE.

He addressed this challenge to a sell-out crowd of 130 at the NSW Division's Luncheon in the City event in August, asking if Australia had the capacity to be a player and what was the best strategy to achieve impact at scale.

He questioned how Australia and the world could transition to zero emissions, when coal was an increasing percentage of the global energy mix and renewables, while growing more quickly, currently made up just 12 per cent.

He noted that three proven technologies – wind, solar thermal and solar PV – had the lowest $CO_2$ emissions and were ripe for large-scale deployment. Prices were falling rapidly and were now comparable with fossil-fuel generation.

Storage, in the form of batteries, hydrogen, pumped hydro and biomass, were part of the solution, as were large-scale grid interconnects to smooth out intermittency, he said.

Dr Finkel reiterated that climate change was a serious challenge that could not be ignored and required a plan, and the high-level vision and strategy to carry it out. He noted that change on this scale could only be directed by governments, but private sector investments and visionary leadership was paramount.

*Richard Sheldrake (left), Alan Finkel, Martin Thomas, Peter Tyree and Richard Kell at the lunch.*

## SEVENTY-FOUR PRIMING GRANTS ANNOUNCED

A range of innovative, technology–business projects have been awarded in the first round of Priming Grants program of the Global Connections Fund.

The Priming Grants program is managed by ATSE as part of the Australian Government's Global Innovation Strategy funded under the Government's National Innovation and Science Agenda (NISA).

The 74 first-round grants were announced by Industry, Innovation and Science Minister Greg Hunt. Worth $7000, they support early stage international researcher–SME engagement in key industry priority areas: advanced manufacturing; food and agribusiness; medical technology and pharmaceuticals; mining equipment, technology and services; and oil, gas and energy resources.

The advanced manufacturing sector was awarded the highest percentage of grants (43 per cent) in this round.

While there was a wide spectrum of international partner engagements, those projects partnering with the EU, the US and China represented close to 80 per cent of all grants awarded.

The awards are available for review on the Global Connections Fund website.

Dr Margaret Hartley FTSE, Chief Executive Officer of ATSE, said: "It is a privilege to see so many diverse and unique projects underway in Australia. I don't think we give ourselves enough credit for the amount of innovative and creative activity that is going on across Australia and this is often not seen until it surfaces through a program like this. It bodes well for our creative future and the linking of our researchers and our business on a global scale."

The Global Connection Fund supports collaborative projects with 17 priority economies and forms part of the Global Innovation Strategy under the Australian Government's National Innovation and Science Agenda.

# NEWS

## Maths literacy "a concern for all"

**What happens outside the maths class is just as important in improving maths literacy as what happens in maths class, according to the Australian Council for Educational Research (ACER).**

It notes that achievement in mathematics has declined over the past 10 years, while engagement in science, technology, engineering and mathematics (STEM) subjects has also been declining.

"There is no doubt that our achievement level in mathematics is slipping," said Dr Sue Thomson, Director of Educational Monitoring and Research at ACER.

According to Program for International Student Assessment (PISA) results, the performance of 15-year-old Australian students in mathematical literacy has declined over the past decade.

"The results show both a decrease in the proportion of high-achieving students and an increase in the proportion of low-achieving students," Dr Thomson said.

The problem doesn't stop there. While Australian students studying maths are being outperformed by their international peers, many students are choosing to forgo maths altogether.

"Secondary school students are increasingly opting out of mathematics subjects that provide the knowledge base for tertiary degrees, thus closing down opportunities for employment and further study," said Professor Merrilyn Goos from the University of Queensland.

"Preliminary analysis suggests there are both whole-school factors and maths classroom factors influencing students' decisions to persist with higher-level mathematics beyond Year 10," she said.

"Whole-school factors that seem to matter are pastoral care and subject selection guidance, and early identification of mathematical capability and flexible placement of students in class groups that extend their capabilities, Professor Goos said.

"While mathematics teachers have an important role to play in encouraging aspirational mathematics subject choices, teachers of all subjects are responsible for developing their students' subject-specific numeracies."

## SCIENCE COUNCIL BACKS FOCUSED TEACHER PD

The Commonwealth Science Council has backed consideration of a requirement for discipline-specific professional development for teachers as part of the review of school funding.

The Council has also encouraged a greater subject-specific focus in teacher training.

At its fourth meeting in Canberra in September, the Council highlighted the important leadership role of school principals in providing comprehensive support for science and mathematics teaching in their schools.

The Council, chaired by the Prime Minister, is responsible for providing advice to the Prime Minister and other Ministers on important science and technology issues facing Australia.

It includes the Chief Scientist, Dr Alan Finkel AO FAA FTSE (Executive Officer), Dr Michael Chaney AO FTSE, Professor Ian Frazer AC FRS FAA FTSE, Mr David Knox FTSE, Ms Catherine Livingstone AO FAA FTSE and Professor Tanya Monro FAA FTSE.

Members noted that demand for STEM capabilities in the workforce is projected to strengthen across the economy and agreed the importance of recognising the role of STEM proficiency in current and future jobs, and the value of STEM graduates in an increasingly broad range of roles.

Members noted that the Government has already made great strides in positioning the education system to build this critical skill-base, but further opportunities for action remain, for governments as well as the Chief Scientist, the education sector and industry.

The Council acclaimed progress made in preparing the National Research Infrastructure Roadmap, which would be a valuable tool for Government and research stakeholders in reaching decisions on future financing and research directions.


*RV Investigator*

## *INVESTIGATOR* TO HOST CAPSTAN LEARNING

CSIRO will use its research vessel *RV Investigator* as a floating classroom to give students and trainers dedicated time onboard to expose them to a range of world-class scientific equipment and technology.

The postgraduate training initiative is called CAPSTAN – Collaborative Australian Postgraduate Sea Training Alliance Network – and will provide a collaborative national approach to teaching future generations of marine scientists and mariners.

The CAPSTAN program will complement other marine science education activities that CSIRO provides, including ship tours for students and a training program that will put secondary school teachers on board *RV Investigator* alongside scientists conducting marine research.

The first participants in the CAPSTAN program are expected to join a transit voyage on *RV Investigator* later next year. The CAPSTAN application process is expected to open in early 2017.

BY PETER PENTLAND, EXECUTIVE MANAGER ATSE SCHOOLS PROGRAM
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# STELR *is* STEM – and it's in more than 500 schools

**ATSE IN ACTION** Ideally, a STEM program should be 'taught' by a team of teachers offering expertise in science, mathematics and technologies (making things and coding things).

For the past few years STEM (science, technology, engineering and mathematics) has been 'flavour of the month' for education and business sectors, both in Australia and internationally. The Office of the Chief Scientist, in conjunction with the Australian Industry Group, released the STEM Program Index 2016, which lists 250 STEM programs across Australia.

Almost all these programs are extracurricular – unlike ATSE's STELR initiative (an acronym for Science and Technology Education Leveraging Relevance) – and have little impact on students' outcomes.

The national focus on STEM education is indicated by the fact that PwC, the multinational professional services network, has released two reports over the past two years on STEM education.

The first (April 2015) was *A Smart Move - Demand for STEM skills will generate the next wave of growth*.

Key findings of this report include:

- 44 per cent, or 5.1 million, current Australian jobs are at risk from digital disruption in 20 years;
- 75 per cent of the fast-growing occupations require STEM skills; and
- 70 per cent of Australian employers identify STEM employees as being the most innovative.

The second (March 2016) was *Making STEM a primary priority*, which recommends providing access to a specialist STEM teacher for every Australian primary school.

PwC has put its money where its mouth is with its 21st Century Minds Accelerator Program, which is supporting 20 existing STEM initiatives (including ATSE's STELR program) to develop business and marketing strategies.

## KEY QUESTIONS

**There are three key questions to address.**

### What is STEM?

Many state education jurisdictions have STEM initiatives. Victoria, for example, launched VicSTEM – STEM in the Education State in September. Queensland recently launched Advance Queensland – Engaging Queenslanders in Science, which aims to build teacher capacity and engage more students in STEM.

Other state initiatives include the South Australia STEM skills strategy and STEM NSW. The NSW initiative includes a program called iSTEM, which was developed in the Hunter Valley using, in part, the STELR renewable energy equipment packs. iSTEM is now being implemented in other states.

Many schools are calling themselves STEM schools but, in general, STEM programs do not rely on students being sufficiently exposed to science, mathematics and technology as they go through their regular schooling. They bring these areas of learning together in STEM classes.

### What does STEM look like in schools?

There are many different models for STEM in schools across Australia. Many schools are content to cover STEM through existing subjects. This approach does not integrate the learning areas and do not use contexts. Students are not shown how everything ties together.

In most cases, the way STEM programs are implemented comes down to the enthusiasm of one teacher and the areas of expertise of these teachers. Some schools have a STEM policy and whole-school ownership, setting up STEM rooms with 3D printers, laser cutters, drone sets and robotics kits. Some schools take existing programs and rebrand them as STEM. There is no overall STEM teaching template.

### Who 'owns' STEM in these schools?

It usually comes down to a STEM subject being taught by either the science or the technology departments. It is often offered to students as an elective subject. This raises the issue of ensuring that the elective encourages participation by girls and other underrepresented groups. I learned of one school that had more than 60 students enrolling in the STEM elective, but there were only three girls involved.

Ideally, a STEM program should be 'taught' by a team of teachers offering expertise in science, mathematics and technologies (making things and coding things).

This enables teaching through contexts or themes that are relevant to the students. It

## IN CASE YOU'VE FORGOTTEN

- STELR is the acronym for Science and Technology Education Leveraging Relevance.
- The STELR Project is ATSE's national school education initiative.
- The STELR architect was Dr Alan Finkel AO FAA FTSE, former ATSE President and now Chief Scientist of Australia.
- The STELR Project is running in more than 530 schools in all states and territories with 50,000 students and over 1500 teachers involved each year.
- To date, STELR has benefited more than 250,000 students.
- STELR is also operating in schools in South-East Asia and New Zealand.

opens opportunities to better engage students with mathematics by demonstrating the answer to the eternal student question, 'When are we ever going to use this?', while also giving due consideration for that other student question, 'Do we have to know this for the exam?'

By having a team of teachers, students will be able to cover traditional subject content but also be able to pursue their own inquiries. They can engage with design and engineering process by designing, making, testing, evaluating and modifying machines.

Students will also collect and analyse their own data, rather than just analysing meaningless sets of data given to them by the teacher.

Coding (and robotics) can easily be incorporated into STEM activities. For example, students can build and program a device that will allow STELR solar panels to track the sun, or make the STELR solar car follow a pathway around the school grounds.

## STELR IN STEM SCHOOLS

STELR produces interdisciplinary and problem-based modules that encourage deeper learning through real-world projects. It uses contexts that are relevant to the students' lives and concerns, for example climate change and sustainability.

Students work in authentic ways – through projects, plans and presentations that mirror what they will be required to do in their careers and in further learning.

Students are encouraged to work independently and collaboratively. They learn the way scientists do – by asking questions that lead them to discover solutions to authentic and complex problems.

STELR uses a hands-on, inquiry-based pedagogy. The STELR modules can be adapted to utilise in-demand technologies such as coding, robotics and data analysis.

STELR also provides career profiles via a range of media platforms that show students what is involved in STEM careers and the study pathways needed to enter these careers.

By participating in STELR classes, teachers and school leaders themselves are able to become STEM learners therefor become more effective in leading STEM programs.

## STELR IS BUILT ON FOUR PILLARS.

### 1 Relevance

STELR uses contexts that are relevant and engaging to students – such as climate change, renewable energy, sustainable housing and water in the 21st century – and also incorporates the cross-curriculum priorities of Australia's National Curriculum: Sustainability; Asia and Australia's engagement with Asia; and Aboriginal and Torres Strait Islander Histories and Cultures

STELR will run a STEM workshop for educators from South-East Asian countries in Indonesia in November this year. To help make STELR more relevant in all communities, an Indigenous writer has been employed to adapt STELR activities using the 'eight ways of learning for Indigenous students' model.

### 2 Curriculum

STELR is intended to be taught as a part of the regular school program rather than just being an extracurricular or elective program that appeals to the 'already converted'. To do this, it must be applicable to the national and individual state requirements. Teachers are shown how STELR activities apply to the science, mathematics, design and technology and digital technologies.

### 3 Pedagogy

STELR is inquiry-based and student-centred. STELR provides support and training, acknowledging that many teachers are teaching 'out-of-field'.

### 4 Equipment kits

STELR provides (sells) sets of purpose-built Australian-designed and manufactured equipment that are used to explore relevant technologies, such as: renewable energy; wind energy; solar cars; electricity and energy; and sustainable housing.

## iSTELR

STELR lessons are available in web-based format delivered by long-term partner Stile Education. The Stile content delivery system operates on all systems – iPad, Android, PC, smart phones and so on.

STELR provides the content including teacher support materials. Teachers are able to fully edit the content and activities to suit their class's needs and interests and their own expertise. They can also keep the up-to-date by embedding the latest news and discoveries.

iSTELR facilitates implementation of the 'flipped classroom' where students watch videos and complete assignments at home and then carry out higher-order cognitive tasks in the classroom.

Students can upload videos, photos and whole multimedia projects. Teachers can track student submissions and keep records.

## WHERE IS IT GOING?

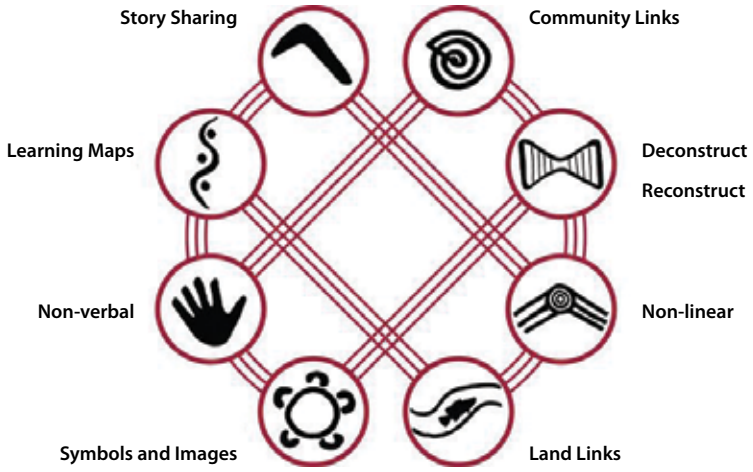
ATSE is in the process of producing more STELR modules that integrate science, mathematics, technology and engineering components.

We are working to provide more models for teachers of how they can turn maths and science lessons into technology and engineering projects. We are also going a step further to extend engineering and technology projects into entrepreneurship and social enterprises.

We are also producing more career profiles, especially of women in STEM and entrepreneurial role models.

• *Readers who wish to support the STELR project can contact Peter Pentland at ATSE (03 9864 0906, peter.pentland@atse.org.au).*

**The eight ways of learning for Indigenous students model.**



# NEWS

## Combining big solar and storage

**An innovative project in far north Queensland is set to combine big battery storage and big solar to supply solar power after sundown and during peak usage times.**

The Australian Renewable Energy Agency (ARENA) is providing $17.4 million funding support for Conergy to build and operate a 10.8 MW (AC) solar photovoltaic plant with 1.4 MW / 5.3 MWh of lithium-ion battery storage, near the town of Lakeland.

The project will be connected to the Ergon Energy network. A detailed battery testing plan will be implemented over the first two years of operations.

ARENA CEO Mr Ivor Frischknecht said ARENA had worked with Conergy to form a knowledge-sharing steering committee, joined by BHP Billiton, Ergon Energy and Origin Energy.

"Sharing these unique lessons is expected to accelerate similar developments across Australia," Mr Frischknecht said.

"BHP Billiton will gain valuable insights into the potential for solar and storage to assist its remote operations, Ergon is considering if the approach could help avoid network upgrade costs in other regional Queensland communities and Origin is buying the power from the plant."

"Figuring out how solar PV and battery storage technologies best work together at a large scale will be crucial for helping more renewables enter our grids," Mr Frischknecht said.

"We know that battery storage will play a critical role in our future energy systems. The benefit of adding batteries to solar farms is simple – they store energy from the sun for use at peak times and overnight. They can also smooth solar energy output on cloudy days.

He said the plant would generate and store enough renewable energy to power more than 3000 homes and create up to 60 jobs in the Lakeland region during construction.

Conergy, the project owner and developer, is one of the world's largest downstream solar companies, specialising in the development, design, finance, building and long-term asset management of commercial, industrial and utility-scale solar power systems. It has been involved in more than 300 projects globally in more than 15 countries.

*The Redbank Plains radar dome.*

## REDBANK PLAINS WEATHER RESEARCH RADAR SIGNS OFF

The Bureau of Meteorology is decommissioning its CP2 Research Radar at Redbank Plains near Brisbane.

The Redbank dome is a prominent feature in the Ipswich landscape, visible from Brisbane due to its elevated positon.

The CP2 Research Radar was originally a 1970s-era radar gifted by the National Centre for Atmospheric Research (NCAR) in the United States, which was upgraded to state of the art capability and installed at Redbank Plains in December 2006.

The radar was switched off late last year, and any reusable parts are now in the process of being packed for return shipping to NCAR as spare parts. The decommissioning of the radar will have no impact on community safety as it has been used for research rather than operational forecasting.

The Bureau says there will be no impact on its weather forecasting services for the area, with Southeast Queensland well-served by two weather watch radars – at Mount Stapylton, near Beenleigh, and at Marburg, west of Ipswich.

The CP in its title stands for cloud physics, and the Bureau says the facility has been used in collaborative hydrological and meteorological research within Australia to inform advances in science, and drive ongoing improvement in the weather forecasting and warning services delivered by the Bureau.

Australia has the fourth largest weather radar network in the world and the highest number of radars per capita – providing one of the most viewed and accessed services on the Bureau's website.

## CSIRO TECH IN ENERGY-MANAGEMENT SYSTEM

Renewable energy start-up Evergen has launched Australia's first intelligent home energy-management system, with the technical backing of CSIRO.

Combining solar panels and batteries with smart technology, the system continuously analyses and optimises home energy use, choosing the most efficient source for the household's electricity supply at any given time, switching from solar to stored power as required.

The system looks at the power consumption patterns of each household and local weather to make smart decisions that reduce energy costs.

The system is remotely managed by Evergen and regularly analysed and updated by CSIRO, which developed Evergen's core energy management intelligence and provided research expertise to help Evergen commercialise the product.

The Evergen system is now available to Australians in an early release program, with a second-stage release program in January 2017.

PICTURE: EVERGEN

*An Evergen system installed in a Sydney home.*

# NEWS

## Running the fleet on alternative energy

*(From left) Rear Admiral Mayer, Mr Hicks, Dr Pond and Mr Chris Tindal, Director for Operational Energy at the US Department of Navy, aboard the* USS Stethem.

**Alternative fuels and energy-efficient systems were key when the *USS Stethem* visited Sydney recently – driven by alternative fuel.**

Commander Australian Fleet, Rear Admiral Stuart Mayer, welcomed the ship and US Deputy Under Secretary of the Navy for Management, Mr Thomas Hicks, at an event onboard the destroyer. Alternate fuels pioneer Dr Susan Pond AM FTSE was also on board.

Rear Admiral Mayer said since Australia signed a statement of cooperation agreement with the US Navy in 2012, the Royal Australian Navy had progressed from testing one Seahawk helicopter on biofuels during Exercise RIMPAC in 2012, to three warships in 2016.

One of the US Navy's carrier strike groups now deploys on alternative fuels, including nuclear power for the carrier and a blend of advanced biofuel made from beef fat and traditional petroleum for its escort ships. *USS Stethem* is a part of that group.

## ARENA GRANTS PUSH SOLAR ENERGY TRIPLING

Twelve new large-scale solar photovoltaic (PV) plants are set to be constructed across Australia, tripling the amount of energy produced from big solar.

The 12 projects have been chosen as part of the Australian Renewable Energy Agency's (ARENA) multi-million-dollar large-scale solar round, which is tagged as Australian solar's brightest day.

ARENA's contribution of nearly $92 million is expected to unlock almost $1 billion of commercial investment and boost regional Australian economies.

"Six plants in Queensland, five plants in NSW and one plant in Western Australia are slated for funding, in a major milestone that's expected to triple Australia's large-scale solar capacity from 240 MW to 720 MW," said ARENA CEO Mr Ivor Frischknecht.

"They will provide enough energy to power 150,000 average Australian homes and deliver one-tenth of the new capacity required to meet Australia's 2020 renewable energy target.

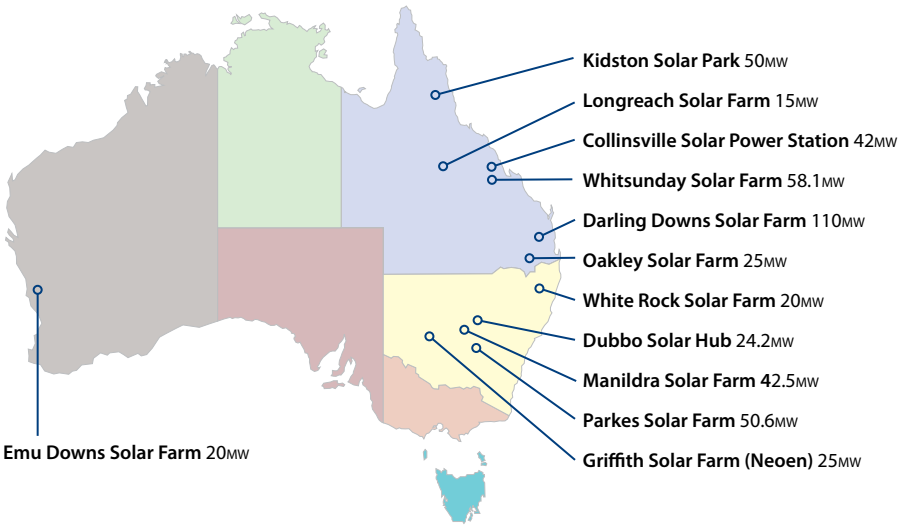
"Regional economies will benefit massively from the growing big solar industry, with 2300 direct jobs and thousands more indirect jobs expected to be created by this round.

"Australia's big solar revolution is tantalisingly close and, as more home-grown businesses step up to provide construction, engineering and financial services, this newest tranche of ARENA-supported projects is well positioned to take the sector even closer to commerciality," he said.

### New arena solar projects

| Applicant | Project name | Size (MW AC) | ARENA funding | Project cost |
|---|---|---|---|---|
| Origin Energy | Darling Downs Solar Farm | 110.0 | $20 m | $216.7 m |
| Edify Energy with Solar Choice | Whitsunday Solar Farm | 58.1 | $9.5 m | $122.4 m |
| Neoen Australia | Parkes Solar Farm | 50.6 | $7.5 m | $107.9 m |
| Genex Power | Kidston Solar Farm | 50.0 | $8.9 m | $126.2 m |
| Manildra Solar Farm | Manildra Solar Farm | 42.5 | $10.9 m | $109.3 m |
| RATCH Australia Corporation | Collinsville Solar Power Station | 42.0 | $9.5 m | $95.9 m |
| Neoen Australia | Griffith Solar Farm | 25.0 | $5.0 m | $54.6 m |
| Canadian Solar (Australia) | Oakey Solar Farm | 25.0 | $2.2 m | $47.5 m |
| Neoen Australia | Dubbo Solar Farm | 24.2 | $5.5 m | $55.6 m |
| APT Pipeline (APA Group) | Emu Downs Solar Farm | 20.0 | $5.5 m | $47.2 m |
| Goldwind Australia | White Rock Solar Farm | 20.0 | $6.0 m | $44.5 m |
| Canadian Solar (Australia) | Longreach Solar Farm | 15.0 | $1.3 m | $28.7 m |
| TOTAL | | 482.0 | $91.7 m | $1,056.4 m |

### Twelve new ARENA-funded Australian solar projects.



BY TOM BIEGLER
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# Energy and climate politics: a sceptical scientist's view

**OPINION** Renewable technologies feature in all plans to cut emissions. Can they deliver? Cost, reliability and scale are important issues for the feasibility of these plans.

PHOTO: ISTOCK

*Expect significant electrification of smaller vehicles.*

Economics, not science, will dominate the future political debate about climate change. The reason is simple – the science is more certain than the economics.

Scientific knowledge about carbon dioxide as a greenhouse gas has a long and respectable history. The 43 per cent increase in atmospheric $CO_2$ caused by burning fossil fuels since the industrial revolution is undisputed. There may be some doubts about the precise impact but the prudent course, at the very least, is to accept that $CO_2$ emissions affect climate and try to lower them.

The economics of reducing emissions is more contentious. Take one example – the 10-year roadmap produced in 2010 by Zero Carbon Australia for 100 per cent renewable energy by the year 2020, which is far more ambitious than any current Australian policy.

The move towards an all-electric economy powered by zero-emission renewables, ZCA said, would be cheap, easy and painless. The impression, as with many similar proposals over recent years, was that we need only 'bite the bullet' about supporting renewable technologies, correct our wasteful energy habits and summon enough political will.

At the other extreme are opinions like that of prominent political journalist Greg Sheridan. Treasury models predicting a cost to GDP of only 0.1 per cent per annum for cutting emissions, he wrote, were "based on insane assumptions about the economic worth of technologies which had not yet been invented". There was "a widespread pattern of a disinclination by Western political leaders to tell their electorates (that) a low carbon economy would come at a massive cost to their living standards".

Where does the truth lie? In 2014 wind and solar accounted for six per cent of our electricity and less than one per cent of total energy. So, at the 40 per cent mark the ZCA trajectory did look very optimistic. Maybe Sheridan was right.

The first step in making these judgements is to recognise energy's key role in creating wealth. It's like a huge lever, enabled by science, invention and engineering, and multiplying the productivity of human effort alone.

All goods and services depend on energy. GDP is quantitatively related to energy usage. The ratio of GDP to energy, called energy productivity (or its reciprocal, energy intensity), defines the connection.

In 2013 the global average energy productivity, in terms of US dollars (2005, at purchasing power parity), was around $150/GJ (gigajoule, primary energy). Australia's energy productivity was $165/GJ. Within 34 OECD nations (the 35th, Latvia, joined later, in 2016) it was somewhat higher, $180/GJ. There has also been a global pattern of slowly rising energy productivity.

Living standards tend to track energy usage closely. For example the 2013 GDPs of 21 OECD members, accounting for 80 per cent of total OECD output, all fitted the relation GDP = $(180 ± 45)/GJ. Some economies, like Ireland and Switzerland, did better than this ±25 per cent spread, with nearly double the $180/GJ average. These economies are often seen as beacons for reducing energy consumption through improved efficiency. But they may well be 'free riders' relying on energy intensive industries elsewhere.

The message from this consistent linkage is that the avenues for reducing energy consumption are limited. An economy might raise its energy productivity by closing some heavy industries but that probably just shifts the energy burden elsewhere. As for efficiency in personal or household energy consumption, most (more than 90 per cent) of the energy we account for goes into the goods, services, infrastructure and so on that we consume or rely on, not just the kilowatt-hours or megajoules listed on our household energy bills.

Renewable technologies feature in all plans to cut emissions. Can they deliver? Cost, reliability and scale are important issues for the feasibility of these plans.

**Solar and wind technologies** are advancing technically but still need government support. They are low intensity and intermittent. For continuity they require some form of electrical or thermal storage, adding to costs. Prices of some components like solar photovoltaic panels and lithium batteries have been falling, but optimistic projections

of renewable energy costs and of feasibility at utility scale still smack of wishful thinking.

**Geothermal and carbon capture and storage technologies** have also been prominent in future energy scenarios. Here, too, I believe that expectations have been unrealistic. They are not commercially proven and their remaining technical risks are significant, especially the challenges of managing large-scale process technologies deep underground.

As for **transportation**, expect oil to be displaced by significant electrification of smaller vehicles powered by rechargeable batteries. Larger 'muscle cars' like Tesla don't really fit with a constrained energy future and, though now successful, will be seen as an aberration.

For **heavy transport, industrial machinery, aircraft** and so on, battery power remains problematic. Forget overhyped hydrogen as a replacement fuel – over its full life cycle it's too inefficient. Biofuels will be limited by land usage concerns.

In the bigger picture energy is more than just electricity. For many major energy uses, like cement production and metallurgical processing, switching from fossil fuels to electricity will be challenging. And of course every success will further add to the electricity demand from low-emission sources.

An important fundamental issue known as energy return on investment (EROI) is receiving increasing attention from economists. EROI is a simple concept when applied to traditional fuels like oil. It compares the energy contained in a barrel of oil with the energy used in finding, extracting and refining it. Oil historically has an EROI of around 30 but as expected this has been decreasing as grades decline and extraction requires more effort.

But how does one determine the EROI for, say, a complete solar photovoltaic energy system? What is the break-even figure for a system EROI to be economically worthwhile and sustainable? Which energy technologies qualify? An EROI of unity is obviously the barest minimum but figures of five and higher have been postulated as the lowest values that would allow modern economies to run sustainably.

These are complex and contentious matters. They deserve a mention here as I believe that ultimately they will be critical for energy policy.

It seems clear that future electricity will come from a portfolio of lower-emission technologies. Gas, with half the emissions of coal, will increase in importance, at least as an interim measure.

Energy costs will rise. As further electrification of industry and transport, combined with increased prosperity, bring even greater demand for electricity, it is difficult to see how climate and economic concerns can be met without nuclear power. Arguably the biggest energy policy challenge Australia faces is the electorate's antipathy towards this low-emission source, commonplace in much of the world.

The politics of higher energy costs flowing through the economy and affecting economic wellbeing will be sensitive. Will the economic burden be 'massive' (Sheridan) or trivial (Treasury)?

Governments like to believe that investing more in energy and related research will provide all the answers. Their (selective) faith in research is, to a scientist, touching – but research does not always translate to success.

Energy technologies seem peculiarly subject to waves of uncritical optimism. A degree of scepticism is important for sound energy policy.

I have selfishly concentrated on our own prosperity, ignoring the economic aspirations of developing economies. They are being asked to give up cheap fossil fuels and make sacrifices far beyond anything here. Not surprisingly, they are resisting.

As Professor Ross Garnaut said at the start of his trailblazing 2008 review on the subject, "Climate change is a diabolical policy problem". It is indeed.

*Wheel casting made out of lightweight magnesium metal.*

*Dr Tom Biegler FTSE was the author of the 2009 ATSE report titled* The hidden costs of electricity: externalities of power generation in Australia. *A former research chemist, he was a divisional head in CSIRO's Institute of Minerals, Energy and Construction and later managed CSIRO's Corporate Business department. Since retiring from CSIRO he has been consulting and writing on fuel cells, hydrogen and other energy technology issues.*

## SAVINGS IN NEW MAGNESIUM TECHNOLOGY

CSIRO and Enirgi Group have joined forces to develop and commercialise an affordable and low-emission technology for producing magnesium metal.

The CSIRO-developed technology, known as MagSonic, produces magnesium using up to 80 per cent less energy and producing up to 60 per cent less carbon dioxide emissions, thanks to a supersonic nozzle.

Magnesium is the lightest of all metals and is in rising demand from car manufacturers who are turning to the metal as a solution for making lightweight, low-emission vehicles.

Dr Mark Cooksey, who leads CSIRO's sustainable process engineering group, said commercialisation of MagSonic would help take advantage of Australia's abundant reserves of magnesite ore that remain largely untapped.

"The growth of magnesium use has been limited because it's been too expensive and labour-intensive to produce the metal from ore using traditional processes," Dr Cooksey said.

"Our MagSonic technology offers an economically viable solution to overcome these issues and make clean magnesium more available and affordable to manufacturers."

MagSonic uses carbothermal reduction and a supersonic nozzle to efficiently produce high-quality magnesium. It involves heating magnesia with carbon to extreme temperatures to produce magnesium vapour and carbon monoxide. The vapour and carbon monoxide are passed through a supersonic nozzle – similar to a rocket engine – at four times the speed of sound to cool the gases in milliseconds, condensing and solidifying the magnesium vapour to magnesium metal.

*Enirgi Group is a privately held international specialty chemicals and diversified industrials company with six unique divisions. Enirgi's Innovation Division specialises in industrial engineering technology and has a track record of delivering transformative solutions. Enirgi Group has the option to take up an exclusive global licence that would see the company initially build a commercial-scale magnesium production facility in Australia.*

# NEWS

## Doubling battery power for cars, phones

**A Massachusetts Institute of Technology (MIT) spin-out is preparing to commercialise a rechargable lithium metal battery that offers double the energy capacity of the lithium ion batteries that power many of today's consumer electronics.**

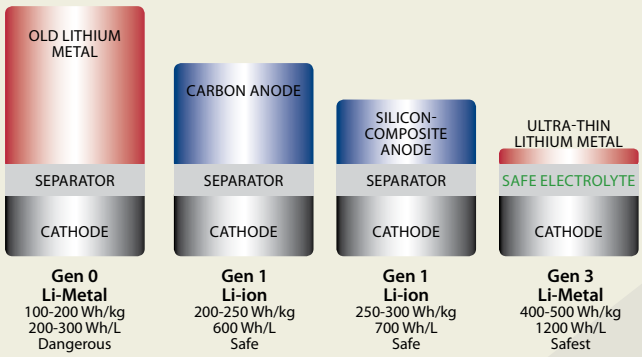
This means smartphone batteries that last twice as long and electric cars that go twice as far – for the same battery weight.

MIT News Office says SolidEnergy Systems, founded in 2012 by MIT alumnus Dr Qichao Hu, has developed an "anode-free" lithium metal battery with several material advances that make it twice as energy-dense, yet just as safe and long-lasting as the lithium ion batteries used in smartphones, electric cars, wearables, drones and other devices.

"With two times the energy density, we can make a battery half the size, but that still lasts the same amount of time, as a lithium ion battery. Or we can make a battery the same size as a lithium ion battery, but now it will last twice as long," says Dr Hu, who co-invented the battery at MIT and is now CEO of SolidEnergy.

The battery essentially swaps out a common battery anode material, graphite, for very thin, high-energy lithium-metal foil, which can hold more ions – and, therefore, provide more energy capacity. Chemical modifications to the electrolyte also make the typically short-lived and volatile lithium metal batteries rechargeable and safer to use. Moreover, the batteries are made using existing lithium ion manufacturing equipment, which makes them scalable, says MIT.

**SolidEnergy's lithium battery: third-generation technology.**




In October 2015, SolidEnergy demonstrated the first-ever working prototype of a rechargeable lithium metal smartphone battery with double energy density, which earned it more than US$12 million from investors. At half the size of the lithium ion battery used in an iPhone 6, it offers 2.0 amp hours, compared with the lithium ion battery's 1.8 amp hours.

SolidEnergy plans to bring the batteries to smartphones and wearables in early 2017, and to electric cars in 2018. But the first application will be drones, coming this November.

Putting these new batteries in electric vehicles as well could represent "a huge societal impact," Dr Hu says.

"Industry standard is that electric vehicles need to go at least 200 miles (322 kilometres) on a single charge. We can make the battery half the size and half the weight, and it will travel the same distance, or we can make it the same size and same weight, and now it will go 400 miles on a single charge."

## GRAPHENE CABLE TECHNOLOGY COULD CUT POWER COSTS

University of NSW technology that promises to cut power costs and greenhouse gas emissions by improving electricity transmission will be developed in Australia following the official opening of the new UNSW and Hangzhou Cable Joint Laboratory.

The $10 million laboratory will develop a prototype of the new graphene-based cable technology that overcomes persistent electricity leakage that plagues conventional power cable and grids, to deliver significant savings in electricity and resulting reductions in costs and emissions.

The new technology was invented by a UNSW research team led by materials scientist Professor Sean Li.

The project is the first to be unveiled as part of the new Torch Innovation Precinct at UNSW, which brings together world-class UNSW-led research teams and Chinese businesses and industries with the capital, capacity and market access needed to translate Australian research into high-impact new products, processes and services. Modelled on China's highly successful Torch program that promotes the co-location of businesses, universities and research organisations within dedicated science and technology parks to drive innovation, the Torch precinct at UNSW is the first outside China.

*Opening the UNSW and Hangzhou Cable Joint Laboratory.*

"The impact on the electricity sector, in terms of financial savings and environmental gains, would be profound," the Director General of China's Torch program, Mr Zhihong Zhang, said of the potential of the new cables.

The Hangzhou Cable Co is one of China's leading state-owned manufacturers. The commercialisation and application of the UNSW technology could save some 275 terawatt hours of power a year across China alone – more than Australia's entire annual energy consumption.

A 10-metre-long prototype cable will be developed in Australia before a planned scale-up to industrial trials and application in China.

Since 1988, China has developed 150 Torch precincts nationwide that now generate some seven per cent of GDP, 10 per cent of industrial output and 16 per cent of export value.

PHOTO: STUART HAY, ANU

*ANU researcher Felix Venn on the solar thermal dish.*

# ANU claims solar thermal world record

**Scientists at The Australian National University (ANU) have claimed a world record for efficiency for a solar thermal dish generating steam that could be used for power stations.**

The team says it designed and built a new receiver for the solar concentrator dish at ANU, halving losses and achieving a 97 per cent conversion of sunlight into steam – a breakthrough that could lead to the generation of cheaper baseload electricity from renewable energy and help lower carbon emissions which cause global warming.

"When our computer model told us the efficiency that our design was going to achieve, we thought it was alarmingly high," said Dr John Pye, from the ANU Research School of Engineering. "But when we built it and tested it, sure enough, the performance was amazing."

Concentrating solar thermal systems use reflectors to concentrate sunlight and generate steam, which can drive conventional power station turbines. It can be combined with efficient heat storage systems and can supply power on demand at a significantly lower cost than solar energy from photovoltaic panels that has been stored in batteries.

The global concentrating solar thermal capacity has grown by a factor of 10 in the past decade, with some of the largest installations in Spain, the US and South Africa.

At 500 square metres, the ANU solar concentrator is the largest of its kind in the world. It focuses the power of 2100 suns onto the receiver, through which water is pumped and heated to 500ºC.

The new receiver design is a cavity that resembles a top hat with narrow opening and a wide brim. Water pipes spiral around the underside of the brim and up into the hat.

The sunlight is focused onto the pipes, heating the water as it enters at the brim and spirals up into the cavity. The water reaches peak temperature in the deepest reaches of the cavity, which minimises heat loss. Heat which does leak out of the cavity can be absorbed by the cooler water around the hat's brim.

## CSIRO LAUNCHES HYBRID ENERGY RESEARCH HUB

CSIRO has launched its Centre for Hybrid Energy Systems, a collaborative facility in Melbourne to research cutting-edge renewable and hybrid energy technologies.

The centre will be a hub for researchers and industry to identify, improve and then tailor energy technologies to meet specific requirements. It will be used to share the benefits of emerging hybrid energy systems with industry and government to maximise the value of local energy sources.

CSIRO Fellow Dr Sukhvinder Badwal FTSE said there was a rapidly growing global demand for hybrid energy systems based on increased availability of renewable and modular power generation and storage technologies such as batteries, fuel cells and household solar.

"These technologies are becoming cost competitive, but the key to greater use is to combine them in connected hybrid systems," Dr Badwal said.

"By doing this, we can offer substantial improvements in performance, reliability of power, flexibility and cost."

The Centre for Hybrid Energy Systems will also provide education, testing and certification services for emerging storage batteries, hydrogen and fuel cell technologies.

*Combining two or more forms of energy generation, storage or end-use technologies, hybrid systems deliver overall cost and efficiency benefits, compared with single-source energy systems. Configurations include renewable or non-renewable energy sources, electrical and chemical energy storage and fuel cells, often connected via a smart grid.*


*CSIRO's new Centre for Hybrid Energy Systems.*

# NEWS

## Collaboration in robotics

**The Commonwealth Bank of Australia, Stockland, the University of Technology Sydney (UTS) and the Australian Technology Network of Universities (ATN) are pioneering technology innovation and research into artificial intelligence through a leading corporate–academic partnership in social robotics.**

They say this partnership will contribute to the growing field of global research in social robotics by identifying opportunities and limitations in human–robot interaction and exploring commercial applications of social robotics across a number of industries.

CBA's Sydney Innovation Lab will be used as a testing environment for students and academics of Australia's leading technology universities to conduct research and development using Chip, a humanoid robot owned by the bank and the only one of its kind in the southern hemisphere.

Professor Mary-Anne Williams FTSE, Director of the Innovation and Enterprise Research Laboratory (The Magic Lab) at UTS, said: "This project is a watershed moment for robotics research in Australia and globally. We're excited to see companies like Stockland and CBA investing in social robotics and opening doors to universities, research institutes and the next generation of robotics students.

"While there are research challenges and risks associated with the broader field of robotics, there are also extraordinary benefits for companies seeking to establish and maintain a leadership position in the disruptive field of social robotics."


*How Chip Candroid works.*

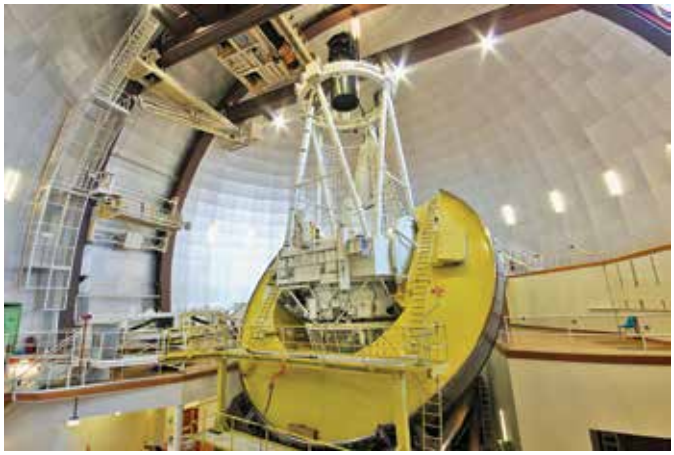


PHOTO: ANGEL LOPEZ-SANCHEZ/AAO

*The Anglo–Australian Telescope at Siding Spring Observatory in NSW.*

## SCOPES SHED LIGHT ON DIFFERENT GALAXY TYPES

Australian scientists have taken a critical step towards understanding why different types of galaxies exist throughout the universe and enabling them to be classified by their physical properties rather than human interpretation of their appearance.

Astronomers note that, for the past 100 years, telescopes have been capable of observing galaxies beyond our own galaxy, the Milky Way. As more galaxies were discovered, astronomers needed a way to consistently group different types of galaxies together. In 1926, American astronomer Edwin Hubble classified galaxies as spiral, elliptical, lenticular or irregular. This 'Hubble sequence' remains the most common way of classifying galaxies, despite its subjectivity hampering identification of the evolutionary pathways followed by different types of galaxies.

Dr Luca Cortese, from The University of Western Australia node of the International Centre for Radio Astronomy Research (ICRAR) – headed by Professor Peter Quinn FTSE – says the world's premier astronomical facilities are now producing surveys consisting of hundreds of thousands of galaxies rather than the dozens that Hubble and his contemporaries were working with.

"We really need a way to classify galaxies consistently using instruments that measure physical properties rather than a time consuming and subjective technique involving human interpretation," he said.

In a study led by Dr Cortese, a team of astronomers used a technique known as Integral Field Spectroscopy to quantify how gas and stars move within galaxies and reinterpret the Hubble sequence as a physically based two-dimensional classification system.

The study involved 488 galaxies observed by the 3.9-metre Anglo–Australian Telescope in NSW and an instrument attached to the telescope called the Sydney-AAO Multi-object Integral-field spectrograph or 'SAMI'.

# NEWS

PHOTO: DAFWA

*Dr Nichols (left), Dr Kaur and Professor Erskine.*

## Decoding clover DNA for better productivity

**Western Australian and Japanese scientists have together cracked the genome sequence of subterranean (sub) clover, which they expect will revolutionise the development of new and improved forage legumes, which underpin WA's $1.8 billion livestock industry.**

The project, led by The University of Western Australia in collaboration with the WA Department of Agriculture and Food, Murdoch University and the Kazusa DNA Research Institute, was funded through the Science and Innovation Award by Australian Department of Agriculture and Water Resources, Meat and Livestock Australia and the Australian Research Council.

Clovers are widely grown around the world as forage legumes for livestock and they add nitrogen to the soil, which assists crop production. Subclover is the most important annual pasture legume in Australia, sown across an estimated 29 million hectares of agricultural land.

UWA molecular biologist Dr Parwinder Kaur said the challenge was not only to determine the sequence of subclover DNA but to understand the genes from a functional point of view.

"The changes provide a breakthrough for breeding of future subclovers, which will increase agriculture production by increasing the health of the soil," she said.

"This work will allow the development of DNA markers that are closely associated with genes controlling traits of interest, which can be used in breeding programs to markedly improve selection efficiency, particularly for traits difficult to measure in the field or glasshouse," said Department senior pasture breeder and UWA Adjunct Associate Professor Phil Nichols.

"Such traits include resistance to redlegged earth mites and important diseases, hardseededness, tolerance to false breaks, early season growth under cool temperatures, phosphorus use efficiency, phtyoestrogen content, methanogenic potential in the rumen, flowering time and other traits related to biomass production."

UWA Centre for Plant Genetics and Breeding Director Professor William Erskine said this understanding of the subclover genome would also aid breeding programs of other important pasture legumes with more complex genomes, such as white and red clovers, annual medics and lucerne.

## TOOLKIT CAN DETECT PLANT VIRUSES

A Plant Biosecurity CRC team is rolling out a plant diagnostic toolkit that can accurately detect plant viruses and viroids in a single test.

"By tapping into the plant's natural defences we are able to detect nearly every known plant virus with much greater accuracy – giving us a test with a very high level of confidence," said Dr Roberto Barrero, project leader from Murdoch University.

The test is based on next-generation small RNA sequencing technologies and is part of a toolkit that provides comprehensive guidance on the new techniques including sample collection, preparation, operating procedures, the informatics analytical environment and screening tools.

The toolkit will be mainly used by post-entry quarantine (PEQ) facilities operated by government quarantine agencies. The Australian Government has already adopted the technology in the toolkit as the new PEQ standard for screening viral pathogens in clonal grasses.

"The new test will significantly reduce the time imported plant material spends in Australia's quarantine system, while improving accuracy of detection," said Mark Whattam, plant pathologist at the new national PEQ Facility at Mickleham, Victoria.

"The toolkit has many benefits for our operations, including improved sensitivity, reduced screening costs and the reduction of manual screening times, which can currently take more than two years.

"It means that imported material such as elite cultivars and breeding lines will be available to Australian plant breeders and nurseries as much as 12 months sooner."

## UK STILL BIGGEST FARM INVESTOR

A September report from the Agricultural Land Register shows foreign investors held 13.6 per cent of all Australian agricultural land at 30 June 2016. The UK is Australia's principal source of investment in agriculture and the preferred means of agricultural investment is through leasehold.

UK investors hold more than 52 per cent of the land held by international investors. The countries with the next largest shares were: the US, Netherlands, Singapore and China, which holds less than half a per cent (0.38 per cent) of Australia's agricultural land.

## POMEGRANATE PLUS IN ALZHEIMER'S

A diet rich in pomegranates had significant positive impacts for the brain health of mice with Alzheimer's disease, an international research team led by UNSW's Centre for Healthy Brain Ageing has found.

UNSW says the study demonstrated that dietary supplementation of four per cent pomegranate extract to a standard diet over a 15-month period resulted in a range of neuroprotective effects in mice.

Bred to provide a model of Alzheimer's disease, the mice demonstrate progressive age-related brain decline linked to the build-up of amyloid-beta (Aβ) protein in the brain. Aβ is the main component of the brain plaques found in Alzheimer's patients and is widely targeted in research seeking to prevent, slow and treat the disease.

Pomegranates contain high concentrations of polyphenols compared to other fruits and vegetables. Naturally occurring in food, polyphenols are compounds with antioxidant properties, which current evidence suggests play an important role in preventing neurodegenerative disease.

# NEWS

## Tobar leads research into superconductivity

**Researchers at the University of Western Australia have shown that 3D-printing can be used to create a resonant microwave cavity via an aluminium-silicon alloy that shows superconductivity when cooled below the critical temperature of aluminium.**

Professor Michael Tobar AM FAA FTSE, an Australian Research Council Laureate Fellow and 2014 Clunies Ross Award winner from UWA's School of Physics, said superconducting cavities were highly useful in many areas of physics, from quantum physics to particle accelerators.

*3D printed from aluminium-silicon alloy.*

Two groups at UWA, one led by Professor Tim Sercombe, an expert in materials and 3D printing, and the other led by Professor Tobar, an expert in engineered quantum systems and novel cavity designs, combined their expertise to explore the superconducting properties of 3D-printed parts.

Professor Tobar said conductivity measured how easily an electrical current flowed through a material, while superconductivity was this measure taken to its extreme.

3D printing is revolutionising many areas of manufacturing and science and particularly 3D printing of metals is being used in fields as diverse as customised medical implants, jet engine bearings and rapid prototyping for the automotive industry.

Most 3D metal printing techniques rely on computer-controlled melting or sintering (a high temperature process for fusing powder together) of a metal alloy powder by a laser or electron beam.

Professor Tobar said the mechanical properties of parts produced by this method had been well studied, but not enough attention had focused on their electrical properties.

"The physics of superconductivity is well understood, and it has been known for decades that aluminium exhibits superconductivity," Professor Tobar said.

"But the 3D printing process relies on aluminium that's far from pure and it undergoes several processes, such as atomisation, laser melting, furnace annealing etc. So we wanted to explore whether a range of known superconducting metals could successfully be 3D printed and retain their desirable electrical property."

## GRANT PROGRAM DRIVES ADVANCED TRAINING TOOLS

Researcher Dr James Zhang from Deakin University's Institute for Intelligent Systems Research and Innovation is working with software company YTEK to develop advanced training tools for surgeons, emergency workers, soldiers and pilots under a new early career researcher grant program.

The grant program, aimed at small and medium-sized businesses (SMEs) is managed by CSIRO and funded through the Science and Industry Endowment Fund (SIEF) STEM+ Business Fellowship program.

YTEK is a Melbourne-based SME developing solutions for simulation and training in the emergency response, defence and aerospace sectors and Dr Zhang is working closely with the company to research machine-learning algorithms that will intelligently monitor and evaluate a trainee's conduct in mission-critical simulations.

Using sensors on training tools, such as manikins, the software will help trainers to assess students in practical training and accreditation, and see individual and group performance.

This was particularly important for medical students in clinical lessons to ensure they had the best education possible, while making the best use of trainer time and education resources, YTEK CEO Richard Yanieri said.

"This is a great opportunity for me to be directly embedded in the business and to use my expertise to help YTEK create a new product," Dr Zhang said. "I've gone from being a researcher to learning about the business environment and it's a really exciting new phase in my career. This new technology is the future for training delivery so I'm pleased to be a part of it."

The project has been facilitated by CSIRO's SME Connect team which links SMEs with researchers to increase productivity and help develop new products and capabilities.

Managed by SME Connect the SIEF STEM+ Business Fellowship program aims to place more than 35 researchers in businesses over the next five years to help create a cohort of industry-savvy early-career researchers.

PHOTO: DEAKIN UNIVERSITY

*(From left) Jason Barkla (CSIRO, SME Connect), Richard Yanieri, Saeid Nahavandi (Director of IISRI), Samer Hanoun (Supervising Researcher, IISRI), Kellie Britt (Simulation Instructor, Deakin School of Medicine) and James Zhang.*

# NEWS

## $34 million for quantum computing research


*The UNSW Quantum Computing team: (from left) Professors Sven Rogge, Andrea Morello, Michelle Simmons and Andrew Dzurak.*

**The University of NSW-headquartered ARC Centre of Excellence for Quantum Computation and Communication Technology, led by Professor Michelle Simmons FAA FTSE, has been awarded $33.7 million in the latest ARC Centre of Excellence grants.**

This will enable it to continue its development of the world's first quantum computer in silicon, expected to provide a strategic advantage in a world where information and information security are of paramount importance.

The Centre will bring together eight Australian universities and more than 35 international partners and end users in the fields of quantum computing and quantum communication.

The Australian Government announced 2017 funding of $283.5 million for nine leading research centres focused on boosting productivity and economic growth.

The ARC Centres of Excellence program is one of the most prestigious government funding schemes, providing resources for up to seven years and bringing together world-class, internationally competitive teams to investigate and find solutions to problems of national priority.

Minister for Education and Training Simon Birmingham said nine programs were picked from nearly 100 detailed applications after an extensive assessment process by independent experts whose selection criteria focused on how the research aligned with Australia's national interest and ensured collaboration across different institutions and with businesses.

"These Centres offer opportunities to make big leaps in the different research fields because they build on previous work, collaborate with partners at home and abroad and are supported by businesses that can see potential commercial value in the outcomes."

Other ARC Centre of Excellence programs funded were:

- Australian Biodiversity and Heritage (Wollongong), $33.75 million;
- Future Low Energy Electronics Technologies (Monash), $33.4 million;
- Engineered Quantum Systems (University of Queensland), $31.9 million;
- Exciton Science (Melbourne), 31.85 million;
- Gravitational Wave Discovery (Swinburne), $31.3 million;
- All Sky Astrophysics in Three Dimensions (Australian National University), $30.3 million;
- Climate Extremes (UNSW), $30.05 million; and
- Population Ageing Research (UNSW), $27.25 million.

## NEW CENTRIFUGE MAKES IT A THREESOME

The University of Western Australia is now home to the only geotechnical modelling facility in the world that operates three centrifuges, after a third 26-tonne, fixed-beam centrifuge was lowered by crane into the new Indian Ocean Marine Research Centre building after arriving from France.

The new facility is part of the National Geotechnical Centrifuge Facility (NGCF) and brings together six Australian universities.

The NGCF is run by the Centre for Offshore Foundation Systems (COFS) – headed by Professor Mark Cassidy FTSE – and aims to service the national and international geotechnical engineering community by developing safe and economical geotechnical structures, notably for the offshore oil and gas and renewable industry.

The centrifuge functions by spinning reduced-scale foundation models at incredible speeds in order to simulate the stresses experienced by the soil at full-scale conditions.

The new centrifuge has a 10-metre diameter and is capable of spinning 2400 kilograms of soil at a G-level of 100, which is a force 10 times greater than an astronaut experiences during training. Results from centrifuge modelling are then applied to full-scale structures and used to help design pipelines, anchors and other offshore infrastructure, at a fraction of the cost and hazard when compared to full-scale testing.

*Installing the new centrifuge.*

# NEWS

## Valuable metals from e-waste

**Professor Veena Sahajwalla FTSE has pioneered an Australian solution to the global e-waste crisis, developing microfactories to turn unwanted electronics into valuable metal alloys.**

The University of NSW pilot micro-factory safely transforms toxic electronic waste (e-waste) into high-value metal alloys – offering a unique low-cost solution to one of the world's fastest-growing waste burdens.

UNSW says Professor Sahajwalla's breakthrough process recovers the considerable wealth of resources embedded in e-waste while overcoming the challenges of toxicity and the often prohibitively high costs of conventional industrial-scale recycling – enabling safe, cost-effective 'mining' of e-waste stockpiles locally, anywhere in the world.

The US$1 trillion global electronics industry generated about 42 million tonnes of obsolete equipment in 2014, a potential loss of some US$52 billion worth of embedded resources, according to a recent United Nations Environment Program report.

Although e-waste contains a range of valuable metals, it is especially challenging to recycle due to the presence of toxins and the complex mix of materials. Currently, large volumes of e-waste are exported from industrial economies like Australia to developing nations, where hand processing to recover metals exposes poor communities to dangerous contaminants.

"The world urgently needs a safe, low-cost recycling solution for e-waste. Our approach is to enable every local community to transform their e-waste into valuable metal alloys, instead of leaving old devices in drawers or sheds, or sending them to landfill," Professor Sahajwalla said.

Professor Sahajwalla uses precisely controlled, high-temperature reactions to produce copper and tin-based alloys from waste printed circuit boards (PCBs), while simultaneously destroying toxins. A programmed drone is able to identify PCBs from within crushed e-waste, and a simple robot is used to extract them, overcoming the risks of contamination, before the PCBs are fed into the furnace.

"A tonne of mobile phones (about 6000 handsets), for example, contains about 130 kilograms of copper, 3.5kg of silver, 340 grams of gold and 140g of palladium, worth tens of thousands of dollars.

"We already understand the value of sourcing green energy from the sun, similarly we can source valuable green materials from our waste. 'Mining' our waste stockpiles makes sense for both the economy and the environment," she said.

PHOTO: PETER MORRIS

*Veena Sahajwalla at UNSW.*

Until now, safe e-waste processing has been restricted to high-cost industrial-scale facilities with very large furnaces, leaving many communities across Australia, and around the world, without a viable solution. CleanUp Australia estimates almost 90 per cent of the four million televisions and three million computers Australians buy each year will end up in landfill.

The new micro-factories are suitable for mobile use: they can be set up in containers and transported to waste sites, avoiding the huge costs and emissions of trucking or shipping e-waste over long distances. Likewise, they promise a safe new way for poor communities in developing nations to generate an income from the production of metal alloys.

## OPAL CLOCKS UP 10 YEARS

ANSTO's Open Pool Australian Lightwater (OPAL) has achieved a decade of operation since the nuclear research reactor went critical for the first time, and began producing neutrons through a self-sustaining fission reaction.

The OPAL reactor is a uniquely Australian design that is currently the best of its kind in the world and is the world's first research reactor to use only low enriched uranium fuel and target plates.

"On a daily basis, OPAL feeds millions of neutrons through to a suite of neutron-scattering instruments that can help deepen our understanding of the world around us," said CEO Dr Adi Paterson FTSE – from how we digest rice, to the possibilities for new stronger forms of antibiotics, understanding how batteries obtain and lose their charge and even how welding joins hold up under extreme environments.

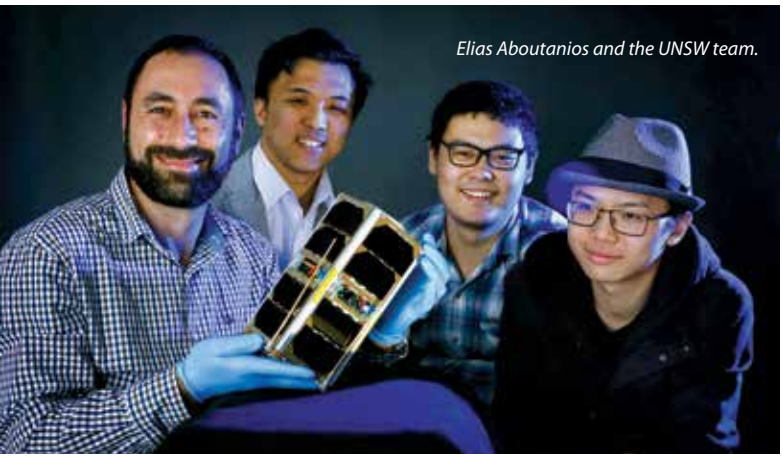

*Adi Paterson cuts the 10-year OPAL cake.*

"Through irradiating samples, OPAL also helps us understand the elemental composition of materials, and is one of the world's major producers of irradiated silicon, an essential part of major green energy sources.

"The most immediate benefit to the average Australian has been through OPAL's role in delivering the base material for over 10,000 patient doses of nuclear medicine that are sent across Australia each week.

"Since OPAL achieved its first sustained nuclear chain reaction, it has produced millions of doses

# NEWS



*Elias Aboutanios and the UNSW team.*

## Australia in swarm of exploration satellites

**Three Australian research satellites will be launched later this year to the International Space Station and deployed into orbit to explore the little-understood region above Earth known as the thermosphere.**

The trio is part of an international mission known as QB50, which will see a swarm of 50 small satellites – known as cubesats and weighing an average of two kilogramss each – carry out the most extensive measurements ever undertaken of the region between 200 and 380 kilometres above Earth.

This is a region vital for communications, weather formation and helps shield Earth from cosmic rays and solar radiation.

The trio are the UNSW Australian Centre for Space Engineering Research (ACSER) UNSW-Ec0, which will study the atomic composition of the thermosphere; INSPIRE-2, a joint project between the University of Sydney, UNSW and the Australian National University, which will measure the electron temperature and density of plasma in the region; and SUSat, a joint project between by the University of Adelaide and the University of South Australia.

All three satellites, along with other QB50 cubesats, will be launched to the International Space Station in December by an Orbital ATK Antares rocket from Wallops Island, Virginia, inside a Cygnus cargo freighter. The cubesats will be deployed from the ISS about a month after arrival, and drift down from the ISS's orbit of 380km toward the target region.

"This is the most extensive exploration of the lower thermosphere ever, collecting measurements in the kind of detail never before tried," said Dr Elias Aboutanios, project leader of UNSW-Ec0 and a senior lecturer at UNSW.

"The satellites will operate for three to nine months – and may last up to a year – orbiting this little-studied region of space, before their orbits decay and they re-enter the atmosphere and burn up."

The QB50 cubesats were built by 48 universities and research institutes from 28 nations, including Canada, China, France, Italy, Korea, the UK and the US.

Each cubesat also carries other instruments with its own engineering and scientific goals. UNSW-Ec0, for example, has three other experiments: a robust computer chip designed to avoid crashing in the harsh radiation of space, as some satellites and space probes are forced to do when hit by cosmic rays; a space-borne GPS to allow satellites to cluster together in swarms; and test a super-reliable computer microkernel in the harsh radiation of space.

In addition, UNSW-Ec0's chassis is made entirely from 3D-printed thermoplastic, itself an experiment to test the reliability of using 3D-printing to manufacture satellites, making them cheaper.

It is the first time an Australian-made satellite has gone into space since FedSat, a 58kg experimental microsatellite satellite, was launched from Japan in 2002.

of nuclear medicine used in the diagnosis and treatment of various cancers, and heart, lung and skeletal conditions."

Dr Paterson said ANSTO had 60 years' expertise in manufacturing and exporting nuclear medicine, 10 with OPAL, and from next year these capabilities would be dramatically enhanced with the ANSTO Nuclear Medicine plant.

"Global demand for potentially lifesaving molybdenum 99 (Mo-99) is increasing, while the reactors capable of supplying it are shutting down, and from next year ANSTO will step up to help fill that gap.

"The $168.8 million project is in the final phases of construction, and will ramp up to a full scale production of 10 million doses a year – 25 per cent of world supply – by the end of 2017."

## SIX IN WORLD TOP 100

Six Australian universities were ranked among the world's top 100 in the 2016-17 QS World University Rankings.

ANU led the pack at 22, followed by Melbourne (42), Sydney (46) UNSW (49), Queensland (51) and Monash (65).

University of WA was out of the top 100 at 102, followed by Adelaide (125) and University of Technology Sydney (193).

The next group was Wollongong (218), Newcastle (245), Macquarie (247), RMIT (252), QUT (276) and South Australia (208).

The next bracket was Curtin (306), Griffith (336), James Cook (340), Deakin (355), Tasmania (370) and La Trobe (386), followed by Swinburne (441) and Bond (461).

The 501–550 rankings included Murdoch, 551–600 covered Charles Darwin, Flinders, Canberra and Western Sydney – followed by Central Queensland (601–650), Victoria (651–700) and Australian Catholic University, Charles Sturt, Elizabeth Cowan, New England and Southern Queensland (all 700+).

In the Times Higher Education World University Rankings for 2016-17, Melbourne topped the Australian list at ranking 33, followed by ANU (47) Queensland (60), Sydney (60), Monash (74) and NSW (78) all in the Top 100.

UWA (125) and Adelaide (142) were in the next bracket, followed by Newcastle and QUT (201–250) and a raft of universities in the 251–300 bracket – Charles Darwin, Deakin, Griffith, James Cook, Macquarie, SA, UTS and Wollongong.

Next came Flinders, La Trobe, Swinburne and Victoria (351–400) followed by Canberra and CQU (401–500).

BY IAN RAE
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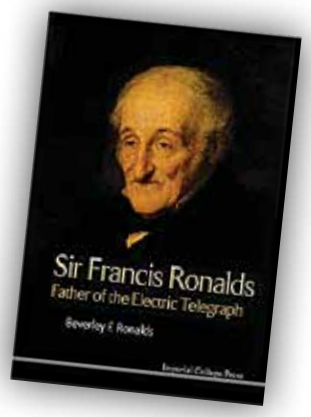
# Admiralty told Ronalds semaphore was fine

**BOOK REVIEW**




*Sir Francis Ronalds: Father of the Electric Telegraph* by Beverley F. Ronalds (Imperial College Press, 2016, xv + 604 pp.).

Dr Ronalds' book is a mine of information about her great-great-great-uncle, who saw that electricity could be used for communication and is accordingly credited with the invention of the electric telegraph.

His device was powered by static electricity and perhaps for this reason Ronalds' name is not as well-known as those of Morse and Wheatstone, who based their telegraphs on electric current.

In addition, when Ronalds offered his telegraph to the British Admiralty in 1816 it was rejected as "wholly unnecessary". Semaphore was fine, thanks very much.

Ronalds (1788–1873) was wealthy as a consequence of belonging to a family of London cheesemongers. He did serve in the business for a few years, but he had no need earn a living and was able to indulge his gift for inventions and scientific studies, all 180 of them, recorded by the author in a table that occupies nine pages.

These included dry piles for generation of electricity (longer-lasting versions of Volta's wet piles), a battery-operated clock, curve-drawing instruments, hinged tripods, adaptations for the lathe (he wrote a book on turning) and recording meteorological instruments – to name but a few.

A lot of effort went into gold-leaf and pith-ball electroscopes that were the detectors in his telegraph, in contrast to the oscillating magnetised needle used in the direct current telegraphs. It was the era of sealing wax and string, so I wasn't totally surprised to find that his atmospheric electricity measuring apparatus included a spirit lamp to prevent condensation on a glass tube and a conducting element made of 'gilt bamboo'.

Not as well-known as the Royal Observatory at Greenwich was another one, at Kew, established in 1768 by King George III.

By 1841 it was disused and empty but the Royal Society rescued it and the British Association for the Advancement of Science took it over. As Honorary Director from 1842 to 1855, Ronalds invented a suite of new instruments and established the observatory as a site of meteorological study.

He was knighted in 1870 after the laying of the trans-Atlantic cable had brought knighthoods to others and belated recognition of Ronalds' pioneering invention. Recognition by the scientific community had come earlier when he was elected a Fellow of the Royal Society in 1844.

In later life Ronalds spent a lot of time on the Continent, visiting sites such as the megaliths at Carnac in western France, but his main interest was in building his library of works on electricity.

On his death the 2000 books were bequeathed to the Society of Telegraph Engineers. Its successor society, the Institution of Electrical Engineers (now the Institution of Engineering and Technology) continued to build the Ronalds Library so that it now occupies five linear kilometres of physical collections and digital resources.

The existence of this massive corpus of Ronalds' papers, plus a collection of letters in Canada, has enabled the author (ATSE Fellow Dr Beverley Ronalds) to dip into them for quotations but in some sections of the book this is overdone (approximately 500 of them!)

## A NEW VIEW OF YOU

'Biomedical Breakthroughs: A New View of You' is the title of a five-month exhibition at Melbourne Museum, which runs until 20 January.

Biomedical Breakthroughs is a science exhibition with a difference. It explores the work of two leading Melbourne-based research organisations, the Walter and Eliza Hall Institute of Medical Research and CSL.

Over 100 years, these two organisations have been breaking new ground across research areas that have changed the world. From pioneering research into antivenoms in the 1920s and 1930s to contemporary research breakthroughs that include a potential vaccine for coeliac disease and a new cancer treatment, the outcomes of these research initiatives are celebrated in this all-new exhibition.

Using large-format projections as well as an interactive cancer molecule spinner – the same technology that researchers use to find weaknesses in a cancerous cell – and a 'space invaders' game that lets audiences target viruses in the immune system, Biomedical Breakthroughs is described as a "stunning new look" at a century of research achievement.

*Sir Francis Ronalds and a friend surveying the ancient standing stones at Carnac in Brittany. Drawn and lithographed using his perspective tracing instrument patented in 1825.*

and it makes for difficult reading.

The occasional quotation to illustrate a point made by the author is fine, but the quotations should not be allowed to carry the story. That's something the biographer should do.

There is also some unevenness in the coverage. For example, there is no explanation of why dry piles work at all, while it seemed unnecessary for us to be told that Euclid was an "ancient Greek mathematician" and Homer an "ancient Greek poet".

This biography of a man who had "more ideas than hours" is extensively documented and illustrated but many of the figures, interesting as they are because they are reproduced from Francis Ronalds' own drawings, lack contrast. I found it hard to make out the details.

Our ATSE colleague has given us, as I introduced it, a mine of information but the mineralogy is complex and the miner/reader needs to work hard to appreciate its riches.

*Professor Ian Rae FTSE, an Honorary Professional 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 served for a decade as a technical adviser to the UN Environment Programme. He is co-editor of the Australian Academy of Science journal* Historical Records of Australian Science.

## MY ANCESTOR WAS A PROLIFIC INVENTOR

On first moving to London in 1980 for postgraduate studies at Imperial College and to gain further engineering experience, I visited the Ronalds Library and Archive at what was then the Institution of Electrical Engineers. Sir Francis Ronalds' books and papers had been bequeathed to the embryonic institution on his death in 1873.

Peeking into his musty journals and sketches I felt I had found a treasure trove and I knew then that I would return to London on my retirement and explore them in detail. I had no idea how much I would learn about my great-great-great-uncle and namesake and his technological and social environment.

My father, another engineer, had told me the story as a child about our ancestor inventing the electric telegraph in 1816 and it being rejected by government as "wholly unnecessary" because they had the semaphore. The bicentenary of that wonderful letter in today's telecommunications era set my research timeline.

At a time when electricity was just a scientific curiosity, Sir Francis had written "Let us have electrical conversazione offices, communicating with each other all over the kingdom… give me materiel enough, and I will electrify the world".

Once I started digging, it became apparent that Ronalds was a prolific inventor, and his notes led me through myriad electrical, mechanical and civil engineering devices to the global atmospheric electricity circuit, archaeology, art, photography, and even his "grand tour".

There were also familiar strains of scientific rivalry and funding difficulties, particularly in his case with the Astronomer Royal, George Airy.

Most descendants of the Ronalds family live in Australia, courtesy of Sir Francis' brother Alfred who migrated to Victoria in 1848. He also made a mark on history, primarily through his classic book *The Fly-fisher's Entomology*.

The family were great adventurers, with other siblings and cousins surrendering their very comfortable English lifestyle to settle in the US Mid-West, Canada and New Zealand.

Sir Francis himself made it as far as the Near East in his travels. He lived long enough to see the electric telegraph reach all these places – Australia was linked to London in 1872. As he mused: "Little did I, in 1817, dream that my electro-telegraphic wires … would make short work of all terrestrial distances and difficulties in so short a period".

*Beverley Ronalds*

I am very fortunate in having a career in academia and industry as a foundation for my project, as well as being able to visit archives around the world to learn more about my ancestor and his achievements.

Today's interconnected world made my plan feasible and I have enjoyed every minute of it

– DR BEVERLEY RONALDS FTSE

# NEWS

*Telehealth nurse showing a patient how to use the home monitoring system.*

## Big savings in health home monitoring

**Australia's first large-scale trial of telehealth, undertaken by CSIRO and partners, has shown that it could save the nation's healthcare system up to $3 billion a year.**

The research trialled telehealth systems with 287 patients over a 12-month period and showed savings of 24 per cent over the year to the healthcare system made through falls in the number and cost of GP visits, specialist visits and procedures carried out.

Test patients were provided with a telehealth device that included participant/clinician video conferencing capabilities, messaging features and the delivery of clinical and study specific questionnaires, as well as vital signs devices to monitor their ECG, heart rate, spirometry, blood pressure, oxygen saturation, body weight and body temperature, with glucometry an optional add-on.

Patients on the trial reported improvements in anxiety, depression and quality of life, with many finding that home monitoring gave them a better understanding of their chronic conditions.

Patients also had a reduced mortality rate of more than 40 per cent.

Telehealth is designed to enable health workers to assess changes in their patients' conditions remotely and provide appropriate care interventions earlier to help them stay out of hospital.

CSIRO lead researcher Dr Rajiv Jayasena said the 12-month trial enabled chronic disease patients to self-manage their conditions at home through the provision of telehealth services.

"Aged patients with multiple chronic diseases, such as cardiovascular disease, diabetes or chronic lung disease account for more than 70 per cent of our health system expenditure," Dr Jayasena said.

"In addition to a 24 per cent savings of Medical Benefits Scheme expenditure over one year, the trial also showed a substantial 36 per cent decrease in hospital admission and most importantly a 42 per cent reduction in length of stay if admitted to hospital during the 12-month trial.

"This is a huge saving when you consider the cost of a hospital bed per day is estimated to be about $2051 in Australia."

More than 500,000 Australians aged over 65 would be good candidates for at-home telemonitoring, Dr Jayasena said.

"Our research showed the return on investment of a telemonitoring initiative on a national scale would be in the order of five to one by reducing demand on hospital inpatient and outpatient services, reduced visits to GPs, reduced visits from community nurses and an overall reduced demand on increasingly scarce clinical resources," he said.

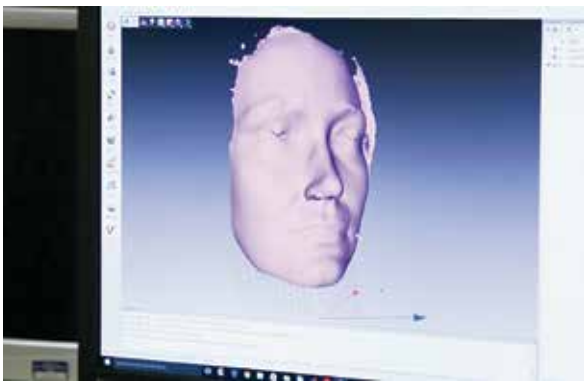
## 3D PREDICTS PLASTIC SURGERY RESULTS

Researchers at The University of Western Australia have produced a new 3D imaging system that will provide patients considering facial cosmetic procedures with an accurate prediction of the results, bettering the 2D photographs that are currently being used by most health practitioners performing cosmetic work.

Professor Mohammed Bennamoun, from UWA's School of Computer Science and Software Engineering, said there was a rising demand for subtle and 'natural' enhancement of personal appearance through cosmetic medical procedures, which was due to many factors including the increasing longevity of the population, more people returning to the workforce and more frequent relationship turnovers.

"Proving these subtle outcomes with confidence can be challenging and currently relies on the use of subjective evaluation of multi-variable 2D photos with predictions of results often deceiving and unreliable for patients," Dr Bennamoun said.

"What we're working on is a 3D system that compares two overlaid images to produce a single and precise evaluation of the actual effects of a cosmetic procedure.



*Facing up to cosmetic changes.*

"The system indicates where the changes have occurred and by how much, in association with a probability-based predictive modelling system to help the patient understand the potential changes before treatment."

The research is a national collaboration led by 3D computer vision expert Professor Bennamoun and includes UWA 3D computer vision researcher Dr Syed Afaq Ali Shah and Dr Michael Molton, a UWA graduate and cosmetic medical practitioner, based in Adelaide.

Dr Molton and his team in Adelaide are running a trial of the first working prototype which demonstrates changes in pre and post-treatment 3D facial scans.

# NEWS

## Mouthguard to help improve sleep

**Brisbane-based Oventus Medical Ltd is taking its new 3D-printed titanium mouthguard to the market to help sleep apnoea sufferers by bypassing airway obstructions.**

Oventus has raised $12 million in a stock exchange listing that will be injected into the commercialisation and distribution of its O2Vent™ sleep apnoea devices.

*The 3D-printed titanium sleep apnoea device.*

Produced in partnership with CSIRO, which 3D-printed the device from titanium at its Lab 22 Innovation Centre in Victoria, the O2Vent™ has successfully completed clinical trials and received FDA clearance, opening up the US market.

The company first approached CSIRO in 2014 when dentist Chris Hart had the idea for a mouthguard with airways that would assist airflow bypass a sleep apnoea sufferer's airway obstructions including from the tongue, soft palate and nose.

The O2Vent™ is a customisable mouthpiece, which is printed to the precise dimensions of a patient's mouth. It ensures optimal airflow during sleep and reduces the effects of snoring and sleep apnoea.

The US Sleep Foundation estimates that 37 million Americans regularly suffer from snoring and the global sleep disorder market is estimated to be worth $50 billion annually. An estimated one million Australians suffer from sleep apnoea.

Lab 22 is one of Australia's leading facilities for metal additive manufacturing and has assisted in world-first medical breakthroughs including 3D-printed body parts for patients in Australia and in Europe.

## NEW HISTORY CLUES IN GREENLAND

Australian researchers have found the world's oldest fossils in a remote area of Greenland, demonstrating that life emerged rapidly during the planet's early history.

The team discovered the 3.7-billion-year-old fossil stromatolites – formations created by communities of ancient microbes – in the world's oldest rocks in the Isua Greenstone Belt along the edge of Greenland's Ice Cap.

The stromatolites, which were exposed by the recent melting of a perennial snow patch, are 220 million years older than stromatolites from the Pilbara region of Western Australia, which were previously regarded as the world's oldest.

The research team says the discovery not only provides greater insight into the early diversity of life on Earth, but could also have implications for our understanding of life on Mars.

PHOTO: JOHN GOLLINGS

*The Hilmer Building.*

## UNSW OPENS HILMER BUILDING

The University of NSW has honoured former Vice-Chancellor Emeritus Professor Fred Hilmer AO by naming its new materials science and engineering research and innovation centre after him.

President and Vice-Chancellor Professor Ian Jacobs said the Hilmer Building would provide staff and students with exceptional research laboratories and flexible collaborative learning spaces, reinforcing UNSW's reputation as a world-leader in the field.

"This amazing building has been designed for Australia's highest ranked materials science school, which sits in the world's top 50," Professor Jacobs said. Earlier this month, the building's research laboratories were recognised with the Educational Architecture Award from the Australian Institute of Architects (NSW).

The Hilmer Building is home to an array of world-class research teams including:

- the Centre for Sustainable Materials Research and Technology (SMaRT Centre), led by ARC Laureate Fellow, Scientia Professor Veena Sahajwalla FTSE; and
- the Mark Wainwright Analytical Centre, named for former Vice- Chancellor Professor Mark Wainwright AM FTSE, which hosts UNSW staff and students, as well as external researchers and industry partners, collaborating on the study of the structure of chemical and physical materials;

Designed by Grimshaw Architects, the building was constructed by Brookfield Multiplex at a cost of $143 million and is the home of the School of Materials Science and Engineering. It links physical and chemical science laboratories and the reconfigurable laboratory system is framed by write-up spaces, offices and meeting rooms that encourage collaboration among teams.

# ATSE PEOPLE

## Ross Large team wins Eureka Prize

*Ross Large and PhD student Indrani Mukerjee examine a sample.*

**A team led by the University of Tasmania's Professor Ross Large FTSE has won the 2016 UNSW Eureka Prize for Excellence in Interdisciplinary Scientific Research.**

Their research has shown that almost every major growth period or extinction in the Earth's history correlates with a change in the amount of the trace element selenium in the ocean – high levels of selenium show growth and low levels indicate extinctions. This research that may change the way we see evolution.

The winning team comprised researchers from the ARC Centre of Excellence at the University of Tasmania, Flinders University, the Russian Academy of Science and the University of California working on the Trace Elements in Past Oceans (TEPO) project.

This is a multidisciplinary research collaboration utilising analytical chemistry, geology, palaeontology, evolutionary biology and toxicology. The project is contributing to a step-change in understanding the connections between plate tectonics, past ocean chemistry and the evolution and extinction of life on Earth.

Their research on the common sulfide mineral pyrite, formed on the seafloor over the past 3.5 billion years, has shown how chemical changes in the ocean, related to the collision of tectonic plates, has driven evolution and extinction of life.

They propose a new theory, that: "Man evolved from the mountains: without plate tectonics and mega-mountains, man, the pinnacle of evolution, would not exist".

Professor Large described the results as "absolutely revolutionary".

The pyrite crystals they analysed recorded the changes in chemistry of ancient oceans, so that the team was able to determine how evolution of bacteria and higher life forms was affected (some scientists say controlled) by ocean trace elements.

They showed that the earliest oceans, more than two billion years old, contained high levels of nickel, cobalt, iron, arsenic and gold, much higher than the modern ocean. They were able to observe the beginnings of life in the oceans; bacteria whose evolution depended on the high levels of nickel and cobalt at this time.

Professor Large said he research added a new dimension to Charles Darwin's theory of evolution, focusing on plate tectonics.

"You might say plate tectonics controls evolution because, indirectly, plate tectonics controls the chemistry of the ocean, and the chemistry of the ocean has a big control on evolutionary pathways."

But Professor Large says Darwin's theory still stands. "It's one of the most important breakthroughs in biology and set evolution on the right path. We're just adding a little background to it; we're taking it back into a geological context."

Professor Large's team used laser beams to analyse just the pyrite in the rock, rather than using the conventional method of core crushing and analysis. "The conventional approach will just not achieve what we've been able to achieve," he said.

### WHAT THE EXPERTS SAY

**Professor Peter Cawood, University of St Andrews**

"To say I was impressed and excited by this body of work would be an understatement. I think the colloquial phrase 'blown away' is more appropriate.

"I truly believe that the research undertaken by Large and his team is defining the way forward in unravelling how the Earth works. The phrase 'leading-edge science' is much overused, but the research by the Tasmanian group is leading and not just following in the footsteps of others.

"Importantly, the research undertaken by Professor Large and co-workers is not the end of the journey but rather a remarkable beginning that provides a new way to view and ultimately understand the evolution of the oceans, atmosphere, and the life they harbour."

**Professor David Rickard, Cardiff University**

"The work of Large's team has set off a wholly new area of enquiry."

**Professor Nicholas Arndt, Institut des Sciences de la Terre, Grenoble**

"A remarkable aspect of the research is that it touches on literally earth-changing events during both the formative part of our planet and in more modern times."

# ATSE PEOPLE

## Andrew Johnson is new Director of Meteorology

**Dr Andrew Johnson FTSE is the new Director of Meteorology, taking up the role on 6 September.**

*Andrew Johnson*

Dr Johnson replaces Dr Rob Vertessy FTSE who retired from the role in April.

Dr Johnson is an internationally recognised leader, manager and scientist who, for nearly a decade, was a member of the CSIRO Executive Team, leading its water, land, atmospheric, marine, biodiversity and urban research. For two years he was CSIRO Executive Director of Strategic Change Programs, with responsibility for implementing shared services for CSIRO's IT, finance and HR functions, as well as implementing the SAP enterprise resource planning system.

Since September 2015 he has been the Principal of Johnson & Associates Consulting, a firm providing environmental and agricultural knowledge services to a diverse range of clients in the private and public sectors both nationally and internationally.

Since 2012, Dr Johnson has been a member of the Australian Government's Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC). He was appointed Chair of the IESC in 2015.

He is a Non-Executive Director of the Planet Ark Environmental Foundation, a Councillor of the Queensland Futures Institute and a member of the Scientific Advisory Board of the Australian Agricultural Company.

He is a former Non-Executive Director of the Rural Industries Research and Development Corporation, Reef and Rainforest Research Pty Ltd and CSIRO Chile, where he was Deputy Chairman and Vice President.

Dr Johnson has served on the Governing Council of the world-renowned International Institute of Applied Systems Analysis in Vienna and as a member International Scientific Advisory Committee of the Great Barrier Reef Foundation.

He has also Chaired the Expert Advisory Council for the Northern Australia Ministerial Forum, been a member of the Prime Minister's Northern Australia Land and Water Task Force and a Governor of the Western Australia Marine Science Institution. He co-Chaired an Australian Government review of environmental performance matters in the Port of Gladstone and the Supervisory Committee of the Australian Centre for Weather and Climate Research and served as a member of the Reef 2050 Advisory Committee.

## FELLOWS DRIVE SMART SENSING NETWORK

Three Fellows are involved in the NSW Government's plan to get hi-tech 'smart sensor' technologies to help address significant challenges – from the environmental impacts of mining and gas extraction to improving quality of life for our ageing population.

The NSW Smart Sensing Network will bring together experts in chemistry, physics, nanotechnology and ICT to craft cutting-edge solutions to problems in agriculture, the environment, health care, minerals and resources, and transport.

The network will be headed by two of the state's most respected researchers: the University of Sydney's Professor Ben Eggleton FAA FTSE, Director of CUDOS (the ARC Centre for Ultrahigh bandwidth Devices for Optical Sensing; and Professor Justin Gooding from the University of NSW.

The two universities have contributed $125,000 each, bringing total investment in the Network to $950,000, including the Government's $700,000.

Dr Susan Pond AM FTSE, company director and Adjunct Professor of the University of Sydney, will chair the Network's Steering Committee.

"This exciting initiative will conduct its work at the cutting edge of several fields of research and at the interfaces between them. The Steering Committee will provide guidance on the strategic direction of the Network and its projects as well as create linkages between academia, industry and government," Dr Pond said.

*Susan Pond*

*Ben Eggleton*

"Researchers, when thrown complex applied problems, are good at breaking them down to identify and solve the underlying fundamental problems," said NSW Chief Scientist and Engineer, Professor Mary O'Kane AC FTSE.

"The Network will initially undertake five pilot projects in agriculture, the environment, health care, mining and gas extraction, and use the considerable R&D capabilities of our public universities to find innovative chemical and physical sensing solutions to a range of problems," Professor O'Kane said.

"By capitalising on the very strong problem-solving abilities of our universities and research organisations we will realise big improvements to our way of life – and that inevitably includes reaping economic wins."

# ATSE PEOPLE

## Gordon Wallace wins Leadership Prize

**Professor Gordon Wallace FAA FTSE, head of the ARC Centre of Excellence for Electromaterials Science (ACES) at the University of Wollongong (UOW), won the 2016 CSIRO Eureka Prize for Leadership in Innovation and Science.**

Professor Wallace is an internationally renowned researcher in the field of electromaterials science and has cultivated a research vision in the area of 'intelligent polymers'.

Through his leadership and ability to inspire, his collaborative team has pioneered the use of nanotechnology and additive fabrication in renewable energy and medical science.

As well as his ACES role, he is Director of the Intelligent Polymer Research Institute, UOW, and Director of the Australian National Fabrication Facility, Materials Node.

Professor Wallace's research interests include organic conductors, nanomaterials and electrochemical probe methods of analysis and the use of these in the development of intelligent polymer systems.

He received the Inaugural Polymer Science and Technology Award from the Royal Australian Chemical Institute (RACI) (1992), the RACI Stokes Medal for Research in Electrochemistry (2004) and the HG Smith Memorial award from the RACI (2008).

He was awarded an ETS Walton Fellowship by the Science Foundation Ireland (2003), named NSW Scientist of the Year (Chemistry) (2008), appointed as a Professor in the World Class University by the South Korean Government (2009), received the SPIE Smart Materials Research Lifetime Achievement Award in the US (March 2009) and was honoured with the 2009 Smart Structures and Materials Lifetime Achievement Award.

He completed his undergraduate (1979) and PhD (1983) degrees at Deakin University and was awarded a DSc from Deakin University in 2000. He was appointed as a Professor at the University of Wollongong in 1990. He was awarded an ARC Professorial Fellowship in 2002; an ARC Federation Fellowship in 2006 and ARC Laureate Fellowship in 2001.

PHOTO: MARK METCALFE/GETTY IMAGES

*Gordon Wallace*

Professor Wallace said his Eureka Prize acknowledged the pioneering work undertaken by his collaborative team in the use of nanotechnology and additive fabrication in renewable energy and medical science.

"This award acknowledges the ability of ACES and its partners to take fundamental discovery to real applications," Professor Wallace said. "It takes an integrated, cohesive and committed team to achieve this."

He thanked the people he has worked with over his 30 years at UOW.

"Thank you to the hundreds of people I've worked with around this country, especially those at ACES and the Australian National Fabrication Facility," Professor Wallace said.

"Thank you also to the community we work for. You can be assured that you have around this country research scientists totally committed not only to discoveries in the lab, but to translating those discoveries to practical outcomes in the most effective and efficient way possible, so that we can all lead better lives."

## MARGARET SHEIL JOINS ANSTO BOARD

*Margaret Sheil*

ATSE Director Professor Margaret Sheil FTSE has been appointed to the Board of the Australian Nuclear Science and Technology Organisation (ANSTO).

Professor Sheil has been Provost of the University of Melbourne since April 2012, and has previously held significant positions across numerous committees, advisory boards and specialist technical institutes.

She was CEO of the Australian Research Council for five years, and prior to that was Deputy Vice-Chancellor (Research), Dean of Science and a Professor of Chemistry at the University of Wollongong.

Professor Sheil joins a distinguished corps of Fellows on the ANSTO Board.

Ms Erica Smyth FTSE, Chair of Toro Energy, is Deputy Chair and Dr Adi Paterson FTSE is CEO.

Dr Paterson said that ANSTO would soon support the world's nuclear medicine supply.

"By the end of next year it will have ramped up to full production, producing some 10 million doses of molybdenum-99 (Mo-99), which is 25 per cent of world supply, annually.

"Nuclear medicine is a cornerstone of medical systems, particularly technetium-99m (Tc-99m), which is derived from molybdenum-99 (Mo-99) and used to diagnose heart, lung and skeletal conditions and a range of cancers.

"In addition, the Australian Synchrotron has joined ANSTO as another research platform, cementing our role as home to much of Australia's landmark science infrastructure and research that is focused on health, environment and supporting Australian industries."

# ATSE PEOPLE

## Henry Muller wins first BHP Billiton award

**SA Division stalwart Mr Henry Muller FTSE has been awarded the inaugural BHP Billiton Technology and Innovation Award for his work in the 1980s that allowed Olympic Dam to become a commercially viable operation making copper, uranium, gold and silver.**

Mr Muller, a former employee, developed a single process flow sheet to mine and process one of the largest, most complex mineral deposits in the world. He was presented with his award in Melbourne.

In recognising his achievement, BHP Billiton Chief Technology Officer Ms Diane Jurgens said she was delighted to present to Mr Muller the inaugural award that recognised outstanding contribution in the field of technology and innovation.

"Mr Muller's process proved that economic benefit could be derived from Olympic Dam and other similar deposit styles. The process flow sheet he created had never been done before. It was a creative and unique application of metallurgical technologies and allowed the company to produce all four products at the one mine site," she said.

"This is an example of how technology can create value by unlocking resources and lowering costs.

"Importantly, Mr Muller's work opened up opportunities for mining of other similar complex ore bodies."

Discovered in 1975, Olympic Dam is the first discovery of an iron oxide-copper-gold-uranium orebody and the largest uranium, fifth-largest copper and third-largest gold deposit in the world.

## BEYOND COAL – NSW SYMPOSIUM

The ATSE NSW Division will hold a one-day symposium in Sydney on 8 November on the future of electricity generation and, in particular, the transition away from coal in a carbon-constrained environment and in a market subject to increasingly disruptive change.

'Beyond Coal - What will power NSW?' will address four key issues:

- demand growth and the key influencing factors, including the rise of consumers who also produce energy;
- the speed with which low-emission technologies can displace coal and the technical challenges in integrating low-carbon sources into the power system;
- the available options for the mix of generation technologies which will support the transition and ensure stability and reliability at least cost; and
- given the investment challenge of up to $70 billion by 2030, on some estimates, who will be willing to invest?

The Symposium will bring together a range of distinguished speakers with unmatched expertise who are well placed to provide fresh insights in an interactive format designed to facilitate discussion, representing AEMO, CSIRO, General Electric, AGL, the NSW Department of Investment and Industry, Transgrid, the Commonwealth Bank of Australia and the Grattan Institute.

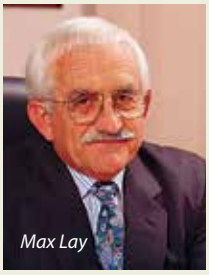
## CHIEF SCIENTIST 'FUELLED BY ATTITUDE'

*Professor Robyn Owens FTSE, Deputy Vice-Chancellor (Research), University of Western Australia, addresses an Australia–Israel Chamber of Commerce (WA) event in Perth in July, supported by ATSE's WA Division. Australia's Chief Scientist Dr Alan Finkel AO FAA FTSE was the keynote speaker. His topic for the event – part of the AICC Technology Series of sundowner events – was 'Fuelled by attitude'. ATSE Fellows attending included Professor Lyn Beazley AO FTSE, Dr Erica Smyth FTSE, Professor Michael Tobar FTSE, Dr Denise Goldsworthy FTSE, Professor Adrian Egan FTSE and Professor Alison Ord FTSE.*

# ATSE PEOPLE

## Max Lay 'kindles' interest *With Power and Purpose*

**Dr Max Lay AM FTSE, internationally recognised for his road transport expertise, has recently placed his new book, *With Power and Purpose*, on Kindle.**


*Max Lay*

Dr Lay says he was led to write the 442-page book as he prepared an international review paper on the factors that had influenced road development in the 20th century, "drawing somewhat glibly on the 19th century legacy that provided the basis for most of those 20th century" events.

The question that increasingly came to his mind was how that creative 19th century legacy had arisen. How did transport reach the transformative stage that it did at the end of the 19th century – so many changes, so many new technologies, so many new markets?

He came to realise the astonishing extent of the transport changes that had occurred during the 19th century. Nothing like it had occurred before, he found, and the 20th century was mere incrementalism compared with the quantum changes of the 19th century.

He realised that there might be a story to uncover and to use to shed more light on our transport inheritance – where did all the 19th century's key transport features come from and why are there so many inventions, innovations, inconsistencies and illogicalities in that story?

*With Power and Purpose: How 19th century transport innovators totally changed the way the world operates* is his attempt to tell that story and to understand the origins of much of our current transport world.

Interested readers can download the book to their Kindle or similar device for $3.96.

## JOHN BEYNON MOVES TO FLINDERS

Professor John Beynon FREng FTSE has joined Flinders University as its new Executive Dean of the Faculty of Science and Engineering,

Professor Beynon graduated from the University of Sheffield with a Bachelor of Metallurgy degree (in physical metallurgy) followed by a PhD in the same department. After postdoctoral study at the Max Planck Institute for Ferrous Research in Düsseldorf, Germany, he took up a lectureship and senior lectureship at the University of Leicester before rejoining Sheffield as a Professor, and later Head, of Mechanical Engineering. He moved to Australia as Dean of Engineering at Swinburne University of Technology in 2005 and became the University of Adelaide's Executive Dean of the Faculty of Engineering, Computer and Mathematical Sciences in 2012.

A former President of the Australian Council of Engineering Deans, Professor Beynon was Chair of the Global Engineering Deans Council for more than two years until December 2015. He has been listed in Engineers Australia's Top 100 Most Influential Engineers in Australia for 2011–15, and last year was awarded the Bessemer Gold Medal in the UK for services to the steel industry.


*John Beynon*

## SRITAWAT KITIPORNCHAI ELECTED TO EASA

UQ civil engineering researcher Professor Sritawat Kitipornchai FTSE has become only the fifth Australian elected to the European Academy of Sciences and Arts (EASA). EASA embraces seven disciplines, from humanities to world religion. Professor Kitipornchai has been invited to receive his honour at the Plenary Session of the EASA meeting in Salzburg, in March.

Professor Kitipornchai's pioneering structural engineering research has drawn accolades worldwide. It gave engineers a comprehensive understanding of structural characteristics and led to new practices and procedures in building design.

He is co-author of *Design of Portal Frame Buildings*, which is widely referenced in engineering internationally.

Professor Kitipornchai and his UQ colleague Associate Professor Faris Albermani gained worldwide recognition for their work in establishing accurate modelling for predicting the behaviour of electricity transmission towers. This work earned them the coveted Munro Prize in 1992.

"It is very hard to calculate the failure load for these structures, and for decades engineers had resorted to full-scale testing," Professor Kitipornchai says. "At the time of this research, no numerical modelling existed to predict the full range of nonl-inear load-carrying capacity for these structures."

The model is now considered a standard by large utility companies in Australia, New Zealand, the UK and elsewhere.

Professor Kitipornchai is recognised for his work in advanced composites and nanomaterials, holds two patents, and has authored eight books, eight book chapters and 320 journal papers.


*Sritawat Kitipornchai*